Mancos Marshal's Office Design & Construction Project
Questions & Answers

1. **Q**. Do we want a red steel building?
   A. Yes
2. **Q**. What is square footage of the building?
   A. 2,000 square feet plus carport
3. **Q**. Do plans need to be stamped by a licensed architect?
   A. No.
4. **Q**. Does electrical system design need to be provided by a licensed Electrical Engineer?
   A. TBD – must work with solar contractor.
5. **Q**. Does foundation design require licensed Structural Engineer stamp?
   A. Yes – may be available from metal building company.
6. **Q**. Does HVAC and Plumbing system need to be designed by licensed Mechanical Engineer?
   A. No
7. Attached is soils testing report from Trautner Geotech.

GEOTECHNICAL ENGINEERING STUDY
PROPOSED TOWN OF MANCOS MARSHAL'S BUILDING

Mancos, Colorado

May 26, 2023

PREPARED FOR:

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Town of Mancos
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PROJECT NO. 57898GE

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1.0 REPORT INTRODUCTION

This report presents our geotechnical engineering recommendations for the proposed Town of Mancos Marshal's Building. This report was requested by Heather Alvarez, Town of Mancos, and was prepared in accordance with our proposal dated March 3, 2023, Proposal No. 23104P.

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;

- Section 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.
- Section 10.0 discussed the limitations of our study.

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 generally understand the proposed project consists of designing and constructing an approximate 2,500 square foot marshal's office building that will be supported by a steel reinforced concrete foundation system. We do not know at this time if the main level will be supported over a crawl space or if concrete slab-on-grade will be considered. We understand that a basement level is not proposed below the structure.

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

The project site is located adjacent to the east side of North Main Street, southeast of the intersection of North Main Street and Bauer Avenue in Mancos, Colorado. The general location of the project site is provided below as Figure 2.1. A more detailed aerial view of the project site is provided as Figure 2.2 in Section 2.2 of this report below. The imagery used for Figures 2.1 and 2.2 were obtained from Google Earth (imagery date: 9/11/2019).

Figure 2.1: General Project Location

We understand that a previous marshal's building was located at the project site, and was recently removed. At the time of our April 27, 2023 field study, the entire structure had been removed including the foundation components. The excavation from the removal of the previous structure was generally square in shape (likely generally matching the perimeter area of the previous structure), and was approximately 4 to 5 feet below the surrounding site grade. Based on the excavated area we anticipate that the previous structure floor system was supported over a crawl space. The ground surface on the lot is relatively flat. We anticipate that historic grading has occurred on the lot, including the placement of fill materials.

The geomorphology in the vicinity of the project site consists of alluvial deposits of material primarily consisting of dense cobbles and gravels overlying the Mancos Shale formation. The Mancos shale formation is generally encountered within about 15 to 25 feet of the ground surface elevation in the area of the project site. The Mancos River is located about 375 feet to the south of the project site.

2.2 Subsurface Soil and Water Conditions

We advanced two continuous flight auger test borings in our understanding of the proposed structure location. The test borings were advanced around the perimeter of the excavation area where the previous building had been recently removed. A schematic showing the approximate test boring locations is provided below as Figure 2.2. It should be noted that the structure shown in the aerial imagery used for Figure 2.2 had been removed prior to our field study. The logs of the soils encountered in our test borings are presented in Appendix A.

Figure 2.2: Approximate Test Boring Locations

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.

Generally, we encountered suspected man placed fill material that varied from soft and very moist sandy clay soil with gravels to silt/organic soils with general debris (trash) from the ground surface to a depth of about 2 feet below the ground surface. We anticipate that the depth of man placed fill will be variable on the project site. Below the suspected man placed fill we encountered medium stiff and very moist sandy clay soil with gravel to depths ranging from about 3½ to 5 feet below the ground surface. At depths ranging from about 3½ to 5 feet we encountered dense to very dense gravel and cobbles with a sandy clay soil matrix. We experienced auger refusal on very dense nested cobbles at depths ranging from about 7 to 10 feet below the ground surface.

We did not encounter free subsurface water in our test borings to the depth of auger refusal, however very moist soil conditions were encountered likely due to heavy spring snowmelt in the area. The subsurface free water elevation should closely correlate to the water elevation in the Mancos River located to the south of the project site. We suspect that the subsurface water elevation and soil moisture conditions will be influenced by snow melt and/or precipitation.

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.

2.3 Site Seismic Classification

The seismic site class as defined by ASCE 7, Chapter 20 is based on some average values of select soil characteristics such as shear wave velocity, standard penetration test result values, undrained shear strength, and plasticity index.

Based on our standard penetration field tests and laboratory test results, as well as experience in the area on adjacent project sites, the subsurface conditions for the project are consistent with a Site Class C designation as outlined in ASCE 7, Chapter 20.

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. The swell-consolidations tests were performed on the material remolded from the minus #10 sieve screen for standard split spoon samples. We were not able to obtain "in-situ" samples due to the gravel/cobble content of the soils.

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; 4-5.5 feet	15	30/15	-	-	-	-
TB-2 @ 3 feet*	-	-	13.6	121.6*	1,000	1.0 (% under 100 psf load)
TB-2 @ 8 feet*	-	-	7.3	112.9*	1,000	0.9 (% under 100 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

Based on the results of the field and laboratory study, spread footings may be considered to support the structure provided the anticipated post construction settlement of spread footings and allowable bearing capacity is adequate for the structure. The swell potential of the granular native soils may be considered as being low based on the overall granular content of the soil mass. Our recommendations for spread footings are presented in Section 4.1 below. We are available to provide recommendations for alternative types of foundation systems at your request.

The integrity and long-term performance of any type of foundation system is influenced by the quality of workmanship which is implemented during construction. It is imperative that all excavation and fill placement operations be conducted by qualified personnel using appropriate equipment and techniques to provide suitable support conditions for the foundation system.

4.1 Spread Footings

The following items in additional to the remainder of the recommendations provided in this report must be followed for a spread footing foundation system;

- The spread footing excavation must extend to the dense gravel and cobble deposits that underlie the site. We encountered these deposits at depths ranging from about 3½ to 5 feet below the ground surface elevation at our test boring locations. The support elevation of the spread footings may then be established by placement of granular structural fill. This support criteria is discussed in more detail below.
- We are not aware of the excavation procedures that were used to remove the previous structure. We suspect that poorly consolidated fill materials may exist in the bottom of the existing excavation. All previously placed fill materials must be removed and replaced with compacted structural fill.
- We should be contacted to observe the subgrade soil conditions prior to placement of structural fill materials for support of the foundation system or concrete flatwork.

Properly designed and constructed continuous spread footings with stem walls (or beams) have the ability to distribute the forces associated with volume changes in the support soils (primarily settlement for the subject project). The rigidity of the system helps reduce differential movement and associated damage to the overlying structure. Volume changes in the soils that support isolated footings will result in direct movement of the columns and structural components supported by the columns. Damage to the structure due to this type of movement can be severe. If possible, we recommend that isolated pad footings be avoided and that the foundation system be designed as rigid as is reasonably possible.

Careful preparation of the subgrade soils, placement of granular compacted structural fill, careful placement and compaction of stem wall backfill and positive surface drainage adjacent to the foundation system all help reduce the potential for volume changes to occur in the foundation support soils.

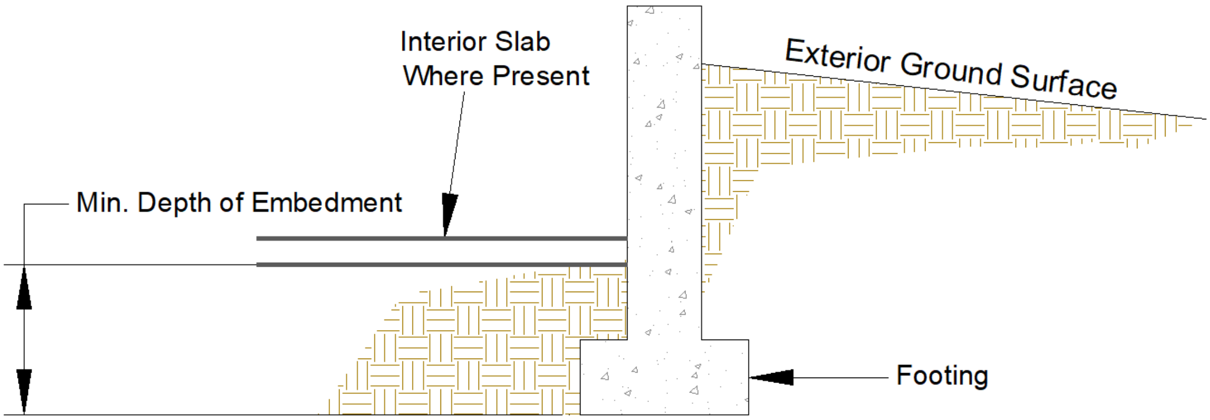
We recommend that the footings be supported by a layer of moisture conditioned and compacted natural soil (subgrade soil) which is overlain by a layer of compacted structural fill material. This concept is outlined below:

- The foundation excavation should be excavated to at least 12 inches below the proposed footing support elevation.
    - The foundation excavation must extend into the native and undisturbed granular soil deposits. We should be contacted to observe the exposed subgrade soil conditions.
- The natural soils exposed in the bottom of the excavation should then be scarified to a depth of about 8 inches.
- The scarified soil should be thoroughly moisture conditioned to about 2 percent above the laboratory determined optimum moisture content and then compacted to at least 90 percent of the maximum dry density as defined by the modified Proctor (ASTM D1557).
- After completion of the compaction of the moisture conditioned natural soil a minimum 12-inch thick layer of granular aggregate base course structural fill material should be placed, moisture conditioned and compacted to 90 percent of the modified Proctor.
- The moisture conditioned natural soil material and the granular soils should be compacted as discussed under the Compaction Recommendations portion of this report below.

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. 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.

The footing embedment is a relatively critical, yet often overlooked, aspect of foundation construction. The embedment helps develop the soil bearing capacity, increases resistance of the footing to lateral movement and decreases the potential for rapid moisture changes in the footing support soils, particularly in crawl space areas. Interior footing embedment reduces the exposure of the crawl space support soils to dry crawl space air. Reduction in drying of the support soil helps reduce downward movement of interior footings due to soil shrinkage.

All footings should have a minimum depth of embedment of at least one 1 foot. The embedment concept is shown below.



Footing Embedment Concept

Not to Scale

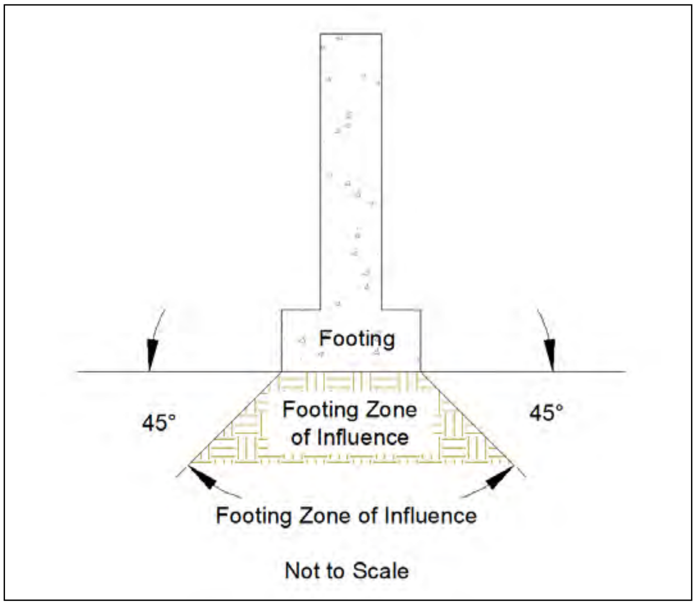
Spread footings located away from sloped areas may be designed using the bearing capacity information tabulated below.

Minimum Depth of Embedment (Feet)	Continuous Footing Design Capacity (psf)	Isolated Footing Design Capacity (psf)
1	1,400	1,400
2	1,900	1,900
3	2,400	2,400

The bearing capacity values tabulated above may be increased by 20 percent for transient conditions associated with wind and seismic loads. Snow loads are not transient loads.

The bearing capacity values tabulated above are based on a continuous spread footing width ranging from about 1½ to 2½ feet, and an isolated footing width ranging from about 3 to 4 feet. Development of the final footing design width is usually an iterative process based on evaluation of design pressures, footing widths and the thickness of compacted structural fill beneath the footings. We should be contacted as the design process continues to re-evaluate the design capacities above based on the actual proposed footing geometry.

The compacted structural fill should be placed and compacted as discussed in the Construction Considerations, “Fill Placement Recommendations” section of this report, below. The zone of influence of the footing (at elevations close to the bottom of the footing) is often approximated as being between two lines subtended at 45 degree angles from each bottom corner of the footing. The compacted structural fill should extend beyond the zone of influence of the footing as shown in the sketch below.



A general and simple rule to apply to the geometry of the compacted structural fill blanket is that it should extend beyond each edge of the footing a distance which is equal to the fill thickness.

We estimate that continuous footings designed and constructed above will have a total post construction settlement in the range of about 1/2 inch. Post construction settlement of isolated footings may be in the range of about 1/2 to 2/3 inch.

All footings should be support at an elevation deeper than the maximum depth of frost penetration for the area. This recommendation includes exterior isolated footings and column supports. Please contact the local building department for specific frost depth requirements.

The post construction differential settlement may be reduced by designing footings that will apply relatively uniform loads on the support soils. Concentrated loads should be supported by footings that have been designed to impose similar loads as those imposed by adjacent footings.

Under no circumstances should any footing be supported by more than 3 feet of compacted structural fill material unless we are contacted to review the specific conditions supporting these footing locations.

The design concepts and parameters presented above are based on the soil conditions encountered in our test borings. We should be contacted during the initial phases of the foundation excavation at the site to assess the soil support conditions and to verify our recommendations.

Some movement and settlement of any shallow foundation system will occur after construction. Utility line connections through and foundation or structural component should be appropriately sleeved to reduce the potential for damage to the utility line. Flexible utility line connections will further reduce the potential for damage associated with movement of the structure.

5.0 RETAINING STRUCTURES

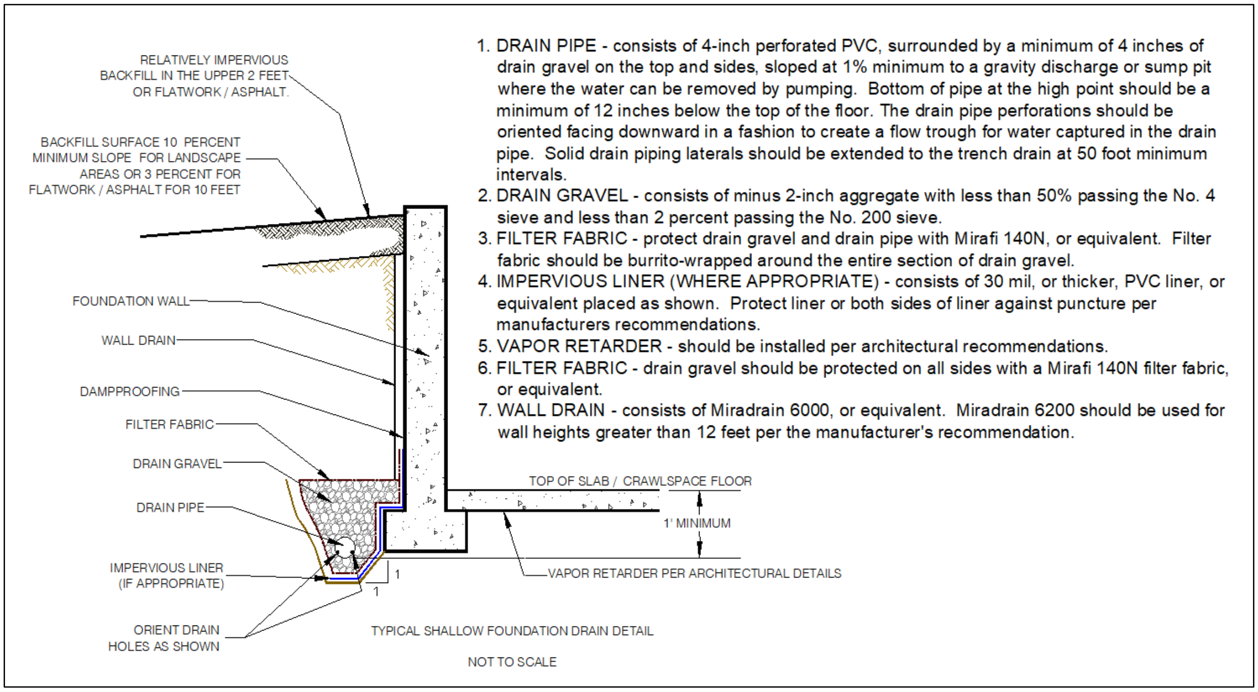
We understand that laterally loaded walls will not be constructed as part of this site development. Please contact us if lateral earth pressure values are needed for the project design.

6.0 SUBSURFACE DRAIN SYSTEM

Since retaining structures are not proposed for this site a subsurface drain system is not needed to reduce hydrostatic pressures. If subsurface areas, such as crawl space area are planned the subsurface drain system concept below may be included in the project design to reduce the tendency for water to accumulate in subsurface areas. 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 generally discussed 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 volume changes in the support soils, including frost heave for exterior flatwork. 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.

7.1 Interior Concrete Slab-on-Grade Floors

Excavations associated with the removal of the previous structure ranged in depth from about 4 to 5 feet. If interior concrete slab-on-grade floors will be used for the new structure, then extremely careful placement and testing of the needed fill materials must be conducted. The fill material must consist of non-expansive granular structural fill.

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

Damage associated with movement of interior concrete slab-on-grade floor can be reduced by designing the floors as "floating" slabs. The concrete slabs should not be structurally tied to the foundations or the overlying structure. Interior walls or columns should not be supported on the interior floor slabs. Movement of interior walls or columns due to uplift of the floor slab can cause severe damage throughout the structure. 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.

If the owner chooses to construct the residence with concrete slab-on-grade floors, the floors should be supported by a layer of granular structural fill overlying the processed natural soils. Again, all needed fill material must consist of non-expansive granular structural fill that is thoroughly moisture conditions and compacted to at least 90 percent of the maximum dry density as defined by the modified Proctor (ASTM D1557). We estimate that post construction settlement of the granular structural fill will be in the range of at least 1/2 inch to 2/3 inch for a fill depth ranging from about 4 to 5 feet.

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 volume changes in the support 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 6 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.

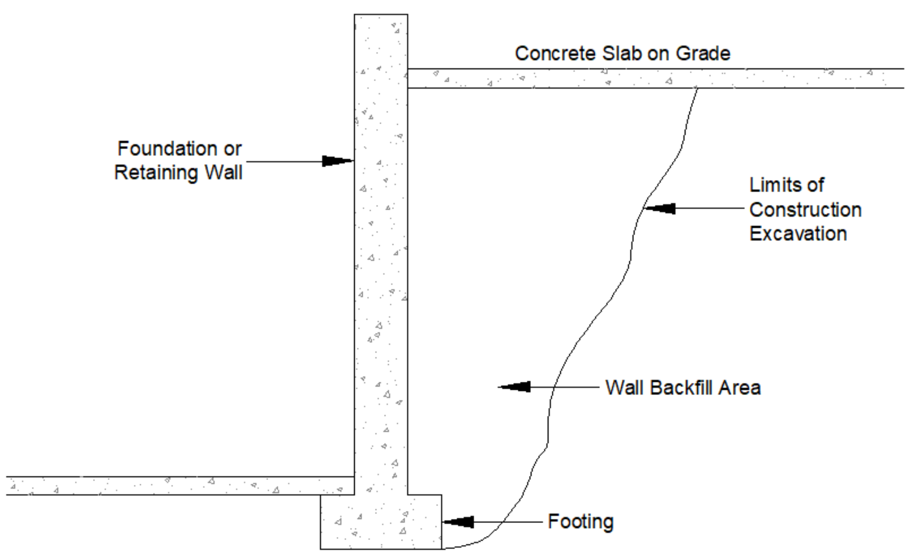
It should be noted that silt and silty sand soils located near the ground surface are particularly prone to frost heave. Soils with high silt content have the ability to retain significant moisture. The ability for the soils to accumulate moisture combined with a relatively shallow source of subsurface 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.



Wall Backfill and Slab Support Schematic

Not to Scale

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 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 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. 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.

8.1.2 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.

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.

8.1.3 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 2 percent; therefore, a 3 foot thick fill may settle up to approximately ½ to ¾ inch over time. A 10 foot thick fill may settle up to approximately 2½ 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 did not encounter free 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.

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.

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

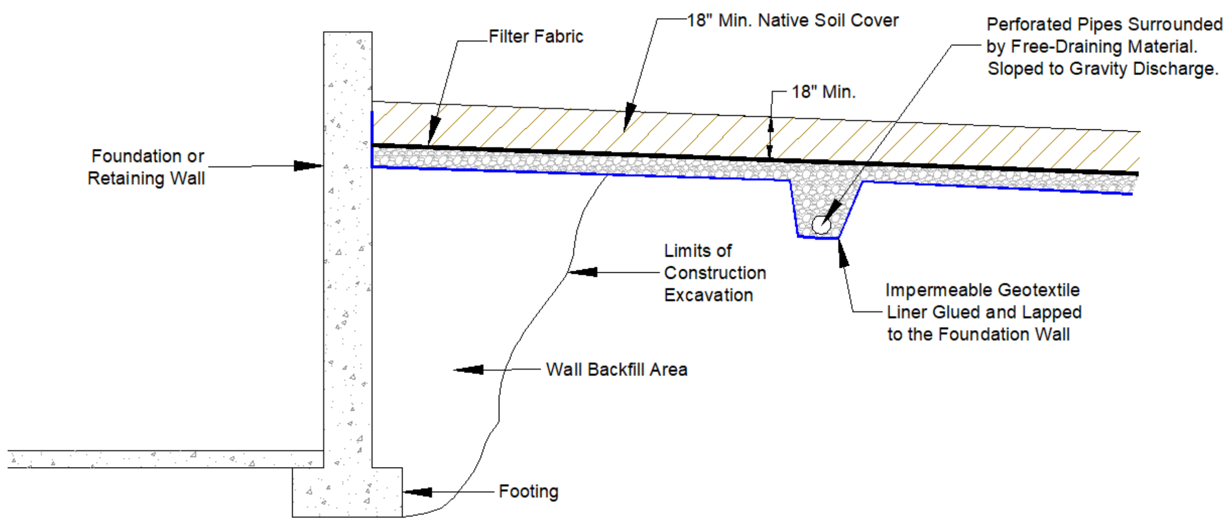
The following recommendations should be following during construction and maintained for the life of the structure with regards to exterior grading and surface drainage.

- 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.



Shallow Landscaping Drain Concept

Not to Scale

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.

The landscape drain system concept provided above is optional for this site and provided only if there is a desire to reduce the potential for subsurface water migration to below grade finished areas or crawl space areas. Often this concept is implemented only on the northern sides of structures and/or where snow may accumulate and melt water may migrate toward subsurface areas under the structure.

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.

- <u>Consultation with design professionals during the design phases:</u> 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.
- 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 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.

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

05/26/2023

Jonathan P. Butler, P.E.
Geotechnical Engineer

APPENDIX A

Field Study Results

TRAUTNER GEOTECH LLC

Field Engineer	: Jonathan Butler
Hole Diameter	: 3.25" I.D.
Drilling Method	: Continuous Flight : Hollow Auger
Sampling Method	: Mod. California Sampler, : Standard Split Spoon
Date Drilled	: April 27, 2023
Total Depth (approx.)	: 7 feet
Location	: See Figure 2.2 in Report

LOG OF BORING TB-1

Town of Mancos Marshals Office
Mancos, Colorado
Heather Alvarez
Town of Mancos, Colorado

Project Number: 57898GE

Sample Type: Mod. California Sampler; Standard Split Spoon; Bag Sample

Water Level: Water Level During Drilling; Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0–2	MAN-PLACED FILL MATERIAL, CLAY, sandy, gravels, soft, very moist, brown	CL					
2–3.5	CLAY, sandy, gravels, medium stiff, very moist, brown	CL					
3.5–7	GRAVEL, COBBLES, sandy, clayey, dense to very dense, very moist, brown	GC-GP		Standard Split Spoon (approx. 4–6.25)	12/6 15/6 17/6 19/6 50/3		
7	Auger refusal at 7 feet on very dense cobbles						

TRAUTNER GEOTECH LLC

Field Engineer	: Jonathan Butler
Hole Diameter	: 3.25" I.D.
Drilling Method	: Continuous Flight
	: Hollow Auger
Sampling Method	: Mod. California Sampler,
	: Standard Split Spoon
Date Drilled	: April 27, 2023
Total Depth (approx.)	: 10 feet
Location	: See Figure 2.2 in Report

LOG OF BORING TB-2

Town of Mancos Marshals Office
Mancos, Colorado
Heather Alvarez
Town of Mancos, Colorado

Project Number: 57898GE

Sample Type
- Mod. California Sampler
- Standard Split Spoon
- Bag Sample

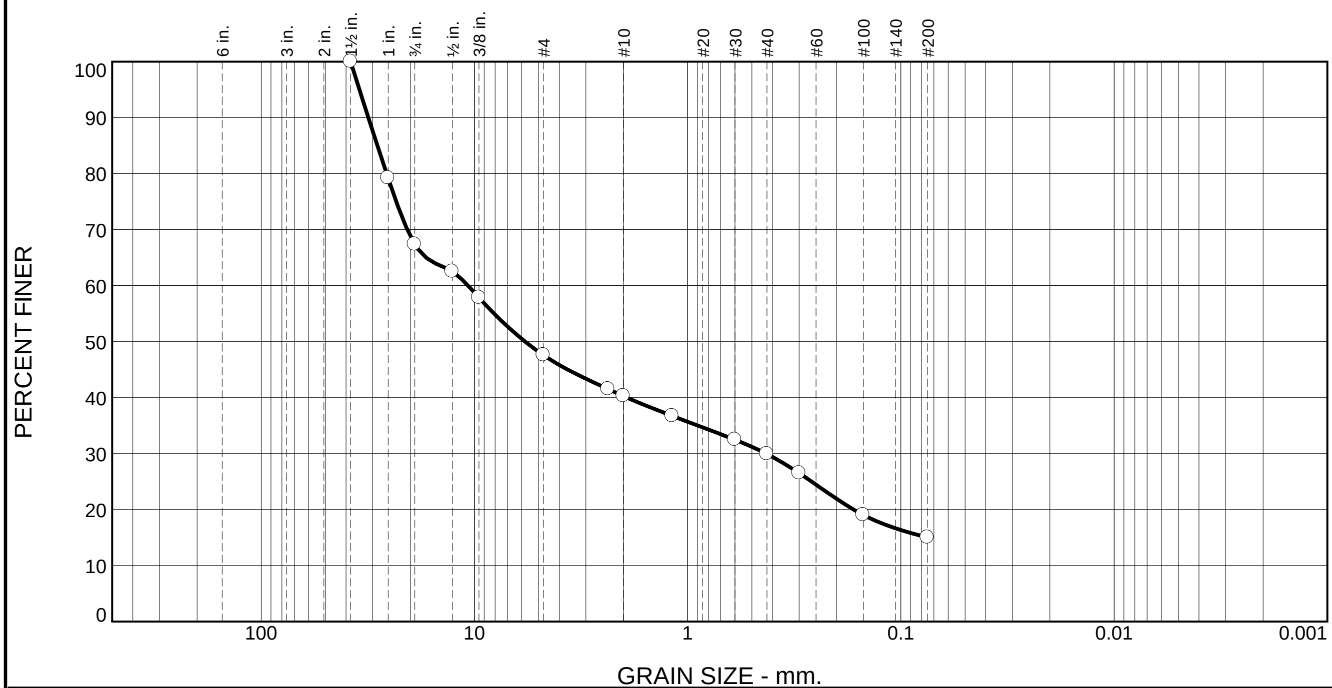
Water Level
- Water Level During Drilling
- Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0–2	MAN-PLACED FILL MATERIAL, Organic material, silt, debris, very soft, very moist, brown	CL		Bag Sample (0–3)			
2–5	CLAY, sandy, few gravels, medium stiff, very moist, brown	CL		Standard Split Spoon (3–4.5)	4/6 5/6 5/6		
5–10	GRAVEL, COBBLES, sandy, clayey, dense to very dense, very moist, brown	GC-GP		Standard Split Spoon (8–9.5)	30/6 24/6 15/6		
10	Auger refusal at 10 feet on very dense cobbles						

APPENDIX B

Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	33	19	8	10	15	15	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1	79		
.75	67		
.5	63		
.375	58		
#4	48		
#8	42		
#10	40		
#16	37		
#30	32		
#40	30		
#50	27		
#100	19		
#200	15		

* (no specification provided)

Material Description

Clayey gravel with sand

Atterberg Limits (ASTM D 4318)

PL= 15 **LL=** 30 **PI=** 15

Classification

USCS (D 2487)= GC **AASHTO (M 145)=** A-2-6(0)

Coefficients

D_{90}= 31.4344	D_{85}= 28.5084	D_{60}= 10.7203
D_{50}= 5.7901	D_{30}= 0.4286	D_{15}= 0.0751
D_{10}=	C_u=	C_c=

Remarks

C10515-B+C

Date Received: 4/27/23 **Date Tested:** 5/8/23

Tested By: R. Barrett

Checked By: J. Butler

Title: P.E.

Location: TB-1
Depth: 4.0'+5.5'

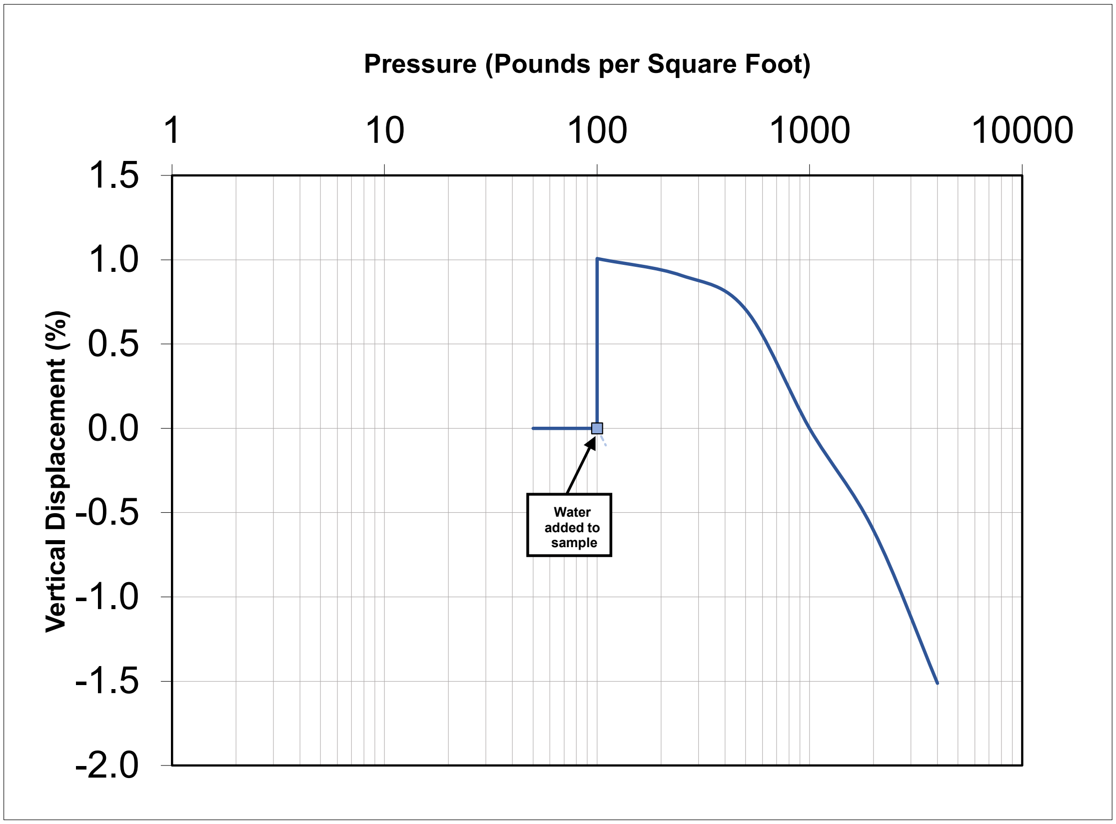
Date Sampled: 4/27/23

TRAUTNER GEOTECH LLC

Client: Heather Alvarez, Town of Mancos, Colorado
Project: Town of Mancos Marshals Office, Mancos, Colorado

Project No: 57898GE **Figure** B.1

SWELL - CONSOLIDATION TEST

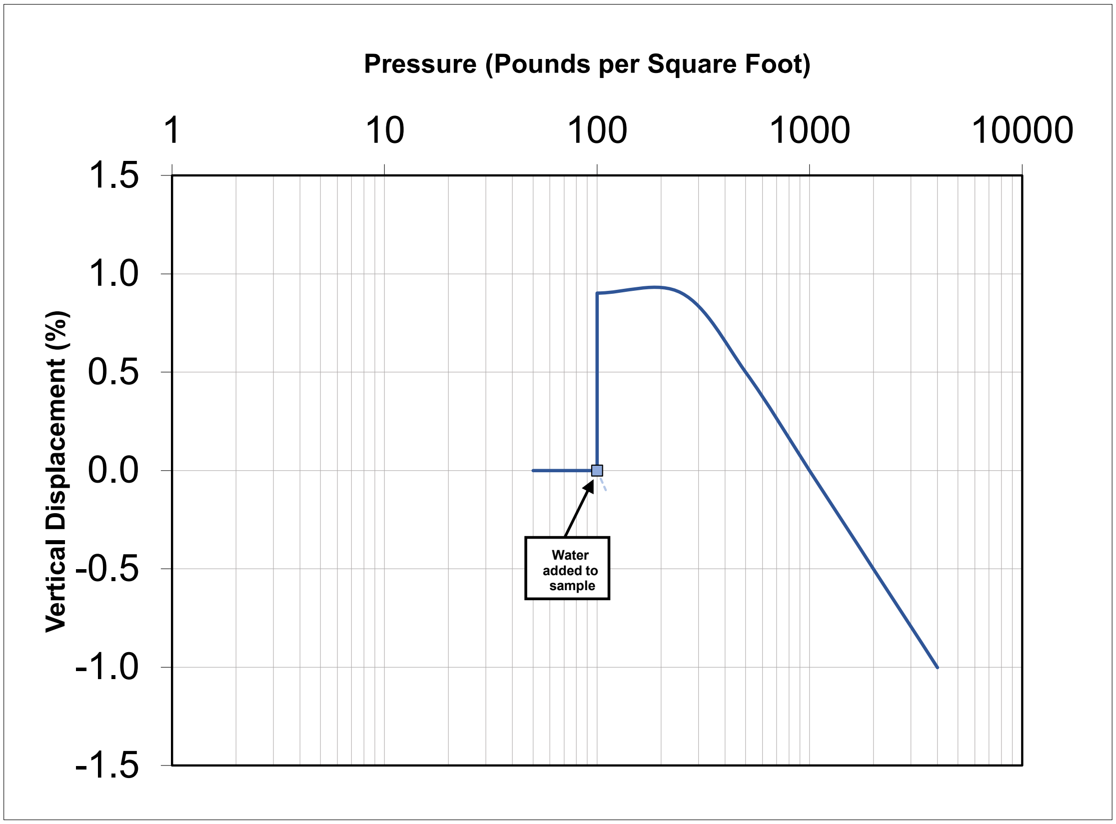


SUMMARY OF TEST RESULTS		
Sample Source:	TB-2 @ 3 feet	
Visual Soil Description:	Clay, sandy (CL)	
Swell Potential (%)	1.0%	
Load-Back Swell Pressure (lb/ft^2):	1,000	
	Initial	**Final**
Moisture Content (%):	13.6	13.9
Dry Density (lb/ft^3):	121.6	124.3
Height (in.):	0.992	0.977
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	57898GE
Sample ID:	C10515E
Figure:	B.2

SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TB-2 @ 8 feet	
Visual Soil Description:	Sand, clayey (SC)	
Swell Potential (%)	0.9%	
Load-Back Swell Pressure (lb/ft^2):	1,000	
	Initial	**Final**
Moisture Content (%):	7.3	16.2
Dry Density (lb/ft^3):	112.9	114.0
Height (in.):	0.998	0.988
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	57898GE
Sample ID:	C10515F
Figure:	B.3