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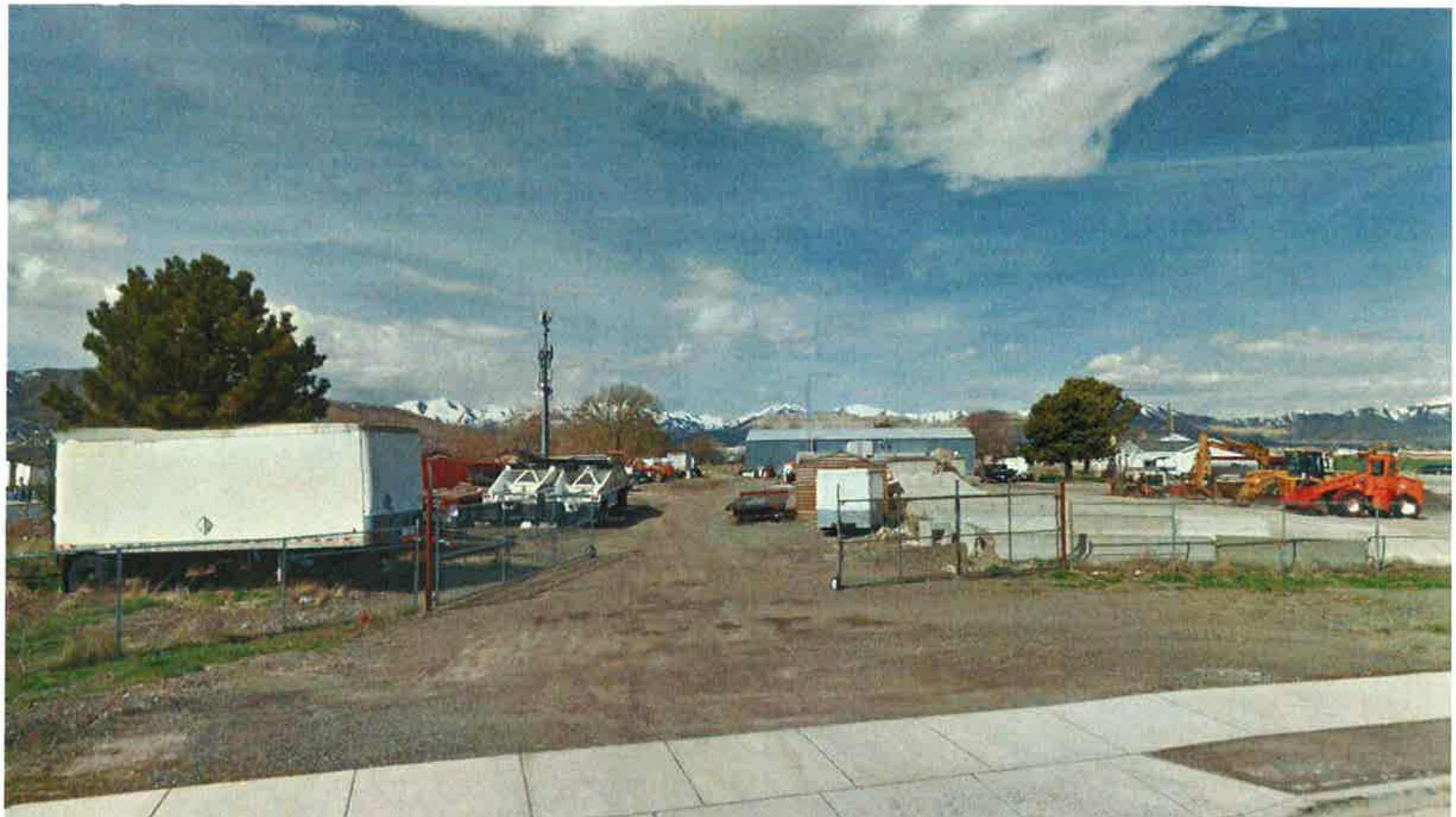

Engineering
Geology
Environmental (ESA I & II)
Organic Chemistry
Materials Testing
Special Inspections

GEOTECHNICAL ENGINEERING STUDY

Proposed Maverik Store

13400 South 4050 West
Riverton, Utah

Prepared For:

Mr. Russ Hamblin
Cardno, Inc.
1142 West 2320 South
Salt Lake City, Utah 84119

CMT Project No. 10419
October 23, 2017

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Mr. Russ Hamblin
Cardno, Inc.
1142 West 2320 South
Salt Lake City, Utah 84119

Subject: Geotechnical Engineering Study
Proposed Maverik Store
13400 South 4050 West
Riverton, Utah
CMT Project Number: 10419

Mr. Hamblin:

Submitted herewith is the report of our geotechnical engineering study for the subject site. This report contains the results of our findings and an engineering interpretation of the results with respect to the available project characteristics. It also contains recommendations to aid in the design and construction of the earth related phases of this project.

On October 5, 2017, a CMT Engineering Laboratories (CMT) engineer was on-site and supervised the drilling of 5 borings extending to depths of about 16.5 to 26.5 feet below the existing ground surface. Soil samples were obtained during the field operations and subsequently transported to our laboratory for further testing and observation.

Conventional spread and/or continuous footings may be utilized to support the proposed structures, provided the recommendations in this report are followed. A detailed discussion of design and construction criteria is presented in this report.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With 4 offices throughout Northern Utah and three offices in Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 492-4132.

Sincerely,
CMT Engineering Laboratories

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CMT ENGINEERING LABORATORIES

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1.0 INTRODUCTION

1.1 General

CMT Engineering Laboratories (CMT) was retained to conduct a geotechnical subsurface study for the construction of a new Maverik convenience store and gas station The site is situated on the south side of 13400 South Street and on the west side 4050 West Street in Riverton, Utah, as shown in **Vicinity Map** below.

Vicinity Map

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Mr. Russ Hamblin of Cardno, Inc., and Mr. Steve Smith of CMT Engineering Laboratories (CMT). In general, the objectives of this study were to define and evaluate the subsurface soil and groundwater conditions at the site, and provide appropriate foundation, earthwork, pavement and seismic recommendations to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope of work has included performing field exploration, which consisted of the drilling/logging/sampling of 5 borings, performing laboratory testing on representative samples, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report. This scope of work was authorized by returning a signed copy of our proposal dated September 15, 2017 and executed on September 22, 2017.

1.3 Description of Proposed Construction

We understand that the proposed construction consists of a new Maverik convenience store, associated fuel island with a steel canopy, installation of underground fuel storage tanks, and concrete and asphalt paving. We project that wall loads will not exceed 3,000 pounds per linear foot and column loads will not exceed 40,000 pounds. Floor slab loads are anticipated to be relatively light, with an average uniform loading not exceeding 150 pounds per square foot. If the loading conditions are different than we have projected, please notify us so that any appropriate modifications to our conclusions and recommendations contained herein can be made.

The parking/drive areas will utilize both asphalt and concrete pavement. Traffic is projected to consist of mostly automobiles and light trucks, a few daily medium-weight delivery trucks, a weekly garbage truck and tanker truck, and an occasional fire truck.

Site development will require some earthwork in the form of minor cutting and filling. A site grading plan was not available at the time of this report, but we project that maximum cuts and fills may be on the order of 3 to 4 feet. If deeper cuts or fills are planned, CMT should be notified to provide additional recommendations, if needed.

1.4 Executive Summary

The most significant geotechnical aspects regarding site development include the following:

1. Up to 7 feet of undocumented fill on the surface of isolated portions of the site that will require removal below foundations and floor slabs.
2. Groundwater was not encountered within the depths explored (maximum 26.5 feet).
3. Variable subsurface soils likely to be encountered at footing grades.
4. Foundations and floor slabs may be constructed on suitable undisturbed natural soils or on structural/engineered fill which extends to natural soils.

CMT must assess that topsoil, undocumented fills, and any debris, disturbed or unsuitable soils have been removed and that suitable soils have been encountered prior to placing site grading fills, footings, slabs, and pavements.

In the following sections, detailed discussions pertaining to the site and subsurface descriptions, geologic/seismic setting, earthwork, foundations, lateral resistance, lateral pressure, floor slabs, and pavements are provided.

2.0 FIELD EXPLORATION

2.1 General

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 5 borings were drilled throughout the site to depths of approximately 16.5 to 26.5 feet below the existing ground surface. Locations of the bore holes are presented on **Figure 1, Site Map**, shown in the Appendix.

Samples of the subsurface soils encountered in the borings were collected at varying depths through the hollow stem drill augers. Relatively undisturbed samples of the subsurface soils were obtained by hydraulically pushing a 3-inch diameter (Shelby) tube. Disturbed samples were collected utilizing a standard split spoon sampler. The split spoon sampler was driven 18 inches into the soils below the drill augers using a 140 pound hammer free-falling a distance of 30 inches. The number of hammer blows needed for each 6 inch interval was recorded. The sum of the hammer blows for the final 12 inches of penetration is known as a standard penetration test and this 'blow count' was recorded on the boring logs.

The borings were logged and the samples collected described in general accordance with ASTM[1] D-2488 based upon visual and textural examination. These field classifications were supplemented by subsequent examination and testing of select samples in our laboratory. Logs of the borings, including a description of the soil strata encountered, is presented on each individual Bore Hole Log, **Figures 2 through 6**, included in the Appendix. Sampling information and other pertinent data and observations are also included on the logs. In addition, a Key to Symbols defining the terms and symbols used on the logs is provided as **Figure 7** in the Appendix.

3.0 LABORATORY TESTING

3.1 General

Selected samples of the subsurface soils were subjected to various laboratory tests to assess pertinent engineering properties, as follows:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Dry Density, ASTM D-2937, Dry unit weight representing field conditions
3. Atterberg Limits, ASTM D-4318, Plasticity and workability
4. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
5. One Dimension Consolidation, ASTM D-2435, Consolidation properties
6. pH, Sulfate, Resistivity, AASHTO T-289, T-290, T-288, Corrosion potential

[1]American Society for Testing and Materials

3.2 Engineering Properties Lab Summary

Laboratory test results are presented on the bore hole logs (**Figures 2 through 6**) and in the following Lab Summary Table:

Engineering Properties Lab Summary Table

Bore Hole	Depth (feet)	Soil Class	Sample Type	Moisture Content (%)	Dry Denstiy (pcf)	Gradation			Atterberg Limits			Collapse (-) or Expansion (+)
						Grav	Sand	Fines	LL	PL	PI	
B-1	2.5	ML (FILL)	SPT	12.5						NP		
B-1	10	SM	SPT	15.8		7	53	40				
B-2	2.5	ML (FILL)	SPT	16.1		7	26	67				
B-2	7.5	GP-GM	SPT	5.5		49	40	11				
B-3	5	SM	SPT	7.9		10	65	25				
B-5	2.5	CL-ML	Shelby	18.1	103				27	20	7	<-1%

3.3 Corrosion Testing Lab Summary

To assess the potential of the natural soils to corrode buried steel and concrete, water soluble sulfate content (AASHTO T-290-95), resistivity (AASHTO T-288-91), and pH (AASHTO T-289) tests were performed on samples of the subsurface soils collected at the site. Test results are presented in the following table:

Corrosion Testing Lab Summary Table

Sample	Test Result		
	Sulfate Concentration (ppm)	Resistivity (ohm/cm)	pH
B-4 @ 5 feet	**123**	**2780**	**8.85**

Results of the test indicate a negligible potential for sulfate attack on concrete, thus Type II cement is acceptable. The resistivity test results indicate a moderate corrosive potential for un-coated or un-galvanized steel. Steps should be taken to ensure that proper cover of the reinforcing steel for reinforced concrete in contact with the natural soils.

4.0 GEOLOGIC & SEISMIC CONDITIONS

4.1 Geologic Setting

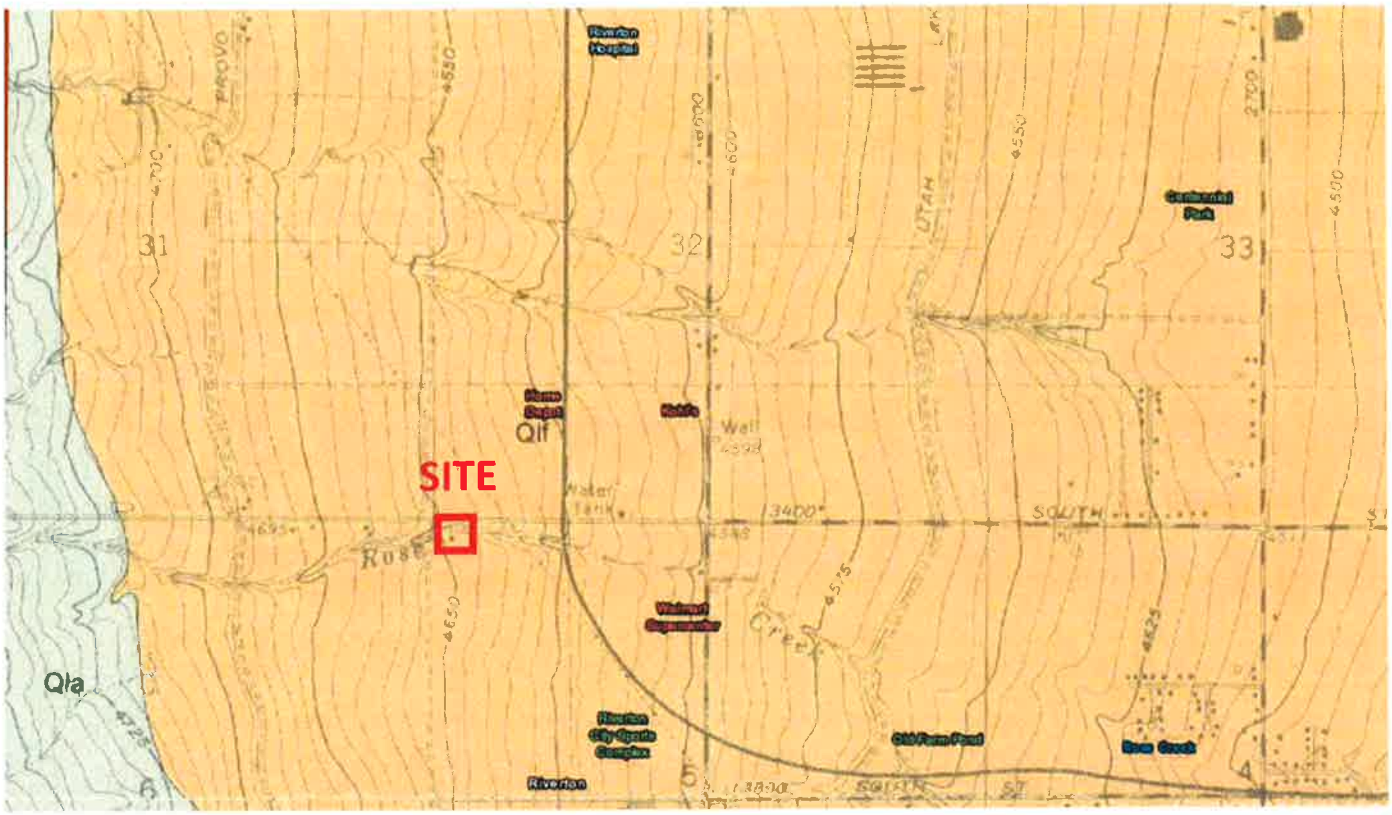
The subject site is located in the southwest portion of the Salt Lake Valley in north-central Utah at an elevation of approximately 4,674 feet above sea level. The Salt Lake Valley is a deep, sediment-filled basin that is part of the Basin and Range Physiographic Province. The valley was formed by extensional tectonic processes during the Tertiary and Quaternary geologic time periods. The valley is bordered by the Wasatch Mountain Range on the east and the Oquirrh Mountains on the west. The Salt Lake Valley is located within the Intermountain

Seismic Belt, a zone of ongoing tectonism and seismic activity extending from southwestern Montana to southwestern Utah. The active (evidence of movement in the last 10,000 years) Wasatch Fault Zone is part of the Intermountain Seismic Belt and extends from southeastern Idaho to central Utah along the western base of the Wasatch Mountain Range.

Much of northwestern Utah, including the Salt Lake Valley, was also previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, located to the northwest of the valley, is a remnant of this ancient fresh water lake. Lake Bonneville reached a high-stand elevation of approximately 5,092 feet above sea level at between 18,500 and 17,400 years ago. Approximately 17,400 years ago, the lake breached its basin in southeastern Idaho and dropped by almost 300 feet relatively fast as water drained into the Snake River. Following this catastrophic release, the lake level continued to drop slowly over time, primarily driven by drier climatic conditions, until reaching the current level of the Great Salt Lake. Shoreline terraces formed at the high-stand elevation of the lake and several subsequent lower lake levels are visible in places on the mountain slopes surrounding the valley. Much of the sediment within the Salt Lake Valley was deposited as lacustrine sediments during both the transgressive (rise) and regressive (fall) phases of Lake Bonneville.

The geology of the USGS Midvale, Utah 7.5 Minute Quadrangle, that includes the location of the subject site, has been mapped by Davis[2]. The surficial geology at the location of the subject site and adjacent properties is mapped as "Fine-grained lacustrine deposits of the Bonneville lake cycle" (Map Unit Qlf) dated to be late Pleistocene. Unit Qlf is described in the mapping as "Transgressive and regressive, deep-water sediments; brown, dark-brown, grayish-brown, and gray calcareous, laminated silt, clayey silt, and sandy silt; commonly contains isolated pebbles, cobbles, and thin lenses of sand and gravel that were deposited by ice-rafting (dropstones) and turbidity flows." No fill has been mapped at the location of the site on the geologic map. Refer to the **Geologic Map**, shown below.

[2]Davis, F.D., 2000, Geologic Map of the Midvale Quadrangle, Salt Lake County, Utah; Utah Geological Survey Map 177, Scale 1:24,000.



Geologic Map

4.2 Faulting

No surface fault traces are shown on the referenced geologic map crossing or projecting toward the subject site. The nearest mapped active fault trace is the Salt Lake segment of the Wasatch fault located about 7.8 miles east-southeast of the site.

The Wasatch Fault is considered a "normal" fault because movement along the fault is typically vertical. The east side of the fault, or the mountain block, typically moves upward relative to the valley block on the west side of the fault. The fault generally dips to the west below the valleys. In an earthquake, the point where the fault initially ruptures is called the 'focus" and generally occurs about 10 miles below the surface. The point on the surface directly above the focus, the epicenter, typically out in the valley, is usually where the strongest ground shaking occurs. The Wasatch Fault is one of the longest and most active normal faults in the world.

4.3 Seismicity

4.3.1 Site Class

Utah has adopted the International Building Code (IBC) 2015. IBC 2015 determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2015 (Section 1613.3.2) refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[3] 7. Given the subsurface soils at the site, including our projection of soils within the upper 100 feet of the soil profile, it is our opinion the site best fits Site Class D – Stiff Soil Profile, which we recommend for seismic structural design.

4.3.2 Ground Motions

The 2008 USGS mapping utilized by the IBC provides values of peak ground, short period and long period accelerations for the Site Class B boundary and the Maximum Considered Earthquake (MCE). This Site Class B boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The following table summarizes the peak ground, short period and long period accelerations for the MCE event, and incorporates the appropriate soil correction factor for a Site Class D soil profile at site grid coordinates of 40.5073 degrees north latitude and -111.9881 degrees west longitude:

Spectral Acceleration Value, T	Site Class B Boundary [mapped values] (g)	Site Coefficient	Site Class D [adjusted for site class effects] (g)	Design Values (g)
Peak Ground Acceleration	0.474	F_a = 1.026	0.486	0.324
Short Period Acceleration (0.2 Seconds)	S_S = 1.185	F_a = 1.026	S_{MS} = 1.216	S_{DS} = 0.811
Short Period Acceleration (1.0 Second)	S_1 = 0.394	F_v = 1.612	S_{M1} = 0.635	S_{D1} = 0.423

4.3.3 Liquefaction

The site is located within an area designated by the Utah Geologic Survey[4] as having "Very Low" liquefaction potential. Liquefaction is defined as the condition when saturated, loose, sandy soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will generally not liquefy during a major seismic event.

We did encounter layers of sand in the borings, however we did not encounter groundwater within the depths we explored (max. 26.5 feet). These conditions support the mapped liquefaction susceptibility designation for the soils we encountered.

4.4 Other Geologic Hazards

No landslide deposits or features, including lateral spread deposits, are mapped on or adjacent to the site. The site is not located within a known or mapped debris flow, or rock fall hazard area. The Federal Emergency

[3]American Society of Civil Engineers

[4] Utah Geological Survey, "Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah," Utah Geological Survey Public Information Series 28, August 1994. https://geology.utah.gov/hazards/earthquakes-faults/liquefaction/#tab-id-2

Management Agency (FEMA) online flood insurance rate map (FIRM)[5] shows the site to be located in a "Zone A" flood hazard potential area associated with drainage channel of Rose Creek which runs adjacent to the southern boundary of the site. FEMA defines the mapped Zone A area as "1% annual chance flood hazard."

5.0 SITE CONDITIONS

5.1 Surface Conditions

The site is currently occupied by a residence, a metal building, a small block building, and a couple small wood sheds. There were also several pieces of construction equipment, and some construction materials being stored on the site. The site grade is relatively level, with a very slight slope downward to the north. Based upon aerial photos dating back to 1997 that are readily available on the internet, most of the existing structures appear to have occupied the site since that time. A nearby residence was removed and 4050 West Street constructed between 2011 and 2013. The site is bordered on the north by 13400 South Street, on the south by a middle school, on the east by 4050 West Street, and on the west by undeveloped land (see **Vicinity Map** in **Section 1.1** above).

5.2 Subsurface Soils

At most boring locations the surficial 12 to 18 inches of soil was a gravelly fill soil, except at the location of B-5 where the gravelly fill was overlain by a couple inches of asphalt. At the location of boring B-1, additional fill soils, composed of silty/clayey sand with some debris, was encountered which extended about 7 feet below the surface. Below the fill soils were encountered layers of natural CLAY (CL), Silty and Silty/Clayey SAND (SM, SM/SP), Silty GRAVEL (GM) and Poorly Graded GRAVEL (GP-GM) with silt extending to the bottom of the borings. The clay soils were dark brown to tan in color, slightly moist to moist, and medium stiff to very stiff in consistency. The sand and gravel soils were reddish brown to tan in color, slightly moist to moist and in a loose to very dense state.

For a more descriptive interpretation of subsurface conditions, please refer to the bore hole logs, **Figures 2 through 6**, which graphically represent the subsurface conditions encountered. The lines designating the interface between soil types on the logs generally represent approximate boundaries; in situ, the transition between soil types may be gradual.

5.3 Groundwater

Groundwater was not encountered in the borings to the maximum depth explored of about 26.5 feet below existing grade. Groundwater levels can fluctuate as much as 1.5 to 2 feet seasonally. Numerous other factors such as heavy precipitation, irrigation of neighboring land, and other unforeseen factors, may also influence ground water elevations at the site. The detailed evaluation of these and other factors, which may be

[5]http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=cbe088e7c8704464aa0fc34eb99e7f30&extent=-112.09783821289032,40.47747563253941,-111.76550178710954,40.56360057284075

responsible for ground water fluctuations, is beyond the scope of this study. We do not anticipate groundwater being encountered during construction.

5.4 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions (particularly the depth/thickness of undocumented fill) should be anticipated. Due to the heterogeneous characteristics of natural soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory locations.

6.0 SITE PREPARATION AND GRADING

6.1 General

Based upon the conditions observed at the time of our subsurface exploration, up to approximately 7 feet of undocumented fill is present on the surface of a portion of the site. All undocumented fill shall be removed from beneath structures. Outside of building and canopy footprint areas, the existing fill can be left in place if the surface is properly prepared by removing the upper 24 inches below the proposed pavement sections recommended in this report, scarifying the exposed subgrade to a minimum depth of 8 inches, compacting the soils in place and then replacing the removed fill in properly compacted lifts. Where the existing fill is less than 2 feet thick below the proposed pavement sections given in this report, the fill may remain in place but must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed (up to a maximum depth of 2 feet) and replaced with structural fill.

The site should be examined by a CMT geotechnical engineer to assess that suitable natural soils have been exposed and any deleterious materials, loose and/or disturbed soils have been removed, prior to placing site grading fills, footings, slabs, and pavements.

Fill placed over large areas to raise overall site grades can induce settlements in the underlying natural soils. If more than 3 feet of site grading fill is anticipated over the natural ground surface, we should be notified to assess potential settlements and provide additional recommendations as needed. These recommendations may include placement of the site grading fill far in advance to allow potential settlements to occur prior to construction.

6.2 Temporary Excavations

In cohesive (clayey) soils, temporary construction excavations not exceeding 4 feet in depth may be constructed with near-vertical side slopes. Temporary excavations up to 15 feet deep, above or below groundwater, may be constructed with side slopes no steeper than one-half horizontal to one vertical (0.5H:1V). Excavations deeper than about 12 to 15 feet are not anticipated at the site.

For cohesionless (sandy/gravelly) soils, temporary construction excavations not exceeding 4 feet in depth should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 12 to 15 feet and above groundwater, side slopes should be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult to maintain, and will require very flat side slopes and/or shoring, bracing and dewatering.

To reduce disturbance of the natural soils during excavation, we recommend that smooth edge buckets/blades be utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated. All excavations should be made following OSHA safety guidelines.

6.3 Fill Material

The table on the following page are our recommendations for the various fill types we anticipate will be used at this site:

Fill Material Type	Description/Recommended Specification
Structural Fill	Placed below structures, flatwork and pavement. Well-graded sand/gravel mixture, with maximum particle size of 4 inches, a minimum 70% passing 3/4-inch sieve, a maximum 20% passing the No. 200 sieve, and a maximum Plasticity Index of 10.
Site Grading Fill	Placed over larger areas to raise the site grade. Sandy to gravelly soil, with a maximum particle size of 6 inches, a minimum 70% passing 3/4-inch sieve, and a maximum 50% passing No. 200 sieve.
Non-Structural Fill	Placed below non-structural areas, such as landscaping. On-site soils or imported soils, with a maximum particle size of 8 inches, including silt/clay soils not containing excessive amounts of degradable/organic material (see discussion below).
Stabilization Fill	Placed to stabilize soft areas prior to placing structural fill and/or site grading fill. Coarse angular gravels and cobbles 1 inch to 8 inches in size. May also use 1.5- to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i or 600X, or equivalent (see **Section 6.6**).

On-site natural sand and gravel soils, and the existing gravel fill soils may be suitable for use as structural fill, and may also be used as site grading fill and non-structural fill.

On-site clay soils may be used as site grading fill and non-structural fill, but are also moisture-sensitive (see discussion below). Note that moisture-sensitive soils, including on-site silt/clay soils, are inherently more difficult to work with in proper moisture conditioning (they are very sensitive to changes in moisture content), requiring very close moisture control during placement and compaction. This will be very difficult, if not impossible, during wet and cold periods of the year. We also recommend that the maximum site grading fill thickness using on-site clay soils be 3 feet below structures, to minimize potential settlements.

All fill material should be approved by a CMT geotechnical engineer prior to placement.

6.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-1557 (or AASHTO[6] T-180) in accordance with the following recommendations:

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of structures, and below flatwork and pavement (applies to structural fill and site grading fill)	0 to 5 5 to 8	95 98
Site grading fill outside area defined above	0 to 5 5 to 8	92 95
Utility trenches within structural areas	--	96
Roadbase and subbase	-	96
Non-structural fill	0 to 5 5 to 8	90 92

Structural fills greater than 8 feet thick are not anticipated at the site. For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

6.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA[7] requirements.

All utility trench backfill material below structurally loaded facilities (foundations, floor slabs, flatwork, parking lots/drive areas, etc.) shall be placed at the same density requirements established for structural fill in the previous section.

Most utility companies and local governments are requiring Type A-1a or A-1b (AASHTO Designation) soils (sand/gravel soils with limited fines) be used as backfill over utilities within public rights of way, and the backfill be compacted over the full depth above the bedding zone to at least 96% of the maximum dry density as determined by AASHTO T-180 (ASTM D-1557). The natural sand and gravel soils at this site may meet these specifications.

[6] American Association of State Highway and Transportation Officials
[7] American Public Works Association

Where the utility does not underlie structurally loaded facilities and public rights of way, on-site fill and natural soils may be utilized as trench backfill above the bedding layer, provided they are properly moisture conditioned and compacted to the minimum requirements stated above in **Section 6.4**.

6.6 Stabilization

The natural clay soils at this site will likely be susceptible to rutting and pumping. The likelihood of disturbance or rutting and/or pumping of the existing natural soils is a function of the load applied to the surface, as well as the frequency of the load. Consequently, rutting and pumping can be minimized by avoiding concentrated traffic, minimizing the load applied to the surface by using lighter equipment and/or partial loads, by working in drier times of the year, or by providing a working surface for the equipment. Rubber-tired equipment particularly, because of high pressures, promotes instability in moist/wet, soft soils.

If rutting or pumping occurs, traffic should be stopped and the disturbed soils should be removed and replaced with stabilization material. Typically, a minimum of 18 inches of the disturbed soils must be removed to be effective. However, deeper removal is sometimes required.

To stabilize soft subgrade conditions (if encountered), a mixture of coarse, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel should be utilized. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i or 600X, or equivalent. Its use will also help avoid mixing of the subgrade soils with the gravelly material. After excavating the soft/disturbed soils, the fabric should be spread across the bottom of the excavation and up the sides a minimum of 18 inches. Otherwise, it should be placed in accordance with the manufacturer's recommendation, including proper overlaps. The gravel material can then be placed over the fabric in compacted lifts as described above.

7.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics, the subsurface conditions observed in the field and the laboratory test data, as well as common geotechnical engineering practice.

7.1 Foundation Recommendations

Based on our geotechnical engineering analyses, the proposed structures may be supported upon conventional spread and/or continuous wall foundations placed entirely on suitable, undisturbed uniform natural soils or entirely on structural fill extending to suitable natural soils. Footings may be designed using a net bearing pressure of 2,000 psf if placed on suitable, undisturbed, uniform natural soils or 2,500 psf if placed on a minimum 18 inches of structural fill.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade, thus the weight of the footing and backfill to lowest adjacent final grade need not be considered. The allowable bearing pressure may be increased by 1/3 for temporary loads such as wind and seismic forces.

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 30 inches below final grade.
2. Interior footings not subject to frost should be placed at least 16 inches below grade.
3. Continuous footing widths should be maintained at a minimum of 18 inches.
4. Spot footings should be a minimum of 24 inches wide.

7.2 Installation

Foundations shall not be placed on topsoil with organics, undocumented fill, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

Deep, large roots may be encountered where larger bushes are present on portions of the site; such large roots should be removed. If unsuitable soils are encountered, they must be completely removed and replaced with properly compacted structural fill. Excavation bottoms should be examined by a qualified geotechnical engineer to confirm that suitable bearing materials soils have been exposed.

All structural fill should meet the requirements for such, and should be placed and compacted in accordance with **Section 6** above. The width of structural replacement fill below footings should be equal to the width of the footing plus 1 foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

The minimum thickness of structural fill below footings should be equivalent to one-third the thickness of structural fill below any other portion of the foundations. For example, if footings will cross over the area where the existing fill on the surface extends about 7 feet, and the maximum depth of structural fill used after removal of the existing fill is 6 feet, all footings for the new structure should be underlain by a minimum 2.5 feet of structural fill.

7.3 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience some settlement, but we anticipate that total settlements of footings founded as recommended above will not exceed 1 inch, with differential settlements on the order of 0.5 inches over a distance of 25 feet. We expect approximately 50% of the total settlement to initially take place during construction.

7.4 Uplift Loads

Uplift loads may be resisted by the weight of the foundation and the backfill wedge above the top of the foundation within the area defined by an imaginary line extending outward from the outside top edge of the footing 10 degrees from vertical, up to final grade. A unit weight of 120 pounds per square foot can be used for well-graded sand and gravel backfill (structural/engineered fill) over the footings.

7.5 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.30 for natural clay soils or 0.40 for structural fill, may be utilized for design. Passive resistance provided by properly placed and compacted structural fill above the water table may be considered equivalent to a fluid with a density of 330 pcf. A combination of passive earth resistance and friction may be utilized if the friction component of the total is divided by 1.5.

8.0 LATERAL EARTH PRESSURES

We project that the building will be constructed slab on grade. However, for shallow retaining walls or utility boxes up to 4 feet tall the following lateral pressure discussion is provided. Parameters, as presented within this section, are for backfills which will consist of drained granular soil placed and compacted in accordance with the recommendations presented herein. If other soil types will be used as backfill, we should be notified so that appropriate modifications to these values can be provided, as needed.

The lateral pressures imposed upon subgrade facilities will depend upon the relative rigidity and movement of the backfilled structure. Following are the recommended lateral pressure values, which also assume that the soil surface behind the wall is horizontal and that the backfill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

Condition	Equivalent Fluid Pressure (psf/ft)	
	Static	Seismic
Active Pressure (wall is allowed to yield, i.e. move away from the soil, with a minimum 0.001H movement/rotation at the top of the wall, where "H" is the total height of the wall)	43	54
At-Rest Pressure (wall is not allowed to yield)	65	---
Passive Pressure (wall moves into the soil)	330	440

9.0 FLOOR SLABS

Floor slabs may be established upon suitable, undisturbed, natural soils and/or on structural fill extending to suitable natural soils (same as for foundations). Under no circumstances shall floor slabs be established directly on any topsoil, non-engineered fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In order to facilitate curing of the concrete, we recommend that floor slabs be directly underlain by at least 4 inches of "free-draining" fill, such as "pea" gravel or 3/4-inch quarters to 1-inch minus, clean, gap-graded gravel. To help control normal shrinkage and stress cracking, the floor slabs should have the following features:

1. Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints;
2. Frequent crack control joints; and
3. Non-rigid attachment of the slabs to foundation walls and bearing slabs.

10.0 DRAINAGE RECOMMENDATIONS

It is important to the long-term performance of foundations and floor slabs that water not be allowed to collect near the foundation walls and infiltrate into the underlying soils. We recommend the following:

1. All areas around the structure should be sloped to provide drainage away from the foundations. We recommend a minimum slope of 4 inches in the first 10 feet away from the structure. This slope should be maintained throughout the lifetime of the structure.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge at least 10 feet from the foundation walls or well beyond the backfill limits, whichever is greater.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-1557. Water consolidation methods should not be used under any circumstances.

4. Landscape sprinklers should be aimed away from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Over watering should be avoided.

5. Other precautions that may become evident during construction.

11.0 PAVEMENTS

We anticipate the natural clay soils will exhibit poor pavement support characteristics when saturated or nearly saturated. Based on our laboratory testing experience with similar soils, our pavement design is based upon a California Bearing Ratio (CBR) of 3 for the natural clay soils. All pavement areas must be prepared as discussed above in **Section 6.1**. Under no circumstances shall pavements be established over topsoil, un-prepared existing non-engineered fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In pavement areas, subsequent to stripping and prior to the placement of pavement materials, the exposed subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or otherwise unsuitable soils are encountered, we recommend they be removed to a minimum of 18 inches below the subgrade level and replaced with structural fill.

Given the projected traffic as discussed above in **Section 1.3**, the following pavement sections are recommended for the given ESAL's (18-kip equivalent single-axle loads) per day:

Material	Pavement Section Thickness (inches)					
	Parking Areas (3 ESAL's per day)			Drive Areas (8 ESAL's per day)		
Asphalt	3	3	---	3	3	---
Concrete	---	--	5	---	---	6
Road-Base	7	4	5	11	5	5
Subbase	0	6	0	0	8	0
Total Thickness	10	13	10	14	16	11

Untreated base course (UTBC) should conform to city specifications, or to 1-inch-minus UDOT specifications for A–1-a/NP, and have a minimum CBR value of 70%. Material meeting our specification for structural fill can be used for subbase, as long as the fines content (percent passing No. 200 sieve) does not exceed 15%. Asphalt should conform to the standard city or UDOT specification.

The asphalt pavement should be compacted to 96% of the maximum density for the asphalt material. Roadbase and subbase material should be compacted as recommended above in **Section 6.4**.

12.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program for which we can offer discounted rates. With CMT onsite we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which vary from those described in this report. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This program may include, but not necessarily be limited to, the following:

12.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

12.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Modified Proctor, ASTM D-1557) tests should be requested by the contractor immediately after delivery of any fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

12.3 Excavations

All excavation procedures and processes should be observed by a geotechnical engineer from CMT or his representative. In addition, for the recommendations in this report to be valid, all backfill and structural fill placed in trenches and all pavements should be density tested by CMT. We recommend that freshly mixed concrete be tested by CMT in accordance with ASTM designations.

12.4 Vibration Monitoring

Construction activities, particularly site grading and fill placement, can induce vibrations in existing structures adjacent to the site. Such vibrations can cause damage to adjacent buildings, depending on the building composition and underlying soils. It can be prudent to monitor vibrations from construction activities to maintain records that vibrations did not exceed a pre-defined threshold known to potentially cause damage. CMT can provide this monitoring if desired.

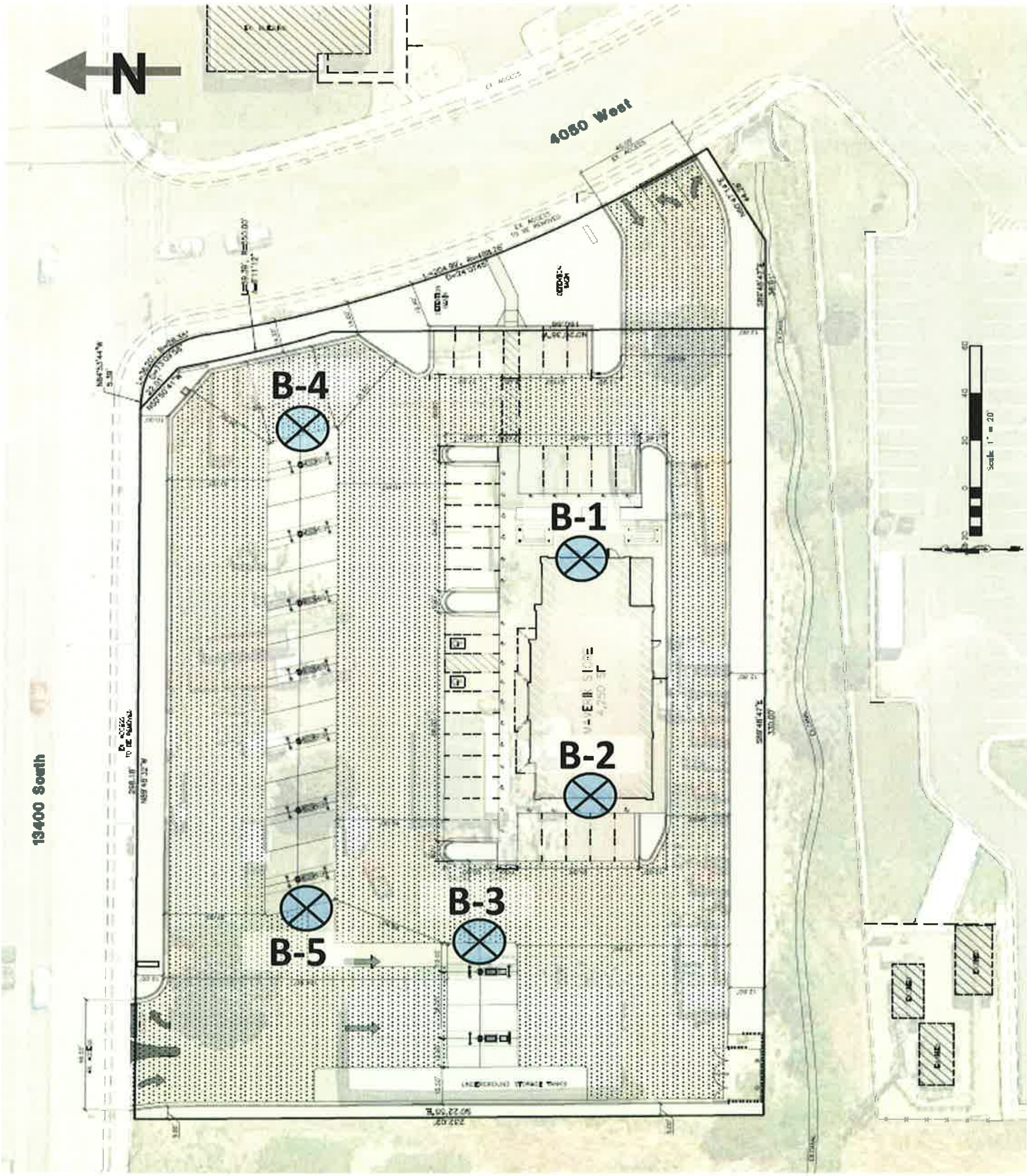
13.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 492-4132. To schedule materials testing, please call (801) 381-5141.

Appendix



Maverik Country Store	CMT ENGINEERING LABORATORIES			Figure:
13400 South 4050 West, Riverton, UT	Site Map	Date:	23-Oct-17	1
		Job #	10419	

Maverik Store

13400 South 4050 West, Riverton, Utah

Bore Hole Log

B-1

Boring Type: Hollow-Stem Auger
Surface Elev. (approx):

Total Depth: 26.5'
Water Depth: (see Remarks)

Date: 10/4/17
Job #: 10419

Depth (ft)	Soil Description	Sample Type	Sample #	Blows (N)	Blows (N) Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	FILL: GRAVEL / ROADBASE												
	FILL: Silty/clayey sand, assorted debris (wood, small concrete chunks)												
			1	8 11 11	22	12.5						NP	NP
4													
			2	7 2 3	5								
	Brown Native Silty SAND (SM) moist to slightly moist, medium dense												
8			3										
			4	4 5 6	11	15.8		7	53	40			
12													
16			5	3 8 5	13								
20			6	4 5 5	10								
24													
	very dense		7	32 50/5"	50/5"								
	REFUSAL AT 26.5'												
28													

Remarks: Groundwater not encountered during drilling.

CMT ENGINEERING LABORATORIES

Drilled By: Great Basin Drilling
Logged By: Sterling Howell

Figure: 2

Maverik Store

13400 South 4050 West, Riverton, Utah

Bore Hole Log

B-2

Boring Type: Hollow-Stem Auger
Surface Elev. (approx):

Total Depth: 16.5'
Water Depth: (see Remarks)

Date: 10/4/17
Job #: 10419

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gravation: Gravel %	Sand %	Fines %	Atterberg: LL	PL	PI
0		FILL: GRAVEL/ROADBASE												
		Dark brown Lean CLAY (CL), some sand, trace gravel moist to slightly moist												
		medium stiff		8	5 4 3	7	16.1		7	26	67			
4														
				9	2 2 2	4								
8		Tan Poorly Graded GRAVEL with silt (GP-GM) and sand medium dense		10	18 18 8	26	5.5		49	40	11			
		Tan Lean CLAY (CL), with sand moist, very stiff		11	5 8 16	24								
12														
		grades with brown silty clay with sand stiff		12	8 6 7	13								
16														
		END AT 16.5'												
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Figure: 3

CMT ENGINEERING LABORATORIES

Excavated By: Great Basin Drilling
Logged By: Sterling Howell
Page: 1 of 1

Maverik Store

13400 South 4050 West, Riverton, Utah

Bore Hole Log — B-3

Boring Type: Hollow-Stem Auger
Surface Elev. (approx):
Total Depth: 16.5'
Water Depth: (see Remarks)
Date: 10/4/17
Job #: 10419

Depth (ft)	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density (pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	FILL: GRAVEL / ROADBASE												
	Reddish Brown Silty SAND (SM), some gravel												
	moist, loose to medium dense		13	13, 5, 4	9								
4													
			14	3, 5, 7	12	7.9		10	65	25			
8			15	14, 4, 3	7								
			16	4, 4, 6	10								
12													
	Brown CLAY (CL), with sand; moist to very moist, stiff		17	4, 5, 4	9								
16	END AT 16.5'												
20													
24													
28													

Remarks: Groundwater not encountered during drilling.

CMT ENGINEERING LABORATORIES

Excavated By: Great Basin Drilling
Logged By: Sterling Howell

Figure: 4

Maverik Store

13400 South 4050 West, Riverton, Utah

Bore Hole Log

B-4

Boring Type: Hollow-Stem Auger
Surface Elev. (approx):

Total Depth: 16.5'
Water Depth: (see Remarks)

Date: 10/4/17
Job #: 10419

Depth (ft)	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	FILL: GRAVEL / ROADBASE												
	Brown to Tan CLAY (CL), with gravel; moist												
	stiff		18	3 5 4	9								
4													
	Brown Silty SAND (SM); moist, medium dense (estimated)		19										
8	Brown CLAY (CL), with sand; moist, medium stiff		20	1 3 2	5								
	Brown Silty GRAVEL (GM), with sand; moist, dense		21	4 7 27	34								
12													
	very dense		22	50/3"	50/3"								
16	END AT 16.5'												
20													
24													
28													

Remarks: Groundwater not encountered during drilling.

CMT ENGINEERING LABORATORIES

Excavated By: Great Basin Drilling
Logged By: Sterling Howell
Page: 1 of 1

Figure: 5

Maverik Store

13400 South 4050 West, Riverton, Utah

Bore Hole Log

B-5

Boring Type: Hollow-Stem Auger
Surface Elev. (approx):

Total Depth: 16.5'
Water Depth: (see Remarks)

Date: 10/4/17
Job #: 10419

Depth (ft)	Soil Description	Sample #	Blows (N)	Blows Total	Moisture (%)	Dry Density (pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	ASPHALT											
	FILL: GRAVEL / ROADBASE											
	Brown Silty CLAY (CL-ML), with sand; moist											
	stiff	23			18.1	103				27	20	7
4												
		24	5, 9, 6	15								
8	very stiff	25	5, 11, 10	21								
	Brown Silty Clayey SAND (SM/SC); moist, loose	26	2, 2, 3	5								
12												
16		27	2, 3, 4	7								
	END AT 16.5'											
20												
24												
28												

Remarks: Groundwater not encountered during drilling.

CMT ENGINEERING LABORATORIES

Excavated By: Great Basin Drilling
Logged By: Sterling Howell

Figure: 6

Maverik Store

13400 South 4050 West, Riverton, Utah

Key to Symbols

Date: 10/4/17

Job #: 10419

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows(N)	Blows(N) Total	Moisture (%)	Dry Density(pcf)	Gradation ⑩ Gravel %	Gradation ⑩ Sand %	Gradation ⑩ Fines %	Atterberg ⑪ LL	Atterberg ⑪ PL	Atterberg ⑪ PI
①	②	③	④	⑤	⑥	⑦	⑧	⑨						

COLUMN DESCRIPTIONS

① **Depth (ft.):** Depth (feet) below the ground surface (including groundwater depth - see water symbol below).

② **Graphic Log:** Graphic depicting type of soil encountered (see ② below).

③ **Soil Description:** Description of soils encountered, including Unified Soil Classification Symbol (see below).

④ **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below-right.

⑤ **Sample #:** Consecutive numbering of soil samples collected during field exploration.

⑥ **Blows:** Number of blows to advance sampler in 6" increments, using a 140-lb hammer with 30" drop.

⑦ **Total Blows:** Number of blows to advance sampler the 2nd and 3rd 6" increments.

⑧ **Moisture (%):** Water content of soil sample measured in laboratory (percentage of dry weight of sample).

⑨ **Dry Density (pcf):** The dry density of a soil measured in laboratory (pounds per cubic foot).

⑩ **Gradation:** Percentages of Gravel, Sand and Fines (Silt/Clay), obtained from lab test results of soil passing the No. 4 and No. 200 sieves.

⑪ **Atterberg:** Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION		MODIFIERS
Description	**Thickness**	**Trace**
Seam	Up to ½ inch	<5%
Lense	Up to 12 inches	**Some**
Layer	Greater than 12 in.	5-12%
Occasional	1 or less per foot	**With**
Frequent	More than 1 per foot	> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Saturated: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	②	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	GRAVELS The coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (< 5% fines)	GW		Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP		Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM		Silty Gravels, Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS The coarse fraction passing through No. 4 sieve.	CLEAN SANDS (< 5% fines)	SW		Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP		Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM		Silty Sands, Sand-Silt Mixtures
			SC		Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS Liquid Limit less than 50%		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Silts and Organic Silty Clays o f Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH		Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT		Peat, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

- Block Sample
- Bulk/Bag Sample
- Modified California Sampler
- 3.5" OD, 2.42" ID D&M Sampler
- Rock Core
- Standard Penetration Split Spoon Sampler
- Thin Wall (Shelby Tube)

WATER SYMBOL

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

CMT ENGINEERING LABORATORIES

Figure: 7