

**REPORT  
GEOTECHNICAL STUDY  
PROPOSED 30<sup>TH</sup> STREET APARTMENTS  
451 AND 475 SOUTH 30<sup>TH</sup> STREET  
OGDEN, UTAH**

April 30, 2019

Job No. 705-001-19

**Prepared for:**

Action Real Estate LLC  
1914 East 9400 South, #235  
Sandy, Utah 84093

**Prepared by:**

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April 30, 2019  
Job No. 705-001-19

Action Real Estate LLC  
1914 East 9400 South, #235  
Sandy, Utah 84093

**Attention: Mr. Andy Peterie**

Ladies and Gentlemen:

Re: Report  
Geotechnical Study  
Proposed 30<sup>th</sup> Street Apartments  
451 and 475 South 30<sup>th</sup> Street  
Ogden, Utah

## **1. INTRODUCTION**

### **1.1 GENERAL**

This report presents the results of our geotechnical study performed at the site of the proposed 30<sup>th</sup> Street Apartments, which is located at 451 and 475 South 30<sup>th</sup> Street in Ogden, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. A detailed location of the site showing existing roadways and surrounding facilities, on an air photograph base, is presented on Figure 2, Area Map. The locations and alignments of photographs taken of the site during the field portion of study are also shown on Figure 2. A more detailed layout of the site showing the proposed development and existing structures and roadways is presented on Figure 3, Site Plan. The boring locations drilled in conjunction with this study are also presented on Figure 3.

During the course of this study, many of the preliminary conclusions were provided in a letter dated April 5, 2019<sup>1</sup>.

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<sup>1</sup> "Preliminary Geotechnical Design Criteria, Proposed 30<sup>th</sup> Street Apartments, 451 and 475 South 30<sup>th</sup> Street, Ogden, Utah", G<sup>2</sup> Job No. 705-001-19 Dated April 5, 2019

## **1.2 OBJECTIVES AND SCOPE**

The objectives and scope of our study were planned in discussions between Mr. Andy Peterie of Action Real Estate LLC and Mr. Patrick Emery of Gordon Geotechnical Engineering, Inc. (G<sup>2</sup>).

In general, the objectives of this study were to:

1. Accurately define and evaluate the subsurface soil and groundwater conditions across the site.
2. Provide appropriate foundation, earthwork, pavement, and geoseismic recommendations to be utilized in the design and construction of the proposed development.

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

1. A field program consisting of the drilling, logging, and sampling of five borings.
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. 19-0314 dated March 26, 2019.

## **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, measured and 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<sup>2</sup> 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**

An apartment building with plan dimensions of 60.8 feet by 142.0 feet is planned for the 0.79-acre site. The structure is anticipated to be three levels in height and of wood-frame construction established slab-on-grade.

Maximum column and wall loads are projected to be on the order of 60 to 120 kips and 3 to 5 kips per lineal foot, respectively.

Site development will require a minor amount of earthwork in the form of site grading. It is estimated that maximum cuts and fills to achieve design grades will be on the order of one to three feet.

Paved surface parking areas are planned for the east and south sides of the structure. Traffic over the pavements will consist of a light to moderately light volume of automobiles and light trucks, and some medium-weight trucks. In roadway areas, the traffic will be somewhat higher.

## **3. INVESTIGATIONS**

### **3.1 FIELD PROGRAM**

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 5 borings were drilled to depths of 5.0 to 13.5 feet below existing grade. The borings were drilled using a rubber tire truck-mounted drill rig equipped with hollow-stem augers. Locations of the borings are presented on Figure 3. It should be noted that we attempted to drill to a depth of 45.0 feet; however, auger refusal was encountered at depths of 9.0 to 13.5 feet due to the dense gravel and cobbles.

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, relatively undisturbed and small disturbed 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 through 4E, Log of Borings. 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 sampler (Dames & Moore) was utilized in the majority of the subsurface sampling at the site. Additionally, a 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) was utilized at select locations and

depths. 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.

### 3.2 LABORATORY TESTING

#### 3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was performed. The program included moisture and density, partial gradation, consolidation, and chemical tests. 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 undisturbed samples. The results of these tests are presented on the boring logs, Figures 4A through 4E.

#### 3.2.3 Partial Gradation Tests

To aid in classifying the soils and to provide general index parameters, a partial gradation test was performed upon seven representative samples of the soils encountered in the exploration borings. The results of the tests are tabulated below:

Boring No.	Depth (feet)	Percent Passing No. 4 Sieve	Percent Passing No. 200 Sieve	Soil Classification
B-1	10.0	3.7	1.7	GP
B-3	2.5	-	96.4	CL

#### 3.2.4 Atterberg Limit Tests

To aid in classifying the soils, an Atterberg limit test was performed on two samples of the fine-grained cohesive soils. Results of the test are tabulated below:

Boring No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soil Classification
B-3	2.5	37	18	19	CL
B-3	5.0	43	20	23	CL

### 3.2.5 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed on each of two representative samples of the fine-grained soils encountered in the exploration borings. The data available indicates that the fine-grained soils are moderately over-consolidated and when loaded below the over-consolidated pressure the soils will exhibit moderate compressibility characteristics. Detailed results of the tests are maintained within our files and can be transmitted to you, at your request.

### 3.2.6 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:

Boring No.	Depth (feet)	Soil Classification	pH	Total Water-Soluble Sulfate (mg/kg-dry)
B-3	2.5	CL	7.9	69.2

## 4. SITE CONDITIONS

### 4.1 SURFACE

The site consists of two parcels containing a total of 0.79-acres of land. Single-family residential structures are present in the northeast and northwest corners of the site. These residential structures will be demolished and removed. Vegetation at the site consists of ankle-high grass with occasional trees up to 30 feet in height. The site is bordered by residential structures to the east, south, and west; and 30<sup>th</sup> Street to the north with residential structures beyond.

The topography of the site is relatively flat with an overall relief on the order of one to two feet across the site. The site grade is at approximately the same elevation as the grade of the adjacent streets.

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

### 4.2 SUBSURFACE SOIL

The soil conditions encountered in the borings, to the depths penetrated, were relatively similar. From the surface and extending to a depth of three and one-half feet in Boring B-4, fill was encountered. The fill consists of fine to coarse sandy clay with some fine and coarse gravel.

The fills were likely placed in a somewhat controlled manner during the previous earthwork operations at the site; however, unless compaction testing reports can be provided, they must be considered a non-engineered fill. The fills are will exhibit variable and, most likely, poor engineering characteristics.

Underlying the fill in Boring B-4, the asphalt concrete in Boring B-1, from the surface in the remainder of the borings and extending to depths of eight to nine and one-half feet, natural silty clay was encountered. The clay is stiff to hard, moist, brown, and will exhibit moderate strength and compressibility characteristics under the anticipated loading range.

Underlying the clay in Borings B-1 through B-3 and extending to the maximum explored depth of 9.0 to 13.5 feet, natural sand and gravel was encountered. The granular soils generally consists of silty fine sand grading to clean fine and coarse gravel with some cobbles. The sand and gravel is very dense, moist, and will exhibit high strength and low compressibility characteristics under the anticipated loading range. It should be noted that auger refusal due to dense gravel with cobbles was encountered at depths of 9 to 13 feet in Borings B-1 through B-3.

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

### **4.3 GROUNDWATER**

During drilling operations, groundwater was not encountered at the maximum explored depth of 13.5 feet. Groundwater is not anticipated to impact the proposed construction.

Seasonal and longer-term groundwater fluctuations on the order of one and 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 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 non-engineered fill encountered to a depth of three and one-half feet in Boring B-4. Additionally, there is a potential for deeper non-engineered fill associated with the demolition and backfill of the existing structures. Non-engineered fills must be completely removed from beneath the building footprint and rigid pavement areas.

Due to the variable nature of the non-engineered fills encountered, a qualified geotechnical engineer must aid in verifying that all non-engineered fills 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, pavement, 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, loose surficial soils, topsoil, debris, and other deleterious materials from beneath an area extending at least three feet beyond the perimeter of the proposed building, rigid pavement, and exterior flatwork areas.

The non-engineered fills may remain in flexible pavement areas as long as they are properly prepared. Proper preparation will consist of scarifying and moisture conditioning the upper eight inches and recompacting to the requirements of structural fill. However, it should be noted that compaction of fine-grained soils (clays and silts, if utilized) as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year. As an option for proper preparation and recompaction, the upper eight inches of the non-engineered fills may be removed and replaced with granular subbase over proofrolled subgrade. Even with proper preparation, flexible pavements established on non-engineered fills may experience some long-term movements. If the possibility of these movements is not acceptable, these non-engineered fills must be completely removed.

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<sup>2</sup> 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 Excavations**

Groundwater is anticipated to be encountered at depths greater than 15 feet below the ground surface. Temporary construction excavations into the natural fine-grained cohesive soils not exceeding four feet in depth may be constructed with near-vertical sideslopes.



Deeper excavations not exceeding 8 to 10 feet in depth nor encountering loose granular soils or groundwater may be constructed with sideslopes no steeper than three-quarters horizontal to one vertical. If granular soils and groundwater are encountered, flatter sideslopes, shoring and bracing, and/or dewatering will be required. Some sloughing of the silty and sandy soils on the sides of the excavations is anticipated.

To minimize disturbance to the underlying soils, it is our recommendation that footings be excavated with a backhoe equipped with a smooth-lip bucket.

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, 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 fill placed over fairly large open areas to raise the overall site grade. For structural site grading fill, the maximum particle size should generally 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 should generally be restricted to two inches.

The on-site non-engineered fills and natural soils may be utilized as structural site grading fill. It should be noted that unless moisture control is maintained, utilization of fine-grained soils (silt or clay) 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.

To stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or one and one-half- to two-inch gravel (stabilizing fill) should be utilized.

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**

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.

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<sup>2</sup> T-180 (ASTM<sup>3</sup> D-1557) compaction criteria in accordance with the table below:

<b>Location</b>	<b>Total Fill Thickness (feet)</b>	<b>Minimum Percentage of Maximum Dry Density</b>
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 8	95
Outside area defined above	0 to 6	90
Outside area defined above	6 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.

### 5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) should 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 should 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-

<sup>2</sup> American Association of State Highway and Transportation Officials

<sup>3</sup> American Society for Testing and Materials

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-1 or A-1-a (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 natural fine-grained cohesive soils are not recommended for use as trench backfill.

### **5.2.6 Areal Settlements**

Areal settlements resulting from site grading fills as much as two to three feet should be less than one-half of an inch. These settlements are in addition to settlements induced by foundation and floor slab loads. To reduce the total settlement that the structures will realize, site grading fill must be placed as far in advance of other construction as possible. The majority of this settlement will occur during placement.

## **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. Under no circumstances shall footings be placed overlying non-engineered fills.

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 <u>natural soils</u> and/or structural fill extending to suitable <u>natural soils</u>	- 2,500 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent*

\* Not applicable for edge bearing pressure when the footings are established upon granular soil. Use 25 percent for overturning or other inclined loading.

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 three-eighths to five-eighths 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 on granular soils, a coefficient of 0.45 should be utilized. In determining frictional resistance on fine-grained soils, a coefficient of 0.40 should be utilized. 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 extending at least five feet from the back of the wall be properly placed and compacted granular soil. 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, 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 with 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 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.

Recommended average seismic lateral uniform pressure for various height walls are tabulated on the following page and assume a granular wall backfill with a horizontal grade above the wall. It should be noted that the lateral pressures as quoted assume that the backfill materials will not become saturated. If the backfill becomes saturated, the above values may be decreased by one-half; however, full hydrostatic water pressures will have to be included.

Wall Height (feet)	Uniform Seismic Lateral Pressure* (psf)
4	78

\* Maximum short-term pressures, they are not sustained loads.

Note that the pressures presented in this section do not include surcharge loadings, such as floor slabs, adjacent footings, etc.

## 5.6 FLOOR SLABS

Floor slabs may be established upon suitable undisturbed natural soils, and/or upon structural fill extending to suitable natural soils. Non-engineered fills and topsoil are not considered suitable. To provide a capillary break, it is recommended that floor slabs be directly underlain by at least four inches of "free-draining" fill, such as "pea" gravel or three-quarters- 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 properly prepared non-engineered fills and surficial natural soils will exhibit relatively poor engineering characteristics when saturated or nearly saturated. Non-engineered fills may remain in flexible pavement areas if properly prepared, as stated previously in this report. Rigid pavements shall not be placed overlying non-engineered fills, even if properly prepared. Considering the fine-grained soils as the subgrade soils and the projected traffic, the pavement sections on the following pages are recommended.

Parking Areas

(Light Volume of Automobiles and Light Trucks,  
Occasional Medium-Weight Trucks,  
and No Heavy-Weight Trucks)  
[1 equivalent 18-kip axle load per day]

Flexible:

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

Rigid:

5.0 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 stabilized natural soils.*

- \* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

Primary Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,  
Light Volume of Medium-Weight Trucks,  
and Occasional Heavy-Weight Trucks)  
[5 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 existing non-engineered fill, and/or structural site grading fill extending to suitable stabilized natural soils.

Rigid:

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

- \* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base, over properly prepared natural stabilized subgrade or site grading structural fills.

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  $\pm$ 1 percent air-entrainment.



## **5.8 GEOSEISMIC SETTING**

### **5.8.1 General**

As of July 2018, the State of Utah will adopt the International Building Code (IBC) 2018. The IBC 2018 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 2018 edition.

### **5.8.2 Faulting**

Based on our review of available literature, no active faults pass through or immediately adjacent to the site.

### **5.8.3 Soil Class**

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 20.3-1, Site Classification, of ASCE 7-16.

### **5.8.4 Ground Motions**

The IBC 2018 code is based on 2008 USGS mapping, which provides peak values of short and long period accelerations ( $S_s$ ,  $S_1$ ) 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 this site 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 (41.2099 degrees north and -111.9688 degrees west, respectively), the values for this site are tabulated on the following page.

<b>Spectral Acceleration Value, T Seconds</b>	<b>Site Class B-C Boundary [mapped values] (% g)</b>	<b>Site Class D [adjusted for site class effects] (% g)</b>
Peak Ground Acceleration	61.8	68.0
0.2 Seconds, (Short Period Acceleration)	$S_S = 136.4$	$S_{MS} = 136.4$
1.0 Seconds (Long Period Acceleration)	$S_1 = 49.6$	$S_{M1} = *$

\* See Section 11.4.8 of ASCE 7-16

The IBC 2018 code design accelerations ( $S_{DS}$  and  $S_{D1}$ ) are based on multiplying the above accelerations ( $S_{MS}$  and  $S_{M1}$ ) for the MCE event by two-thirds ( $\frac{2}{3}$ ).

### 5.8.5 Liquefaction

The site is located in an area that has been identified by the Utah Geological Survey as having “high” 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

Due to the lack of a shallow groundwater table and very dense nature of the granular soils encountered, our analysis indicates liquefaction is not anticipated within the depths explored.

Calculations were performed using the procedures described in the 2008 Soil Liquefaction During Earthquakes Monograph by Idriss and Boulanger<sup>4</sup>.

### 5.9 SITE OBSERVATIONS

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

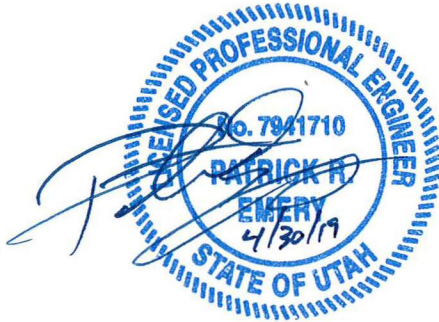
<sup>4</sup> Idriss, I. M., and Boulanger, R. W. (2008), Soil liquefaction during earthquakes: Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, CA, 261 pp.

Job No. 705-001-19  
Geotechnical Study  
April 30, 2019

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.**



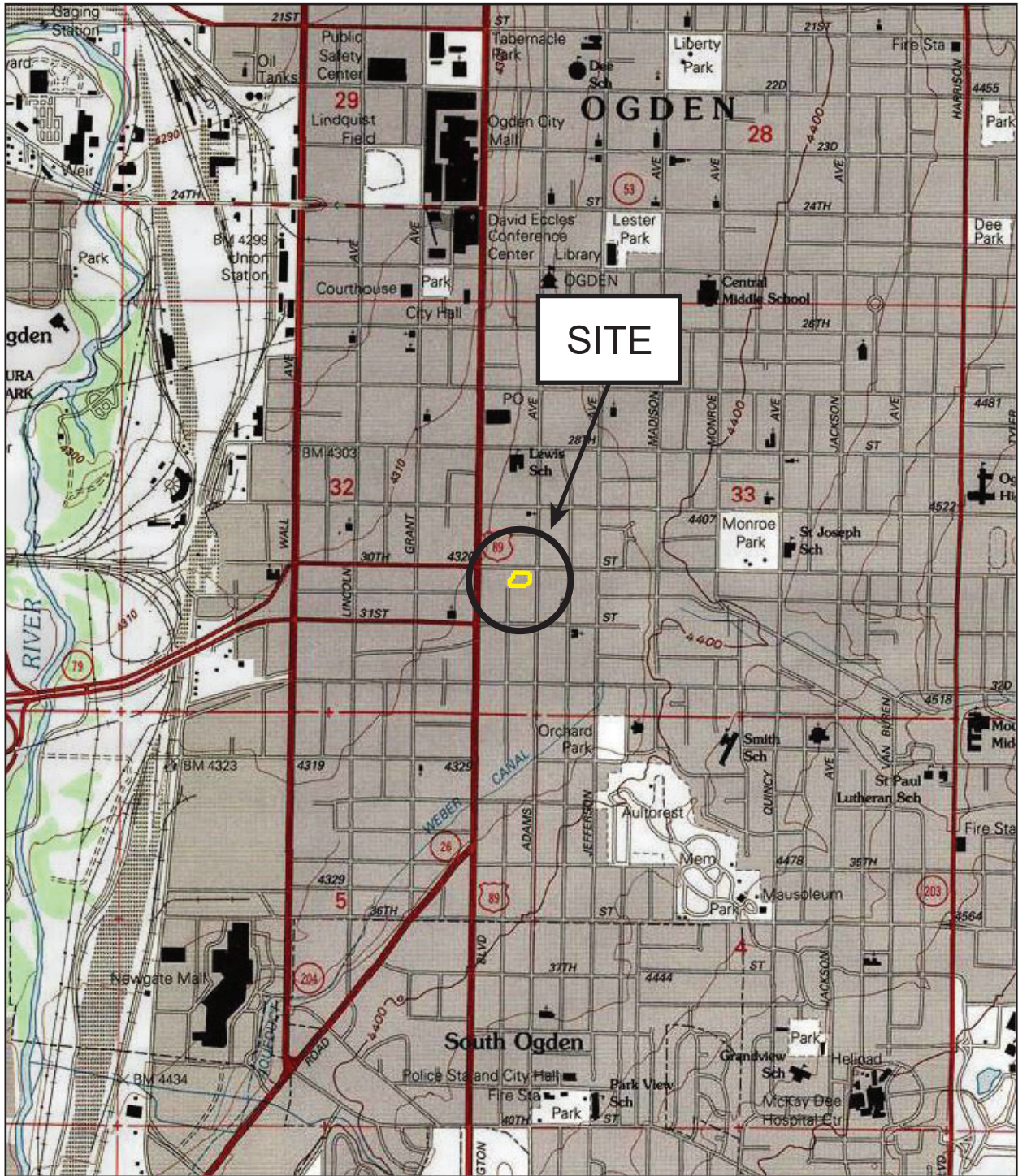
Patrick R. Emery, State of Utah No. 7941710  
Principal Engineer

PRE:sn

- Encl. Figure 1, Vicinity Map
- Figure 2, Area Map
- Figure 3, Site Plan
- Figures 4A through 4E, Log of Borings
- Figure 5, Unified Soil Classification System
- Figure 6, Photographs

Addressee (3 + email)

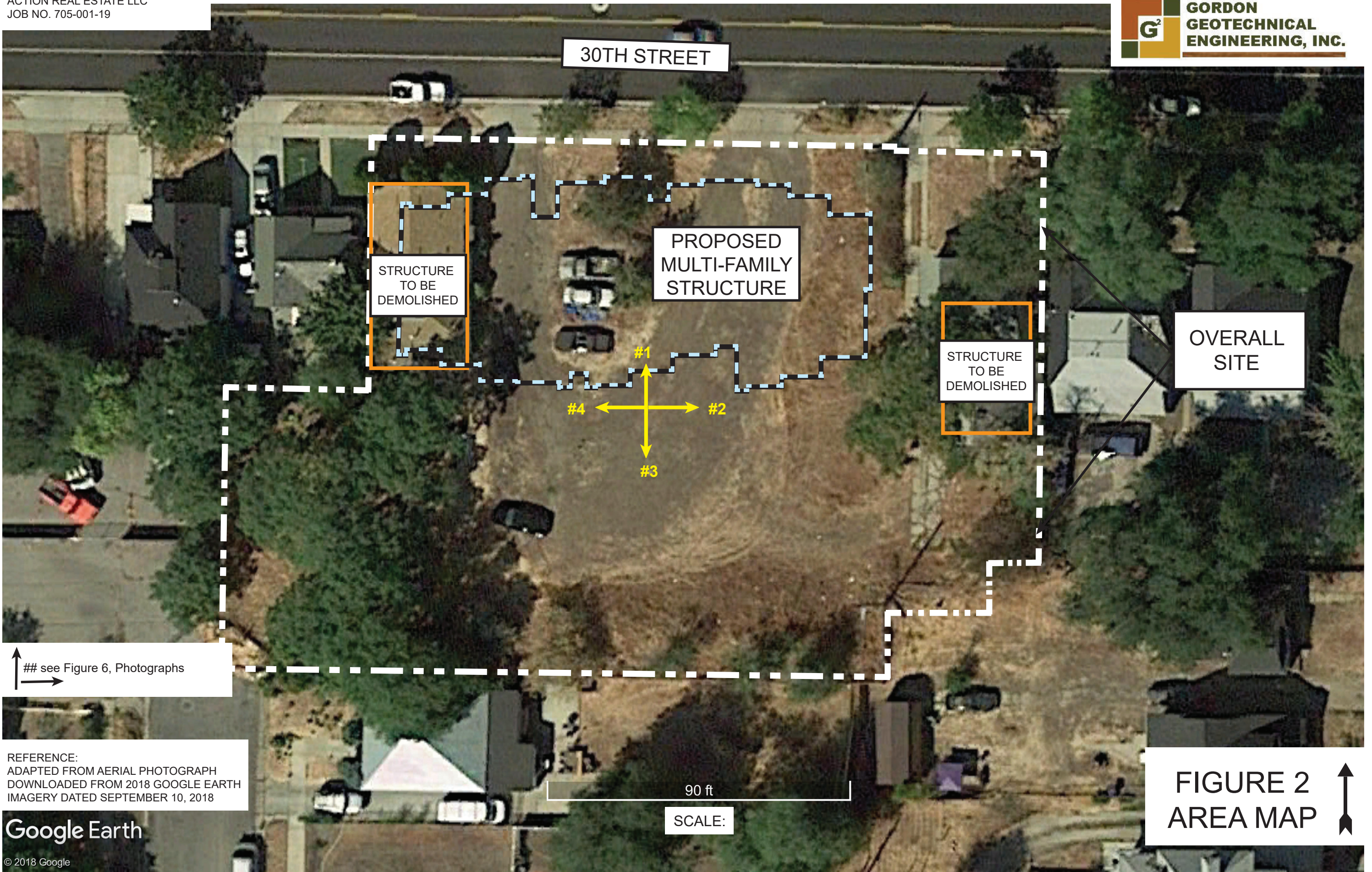




REFERENCE:  
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP  
TITLED "OGDEN, UTAH", DATED 1998

**FIGURE 1**   
**VICINITY MAP**





↑ ## see Figure 6, Photographs  
→

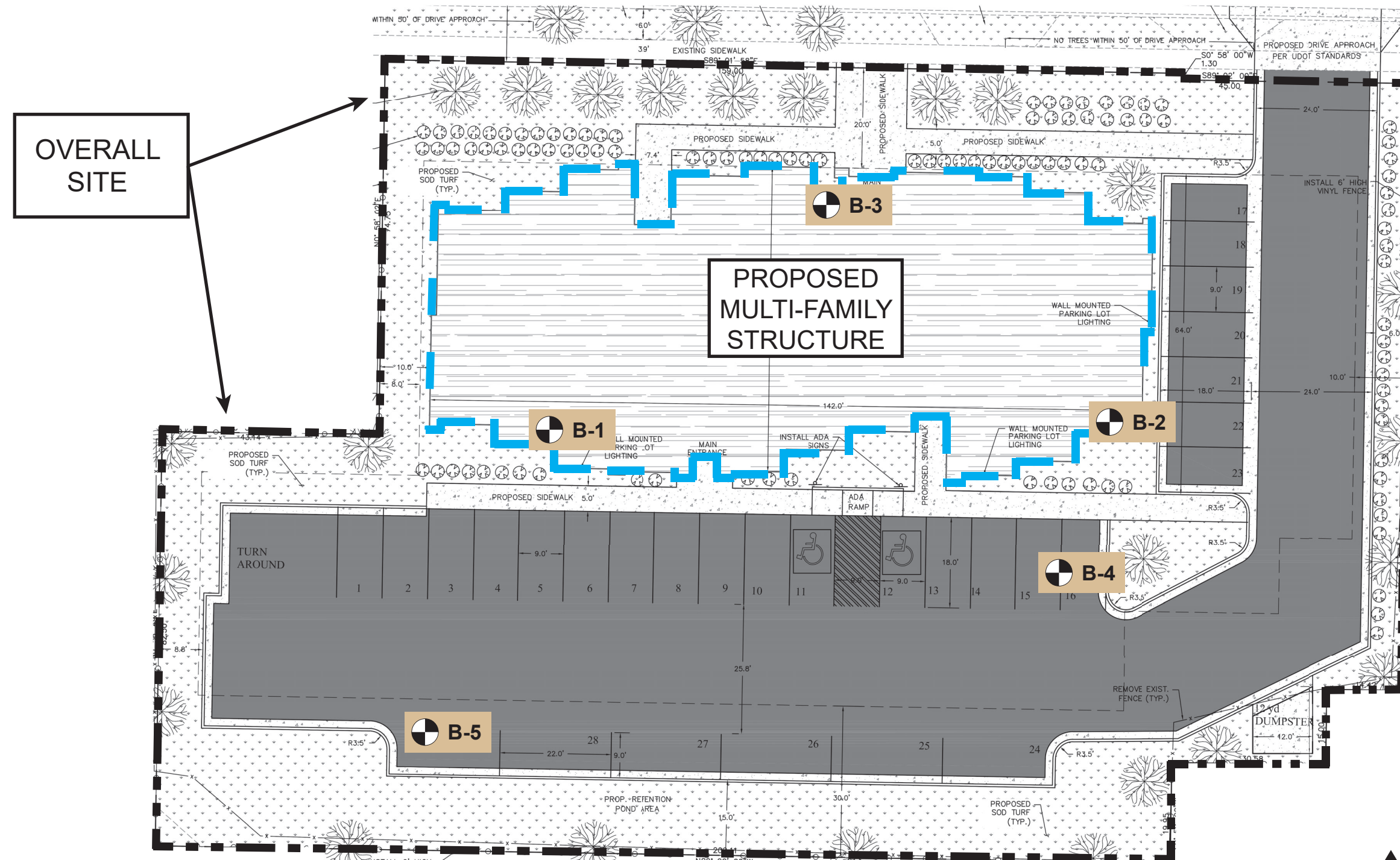
REFERENCE:  
ADAPTED FROM AERIAL PHOTOGRAPH  
DOWNLOADED FROM 2018 GOOGLE EARTH  
IMAGERY DATED SEPTEMBER 10, 2018

Google Earth

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FIGURE 2  
AREA MAP





OVERALL  
SITE

PROPOSED  
MULTI-FAMILY  
STRUCTURE

FIGURE 3  
SITE PLAN

REFERENCE:  
ADAPTED FROM DRAWING ENTITLED  
"30TH STREET APARTMENTS - SITE PLAN",  
SHEET NO. 2/5, BY PARK ENGINEERING, LLC,  
NOT DATED

NOT TO SCALE



Project Name: Proposed 30th Street Apartments

Project No.: 705-001-19

Location: 451 and 475 South 30th Street, Ogden, Utah

Client: Action Real Estate LLC






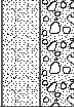

Drilling Method: 3.75" ID Hollow-Stem Auger

Date Drilled: 04-03-19

Elevation: ---

Water Level: No groundwater encountered.

Remarks: \_\_\_\_\_

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
<b>SILTY CLAY</b> with trace fine sand; major roots (topsoil) to 3"; dark brown to brown and gray (CL)  grades dark brown waxy			5		D	42						moist very stiff
			5		D	60						
<b>FINE TO MEDIUM SAND</b> with trace silt; tan (SP)			10		D	43						slightly moist medium dense
<b>FINE TO COARSE SAND AND COBBLES</b> with trace silt; tan (SP/GP)					D							slightly moist very dense
Drilling refusal at 13.0'.  Sampling refusal at 13.5'.  No groundwater encountered at time of drilling.			15			100 5"						
			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 4B



Project Name: Proposed 30th Street Apartments

Project No.: 705-001-19

Location: 451 and 475 South 30th Street, Ogden, Utah

Client: Action Real Estate LLC

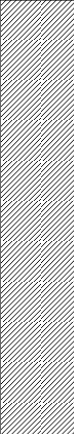





Drilling Method: 3.75" ID Hollow-Stem Auger

Date Drilled: 04-03-19

Elevation: ---

Water Level: No groundwater encountered.

Remarks: \_\_\_\_\_

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
<b>SILTY CLAY</b> with trace fine sand; major roots (topsoil) to 3"; dark brown (CL)  grades dark brown and tan			4.5		D	28	23.5	99	96.4	37	18	moist very stiff
			5.5		D	38					43	20
<b>FINE AND COARSE GRAVEL</b> with some fine to coarse sand and abundant cobbles; tan (GP)			9.5									
Drilling refusal at 9.0'. Sampling refusal at 9.0'. No groundwater encountered at time of drilling.			10									
			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 4C

Project Name: Proposed 30th Street Apartments

Project No.: 705-001-19

Location: 451 and 475 South 30th Street, Ogden, Utah

Client: Action Real Estate LLC

Drilling Method: 3.75" ID Hollow-Stem Auger

Date Drilled: 04-03-19

Elevation: ---

Water Level: No groundwater encountered.

Remarks: \_\_\_\_\_

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
<b>FINE TO COARSE SANDY CLAY, FILL</b> with some fine and coarse gravel; major roots (topsoil) to 3"; dark brown (CL-FILL)				☒	D	15						moist stiff
<b>SILTY CLAY</b> with trace fine sand; dark brown and brown (CL)			5	☒	D	30						moist very stiff
<p>Stopped drilling at 3.5'.            Stopped sampling at 5.0'.            No groundwater encountered at time of drilling.</p>												
			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 4D**

Project Name: Proposed 30th Street Apartments

Project No.: 705-001-19

Location: 451 and 475 South 30th Street, Ogden, Utah

Client: Action Real Estate LLC

Drilling Method: 3.75" ID Hollow-Stem Auger

Date Drilled: 04-03-19

Elevation: ---

Water Level: No groundwater encountered.

Remarks: \_\_\_\_\_

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
<b>SILTY CLAY</b> with trace fine sand; major roots (topsoil) to 3"; dark brown, brown, and tan (CL)												moist very stiff
			5		D	36						hard
					D	71						
Stopped drilling at 3.5'.  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 4E**

UNIFIED SOIL CLASSIFICATION SYSTEM					GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS	
FIELD IDENTIFICATION PROCEDURES								
COARSE GRAINED SOILS  More than half of material is larger than No. 200 sieve size.	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.  (The No. 200 sieve size is about the smallest particle visible to the naked eye)	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.		
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)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 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.
		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**

- In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There fore, actual designations (based on laboratory testing) may differ.
- Lines separating strata on the logs represent approximate boundaries only Actual transitions may be gradual.
- Logs represent general soil conditions observed at teh point of exploration onthe date indicated.
- No warranty is provided as to the continuity of soil conditions between individual sample locations.

**LOG KEY SYMBOLS**

	Thin Wall
	No Recovery
	3-3/4" ID D&M Sampler
	3" ID D&M Sampler
	California Sampler

**CEMENTATION**

DESCRIPTION	DESCRIPTION
Weakly	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

**FINE - GRAINED SOIL TORVANE POCKET PENETROMETER**

CONSISTENCY	SPT (blows/ft)	UNDRAINED SHEAR STRENGTH (tsf)	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

**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

**FIGURE 5**





#1 Looking north.



#2 Looking east.



#3 Looking south.



#4 Looking west.

# FIGURE 6 PHOTOGRAPHS