Overland Trails – Lot 1

Geotechnical Engineering Report

June 29, 2023 | Terracon Project No. 24235044

Prepared for:

Y2 Consultants
1725 Carey Avenue
Cheyenne, Wyoming 82001

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June 29, 2023

Y2 Consultants
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Attn: Maxwell Waite
P: (307) 632-5656 ext. 206
E: mwaite@y2consultants.com

Re: Geotechnical Engineering Report
Overland Trails – Lot 1
Northeast of the Intersection of Granite Peak Drive and Quartz Drive
Laramie County, Wyoming
Terracon Project No. 24235044

Dear Mr. Waite:

We have completed the scope of Geotechnical Engineering services for the project referenced above in general accordance with Terracon Proposal No. P24235044 dated April 24, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Mary L. Tardona	Eric D. Bernhardt, P.E.
Group Manager	Senior Associate

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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Report Summary

Topic [1]	Overview Statement [2]
Project Description	The project includes the construction of an approximately 9,000 to 10,000 square foot commercial building, paved drive lanes and parking areas, and an equipment laydown yard. We understand rigid (concrete) and flexible (asphalt) pavements are planned for the parking areas and drive lanes and aggregate surfacing is planned for the equipment laydown yard area. Traffic frequency and loading information was not provided for this report. Our estimated traffic information can be found in the **Pavements** section of this report.
Geotechnical Characterization	■ Existing surficial fill, likely associated with previous site grading activities, was encountered in Boring No. B-4 to a depth of about 1 foot below ground surface. ■ Native soils consist predominately of medium dense to very dense sand with varying amounts of silt and gravel. ■ Sandy lean clay, varying to clayey sand was encountered in Boring No. B-3 at about 6 feet below ground surface. ■ Groundwater was not encountered to the maximum depth of our borings (about 25½ feet below ground surface).
Earthwork	■ Site preparation should commence with removal of existing fill where encountered, vegetation and any loose, soft, or otherwise unsuitable material from the proposed construction areas. ■ We anticipate excavations for the proposed construction can be accomplished with conventional earthmoving equipment; however, cemented sand soils are anticipated to be encountered at various locations and depths across the site, and may require the use of heavy-duty excavation equipment. ■ After required cuts and over-excavations in structural areas have been completed, the exposed ground surface should be scarified to a depth of about 10 inches, moisture conditioned, compacted, and proof-rolled before any new fill is placed. ■ Onsite soils are suitable for use as engineered fill. ■ Engineered fill should be placed and compacted in accordance with this report.

Topic [1]	Overview Statement [2]
Shallow Foundations	Shallow foundations bearing on native soils prepared in accordance with the **Earthwork** section of this report are recommended for building support ▪ Allowable bearing pressure = 2,500 psf
Pavements	With subgrade prepared as noted in **Earthwork**. Drive lanes and parking areas: ▪ 4" AC over 5" ABC ▪ 6" PCC Equipment laydown yard: ▪ 8" aggregate surfacing
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed lot improvements to be located northeast of the Intersection of Granite Peak Drive and Quartz Drive in Laramie County, Wyoming. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning, and our final understanding of the project conditions is as follows.

Item	Description
Information Provided	Information for this report was provided by Mr. Waite with Y2 via email correspondences beginning on May 1, 2023. The following was provided: ▪ Aerial site plan dated June 16, 2022; ▪ Overland Trails real estate brochure prepared by the Graham Group and Coldwell Banker (no date); and ▪ Surveyed coordinates and ground surface elevations at our boring locations.

Item	Description
Project Description	The project includes the construction of an approximately 9,000 to 10,000 square foot commercial building, paved drive lanes and parking areas, and an equipment laydown yard.
Proposed Structure	We assume the structure will be a single-story, wood- or steel-framed building supported on reinforced concrete foundations and include a slab-on-grade floor.
Finished Floor Elevation	Planned FFE was not provided at the time of this report. We assume the finished floor elevation is planned about 3 feet above existing surface elevations.
Assumed Maximum Loads	Anticipated structural loads were not provided. In the absence of information provided by the design team, we used the following loads in estimating settlement based on our experience with similar projects. ▪ Columns: 50 to 75 kips ▪ Walls: 1 to 3 kips per linear foot (klf) ▪ Slabs: 100 to 150 pounds per square foot (psf)
Grading	We assume planned site improvements will generally follow the existing topography, and site grading cuts/fills on the order of about 3 to 5 feet or less will be necessary to achieve final grades across the project site.
Pavements	We assume rigid (concrete) and/or flexible (asphalt concrete) pavement sections are planned for parking areas and drive lanes, and aggregate surfacing is planned for the equipment laydown yard.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration.

Item	Description
Location	The project is located at the northeast corner of the intersection of Granite Peak Drive and Quartz Drive, approximately 2 miles south of Cheyenne in Laramie County, Wyoming. Approximate coordinates near the center of the site are 41.0886ºN, 104.8531ºW. See **Site Location**.
Existing Improvements	The site is currently vacant. Based on Google Earth aerial imagery, the site appears to have undergone mass grading between 2012 and 2014. The asphalt-paved Quartz Drive and Granite Peak Drive appear to have been constructed during this time frame. The western and eastern site borders are formed by Granite Peak Drive and Interstate 25, respectively.
Current Ground Cover	Current ground cover consists of sparse vegetation.
Existing Topography	The site slopes gently down to north exhibiting an elevation change of approximately 10 feet over a length of about 300 feet across the site.

Geotechnical Characterization

GeoModel

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Vegetative Soils**	About 3 to 4 inches of root penetration.
2	**Apparent Existing Fill**	Poorly graded sand with silt encountered in Boring No. B-4 only. Light brown.
3	**Sand**	Predominately medium dense to very dense well to poorly graded sand and silty sand with varying amounts of gravel. Mixed browns and tans.
4	**Clay**	Stiff to hard sandy lean clay, varying to clayey sand. Light brown.

Groundwater

Groundwater was not observed in the boreholes during drilling or for the short amount of time the boreholes remained open. Groundwater levels can be and should be expected to fluctuate with varying seasonal and weather conditions, irrigation demands on or adjacent to the site and other factors not apparent. However, we do not believe groundwater will significantly impact the proposed construction.

Seismic Site Class

seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties observed at the site and as described on the exploration logs and results, we recommend a **Seismic Site Classification of D** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of about 25½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Corrosivity

The table below lists the results of laboratory pH, soluble sulfate, sulfides, soluble chloride, RedOx, total salts, and electrical resistivity testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary

Boring No.	Sample Depth (feet)	Soil Description (USCS)	pH	Soluble Sulfate (mg/kg)	Sulfides (mg/kg)	Soluble Chloride (mg/kg)	RedOx (mV)	Total Salts (mg/kg)	Electrical Resistivity[1] (Ω-cm)
B-1	1 to 6	SW-SM	7.9	1,107	Nil	16	+250	2,774	5,092

1. Test performed on a saturated soil sample.

The sulfates concentration measured in the sample is 1,107 mg/kg which equates to approximately 0.11 percent. Sulfate concentrations in the range of 0.1 to 0.2 indicate Class 1 exposure to sulfate attack for concrete in contact with the subsoils, according to the American Concrete Institute (ACI) 318-19. Foundation concrete should be designed in accordance with the provisions of the *ACI Design Manual*.

Results of soluble sulfate testing can be classified in accordance with ACI 318 – Building Code Requirements for Structural Concrete. Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (e.g., utilities, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

We recommend a certified corrosion engineer be employed to determine the need for corrosion protection and to design appropriate protective measures.

Geotechnical Overview

Based on geotechnical conditions encountered in our test borings, the site appears suitable for the proposed construction from a geotechnical point of view provided certain precautions and design and construction recommendations presented in this report are followed. Geotechnical conditions that could impact design, construction, and performance of the planned building and other site improvements are discussed in the following paragraphs. These conditions will require particular attention in project planning, design, and construction and are discussed in greater detail in the following section.

Potential Existing Fill

Based on review of available historical aerial imagery, it is apparent that some amount of earthwork has occurred on the project site in the past. However, it is not apparent whether the previous earthwork on the site consisted of site grading cuts or fill placement. Identifying existing fill soils based solely on visual inspection of isolated soil samples can be difficult, particularly if the existing fill soils are granular and similar in composition to the native site soils.

Apparent existing fill was observed in Boring No. B-4 to a depth of about 1 foot below the existing ground surface at the time of our subsurface exploration. Given the apparent historical earthwork activities on the site, it is possible that existing fills may be encountered at other locations and extend to greater depths. Existing fills can present a risk of post-construction movement to foundations, concrete slabs, pavements and other site improvements supported on them.

Due to the surficial nature of the apparent fill encountered during exploration, we anticipate existing fills will likely be effectively removed or remediated during construction of foundations, floor slabs, and pavements, provided the recommendations in this report are followed. However, excavations for structural areas should be observed by Terracon during site preparation and construction activities in order to confirm existing fill is not present at foundation and floor slab bearing depths.

If existing fill is encountered at depths greater than about 1 foot below structural areas, we recommend the following:

- Existing fill should not be relied upon for support of the proposed building, pavements and other site improvements and should be removed and replaced or re-worked (over-excavated, moisture conditioned and recompacted) as part of site preparation prior to the placement of any new fills and/or construction.
- Provided the existing fill is free of debris or other deleterious materials, it should be suitable for reuse as new fills and backfill.
- Consideration could be given to supporting pavements on a minimum of 10 inches of reworked (scarified, moisture conditioned, and recompacted) fill materials, if some risk of pavement settlement can be accepted.

Cemented Soils

Soil lenses and nodules with varying degrees of cementation were encountered at various locations and depths across the site. Difficult excavation of the cemented soils should be expected where encountered. Excavations penetrating these materials may require the use specialized heavy-duty equipment, such as large excavators, to advance excavations. Therefore, and methods for excavation should be evaluated and determined by the excavation contractor. Cemented soil conditions resulting in difficult excavation may exist on the site and a contingency fee to accommodate such conditions should be included in the contractors bid.

Earthwork

The following presents recommendations for site preparation, excavation, structural subgrade preparation, fill materials, compaction requirements, utility trench backfill, grading and drainage, and exterior slab design and construction. Earthwork on the project should be observed and evaluated by the Geotechnical Engineer. Evaluation of earthwork should include observation and/or testing of over-excavation, removal of existing fill, subgrade preparation, placement of engineered fills, subgrade stabilization and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Site preparation should commence with removal of existing fill, vegetation and any loose, soft, or otherwise unsuitable material from the proposed construction areas. Stripped materials consisting of vegetation and organic materials should be wasted from the site or used in planned landscape areas.

Excavation

We anticipate excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Cemented sand soils are anticipated to be encountered at various locations and depths across the site and may require the use of heavy-duty excavation equipment. The means and methods for excavation should be evaluated and determined by the excavation contractor.

The soils to be excavated can vary significantly across the site as their classifications are based solely on the materials encountered in widely-spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.

Although evidence of underground facilities such as grease pits, septic tanks, vaults, basements, and utilities were not observed during the site exploration, such features could be encountered during construction. If unexpected underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Any excavation extending below the bottom of the foundation elevation should extend laterally beyond all edges of the foundations at least 8 inches per foot of excavation depth below the foundation base elevation. The excavation should be backfilled to the foundation base elevation in accordance with the recommendations presented in this report.

Though not anticipated, surface water infiltration and/or groundwater may be encountered in excavations on the site depending upon depth of excavation and seasonal conditions. In this case, we anticipate pumping from sumps may be utilized to control water within excavations.

The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards. As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to the slope height. The exposed slope face should be protected against the elements.

Subgrade Preparation Below Structural Areas

After the site has been stripped of any topsoil and existing vegetation from within the construction areas and required cuts and over-excavations in structural areas (those planned for foundation, concrete slab, and pavement construction) have been completed, the exposed ground surface should be scarified to a depth of about 10 inches, moisture conditioned, and compacted before any new fill is placed. The subgrade should then be proof-rolled with adequately loaded equipment. The proof-rolling should be performed under the observation of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer. Excessively wet or dry material should either be removed or moisture conditioned and compacted.

After exposed subgrades and base of excavations in structural areas have been prepared as recommended above, engineered fill can be placed to bring structure pad and pavement subgrade to the desired grade. Engineered fill should be placed in accordance with the recommendations presented in subsequent sections of this report.

The stability of the subgrade may be affected by precipitation, repetitive construction traffic, or other factors. If unstable conditions develop, workability may be improved by scarifying and drying. Alternatively, over-excavation of wet zones and replacement with granular materials may be used, or crushed gravel and/or rock can be tracked or "crowded" into the unstable surface soil until a stable working surface is attained. Use of geosynthetics could also be considered as a stabilization technique. Lightweight excavation equipment may also be used to reduce subgrade pumping if unstable subgrades develop.

Fill Material Types

Fill for this project should consist of engineered fill. Engineered fill is fill that meets the criteria presented in this report and has been properly documented. On-site soils or approved granular and low plasticity cohesive imported materials may be used as fill material.

Imported materials meeting the properties presented below should be acceptable for use as engineered fill. However, imported soils should be evaluated and approved by the geotechnical engineer prior to delivery to the site.

Gradation/Property	Percent Finer by Weight (ASTM C136/D422)
3-inch	100
No. 4 Sieve	30 to 100
No. 200 Sieve	50 (max.)
Soil Properties	**Values**
Liquid Limit (LL)	35 (max.)
Plasticity Index (PI)	15 (max.)

Aggregate base course used for roadways and parking areas should meet WYDOT requirements for Grading L or W aggregate base course materials, or similar.

Other import fill material types may be suitable for use depending upon proposed application and location on the site and should be tested and approved for use on a case-by-case basis.

Fill Placement and Compaction Requirements

Placement of engineered fill should be performed according to the following compaction requirements.

Item	Description
Maximum Lift Thickness	▪ 8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used ▪ 4 to 6 inches in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used
Minimum Compaction Requirements [1,2,3]	▪ At least 95% of the standard Proctor maximum dry density (ASTM D698)
Water Content Range [1]	▪ Cohesive soil (clay) [4]: -1% to +3% of the optimum moisture content as determined by the standard Proctor test ▪ Cohesionless soil (sand) [5]: -3% to +3% of optimum

1. Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. A construction disc or other suitable processing equipment will be needed to thoroughly process the materials and to aid in achieving uniform moisture content throughout the fill.
2. The contractor should expect some moisture adjustment and processing of the site soils or import materials will be needed prior to or during compaction operations.
3. Care should be taken during the fill placement process to avoid zones of dissimilar fill. Improvements constructed over varying fill types are at a higher risk of differential movement compared to improvements over a uniform fill zone.
4. Moisture conditioned clay materials should not be allowed to dry out. A loss of moisture within these materials could result in an increase in the material's expansive potential. Subsequent wetting of these materials could result in undesirable movement.
5. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the fill material pumping when proof rolled.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction.

All underground piping within or near the proposed building should be designed with flexible couplings, so minor deviations in alignment do not result in breakage or distress. Utility knockouts in foundation walls should be oversized to accommodate differential movements. It is imperative that utility trenches be properly backfilled with relatively clean materials.

It is strongly recommended that a representative of the Geotechnical Engineer provide full-time observation and compaction testing of trench backfill within structure and pavement areas.

Grading and Drainage

Grades must be adjusted to provide effective drainage away from the proposed building during construction and maintained throughout the life of the proposed project. Infiltration of water into foundation excavations must be prevented during construction. Water permitted to pond near or adjacent to the perimeter of the building (either during or post-construction) can result in significantly higher soil movements than those discussed in this report. As a result, any estimations of potential movement described in this report cannot be relied upon if positive drainage is not obtained and maintained, and water is allowed to infiltrate the fill and/or subgrade.

Exposed ground (if any) should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Exterior Slab Design and Construction

Exterior slabs on-grade, exterior architectural features, and utilities founded on, or in backfill or the site soils will likely experience some movement due to the volume change of the material. Potential movement could be reduced by:

- Minimizing moisture increases in the backfill;
- Controlling moisture-density during placement of the backfill;
- Using designs which allow vertical movement between the exterior features and adjoining structural elements; and
- Placing control joints on relatively close centers.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of soils containing vegetation and topsoil, removal of existing fill, new fill compaction efforts, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. In areas of foundation excavations, the bearing subgrade should be evaluated under the guidance of the Geotechnical Engineer. If unanticipated conditions are encountered, we should be contacted to prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Shallow Foundation – Design Recommendations

Description	Values
Maximum Net Allowable Bearing Pressure [1, 2]	2,500 psf
Required Bearing Stratum	Native soils prepared in accordance with the requirements noted in **Earthwork**
Minimum Foundation Dimensions [3]	Columns: 24 inches Continuous: 18 inches
Maximum Foundation Dimensions [4]	Column: 10 feet Continuous: 3½ feet
Lateral Earth Pressure Coefficients [5]	Active, K_a = 0.25 Passive, K_p = 4.00 At-rest, K_o = 0.40
Sliding Coefficient [5]	μ = 0.60
Moist Soil Unit Weight	γ = 120 pcf
Minimum Embedment Below Finished Grade [6]	36 inches
Estimated Total Movement [7]	Less than about 1 inch
Estimated Differential Movement [7]	About ½ of total settlement

Description	Values

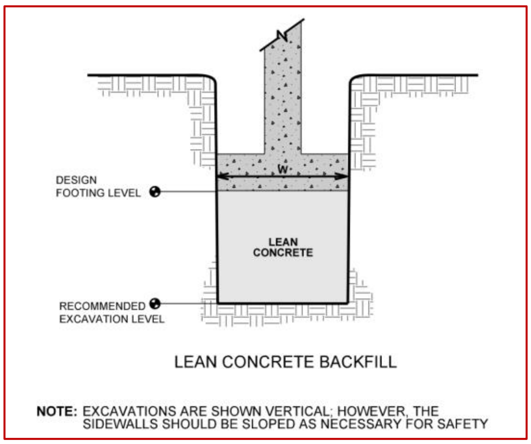
1. The recommended maximum net allowable bearing pressure assumes the site has been prepared in accordance with recommendations of this report, and any unsuitable, soft, or loose soils, if encountered, will be over-excavated and replaced with properly compacted engineered fill. The design bearing pressure applies to a dead load plus design live load condition. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Minimum foundation dimensions are established to protect against bearing capacity failure at the allowable bearing pressure provided.
4. Based on the allowable bearing pressure value presented above, maximum foundation dimensions are established to maintain settlement estimates within tolerable limits. Larger foundation footprints will require reduced allowable soil bearing pressures to reduce risk for potential settlement.
5. The lateral earth pressure coefficients and sliding coefficients are ultimate values and do not include a factor of safety. The foundation designer should include the appropriate factors of safety.
6. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils. The minimum embedment depth is for footings beneath unheated areas and is relative to lowest adjacent finished grade, typically exterior grade. Foundations not protected against frost and seasonal moisture variations should bear at least 18 inches below the adjacent grade for confinement of the bearing materials and to develop the recommended bearing pressure.
7. Foundation movement will depend upon variations within the subsurface soil profile, structural loading conditions, embedment depth of foundations, thickness of compacted fill, and the quality of the earthwork operations. Settlement estimates are based on the assumed structural loads and foundation geometry as discussed in the **Project Description** section and as indicated in the table above. If the actual foundation loads or geometry vary significantly from those assumed, we should be contacted to review our recommendations. Additional foundation movements could occur if surface water infiltrates the foundation soils; therefore, proper drainage away from the foundation system should be provided in the final design, during construction and maintained throughout the life of the structure.

Excavations for fill extending below the bottom of foundation elevation should extend laterally beyond all edges of the foundation at least 8 inches per foot of fill depth below the foundation base elevation. The excavation should be backfilled to the foundation base elevation in accordance with the recommendations presented in this report.

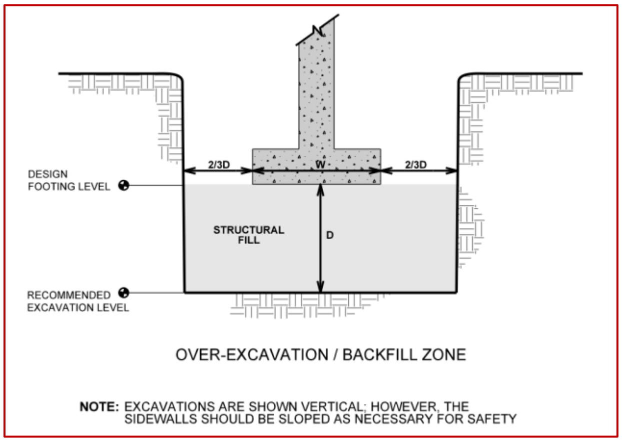
Shallow Foundation Construction Considerations

Subgrade soils beneath footings should be prepared and compacted as described in the **Earthwork** section of this report. The moisture content and compaction of subgrade soils should be maintained until foundation construction.

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of existing fill, water, and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed. If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with engineered fill placed, as recommended in the **Earthwork** section.



Floor Slabs

All slabs-on-grade undergo some movement. Provided the site is prepared in accordance with the **Earthwork** section of this report, we believe risk of movement is generally low for the soil conditions encountered on this site. We estimate settlement of slabs-on-grade constructed on native onsite soils prepared in accordance with this report should be on the order of about 1 inch or less. Where slab movement cannot be accepted or must be reduced, we are available to discuss floor movement mitigation techniques upon your request.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Native onsite soils prepared in accordance with **Earthwork** section of this report
Estimated Modulus of Subgrade Reaction [2,3]	For limited area loads or concentrated/point loads placed directly on slabs: ▪ 140 pounds per square inch per in (psi/in.) for slabs supported on compacted subgrade consisting of the on-site sand soils.

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads, the modulus of subgrade reaction would be lower.

We recommend the following precautions be observed where slabs-on-grade are used. These precautions will not eliminate slab movement, but they tend to reduce damage when movement occurs. Additional floor slab design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and foundations, columns, or utility lines to allow free vertical movement. This detail can reduce cracking when movement of the slab occurs. Non-bearing partition walls placed on the floor slab should be designed and constructed to allow at least 1 inch of slab movement.
- Frequent control joints should be provided in slabs to control the location and extent of cracking in accordance with the American Concrete Institute (ACI). For additional recommendations refer to the ACI Design Manual.
- The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder/barrier, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder/barrier.
- Other design and construction considerations, as outlined in the ACI Design Manual, Section 302.1R are recommended.

Floor Slab Construction Considerations

Fill/backfill placed beneath slabs should be scarified, moisture conditioned, and compacted as described in the **Earthwork** section of this report. Soils loosened during excavation or other construction activities should be removed or replaced as described in this report. Floor slabs should not be constructed on frozen subgrade.

Once fill is placed and the subgrade is prepared, it is important measures be planned and taken to reduce drying of the near surface materials. If the fill dries excessively prior to building construction, then it will be necessary to rework the upper, drier materials just prior to installing floor slabs.

We recommend the area underlying the floor slab be proof rolled shortly before slab construction. Particular attention should be paid to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material with properly compacted fill. Floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report shortly before placement of concrete.

Pavements and Aggregate Surfacing

Subgrade Preparation

Subgrade soils in areas planned for pavement and aggregate surfacing should be prepared in accordance with the **Earthwork** section of this report.

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are typically placed and compacted in a uniform manner. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, or rainfall/snow melt. As a result, the subgrade in areas of planned pavement and aggregate surfacing may not be suitable for construction and corrective action will be required. The subgrade should be carefully evaluated at the time of construction for signs of disturbance or instability. We recommend the subgrade be thoroughly proof rolled with a loaded tandem-axle dump truck or water truck prior to final grading. All subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to pavement construction and placement of the aggregate surfacing.

Pavement Design Considerations

Based on our boring data and anticipated grading, we expect on-site or import soils having similar or better properties will support pavements on this site. Pavement subgrade should be prepared in accordance with recommendations in the **Earthwork** section of this report. Testing indicates the subgrade materials generally classify as A-1-b and A-2-4 soils according to the American Association of State Highway and Transportation Officials (AASHTO) classification system. The AASHTO group index of these soils is 0. These subgrade materials have "SM" and "SW-SM " classifications in accordance with the Unified Soil Classification System (USCS) methods.

Traffic loading conditions were not available at the time this report was prepared. However, considering the type of development, we anticipate traffic loads at the site will be produced primarily by automobile and pick-up trucks, light delivery trucks and occasional trash removal trucks, semi-trucks, and emergency vehicles (such as fire trucks). The following table summarizes the traffic information assumed for determining pavement thickness.

Traffic Area	Traffic Type and Volume
Drive Lanes and Parking Areas	▪ Passenger cars and trucks: 100 vehicles per day ▪ Trash collection trucks: 2 per week ▪ Light delivery trucks: 3 per week

Traffic Area	Traffic Type and Volume
	▪ Occasional emergency vehicle (fire truck or ambulance)

Based on the assumed traffic type and volume, we used a total 18-kip equivalent single-axle load (ESAL's) of 80,000 (flexible) and 100,000 (rigid) and a performance period of 20 years was used to develop pavement thickness design.

Traffic type and volume estimates and/or design ESAL values used to determine pavement thickness for this project should be reviewed and approved by the owner and design team prior to commencement of paving operations. If heavier trucks or more frequent truck traffic will be present at the facility, Terracon should be provided with the information and allowed to review the pavement sections and provide supplemental recommendations if needed.

The required total thickness for flexible pavements is dependent primarily upon the soil or subgrade support characteristics and upon traffic loading conditions. Soil classifications and our experience indicate the subgrade soils at the site offer good pavement support when prepared properly.

In addition, a rigid pavement thickness was completed for the project. Rigid pavement thickness is based on an evaluation of the Modulus of Subgrade Reaction of the soils (k-value), the Modulus of Rupture of the concrete, and other factors. The k-value of the subgrade soil was estimated by correlation to the laboratory test results and was adjusted to take into consideration variations in subgrade materials and changing support throughout the year.

Minimum Asphalt and Concrete Pavement Thickness

Typical Pavement Section Thickness (inches)

Traffic Area	Alternative	Asphalt Concrete [1]	Aggregate Base Course [2]	Portland Cement Concrete [3]	Total Thickness
Drive Lanes and Parking Areas	AC + ABC	4	5	--	9
	PCC	--	--	6	6

Typical Pavement Section Thickness (inches)

Traffic Area	Alternative	Asphalt Concrete [1]	Aggregate Base Course [2]	Portland Cement Concrete [3]	Total Thickness
Trash container pads and other areas subjected to concentrated and repetitive loading conditions [4]	PCC	--	---	6	6

1. Asphalt concrete (AC) should be composed of a mixture of aggregate, filler and additives, if required, and approved bituminous material. AC should conform to approved mix designs stating the Marshall or Superpave properties, optimum asphalt content, job mix formula and recommended mixing and placing temperatures. Aggregate used in plant-mixed AC should meet particular gradations. Material meeting City of Cheyenne ¾" or ½" nominal maximum size specifications is recommended for AC. AC should be placed in lift thicknesses appropriate for the maximum nominal particle size of mix and compacted to a minimum of 92 percent of the maximum theoretical specific gravity.
2. Aggregate base course (ABC) should consist of a blend of sand and gravel which meets strict specifications for quality and gradation and should have an R-value of at least 70. Use of materials meeting Wyoming Department of Transportation (WYDOT) Class W specifications is recommended. ABC should be placed in maximum 6-inch lifts and compacted to at least 98 percent of the standard Proctor maximum dry density (ASTM D698).
3. Modulus of rupture of 600 psi minimum. This is roughly equivalent to a 28-day compressive strength of at least 4,200 psi. Four-inch maximum slump and 5 to 7 percent entrained air, 6-sack min. mix. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic.
4. Trash container pads should be large enough to support the container and the tipping axle of the collection truck. The use of steel reinforcement and/or a 6-inch thick layer of ABC could be considered to reduce and/or control cracking.

Longitudinal and transverse joints should be provided as needed in concrete pavements for expansion/contraction and isolation. The location and extent of joints should be based upon the final pavement geometry. Sawed joints should be cut within 24-hours of concrete placement. Joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

The pavement sections presented are based, in part, on design parameters selected by Terracon based on experience with similar projects and soil conditions and other information discussed above. Design parameters such as performance period, traffic type and frequency and other factors may vary with specific project requirements. Variation of these parameters may change the thickness of the pavement sections presented. Terracon is prepared to discuss the details of these parameters and their effects on pavement design and reevaluate pavement thickness, as appropriate.

Asphalt and Concrete Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. Collection and diversion of surface drainage away from paved areas is critical to satisfactory performance of pavements.

Openings in pavement, such as landscape islands, are sources for water infiltration into surrounding pavements. Water collects in the islands and migrates into the surrounding subgrade soils thereby degrading support of the pavement. This is especially applicable for islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils. The civil design for pavements with these conditions should consider features to restrict or to collect and discharge excess water from the islands. Examples of features are edge drains connected to the storm water collection system or other suitable outlet and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

Asphalt and Concrete Pavement Performance/Maintenance

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer and other members of the design team should consider the following recommendations in the design and layout of pavements:

- Subgrade and pavement surfaces should have a minimum 2 percent slope to promote proper surface drainage.
- Install pavement drainage surrounding areas anticipated for frequent wetting
- Install joint sealant and seal cracks immediately.
- Use low water-demand plantings and drip irrigation for landscaped areas.
- Seal all landscaped areas in, or adjacent to pavements or provide drains to reduce the risk of moisture migration to subgrade soils.
- Compaction of utility trenches for landscaped areas to the same criteria as the pavement subgrade.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on subgrade soils rather than base course materials.

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration.

Preventive maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Aggregate-Surfaced Roadways – Design Recommendations

Design of aggregate-surfaced roadways for the project has been based in general accordance with the "Aggregate-Surfaced Road Design Catalog" subsection of the 1993 AASHTO "Guide for the Design of Pavement Structures" and based on subsurface conditions encountered at the site and laboratory test results.

Recommended minimum pavement sections are provided in the table below.

Area	Relative Quality of Roadway Subgrade	Traffic Level	U.S. Climate Region	Aggregate-Surfacing Material Thickness (in.)
Equipment yard area	Fair to good [1]	Low	VI	8

1. Relative quality of roadway subgrade determined by the AASHTO low volume subgrade support characteristics for sand soils.

Quality roadway surfacing materials should consist of a blend of gravel, sand, and fines (clay and silt). We believe the maximum size particle should not exceed 1 inch in diameter and the gravel should be crushed with angular edges (not rounded). The blend of materials should be selected to allow for easy compaction resulting in a firm, low permeable surface promoting surface drainage off of the roadway surface. Aggregate base course should be placed in lifts not exceeding 6 inches and compacted to a minimum of 98 percent of the maximum dry unit weight as determined by ASTM D698.

A quality roadway surfacing material should also contain approximately 10 to 25 percent fines (silt and clay-sized particles passing the No. 200 sieve). The fines should exhibit low to moderate plasticity (plastic index less than 15) and will act as a binder to help reduce risk for wash boarding. If the fines content of a roadway surfacing material is comprised mostly of silt, the fines will be non-plastic and the surfacing materials will not have the benefit of the binder or cohesive aspects.

In order to reduce dust, reclaimed asphalt pavement (RAP) may be used as the upper 2 to 4 inches of the aggregate-surfacing. The RAP should be graded to the specified limits for WYDOT Grading W or L aggregate base course but modified to contain 10 to 25 percent fines and properly compacted. Periodic (1 to 2 times a year following maintenance grading) spraying of the surface with magnesium chloride or other dust suppressant may also be considered to reduce dust and wash boarding.

Aggregate-surfaced roadways performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of aggregate-surfaced roadways:

- Site grades should slope a minimum of 10 percent away from the roadways.
- The subgrade and the aggregate-surfaced roadways have a minimum 10 percent slope to promote proper surface drainage.
- Consider appropriate edge drainage.
- Install pavement drainage in surrounding areas anticipated for frequent wetting.

Aggregate-Surfaced Roadways – Maintenance

Preventative maintenance should be planned and provided for an ongoing aggregate-surfaced roadways management program in order to enhance future roadway performance. Preventative maintenance is usually the first priority when implementing a planned maintenance program and provides the highest return on investment for aggregate-surfaced roadways.

Periodic maintenance extends the service life of the aggregate-surfaced roadways and should include re-grading and replacement of aggregate base course in any deteriorated areas. Also, thicker aggregate base course sections could be used to reduce the required maintenance and extend the service life of the aggregate-surfaced roadways. Design alternatives which could reduce the risk of subgrade saturation and improve long-term performance include installing surface drains next to any areas where surface water could pond. Properly designed and constructed subsurface drainage will reduce the time subgrade soils are saturated and can also improve subgrade strength and performance.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

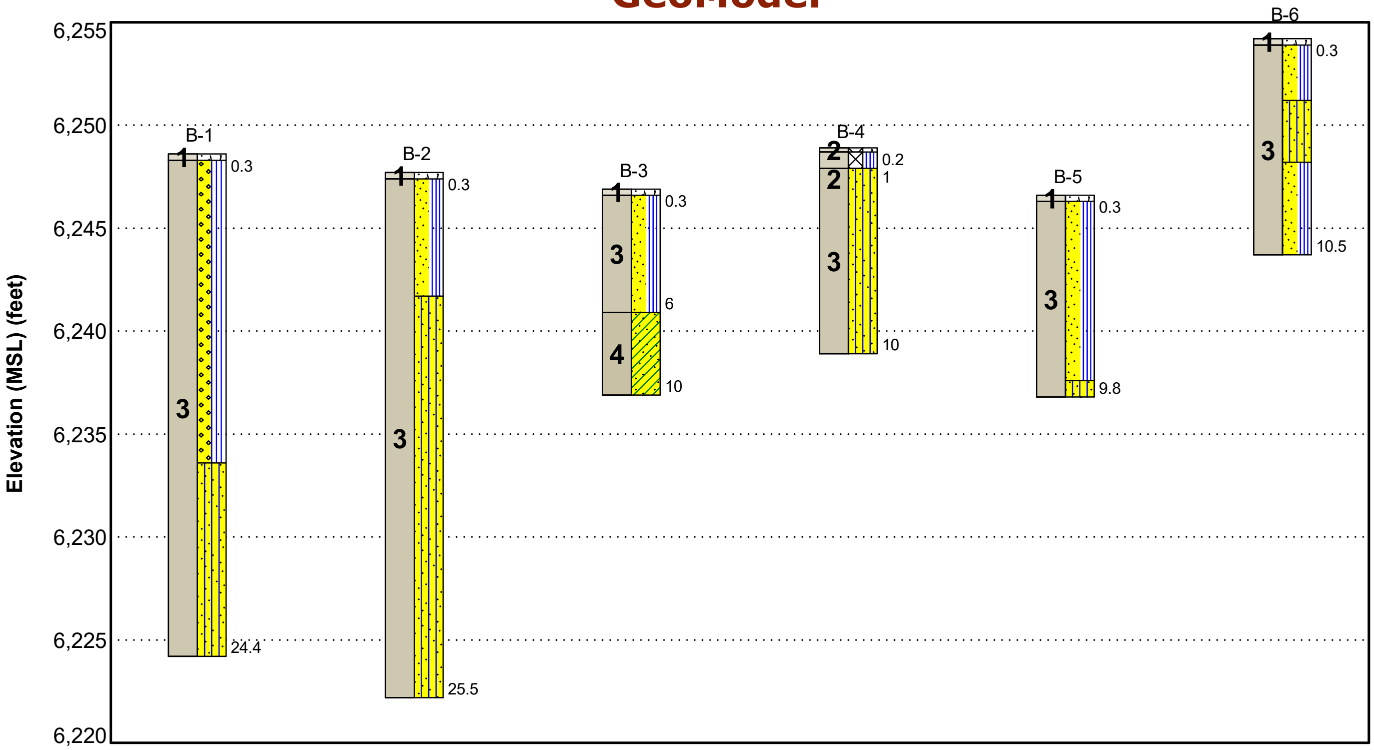
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

GeoModel

1505 Old Happy Jack Rd
Cheyenne, WY

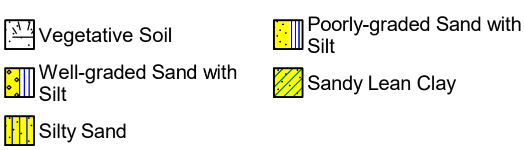
GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Vegetative Soil	About 3 to 4 inches of root penetration.
2	Apparent Existing Fill	Poorly graded sand with silt encountered in Boring No. B-4 only. Light brown.
3	Sand	Predominately medium dense to very dense well to poorly graded sand and silty sand with varying amounts of gravel. Mixed browns and tans.
4	Clay	Stiff to hard sandy lean clay, varying to clayey sand. Light brown.

LEGEND



NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures
Site Location and Exploration Plans
Exploration and Laboratory Results
Supporting Information

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
2	24.4 to 25.5	Planned building area
4	9.5 to 10.5	Planned pavement and aggregate surfacing areas

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±20 feet). Ground surface elevations and boring coordinates were surveyed and provided by Y2 Consultants after completion of drilling.

Subsurface Exploration Procedures: Borings were advanced with a truck-mounted, drill rig using solid-stem, continuous-flight augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was typically performed using modified California barrel and/or split-barrel sampling procedures. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. Modified California barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. The SPT resistance values, also referred to as N-values, are indicated in the boring logs at the test depths. Additionally, a bulk sample was collected at Boring No. B-1 from depths of approximately 1 to 6 feet below the ground surface. We observed and recorded groundwater levels during and shortly after the completion of drilling. Borings were backfilled with auger cuttings after completion of drilling.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Dry Unit Weight
- Atterberg Limits
- Grain Size Analysis
- Swell/Consolidation
- Chemical Analyses – pH, water soluble sulfate, sulfides, chlorides, RedOx, total salts, and electrical resistivity

The laboratory testing program included examination of soil samples by an engineer. Laboratory test results are indicated on the boring logs and are presented in depth in the **Exploration Results** section. The test results are used for the geotechnical engineering analyses and the development of pavement and earthwork recommendations. Laboratory tests are performed in general accordance with applicable local standards or other accepted standards. Procedural standards are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Based on the results of our field and laboratory programs, soils samples were described and classified in accordance with the General Notes and Unified Soil Classification System presented in the **Supporting Information** section.

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless noted above.

Site Location

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES   MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 41.088710° Longitude: -104.852800°

Model Layer	Depth (Ft.)	Description	Elevation.: 6248.6 (Ft.)
1	0.3	**VEGETATIVE SOIL**, about 3 inches of root penetration	6248.3
3	15.0	**WELL GRADED SAND WITH SILT (SW-SM)**, trace fine grained gravel, fine to coarse grained sand, light brown to tan, loose to very dense Weak to moderate cementaion below about 5 feet	6233.6
3	24.4	**SILTY SAND (SM)**, fine to medium grained, brown to light brown, very dense, weak to moderate cementation	6224.2
		Boring Terminated at 24.4 Feet	

Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Swell - Consol / Load (% / psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0–1.5			2-3-6 N=9		5.3			
3–4			21/12"		24.8	93		
6–7.5			13-27-45 N=72		3.0		NP	7
9–10.5			15-35-50/2"		2.8			
14–15.5			50/5"		2.5			
19–20.5			18-45-33 N=78		6.0			
24–24.4			50/5"					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
None encountered at completion of drilling.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Terracon Consultants, Inc.

Notes
Elevation Reference: Elevations provided by Y2 Consultants.

Advancement Method
4-inch diameter, solid-stem auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Boring Started
06-02-2023

Boring Completed
06-02-2023

Terracon

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 41.088570° Longitude: -104.853300°

Depth (Ft.) Elevation.: 6247.7 (Ft.)

Model Layer	Depth (Ft.)	Description	Elevation (Ft.)
1	0.3	**VEGETATIVE SOIL**, about 4 inches of root penetration	6247.4
3	6.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, light brown to tan, medium dense to very dense, varies to well graded sand with silt Weak to moderate cementation below about 3 feet	6241.7
3	25.5	**SILTY SAND (SM)**, fine grained, light brown, medium dense to very dense, weak to moderate cementation Fine to coarse grained sand, trace fine grained gravel below about 19 feet	6222.2

Boring Terminated at 25.5 Feet

Sample Depth (Ft.)	Field Test Results	Swell - Consol / Load (% / psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0–1.5	3-7-7 N=14		4.7			
3–4	50/5"		2.3			
6–7.5	14-9-15 N=24		3.1			
9–10	28/12"	-0.2/500	16.5	106	NP	32
14–15.5	6-14-21 N=35		15.8			
19–20	51/12"		15.3	117		
24–25.5	10-23-25 N=48		19.2			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations provided by Y2 Consultants.

Water Level Observations

None encountered at completion of drilling.

Advancement Method
4-inch diameter, solid-stem auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Terracon Consultants, Inc.

Boring Started
06-02-2023

Boring Completed
06-02-2023

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 41.088850° Longitude: -104.853500°

Elevation.: 6246.9 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Sample Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Swell - Consol / Load (% / psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.3	**VEGETATIVE SOIL**, about 4 inches of root penetration	6246.6									
3	6.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace fine grained gravel, fine to coarse grained sand, light brown to tan, dense to very dense, weak to moderate cementation, varies to well graded sand with silt	6240.9	0–1.5			6-19-17 N=36		11.0			
				3–4.5			27-50/5"		2.3			
4	10.0	**SANDY LEAN CLAY (CL)**, fine to medium grained sand, light brown, stiff to hard, weak to moderate cementation, varies to clayey sand	6236.9	6–7.5			7-7-10 N=17		14.2			
				9–10			63/12"		11.8		29-18-11	50

Boring Terminated at 10 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations provided by Y2 Consultants.

Water Level Observations
None encountered at completion of drilling.

Advancement Method
4-inch diameter, solid-stem auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Terracon Consultants, Inc.

Boring Started
06-02-2023

Boring Completed
06-02-2023

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 41.088390° Longitude: -104.853500°

Elevation.: 6248.9 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Sample Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Swell - Consol / Load (% / psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.2	**FILL - VEGETATIVE SOIL**, about 2 inches of root penetration	6248.7	0–1.5			2-2-12 N=14		15.3			
2	1.0	**FILL - POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, light brown	6247.9									
3	10.0	**SILTY SAND (SM)**, trace fine grained gravel, fine to coarse grained sand, light brown, medium dense to very dense, weak to moderate cementation, varies to well graded sand with silt	6238.9	3–4.5			55-50/3"		1.9		NP	12
				6–7.5			5-9-15 N=24		18.8			
				9–10			41/12"		6.8	114		

Boring Terminated at 10 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations provided by Y2 Consultants.

Water Level Observations

None encountered at completion of drilling.

Advancement Method
4-inch diameter, solid-stem auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Terracon Consultants, Inc.

Boring Started
06-02-2023

Boring Completed
06-02-2023

Boring Log No. B-5

Location: See Exploration Plan

Latitude: 41.088940° Longitude: -104.852300°

Depth (Ft.) Elevation.: 6246.6 (Ft.)

Model Layer	Depth (Ft.)	Description	Elevation (Ft.)	Water Level Observations	Sample Type	Field Test Results	Swell - Consol / Load (% / psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.3	**VEGETATIVE SOIL**, about 3 inches of root penetration	6246.3								
3		**POORLY GRADED SAND WITH SILT (SP-SM)**, trace fine grained gravel, fine to coarse grained sand, light brown to tan, medium dense, weak to moderate cementation, varies to well graded sand wtih silt				25-6-7 N=13		4.9			
						6-7-16 N=23		3.9			
						54/12"		11.5			
	9.0		6237.6								
		SILTY SAND (SM), fine to medium grained, tan, very dense, moderate cementation				18-50/3"		16.1			
	9.8		6236.8								

Boring Terminated at 9.8 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations provided by Y2 Consultants.

Water Level Observations

None encountered at completion of drilling.

Advancement Method
4-inch diameter, solid-stem auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Terracon Consultants, Inc.

Boring Started
06-02-2023

Boring Completed
06-02-2023

Boring Log No. B-6

Location: See Exploration Plan

Latitude: 41.088290° Longitude: -104.852500°

Elevation.: 6254.2 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Sample Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Swell - Consol / Load (% / psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.3	**VEGETATIVE SOIL**, about 6 inches of root penetration	6253.9									
3	3.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace fine grained gravel, fine to coarse grained sand, light brown, medium dense	6251.2				3-5-15 N=20		15.8			
3	6.0	**SILTY SAND (SM)**, fine to medium grained, light brown, medium dense	6248.2				14/12"	-0.1/500	7.6	109	NP	22
3	10.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace fine grained gravel, fine to coarse grained sand, light brown, dense, weak cementation	6243.7				9-20-19 N=39		3.5			
				10			8-14-23 N=37		3.5			

Boring Terminated at 10.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations provided by Y2 Consultants.

Water Level Observations

None encountered at completion of drilling.

Advancement Method
4-inch diameter, solid-stem auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

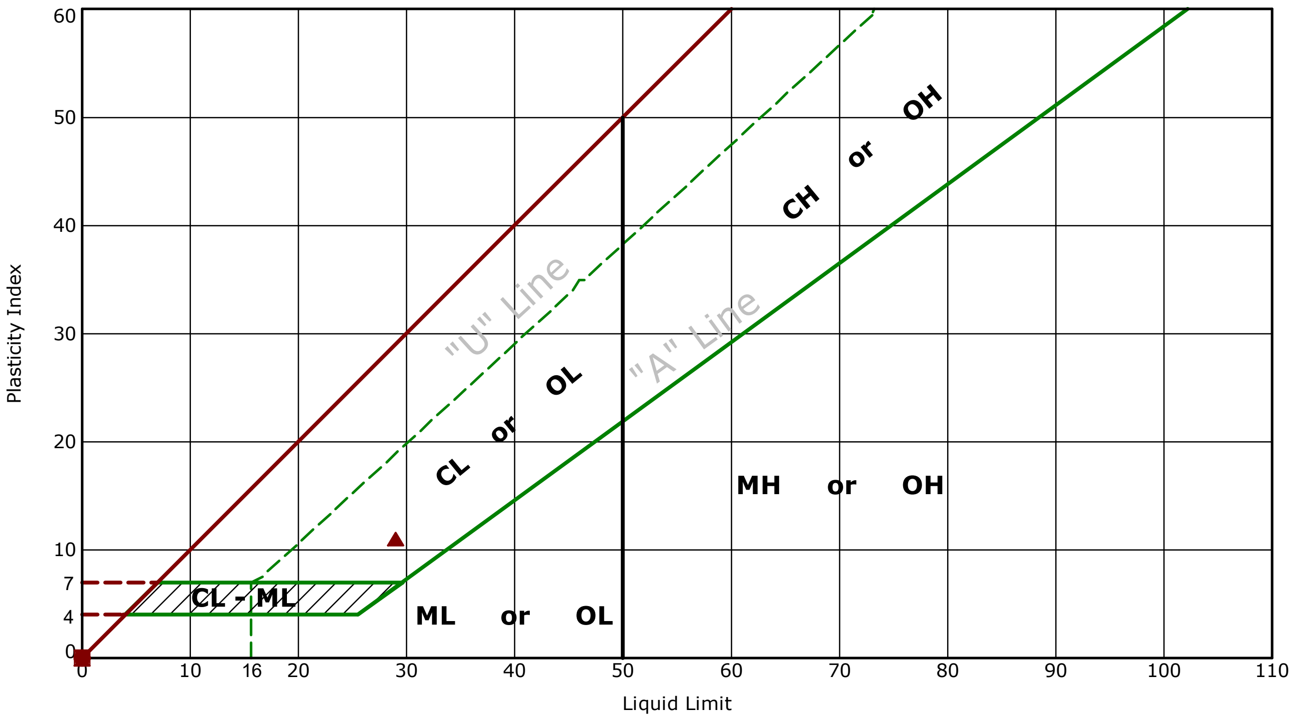
Driller
Terracon Consultants, Inc.

Boring Started
06-02-2023

Boring Completed
06-02-2023

Atterberg Limit Results

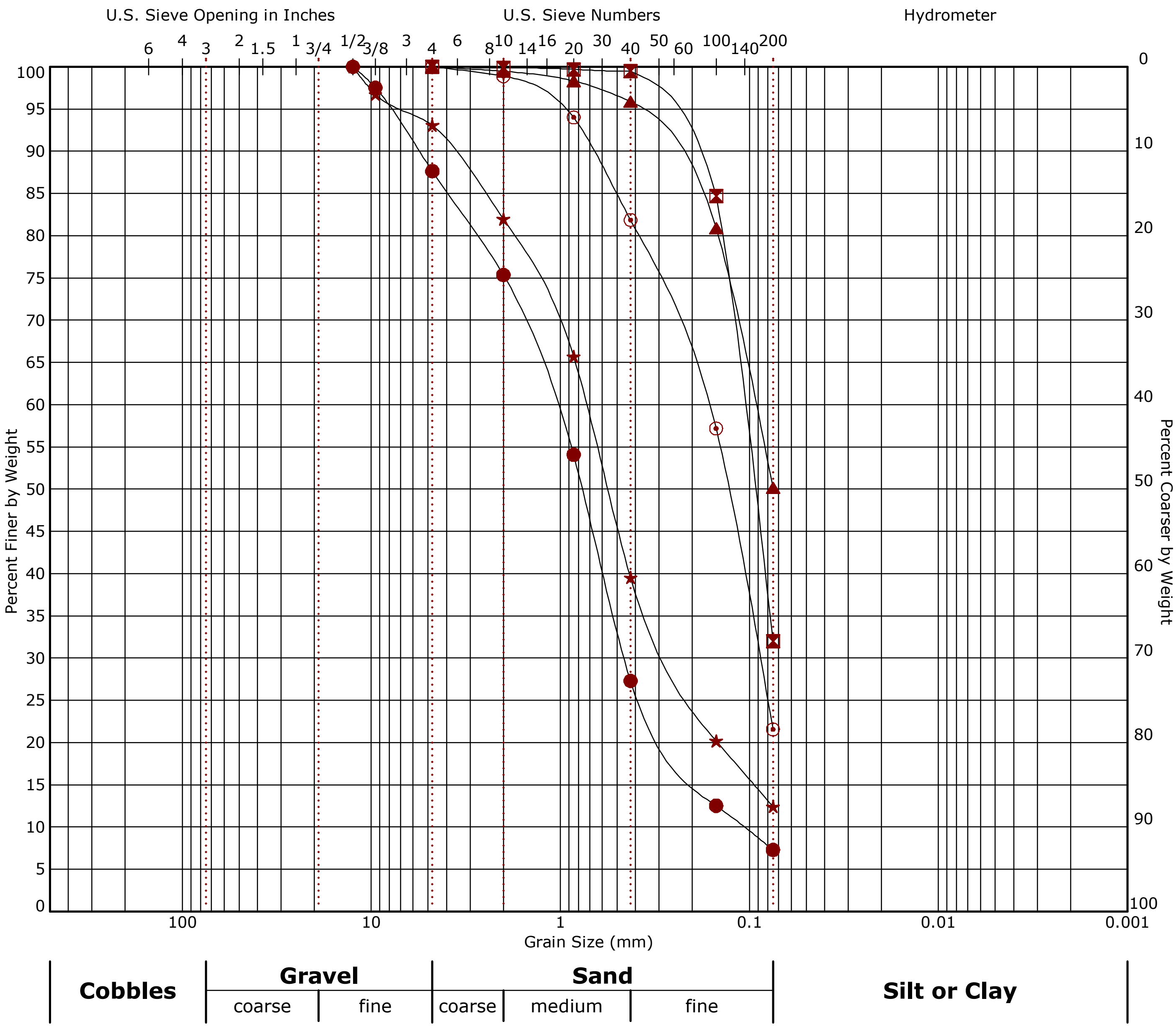
ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	6 - 7.5	NP	NP	NP	7.3	SW-SM	WELL-GRADED SAND with SILT
⊠	B-2	9 - 10	NP	NP	NP	32.0	SM	SILTY SAND
▲	B-3	9 - 10	29	18	11	50.2	CL	SANDY LEAN CLAY
★	B-4	3 - 4.5	NP	NP	NP	12.4	SM	SILTY SAND
⊙	B-6	3 - 4	NP	NP	NP	21.6	SM	SILTY SAND

Grain Size Distribution

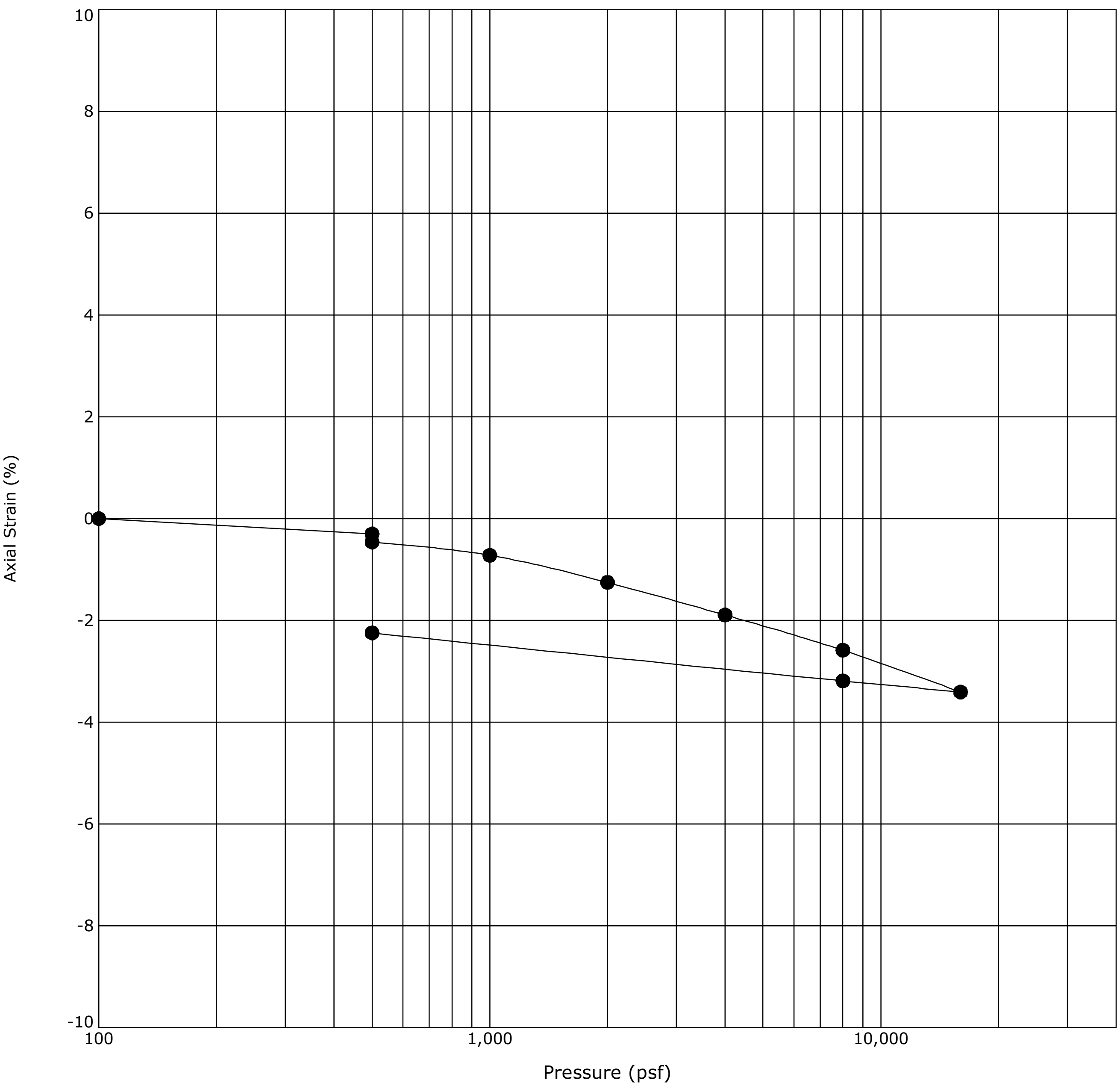
ASTM D422 / ASTM C136



	Boring ID	Depth (Ft)	USCS Classification	USCS	AASHTO	LL	PL	PI	Cc	Cu
●	B-1	6 - 7.5	WELL-GRADED SAND with SILT	SW-SM	A-1-b (0)	NP	NP	NP	1.79	10.04
⊠	B-2	9 - 10	SILTY SAND	SM	A-2-4 (0)	NP	NP	NP		
▲	B-3	9 - 10	SANDY LEAN CLAY	CL	A-6 (3)	29	18	11		
★	B-4	3 - 4.5	SILTY SAND	SM	A-1-b (0)	NP	NP	NP	1.46	12.09
⊙	B-6	3 - 4	SILTY SAND	SM	A-2-4 (0)	NP	NP	NP		

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-1	6 - 7.5	12.5	1.079	0.456	0.107	0.0	12.4	80.4	7.3		
⊠	B-2	9 - 10	4.75	0.108			0.0	0.0	68.0	32.0		
▲	B-3	9 - 10	4.75	0.094			0.0	0.0	49.8	50.2		
★	B-4	3 - 4.5	12.5	0.731	0.254		0.0	6.9	80.7	12.4		
⊙	B-6	3 - 4	4.75	0.169	0.088		0.0	0.0	78.4	21.6		

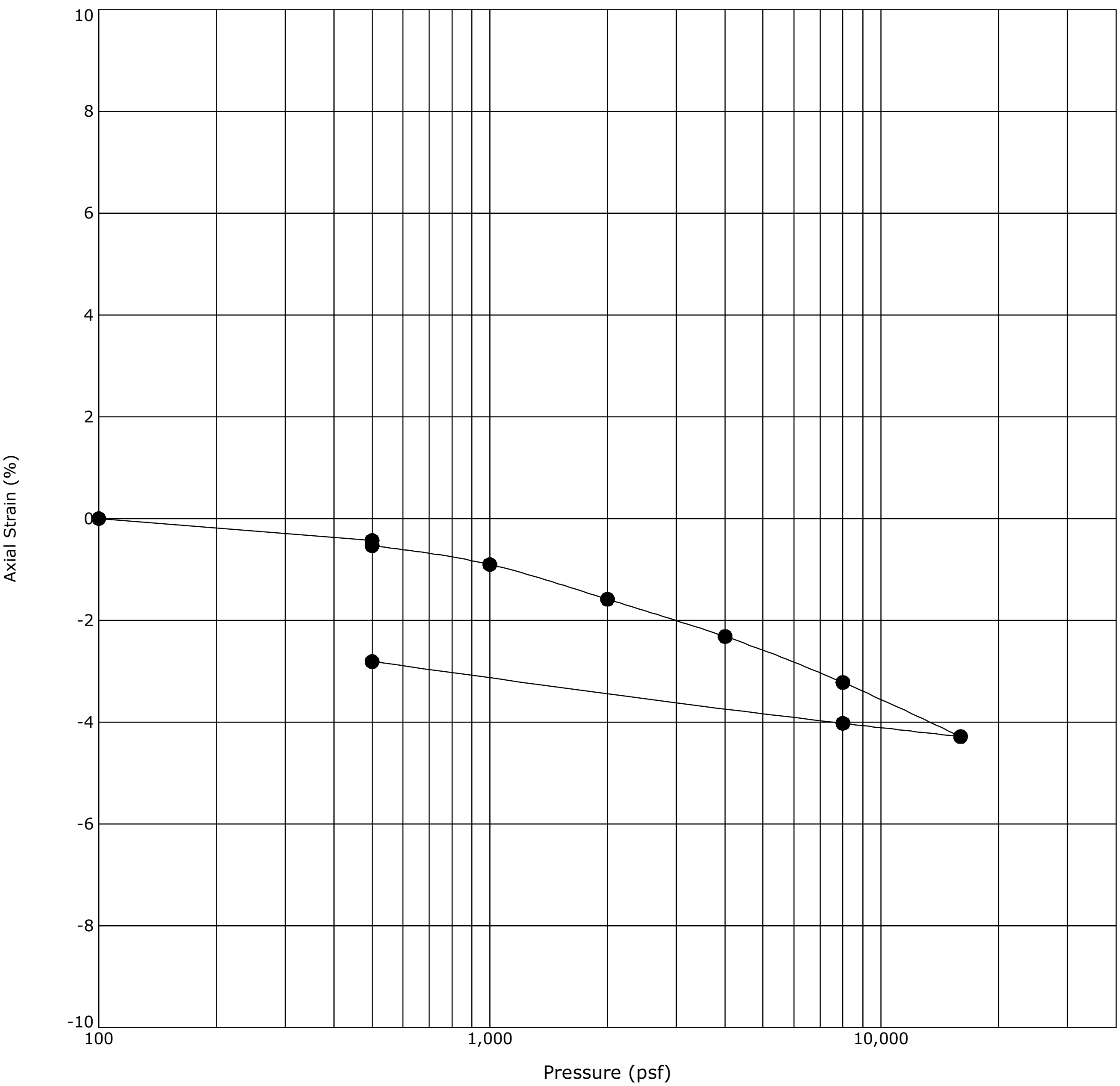
Swell Consolidation Test



Boring ID		Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
○	B-2	9 - 10	SILTY SAND (SM)	SM	106	16.6

Notes: Sample exhibited 0.2 percent compression when wetted under an applied pressure of 500 psf.

Swell Consolidation Test



Boring ID		Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
○	B-6	3 - 4	SILTY SAND (SM)	SM	109	7.5
Notes: Sample exhibited 0.1 percent compression when wetted under an applied pressure of 500 psf.						

CHEMICAL LABORATORY TEST REPORT

Project Number: 24235044
Service Date: 6/21/2023
Report Date: 6/21/2023

1505 Old Happy Jack Road
Cheyenne, Wyoming 82001
(307) 632-9224

Project: Overland Trails - Lot 1

Sample Location	B-1
Sample Depth (ft.)	1-6
pH Analysis, ASTM - G51	7.9
Water Soluble Sulfate (SO4), ASTM C1580 (mg/kg)	1,107
Sulfides, ASTM - D4658 (mg/kg)	0
Chlorides, ASTM - D512 (mg/kg)	16
RedOx, ASTM - D1498 (mV)	+250
Total Salts, ASTM - D1125 (mg/kg)	2,774
Resistivity, ASTM - G187 (ohm-cm)	5,092

Reviewed By: Steve Anderson
Laboratory Manager

Supporting Information

Contents:

Note: All attachments are one page unless noted above.

General Notes

Sampling	Water Level	Field Tests
Auger Cuttings Modified California Ring Sampler Standard Penetration Test	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N — Standard Penetration Test Resistance (Blows/Ft.) (HP) — Hand Penetrometer (T) — Torvane (DCP) — Dynamic Cone Penetrometer UC — Unconfined Compressive Strength (PID) — Photo-Ionization Detector (OVA) — Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Ring Sampler (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (psf)**	**Standard Penetration or N-Value (Blows/Ft.)**	**Ring Sampler (Blows/Ft.)**
Very Loose	0 - 3	0 - 5	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	6 - 14	Soft	500 to 1,000	2 - 4	3 - 5
Medium Dense	10 - 29	15 - 46	Medium Stiff	1,000 to 2,000	4 - 8	6 - 10
Dense	30 - 50	47 - 79	Stiff	2,000 to 4,000	8 - 15	11 - 18
Very Dense	> 50	> 80	Very Stiff	4,000 to 8,000	15 - 30	19 - 36
			Hard	> 8,000	> 30	> 36

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.