GORDON GEOTECHNICAL ENGINEERING, INC.

REPORT
GEOTECHNICAL STUDY
Zwahlen ~~PROPOSED TWO-LOT~~ SUBDIVISION
2940 WEST 13400 SOUTH STREET
RIVERTON, UTAH

July 29, 2015

Job No. 312-001-15

Prepared for:
Jon Zwahlen
2940 West 13400 South
Riverton, Utah 84065

Prepared by:
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July 29, 2015
Job No. 312-001-15

Jon Zwahlen
2940 West 13400 South
Riverton, Utah 84065

Attention: Mr. Jon Zwahlen

Ladies and Gentlemen:

Re: Report
Geotechnical Study
Proposed Two-Lot Subdivision
2940 West 13400 South Street
Riverton, Utah

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed at the site of the proposed two-lot subdivision which is located at 2940 West 13400 South Street in Riverton, 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 detailed location of the site showing existing roadways and structures, on an air photograph base, is presented on Figure 2, Area Map. A more detailed layout of the site showing the proposed locations of lots and roadways, site-specific topography, and existing facilities is presented on Figure 3, Site Plan. The locations of the test pits excavated in conjunction with this study are also presented on Figure 3.

During the course of this study, many of the conclusions and recommendations were presented to the design team and owner.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Jon Zwahlen, homeowner, and Mr. Patrick Emery of Gordon Geotechnical Engineering, Inc. (G^2).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide appropriate foundation, earthwork, 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. A field program consisting of the excavating, logging, and sampling of two test pits.

2. A laboratory testing program.

3. 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 our Professional Services Agreement No. 15-0614 dated June 15, 2015 and executed on July 1, 2015.

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 test pits, 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, G^2 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

The existing 0.95-acre parcel is to be subdivided into two residential lots. The existing residential structure on the south side of the lot will remain and a new residential structure will be constructed in the back of the lot. The new structure is anticipated to be two to three levels above grade with a full-depth basement level. Above grade, the structure will be of wood-frame construction with some brick, stone, or stucco veneer. Below grade, the structure will be of reinforced concrete construction. The development will also include minor at-grade asphalt concrete paved roadways.

Maximum column and wall loads are anticipated to be on the order of 40 to 60 kips and 2 to 3 kips per lineal foot, respectively. Real loads are defined as the total of all dead plus frequently applied (reduced) live loads. Floor slab loads will be relatively light, on the order of 200 pounds per square foot or less.

Site development will require a minor amount of earthwork in the form of site grading with cuts and fills on the order of two to three feet.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 2 test pits were excavated to depths of 14.5 to 15.0 feet below existing grade. The test pits were excavated using a moderate-sized rubber tire backhoe. Locations of the test pits are presented on Figure 3.

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 4A and 4B, Log of Test Pits. Soils were classified in accordance with the nomenclature described on Figure 5, Unified Soil Classification System.

A 2.5-inch outside diameter, 2.42-inch inside diameter drive hand driven thin wall sampler was utilized in the subsurface sampling at the site.

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

GORDON GEOTECHNICAL ENGINEERING, INC.

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, density, swell/collapse-consolidation, and chemical tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Swell/Collapse-Consolidation Test

Swell/collapse-consolidation tests have been performed on each of two representative samples of the natural clay soils encountered in order to assess their moisture sensitivity and load deformation characteristics. The swell/collapse-consolidation test was performed as follows:

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 test results are tabulated below:

Test Pit No.	Depth (feet)	Soil Classification	In-Situ Dry Density (pcf)	In-Situ Moisture Content (percent)	Axial Load When Saturated (psf)	Collapse (-) or Swell (+) (percent)
TP-1	3.0	CL	83.0	15.7	1,600	-3.16
TP-1	13.5	CL	87.4	25.1	1,600	-0.37*

* Slight collapse due to sample disturbance.

The swell/collapse portion of the test indicates that the near-surface natural clay soils that contain a "pinhole" type structure are moderately collapsible. Following completion of the swell/collapse portion of the test, normal consolidation test loading was applied. The results of this portion of the test indicated that the sample from a depth of three feet is moderately compressible after saturation. The sample from a depth of 13.5 feet is slightly over-consolidated, and will exhibit moderately low compressibility characteristics under the anticipated loading range.

Detailed results of the tests are maintained within our files and can be transmitted to you, at your request.

3.2.3 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 at the site. The results of the chemical tests are tabulated below:

Test Pit No.	Depth (feet)	Soil Classification	pH	Total Water Soluble Sulfate (mg/kg-dry)
TP-2	4.0	CL	8.04	108

4. SITE CONDITIONS

4.1 SURFACE

The site is rectangular in shape and consists of 0.95-acres of land containing a single-family residential structure. The existing residential structure contains two above-grade levels and a full-depth basement level. Vegetation consists of grass and small bushes in the landscaped areas with several large trees. The site is bordered by residential structures to the north, east, and west, and 13400 South Street to the south.

The topography of the site slopes gently down to the west with an overall relief on the order of two to three feet.

Representative photographs of the site area are shown on Figure 6, Photographs.

4.2 SUBSURFACE SOIL AND GROUNDWATER

The soil conditions encountered in the test pits were relatively similar. From the surface in each of the test pits and extending to a depth of four to five feet, silty clay was encountered. The silty clay contains some fine sand and occasional thin layers of silty fine to coarse sand with some fine gravel and is stiff to very stiff, slightly moist, light brown, and contains a "pinhole"-type structure. Laboratory testing indicates that these surficial clay soils with a "pinhole" structure are moderately collapsible when saturated (moisture sensitive). The upper four inches was loose, contained major roots, and has been classified as topsoil.

Underlying the clay and extending to a depth of five and one-half to seven feet in each of the test pits is silty fine to coarse sand with some fine and coarse gravel. The sand is medium dense, moist, grayish-brown, and will exhibit high strength and low compressibility characteristics under the anticipated loading range.

Underlying the sand and extending to the maximum explored depths of 14.5 to 15.0 feet, silty clay with some fine sand was encountered. In Test Pit TP-2, the clay contained occasional thin layers of silty fine to coarse sand with some fine gravel. The clay is medium stiff to stiff, moist, brown, slightly over-consolidated, and is projected to exhibit moderate strength and compressibility characteristics under the anticipated loading range.

The lines designating the interface between soil types on the test pit logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

During excavation operations, groundwater was not encountered at the maximum explored depth, 15 feet.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The proposed structure may be supported upon conventional spread and continuous wall foundations over suitable natural soils and/or structural fill extending to suitable natural soils.

The most significant geotechnical aspect of the site is the moisture sensitive (collapsible) soils encountered in the upper four to five feet at each of the test pit locations. Moisture sensitive soils must be completely removed below the building footprint and rigid pavement areas. We project that the proposed below-grade basement level will extend below the moisture sensitive soils.

Due to the variable nature of the moisture sensitive soils encountered, a qualified geotechnical engineer must aid in verifying that all moisture sensitive soils have been completely removed prior to the placement of structural site grading fills, footings, or foundations.

Detailed discussions pertaining to earthwork, foundations, floor slabs, lateral resistance, and the geoseismic setting of the site are discussed in the following sections.

5.2 EARTHWORK

5.2.1 Site Preparation

Preparation of the site must consist of the removal of all non-engineered fills (if encountered), moisture sensitive soils, debris, surface vegetation, topsoil, root bulbs, sod, and any other deleterious materials extending out at least three feet beyond the perimeter of the building footprint and rigid pavement areas. Stripping in areas containing major root bulbs will be deeper. Stripped topsoil will be unsuitable for structural fill but may be stockpiled for subsequent landscaping purposes. Any existing utilities will need to be properly abandoned and/or relocated.

The moisture sensitive soils may remain in flexible pavement areas as long as they are properly prepared. Proper preparation will consist of scarifying and moisture conditioning the upper nine inches and recompacting to the requirements of structural fill. However, it should be noted that compaction of fine-grained soils (clays and silts) as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, or floor slabs, the exposed natural subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If any loose, soft, or disturbed zones are encountered, they must be completely removed in footing and floor slab areas and replaced with granular structural fill. If removal depth required is greater than two feet, G^2 must be notified to provide further recommendations. In pavement areas, unsuitable soils encountered during recompaction and proofrolling must be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

5.2.2 Temporary Excavations

Groundwater is anticipated to be encountered at depths greater than 15 feet below the ground surface. Temporary construction excavations in cohesive soil, above or below the water table, not exceeding four feet in depth, may be constructed with near-vertical sideslopes. Temporary excavations up to eight feet deep in fine-grained cohesive soils (clays) may be constructed with sideslopes no steeper than one-half horizontal to one vertical. Temporary excavations up to eight feet deep in granular soils may be constructed with sideslopes no steeper than one horizontal to one vertical.

Excavations encountering loose and/or saturated cohesionless soils (not anticipated) will be very difficult and will require very flat sideslopes and/or shoring, bracing, and dewatering as these soils will tend to flow into the excavation.

Excavations deeper than eight feet are not anticipated at the site.

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 possibly as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

Structural site grading fill is defined as structural fill placed over relatively large open areas to raise the overall grade. For structural site grading fill, the maximum particle size shall not exceed four inches; although occasional larger particles not exceeding six inches in diameter may be incorporated if placed randomly in a manner such that "honeycombing" does not occur and the desired degree of compaction can be achieved. The maximum particle size within structural fill placed within confined areas shall be restricted to two inches.

The on-site natural fine-grained soils and underlying granular soils may be utilized as structural site grading fill if they meet the requirements of such stated herein. It should be noted that unless moisture control is maintained, utilization of fine-grained 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.

All imported granular structural fills should consist of a fairly well-graded mixture of sand and gravel containing less than 18 percent fines (percent by weight of material passing the No. 200 sieve).

To stabilize soft subgrade conditions (if needed), a mixture of coarse gravels and cobbles (stabilizing fill) should be utilized. A layer of stabilizing fill approximately 12 to 18 inches thick is typically sufficient to stabilize most soft/disturbed areas.

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 other structural fill shall be placed in lifts not exceeding eight inches in loose thickness. Structural fills shall be compacted in accordance with the percent of the maximum dry density as determined by the AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria in accordance with the table on the following page.

1 American Association of State Highway and Transportation Officials
2 American Society for Testing and Materials

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 8	95
Outside area defined above	0 to 5	90
Outside area defined above	5 to 8	92
Road base	-	96

Structural fills greater than eight feet thick are not anticipated at the site.

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 should 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.

Coarse gravel and cobble mixtures (stabilizing fill), if utilized, shall be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately placed so that the "fines" are "worked into" the voids in the underlying coarser gravels and cobbles.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same 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 shall 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 shall 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. 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 on-site clays and silts are not suitable for re-use as trench backfill. The natural granular soils, if meeting the requirements for Type A-1a or A-1b, may be used.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Moisture sensitive soils must be completely removed from below the building footprint. For design, the following parameters are provided with respect to the projected loading discussed in Section 2., Proposed Construction, of this report:

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	
For footings on suitable natural soils and/or structural fill extending to suitable granular soils	- 2,000 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent

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 the 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.

5.3.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill.

The width of structural replacement fill below footings should be equal to the width of the footing plus one foot for each foot of fill thickness.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with above recommendations and supporting maximum projected structural loads are anticipated to be on the order of one-half to five-eighth of an inch. Settlements are expected to occur rapidly with approximately 60 to 70 percent of the settlements occurring during construction.

5.4 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, a coefficient of 0.40 should be utilized for the natural fine-grained soils. 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. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

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

5.5 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 basement walls that are not more than 10 inches thick and 8 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, granular backfill should be considered equivalent to a fluid with a density of at least 55 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.

For seismic loading, a uniform pressure of 115 pounds per square foot should be added for basement walls up to 8 feet in height.

5.6 FLOOR SLABS

Floor slabs may be established directly upon suitable natural soils and/or structural fill extending to suitable natural soils. Topsoil and moisture sensitive soils are not considered suitable. To provide a capillary break, it is recommended that interior floor slabs are directly underlain by a minimum of four inches of "free-draining" fill, such as "pea" gravel or three-quarter- to one-inch minus clean gap-graded gravel. Settlements of lightly to moderately loaded floor slabs are anticipated to be minor.

5.7 PAVEMENTS

The near-surface natural clay soils will exhibit poor engineering characteristics when saturated or near saturated. Considering fine-grained soils as the subgrade soils and the projected traffic, the following pavement sections are recommended:

Residential Roadways

(Moderate Volume of Automobiles and Light Trucks,
Occasional Medium-Weight and Heavy-Weight Trucks)
[1 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base
Over	Properly prepared natural soils, properly prepared non-engineered fills, and/or structural site grading fill extending to suitable natural soils.

Rigid:

5.5 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base
Over	Properly prepared natural soils, and/or structural site grading fill extending to suitable natural soils.*

* Rigid pavements shall not be established overlying non-engineered fills even if they are properly prepared.

These above 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 to 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.

5.8 CEMENT TYPES

The laboratory tests indicate that the natural soils tested contain a negligible amount of water soluble sulfates. Based on our test results, concrete in contact with the on-site soil will have a low potential for sulfate reaction. Therefore, all concrete which will be in contact with the site soils may be prepared using Type I/II or IA/IIA cement.

5.9 GEOSEISMIC SETTING

5.9.1 General

As of July 2013, the State of Utah has adopted the International Building Code (IBC) 2012 and International Residential Code (IRC) 2012. The IRC 2012 code determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2012 edition.

5.9.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The site is located outside fault investigation zones identified by Salt Lake County. The nearest active fault is the Salt Lake segment of the Wasatch Fault, approximately 6.5 miles east of the site.

5.9.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 20.3-1, Site Classification, of ASCE 7-10 April 6, 2011 can be utilized.

5.9.4 Ground Motions

The IBC 2012 code is based on 2008 USGS mapping, which provides values of short and long period accelerations for the Site Class B boundary for the Maximum Considered Earthquake (MCE). Site Class B 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 (40.5085 degrees north and -111.9622 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T Seconds	Site Class B Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration	51.7	51.7
0.2 Seconds (Short Period Acceleration)	S_S =129.3	S_{MS} =129.3
1.0 Seconds (Long Period Acceleration)	S_1 =42.9	S_{M1} =67.5

The IBC 2012 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.

5.9.5 Liquefaction

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.

The site is located within an area that has been mapped by Salt Lake County as having a "low" liquefaction potential. Due to the lack of a shallow groundwater table and primarily cohesive nature of the soils encountered, liquefaction is not anticipated to occur during the design seismic event.

5.10 SITE VISITS

As stated previously, due to the variable nature of the moisture sensitive soils encountered, a qualified geotechnical engineer must aid in verifying that all moisture sensitive soils have been completely removed prior to the placement of structural site grading fills, floor slabs, footings, or foundations.

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,

Gordon Geotechnical Engineering, Inc.

Patrick R. Emery, State of Utah No. 7941710
Senior Engineer

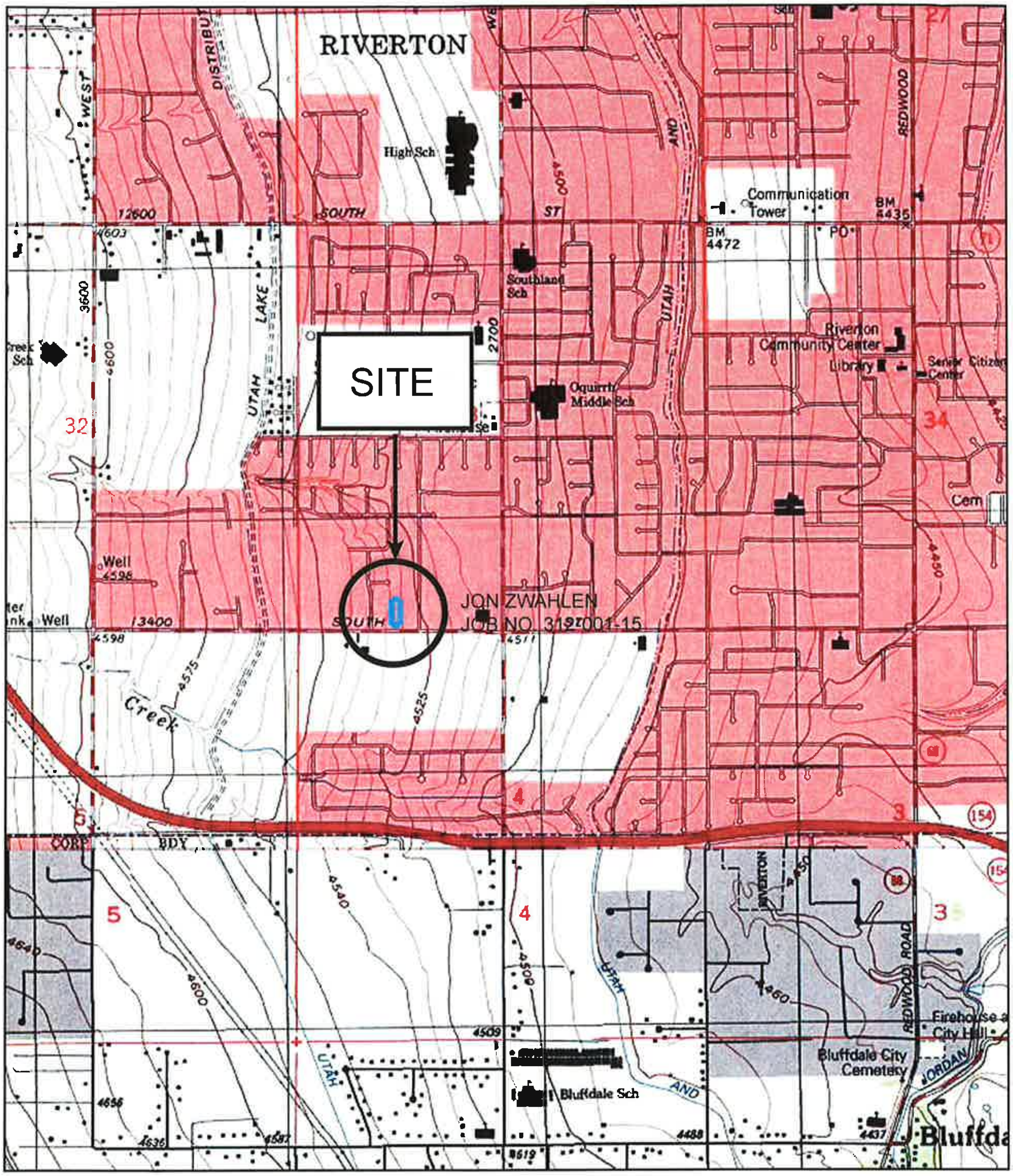
PRE:sn

Encl.	Figure	1,	Vicinity Map
	Figure	2,	Area Map
	Figure	3,	Site Plan
	Figures	4A	and 4B, Log of Test Pits
	Figure	5,	Unified Soil Classification System
	Figure	6,	Photographs

Addressee (3 + email)

JON ZWAHLEN
JOB NO. 312-001-15

GORDON GEOTECHNICAL ENGINEERING, INC.



SCALE IN FEET

1000 0 1000 2000

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAPS TITLED "MIDVALE, UTAH", AND "JORDAN NARROWS, UTAH" BOTH DATED 1999

FIGURE 1
VICINITY MAP

JON ZWAHLEN
JOB NO. 312-001-15

GORDON
GEOTECHNICAL
ENGINEERING, INC.

REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
DOWNLOADED FROM 2015 GOOGLE EARTH
IMAGERY DATED JUNE 04, 2013

FIGURE 2
AREA MAP

SCALE: feet 600
meters

JON ZWAHLEN
JOB NO. 312-001-15

GORDON GEOTECHNICAL ENGINEERING, INC.

REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"ZWHALEN SUBDIVISION - UTILITY PLAN",
SHEET NO. C1 of 2, BY: BUSH & GUDGELL, INC.,
DATED APRIL 2015

FIGURE 3
SITE PLAN

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

TEST PIT TP-1

Project Name: Proposed Two-Lot Subdivision
Project No.: 312-001-15
Location: 2940 West 13400 South Street, Riverton, Utah
Client: Jon Zwahlen
Excavating Method: JCB 4CX Backhoe
Date Excavated: 07-07-15
Elevation: ---
Water Level: No groundwater encountered.
Remarks:

DESCRIPTION	DEPTH FT.	SAMPLE TYPE	SAMPLE SYMBOL	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface	0									
SILTY CLAY with some fine sand and occasional layers up to 6" thick of silty fine to coarse sand with some fine gravel; root holes/"pinholes"; major roots (topsoil) to 4"; brown (CL)										moist "very stiff"
		TW	■							
		TW	■		15.7	83				stiff"
SILTY FINE TO COARSE SAND with some fine and coarse gravel; grayish-brown (SM)	5	B	◢							moist "medium dense"
SILTY CLAY with some fine sand; root holes; brown (CL)										moist "stiff"
	10									
										"medium stiff"
		TW	■		25.1	87				
	15	B	◢							
	20									
	25									

Stopped excavating at 15.0'.

Stopped sampling at 15.0'.

No groundwater encountered at time of excavation.

No significant sidewall caving.

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 Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-2

Project Name: Proposed Two-Lot Subdivision
Location: 2940 West 13400 South Street, Riverton, Utah
Excavating Method: JCB 4CX Backhoe
Elevation: ---
Remarks:

Project No.: 312-001-15
Client: Jon Zwahlen
Date Excavated: 07-07-15
Water Level: No groundwater encountered.

DESCRIPTION	GRAPHIC LOG	Water Level	DEPTH FT.	SAMPLE TYPE	SAMPLE SYMBOL	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
SILTY CLAY with some fine sand and occasional layers of sandy clay with trace fine gravel; major roots (topsoil) to 4"; root holes/"pinholes"; brown (CL)												moist "very stiff"
				TW								
				TW			12.7	84				stiff"
			5	B								
SILTY FINE TO COARSE SAND with some fine gravel; grayish-brown (SM)												moist "medium dense"
SILTY CLAY with some fine sand and occasional layers up to 4" thick of silty fine to coarse sand with fine gravel; brown (CL)			10									
			15									
			20									
			25									

Stopped excavating at 14.5'.

Stopped sampling at 5.5'.

No groundwater encountered at time of excavation.

No significant sidewall caving.

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 GEOTECHNICAL ENGINEERING, INC.

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	GRAVELS — More than half of coarse fraction is larger than No. 4 sieve size (For visual classification 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)	Nonplastic 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
The No. 200 sieve size is about the smallest particle visible to the naked eye	SANDS — More than half of coarse fraction is smaller than No. 4 sieve size (For visual classification 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)	Nonplastic 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	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
The No. 200 sieve size is about the smallest particle visible to the naked eye	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. Therefore, 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 the point of exploration on the date indicated.

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

LOG KEY SYMBOLS

- Bulk - Bag Sample
- Thin Wall
- Standard Penetration Split Spoon Sampler
- No Recovery
- Rock Core
- 1-2/3" ID D&M Sampler
- 1" ID D&M Sampler
- Water Level
- California Sampler

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 moderate 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

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 thickness

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 GEOTECHNICAL ENGINEERING, INC.

#1 Facing west along the northern site boundary.

#2 Facing south along the eastern site boundary.

#3 Facing north along the eastern site boundary.

#4 Facing south along the western site boundary.

Locations and direction, see Figure 2, Area Map

FIGURE 6
PHOTOGRAPHS