Geotechnical Engineering Report

4651 West 13400 South Office Building
Riverton, Utah
September 23, 2016
Terracon Project No. 61165143

Prepared for:
JLL Project and Development Services
Salt Lake City, Utah

Prepared by:
Terracon Consultants, Inc.
Midvale, Utah

September 23, 2016

Terracon

JLL Project and Development Services
90 South 400 West, Suite 100
Salt Lake City, Utah 84101

Attn: Mr. Steve Borup
M: (435) 994-9455
D: (801) 456-9513
E: Steven.Borup@am.jll.com

Re: Geotechnical Engineering Report
Proposed 4651 West 13400 South Office Building
Riverton, Utah
Terracon Project No. 61165143

Dear Mr. Borup:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above-referenced project. The field exploration and laboratory testing were performed in general accordance with Terracon Proposal No. P61165083, dated June 8, 2016. This geotechnical engineering report presents the results 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 Consultants, Inc.

Christopher A. Kulish

Christopher A. Kulish, E.I.T.
Field Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
RICK L. CHESNUT
9-23-16
CIVIL
STATE OF UTAH

Rick L. Chesnut, P.E., P.G.
Principal

Enclosures
cc: 1 – Client (PDF)

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EXECUTIVE SUMMARY

A geotechnical exploration has been performed for the proposed 4651 West 13400 South office building development to be located in Riverton, Utah. Our scope of services included the advancement of six soil borings, designated B-1 through B-6, to depths of approximately 6½ to 21½ feet below existing site grade within the areas of the proposed development.

Based on the information obtained from our subsurface exploration, the site can be developed for the proposed project, provided the geotechnical recommendations presented in this report are followed. The following geotechnical considerations were identified:

- **Site Soils:** Existing native soils generally consist of silt with gravel to approximately 4 ½ to 7 feet, followed by silty sand to approximately 10 to 16 feet, followed by silty gravel with sand to a maximum depth explored of 21 ½ feet. Borings B-1 and B-2 of the northwest corner of the project area contained a soil strata approximately 2 foot thick of very stiff silty clay to a depth of approximately 5 to 9 feet. Groundwater was not encountered while drilling.

  Hydro-collapsible soils have been encountered in the project vicinity. Although the hydro-collapse test performed on this site did not indicate a potential for hydro-collapse such soils could exist. In order to reduce the potential for excessive settlement special measures must be followed during design and construction, as outlined in this report.

- **Foundations:** Spread footing foundations bearing on a minimum of 36 inches of reworked native soil or properly placed and compacted Structural Fill may be considered for the support of the proposed building due to the potential presence of hydro-collapsible soil at the site. Hydro-collapsible soil may remain in place below the zone of rework. If these soils become wetted, additional settlement could occur. The owner will need to be willing to accept a risk of additional settlement and potential structural distress if this foundation system is used, otherwise more expensive foundation systems, such as helical piers or drilled shafts, will be required. We can provide information and recommendations for alternative foundation systems upon request. Spread footing foundations may be proportioned for a maximum net allowable bearing pressure of 1,800 psf.

- **Seismic:** The soil profile is best represented by a Seismic Site Class of D based on criteria presented in the International Building Code (IBC).

- **Floor Slabs:** Floor slabs should be placed on a minimum of 4 inches of crushed gravel underlain by a minimum of 24 inches of reworked native soil or compacted Structural Fill.

- **Pavement Sections:** Automobile parking areas – 3" asphalt concrete Asphaltic Concrete (AC) over 6" Untreated Base Course (UBC) or 5" Portland Cement Concrete (PCC) over 6" UBC. Drive lanes – 4" AC over 8" UBC or 5" PCC over 8" UBC. Dumpster pad – 6" PCC

over 6" UBC. Underlying subgrade native soils should be excavated 18 inches and reworked to Structural Fill specifications.

- **Earthwork:** Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include the observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during construction.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
4651 West 13400 South Office Building
Riverton, Utah
Terracon Project No. 61165143
September 23, 2016

1.0 INTRODUCTION

A geotechnical exploration has been performed for the proposed office building development to be located at 4651 West 13400 South, Riverton, Utah. Our scope of services included the advancement of six soil borings, designated B-1 to B-6, to depths of approximately 6½ to 21½ feet below existing site grade within the areas of the proposed development.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pavement design and construction
- foundation design and construction
- slab design and construction
- seismic considerations

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Structure	Two-story office building, approximately 20,000 ft^2.
Building construction	Wood or metal-framed with shallow foundations and slab-on-grade.
Finished floor elevation (FFE) (assumed)	Unknown.
Grading	None, assumed to be within ± two feet of existing ground surface.
Free-standing retaining walls	None
Below-grade areas	None
Liquefaction potential[1]	Low probability, based on available published liquefaction maps.

1. Christenson, G.E., Shaw, L.M., 2008, *Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah*, Supplement Map to Utah Geological Survey Circular 106

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	4651 West 13400 South, Riverton, Utah.
Existing improvements	Vacant lot.
Current ground cover	Weeds and grasses
Existing topography	Moderate to steeply sloping to the south

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	4.5 to 7	Silt with gravel	Medium stiff to very stiff
2[1]	6.5 to 9	Silty clay	Very stiff
3	10 to 16	Silty sand, silty sand with gravel, silt with sand	Medium dense to dense / very stiff
4	21.5 to 20.5	Silt with gravel, silty gravel, silty gravel with sand	Stiff to very stiff / dense to very dense
5[2]	21.5[3]	Silty clay	Very stiff

1. Encountered in borings B-1, and B-2
2. Encountered in borings B-2
3. Maximum depth explored.

Laboratory tests were conducted on selected soil samples, and the test results are presented in Appendix B.

Hydro-collapsible soil was encountered at the site during field observations in the form of pinholes; however, laboratory test results do not specifically indicate hydro-collapse potential. Hydro-collapsible soils have also been encountered in the project vicinity.

Conditions encountered at each exploration location are indicated on the individual exploration logs. Stratification boundaries on the logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the exploration points can be found on the boring logs in Appendix A of this report.

3.2 Groundwater

Groundwater was not encountered during the subsurface exploration. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Groundwater conditions can change with varying seasonal and weather conditions, as well as other factors. Evaluation of these factors is beyond the scope of this exploration. Therefore, subsurface water levels during construction, or at other times in the life of the structure, may be higher or lower than the levels indicated on the boring logs.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The results of our exploration indicate the site can be developed for the proposed project, provided the recommendations presented in this report are followed. During our exploration, the following geotechnical considerations were identified:

Hydro-collapsible soils were visually observed at the site. A collapse/consolidation test in boring B-2 at 5 feet did not indicate a collapse potential, yet due to soil structure observed in the field during sampling, collapse potential is expected to exist. This report provides recommendations to help mitigate the effects of soil hydro-collapse. However, even if these procedures are followed, some movement and minor cracking in the structure should be anticipated if subgrade soils become wetted. The severity of cracking and other damage, such as uneven floor slabs, will probably increase if any modification of the site results in excessive wetting or drying of the supporting soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

We recommend that the geotechnical engineer be retained to evaluate the bearing material for the foundations, floor slab and pavement subgrade soils.

Geotechnical engineering recommendations for foundation systems and other earth-connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of data presented herein, engineering analyses, and our current understanding of the proposed project.

4.2 Earthwork

The following presents recommendations for site preparation, excavation, subgrade preparation, and placement of engineered fills on the project. The recommendations presented for design and construction of earth-supported elements, including foundations, slabs, and pavements, are contingent upon following the recommendations outlined in this section.

Terracon should be retained during construction to observe stripping, site preparation, removal of existing fill, and subgrade preparation. Terracon can assist in identifying existing fill soils or low-strength native soils that should be undercut and removed, as well as identifying additional corrective measures that may become apparent during construction. We should be retained to evaluate proposed fill materials, to monitor fill placement, and to perform field density tests as each lift of fill is place, in order to evaluate compliance with the design requirements. We also should be retained to observe and test bearing soils exposed in footing foundation excavations, and also floor slab and pavement subgrades immediately

4.2.1 Site Preparation

All existing fill, debris, vegetation, topsoil, deleterious materials, and loose, soft or otherwise unsuitable material should be removed below the planned building footprint and extend outward a minimum of 5 feet. Excavations resulting from the removal of unsuitable materials should be replaced with compacted Structural Fill.

Although evidence of underground facilities, such as septic tanks, building components, cesspools, and unknown utilities, was not observed during the site reconnaissance, 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.

4.2.2 Subgrade Preparation

Native soils should be removed a minimum of 3 feet below foundations and 2 feet below floor slabs. The native soils should be reworked and replaced back into the excavations in properly compacted lifts, or Structural Fill that is properly placed and compacted may be used. Exposed subgrades a minimum of 3 feet beneath proposed foundations and 2 feet below floor slabs should be observed by Terracon's geotechnical engineer for presence of pinholes and proof rolled to aid in assessing subgrade conditions prior to placing reworked native soil or structural fill. Extensive pinholes observed in subgrade soils may require additional excavation.

The site should be initially graded to create a relatively level surface to receive fill and to provide for a relatively uniform thickness of fill beneath proposed building and pavement areas.

The moisture content and stability of subgrade soils should be maintained until slab or pavement construction.

4.2.3 Material Requirements

Acceptable fill material designations for various locations on the project are outlined in the following table:

Fill Type [1]	Application	Requirements		
		Gradation		Plasticity
		Size	Percent finer by weight	
Structural Fill	Under foundations, floor slabs or pavements	3 inch No. 4 Sieve No. 200 Sieve	100 40-60 15 - 50	Liquid Limit 30 max Plasticity Index 6 max

1. All fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.
2. Fill should be suitable for compaction testing – less than 30 percent retained on the ¾ inch sieve, and well graded.

Onsite granular soils may be considered for reuse as Structural Fill. Materials proposed for use as Structural Fill should be tested to verify conformance with the materials requirements presented above.

4.2.4 Compaction Requirements

Item	Description
Fill lift thickness	8-inches or less in loose thickness
Compaction [1]	Structural Fill ■ 95% of the material's maximum dry density (modified Proctor - ASTM D 1557) in foundation, pavement and floor slab areas; ■ 92% of material's maximum dry density (ASTM D1557) in other areas of fill and backfill Native Soils ■ 95% of the material's maximum dry density (Standard Proctor – ASTM D698) in foundation, floor slab, and pavement areas; 92% of the maximum dry density in other non-structural areas of fill and backfill.
Moisture content during compaction	Within 2% of the range of optimum moisture content value as determined by the modified Proctor test at the time of placement and compaction

Item	Description
1.	Fill should be tested frequently for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met; the area represented by the test should be reworked and retested as required until the specified compaction is achieved. This may require adjustment of the moisture content.

Where light compaction equipment is used, as is customary within a few feet of retaining walls and in utility trenches, the lift thickness may need to be reduced to achieve the desired degree of compaction.

4.2.5 Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction, including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill. A minimum 5-foot-long clay plug should be installed in utility trenches extending below the building to prevent water from migrating below foundations.

4.2.6 Grading and Drainage

Positive drainage away from the structure and pavements must be provided during construction and maintained throughout the life of the proposed project. Infiltration of water into excavations should be prevented during construction. It is important that foundation and pavement subgrade soils are not allowed to become wetted. All grades should provide effective drainage away from structure and pavements during and after construction. Water permitted to pond next to the structure or pavements can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls and pavement deterioration. Estimated movements described in this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained. Surface drainage should be collected and discharged far away from the structure to prevent wetting of the foundation soils.

Planters and other surface features that could retain water in areas adjacent to the building or pavements should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately five percent or at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Roof gutters and downspouts that drain water a minimum of 10 feet beyond the footprint of the proposed structures are recommended. This can be accomplished through the use of splash-blocks, downspout extensions, and flexible pipes that are designed to attach to the end of the downspout. Flexible pipe should only be used if it is day lighted in such a manner that it gravity-

drains collected water. Splash-blocks should also be considered below hose bibs and water spigots. Sprinkler systems should not be installed within five feet of foundation walls. Landscaped irrigation adjacent to the foundation systems should be minimized or eliminated.

4.2.7 Earthwork Construction Considerations

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

Upon completion of grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction and observed by Terracon.

All excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean that Terracon is assuming any responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

4.3 Foundations

We recommend that the proposed building be supported using lightly loaded, conventional strip and spread footing foundations supported on a minimum of 36 inches of reworked native soil or properly placed and compacted Structural Fill. The use of reworked native soils will minimize hydro-collapse potential directly below foundations and floor slabs and decrease the potential for collection of moisture below structures. Use of porous soil should be avoided where practical in these areas due to a potential for water to accumulate in the higher porosity soil. Structural fill requirements presented in Section 4.2.3 include increased fines content over conventional Structural Fill to avoid highly porous soils. Moisture control measures should be implemented to reduce the potential of subgrade soils becoming wetted. Design recommendations for shallow foundations for the proposed structure are presented in the following table and paragraphs.

4.3.1 Foundation Design Recommendations

Description	Wall	Column
Net allowable bearing pressure[1] Bearing on a minimum 36 inches of reworked native on properly placed and compacted Structural Fill.	1,800 psf [3]	
Minimum footing width	16 inches	24 inches
Minimum embedment below finished grade for frost protection[4]	30 inches	
Approximate total settlement from foundation loads[5]	1 inch or less for similarly loaded foundations	
Estimated differential settlement from foundation loads[4]	About ½ inch over 40 feet	About ½ inch between columns
Ultimate coefficient of sliding friction	0.4 (Structural Fill)	

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable fill or soft soils, if encountered, will be undercut and replaced with compacted Structural. Based upon a Factor of Safety of 3 and adjusted to limit settlement to 1 inch or less.
2. Net allowable bearing pressures provided limit estimated total settlements to 1 inch or less. A maximum footing width of three feet and five by five feet may be used for wall and column footings respectively.
3. Embedment depth is for perimeter footings and footings beneath unheated areas.
4. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, the size of the footing and the quality of the earthwork operations.

The net allowable foundation bearing pressures apply to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations. Interior footings should bear a minimum of 12 inches below finished grade. Finished grade is the lowest adjacent grade for perimeter footings and floor level for interior footings.

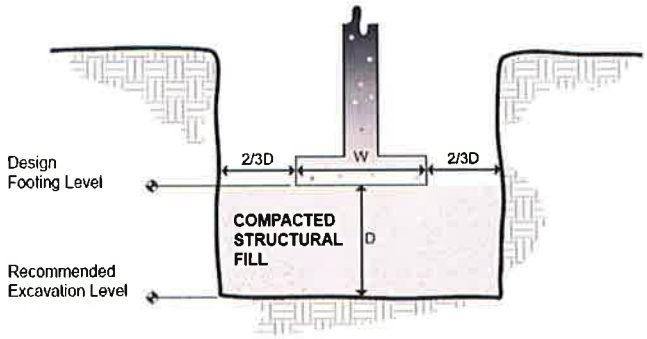
Footings and foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

Foundation excavations should be observed by Terracon's geotechnical engineer. If the soil conditions encountered differ from those presented in this report, supplemental recommendations will be required.

4.3.2 Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose or disturbed soil prior to placing Structural Fill. Structural Fill and concrete should be placed soon after excavating to reduce bearing soil disturbance. If the soils at bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed. Terracon's geotechnical engineer should be retained to observe soil at bottom of foundation excavations.

If unsuitable bearing soils are encountered in footing excavations, the excavation should be extended deeper to suitable soils and the footings bear on properly placed and compacted Structural Fill or reworked native soil extending to the suitable soil. Placement of fill below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. Placement and compaction should be completed in accordance with Section 4.2.4. The overexcavation and backfill procedure is described in the following figure.



Overexcavation / Backfill

4.4 Floor Slabs

4.4.1 Floor Slab Design Recommendations

ITEM	DESCRIPTION
Floor slab support	A minimum of 4 inches of crushed gravel underlain by a minimum of 2 feet of reworked native soils or properly placed and compacted structural fill extending to the suitable native soils
Modulus of subgrade reaction	170 pounds per square inch per in (psi/in) for point loading conditions

Where appropriate, saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI design manuals. Joints

or any cracks that develop should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpeting, 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, 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.

4.4.2 Floor Slab Construction Considerations

On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall, etc. As a result, the floor slab subgrade may not be suitable for placement of crushed gravel and concrete and corrective action will be required.

We recommend areas underlying floor slabs be rough graded and then thoroughly proof rolled with a dump truck prior to final grading and placement of Floor Slab Base Course. Particular attention should be given to high traffic areas that were rutted and disturbed earlier and to areas containing backfilled trenches. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material with properly compacted Structural Fill. All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the gravel and concrete.

4.5 Pavements

Pavement sections were developed using AASHTO 93 design methodology and assumed traffic volumes. Pavement sections were developed for vehicular parking. Pavement sections for truck traffic areas are not part of this scope of work. If truck traffic is anticipated we should be notified

so appropriate pavement sections can be provided for the truck traffic. Design traffic and estimated 18-kip Equivalent Single Axle Loads (ESAL) are summarized in the following table.

Section	Design ESALs[1]
Automobile Parking	15,000
Truck Drive Lanes	60,000

Notes:
1. Design ESALs assumed.

Based on N-values from the STP tests during the field exploration and soil classifications of samples, a design CBR value of 7 percent was chosen, which resulted in a subgrade resilient modulus of 10,500 pci and a k-value of 167 pci.

The following minimum pavement section, or approved equivalent, should be placed on the properly prepared subgrade soils.

Section	Recommended Pavement Sections (Inches) – Parking Lots Only			
	Asphalt Concrete	Portland Cement Concrete Surfacing	Untreated Base Course	Total
Automobile Parking	3.0	---	6.0	9.0
	---	5.0	6.0	11.0
Truck Drives	4.0	---	8.0	12.0
	---	5.0	8.0	11.0
Dumpster Pad[1]	---	6.0	6.0	12.0

1. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

Due to the presence of hydro-collapsible soils at this site, it is recommended that a minimum of 12 inches of pavement subgrade be scarified and reworked to the compaction requirements of this report.

4.5.1 Construction Considerations

All paved areas should have adequate crown and slope to provide positive drainage and prevent ponding of surface water and infiltration below the pavement section. Water collection devices,

such as gutters and ditches, should be incorporated into the parking lot design to prevent percolation of surface water below the pavement section.

Pavement sections have not been designed to support construction equipment. As such, the contractor should protect pavement areas from damage that may result from construction traffic.

The pavement sections provided in this report are minimums for the given design criteria. Periodic maintenance is critical to the long-term performance of the pavement sections. A maintenance program that includes surface sealing, joint cleaning and sealing, joint grinding, repair and replacement of cracked slabs and timely repair of cracks and deteriorated areas will aid the pavement in meeting its design life.

4.6 Seismic Considerations

Based on the results of our exploration, the subsurface soil profile is best represented by Site Class D, according to the 2012 IBC. The National Seismic Hazard Map database was searched to identify the peak ground acceleration (PGA) and spectral accelerations for 0.2 second (Ss) and 1.0 second (S1) periods for a 2% probability of exceedance (PE) in 50 years at the project site for site class B. These values should be adjusted for site effects using appropriate site class factors from the 2012 IBC.

DESCRIPTION	VALUE
2012 International Building Code Site Classification (IBC) [1]	D[2]
Site Latitude	N 40.5076
Site Longitude	W -111.00246
S_o PGA	0.474 g
S_s Spectral Acceleration for a Short Period	1.123 g
S_1 Spectral Acceleration for a 1-Second Period	0.374 g
F_a Site Coefficient for a Short Period	1.051
F_v Site Coefficient for a 1-Second Period	1.652

[1] Note: In general accordance with the *2012 International Building Code,* Table 1613.5.2. IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.

[2] Note: The 2012 IBC requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100 foot soil profile determination. Borings extended to a maximum depth of 21½ feet, and this seismic site class definition considers that encountered soils continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

The site is located in an area mapped as having a low potential for liquefaction. Based on the subsurface soil conditions and boring information, soils vulnerable to potential liquefaction were not encountered within the depth explored.

4.7 Chemical Testing

Chemical testing completed on selected soil samples is summarized in the following table. Results have also been included in Appendix B.

Sample Location	TEST RESULTS		
	pH	Resistivity (ohm-cm)	Sulfate (ppm)
B-2 @ 5'	7.59	74.4	3,570

An aggressive subsurface environment where corrosion can deteriorate the buried steel over its design life can generally be identified by soil resistivity and pH tests. The following criteria for corrosive soil are specified in AASHTO LRFD Section 10.7.5.

- Electrical resistivity less than 2,000 ohm-cm
- pH less than 5.5
- pH between 5.5 and 8.5 in soils with high organic content

On-site soils are considered to be aggressive to buried steel based on laboratory test results. Based on the test results, sulfate exposure to concrete appears to be high. A corrosion engineer should be retained to provide additional corrosion protection recommendations

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

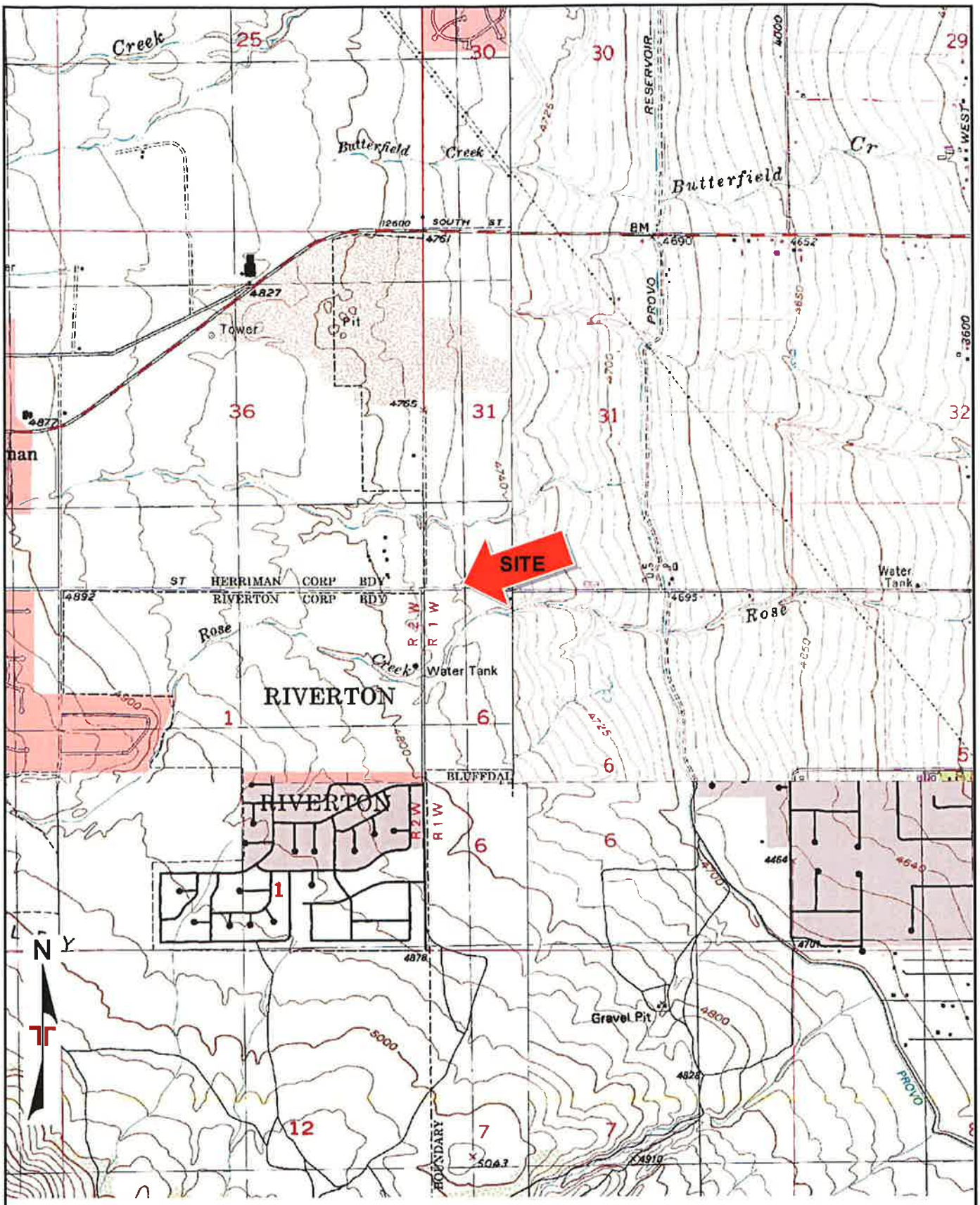
The analysis and recommendations presented in this report are based upon the data obtained from the exploration locations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between exploration points, across the site, 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. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project 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.

This report has been prepared for the exclusive use of JLL Project and Development Services client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: COPPERTON, UT (1/1/1999), MIDVALE, UT (1/1/1999), TICKVILLE SPRING, UT (1/1/1997) and JORDAN NARROWS, UT (1/1/1999).

Project Manager:	CVM
Drawn by:	CVM
Checked by:	RLC
Approved by:	RLC

Project No.	61165143
Scale:	1"=2,000'
File Name:	NA
Date:	9/12/2016

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT 84047-3707

SITE LOCATION

4651 West 13400 South Office Building
4651 West 13400 South
Riverton, UT

Exhibit
A-1

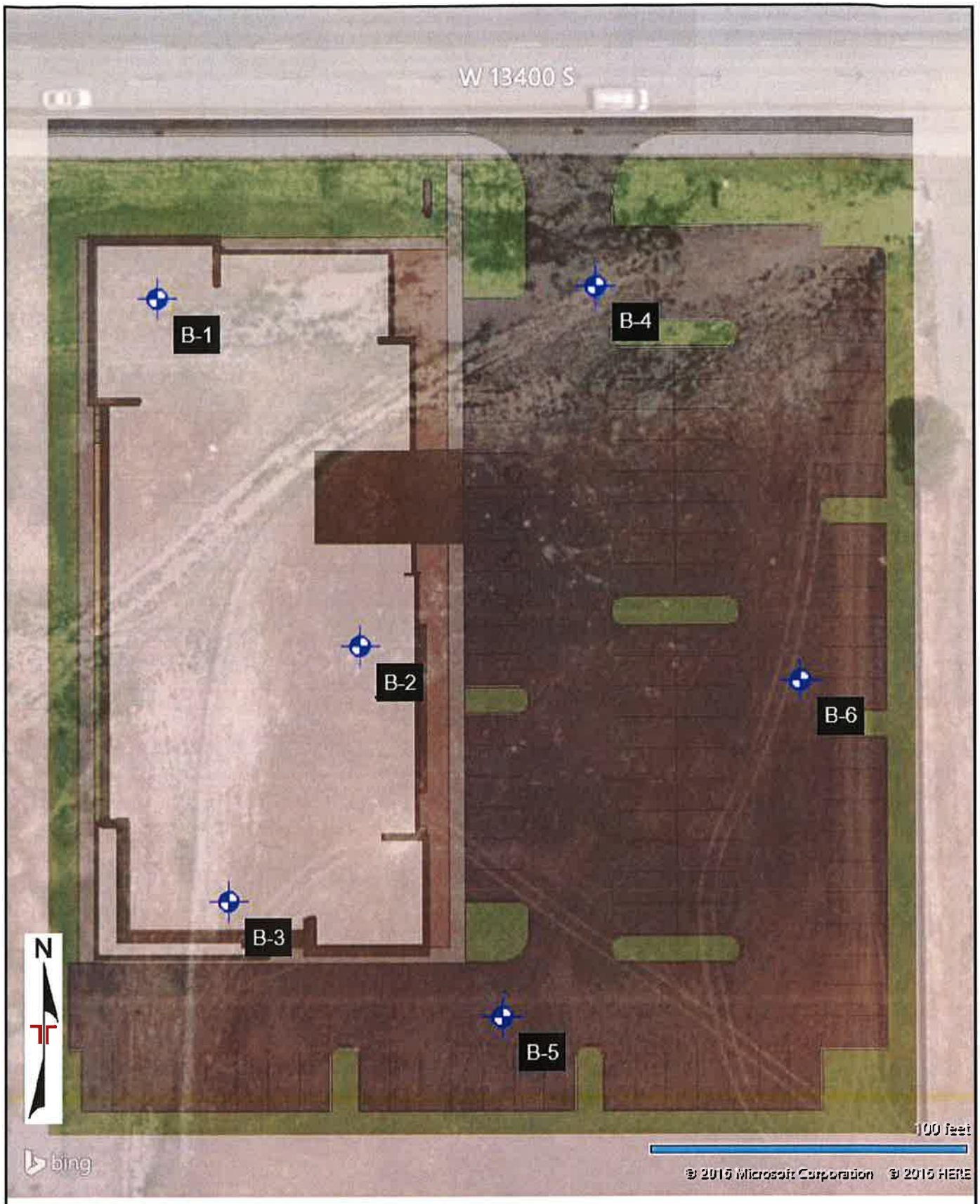


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: CVM	Project No. 61165143	Terracon 6949 S High Tech Dr Ste 100 Midvale, UT 84047-3707	EXPLORATION PLAN 4651 West 13400 South Office Building 4651 West 13400 South Riverton, UT	Exhibit A-2
Drawn by: CVM	Scale: AS SHOWN			
Checked by: RLC	File Name: NA			
Approved by: RLC	Date: 9/12/2016			

Field Exploration Description

The exploration locations were marked by Terracon personnel based on the supplied site drawings, in relation to the existing site features, and aerial images. Exploration locations, once completed, were documented, using a recreational-grade, hand-held GPS with an accuracy of approximately 20 feet. The locations of the exploration points should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a truck-mounted rotary drill rig using continuous flight hollow-stem augers. Samples of the soil encountered in the borings were obtained using the standard split barrel, Ring sampler and thin-walled tube sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils.

An automatic hammer was used to advance the split-barrel sampler in the auger advanced borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional pin hammer operated with a cathead and rope. This difference in efficiency has an appreciable effect on the SPT-N value. The effect of the hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The soil samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings prior to the drill crew leaving the site.

A field log of each boring was prepared by the field engineer. These logs included visual classifications of the materials encountered during the exploration as well as the field engineer's interpretation of the subsurface conditions between samples. Final logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: 4651 West 13400 South Office Building

CLIENT: JLL Project and Development Services
Salt Lake City, UT

SITE: 4651 West 13400 South
Riverton, Utah

LOCATION See Exhibit A-2

Latitude: 40.5076° Longitude: -112.00246°

DEPTH	GRAPHIC LOG		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILT (ML), light brown to tan, medium stiff, with gravel at ground surface								
					X	2-2-4 N=6	7		36-25-11	85
		light brown to brown, stiff, weak cementation, with oxidation stains	5		X	4-5-9 N=14	15			
7.0										
		SILTY CLAY (CL-ML), light brown, very stiff, with oxidation stains, interbedded silt lenses				4-7-10				
9.0										
10.0		**SILTY SAND WITH GRAVEL (SM)**, brown, dense	10		X	12-22-35 N=57				
		SILTY GRAVEL WITH SAND (GM), light brown to brown, very dense								
		possible cobbles	15		X	16-29-50/5"				
			20		X	16-37-35 N=72				
21.5		***Boring Terminated at 21.5 Feet***								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 8/9/2016 | Boring Completed: 8/9/2016

Drill Rig: CME-75 | Driller: Davis Drilling Services

Project No.: 61165143 | Exhibit: A-4

BORING LOG NO. B-2

PROJECT: 4651 West 13400 South Office Building

CLIENT: JLL Project and Development Services
Salt Lake City, UT

SITE: 4651 West 13400 South
Riverton, Utah

LOCATION See Exhibit A-2

Latitude: 40.5073° Longitude: -112.00223°

DEPTH	GRAPHIC LOG		WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILT (ML), light brown, stiff, with gravel at the surface							
					4-5-8				
		water perched at 4 to 5 feet							
5.0		**SILTY CLAY (CL-ML)**, light brown, with oxidation stains				27			81
6.5		**SILTY SAND (SM)**, brown, medium dense							
					6-9-10 N=19	8		NP	32
		light brown to brown, weak cementation, interbedded silt lenses							
					7-9-12 N=21				
16.0		**SILT WITH GRAVEL (ML)**, trace clay, light brown, stiff to very stiff							
					10-11-8 N=19				
20.5		increasing gravel with depth							
					25-19-19 N=38				
21.5		**SILTY CLAY (CL-ML)**, trace gravel, light brown, very stiff, weak to moderate cementation							
		Boring Terminated at 21.5 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:
Collapse consolidation test

WATER LEVEL OBSERVATIONS

Perched water encountered at 4 to 5 feet

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 8/9/2016 Boring Completed: 8/9/2016

Drill Rig: CME-75 Driller: Davis Drilling Services

Project No.: 61165143 Exhibit: A-5

BORING LOG NO. B-3

PROJECT: 4651 West 13400 South Office Building

CLIENT: JLL Project and Development Services
Salt Lake City, UT

SITE: 4651 West 13400 South
Riverton, Utah

LOCATION See Exhibit A-2

Latitude: 40.50708° Longitude: -112.00238°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILT (ML), trace gravel, light brown to brown, stiff, weak cementation								
	4.5			X	5-6-8 N=14				
	SILTY SAND (SM), light brown, medium dense, weak cementation	5			12-14-13	14		NP	35
	6.5								
	SILT WITH SAND (ML), trace clay, light brown, very stiff, moderate cementation, brown mottling			X	7-9-14 N=23	15			
	11.0	10		X	5-16-11 N=27				
	SILTY SAND WITH GRAVEL (SM), trace clay, light brown, medium dense								
	14.5								
	SILTY GRAVEL WITH SAND (GM), light brown to light gray, dense to very dense	15		X	13-20-12 N=32				
	possible cobbles	20		X	18-29-48 N=77				
	21.5								
	Boring Terminated at 21.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 8/9/2016 | Boring Completed: 8/9/2016

Drill Rig: CME-75 | Driller: Davis Drilling Services

Project No.: 61165143 | Exhibit: A-6

BORING LOG NO. B-4

PROJECT: 4651 West 13400 South Office Building

CLIENT: JLL Project and Development Services
Salt Lake City, UT

SITE: 4651 West 13400 South
Riverton, Utah

LOCATION See Exhibit A-2

Latitude: 40.50761° Longitude: -112.00196°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILT WITH GRAVEL (ML), light brown to tan, very stiff				15-18-17 N=35				
	2.0								
	SILTY SAND (SM), light brown to tan, loose to medium dense				5-5-6 N=11	3		23-20-3	42
	weak cementation, oxidation stains	5			2-2-4 N=6				
	6.5								
	Boring Terminated at 6.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 8/9/2016 Boring Completed: 8/9/2016

Drill Rig: CME-75 Driller: Davis Drilling Services

Project No.: 61165143 Exhibit: A-7

BORING LOG NO. B-5

PROJECT: 4651 West 13400 South Office Building

CLIENT: JLL Project and Development Services
Salt Lake City, UT

SITE: 4651 West 13400 South
Riverton, Utah

LOCATION See Exhibit A-2

Latitude: 40.50698° Longitude: -112.00207°

GRAPHIC LOG	DEPTH	DEPTH (FL)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILT WITH GRAVEL (ML), light brown to tan, very stiff, weak cementation			X	2-9-8 N=17				
	2.0 **SILT (ML)**, light brown to tan, stiff, weak cementation			X	3-5-5 N=10				
		5		X	5-8-10 N=18				
	6.5 ***Boring Terminated at 6.5 Feet***								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 8/9/2016 Boring Completed: 8/9/2016

Drill Rig: CME-75 Driller: Davis Drilling Services

Project No.: 61165143 Exhibit: A-8

BORING LOG NO. B-6

PROJECT: 4651 West 13400 South Office Building

CLIENT: JLL Project and Development Services
Salt Lake City, UT

SITE: 4651 West 13400 South
Riverton, Utah

LOCATION See Exhibit A-2

Latitude: 40.50727° Longitude: -112.00173°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILT (ML), trace gravel, light brown to tan, stiff to very stiff			X	5-7-7 N=14	4		28-21-7	50
	light brown to brown, weak to moderate cementation	5		X	6-7-11 N=18				
	6.5 sand in the shoe			X	7-9-11 N=20				
	Boring Terminated at 6.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 8/9/2016 | Boring Completed: 8/9/2016

Drill Rig: CME-75 | Driller: Davis Drilling Services

Project No.: 61165143 | Exhibit: A-9

APPENDIX B
SUPPORTING INFORMATION

Laboratory Testing

As part of the testing program, all samples were examined in the laboratory by experienced personnel and classified in accordance with the attached General Notes and the Unified Soil Classification System based on the texture and plasticity of the soils. The group symbol for the Unified Soil Classification System is shown in the appropriate column on the boring logs and a brief description of the classification system is included with this report in the Appendix.

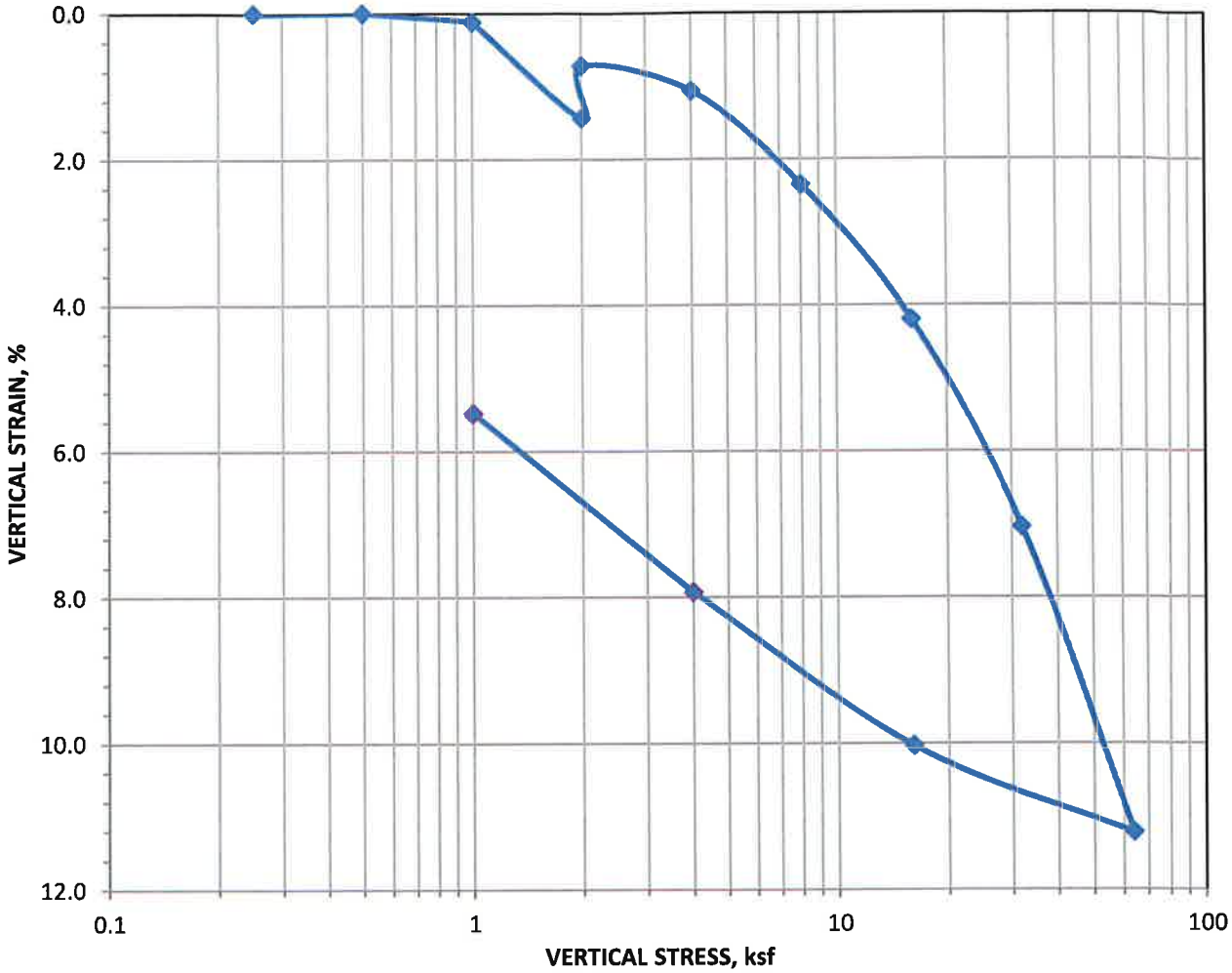
At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- Dry Unit Weight
- Sieve Analysis
- Atterberg Limits
- Sulfate
- Percent Fines
- In-situ Water Content
- Consolidation/Collapse
- pH
- Resistivity
- Triaxial Compression

Consolidation Test Data (ASTM D 2435-04)



Before Consolidation

Sample Diameter (in):	2.50	Moist Unit Weight (pcf):	**103**
Sample Height (in):	1	Moisture Content (%):	**29**
Sample Volume (cf):	0.0028	Dry Unit Weight (pcf):	**81**

After Consolidation

Sample Diameter (in):	2.50	Moist Unit Weight (pcf):	**124**
Sample Height (in):	0.92113	Moisture Content (%):	**42**
Sample Volume (cf):	0.0026	Dry Unit Weight (pcf):	**87**

Liquid Limit:	--	Percent Fines:	13.1
Plasticity Index:	--	Classification:	CL-ML

Terracon

Project Name: 4651 W 13400 S
Project No.: 61165143
Location: Riverton
Sample: B-2 @ 5

INORGANIC ANALYTICAL REPORT

Client: Terracon Consultants, Inc. **Contact:** Carlos Montilla
Project: 4651 W 13400 S Office Building / 61165143
Lab Sample ID: 1609257-001
Client Sample ID: B-2 @ 5'
Collection Date: 9/8/2016
Received Date: 9/14/2016 735h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		9/14/2016 2051h	SW9045D	1.00	**7.59**	H
Resistivity	ohm-cm		9/15/2016 610h	SM2510B	10.0	**74.4**	&
Sulfate	mg/kg-dry		9/15/2016 654h	SM4500-SO4-E	644	**3,570**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

American West ANALYTICAL LABORATORIES
3440 South 700 West
Salt Lake City, UT 84119
Phone: (801) 263-8686
Toll Free: (888) 263-8686
Fax: (801) 263-8687
e-mail: awal@awal-labs.com
web: www.awal-labs.com

Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

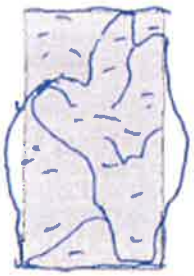
Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

(ASTM D2850)

Project: Terracon
No: M00385-157 (61165143)
Location: Riverton
Date: 9/22/2016
By: JDF

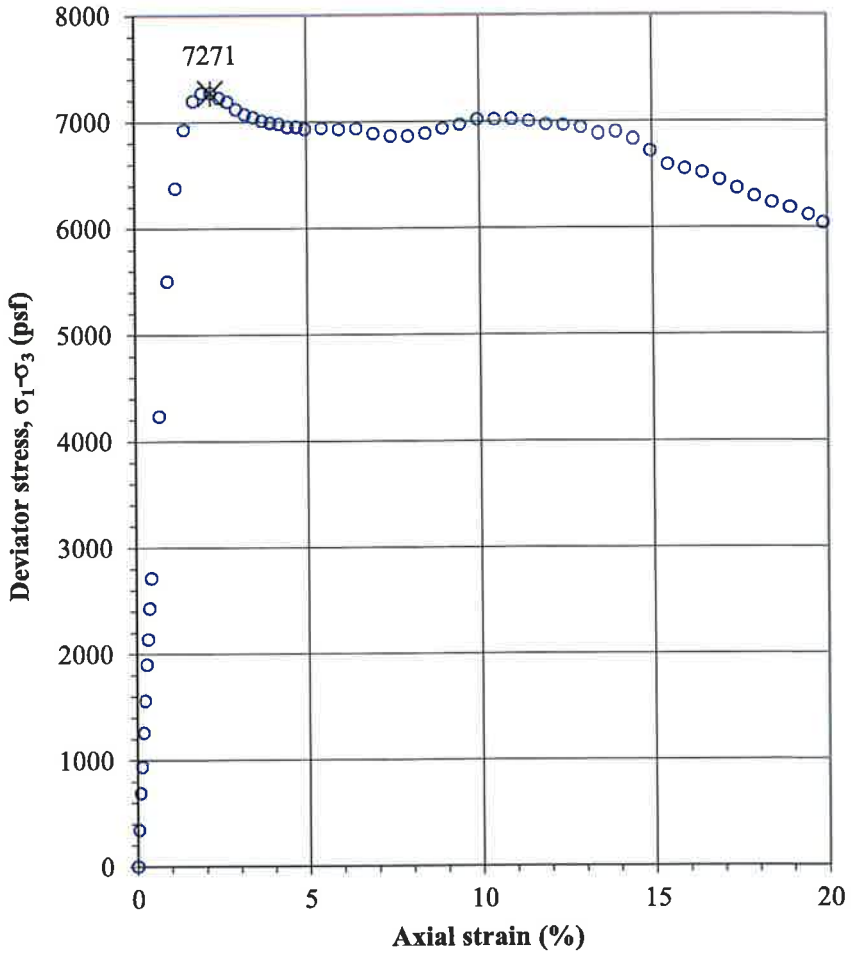
Boring No.: B-2
Sample:
Depth: 5'
Sample Description: Light brown clay with sand
Sample type: Undisturbed

Specific gravity, Gs	2.70	Assumed
Sample height, H (in.)	5.610	
Sample diameter, D (in.)	2.774	
Sample volume, V (ft^3)	0.0196	
Wt. rings + wet soil (g)	1755.42	
Wt. rings/tare (g)	758.26	
Moist soil, Ws (g)	997.16	
Moist unit wt., γ_m (pcf)	112.0	
Dry unit wt., γ_d (pcf)	**92.8**	
Saturation (%)	68.3	
Void ratio, *e*	0.82	



Wet soil + tare (g)	1217.23
Dry soil + tare (g)	1046.43
Tare (g)	221.93
Water content, w (%)	**20.7**
Confining stress, σ_3 (psf)	1000
Shear rate (in/min)	0.0168
Strain at failure, ε_f (%)	2.20
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	7271
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	3636

Axial Strain (%)	σ_d $\sigma_1-\sigma_3$ (psf)	Q 1/2 σ_d (psf)
0.00	0.0	0.0
0.05	343.4	171.7
0.10	689.6	344.8
0.15	935.5	467.7
0.20	1259.2	629.6
0.25	1560.8	780.4
0.30	1899.3	949.6
0.35	2138.0	1069.0
0.40	2429.3	1214.6
0.45	2714.0	1357.0
0.70	4232.9	2116.4
0.95	5499.3	2749.6
1.21	6372.7	3186.3
1.45	6924.7	3462.3
1.70	7193.7	3596.8
1.95	7271.1	3635.5
2.20	7271.5	3635.7
2.45	7226.1	3613.0
2.70	7190.0	3595.0
2.95	7117.4	3558.7
3.20	7069.4	3534.7
3.45	7042.6	3521.3
3.70	7006.9	3503.4
3.95	6986.0	3493.0
4.20	6977.5	3488.7
4.45	6950.8	3475.4
4.70	6950.8	3475.4
4.95	6930.2	3465.1
5.45	6936.1	3468.0
5.95	6923.8	3461.9
6.45	6928.6	3464.3
6.95	6880.7	3440.3
7.45	6858.9	3429.4
7.95	6857.0	3428.5
8.45	6880.4	3440.2
8.95	6931.5	3465.7
9.45	6967.5	3483.7
9.95	7016.7	3508.3
10.45	7014.3	3507.1
10.95	7017.2	3508.6
11.45	6997.4	3498.7
11.95	6966.3	3483.1
12.45	6959.6	3479.8
12.95	6938.8	3469.4
13.45	6882.8	3441.4
13.95	6896.7	3448.3
14.45	6832.3	3416.1
14.95	6715.0	3357.5
15.45	6587.9	3293.9
15.95	6548.5	3274.2
16.45	6511.7	3255.8
16.95	6443.5	3221.7
17.45	6362.9	3181.4
17.95	6287.7	3143.8
18.45	6228.3	3114.1
18.95	6181.8	3090.9
19.45	6115.0	3057.5
19.88	6039.8	3019.9



Entered by:_____

Reviewed:_____

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube – 2" O.D., 3" O.D., unless otherwise noted	PA:	Power Auger (Solid Stem)
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	BCR:	Before Casing Removal
WCI:	Wet Cave in	WD:	While Drilling	ACR:	After Casing Removal
DCI:	Dry Cave in	AB:	After Boring	N/E:	Not Encountered

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 – 1	Very Soft
500 – 1,000	2 – 3	Soft
1,000 – 2,000	4 – 6	Medium Stiff
2,000 – 4,000	7 – 12	Stiff
4,000 – 8,000	13 – 26	Very Stiff
8,000+	> 26	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 – 10
Medium	11 – 30
High	> 30

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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [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 on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			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:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.

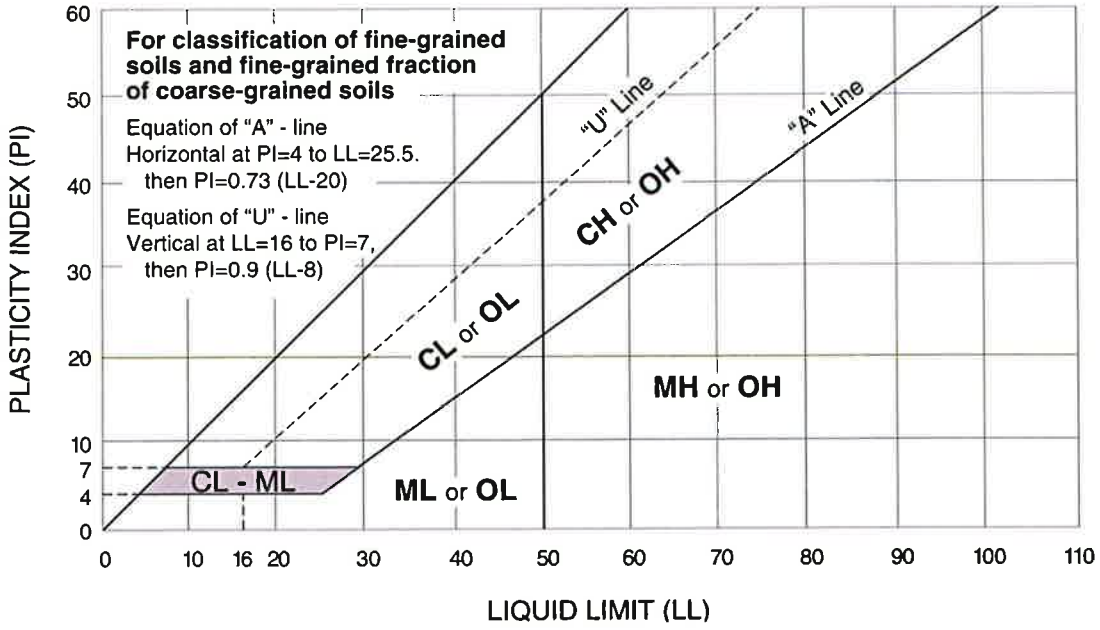
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.



Terracon

Exhibit C-2