State of Utah

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Division of Facilities Construction and Management
RICH AMON
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Addendum No. 1

Date:	May 7, 2013
To:	Architects / Engineers
From:	Jim Russell - Project Manager
Reference:	Unified State Laboratory Module 2 Departments of Public Safety, Health, and Agriculture/Food Salt Lake City, Utah DFCM Project No. 13020300
Subject:	**Addendum No. 1**

Pages			
	Addendum Cover Sheet	1	page
	Final Geotechnical Report	44	pages
	Total	45	pages

Note: This Addendum shall be included as part of the Contract Documents. Items in this Addendum apply to all drawings and specification sections whether referenced or not involving the portion of the work added, deleted, modified, or otherwise addressed in the Addendum. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to Disqualification.

1.1 SCHEDULE CHANGES: There are no Project Schedule changes.

1.2 GENERAL ITEMS: See attached Final Geotechnical Report from GSH.

May 2, 2013
Job No. 0068-13B-13

State of Utah
Division of Facilities Construction and Management (DFCM)
4110 State Office Building
Salt Lake City, Utah 84114

Attention: Mr. Jim Russell

Gentlemen:

Re: Letter
Seismic Update to Original Geotechnical Report
Proposed New UDOT Facility
4500 South 2700 West
Taylorsville, Utah 84102

1. INTRODUCTION

At the request of Mr. Jim Russell of the Utah Division of Facilities Construction and Management (DFCM), this seismic update letter is provided with respect to the geotechnical study performed for the proposed new UDOT facility (Unified Lab Module 1) located at 4500 South 2700 West in Taylorsville, Utah.

The original geotechnical study was completed by GSH Geotechnical Inc. (GSH), dated February 26, 2008[1]. If no significant changes to the site property and/or code changes have been made since the time of the original report, the findings and recommendations provide therein would remain applicable. If significant changes, such as soil placement or removal, dumping, location change of new facility, construction, or removal of structures, etc., have occurred from the time of the report, the site may need to be re-evaluated with respect to the geotechnical scope. Additionally, if building codes have changed, they must be updated where necessary.

At the time of the 2008 geotechnical report, the building code utilized was of the 2006 edition of the International Building Code (IBC). Since that time, new addition of the IBC (2009) has been accepted.

1 "Report, Final Geotechnical Study, Proposed New UDOT Laboratory Facility, 4500 South 2700 West, Taylorsville, Utah 84102" GSH Job No. 0068-13A-07, Dated February 26, 2008.

2. GEOSEISMIC SETTING UPDATE

2.1.1 General

The 2009 edition of the IBC code is similar to the 2006 edition in determining the seismic classification and acceleration, which are based upon 2002 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented upon maps incorporated into the IBC codes and are also available based upon latitude and longitude coordinates (grid points).

The structures must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2009 edition.

2.1.2 Faulting

Based upon our review of available literature, the site exists within the Granger Fault investigation zone identified by Salt Lake County. City and County ordinances require that a site-specific fault study be performed to identify signs of surface fault rupture and/or related deformations within the site area. It is our understanding that a site-specific fault study was subsequently completed by others and the structure was located on the property according to the guidelines set forth in that study.

2.1.3 Soil Class

A Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions of the IBC 2009, can be utilized.

2.1.4 Ground Motions

The IBC 2009 codes are based on 2002 USGS mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for an MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (40.67453 degrees north and 111.95459 degrees west, respectively), the values for this site are tabulated on the following page.

Spectral Acceleration Value, T Seconds	Site Class B-C Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration	61.0	61.0
0.2 Seconds, (Short Period Acceleration)	$S_S = 152.4$	$S_{MS} = 152.4$
1.0 Seconds (Long Period Acceleration)	$S_1 = 59.9$	$S_{M1} = 89.9$

The IBC 2009 code design accelerations (S_{DS} and S_{D1}) are based on multiplying the above accelerations (adjusted for site class effects) for the MCE event by two-thirds.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

Respectfully submitted,

GSH Geotechnical, Inc.

Bryan N. Roberts, P.E.
State of Utah No. 276476
Project Geotechnical Engineer

Reviewed by:

William G. Turner, P.E.
State of Utah No. 171715
Senior Geotechnical Engineer

BRN/WGT:jlh

Addressee (3 + email)

LICENSED PROFESSIONAL ENGINEER
#276476
BRYAN N.
ROBERTS
STATE OF UTAH

REPORT
FINAL GEOTECHNICAL STUDY
PROPOSED NEW UDOT LABORATORY FACILITY
4500 SOUTH 2700 WEST
TAYLORSVILLE, UTAH 84102

Submitted To:

VCBO Architecture
524 South 600 East
Salt Lake City, Utah

Submitted By:

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

February 26, 2008

Job No. 0068-13A-07

Gordon Spilker Huber
Geotechnical Consultants, Inc.

February 26, 2008
Job No. 0068-013A-07

VCBO Architecture
524 South 600 East
Salt Lake City, Utah

Attention: Mr. Peter Brunjes

Ladies and Gentlemen:

Re: Report
Final Geotechnical Study
Proposed New UDOT Laboratory Facility
4500 South 2700 West
Taylorsville, Utah 84102

1. INTRODUCTION

1.1 GENERAL

Gordon Spilker Huber Geotechnical Consultants, Inc. (GSH) performed a preliminary geotechnical study dated October 25, 2007[1]. Based on our preliminary report and other design data, including setbacks from the fault study, the final structure was located on the site.

This report presents the results of our final geotechnical study performed at the site of the proposed new Utah Department of Transportation (UDOT) Laboratory Facility, which is located at 4500 South 2700 West, north of the existing UDOT facilities in Taylorsville, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1999, is presented on Figure 1, Vicinity Map. A more detailed drawing showing the overall site property, the proposed structure location and parking areas with access roads, and the adjacent existing UDOT north parking area is presented on Figure 2, Site Plan. The locations of the Borings B-1A through B-6A, drilled in conjunction with this study, and Borings B-1 through B-3, drilled in conjunction with the preliminary study, are also presented on Figure 2.

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[1] "Report, Preliminary Geotechnical Study, Proposed New UDOT Facility 4500 South and 2700 West, Taylorsville, Utah," GSH Job No. 0068-013-07.

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123
Tel: (801) 685-9190 Fax: (801) 685-2990
www.gshgeotech.com

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Peter Brunjes of VCBO Architecture, and Mr. Alan Spilker of Gordon Spilker Huber Geotechnical Consultants, Inc. (GSH).

In general, the objectives of this study were to:

1. Further define and evaluate the subsurface soil and groundwater conditions within the proposed structure and parking areas.

2. Provide appropriate foundation, earthwork, pavement, and geoseismic recommendations to be utilized in the design and construction of the proposed facility.

In accomplishing these objectives, our scope has included the following:

1. Review a preliminary geotechnical study performed by GSH for the proposed construction.

2. A field program consisting of the drilling, logging, and sampling of six borings.

3. A laboratory testing program.

4. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of the State of Utah Division of Facilities Construction and Management Contract Number 087166, Change Order M001 dated February 11, 2008.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration borings, projected groundwater conditions, and the layout and design data discussed in Section 2., Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

Proposed construction is to consist of an office/laboratory structure. The proposed structure will be three to four levels in height of steel-frame and masonry construction established slab-on-grade. It is our understanding that 48-inch dock wells will be constructed below the final grade of the site.

Preliminary maximum design column and wall loads provided by the client are on the order of 100 to 400 kips and 3 to 9 kips per lineal foot, respectively. Anticipated average uniform floor loadings could be up to 200 pounds per square foot.

Uplift forces on the order of 400 kips are projected by Dunn Engineering (project structural engineers). To provide adequate mass to resist uplift forces, footings and foundations may be thickened and extend to depths which allow for overlying soils to provide resistance. Potential economical alternatives for resisting uplift forces may include Geopiers®, helical piers, or drilled shaft deep foundations. Additionally, the use of deep foundations will allow for higher bearing capacities which may allow for smaller footing sizes. Discussions concerning deep foundation are included in Sections 5.4, Geopiers®, and 5.5, Helical Piers

Site development will require a moderate amount of earthwork in the form of site grading. We estimate that maximum cuts and fills to achieve design grades will be on the order of two to three feet.

Paved roadways and parking will also be a part of the overall development. Traffic within the parking areas will likely consist of a moderate volume of automobiles and light trucks, a light volume of medium-weight trucks, and no heavy-weight trucks. Traffic over the roadways will likely consist of a moderate volume of automobiles and light trucks, and a light to moderate volume of medium- and heavy-weight trucks.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

A preliminary geotechnical study dated October 25, 2007 and a surface rupture fault study by others were conducted previously at the site. The surface rupture fault study identified the Granger fault within the western portion of the site. A final structure location was selected using adequate setbacks as recommended within the fault study.

During our preliminary study, 3 borings were drilled within the site area to depths of 31.5 feet below existing grade. Locations of these borings are presented on Figure 2 (B-1, B-2, and B-3).

Once the final structure location was determined, 3 borings were explored to a depth 28.5 to 31.5 feet below existing grade within the proposed structure footprint, and 3 borings were explored to depths of 5 feet below existing grade within parking areas. The borings were drilled using a rubber tire truck-mounted drill rig equipped with hollow-stem augers. Locations of the borings drilled for this study (B-1A through B-6A) are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3F, Log of Borings (current study) and Figures 4A through 4C, Log of Borings (October 25, 2007 Preliminary Study). Soils were classified in accordance with the nomenclature described on Figure 5, Unified Soil Classification System.

A 3.25-inch outside diameter, 2.42-inch inside diameter drive (Dames & Moore) sampler was utilized in the subsurface sampling at the site. The blow-counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling operations, one and one-quarter-inch diameter slotted PVC pipe was installed in Boring B-1A in order to provide a means of monitoring the groundwater fluctuations.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was completed. The program included moisture and density, collapse-consolidation, partial gradation, and chemical tests. Laboratory data developed in conjunction with our October 25, 2007 preliminary study was also utilized. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

To aid in classifying the soils and to help correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the boring logs, Figures 3A through 3F and Figures 4A through 4C.

3.2.3 Collapse-Consolidation Tests

To provide data necessary for our settlement analyses, a collapse-consolidation test was performed on each of four representative samples in conjunction with this study. Four representative samples were also tested in conjunction with the October 25, 2008 preliminary study. The collapse portion of the overall test was performed in accordance with the following procedure:

1. Load sample at in-situ moisture content to specific axial pressure.
2. Measure and record axial deflection.
3. Saturate sample.
4. Measure and record resulting collapse.

The results of the collapse portion of the tests are tabulated below:

Boring No.	Depth (feet)	Soil Type	Natural Dry Density (pcf)	Natural Moisture Content (percent)	Axial Load When Saturated (psf)	Swell (+) Collapse (-) (percent)
B-1**	2.0	CL	85	7.5	100	*
B-1**	10.5	CL	95	27.2	100	Slight Swell
B-2**	15.5	CL	97	17.7	100	Slight Swell
B-3**	20.5	CL	103	20.2	100	0.01 (-)
B-1A	4.5	CL	87	11.3	1600	2.3 (-)
B-1A	7.5	CL	85	19.9	1600	2.2 (-)
B-1A	10.5	CL	92	15.8	100	Slight Swell
B-1A	15.5	CL	105	21.6	100	Slight Swell
B-2A	2.5	CL	92	10.2	100	Slight Swell
B-3A	5.5	CL	88	18.5	1600	0.9 (-)

* Upon saturation, the sample exhibited a low pre-consolidation pressure and was highly compressible. This is often indicative of a collapsible soil.

** From October 25, 2007 Study.

The tests performed on the clay samples at two feet in Boring B-1, four and one-half and seven and one-half feet in Boring B-1A, and five and one-half feet in Boring B-3A indicate that they are highly compressible after saturation and moderately collapsible.

Test results from the deeper clay soils indicate that they are not collapsible, are moderate to highly over-consolidated, and will exhibit moderate compressibility characteristics under the anticipated loads. Detailed results are maintained within our files and can be transmitted to you, upon your request.

3.2.4 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated below:

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Soil Classification
B-1*	15.5	26.8	SM
B-2*	2.0	41.7	SM/ML
B-2*	5.0	36.0	SM
B-3*	10.5	19.6	SM

* October 25, 2007 Study.

3.2.5 Chemical Tests

To determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the soils encountered in Boring B-2 at a depth of two and one-half feet below existing grade. The results of the chemical tests are tabulated below:

Boring No.	Depth (feet)	pH	Total Water Soluble Sulfate (ppm)
B-2*	2.5	8.0	800

* October 25, 2007 Study.

4. SITE CONDITIONS

4.1 SURFACE

The overall site consists of a rectangular-shaped parcel located at 4500 South 2700 West in Taylorsville, Utah. The site is bounded on the south by the existing UDOT facilities and on the north by the American Express building. Interstate 215 bounds the site to the east and 2700 West Street to the west.

The site grade is approximately eight feet lower than 2700 West Street and at the same elevation as the parking lot to the south. The site slopes gently from the west downhill to the east. Total overall relief within the proposed structure and pavement area is on the order of two to four feet. The surface is covered with a moderate amount of grasses and weeds with some scattered trees on the order of 15 feet high along the south boundary

4.2 SUBSURFACE SOIL AND GROUNDWATER

The upper approximately three to four inches of the soil at the boring locations are loose with approximately one to two inches of topsoil. In general, the subsurface soils to the depths penetrated consist of layers of silty clay, silty sand, and silty sand and gravel mixtures.

The upper three feet in Boring B-1A and one and one-half feet in Boring B-2A are non-engineered fills consisting of mixtures of sand, silt, and gravel.

The clay layers, within the depths penetrated, range from four and one-half to nine and one-half feet thick. These clays are light brown grading-grayish brown, medium stiff to very stiff, and dry near the surface grading to very moist with depth. A surficial layer of light brown to brown silty clay encountered in Boring B-1A, from three to seven and one-half feet, exhibit a “pinhole” structure and have relatively low moisture contents and low in-situ densities. Similar soils were encountered in the upper three feet of Boring B-1 from the October 25, 2007 preliminary study. These characteristics are typically indicative of potentially collapsible soils. Potentially collapsible soils are considered to be moisture sensitive. Moisture sensitivity, in this case, is defined as the condition where the soil will exhibit moderate strength and compressibility characteristics when dry, but lose strength, become highly compressible, and collapse under loading with significant moisture increase.

Potentially collapsible soils were not encountered in the other five borings completed within this study. The potentially collapsible soil deposits are anticipated to be in isolated areas; however, they are likely to vary in depth and lateral extent across the site.

The non-collapsible clay soils encountered at the site are anticipated to exhibit moderate compressibility and strength characteristics under the anticipated loadings.

The silty sand and gravel layers encountered within the borings range from 3 to 15 feet thick. These sands and gravels are light brown to brown, moist, and medium dense. These sand and gravel soils will exhibit moderately high strength and moderately low compressibility characteristics.

4.3 GROUNDWATER

Groundwater was not encountered to the depths penetrated during drilling operations. Within the preliminary study, static groundwater was measured and only encountered within Boring B-3 located to the northeast of the proposed site. In Boring B-3, groundwater was encountered at a depth of 28.4 feet below the existing surface.

Seasonal and longer-term groundwater fluctuations on the order of one-half to two feet are projected with the highest seasonal levels generally occurring during the late spring and early summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The most significant geotechnical aspects of the site are:

1. The site is located within the Granger fault investigation zone identified by Salt Lake County.

2. Potentially collapsible soils were encountered in Boring B-1 of the preliminary study to a depth of three feet, and in Boring B-1A to a depth of seven and one-half feet.

3. Non-engineered fills encountered from the surface to a depth of one-half to three feet in Borings B-1A and B-2A.

4. High uplift loads on the order of 400 kips.

A site-specific study was subsequently completed by others. The surface rupture fault study identified the Granger fault within the western portion of the site. A final structure location was selected using adequate setbacks as recommended within the fault study.

All potentially collapsible soils and non-engineered fills must be completely removed in structure, rigid pavement, and exterior flatwork areas. The potentially collapsible soils, in our opinion, can be reasonably handled by careful observation during footing excavation and structure pad preparation by a qualified geotechnical engineer. If these soils are encountered below structure and rigid pavement and exterior flatwork areas, they should be over-excavated and replaced with compacted granular fill. Potentially collapsible soils may remain beneath flexible pavement sections provided the soils are properly prepared, as outlined later in this report. Existing non-engineered fills three feet or less in thickness and clean of debris and deleterious material may also remain beneath the flexible pavement sections provided the soils are properly prepared, as outlined later in this report. However, the flexible pavements established overlying these soils/fills, may be subjected to long-term settlements unless these soils are completely removed. As previously mentioned, the potentially collapsible soils were encountered in Boring B-1A from this study and B-1 from the preliminary study dated October 25, 2007, and are anticipated to be isolated but will likely vary in depth and lateral extent.

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural, non-collapsible soils, and/or structural fill extending to suitable natural soils. Due to the high uplift loads, embedment depths for conventional spread and continuous wall foundations may be cost prohibitive. As an alternative, footings may be placed overlying deep foundations. In conjunction with this study, deep foundation systems including driven piles, drilled piers, micro piles, rammed aggregate piers (Geopiers®), and helical piers were considered. Based upon our experience, it is our recommendation that both Geopiers® and helical piers be considered. Discussions concerning deep foundations are presented in Sections 5.4, Geopiers®,and 5.5, Helical Piers.

In the following sections, detailed discussions pertaining to earthwork, foundations, lateral resistance and pressure, floor slabs, pavements, and the geoseismic setting of the site are provided.

5.2 EARTHWORK

5.2.1 Site Preparation

Site preparation will consist of the stripping of all potentially collapsible soils, non-engineered fill, surface vegetation, topsoil, and other deleterious materials from beneath an area extending out at least five feet beyond the perimeter of the proposed structure, and three feet beyond the perimeter of proposed exterior flatwork and rigid pavement areas.

Potentially collapsible soils and existing non-engineered fills may remain beneath the flexible pavement section provided that the upper 12 inches are scarified, moisture prepared, and recompacted to the requirements of structural fill.

The fine-grained soils/fills will require that very close moisture control be maintained during placement and compaction. It will be very difficult, if not impossible, to recompact these soils/fills during wet and cold periods of the year. Within flexible pavement areas, as an option to scarification and recompaction, the upper 12 inches of potentially collapsible soils or non-engineered fills may be removed and replaced with structural fill over proofrolled subgrade. Even with proper preparation, flexible pavements established overlying potentially collapsible soils and existing non-engineered fill may encounter some long-term movements unless these soils are completely removed.

Prior to the placement of structural site grading fill, pavements, floor slabs, or footings, the exposed natural subgrade should be proofrolled by running moderate-weight rubber tire-mounted construction equipment uniformly over the surface at least two times. If excessively soft or otherwise unsuitable soils are encountered beneath footings, they must be completely removed. In rigid pavement, floor slab, and outside flatwork areas, unsuitable natural soils, (excluding potentially collapsible soils and non-engineered fills, which should be completely removed as stated above), should be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

Surface vegetation and other deleterious materials should generally be removed from the site. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled for subsequent landscaping purposes.

5.2.2 Excavations

Construction excavations not exceeding four feet in depth may be constructed with near-vertical sideslopes. Temporary construction excavations not exceeding eight feet in depth in cohesive soils may be constructed no steeper than one-half horizontal to one vertical. Where granular soils are encountered, temporary construction excavations not exceeding eight feet should be constructed with sideslopes no steeper than one horizontal to one vertical. Excavations deeper than eight feet are not anticipated at the site. If extensive layers of clean granular soils and/or groundwater are encountered, flatter sideslopes, shoring and bracing, and/or dewatering may be required.

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.

5.2.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and in some areas, replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

For structural site grading fill, the maximum particle size should generally not exceed four inches; although, occasional particles up to six to eight inches may be incorporated provided that they do not result in "honeycombing" or preclude the obtainment of the desired degree of compaction. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. In confined areas, the maximum particle size should generally not exceed two and one-half inches.

The on-site fine-grained soils/fills may be utilized as structural site grading fill. However, it should be noted that unless moisture control is maintained near optimum, utilization of these natural on-site silty clay soils as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year. Only granular soils are recommended as structural fill in confined areas, such as around foundations and within utility trenches.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

All structural fill shall be placed in lifts not exceeding eight inches in loose thickness. Structural fills 5 to 10 feet thick and beneath an area extending out at least 5 feet from the perimeter of the proposed structure must be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[2] T-180 (ASTM[3] D-1557) compaction criteria. Structural fills greater than 10 feet thick are not anticipated at the site. Structural fills less than 5 feet thick, which are not beneath an area extending out at least 5 feet from the perimeter of the structure, shall be compacted to at least 90 percent of the above-defined criteria.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade must be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation shall consist of the removal of all loose or disturbed soils.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, paved areas, etc.) shall be placed to the same material and density requirements established for structural fill.

If the surface of the backfill becomes disturbed during the course of construction, the backfill shall be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they should be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1a or A-1b (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. <u>However, utility trench backfill placed within flexible pavement areas over potentially collapsible soils should have a minimum of 20 percent fines to reduce the permeability</u>.

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[2] American Association of State Highway and Transportation Officials
[3] American Society for Testing and Materials

These organizations are also requiring that in public roadways, the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

The natural fine-grained cohesive soils are not recommended for use as trench backfill. However, due to the presence of potentially collapsible soils at the site, all structural fill/backfill within utility trenches should have a minimum of 20 percent fines to reduce the permeability.

5.3 FOUNDATIONS

5.3.1 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1.1 Design Data

The results of our analyses indicate that the proposed structure may be supported upon conventional spread and continuous wall foundations. Higher loaded footings must be underlain by granular replacement structural fills to control settlement. For design, the following parameters are recommended:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions	- 3,000 pounds per square foot*
Bearing Pressure Increase for Seismic Loading	- 50 percent

* Higher loaded footings must be underlain by granular structural fills to control settlement, (see Section 5.3.3.1, Settlements).

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.3.1.2 Installation

Under no circumstances shall the footings be installed over potentially collapsible, non-engineered fill, soft, excessively loose or otherwise disturbed soil, sod, topsoil, rubbish, debris, frozen soil, other deleterious materials, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted granular structural fill.

The width of granular structural fill beneath the footings should be equal to the width of the footing plus one foot for each foot of fill thickness. If granular soils are loose, they must be recompacted before the footings are poured.

5.3.1.3 Settlements

Settlements of foundations designed and installed in accordance with the above recommendations and supporting maximum projected loads should not exceed three-quarters to one inch. Settlements should occur rapidly with approximately 50 to 60 percent of quoted settlements occurring during construction. Higher loaded footings must be underlain by granular structural fills to control settlement. Loading and associated thickness of replacement granular structural fill under spread and continuous wall foundations are tabulated below:

Foundations	Loading	Minimum Thickness of Replacement Granular Structural Fill (feet)
Spread	Up to 50 kip	0.0
Spread	50+ to 100 kips	1.0
Spread	100+ to 200 kips	2.0
Spread	200+ to 300 kips	3.0
Spread	300+ to 400 kips	4.0
Wall	Up to 7 kips per lineal foot	0.0
Wall	7+ to 10 kips per lineal foot	1.5

Settlements will occur rapidly, with approximately 50 to 60 percent of the quoted settlements occurring during construction.

5.3.1.4 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, coefficients of 0.40 and 0.45 should be utilized for natural soils and granular structural fills, respectively.

Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. The upper 12 inches of soil at the surface should be excluded.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.3.2 Geopiers®

To resist the projected uplift forces, conventional spread and continuous wall foundations for the structures can be installed overlying deep foundations, such as Geopiers®. For these footings, the following design parameters are provided:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Bearing Pressure for Footings Overlying Geopiers® (To be developed by Geopiers®)	~ 5,500 pounds per square foot*
Uplift Resistance for Footings Overlying Geopiers® (To be developed by Geopiers®)	~ 30,000 to 40,000 pounds per pier*

* Geopiers® elements are spaced singly or in close groups beneath footings to support concentrated column loads or resist uplift forces.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

Geopiers® Foundation Company was contacted to provide preliminary recommendations for the design of foundations at this site. Their preliminary recommendations include a maximum allowable bearing pressure of 5,500 pounds per square foot for spread footings bearing on a Geopiers®-reinforced subgrade and an uplift resistance force of 30 to 40 kips per pier. This pressure is a composite pressure, applicable across the entire area of the footing. The allowable bearing pressure may be increased by one-third for consideration of short-term seismic loading. Geopiers® elements would be 30 inches in diameter and, depending on the magnitude of the column loads, would extend 10 to 15 feet below bottom-of-footing elevation in order to limit total and differential settlement to one-half to one inch.

Geopiers® soil reinforcement should be designed and constructed by an installer licensed by the Geopiers® Foundation Company, Inc. The installer should provide a Geopiers® layout and detailed design calculations sealed by a professional engineer licensed in the State of Utah. The design calculations should demonstrate that Geopiers® soil reinforcement is designed to control long-term settlement to magnitudes within the criteria for this project.

The design parameters should be verified by a full-scale Geopiers® load/uplift test (similar to a pile test) performed in the field. The geotechnical consultant should be retained to monitor the test and subsequent installation of production Geopiers® elements.

5.3.2.1 Installation

Under no circumstances shall the footings be established over loose or disturbed structural fill, non-engineered fills, or other deleterious materials. Unsuitable soils would be removed in conjunction with previous earthwork operations. If the granular structural fills become loose or disturbed, they shall be recompacted before the footings are installed.

If Geopiers® are utilized, then conventional spread and continuous wall foundations would be established directly upon the tops of the pier systems.

5.3.2.2 Settlements

Settlements of foundations will be determined by Geopiers® subsequent analysis but are anticipated to be one-half to one inch.

5.3.2.3 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, coefficients of 0.40 and 0.45 should be utilized for natural soils and granular structural fills, respectively. Geopiers® subsequent analysis may provide coefficients greater than that provided above.

Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. The upper 12 inches of soil at the surface should be excluded.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.3.3 Helical Piers

5.3.3.1 Design Data

As stated previously, helical piers may be used to provide uplift resistance as well as downward axial capacity. Individual helical piers extending to suitable soils will exhibit uplift resistance and downward axial capacities of 90 to 100 kips, depending on the size of the shaft. To facilitate installation and increase lateral capacity, it is our recommendation that the piers incorporate a minimum two and one-half-inch diameter center shaft. The helical piers should extend to the depth of 20 to 30 feet.

Anticipated piers settlement should not exceed one-half of an inch.

5.3.3.2 Installation

Helical piers must be installed by qualified contractors familiar with the subsurface conditions in the area. At the site of the structure covered by this study, very stiff clay soils were encountered at depths of approximately 8 to 10 feet. Test piers shall be installed prior to any construction to provide evidence that the very stiff clay soils can be penetrated.

5.3.3.3 Lateral Resistance

The lateral resistance of individual vertical helical piers is low. For the existing structures to the east, lateral resistance of seismic and wind loading was provided by the passive resistance of the structural backfill placed against pier cap-grade beams and subgrade walls. For initial design, properly compacted granular backfill may be considered equivalent to a fluid with a density of 400 pounds per cubic foot.

5.4 LATERAL PRESSURES

The lateral pressure parameters, as presented within this section, assume that the backfill will consist of a drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid below-grade walls that are not more than 10 inches thick and 12 feet or less in height, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid non-yielding walls (at-rest), granular backfill should be considered equivalent to a fluid with a density of at least 60 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal, that the granular fill has been placed and lightly compacted, not as a structural fill. If the fill is placed as a structural fill, the values should be increased to 45 pounds per cubic foot, 60 pounds per cubic foot, and 120 pounds per cubic foot, respectively. If the slope behind the wall is two horizontal to one vertical, the values for purely active walls and moderately yielding walls should increase to 57 pounds per cubic foot and 67 pounds per cubic foot, respectively.

For seismic loading, a uniform pressure of 125 pounds per square foot should be added for subgrade/retaining walls up to 8 feet in height.

5.5 FLOOR SLABS

Floor slabs may be established upon suitable undisturbed non-collapsible natural soils and/or upon structural fill extending to suitable natural soils. Floor slabs shall not be placed overlying potentially collapsible soils or non-engineered fill. Topsoil is not considered suitable. To facilitate construction and to act as a capillary break for slabs placed on the natural fine-grained soils, we recommend that all floor slabs in structure areas be directly underlain by four inches of "free-draining" fill, such as three-quarters to one-inch minus clean gap-graded gravel. Settlement of lightly to moderately loaded (up to 200 pounds per square foot) floor slabs is anticipated to be less than one-quarter inch.

5.6 PAVEMENTS

For design, the natural fine-grained surface soils and non-engineered fills are projected as the typical subgrade. These soils will exhibit poor pavement support characteristics, particularly when saturated or nearly saturated. For the projected subgrade conditions and the projected traffic conditions, the pavement sections on the following pages are recommended.

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Parking Areas

(Moderate Volume of Automobiles and Light Trucks
with Occasional Medium-Weight Trucks;
No Heavy-Weight Trucks)
[1 equivalent 18-kip axle loads per day]

Flexible Pavement:

2.5 inches	Asphalt concrete
7.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, potentially collapsible soil or existing non-engineered fill, and/or structural fill extending to these soils

Rigid Pavement:

5.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Suitable natural soils or structural fills extending into suitable natural soil*

* Collapsible soils and non-engineered fill shall be completely removed below rigid pavements.

Roadway Areas

Moderate Volume of Automobiles and Light Trucks;
Moderate Volume of Medium- and Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible Pavement:

3.5 inches	Asphalt concrete
8.0 inches	Aggregate base course
Over	Properly prepared suitable natural soils, potentially collapsible soil or existing non-

		engineered fill, and/or structural fill extending to these soils

Rigid Pavement:

6.0 inches	Portland cement concrete (non-reinforced)
5.0 inches	Aggregate base course
Over	Suitable natural soils or structural fills extending into suitable natural soil*

* Collapsible soils and non-engineered fill shall be completely removed below rigid pavements.

For dumpster pads, we recommend a pavement section outlined for rigid pavements in roadway areas.

These rigid pavement sections are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform with the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.7 CEMENT TYPES

The laboratory tests indicate that the natural silty sand soils contain a moderate amount of water soluble sulfates. Based on our test results, concrete in contact with the on-site soil will have a moderate potential for sulfate reaction (ACI 318, Table 4.3.1). To achieve the required protection against sulfate-related corrosion, we recommend a maximum water-to-cement ratio of 0.5 (by weight, normal weight aggregate concrete) and using Type II cement in concrete to obtain a minimum compressive strength of 4,000 pounds per square inch (psi). Details can be found in the above ACI reference and in the Portland Cement Association publication, "Design and Control of Concrete Admixtures."

5.8 GEOSEISMIC SETTING

5.8.1 General

Utah municipalities adopted the International Building Code (IBC) 2006 on January 1, 2007. The IBC 2006 code determines the seismic hazard for a site based upon 2002 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).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2006 edition.

5.8.2 Faulting

Based upon our review of available literature, the site exists within the Granger fault investigation zone identified by Salt Lake County. City and County ordinances require that a site-specific fault study be performed to identify signs of surface fault rupture and/or related deformations within the site area. It is our understanding that a site-specific fault study was subsequently completed by others and the structure was located on the property according to the guidelines set forth in that study.

5.8.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions, of the IBC 2006 can be utilized.

5.8.4 Ground Motions

The IBC 2006 code is based on 2002 USGS (United States Geologic Survey) mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (40.67453 degrees north and 111.95459 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T Seconds	**Site Class B-C Boundary [mapped values] (% g)**	**Site Class D [adjusted for site class effects] (% g)**
Peak Ground Acceleration	61.0	61.0
0.2 Seconds, (Short Period Acceleration)	S_S = 152.4	S_{MS} = 152.4
1.0 Seconds (Long Period Acceleration)	S_1 = 59.9	S_{M1} = 89.9

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The IBC 2006 code design accelerations (S_{DS} and S_{D1}) are based on multiplying the above accelerations (adjusted for site class effects) for the MCE event by two-thirds (⅔).

5.8.5 Liquefaction

The site is located in an area that has been identified by Salt Lake County as having a "moderate" liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event.

Groundwater was measured at 28.4 feet below grade in Boring B-3 within cohesive soils, which are not susceptible to liquefaction, even during the design seismic event. Due to the depth of the groundwater and the clay soils encountered below the groundwater table, liquefaction in not anticipated to occur at the site during the design seismic event.

5.9 SITE OBSERVATIONS

Due to the presence and variable nature of the collapsible soils and non-engineered fill at the site, a qualified geotechnical engineer or his representative must observe that the collapsible soils and non-engineered fill have been completely removed prior to the placement of structural site grading fills, floor slabs, footings, or rigid pavements as previously discussed in this report.

oOo

Gordon Spilker Huber
Geotechnical Consultants, Inc.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Respectfully submitted,

GSH Geotechnical Consultants, Inc. And

Bryan N. Roberts , State of Utah No. 276476
Professional Engineer

Alan D. Spilker P.E., State of Utah No. 334228
Professional Engineer

Reviewed by:

Michael S. Huber, State of Utah No. 343650
Professional Engineer

BNR/ADS/MSH:jlh

Encl.	Figure	1,	Vicinity Map
	Figure	2,	Site Plan
	Figures	3A	through 3F, Log of Borings (Current Study)
	Figures	4A	through 4C, Log of Borings (October 25, 2007 Preliminary Study)
	Figure	5,	Unified Soil Classification System

Addressee (3 + email)
c: Mr. Nicholas J. Schou (email only)
VCBO Architecture
524 South 600 East
Salt Lake City, Utah 84102

Ms. Whitney Ward (email only)
VCBO Architecture
524 South 600 East
Salt Lake City, Utah 84102

VCBO ARCHITECTUE
JOB NO. 0068-13A-08

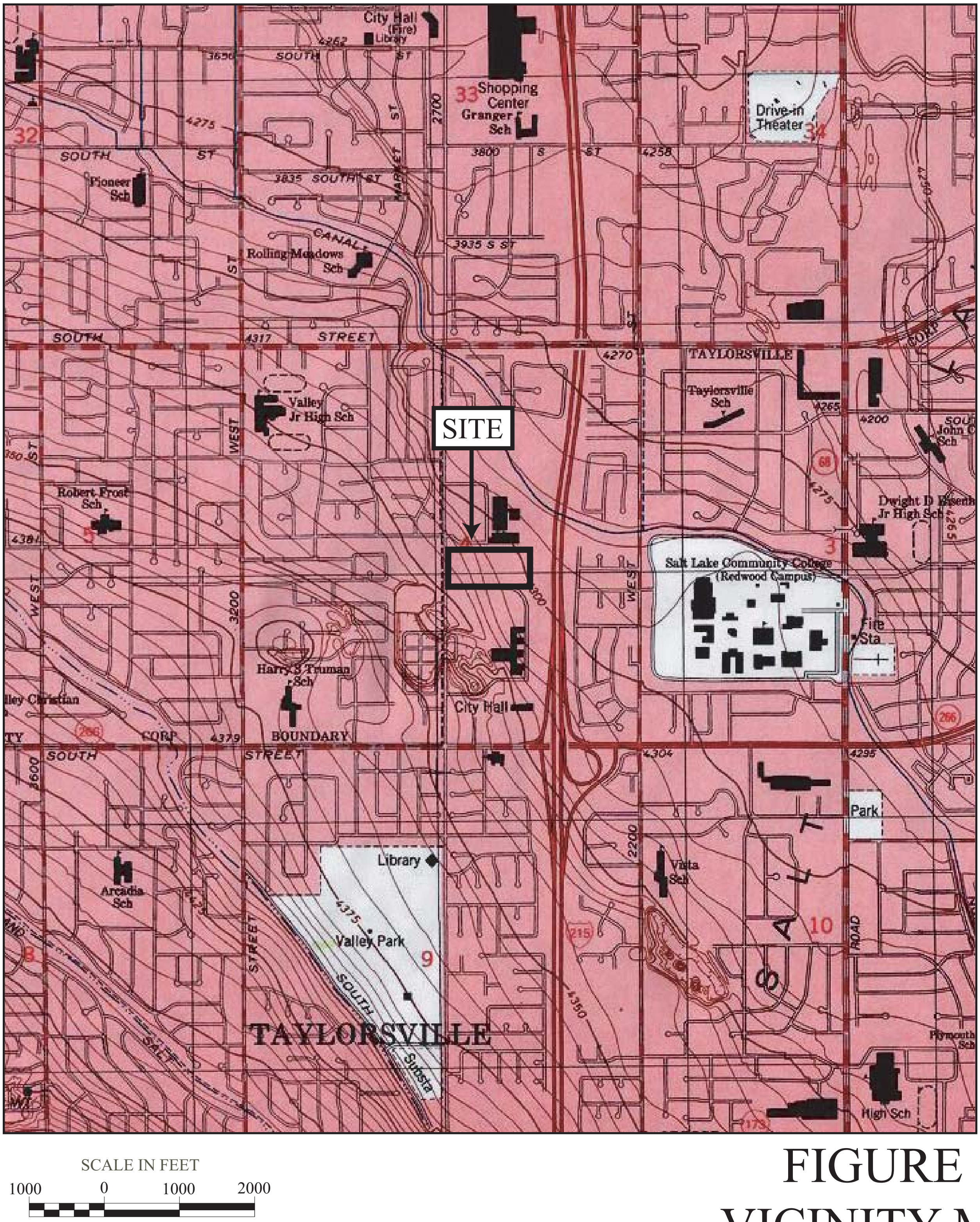

FIGURE 1
VICINITY MAP

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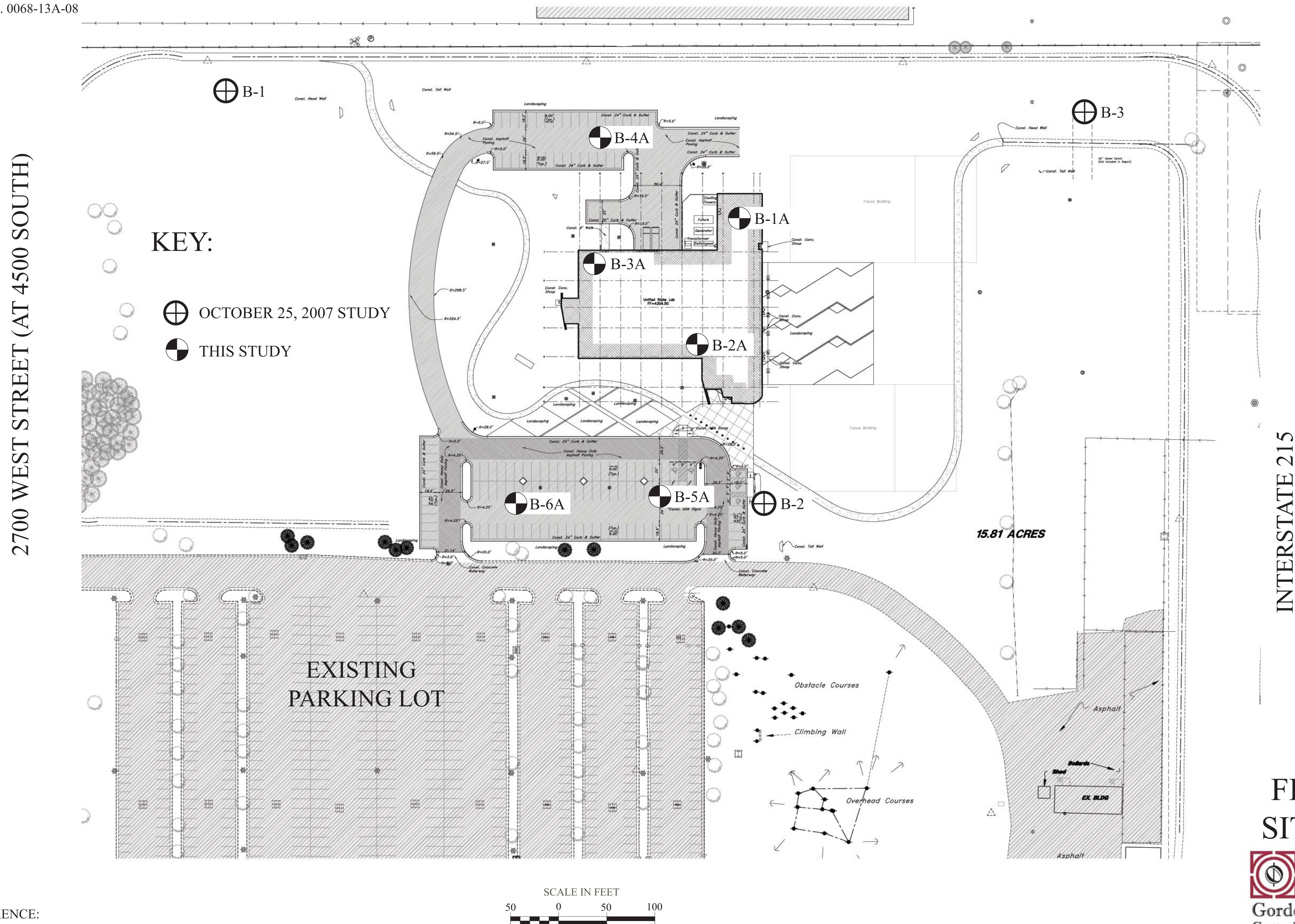
REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC AREA MAP
TITLED "SALT LAKE CITY SOUTH, UTAH"
DATED 1999

VCBO ARCHITECTURE
JOB NO. 0068-13A-08



REFERENCE:
ADAPTED FROM DRAWING PROVIDED BY CLIENT

FIGURE 2
SITE PLAN

GSH
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Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility	Project No.: 0068-013A-07
Location: 450 South 2700 West, Taylorsville, Utah	Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger	Date Drilled: 01-18-08
Elevation: Overall Site Approximately 4306' +/-	Water Level: No groundwater encountered (01-18-08)
Remarks:	

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY SAND/SANDY SILT, FILL with some fine to coarse sand and fine and coarse gravel; major roots (topsoil) to 2"; light brown, FILL (SM/ML)		41	X						moist loose 3" to 4" slightly moist medium dense
		SILTY CLAY with some fine sand; blocky structure; trace pinholes and organics; light brown oxidation mottling (CL)	5	35	X						slightly moist very stiff
				16	X						stiff
		oxidation mottling; occasional layers to 1/4" thick of silty fine sand; light brown	10	22	X						moist
		SAND with some fine gravel; trace silt; brown with oxidation									moist medium dense??
		SILTY CLAY with some fine sand; brown (CL) gravelly drilling at 18'	15	19	X						moist stiff
		SILTY SAND AND SILTY GRAVEL with fine and coarse gravel; fine to coarse sand; brown (SM/GM)	20	96	X						moist dense
		SILTY CLAY with some fine sand; brown?? (CL)	25		X						moist stiff

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3A

BOREHOLE B-1

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility
Location: 450 South 2700 West, Taylorsville, Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Elevation: Overall Site Approximately 4306' +/-
Remarks:

Project No.: 0068-013A-07
Client: VCBO Architecture
Date Drilled: 01-18-08
Water Level: No groundwater encountered (01-18-08)

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		SILTY CLAY with some fine sand; pinholes; light brown oxidation mottling (CL)		12							moist stiff
			30	12							very moist
		Stopped drilling at 30.0'. Stopped sampling at 31.5'. Installed 1-1/4" diameter slotted PVC pipe to 31.5'. No groundwater encountered at time of drilling.	35								
			40								
			45								
			50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3A
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility
Project No.: 0068-013A-07
Location: 450 South 2700 West, Taylorsville, Utah
Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-18-08
Elevation: Overall Site Approximately 4306' +/-
Water Level: No groundwater encountered (01-18-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SAND AND GRAVEL, FILL some fine gravel; silty fine to coarse sand; major roots (topsoil) to 1" to 2"; brown, FILL (SM/GM)									moist loose 3" to 4" medium dense
		SILTY CLAY with some fine sand; blocky structure; light brown (CL)									moist very stiff
				30							
			5								
		occasional layers to 1/2" thick of silty fine sand; light brown		22							stiff
		occasional layers to 1" thick of silty fine sand; light brown		39							very stiff
			10								
		SAND AND GRAVEL with fine sand and coarse gravel; light brown (SM/GM)									moist medium dense
				35							
			15								
		grades fine to coarse sand with some fine gravel; trace silt; brown		25							
			20								
		SILTY CLAY with some fine sand; grayish-brown oxidation mottling (CL)		16							moist stiff
			25								very moist

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-2

Project Name: Proposed New UDOT Facility
Project No.: 0068-013A-07
Location: 450 South 2700 West, Taylorsville, Utah
Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-18-08
Elevation: Overall Site Approximately 4306' +/-
Water Level: No groundwater encountered (01-18-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		SILTY CLAY with some fine sand; grayish-brown oxidation mottling (CL)									stiff
				14							
			30								
		Stopped drilling at 27.0'. Stopped sampling at 28.5'. No groundwater encountered at time of drilling.									
			35								
			40								
			45								
			50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3B
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility

Project No.: 0068-013A-07

Location: 450 South 2700 West, Taylorsville, Utah

Client: VCBO Architecture

Drilling Method: 3-3/4" ID Hollow-Stem Auger

Date Drilled: 01-18-08

Elevation: Overall Site Approximately 4306' +/-

Water Level: No groundwater encountered (01-18-08)

Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY with some fine sand; occasional fine and coarse gravel; major roots (topsoil) to 1" to 2"; brown (CL)									moist loose 3" to 4" very stiff
				30	X						
		oxidation mottling; trace pinholes and rootholes; light brown	5	22	X						
				39	X						
		SILTY SAND fine sand; light brown (CL)									moist medium dense
		grades silty fine to coarse sand with fine and coarse gravel; light brown	10								
				35	X						
			15								
				25	X						
		grades silty fine to coarse sand with fine and coarse gravel; light brown	20								
				16	X						
		CLAY fine sandy clay; light brown??? oxidation mottling (SC)									moist stiff
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3C

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-3

Project Name: Proposed New UDOT Facility
Project No.: 0068-013A-07
Location: 450 South 2700 West, Taylorsville, Utah
Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 01-18-08
Elevation: Overall Site Approximately 4306' +/-
Water Level: No groundwater encountered (01-18-08)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
				14							
		grades silty clay with some fine sand; oxidation mottling	30								very moist medium stiff
		Stopped drilling at 30.0'. Stopped sampling at 31.5'. No groundwater encountered at time of drilling.	35								
			40								
			45								
			50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3C
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility	Project No.: 0068-013A-07
Location: 450 South 2700 West, Taylorsville, Utah	Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger	Date Drilled: 01-18-08
Elevation: Overall Site Approximately 4306' +/-	Water Level: No groundwater encountered (01-18-08)
Remarks:	

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; major roots (topsoil) to 2"; brown (CL)	0–5								moist loose 3" to 4" stiff
		Stopped drilling at 5.0'. Stopped sampling at 5.0'. No groundwater encountered at time of drilling.	5–25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3D

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility
Location: 450 South 2700 West, Taylorsville, Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Elevation: Overall Site Approximately 4306' +/-
Remarks:

Project No.: 0068-013A-07
Client: VCBO Architecture
Date Drilled: 01-18-08
Water Level: No groundwater encountered (01-18-08)

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		SILTY CLAY with some fine sand; major roots (topsoil) to 2"; brown (CL)	0–5								moist loose 3" to 4" stiff
		Stopped drilling at 5.0'. Stopped sampling at 5.0'. No groundwater encountered at time of drilling.	5–25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3E

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

BOREHOLE B-6

Project Name: Proposed New UDOT Facility
Location: 450 South 2700 West, Taylorsville, Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Elevation: Overall Site Approximately 4306' +/-
Remarks:

Project No.: 0068-013A-07
Client: VCBO Architecture
Date Drilled: 01-18-08
Water Level: No groundwater encountered (01-18-08)

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		SILTY CLAY with some fine sand; major roots (topsoil) to 2"; brown (CL)	0–5								moist loose 3" to 4" stiff
			5								
		Stopped drilling at 5.0'. Stopped sampling at 5.0'. No groundwater encountered at time of drilling.									
			10								
			15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3F

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility
Location: 4500 South 2700 West, Taylorsville, Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Elevation: Approximately 4306' +/-
Remarks:

Project No.: 0068-013-07
Client: VCBO Architecture
Date Drilled: 09-21-07
Water Level: No groundwater encountered (10-11-07)

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		CLAYEY SILT/SILTY CLAY with some fine sand; major roots (topsoil) to 2"-3"; pinholes; brown (ML/CL)									loose to 3"-4" dry stiff
				16	X	7.5		85			
		SILTY SAND with fine and coarse gravel; light brown (SM)									slightly moist medium dense
		SILTY CLAY with some fine sand; oxidation mottling; light brown (CL)	5	26	X						moist very stiff
		grades silty clay with some fine sand; oxidation mottling	10	21	X	27.2		95			stiff
		SILTY SAND fine sand; light brown (SM)									moist loose
			15	23	X	23.1	26.8	89.5			
		SILTY CLAY with some fine sand; gray and light brown with oxidation mottling (CL)									moist stiff
			20	12	X						
		SILTY SAND fine sand; light brown (SM)									moist medium dense
			25		X						

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4A

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility
Project No.: 0068-013-07
Location: 4500 South 2700 West, Taylorsville, Utah
Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 09-21-07
Elevation: Approximately 4306' +/-
Water Level: No groundwater encountered (10-11-07)
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
				37							
		SILTY CLAY with some fine sand; light brown grading gray (CL)	30	13		28.3		96.4			moist stiff
		Stopped drilling at 30.0'. Stopped sampling at 31.5'. Installed 1-1/4" diameter slotted PVC pipe to 31.5'. No groundwater encountered at time of drilling.	35 40 45 50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4A
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility

Project No.: 0068-013-07

Location: 4500 South 2700 West, Taylorsville, Utah

Client: VCBO Architecture

Drilling Method: 3-3/4" ID Hollow-Stem Auger

Date Drilled: 09-21-07

Elevation: Approximately 4304' +/-

Water Level: No groundwater encountered (10-11-07)

Remarks:

DEPTH FT.	DESCRIPTION	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
0	Ground Surface **SILTY SAND** major roots (topsoil) to 2"-3"; fine sand; light brown (SM)								loose to 3"-6" dry slightly moist medium dense moist loose
		14	(sample symbol: vertical bars)	6.9	41.7	97.2			
5		21	(sample symbol: hourglass)	6.0	36.0				
10		6	(sample symbol: vertical bars)						
	SILTY CLAY with some fine sand; light brown with oxidation mottling (CL)								moist stiff
	SILTY SAND with some fine gravel; fine to coarse sand; light brown (SM)								moist medium dense
15	**SILTY CLAY** with some fine sand; occasional layers to 1/4" thick of silty fine sand; brown (CL)	23	(sample symbol: hourglass)	17.7		97			moist very stiff
20	grades gray with black mottling; no sand layers	24	(sample symbol: hourglass)	28.4		92.3			
	SILTY SAND fine to medium sand; light brown (SM)								moist medium dense
25			(sample symbol: hourglass)						

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4B

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility

Project No.: 0068-013-07

Location: 4500 South 2700 West, Taylorsville, Utah

Client: VCBO Architecture

Drilling Method: 3-3/4" ID Hollow-Stem Auger

Date Drilled: 09-21-07

Elevation: Approximately 4304' +/-

Water Level: No groundwater encountered (10-11-07)

Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
				35							
		SILTY SAND AND GRAVEL fine to coarse sand and coarse gravel; brown (SM/GM)									moist dense
			30	80							
		Stopped drilling at 30.0'. Stopped sampling at 31.5'. No groundwater encountered at time of drilling.									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4B
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility
Project No.: 0068-013-07
Location: 4500 South 2700 West, Taylorsville, Utah
Client: VCBO Architecture
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 09-21-07
Elevation: Approximately 4307' +/-
Water Level: 27' (09-21-07), 28.4 (10-11-07)
Remarks:

DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
Ground Surface									
SILTY CLAY with some fine sand; major roots (topsoil) to 2"-5", blocky; light gray (CL)	0								loose to 3"-4"; dry; moist; medium stiff
	1–2.5	8	X	14.8		72.8			
SILTY SAND AND GRAVEL fine to coarse sand; fine and coarse gravel; light brown (SM/GM)	5–6.5	40	X						slightly moist; medium dense; moist
grades silty fine sand; light brown									
SILTY SAND fine sand; light brown (SM)	10–11.5	59	X	5.5	19.6				
grades fine to coarse sand with fine and coarse gravel; decreasing silt; light brown	15–16.5	34	X						
SILTY CLAY/FINE SANDY CLAY fine sand; gray and brown with oxidation mottling (CL/SC)									very moist; loose
	20–21.5	24	X	20.2		103			
	25		X						stiff

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4C

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed New UDOT Facility

Location: 4500 South 2700 West, Taylorsville, Utah

Drilling Method: 3-3/4" ID Hollow-Stem Auger

Elevation: Approximately 4307' +/-

Remarks:

Project No.: 0068-013-07

Client: VCBO Architecture

Date Drilled: 09-21-07

Water Level: 27' (09-21-07), 28.4 (10-11-07)

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		SILTY CLAY with some fine sand; brown and gray with oxidation mottling (CL)		12		30.7		90.7			very moist
		grades brown	30	19							saturated
		Stopped drilling at 30.0'. Stopped sampling at 31.5'. Installed 1-1/4" diameter slotted PVC pipe to 31.5'.	35								
			40								
			45								
			50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4C
(con't)

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. [2] (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures.

	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

[1] Boundary classifications:—Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW—GC, well graded gravel—sand mixture with clay binder.
[2] All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

- Bulk / Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- Water Level
- Thin Wall
- No Recovery
- 3-3/4" ID D&M Sampler
- 3" ID D&M Sampler
- California Sampler

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thichness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

DESCRIPTION	%
Trace	<5
Some	5 - 12
With	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 5

Gordon Spilker Huber
Geotechnical Consultants, Inc.