

GEOTECHNICAL ENGINEERING STUDY
PROPOSED ICE RINK
YAMAGUCHI PARK
PAGOSA SPRINGS, COLORADO

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Table of Contents

1.0 REPORT INTRODUCTION	1
1.1 Proposed Construction	2
2.0 FIELD STUDY	2
2.1 Site Description and Geomorphology	2
2.2 Subsurface Soil and Water Conditions	2
3.0 LABORATORY STUDY	5
4.0 FOUNDATION RECOMMENDATIONS.....	5
4.1 Deep Foundation System Concepts	6
4.1.1 Micropiles	6
4.2 Shallow Foundation System Discussion	8
5.0 RETAINING STRUCTURES.....	8
6.0 SUBSURFACE DRAIN SYSTEM	9
7.0 CONCRETE FLATWORK	11
7.1 Interior Concrete Slab-on-Grade Floors.....	11
7.1.1 Capillary and Vapor Moisture Rise.....	12
7.1.2 Slab Reinforcement Considerations.....	13
7.2 Exterior Concrete Flatwork Considerations.....	13
7.3 General Concrete Flatwork Comments.....	14
8.0 CONSTRUCTION CONSIDERATIONS.....	15
8.1 Fill Placement Recommendations.....	15
8.1.1 Subgrade Soil Stabilization.....	16
8.1.2 Embankment Fill on Slopes	17
8.1.3 Natural Soil Fill.....	18
8.1.4 Granular Compacted Structural Fill	18
8.1.5 Deep Fill Considerations	19
8.2 Excavation Considerations.....	20
8.2.1 Excavation Cut Slopes	20
8.3 Utility Considerations	20
8.4 Exterior Grading and Drainage Comments.....	21
8.5 Landscaping Considerations	21
8.6 Soil Sulfate and Corrosion Issues	22
8.7 Radon Issues	23
8.8 Mold and Other Biological Contaminants	23
9.0 CONSTRUCTION MONITORING AND TESTING	23
10.0 CONCLUSIONS	24
11.0 LIMITATIONS	24
FIELD STUDY RESULTS.....	Appendix A
Log of Test Borings	
LABORATORY TEST RESULTS	Appendix B
Sieve and Atterberg Limit Test Results	
Swell-Consolidation Test Results	

1.0 REPORT INTRODUCTION

This report presents our geotechnical engineering recommendations for the proposed Sheltered Ice Rink to be located at Yamaguchi Park. This report was requested by James Dickhoff and was prepared in accordance with our proposal dated June 5, 2023, Proposal No. 23227P.

As outlined within our proposal for services for this project the client is responsible for appropriate distribution of this report to other design professionals and/or governmental agencies unless specific arrangements have been made with us for distribution.

Geotechnical engineering is a discipline which provides insight into natural conditions and site characteristics such as; subsurface soil and water conditions, soil strength, swell (expansion) potential, consolidation (settlement) potential, and often slope stability considerations. The information provided by the geotechnical engineer is utilized by many people including the project owner, architect or designer, structural engineer, civil engineer, the project builder and others. The information is used to help develop a design and subsequently implement construction strategies that are appropriate for the subsurface soil and water conditions, and slope stability considerations. We are available to discuss any aspect of this report with those who are unfamiliar with the recommendations, concepts, and techniques provided below.

This geotechnical engineering report is the beginning of a process involving the geotechnical engineering consultant on any project. It is imperative that the geotechnical engineer be consulted throughout the design and construction process to verify the implementation of the geotechnical engineering recommendations provided in this report. Often the design has not been started or has only been initiated at the time of the preparation of the geotechnical engineering study. Changes in the proposed design must be communicated to the geotechnical engineer so that we have the opportunity to tailor our recommendations as needed based on the proposed site development and structure design.

The following outline provides a synopsis of the various portions of this report;

- ❖ Sections 1.0 provides an introduction and an establishment of our scope of service.
- ❖ Sections 2.0 and 3.0 of this report present our geotechnical engineering field and laboratory studies
- ❖ Sections 4.0 through 7.0 presents our geotechnical engineering design parameters and recommendations which are based on our engineering analysis of the data obtained.
- ❖ Section 8.0 provides a brief discussion of construction sequencing and strategies which may influence the geotechnical engineering characteristics of the site. Ancillary information such as some background information regarding soil corrosion and radon considerations is also presented as general reference.
- ❖ Section 9.0 provides our general construction monitoring and testing recommendations.
- ❖ Sections 10.0 and 11.0 provides our conclusions and limitations.

The data used to generate our recommendations are presented throughout this report and in the attached figures.

All recommendations provided within this report must be followed in order to achieve the intended performance of the foundation system and other components that are supported by the site soil.

1.1 Proposed Construction

Architectural details and grading plans were not available at the time of this report. We understand the proposed construction will likely be a sheltered ice rink with post-tension, slab-on-grade concrete floors and supported by a steel reinforced concrete foundation system. Grading for the structure is assumed to be relatively minor with cuts of approximately 3 to 5 feet below the adjacent ground surface. We assume relatively light foundation loadings, typical of the proposed type of construction.

When final building location, grading and loading information have been developed, we should be notified to re-evaluate the recommendations presented in this report

2.0 FIELD STUDY

2.1 Site Description and Geomorphology

At the time of our exploration, the lot is currently used as a storage/lay down yard for the public works department of Pagosa Springs. Based on review of historical imagery, we understand the sewer lagoons for the Town of Pagosa Springs previously occupied the site and has since been filled in for the current use. The historical imagery is presented in Figure 2 below with our approximate test boring locations. The lot is relatively flat and has a steep drop off into the wetlands to the east of the proposed building location. There is minor vegetation at the location of the sheltered ice rinks, but wetlands and cotton woods are located to the east of the designated rink location. The lot is bordered by Yamaguchi Park to the north, Pagosa Springs High School to the west, the San Juan River to the east, and a vacant lot to the south.

2.2 Subsurface Soil and Water Conditions

We advanced five test borings in the vicinity of the proposed structure. A schematic showing the approximate boring locations is provided below as Figure 1. The logs of the soils encountered in our test borings are presented in Appendix A.



Figure 1: Locations of Exploratory Borings. Adapted from Archuleta County GIS.



Figure 2: Approximate Locations of Exploratory Borings on the historical imagery dated 9/16/1995. Adapted from Google Earth.

The schematic presented above was prepared using notes and field measurements obtained during our field exploration and is intended to show the approximate test boring locations for reference purposes only.

The subsurface conditions encountered in our test borings consisted of various soils and depths between the test bores (TB). TB-1 consisted of sandy lean clay fill material (CL) down to 10 feet, where the soils transitioned into a clayey gravel with sand and cobble (GC). Beneath the GC material, we encountered poorly graded gravel with sand and cobble (GP) at 16 feet and had auger refusal on cobble at 16½ feet. TB-2 and TB-2A soils consisted of GC fill material in the top 8 inches, followed by CL soils to 2 feet, which transitioned to GC material again, and auger refusal on cobble at 2 and 3 feet, respectively. TB-3 consisted of 8 inches of GC fill material, followed by CL soils down to a depth of 4½ feet. Beneath the CL material we encountered GP material, and experienced auger refusal at 5 feet. TB-4 subsurface conditions consisted of GC fill material down to a depth of 8 feet, where it transitioned in CL soils. Beneath the CL material we encountered GC material and had auger refusal at 15 feet.

We did encounter free subsurface water in test borings TB-1 at 9½ feet and TB-4 at 10 feet at the time of the advancement of our test borings on the project site. We suspect that the subsurface water elevation and soil moisture conditions will be influenced by snow melt and/or precipitation and local irrigation. Additional hydrological influences may be dependent on increasing or decreasing discharge levels from the San Juan River.

The logs of the subsurface soil conditions encountered in our test borings are presented in Appendix A. The logs present our interpretation of the subsurface conditions encountered in the test borings at the time of our field work. Subsurface soil and water conditions are often variable across relatively short distances. It is likely that variable subsurface soil and water conditions will be encountered during construction. Laboratory soil classifications of samples obtained may differ from field classifications.

3.0 LABORATORY STUDY

The laboratory study included tests to estimate the strength, swell and consolidation potential of the soils tested. We performed the following tests on select samples obtained from the test borings. The laboratory test results are provided in Appendix B.

- Moisture Content and Dry Density
- Sieve Analysis (Gradation)
- Atterberg Limits, Liquid Limit, Plastic Limit and Plasticity Index
- Swell Consolidation Tests

A synopsis of some of our laboratory data for some of the samples tested is tabulated below.

Sample Designation	Percent Passing #200 Sieve	Atterberg Limits LL/PI	Moisture Content (percent)	Dry Density (PCF)	Estimated Load-Back Swell Pressure (PSF)	Swell or Consolidation Potential
TB-1 @ 2'	-	-	15.8	116.1	270	0.2 (% under 100 psf load)
TB-1 @ 1'-2'	77	54/34	17.3	-	-	-
TB-4 @ 4'	-	-	19.8	105.6	730	0.1 (% under 500 psf load)

***NOTES:**

1. We determine the swell pressure as measured in our laboratory using the graphically estimated load-back swell pressure method.
2. * = Swell-Consolidation test performed on remolded sample due to rock content. Test results should be considered an estimate only of the swell or consolidation potential at the density and moisture content indicated.

4.0 FOUNDATION RECOMMENDATIONS

There are two general types of foundation system concepts, “deep” and “shallow”, with the designation being based on the depth of support of the system. We have provided a discussion of viable foundation system concepts for this project below. The choice of the appropriate foundation system for the project is best made by the project structural engineer or project architect. We should be contacted once the design choice has been made to provide consultation regarding implementation of our design parameters.

Due to the presence of previously placed fill material, we recommend the structure be supported by a deep foundation system. Deep foundations will provide for the least likelihood of post-construction movement of the structure. A shallow foundation system or a post-tension slab foundation would need to include over-excavation through the existing fill material, followed by placement of compacted structural fill.

4.1 Deep Foundation System Concepts

Deep foundation system design concepts will provide the least likelihood of post-construction movement associated with volume changes within the soil. Due to the existing fill material, we recommend that a shallow foundation system be avoided unless the owner is willing to accept the risk of foundation movement and associated damage to the structure. Deep Foundation System Concepts Discussed below include:

- Micropiles

Regardless of the type of deep foundation system concept utilized, the system design must include provisions to isolate and structurally support and building components, including flatwork, that may be influenced by volume changes within the site soil. Grade beams are utilized with most deep foundation system design concepts to facilitate isolation and structural support of various building elements. Grade beams, and any other horizontal component of a deep foundation system must be isolated from the support soil with void forms, or similar concept.

The elevation of the existing ground surface at our test boring locations at the time the borings were advanced should be established as part of the design process for deep foundation systems for this project. It is critical that the depths to various strata delineated in our test borings logs can be correlated to final project elevations.

4.1.1 Micropiles

A micro-pile design is a viable alternative for support of the proposed structure. An experienced micro-pile/soil nail anchor contractor with in-house engineering design service licensed in the State of Colorado should be contacted for the installation and to assist in the structural design of the micro-pile elements and potential soil nail anchors that may be needed to resist lateral forces acting on the foundation system. Our preliminary design recommendations for a micro-pile foundation system are provided below.

- Based on our limited field data to date, we recommend that an ultimate grout to soil bond capacity in the native soils of about 2,500 pounds per square foot be assumed; therefore, an allowable grout to soil bond capacity of about 1,000 pounds per square foot (factor of safety of 2.5) should be used for the initial project design. The grout to soil bond capacity may be considered valid for both tensional and compressive capacity. It is possible that higher strength soil materials, and therefore, higher grout to soil bond capacities will be encountered in some areas of the project. The actual grout bond capacity must be established from verification tests that are performed on sacrificial micropiles (discussed in more detail below).

- Due to the fill material, the upper 10 feet of the grouted bond from the pile surface should be discounted for contribution to the total capacity of the pile. Please contact us if additional capacity is desired, as we are available to perform pull-out tests on sacrificial piles during the design of the foundation system.
- For micro-pile groups, no reduction in the allowable capacity for the individual piles will be necessary for individual piles spaced greater than 6 pile diameters center-to-center. A reduction factor of 0.65 for each individual pile should be assumed for piles spaced as close as 2.5 pile diameters center-to-center. The reduction factor for piles spaced between 6 and 2.5 pile diameters center-to-center may be interpolated between the reduction factors provided above. The micro-piles should not be spaced closer than 2.5 pile diameters center-to-center.
- A minimum pile length of at least 20 feet should be assumed for the initial project design and project budgeting purposes. The final micropile length will be influenced by the required load capacity of the individual micropiles.
- The recommended minimum pile diameter is 4 inches. For design purposes, 6 inch piles are most common in this area.
- We do not recommend accounting for any lateral resistance for uncased micropiles. Lateral forces should be resolved with battered or heavy section steel cased micropile components.
- If hollow bar “injection-type” micropiles are used the volume of grout, or “grout take” should be measured and monitored during the installation process to ensure that the effective bond diameter is achieved.
- If open-hole micropiles are constructed centralizers should be utilized to ensure that the tendon is maintained in the central portion of the micropile grout.
- Void forms are not required for under the grade beams and slab.
- We recommend that the grout used for the micropiles develop a minimum compressive strength of at least 5,000 pounds per square inch within 7 days of placement. The micropiles should not receive loads that will cause failure between the grout-tendon interface, or the grout-soil interface at any time during construction or after completion of the foundation system.
- We recommend that several test piles be installed to obtain the actual grout to soil bond resistance. We are available to assist with the testing and location of test piles as the project progresses.
 - We recommend that verification tests be performed on at least two sacrificial micropiles at each structure location to determine the actual ultimate grout bond capacity for the micropiles. The installed length of the sacrificial test piles should be calculated such that failure of the micropile occurs prior to 80 percent of the yield capacity of the steel reinforcement.
 - We recommend that a minimum of 10 percent of the production piles be proof tested to at least 1.6 times the calculated needed design load of the micropiles. The actual number of proof tests on production piles will be somewhat dependent on the layout of the structure and orientation of the micropiles (such as battered piles to resist shear forces). We are available to assist with the development of a testing schedule as the project design progresses.

4.2 Shallow Foundation System Discussion

Subsurface data indicate that existing man-placed fill will likely be the predominant soil type encountered beneath shallow foundations. Based on the laboratory analysis, the soils encountered in our borings were found to have a low swell potential. Due to the presence of previously placed fill material, the anticipated soils at the foundation level are considered poor for shallow foundation support. Deep foundation system design concepts which include isolation of shallow components including floor systems from shallow soils are less likely to experience post-construction movement due to volume changes in the site soil. We recommend that a shallow foundation system be avoided unless the owner is willing to accept the risk of foundation movement outside of recommended tolerances.

5.0 RETAINING STRUCTURES

We understand that laterally loaded walls will be constructed as part of this site development. Lateral loads will be imposed on the retaining structures by the adjacent soils and, in some cases, additional surcharge loads will be imposed on the retained soils from vehicles or adjacent structures. The loads imposed by the soil are commonly referred to as lateral earth pressures. The magnitude of the lateral earth pressure forces is partially dependent on the soil strength characteristics, the geometry of the ground surface adjacent to the retaining structure, the subsurface water conditions and on surcharge loads.

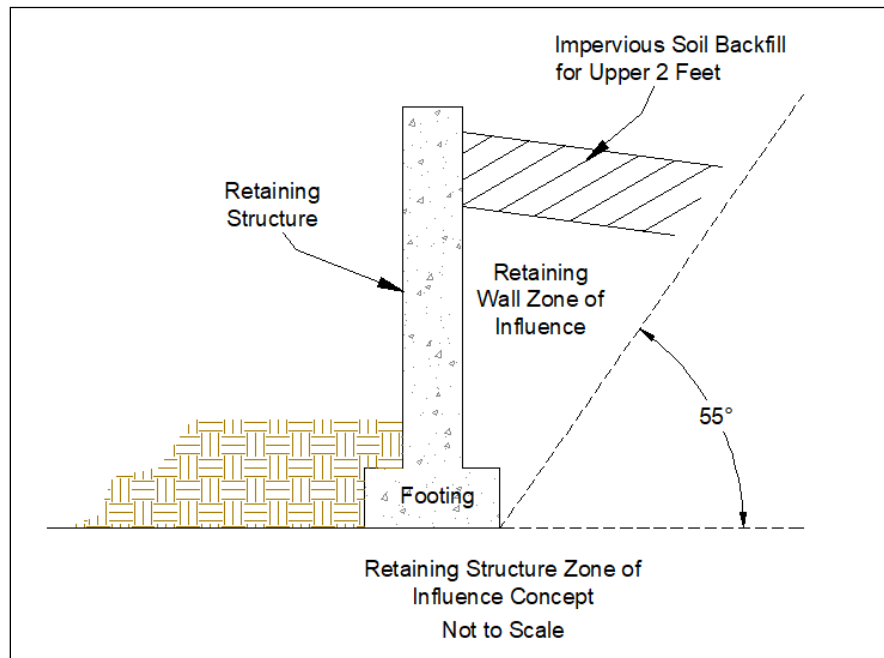
We do not recommend that the site soils be used for retaining wall backfill. The retaining walls may be designed using the lateral earth pressure values for imported granular soil that are tabulated below.

Type of Lateral Earth Pressure	Level Granular Soil Backfill (pounds per cubic foot/foot)
Active	35
At-rest	55
Passive	460
Allowable Coefficient of Friction	0.45

The granular soil that is used for the retaining wall backfill may be permeable and may allow water migration to the foundation support soils. There are several options available to help reduce water migration to the foundation soils, two of which are discussed here. An impervious geotextile layer and shallow drain system may be incorporated into the backfill, as discussed in Section 9.5, Landscaping Considerations, below. A second option is to place a geotextile filter material on top of the granular soils and above that place about 1½ to 2 feet of moisture conditioned and compacted site clay soils. It should be noted that if the site clay soils are used volume changes may occur which will influence the performance of overlying concrete flatwork or structural components.

The values tabulated above are for well drained backfill soils. The values provided above do not include any forces due to adjacent surcharge loads or sloped soils. If the backfill soils become saturated the imposed lateral earth pressures will be significantly higher than those tabulated above.

The granular imported soil backfill values tabulated above are appropriate for material with an angle of internal friction of 35 degrees, or greater. The granular backfill must be placed within the retaining structure zone of influence as shown below in order for the lateral earth pressure values tabulated above for the granular material to be appropriate.



If an open graded, permeable, granular backfill is chosen it should not extend to the ground surface. Some granular soils allow ready water migration which may result in increased water access to the foundation soils. The upper few feet of the backfill should be constructed using an impervious soil such as silty-clay and clay soils from the project site, if these soils are available. The 55 degree angle shown in the figure above is approximately correct for most clay soils. The angle is defined by $45 + (\phi/2)$ where “ ϕ ” is the angle of internal friction of the soil.

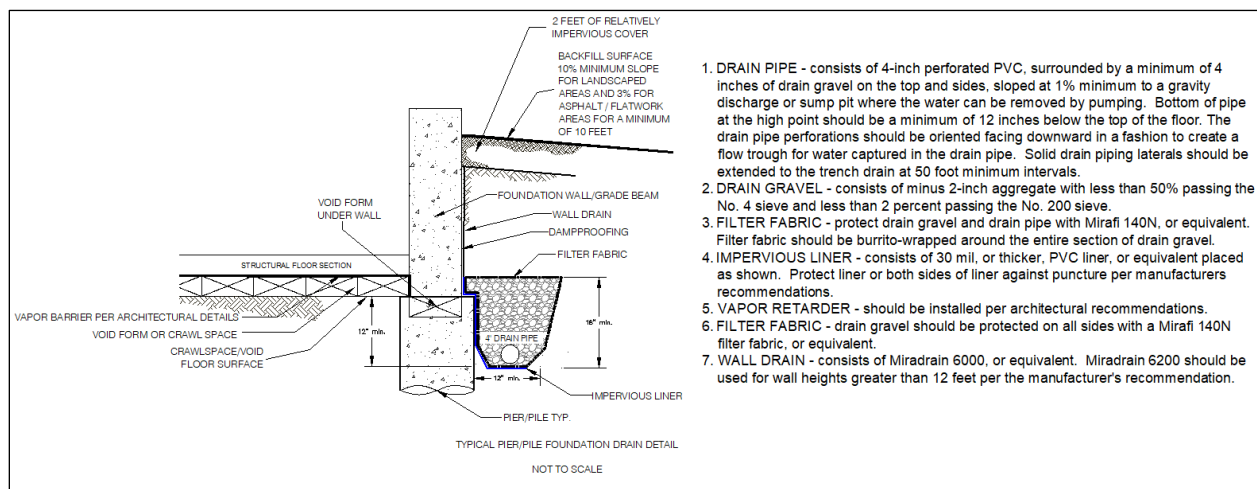
Backfill should not be placed and compacted behind the retaining structure unless approved by the project structural engineer. Backfill placed prior to construction of all appropriate structural members such as floors, or prior to appropriate curing of the retaining wall concrete, may result in severe damage and/or failure of the retaining structure.

6.0 SUBSURFACE DRAIN SYSTEM

We recommend below-grade construction, such as retaining walls, crawlspace and basement areas, be protected from wetting and hydrostatic pressure buildup by an underdrain and wall drain system. Exterior retaining structures may be constructed with weep holes to allow subsurface water migration through the retaining structures. Topographic conditions on the site may influence the ability to install a subsurface drain system which promotes water flow away from the foundation system. The subsurface drain system concept is discussed under the Subsurface Drain System section of this report below.

A drain system constructed with a free draining aggregate material and a 4 inch minimum diameter perforated drain pipe should be constructed adjacent to retaining structures and/or adjacent to foundation walls. The drain pipe perforations should be oriented facing downward. The system should be protected from fine soil migration by a fabric-wrapped aggregate which surrounds a rigid perforated pipe. We do not recommend use of flexible corrugated perforated pipe since it is not possible to establish a uniform gradient of the flexible pipe throughout the drain system alignment. Corrugated drain tile is perforated throughout the entire circumference of the pipe and therefore water can escape from the perforations at undesirable locations after being collected. The nature of the perforations of the corrugated material further decreases its effectiveness as a subsurface drain conduit.

The drain should be placed at each level of excavation and at least 12 inches below lowest adjacent finish floor or crawlspace grade. The drain system pipe should be graded to surface outlets or a sump vault. The drain system should be sloped at a minimum gradient of about 2 percent, but site geometry and topography may influence the actual installed pipe gradient. Water must not be allowed to pool along any portion of the subsurface drain system. An improperly constructed subsurface drain system may promote water infiltration to undesirable locations. The drain system pipe should be surrounded by about 2 to 4 cubic feet per lineal foot of free draining aggregate. If a sump vault and pump are incorporated into the subsurface drain system, care should be taken so that the water pumped from the vault does not recirculate through pervious soils and obtain access to the basement or crawl space areas. An impervious membrane should be included in the drain construction for grade beam and pier systems or other foundation systems such as interrupted footings where a free pathway for water beneath the structure exists. A generalized subsurface drain system concept is shown below.



There are often aspects of each site and structure which require some tailoring of the subsurface drain system to meet the needs of individual projects. Drain systems that are placed adjacent to void forms must include provisions to protect and support the impervious liner adjacent to the void form. We are available to provide consultation for the subsurface drain system for this project, if desired.

Water often will migrate along utility trench excavations. If the utility trench extends from areas above the site, this trench may be a source for subsurface water within the proposed basement or crawl space. We suggest that the utility trench backfill be thoroughly compacted to help reduce the amount of water migration. The subsurface drain system should be designed to collect subsurface water from the utility trench and direct it to surface discharge points.

7.0 CONCRETE FLATWORK

We anticipate that both interior and exterior concrete flatwork will be considered in the project design. Concrete flatwork is typically lightly loaded and has a limited capability to resist shear forces associated with uplift from swelling soils and/or frost heave. It is prudent for the design and construction of concrete flatwork on this project to be able to accommodate some movement associated with swelling soil conditions.

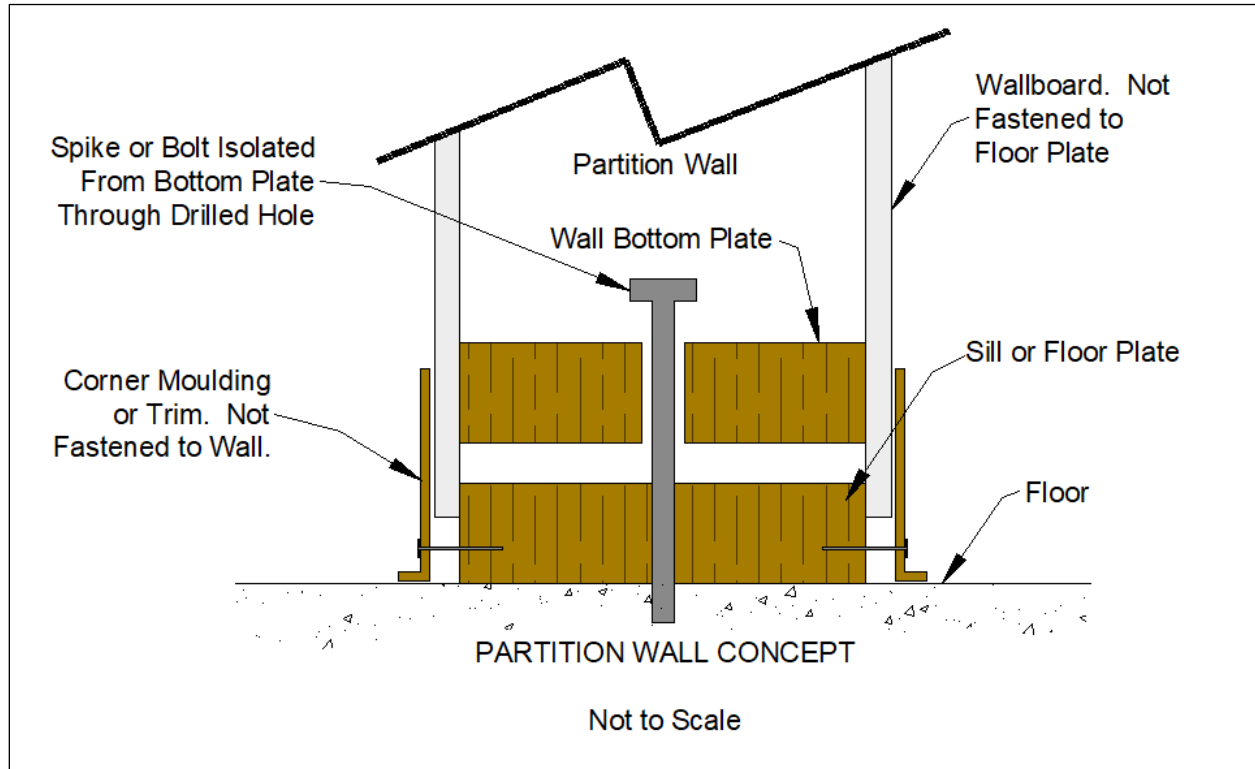
The soil samples tested have a measured swell pressure of about 730 pounds per square foot and a magnitude swell potential of about 0.2 percent under a 100 pound per square foot surcharge load. Due to the presence of existing man-placed fill, interior floors supported over a crawl space are less likely to experience movement than are concrete slabs support on grade. The following recommendations are appropriate for garage floor slabs and for interior floor slabs if the owner is willing to accept the risk of potential movement beyond normal tolerances.

7.1 Interior Concrete Slab-on-Grade Floors

A primary goal in the design and construction of concrete slab-on-grade floors is to reduce the amount of post construction uplift associated with swelling soils, or downward movement due to consolidation of soft soils or existing fill material. A parallel goal is to reduce the potential for damage to the structure associated with any movement of the slab-on-grade which may occur. There are limited options available to help mitigate the influence of volume changes in the support soil for concrete slab-on-grade floors, these include:

- Preconstruction scarification, moisture conditioning and re-compaction of the natural soils in areas proposed for support of concrete flatwork, and/or,
- Placement and compaction of granular compacted structural fill material

Although the soil on this site does not exhibit a high swell potential when wetted, performance of the structure may be improved by isolating the floors from the interior partition walls. Interior walls may be structurally supported from framing above the floor, or interior walls and support columns may be supported on interior portions of the foundation system. Partition walls should be designed and constructed with voids above, and/or below, to allow independent movement of the floor slab. This concept is shown below.



The sketch above provides a concept. If the plans include isolation of the partition walls from the floor slab, the project architect or structural engineer should be contacted to provide specific details and design of the desired system.

If the owner chooses to construct concrete slab-on-grade floors, the floors should be supported by a layer of granular structural fill overlying the processed site soils. Interior concrete flatwork, or concrete slab-on-grade floors, should be underlain by scarification, moisture conditioning and compaction of about 6 inches of the natural soils followed by placement of at least 12 inches of compacted granular structural fill material that is placed and compacted as discussed in the Construction Considerations, “Fill Placement Recommendations” section of this report, below.

The above recommendations will not prevent slab heave if the expansive soils underlying slabs-on-grade become wet. However, the recommendations will reduce the effects if slab heave occurs. All plumbing lines should be pressure tested before backfilling to help reduce the potential for wetting. The only means to completely mitigate the influence of volume changes on the performance of interior floors is to structurally support the floors over a void space. Floors that are suspended by the foundation system will not be influenced by volume changes in the site soils. The suggestions and recommendations presented in this section are intended to help reduce the influence of swelling soils on the performance of the concrete slab-on-grade floors.

7.1.1 Capillary and Vapor Moisture Rise

Capillary and vapor moisture rise through the slab support soil may provide a source for moisture in the concrete slab-on-grade floor. This moisture may promote development of mold or mildew in poorly ventilated areas and may influence the performance of floor coverings and mastic placed

directly on the floor slabs. The type of floor covering, adhesives used, and other considerations that are not related to the geotechnical engineering practice will influence the design. The architect, builder and particularly the floor covering/adhesive manufacturer should be contacted regarding the appropriate level of protection required for their products.

Comments for Reduction of Capillary Rise

One option to reduce the potential for capillary rise through the floor slab is to place a layer of clean aggregate material, such as washed concrete aggregate for the upper 4 to 6 inches of fill material supporting the concrete slabs.

Comments for Reduction of Vapor Rise

To reduce vapor rise through the floor slab, a moisture barrier such as a 6 mil (or thicker) plastic, or similar impervious geotextile material is often be placed below the floor slab. The material used should be protected from punctures that will occur during the construction process.

There are proprietary barriers that are puncture resistant that may not need the underlying layer of protective material. Some of these barriers are robust material that may be placed below the compacted structural fill layer. We do not recommend placement of the concrete directly on a moisture barrier unless the concrete contractor has had previous experience with curing of concrete placed in this manner. As mentioned above, the architect, builder and particularly the floor covering/adhesive manufacturer should be contacted regarding the appropriate level of moisture and vapor protection required for their products.

7.1.2 Slab Reinforcement Considerations

The project structural engineer should be contacted to provide steel reinforcement design considerations for the proposed floor slabs. Any steel reinforcement placed in the slab should be placed at the appropriate elevations to allow for proper interaction of the reinforcement with tensile stresses in the slab. Reinforcement steel that is allowed to cure at the bottom of the slab will not provide adequate reinforcement.

7.2 Exterior Concrete Flatwork Considerations

Exterior concrete flatwork includes concrete driveway slabs, aprons, patios, and walkways. The desired performance of exterior flatwork typically varies depending on the proposed use of the site and each owner's individual expectations. As with interior flatwork, exterior flatwork is particularly prone to movement and potential damage due to movement of the support soils. This movement and associated damage may be reduced by following the recommendations discussed under interior flatwork, above. Unlike interior flatwork, exterior flatwork may be exposed to frost heave, particularly on sites where the bearing soils have a high silt content. It may be prudent to remove silt soils from exterior flatwork support areas where movement of exterior flatwork will adversely affect the project, such as near the interface between the driveway and the interior garage floor slab. If silt soils are encountered, they should be removed to the maximum depth of frost penetration for the area where movement of exterior flatwork is undesirable.

If some movement of exterior flatwork is acceptable, we suggest that the support areas be prepared by scarification, moisture conditioning and re-compaction of about 6 inches of the natural soils followed by placement of at least 12 inches of compacted granular fill material. The scarified material and granular fill materials should be placed as discussed under the Construction Considerations, "Fill Placement Recommendations" section of this report, below.

It is important that exterior flatwork be separated from exterior column supports, masonry veneer, finishes and siding. No support columns, for the structure or exterior decks, should be placed on exterior concrete unless movement of the columns will not adversely affect the supported structural components. Movement of exterior flatwork may cause damage if it is in contact with portions of the structure exterior.

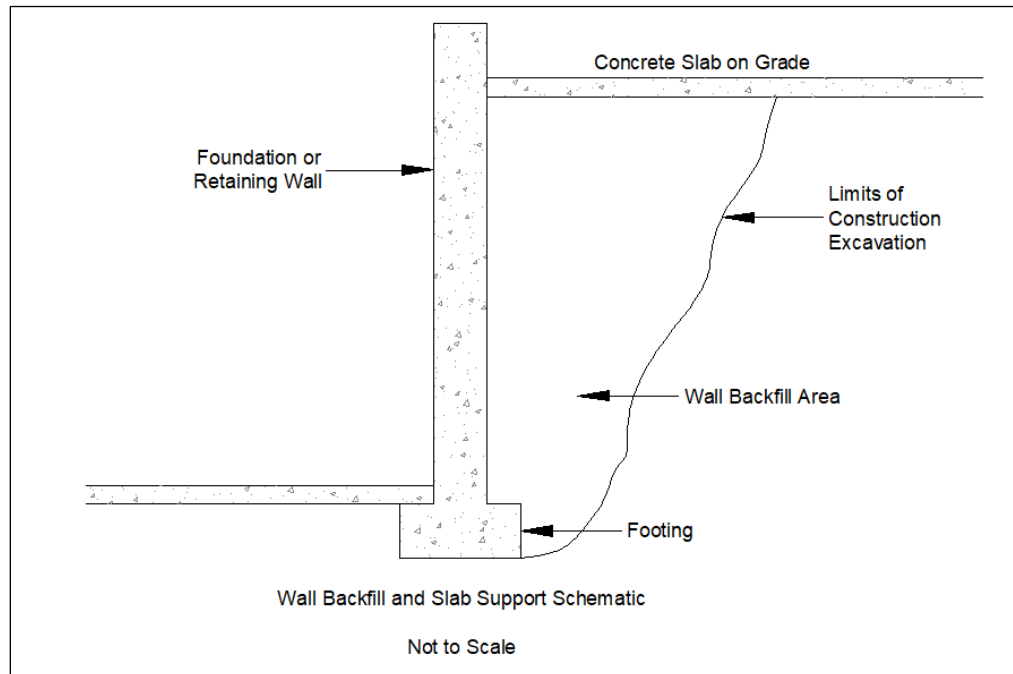
It should be noted that silt and silty sand soils located near the ground surface are particularly prone to frost heave. Soils with high silt content have the ability to retain significant moisture. The ability for the soils to accumulate moisture combined with a relatively shallow source of subsurface water and the fact that the winter temperatures in the area often very cold all contribute to a high potential for frost heave of exterior structural components. We recommend that silty soils be removed from the support areas of exterior components that are sensitive to movement associated with frost heave. These soils should be replaced with a material that is not susceptible to frost heave. Aggregate road base and similar materials retain less water than fine-grained soils and are therefore less prone to frost heave. We are available to discuss this concept with you as the plans progress.

Landscaping and landscaping irrigation often provide additional moisture to the soil supporting exterior flatwork. Excessive moisture will promote heave of the flatwork either due to expansive soil, or due to frost action. If movement of exterior slabs is undesirable, we recommend against placement of landscaping that requires irrigation. The ground surfaces near exterior flatwork must be sloped away from flatwork to reduce surface water migration to the support soil.

Exterior flatwork should not be placed on soils prepared for support of landscaping vegetation. Cultivated soils will not provide suitable support for concrete flatwork.

7.3 General Concrete Flatwork Comments

It is relatively common that both interior and exterior concrete flatwork is supported by areas of fill adjacent to either shallow foundation walls or basement retaining walls. A typical sketch of this condition is shown below.



Settlement of the backfill shown above will create a void and lack of soil support for the portions of the slab over the backfill. Settlement of the fill supporting the concrete flatwork is likely to cause damage to the slab-on-grade. Settlement and associated damage to the concrete flatwork may occur when the backfill is relatively deep, even if the backfill is compacted.

If this condition is likely to exist on this site it may be prudent to design the slab to be structurally supported on the retaining or foundation wall and designed to span to areas away from the backfill area as designed by the project structural engineer. We are available to discuss this with you upon request.

8.0 CONSTRUCTION CONSIDERATIONS

This section of the report provides comments, considerations and recommendations for aspects of the site construction which may influence, or be influenced by the geotechnical engineering considerations discussed above. The information presented below is not intended to discuss all aspects of the site construction conditions and considerations that may be encountered as the project progresses. If any questions arise as a result of our recommendations presented above, or if unexpected subsurface conditions are encountered during construction we should be contacted immediately.

8.1 Fill Placement Recommendations

There are several references throughout this report regarding both natural soil and compacted structural fill recommendations. The recommendations presented below are appropriate for the fill placement considerations discussed throughout the report above.

All areas to receive fill, structural components, or other site improvements should be properly prepared and grubbed at the initiation of the project construction. The grubbing operations should include scarification and removal of organic material and soil. No fill material or concrete should be placed in areas where existing vegetation or fill material exist.

We observed evidence of previous site use and existing man-placed fill during our field work. We encountered man-placed fill in our test borings. We suspect that man-placed fill and subterranean structures may be encountered as the project construction progresses. All existing fill material should be removed from areas planned for support of structural components. Excavated areas and subterranean voids should be backfilled with properly compacted fill material as discussed below.

8.1.1 Subgrade Soil Stabilization

We encountered subsurface water within our test borings above the elevation of some of the anticipated footing support elevations. We suspect that soft, yielding soil conditions may be encountered at various locations on the project site during construction. This material may be challenging to compact in preparation for placement of overlying fill material. We have provided two general categories of concepts to stabilize these soils to provide a suitable substrate for placement and compaction of overlying compacted fill. These include:

- 1.) Mechanical Stabilization; using soil and/or geotextile materials, and,
- 2.) Chemical Stabilization; using dry Portland cement.

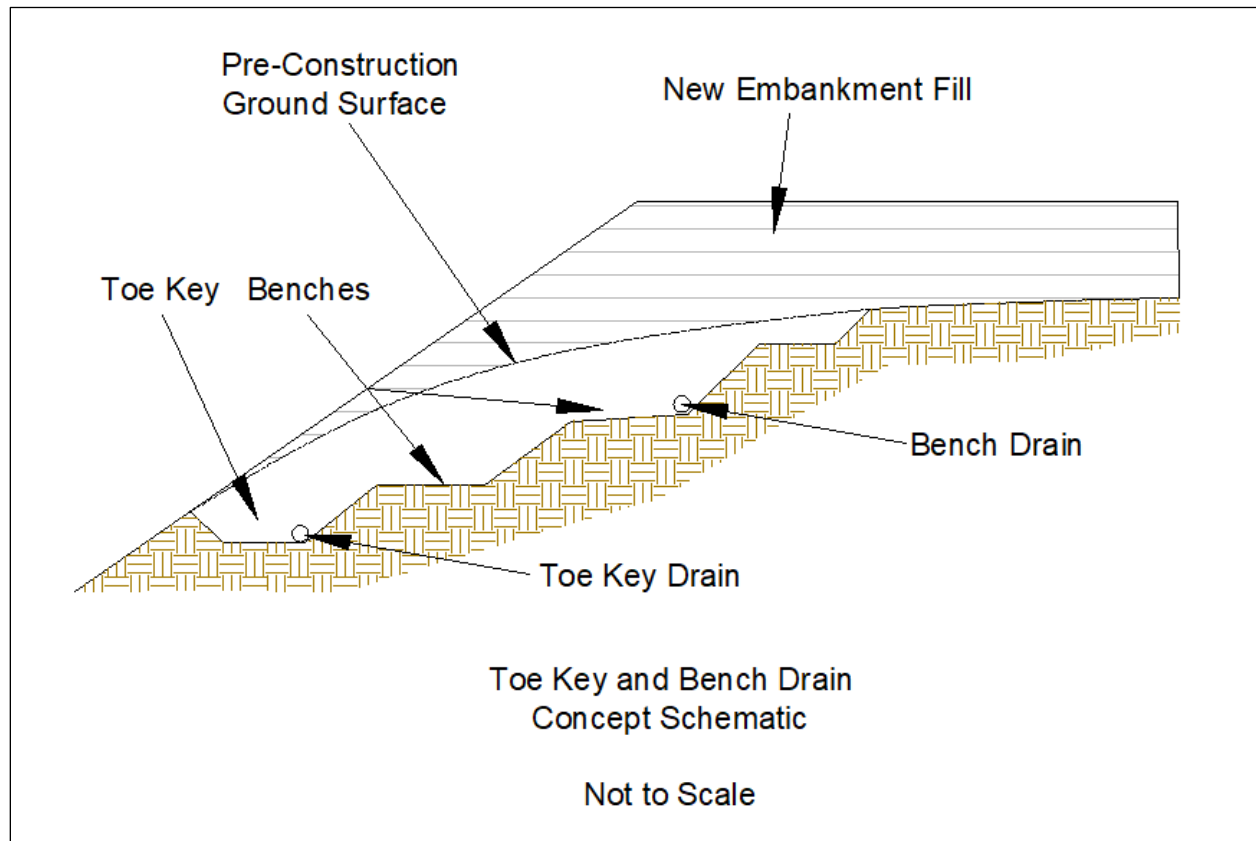
Mechanical stabilization of soil often includes placement of aggregate material and/or larger cobbles (3-4 inch size) into an area where the soils are yielding. The most predictable technique is to over-excavate these soft areas by about 8 to 12 inches, (or more, if needed) lightly proof compact the exposed soil, place a layer of woven geosynthetic or geogrid-type material, such as or Mirifi RS 280i or BXG 120 geogrid, followed by placement of a “clean crushed aggregate” material with a nominal maximum size of 3 inches and not more than about 5 percent passing the #4 sieve. This clean crushed aggregate material should then be consolidated with a plate-type compactor. A less robust fabric, such as a non-woven geofabric, (such as Mirifi 140N) is placed on top of this aggregate layer followed by placement and compaction of the overlying fill material. For sites with extremely soft conditions it may be necessary to increase the clean aggregate layer to about 18 inches and place an intermediate layer of geogrid (or fabric) at mid-height of this layer.

Chemical stabilization using Portland cement is effective for most soils. Generally, this technique is more suitable for isolated soft areas. Generally dry Portland cement powder may be placed on the surface of the soft yielding material and subsequently mixed into the soil. The effectiveness of this technique is partially dependent upon the thoroughness of the mixing. If it can be thoroughly mixed the application rate of the Portland cement need not be more than 10 percent, and often an application of 5 to 7 percent will provide a significant decrease in free water and stabilize the material. After mixing, the material should be allowed to “rest” for about two or more hours prior to compaction. The treated material will often yield some during initial compaction, but will generally increase in rigidity as the process of hydration begins takes place. If yielding under compaction is excessive, the material should be allowed “cure” additionally prior to continued compaction effort being applied. Often it takes more time, such as overnight, to allow

the cement to fully stabilize the material so this strategy is often implemented in an area at the end of a work day and allowed to cure overnight followed by subsequent fill placement on the following day.

8.1.2 Embankment Fill on Slopes

Embankment fill placed on slopes must be placed in areas that have been properly prepared prior to placement of the fill material. The fill should be placed in a toe key and benches constructed into the slope. The concept is shown below.



The width of the toe key should be at least one-fourth of the height of the fill. The elevation difference between each bench, width, and geometry of each bench is not critical; however, the elevation difference between each lift should not exceed about 3 to 4 feet. The benches should be of sufficient width to allow for placement of horizontal lifts of fill material; therefore, the size of the compaction equipment used will influence the bench widths.

Embankment fill material thicker than 5 feet should be analyzed on a site-specific basis. The fill mass may impose significant loads on, and influence the stability of the underlying slope. We suggest that no fill slopes steeper than two and one-half to one ($2\frac{1}{2}:1$, horizontal to vertical) be constructed unless a slope stability analysis of the site is conducted.

The toe key and bench drains shown above should be placed to reduce the potential for water accumulation in the embankment fill and in the soils adjacent to the embankment fill. The

placement of these drains is more critical on larger fill areas, areas where subsurface water exists and in areas where the slopes are marginally stable.

The toe key and bench drains may consist of a perforated pipe which is surrounded by a free draining material which is wrapped by a geotextile filter fabric. The pipe should be surrounded by 4 to 6 cubic feet of free draining material per lineal foot of drain pipe.

8.1.3 Natural Soil Fill

Any natural soil used for any fill purpose should be free of all deleterious material, such as organic material and construction debris. Natural soil fill includes excavated and replaced material or in-place scarified material. Due to the expansive characteristics of the natural soil we do not recommend that it be used as fill material for direct support of structural components. The natural soils may be used to establish general site elevation. Our recommendations for placement of natural soil fill are provided below.

- The natural soils should be moisture conditioned, either by addition of water to dry soils, or by processing to allow drying of wet soils. The proposed fill materials should be moisture conditioned to between about optimum and about 2 percent above optimum soil moisture content. This moisture content can be estimated in the field by squeezing a sample of the soil in the palm of the hand. If the material easily makes a cast of soil which remains in-tact, and a minor amount of surface moisture develops on the cast, the material is close to the desired moisture content. Material testing during construction is the best means to assess the soil moisture content.
- Moisture conditioning of clay or silt soils may require many hours of processing. If possible, water should be added and thoroughly mixed into fine grained soil such as clay or silt the day prior to use of the material. This technique will allow for development of a more uniform moisture content and will allow for better compaction of the moisture conditioned materials.
- The moisture conditioned soil should be placed in lifts that do not exceed the capabilities of the compaction equipment used and compacted to at least 90 percent of maximum dry density as defined by ASTM D1557, modified Proctor test.
- We typically recommend a maximum fill lift thickness of 6 inches for hand operated equipment and 8 to 10 inches for larger equipment.
- Care should be exercised in placement of utility trench backfill so that the compaction operations do not damage underlying utilities.
- The maximum recommended lift thickness is about 6 to 8 inches. The maximum recommended rock size for natural soil fill is about 3 inches. This may require on-site screening or crushing if larger rocks are present. We must be contacted if it is desired to utilize rock greater than 3 inches for fill materials.

8.1.4 Granular Compacted Structural Fill

Granular compacted structural fill is referenced in numerous locations throughout the text of this report. Granular compacted structural fill should be constructed using an imported commercially produced rock product such as aggregate road base. Many products other than road base, such as clean aggregate or select crusher fines may be suitable, depending on the intended use. If a

specification is needed by the design professional for development of project specifications, a material conforming to the Colorado Department of Transportation (CDOT) “Class 6” aggregate road base material can be specified. This specification can include an option for testing and approval in the event the contractor’s desired material does not conform to the Class 6 aggregate specifications. We have provided the CDOT Specifications for Class 6 material below.

Grading of CDOT Class 6 Aggregate Base-Course Material	
Sieve Size	Percent Passing Each Sieve
1 inch	100
¾ inch	95-100
#4	30-65
#8	25-55
#200	3-12

Liquid Limit less than 30

All compacted structural fill should be moisture conditioned and compacted to at least 90 percent of maximum dry density as defined by ASTM D1557, modified Proctor test. Areas where the structural fill will support traffic loads under concrete slabs or asphalt concrete should be compacted to at least 95 percent of maximum dry density as defined by ASTM D1557, modified Proctor test.

Although clean-screened or washed aggregate may be suitable for use as structural fill on sites with sand or non-expansive silt soils, or on sites where shallow subsurface water is present, clean aggregate materials must not be used on any site where expansive soils exist due to the potential for water to accumulate in the voids of the clean aggregate materials.

Clean aggregate fill, if appropriate for the site soil conditions, must not be placed in lifts exceeding 8 inches and each lift should be thoroughly vibrated, preferably with a plate-type vibratory compactor prior to placing overlying lifts of material or structural components. We should be contacted prior to the use of clean aggregate fill materials to evaluate their suitability for use on this project.

8.1.5 Deep Fill Considerations

Deep fills, in excess of approximately 3 feet, should be avoided where possible. Fill soils will settle over time, even when placed properly per the recommendations contained in this report. Natural soil fill or engineered structural fills placed to our minimum recommended requirements will tend to settle an estimated 1 to 3 percent; therefore, a 3 foot thick fill may settle up to approximately 1 inch over time. A 10 foot thick fill may settle up to approximately 3½ inches even when properly placed. Fill settlement will result in distress and damage to the structures they are intended to support. There are methods to reduce the effects of deep fill settlement such as surcharge loading and surveyed monitoring programs; however, there is a significant time period of monitoring required for this to be successful. A more reliable method is to support structural components with deep foundation systems bearing below the fill envelope. We can provide additional guidance regarding deep fills up on request.

8.2 Excavation Considerations

Unless a specific classification is performed, the site soils should be considered as an Occupational Safety and Health Administration (OSHA) Type C soil and should be sloped and/or benched according to the current OSHA regulations. Excavations should be sloped and benched to prevent wall collapse. Any soil can release suddenly and cave unexpectedly from excavation walls, particularly if the soils is very moist, or if fractures within the soil are present. Daily observations of the excavations should be conducted by OSHA competent site personnel to assess safety considerations.

We encountered subsurface water in our test borings. If water is encountered during construction, it may be necessary to dewater excavations to provide for suitable working conditions.

Scattered boulders were encountered in our test borings and large boulders are known to be present throughout the vicinity. Due to the size of the boulders encountered in the vicinity, if encountered, they may be difficult to remove using conventional excavation techniques and equipment. Removal of large boulders can also create a void of loose soil beneath structural components, which may require additional removal of loose soil and replacement with structural fill. In some instances, it may be preferable to leave boulders in place. Reduction in the thickness of the recommended structural fill beneath footings and slabs may also be prudent to limit disturbance to the bearing soils. If large boulders are encountered in the building footprint, a representative of the geotechnical engineer can provide field observations and provide additional recommendations for subgrade preparation.

If possible, excavations should be constructed to allow for water flow from the excavation the event of precipitation during construction. If this is not possible it may be necessary to remove water from snowmelt or precipitation from the foundation excavations to help reduce the influence of this water on the soil support conditions and the site construction characteristics.

8.2.1 Excavation Cut Slopes

We anticipate that some permanent excavation cut slopes may be included in the site development. Temporary cut slopes should not exceed 5 feet in height and should not be steeper than about 1:1 (horizontal to vertical) for most soils. Permanent cut slopes greater than 5 feet or steeper than 2½:1 must be analyzed on a site-specific basis.

We did not observe evidence of existing unstable slope areas influencing the site, but due to the steepness and extent of the slopes in the area we suggest that the magnitude of the proposed excavation slopes be minimized and/or supported by retaining structures.

8.3 Utility Considerations

Subsurface utility trenches will be constructed as part of the site development. Utility line backfill often becomes a conduit for post construction water migration. If utility line trenches approach the proposed project site from above, water migrating along the utility line and/or backfill may have direct access to the portions of the proposed structure where the utility line penetrations are made through the foundation system. The foundation soils in the vicinity of the utility line

penetration may be influenced by the additional subsurface water. There are a few options to help mitigate water migration along utility line backfill. Backfill bulkheads constructed with high clay content soils and/or placement of subsurface drains to promote utility line water discharge away from the foundation support soil.

Some movement of all structural components is normal and expected. The amount of movement may be greater on sites with problematic soil conditions. Utility line penetrations through any walls or floor slabs should be sleeved so that movement of the walls or slabs does not induce movement or stress in the utility line. Utility connections should be flexible to allow for some movement of the floor slab.

8.4 Exterior Grading and Drainage Comments

The following recommendations should be following during construction and maintained for the life of the structure with regards to exterior grading and surface drainage.

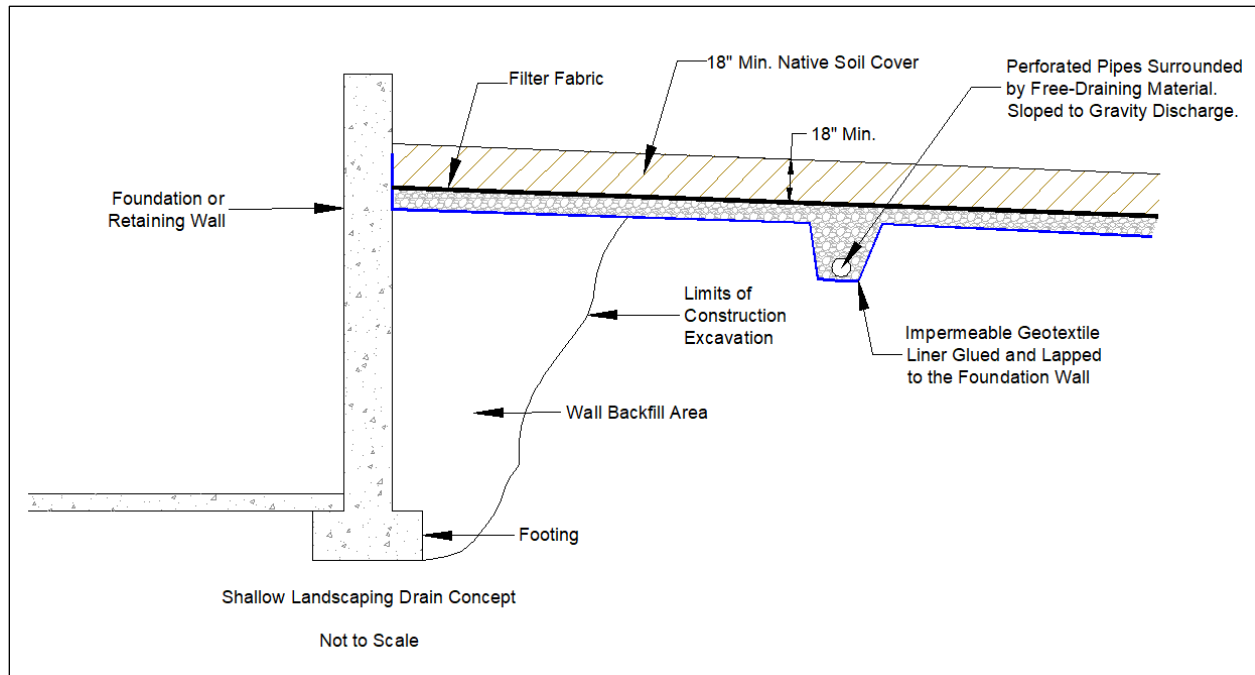
- The ground surface adjacent to the structure should be sloped to promote water flow away from the foundation system and flatwork.
- Snow storage areas should not be located in areas which will allow for snowmelt water access to support soils for the foundation system or flatwork.
- The project civil engineer, architect or builder should develop a drainage scheme for the site. We typically recommend the ground surface surrounding the exterior of the building be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 12 inches in the first 10 feet in unpaved areas and a minimum slope of 3 inches in the first 10 feet in paved areas.
- Water flow from the roof of the structure should be captured and directed away from the structure. If the roof water is collected in an eave gutter system, or similar, the discharge points of the system must be located away from areas where the water will have access to the foundation backfill or any structure support soils. If downspouts are used, provisions should be made to either collect or direct the water away from the structure.
- Care should be taken to not direct water onto adjacent property or to areas that would negatively influence existing structures or improvements.

8.5 Landscaping Considerations

We recommend against construction of landscaping which requires excessive irrigation. Generally landscaping which uses abundant water requires that the landscaping contractor install topsoil which will retain moisture. The topsoil is often placed in flattened areas near the structure to further trap water and reduce water migration from away from the landscaped areas. Unfortunately, almost all aspects of landscape construction and development of lush vegetation are contrary to the establishment of a relatively dry area adjacent to the foundation walls. Excess water from landscaped areas near the structure can migrate to the foundation system or flatwork support soils, which can result in volume changes in these soils.

A relatively common concept used to collect and subsequently reduce the amount of excess irrigation water is to glue or attach an impermeable geotextile fabric or heavy mill plastic to the foundation wall and extend it below the topsoil which is used to establish the landscape vegetation.

A thin layer of sand can be placed on top of the geotextile material to both protect the geotextile from punctures and to serve as a medium to promote water migration to the collection trench and perforated pipe. The landscape architect or contractor should be contacted for additional information regarding specific construction considerations for this concept which is shown in the sketch below.



A free draining aggregate or sand may be placed in the collection trench around the perforated pipe. The perforated pipe should be graded to allow for positive flow of excess irrigation water away from the structure or other area where additional subsurface water is undesired. Preferably the geotextile material should extend at least 10 or more feet from the foundation system.

Care should be taken to not place exterior flatwork such as sidewalks or driveways on soils that have been tilled and prepared for landscaping. Tilled soils will settle which can cause damage to the overlying flatwork. Tilled soils placed on sloped areas often “creep” down-slope. Any structure or structural component placed on this material will move down-slope with the tilled soil and may become damaged.

8.6 Soil Sulfate and Corrosion Issues

The requested scope of our services did not include assessment of the chemical constituents of corrosion potential of the site soils. Most soils in southwest Colorado are not typically corrosive to concrete. There has not been a history of damage to concrete due to sulfate corrosion in the area.

We are available to perform soluble sulfate content tests to assess the corrosion potential of the soils on concrete if desired.

8.7 Radon Issues

The requested scope of service of this report did not include assessment of the site soils for radon production. Many soils and formational materials in western Colorado produce Radon gas. The structure should be appropriately ventilated to reduce the accumulation of Radon gas in the structure. Several Federal Government agencies including the Environmental Protection Agency (EPA) have information and guidelines available for Radon considerations and home construction. If a radon survey of the site soils is desired, please contact us.

8.8 Mold and Other Biological Contaminants

Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants developing in the future. If the client is concerned about mold or other biological contaminants, a professional in this special field of practice should be consulted.

9.0 CONSTRUCTION MONITORING AND TESTING

Engineering observation of subgrade bearing conditions, compaction testing of fill material and testing of foundation concrete are equally important tasks that should be performed by the geotechnical engineering consultant during construction. We should be contacted during the construction phase of the project and/or if any questions or comments arise as a result of the information presented below. It is common for unforeseen, or otherwise variable subsurface soil and water conditions to be encountered during construction. As discussed in our proposal for our services, it is imperative that we be contacted during the foundation excavation stage of the project to verify that the conditions encountered in our field exploration were representative of those encountered during construction. Our general recommendations for construction monitoring and testing are provided below.

- Consultation with design professionals during the design phases: This is important to ensure that the intentions of our recommendations are properly incorporated in the design, and that any changes in the design concept properly consider geotechnical aspects.
- Grading Plan Review: A grading plan was not available for our review at the time of this report. A grading plan with finished floor elevations for the proposed construction should be prepared by a civil engineer licensed in the State of Colorado. Trautner Geotech should be provided with grading plans once they are complete to determine if our recommendations based on the assumed bearing elevations are appropriate.
- Observation and monitoring during construction: A representative of the Geotechnical engineer from our firm should observe the foundation excavation, earthwork, and foundation phases of the work to determine that subsurface conditions are compatible with those used in the analysis and design and our recommendations have been properly implemented. Placement of backfill should be observed and tested to judge whether the proper placement conditions have been achieved. Compaction tests should be performed on each lift of material placed in areas proposed for support of structural components.
- We recommend a representative of the geotechnical engineer observe the drain and dampproofing phases of the work to judge whether our recommendations have been properly implemented.

- If asphaltic concrete is placed for driveways or aprons near the structure we are available to provide testing of these materials during placement.

10.0 CONCLUSIONS

This site has previously placed fill material to depths of 10 feet and a deep foundation system is recommended. While we feel that it is feasible to develop this site as planned using relatively conventional techniques we feel that it is prudent for us to be part of the continuing design of this project to review and provide consultation in regard to the proposed development scheme as the project progresses to aid in the proper interpretation and implementation of the recommendations presented in this report. This consultation should be incorporated in the project development prior to construction at the site.

11.0 LIMITATIONS

This study has been conducted based on the geotechnical engineering standards of care in this area at the time this report was prepared. We make no warranty as to the recommendations contained in this report, either expressed or implied. The information presented in this report is based on our understanding of the proposed construction that was provided to us and on the data obtained from our field and laboratory studies. Our recommendations are based on limited field and laboratory sampling and testing. Unexpected subsurface conditions encountered during construction may alter our recommendations. We should be contacted during construction to observe the exposed subsurface soil conditions to provide comments and verification of our recommendations.

The recommendations presented above are intended to be used only for this project site and the proposed construction which was provided to us. The recommendations presented above are not suitable for adjacent project sites, or for proposed construction that is different than that outlined for this study.

This report provides geotechnical engineering design parameters, but does not provide foundation design or design of structure components. The project architect, designer or structural engineer must be contacted to provide a design based on the information presented in this report.

This report does not provide an environmental assessment nor does it provide environmental recommendations such as those relating to Radon or mold considerations. If recommendation relative to these or other environmental topics are needed and environmental specialist should be contacted.

The findings of this report are valid as of the present date. However, changes in the conditions of the property can occur with the passage of time. The changes may be due to natural processes or to the works of man, on the project site or adjacent properties. In addition, changes in applicable or appropriate standards can occur, whether they result from legislation or the broadening of knowledge. Therefore, the recommendations presented in this report should not be relied upon after a period of two years from the issue date without our review.

Project No. 57990GE
August 7, 2023

We are available to review and tailor our recommendations as the project progresses and additional information which may influence our recommendations becomes available.

Please contact us if you have any questions, or if we may be of additional service.

Respectfully,
TRAUTNER GEOTECH



Tom R. Harrison, P.E.
Geotechnical Engineer

APPENDIX A

Field Study Results

Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
	Mod. California Sampler Standard Split Spoon Bag Sample	Water Level During Drilling Water Level After Drilling						
0	SANDY LEAN CLAY, with organics and gravel few cobbles, very stiff to stiff, moist to wet, brown to dark brown			CL				

Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
	Mod. California Sampler Standard Split Spoon Bag Sample	Water Level During Drilling Water Level After Drilling						
0	CLAYEY GRAVEL WITH SAND, medium dense, slightly moist, tan			GC				ABC fill top 8 inches
1	SANDY LEAN CLAY, few organics, very stiff, moist, brown							
2	CLAYEY GRAVEL WITH SAND AND COBBLE, very dense, moist, brown			GC		50/6		Fill to 3 feet
3	Auger refusal on cobble at 3 feet							

Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
	Mod. California Sampler Standard Split Spoon Bag Sample Water Level During Drilling Water Level After Drilling	DESCRIPTION						
0	CLAYEY GRAVEL WITH SAND, medium dense, slightly moist, tan		GC					ABC fill top 8 inches
1	SANDY LEAN CLAY, few organics, very stiff, moist, brown							
2	CLAYEY GRAVEL WITH SAND AND COBBLE, very dense, moist, brown Auger refusal on cobble at 2 feet		GC					
3								

Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
	Mod. California Sampler Standard Split Spoon Bag Sample	Water Level During Drilling Water Level After Drilling						
0	CLAYEY GRAVEL, medium dense, slightly moist, tan			GC				ABC top 8 inches
1	SANDY LEAN CLAY, with gravel and few organics and cobbles, very stiff, moist, brown			CL		18/6 15/6		
5	POORLY GRADED GRAVEL WITH SAND AND COBBLE, few boulders, very dense, moist, brown			GP				
Auger refusal on boulder at 5 feet								

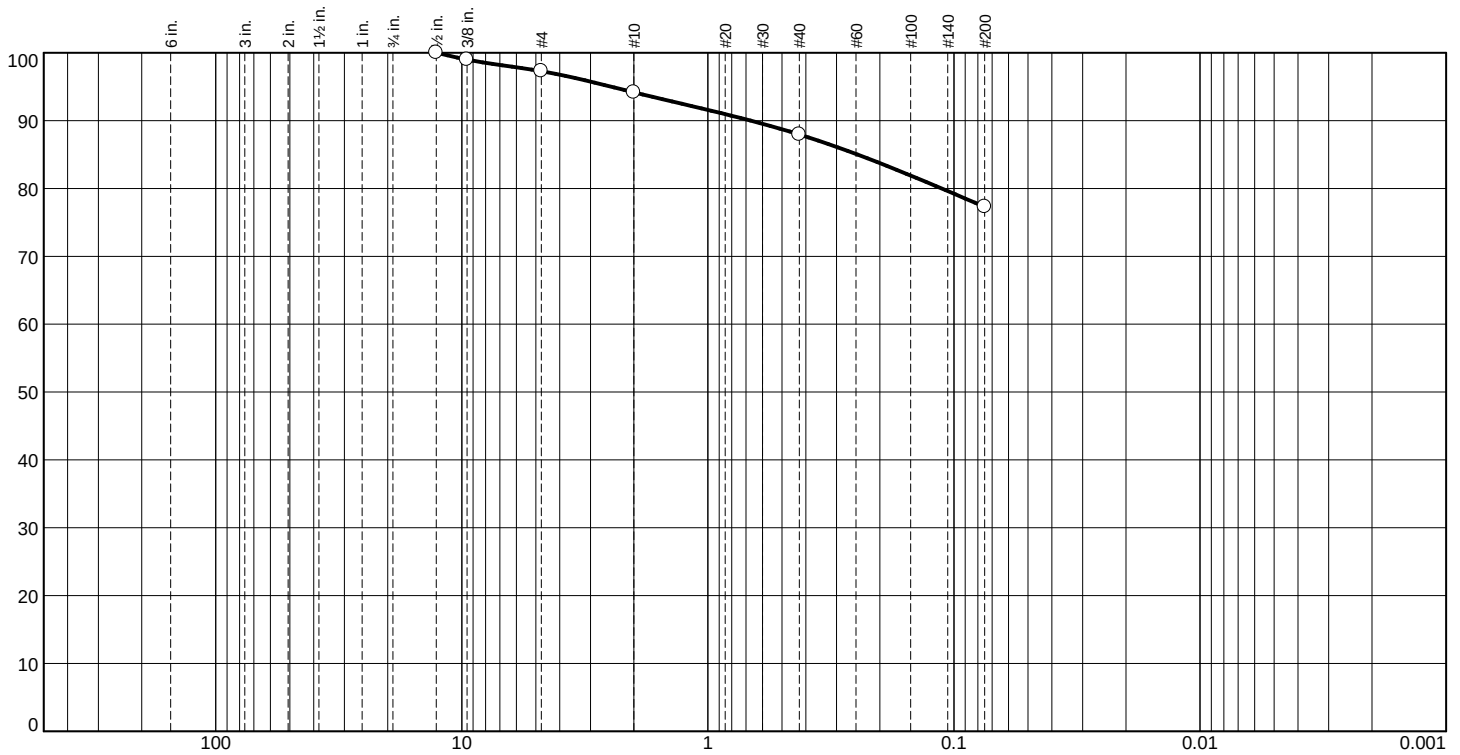
Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
	Mod. California Sampler Standard Split Spoon Bag Sample	Water Level During Drilling Water Level After Drilling						
0	CLAYEY GRAVEL WITH SAND AND COBBLES, dense to medium dense, moist, brown to gray			GC				
1								
2								
3								
4								
5								
6								
7								
8	LEAN CLAY, slightly silty with few gravels, very stiff, very moist, brown			CL				Fill to 8 feet
9								
10								
11	CLAYEY GRAVEL WITH SAND AND COBBLES, dense to very dense, wet, brown			GC				
12								
13								
14								
15	Auger refusal on cobble at 15 feet							

APPENDIX B

Laboratory Test Results

Particle Size Distribution Report

PERCENT FINER



GRAIN SIZE - mm.

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	3	6	11	77	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.50	100		
.375	99		
#4	97		
#10	94		
#40	88		
#200	77		

* (no specification provided)

Source of Sample: Test Boring 1
Sample Number: 13095-A

Depth: 1'-2'

Date: 6-26-23

Material Description

CH-Fat Clay with Sand

Atterberg Limits

PL= 20

LL= 54

PI= 34

Coefficients

D₉₀= 0.6698

D₈₅= 0.2467

D₅₀=

D₃₀=

D₁₀=

C_u=

D₆₀=

D₁₅=

C_c=

Classification

USCS= CH

AASHTO=

A-7-6(26)

Remarks

TRAUTNER GEOTECH LLC

Client: James Dickoff-Town of Pagosa Springs

Project: Sheltered Ice Rink-Yamaguchi South, Pagosa Springs

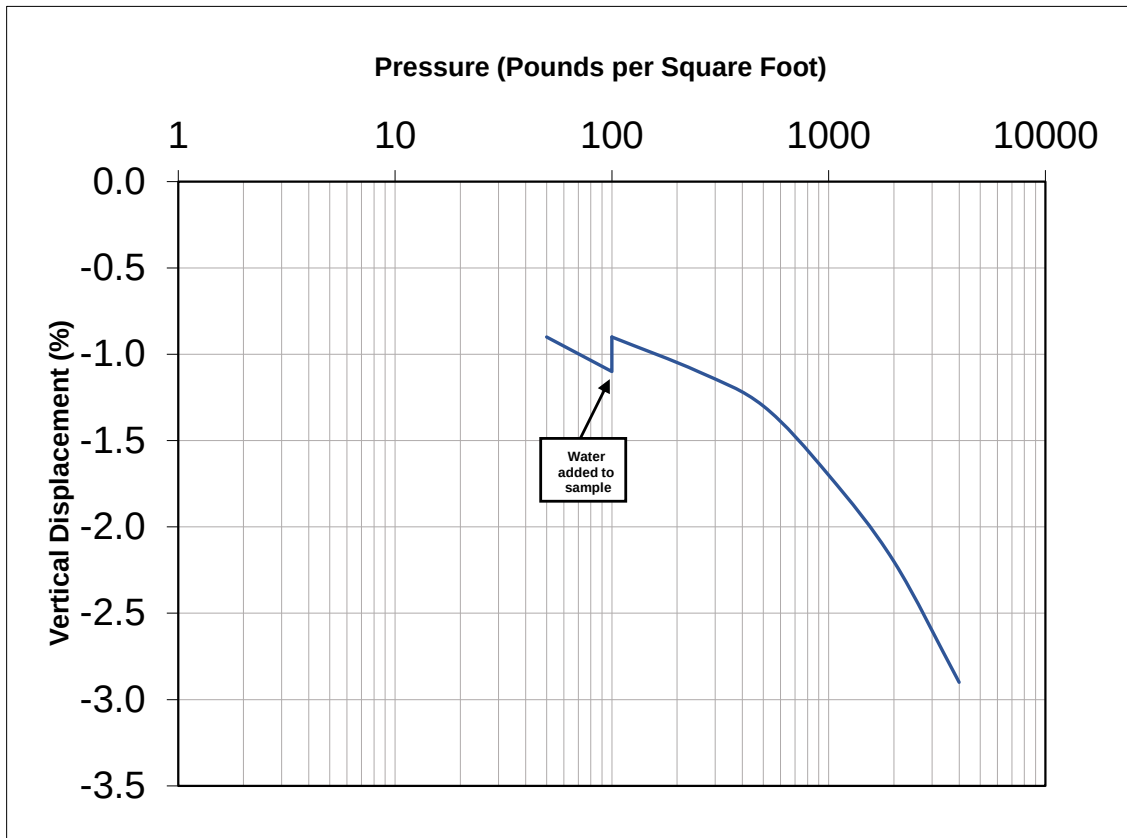
Project No: 57990GE

Figure B.1

Tested By: C. Manchester

Checked By: J. Koch

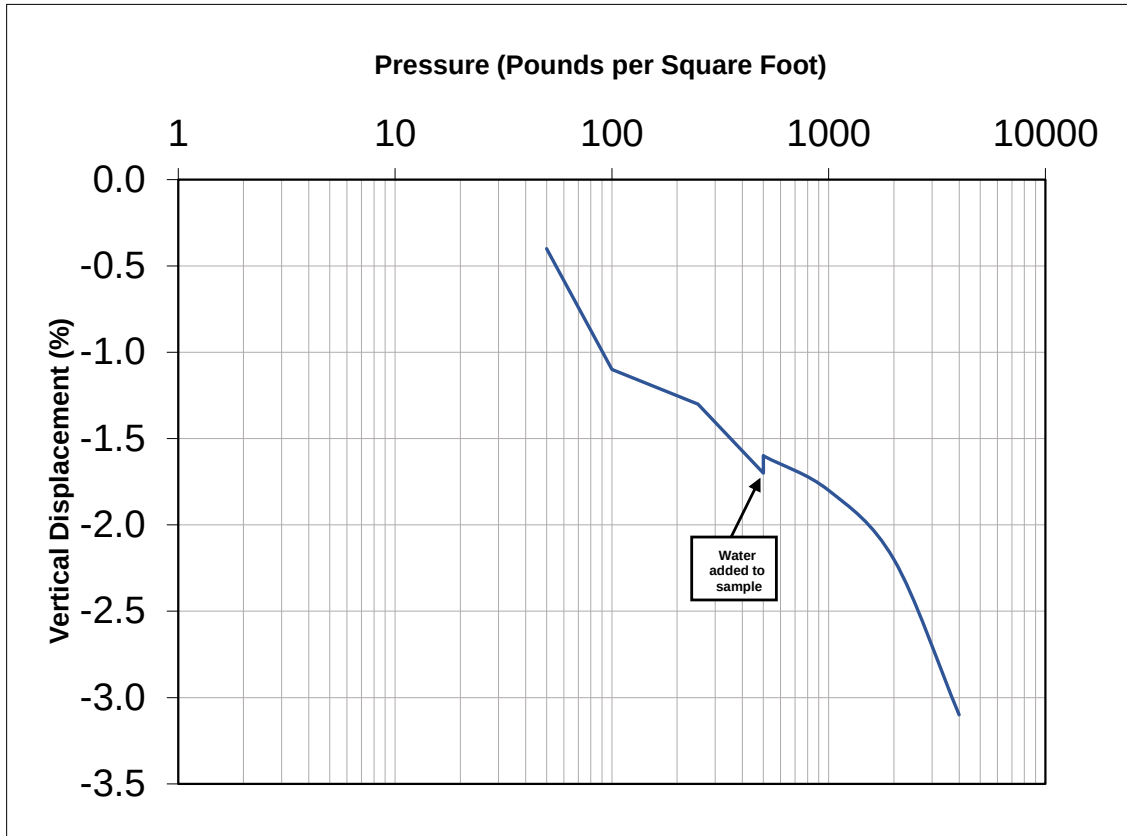
SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TB-1 @ 2'	
Visual Soil Description:	CL	
Swell Potential (%)	0.2%	
Estimated Load-Back Swell Pressure (lb/ft²):	270	
	Initial	Final
Moisture Content (%):	15.8	15.1
Dry Density (lb/ft³):	116.1	120.4
Height (in.):	1.000	0.971
Diameter (in.):	1.94	1.94

Project Number:	57990GE
Sample ID:	13095-B
Figure:	B.2

SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TB-4 @ 4'	
Visual Soil Description:	CL	
Swell Potential (%)	0.1%	
Estimated Load-Back Swell Pressure (lb/ft²):	730	
	Initial	Final
Moisture Content (%):	19.8	20.0
Dry Density (lb/ft³):	105.6	108.8
Height (in.):	1.000	0.969
Diameter (in.):	1.94	1.94

Project Number:	57990GE
Sample ID:	13095-M
Figure:	B.3