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Geotechnical Study
One O'clock Hill
Settlement Canyon Road and UT-36
Tooele, Utah

Project No. 219074

November 2, 2021

Prepared For:

SJ Company
Attention: Mr. Shaun Johnson
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APPENDIX A

1.0 SUMMARY

This entire report presents the results of Earthtec Engineering's completed geotechnical study for the One O'clock Hill in Tooele, Utah. This summary provides a general synopsis of our recommendations and findings. Details of our findings, conclusions, and recommendations are provided within the body of this report.

- The native clay soils have a negligible potential for collapse (settlement) and a slight potential for compression under increased moisture contents and anticipated load conditions. (see Section 6)
- Conventional strip and spread footings may be used to support the structures, with foundations placed entirely on firm, undisturbed, uniform native soils (i.e. completely on clay soils, or completely on sand soils, etc.), or entirely on a minimum of 12 inches of properly placed, compacted, and tested structural fill extending to undisturbed native soils for structural loads up to 4,000 pounds per linear foot for bearing walls and up to 30,000 pounds for column loads. If loads exceed these see Section 10 for further recommendations.

Based on the results of our field exploration, laboratory testing, and engineering analyses, it is our opinion that the subject site may be suitable for the proposed development, provided the recommendations presented in this report are followed and implemented during design and construction.

Failure to consult with Earthtec Engineering (Earthtec) regarding any changes made during design and/or construction of the project from those discussed herein relieves Earthtec from any liability arising from changed conditions at the site. We also strongly recommend that Earthtec observes the building excavations to verify the adequacy of our recommendations presented herein, and that Earthtec performs materials testing and special inspections for this project to provide continuity during construction.

2.0 INTRODUCTION

The project is located at approximately Settlement Canyon Road and UT-36 in Tooele, Utah. The general location of the site is shown on Figure No. 1, *Vicinity Map* and Figure No. 2, *Site Plan Showing Location of Test Pits and Slope Cross-Sections*, at the end of this report. The purposes of this study are to evaluate the subsurface soil conditions at the site, assess the engineering characteristics of the subsurface soils, and provide geotechnical recommendations for general site grading and the design and construction of foundations, concrete floor slabs, miscellaneous concrete flatwork, and asphalt paved residential streets.

The scope of work completed for this study included field reconnaissance, subsurface exploration, field and laboratory soil testing, geotechnical engineering analysis, and the preparation of this report.

3.0 PROPOSED CONSTRUCTION

We understand that the proposed project, as described to us by Mr. Shaun Johnson, consists of subdividing the approximately 38-acre span of three existing parcels with the construction of a new residential subdivision containing up to 130 lots. The proposed structures will consist of conventionally framed, one- to two-story, single-family dwellings with basements. We have based our recommendations in this report that the anticipated foundation loads for the proposed structures will not exceed 4,000 pounds per linear foot for bearing walls, 30,000 pounds for column loads, and 100 pounds per square foot for floor slabs. If structural loads will be greater Earthtec should be notified so that we may review our recommendations and make modifications, if necessary.

In addition to the construction described above, we anticipate that utilities will be installed to service the proposed buildings, exterior concrete flatwork will be placed in the form of curb, gutter, sidewalks, driveways, and asphalt paved residential streets will be constructed.

4.0 GENERAL SITE DESCRIPTION

4.1 Site Description

At the time of our subsurface exploration the site consisted of three undeveloped parcels vegetated with native grasses, trees, and sagebrush. Large power line poles run northeast-southwest throughout the property, and a pump house is built on the northern section against the mountain slope with an asphalt driveway leading to it. An emergency two-track road exists running along the central run of powerlines and does not appear to be regularly maintained, according to local residents at the south end of the property. The ground surface appears to be relatively flat past the edge of the mountain slopes, we anticipate less than 3 feet of cut and fill may be required for site grading. The lot was bounded on the northwest by UT-36 Highway, on the southeast by open mountainous land, on the southwest by open field, and on the northeast by Settlement Canyon Road.

4.2 Geologic Setting

The subject property is located in the southeastern portion of Tooele Valley near the western slope of the Oquirrh Mountains. Tooele Valley is a deep, sediment-filled basin that is part of the Basin and Range Physiographic Province. The valley was formed by extensional tectonic processes during the Tertiary and Quaternary geologic time periods. The valley is bordered by the Oquirrh Mountains on the east and the Stansbury Mountains on the west. Much of northwestern Utah, including Tooele Valley, was previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, which borders Tooele Valley to the north, is a remnant of this ancient fresh water lake. The surficial geology of much of the eastern margin of the valley has been mapped by Clark, et al., 2017[1]. The surficial geology at the location of the subject site and

[1] Clark, D.L., Oviatt, C.G., Dinter, D.A., 2017, Interim Geologic Map of the Tooele 30'x60' Quadrangle, *Tooele, Salt*

adjacent properties contains four geologic units which are mapped as "Lacustrine and alluvial deposits, undivided" (Map Unit Qla), "Younger fan alluvium, post-Lake Bonneville (Map unit Qafy), "Older fan alluvium, pre-Lake Bonneville" (Map unit Qafo), and "Oquirrh Group, Bingham Mine Formation, upper member" (IPobmu) dated from the upper Pennsylvanian (IPobmu) to the Holocene (Qla) and middle- to upper-Pleistocene (Qafy and Qafo). The named geologic units are described, in part, below:

Qafy **Younger fan alluvium, post-Lake Bonneville (Holocene to uppermost Pleistocene)** – Poorly sorted gravel, sand, silt, and clay; deposited by streams, debris flows, and flash floods on alluvial fans and in mountain valleys; merges with unit Qal; includes alluvium and colluvium in canyon and mountain valleys; may include areas of eolian deposits and lacustrine fine-grained deposits below the Bonneville shoreline; includes active and inactive fans younger than Lake Bonneville, but may also include some older deposits above the Bonneville shoreline.

Qafo **Older fan alluvium, pre-Lake Bonneville (upper to middle? Pleistocene)** – Poorly sorted gravel, sand, silt, and clay; similar to unit Qafy, but forms higher level incised deposits that predate Lake Bonneville; includes fan surfaces of different levels; fans are incised by younger alluvial deposits and locally etched by Lake Bonneville.

Qla **Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene)** – Sand, gravel, silt, and clay; consist of alluvial deposits reworked by lakes, lacustrine deposits reworked by streams and slopewash, and alluvial and lacustrine deposits that cannot be readily differentiated at map scale.

IPobmu **Oquirrh Group, Bingham Mine Formation, upper member (Upper Pennsylvanian, Virgilian-Missourian)** – Light gray to tan, thinly color-banded and locally cross-bedded quartzite with interbedded thin, light- to medium-gray, calcareous, fine-grained sandstone, limestone, and siltstone.

Additionally, a surface fault rupture hazard study and a rock fall hazard study were conducted at the subject site as part of this investigation. The results for those studies can be found in their respective reports and not as a part of the geotechnical investigation.

5.0 SUBSURFACE EXPLORATION

5.1 Soil Exploration

Under the direction of a qualified member of our geotechnical staff, subsurface explorations were conducted at the site on September 21 and 22, 2021 by the excavation of ten (10) test pits to

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Lake, and Davis Counties, Utah; Utah Geological Survey, Open-File 669DM, Scale 1: 62,500.

depths of 4 to 10 feet below the existing ground surface using a a track-mounted excavator. The approximate locations of the test pits are shown on Figure No. 2, *Site Plan Showing Location of Test Pits and Slope Cross-Sections*. Graphical representations and detailed descriptions of the soils encountered are shown on Figure Nos. 3 through 12, *Test Pit Log* at the end of this report. The stratification lines shown on the logs represent the approximate boundary between soil units; the actual transition may be gradual. Due to potential natural variations inherent in soil deposits, care should be taken in interpolating between and extrapolating beyond exploration points. A key to the symbols and terms on the logs is presented on Figure No. 13, *Legend*.

Disturbed bag samples and relatively undisturbed block samples were collected at various depths in each test pit.

The soil samples collected were classified by visual examination in the field following the guidelines of the Unified Soil Classification System (USCS). The samples were transported to our Lindon, Utah laboratory where they will be retained for 30 days following the date of this report and then discarded, unless a written request for additional holding time is received prior to the 30-day limit.

6.0 LABORATORY TESTING

Representative soil samples collected during our field exploration were tested in the laboratory to assess pertinent engineering properties and to aid in refining field classifications, if needed. Tests performed included natural moisture contents, dry density tests, liquid and plastic limits determinations, mechanical (partial) gradation analyses, direct shear tests, and a one-dimensional consolidation test. The laboratory test results are also included on the attached *Test Pit Logs* at the respective sample depths, on Figure No. 14, *Consolidation-Swell Test,* on Figure Nos. 15 and 16, *Direct Shear Test*, and on Figure Nos. 17 through 20, *Stability Results*.

As part of the consolidation test procedure, water was added to a sample to assess moisture sensitivity when the sample was loaded to an equivalent pressure of approximately 1,000 psf. The native clay soils have a negligible potential for collapse (settlement) and a slight potential for compressibility under increased moisture contents and anticipated load conditions.

A water-soluble sulfate test was performed on a representative sample obtained during our field exploration which indicated a value of less than 10 parts per million. Based on this result, the risk of sulfate attack to concrete appears to be "negligible" according to American Concrete Institute standards. Therefore, there are no restrictions on the type of Portland cement that may be used for concrete in contact with on-site soils. The results can be found in Appendix A.

7.0 SUBSURFACE CONDITIONS

7.1 Soil Types

On the surface of the site, we encountered topsoil which is estimated to extend about ½ to 1 foot in depth at the test pit locations. Below the topsoil we encountered layers of primarily gravel, sand, and bedrock, extending to depths of 4 to 10 feet below the existing ground surface. Graphical representations and detailed descriptions of the soils encountered are shown on Figure Nos. 3 through 12, *Test Pit Log* at the end of this report. Based on our experience and observations during field exploration, the clay soils visually were stiff in consistency and the sand and gravel soils visually had a relative density varying from loose to very dense.

It should be considered that a limited number of test pits were used during the course of our subsurface exploration. Topsoil and fill material composition and contacts are difficult to determine from test pit sampling. Variation in topsoil depths may occur at the site.

7.2 Collapsible Soils

Collapsible soils are typically characterized by a pinhole structure and relatively low unit weights. Foundations, floor slabs, and roadways supported on these soils may be susceptible to large settlements and structural distress when wetted. Significantly collapsible soils were not encountered in our explorations.

7.3 Groundwater Conditions

Groundwater was not encountered within the excavations at the depths explored. Note that groundwater levels will fluctuate in response to the season, precipitation, snow melt, irrigation, and other on and off-site influences. Quantifying these fluctuations would require long term monitoring, which is beyond the scope of this study. The contractor should be prepared to dewater excavations as needed.

8.0 SITE GRADING

8.1 General Site Grading

All surface vegetation and unsuitable soils (such as topsoil, organic soils, undocumented fill, soft, loose, or disturbed native soils, collapsible, and any other inapt materials) should be removed from below foundations, floor slabs, exterior concrete flatwork, and pavement areas. We encountered topsoil on the surface of the site. The topsoil (including soil with roots larger than about ¼ inch in diameter) should be completely removed, even if found to extend deeper, along with any other unsuitable soils that may be encountered. Over-excavations below footings and slabs also may be needed, as discussed in Section 10.0.

Fill placed over large areas, even if only a few feet in depth, can cause consolidation in the underlying native soils resulting in settlement of the fill. Because the site is relatively flat, we anticipate that less than 3 feet of grading fill will be placed. If more than 3 feet of grading fill will be placed above the existing surface (to raise site grades), Earthtec should be notified so that we may provide additional recommendations, if required. Such recommendations will likely include placing the fill several weeks (or possibly more) prior to construction to allow settlement to occur.

8.2 Temporary Excavations

Temporary excavations that are less than 4 feet in depth and above groundwater should have side slopes no steeper than ½H:1V (Horizontal:Vertical). Temporary excavations where water is encountered in the upper 4 feet or that extend deeper than 4 feet below site grades should be sloped or braced in accordance with OSHA[2] requirements for Type B soils.

8.3 Fill Material Composition

Structural fill is defined as imported fill material that will ultimately be subjected to any kind of structural loading, such as those imposed by footings, floor slabs, pavements, etc. Gradation requirements stated below shall be verified in intervals not exceeding 1,000 tons. We recommend that imported structural fill consist of sandy/gravelly soils meeting the following requirements in the table below:

Table 1: Imported Structural Fill Recommendations

Sieve Size/Other	Percent Passing (by weight)
4 inches	100
3/4 inches	70 – 100
No. 4	40 – 80
No. 40	15 – 50
No. 200	0 – 20
Liquid Limit	35 maximum
Plasticity Index	15 maximum

Engineered fill is defined as reworked granular (sands or gravels), native material that will ultimately be subjected to any kind of structural loading, such as those imposed by footings, floor slabs, pavements. Native clay and silt soils are not suitable for use as engineered fill. We recommend that a professional engineer or geologist verify that the engineered fill to be used on this project meets the requirements. Engineered fill should be clear of all organics, have a maximum particle size of 4 inches, less than 70 percent retained on the ¾-seive, a maximum Liquid Limit of 35, and a maximum Plasticity Index of 15.

In some situations, particles larger than 4 inches and/or more than 30 percent coarse gravel may be acceptable but would likely make compaction more difficult and/or significantly reduce the possibility of successful compaction testing. Consequently, stricter quality control measures than normally used may be required, such as using thinner lifts and increased or full-time observation of fill placement.

We recommend that utility trenches below any structural load be backfilled using structural fill or engineered fill. Local governments or utility companies required specification for backfill should be followed unless our recommendations stricter.

If native soil is used as fill material, the contractor should be aware that native clay and silt soils

[2] OSHA Health and Safety Standards, Final Rule, CFR 29, part 1926.

(as observed in the explorations) may be time consuming to compact due to potential difficulties in controlling the moisture content needed to obtain optimum compaction and changes proctor values.

If required (i.e. fill in submerged areas), we recommend that free draining granular material (clean sand and/or gravel) meet the following requirements in the table below:

Table 2: Free-Draining Fill Recommendations

Sieve Size/Other	Percent Passing (by weight)
3 inches	100
No. 10	0 – 25
No. 40	0 – 15
No. 200	0 – 5
Plasticity Index	Non-plastic

Three-inch minus washed rock (sometimes called river rock or drain rock) and pea gravel materials usually meet these requirements and may be used as free draining fill. If free draining fill will be placed adjacent to soil containing a significant amount of sand or silt/clay, precautions should be taken to prevent the migration of fine soil into the free draining fill. Such precautions should include either placing a filter fabric between the free draining fill and the adjacent soil material, or using a well-graded, clean filtering material approved by the geotechnical engineer.

8.4 Fill Placement and Compaction

Fill should be placed on level, horizontal surfaces. Where fill will be placed on existing slopes steeper than 5H:1V, the existing ground should be benched prior to placing fill. We recommend bench heights of 1 to 4 feet, with the lowest bench being a minimum 3 feet below adjacent grade and at least 10 feet wide.

The thickness of each lift should be appropriate for the compaction equipment that is used. We recommend a maximum lift thickness prior to compaction of 4 inches for hand operated equipment, 6 inches for most "trench compactors" and 8 inches for larger rollers, unless it can be demonstrated by in-place density tests that the required compaction can be obtained throughout a thicker lift. The full thickness of each lift of structural fill placed should be compacted to at least the following percentages of the maximum dry density, as determined by ASTM D-1557:

- In landscape and other areas not below structurally loaded areas: 90%
- Less than 5 feet of fill below structurally loaded areas: 95%
- 5 feet or greater of fill below structurally loaded areas: 98%

Generally, placing and compacting fill at moisture contents within ±2 percent of the optimum moisture content, as determined by ASTM D-1557, will facilitate compaction. Typically, the further the moisture content deviates from optimum the more difficult it will be to achieve the required compaction.

Fill should be tested frequently during placement and we recommend early testing to demonstrate that placement and compaction methods are achieving the required compaction. The contractor is responsible to ensure that fill materials and compaction efforts are consistent so that tested areas are representative of the entire fill.

8.5 Stabilization Recommendations

Near surface soils may rut and pump during grading and construction. The likelihood of rutting and/or pumping, and the depth of disturbance, is proportional to the moisture content in the soil, the load applied to the ground surface, and the frequency of the load. Consequently, rutting and pumping can be minimized by avoiding concentrated traffic, minimizing the load applied to the ground surface by using lighter equipment, partially loaded equipment, tracked equipment, by working in dry times of the year, and/or by providing a working surface for equipment.

During grading the soil in any obvious soft spots should be removed and replaced with granular material. If rutting or pumping occurs traffic should be stopped in the area of concern. The soil in rutted areas should be removed and replaced with granular material. In areas where pumping occurs the soil should either be allowed to sit until pore pressures dissipate (several hours to several days) and the soil firms up or be removed and replaced with granular material. Typically, we recommend removal to a minimum depth of 24 inches.

For granular material, we recommend using angular well-graded gravel, such as pit run, or crushed rock with a maximum particle size of four inches. We suggest that the initial lift be approximately 12 inches thick and be compacted with a static roller-type compactor. A finer granular material such as sand, gravelly sand, sandy gravel or road base may also be used. Materials which are more angular and coarse may require thinner lifts in order to achieve compaction. We recommend that the fines content (percent passing the No. 200 sieve) be less than 15%, the liquid limit be less than 35, and the plasticity index be less than 15.

Using a geosynthetic fabric, such as Mirafi 600X or equivalent, may also reduce the amount of material required and avoid mixing of the granular material and the subgrade. If a fabric is used, following removal of disturbed soils and water, the fabric should be placed over the bottom and up the sides of the excavation a minimum of 24 inches. The fabric should be placed in accordance with the manufacturer's recommendations, including proper overlaps. The granular material should then be placed over the fabric in compacted lifts. Again, we suggest that the initial lift be approximately 12 inches thick and be compacted with a static roller-type compactor.

9.0 SEISMIC AND GEOLOGIC CONSIDERATIONS

9.1 Seismic Design

The State of Utah has adopted the 2015 International Residential Code (IRC) and residential structures should be designed in accordance with the 2015 IRC. The IRC designates this area as a seismic design class D_0.

The site is located at approximately 40.513 degrees latitude and -112.311 degrees longitude from the approximate center of the site. The IRC site value for this property is 0.583g. The design spectral response acceleration parameters are given below.

Table 3: Design Acceleration for Short Period

S_S	F_a	Site Value (S_{DS})
		2/3 S_S*F_a
0.709g	1.233	0.583g

9.2 Faulting

The subject property is located within the Intermountain Seismic Belt where the potential for active faulting and related earthquakes is present. Based upon published geologic maps[3], no active faults traverse through the site and the site is not located within local fault study zones. However, an implied trace of the Oquirrh Fault Zone is mapped along the northwest edge of UT-36 which runs along the northwest boundary of the subject site. A surface fault rupture hazard study was performed on the property, the results of which are detailed in a separate report.

9.3 Liquefaction Potential

According to current liquefaction maps[4] for Tooele Valley, the site is located within an area designated as "Very Low" in liquefaction potential. Liquefaction can occur when saturated subsurface soils below groundwater lose their inter-granular strength due to an increase in soil pore water pressures during a dynamic event such as an earthquake. Loose, saturated sands are most susceptible to liquefaction, but some loose, saturated gravels and relatively sensitive silt to low-plasticity silty clay soils can also liquefy during a seismic event. Subsurface soils encountered were composed of unsaturated sand and gravel soils.

The soils encountered at this project do not appear liquefiable, but the liquefaction susceptibility of underlying soils (deeper than our explorations) is not known and would require deeper explorations to quantify.

10.0 FOUNDATIONS

10.1 General

The foundation recommendations presented in this report are based on the soil conditions encountered during our field exploration, the results of laboratory testing of samples of the native soils, the site grading recommendations presented in this report, and the foundation loading conditions presented in Section 3.0, *Proposed Construction*, of this report. If loading conditions and assumptions related to foundations are significantly different, Earthtec should be notified so

[3] U.S. Geological Survey, Quaternary Fault and Fold Database of the United States, November 3, 2010.
[4] Utah Geological Survey, Liquefaction Susceptibility Map for Tooele Valley, Tooele County, Utah, Public Information Series 80, August 2003.

that we can re-evaluate our design parameters and estimates (higher loads may cause more settlement), and to provide additional recommendations if necessary.

Conventional strip and spread footings may be used to support the proposed structures after appropriate removals as outlined in Section 8.1. Foundations should not be installed on topsoil, undocumented fill, debris, combination soils, organic soils, frozen soil, or in ponded water. If foundation soils become disturbed during construction, they should be removed or compacted.

10.2 Strip/Spread Footings

We recommend that conventional strip and spread foundations be constructed entirely on firm, undisturbed, uniform native soils (i.e. completely on clay soils, or completely on sand soils, etc.), or entirely on a minimum of 12 inches of properly placed, compacted, and tested structural fill extending to undisturbed native soils for structural loads up to 4,000 pounds per linear foot for bearing walls and up to 30,000 pounds for column loads. If loads exceed 4,000 pounds per linear foot for bearing walls or 30,000 pounds for column loads, please contact Earthtec for further recommendations. For foundation design we recommend the following:

- Footings founded on undisturbed native soils may be designed using a maximum allowable bearing capacity of 2,000 pounds per square foot. Footings founded on a minimum of 12 inches of structural fill extending to undisturbed native soil may be designed using a maximum allowable bearing capacity of 2,500 pounds per square foot. The values for vertical foundation pressure can be increased by one-third for wind and seismic conditions per Section 1806 when used with the Alternative Basic Load Combinations found in Section 1605.3.2 of the 2018 International Building Code.
- Continuous and spot footings should be uniformly loaded and should have a minimum width of 20 and 30 inches, respectively.
- Exterior footings should be placed below frost depth which is determined by local building codes. In general, 30 inches of cover is adequate for most sites; however local code should be verified by the end design professional. Interior footings, not subject to frost (heated structures), should extend at least 18 inches below the lowest adjacent grade.
- Foundation walls and footings should be properly reinforced to resist all vertical and lateral loads and differential settlement.
- The bottom of footing excavations should be compacted with at least 4 passes of an approved non-vibratory roller prior to erection of forms or placement of structural fill to densify soils that may have been loosened during excavation and to identify soft spots. If soft areas are encountered, they should be stabilized as recommended in Section 8.5.
- Footing excavations should be observed by the geotechnical engineer prior to beginning fill placement or footing construction if fill is not required to evaluate whether suitable bearing soils have been exposed and whether excavation bottoms are free of loose or disturbed soils.
- In lieu of traditional structural fill, clean 1- to 2-inch clean gravel may be used in conjunction

with a stabilization fabric, such as Mirafi 600X or equivalent, which should be placed between the native soils and the clean gravel (additional recommendations for placing clean gravel and stabilization fabric are given in Section 8.5 of this report).

- Structural fill used below foundations should extend laterally a minimum of 6 inches for every 12 vertical inches of structural fill placed. For example, if 18 inches of structural fill is required to bring the excavation to footing grade, the structural fill should extend laterally a minimum of 9 inches beyond the edge of the footings on both sides.

10.3 Estimated Settlements

If the proposed foundations are properly designed and constructed using the parameters provided above, we estimate that total settlements should not exceed one inch and differential settlements should be one-half of the total settlement over a 25-foot length of continuous foundation, for non-earthquake conditions. Additional settlement could occur during a seismic event due to ground shaking, if more than 3 feet of grading fill is placed above the existing ground surface, if loading conditions are greater than anticipated in Section 2, and/or if foundation soils are allowed to become wetted.

10.4 Lateral Earth Pressures

Below grade walls act as soil retaining structures and should be designed to resist pressures induced by the backfill soils. The lateral pressures imposed on a retaining structure are dependent on the rigidity of the structure and its ability to resist rotation. Most retaining walls that can rotate or move slightly will develop an active lateral earth pressure condition. Structures that are not allowed to rotate or move laterally, such as subgrade basement walls, will develop an at-rest lateral earth pressure condition. Lateral pressures applied to structures may be computed by multiplying the vertical depth of backfill material by the appropriate equivalent fluid density. Any surcharge loads in excess of the soil weight applied to the backfill should be multiplied by the appropriate lateral pressure coefficient and added to the soil pressure. For static conditions the resultant forces are applied at about one-third the wall height (measured from bottom of wall). For seismic conditions, the resultant forces are applied at about two-third times the height of the wall both measured from the bottom of the wall. The lateral pressures presented in the table below are based on drained, horizontally placed native soils as backfill material using a 35° friction angle and a dry unit weight of 120 pcf.

Table 4: Lateral Earth Pressures (Static and Dynamic)

Condition	Case	Lateral Pressure Coefficient	Equivalent Fluid Pressure (pcf)
Active	Static	0.27	33
	Seismic	0.34	41
At-Rest	Static	0.43	51
	Seismic	0.62	74
Passive	Static	3.69	443
	Seismic	6.50	779

*Seismic values combine the static and dynamic values

These pressure values do not include any surcharge and are based on a relatively level ground surface at the top of the wall and drained conditions behind the wall. It is important that water is not allowed to build up (hydrostatic pressures) behind retaining structures. Retaining walls should incorporate drainage behind the walls as appropriate, and surface water should be directed away from the top and bottom of the walls.

Lateral loads are typically resisted by friction between the underlying soil and footing bottoms. Resistance to sliding may incorporate the friction acting along the base of foundations, which may be computed using a coefficient of friction of soils against concrete of 0.30 for native clay and silts, 0.40 for native sands, and 0.55 for native gravels, clean gravel, or structural fill meeting the recommendations presented herein. Concrete or masonry walls shall be selected and constructed in accordance with Section R404 of the 2015 International Residential Code or sections referenced therein. Retaining wall lateral resistance design should further reference Section R404.4 for reference of Safety Factors.

11.0 FLOOR SLABS AND FLATWORK

Concrete floor slabs and exterior flatwork may be supported on undisturbed native soils or on a minimum of 12 inches properly placed, compacted, and tested engineered fill or imported structural fill extending to undisturbed native soils after appropriate removals and grading as outlined in Section 8.1 are completed. We recommend placing a minimum of 4 inches of free-draining fill material (see Section 8.3) beneath floor slabs to facilitate construction, act as a capillary break, and aid in distributing floor loads. For exterior flatwork, we recommend placing a minimum of 4 inches of road-base material. Prior to placing the free-draining fill or road-base materials, the native sub-grade should be proof-rolled to identify soft spots, which should be stabilized as discussed above in Section 8.5.

For slab design, we recommend using a modulus of sub-grade reaction of 120 pounds per cubic inch. The thickness of slabs supported directly on the ground shall not be less than 3½ inches. A 6-mil polyethylene vapor retarder with joints lapped not less than 6 inches shall be placed between the ground surface and the concrete, as per Section R506 of the 2015 International Residential Code.

To help control normal shrinkage and stress cracking, we recommend that floor slabs have adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints, frequent crack control joints, and non-rigid attachment of the slabs to foundation and bearing walls. Special precautions should be taken during placement and curing of all concrete slabs and flatwork. Excessive slump (high water-cement ratios) of the concrete and/or improper finishing and curing procedures used during hot or cold weather conditions may lead to excessive shrinkage, cracking, spalling, or curling of slabs. We recommend all concrete placement and curing operations be performed in accordance with American Concrete Institute (ACI) codes and practices.

12.0 DRAINAGE

12.1 Surface Drainage

As part of good construction practice, precautions should be taken during and after construction to reduce the potential for water to collect near foundation walls. Accordingly, we recommend the following:

- The contractor should take precautions to prevent significant wetting of the soil at the base of the excavation. Such precautions may include: grading to prevent runoff from entering the excavation, excavating during normally dry times of the year, covering the base of the excavation if significant rain or snow is forecast, backfill at the earliest possible date, frame floors and/or the roof at the earliest possible date, other precautions that might become evident during construction.
- Adequate compaction of foundation wall backfill must be provided i.e. a minimum of 90% of ASTM D-1557. Water consolidation methods should not be used.
- The ground surface should be graded to drain away from the building in all directions. We recommend a minimum fall of 8 inches in the first 10 feet.
- Roof runoff should be collected in rain gutters with down spouts designed to discharge well outside of the backfill limits, or at least 10 feet from foundations, whichever is greater.
- Sprinkler nozzles should be aimed away, and all sprinkler components kept at least 5 feet, from foundation walls. A drip irrigation system may be utilized in landscaping areas within 10 feet of foundation walls to minimize water intrusion at foundation backfill. Also, sprinklers should not be placed at the top or on the face of slopes. Sprinkler systems should be designed with proper drainage and well maintained. Over-watering should be avoided.
- Any additional precautions which may become evident during construction.

12.2 Subsurface Drainage

Section R405.1 of the 2015 International Residential Code states, "Drains shall be provided around all concrete and masonry foundations that retain earth and enclose habitable or usable spaces located below grade." Section R310.2.3.2 of the 2015 International Residential Code states, "Window wells shall be designed for proper drainage by connecting to the building's foundation drainage system." An exception is allowed when the foundation is installed on well drained ground consisting of Group 1 soils, which include those defined by the Unified Soil Classification System as GW, GP, SW, SP, GM, and SM. The soils observed in the explorations at the depth of foundation consisted primarily of poorly-graded gravel (GP-GM) which is a Group 1 soil.

13.0 PAVEMENT RECOMMENDATIONS

We understand that asphalt paved residential streets will be constructed as part of the project. The native soils encountered beneath the topsoil during our field exploration were predominantly composed of gravels. We estimate that a California Bearing Ratio (CBR) value of 5 is appropriate for these soils. If the topsoil is left beneath concrete flatwork and pavement areas, increased maintenance costs over time should be anticipated.

We anticipate that the traffic volume will be about 1,250 vehicles per day (4.1 ESAL/day) or less for the residential streets, consisting of mostly cars and pickup trucks, with a daily delivery truck and a weekly garbage truck. Based on these traffic parameters, the estimated CBR given above, a 20-year life expectancy, and the procedures and typical design inputs outlined in the UDOT Pavement Design Manual (2008), we recommend the minimum asphalt pavement section presented below. The pavement section should meet the minimum values are required by the jurisdiction or the values below, whichever is greater.

Table 5: Pavement Section Recommendations

Asphalt Thickness (in)	Compacted Aggregate Base Thickness (in)	Compacted Subbase Thickness (in)
3	8*	0

* Stabilization may be required

If the pavement will be required to support excessive construction traffic (such as dump trucks hauling soil to raise or lower the site), more than an occasional semi-tractor or fire truck, or more traffic than listed above, our office should be notified so that we can re-evaluate the pavement section recommendations. The following also apply:

- The subgrade should be prepared by proof rolling to a firm, non-yielding surface, with any identified soft areas stabilized as discussed above in Section 8.5.
- Site grading fills below the pavements should meet structural fill composition and placement recommendations per Sections 8.3 and 8.4 herein.
- Asphaltic concrete, aggregate base and sub-base material composition should meet local, APWA, or UDOT requirements. Gradation requirements and frequency shall be followed as

required by local, APWA, or UDOT requirements, but not to exceed 500 tons.

- Aggregate base and sub-base is compacted to local, APWA, or UDOT requirements, or to at least 95 percent of maximum dry density (ASTM D 1557).
- The aggregate base shall have a CBR value to 70 percent or greater and the subbase shall have a CBR value of 10 percent or greater.
- Asphaltic concrete is compacted to local or UDOT requirements, or to at least 96 percent of the laboratory Marshall density (ASTM D 6927).

14.0 SLOPE STABILITY

We evaluated the stability of the existing slopes as shown in Figure No. 2, *Site Plan Showing Location Test Pits and Slope Cross-Sections*. The properties of the soils observed at the site were determined from laboratory testing. Direct shear tests were run on samples obtained from our field exploration. The test results indicate that the silt soils have an internal friction angle of 35 degrees and a cohesion of 675 psf, while the gravel soils have an internal friction angle of 41 and a cohesion of 330 psf. We conservatively used the following soil strength parameters to run the slope stability on this lot:

Table 6: Soil Strength Parameters

Soil Classification	Moist Unit Weight (pcf)	Friction Angle (ϕ)	Cohesion (psf)
ML	121.3	35	675
GP-GM	117.0	41	330

For the seismic (pseudostatic) analysis, a peak horizontal ground acceleration of 0.299g for the 2% probability of exceedance in 50 years was obtained for site (grid) locations of 40.513 degrees latitude and -112.311 longitude. Typically, one-third this value is utilized in analysis. A peak horizontal ground acceleration of 0.099g was used as the pseudostatic coefficient for the stability analysis.

We evaluated the stability of the proposed site using the computer program XSTABL. This program uses a limit equilibrium (Bishop's modified) method for calculating factors of safety against sliding on an assumed failure surface and evaluates numerous potential failure surfaces, with the most critical failure surface identified as the one yielding the lowest factor of safety of those evaluated. The configuration analyzed was based on the historical photographs, our observations during the field investigation, and available topographic maps. The cross-section analyzed is shown on Figure No. 2, *Site Plan Showing Location of Test Pits and Slope Cross-Sections.*

Typically, the required minimum factors of safety are 1.5 for static conditions and 1.1 for seismic (pseudostatic) conditions. The results of our analyses indicate that the slope configuration at the proposed lot analyzed is stable under these conditions. The slope stability data are attached as Figure Nos. 17 through 20, *Stability Results*. If unretained cuts greater than 6 feet on the slope area are planned or retaining walls, we recommend that further analysis of the slope be performed.

15.0 GENERAL CONDITIONS

The exploratory data presented in this report was collected to provide geotechnical design recommendations for this project. The explorations may not be indicative of subsurface conditions outside the study area or between points explored and thus have a limited value in depicting subsurface conditions for contractor bidding. Variations from the conditions portrayed in the explorations may occur and which may be sufficient to require modifications in the design. If during construction, conditions are different than presented in this report, Earthtec should be advised immediately so that the appropriate modifications can be made.

The findings and recommendations presented in this geotechnical report were prepared in accordance with generally accepted geotechnical engineering principles and practice in this area of Utah at this time. No warranty or representation is intended in our proposals, contracts, letters, or reports. Failure to consult with Earthtec regarding any changes made during design and/or construction of the project from those discussed herein relieves Earthtec from any liability arising from changed conditions at the site.

This geotechnical report is based on relatively limited subsurface explorations and laboratory testing. Subsurface conditions may differ in some locations of the site from those described herein, which may require additional analyses and possibly modified recommendations. Thus, we strongly recommend consulting with Earthtec regarding any changes made during design and construction of the project from those discussed herein. Failure to consult with Earthtec regarding any such changes relieves Earthtec from any liability arising from changed conditions at the site.

To maintain continuity, Earthtec should also perform materials testing and special inspections for this project. The recommendations presented herein are based on the assumption that an adequate program of tests and observations will be followed during construction to verify compliance with our recommendations. We also assume that we will review the project plans and specifications to verify that our conclusions and recommendations are incorporated and remain appropriate (based on the actual design). Earthtec should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Earthtec also should be retained to provide observation and testing services during grading, excavation, foundation construction, and other earth-related construction phases of the project.

We appreciate the opportunity of providing our services on this project. If we can answer questions or be of further service, please contact Earthtec at your convenience.

Respectfully;

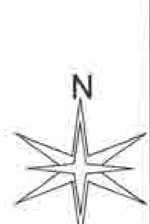
EARTHTEC ENGINEERING

Michael S. Schedel
Staff Geologist

PROFESSIONAL ENGINEER
No. 5567049-2202
TIMOTHY ALLAN MITCHELL
11/02/2021
STATE OF UTAH

Timothy A. Mitchell, P.E.
Senior Geotechnical Engineer

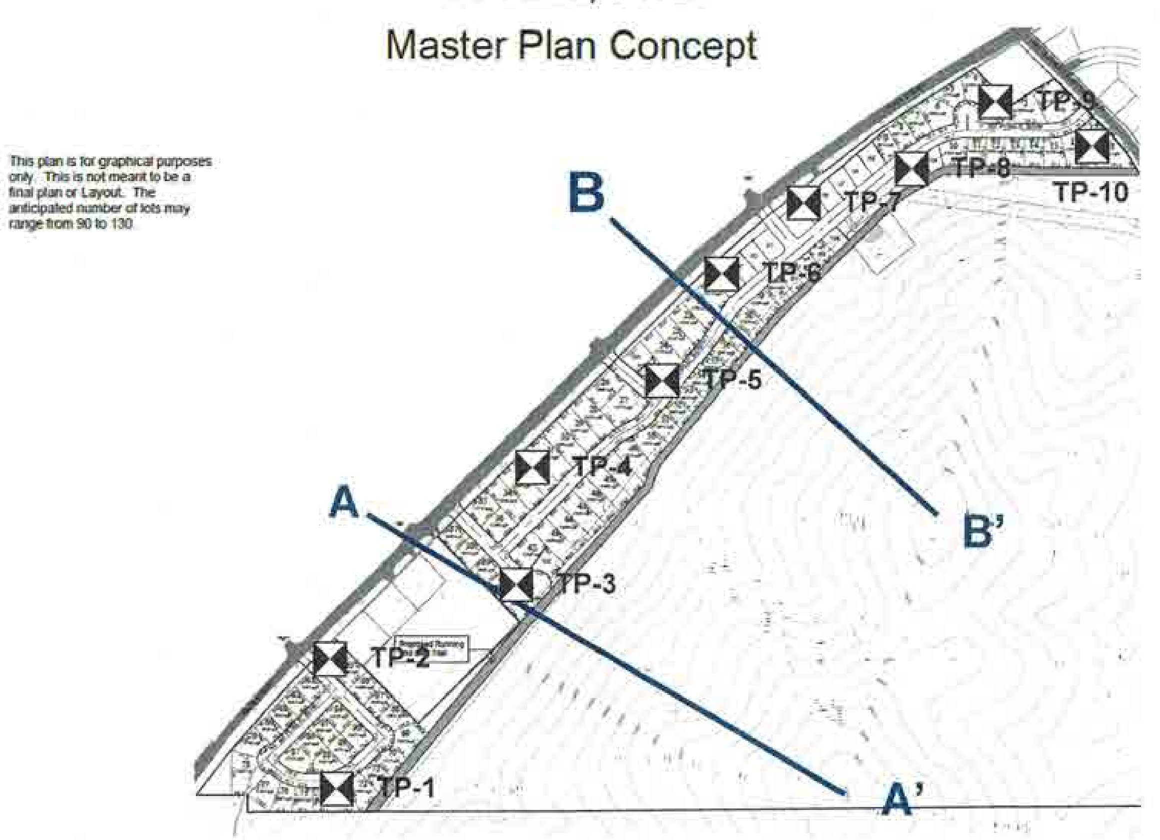
VICINITY MAP
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAD AND UT-36
TOOELE, UTAH



PROJECT NO.: 219074	EARTHTEC ENGINEERING	FIGURE NO.: 1

SITE PLAN SHOWING LOCATION OF TEST PITS AND SLOPE CROSS-SECTIONS

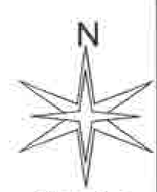
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAD AND UT-36
TOOELE, UTAH



*Site Plan provided by Client.

Approximate Test Pit Locations

Slope Cross-Section Locations



Not to Scale

PROJECT NO.: 219074	EARTHTEC ENGINEERING	**FIGURE NO.:** 2

TEST PIT LOG
NO.: TP-01

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL, sandy silt with gravel, dry, dark brown, organics									
1			Poorly Graded GRAVEL with sand, loose to very dense (estimated), dry, light brown									
2												
3		GP	...cobbles and boulders	X	1				67	31	2	
4												
5			...large boulders	X								
6			End of Test Pit at 6 Feet due to Large Boulders									
7												
8												
9												
10												
11												
12												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

TEST PIT LOG
NO.: TP-02

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1			TOPSOIL, silty sand, dry, light brown, organics									
1–4		SM	Silty SAND with gravel, loose to medium dense (estimated), dry, brown, lightly cemented	X (~2.5)								
4–6		GP	Poorly Graded GRAVEL with sand, medium dense (estimated), dry, light brown	X (~4)	1		21	NP	51	44	5	
6–10		SP	Poorly Graded SAND with gravel, medium dense (estimated), dry, light brown	X (~7)								
			...gravel lenses encountered	X (~9.5)	3		23	NP	34	62	4	
10			Test Pit Terminated at 10 Feet									

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

TEST PIT LOG
NO.: TP-03

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL, silty sand with gravel, dry, light brown, organics									
1		GP-GM	Poorly Graded GRAVEL with silt and sand, dense to very dense (estimated), dry, brown, cobbles and boulders									
2			...large boulders									
3				X								
4			End of Test Pit at 4 Feet due to Quartzite Bedrock									
5												
6												
7												
8												
9												
10												
11												
12												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

PROJECT NO.: 219074

FIGURE NO.: 5

LOG OF TESTPIT LOGS.GPJ EARTHTEC.GDT 10/28/21

TEST PIT LOG
NO.: TP-04

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL, silty sand with gravel, dry, brown, organics, boulders									
1–4		CL-ML	Sandy Silty CLAY, stiff (estimated), slightly moist, brown and white, calcareous	☒	7		25	7	1	40	59	
4–7½		ML	Sandy SILT, stiff to very stiff (estimated), slightly moist, brown, lightly cemented	☒	3		22	NP	3	39	58	DS
			...with gravel	☒								
7½			End of Test Pit at 7½ Feet due to Large Boulders									

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

TEST PIT LOG
NO.: TP-05

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/22/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1			TOPSOIL, clayey sand with gravel, dry, brown, organics, boulders									
1–3		GP-GM	Poorly Graded GRAVEL with silt and sand, dense (estimated), dry, brown, cobbles and boulders	X								
3–4			Quartzite BEDROCK, medium-grained, massive, light tan and white, moderately weathered, hard, moderately fractured									
4			End of Test Pit at 4 Feet due to Bedrock									

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

LOG OF TESTPIT LOGS.GPJ EARTHTEC.GDT 10/28/21

TEST PIT LOG
NO.: TP-06

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ∇ **:**

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ **:**

Depth (Ft.) 0	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
1			TOPSOIL, silty sand with gravel, dry, light brown, organics									
2		GP-GM	Poorly Graded GRAVEL with silt and sand, dense (estimated), dry, light brown, cobbles and boulders	☒	2				57	32	11	
3–4			Quartzite BEDROCK, medium-grained, massive, light tan and white, moderately weathered, hard, moderately fractured	☒								
5			End of Test Pit at 4 Feet due to Bedrock									
6												
7												
8												
9												
10												
11												
12												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

TEST PIT LOG
NO.: TP-07

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1			TOPSOIL, silty sand with gravel, dry, brown, organics, cobbles and boulders									
1–3		GP-GM	Poorly Graded GRAVEL with silt and sand, dense (estimated), dry, brown, angular boulders	X								
3–4			Quartzite BEDROCK, medium-grained, massive, light tan and white, moderately weathered, hard, moderately fractured									
4			End of Test Pit at 4 Feet due to Bedrock									

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

LOG OF TESTPIT LOGS.GPJ EARTHTEC.GDT 10/28/21

TEST PIT LOG
NO.: TP-08

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/21/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL, clayey sand with gravel, dry, brown, organics									
1–2		SP	Poorly Graded SAND with gravel, dense (estimated), dry, brown, cobbles									
3–4			Quartzite BEDROCK, medium-grained, massive, light tan and white, moderately weathered, hard, moderately fractured	☒								
4			End of Test Pit at 4 Feet due to Bedrock									

5 6 7 8 9 10 11 12

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

TEST PIT LOG
NO.: TP-09

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/22/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL, clayey sand with gravel, dry, brown, organics									
1		GP-GM	Poorly Graded GRAVEL with silt and sand, medium dense (estimated), dry, brown									
3				X	2		19	NP	62	26	12	DS
4		GM	Silty GRAVEL with sand, very dense (estimated), dry, white and light brown, moderately cemented	X								
5		CL-ML	Sandy Silty CLAY, stiff (estimated), slightly moist, light brown and white, calcareous									
7				■	13	98	26	4	6	37	57	C
8			...with gravel	X								
9			...clay lenses encountered									
10			Test Pit Terminated at 10 Feet									
11												
12												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

LOG OF TESTPIT LOGS.GPJ EARTHTEC.GDT 10/28/21

TEST PIT LOG
NO.: TP-10

PROJECT: One O'clock Hill
CLIENT: SJ Company
LOCATION: See Figure No. 2
OPERATOR: Blaine Hone Excavating
EQUIPMENT: Track Mounted Excavator
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 219074
DATE: 09/22/21
ELEVATION: Not Measured
LOGGED BY: M. Schedel
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL, silty sand with gravel, dry, brown, organics									
1		GP-GM	Poorly Graded GRAVEL with silt and sand, loose to very dense (estimated), dry, brown, lightly cemented									
2			...boulders									
3				X								
4				X	2		24	NP	69	26	5	
5			...moderately cemented									
6				X								
7			...not cemented									
8				X	4				62	30	8	
9												
10			Test Pit Terminated at 10 Feet									
11												
12												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
B = Burnoff

PROJECT NO.: 219074

EARTHTEC ENGINEERING

FIGURE NO.: 12

LOG OF TESTPIT LOGS.GPJ EARTHTEC.GDT 10/28/21

LEGEND

PROJECT: One O'clock Hill
CLIENT: SJ Company
DATE: 09/21/21
LOGGED BY: M. Schedel

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR SOIL DIVISIONS			USCS SYMBOL	TYPICAL SOIL DESCRIPTIONS
COARSE GRAINED SOILS (More than 50% retaining on No. 200 Sieve)	GRAVELS (More than 50% of coarse fraction retained on No. 4 Sieve)	CLEAN GRAVELS (Less than 5% fines)	GW	Well Graded Gravel, May Contain Sand, Very Little Fines
			GP	Poorly Graded Gravel, May Contain Sand, Very Little Fines
		GRAVELS WITH FINES (More than 12% fines)	GM	Silty Gravel, May Contain Sand
			GC	Clayey Gravel, May Contain Sand
	SANDS (50% or more of coarse fraction passes No. 4 Sieve)	CLEAN SANDS (Less than 5% fines)	SW	Well Graded Sand, May Contain Gravel, Very Little Fines
			SP	Poorly Graded Sand, May Contain Gravel, Very Little Fines
		SANDS WITH FINES (More than 12% fines)	SM	Silty Sand, May Contain Gravel
			SC	Clayey Sand, May Contain Gravel
FINE GRAINED SOILS (More than 50% passing No. 200 Sieve)	SILTS AND CLAYS (Liquid Limit less than 50)		CL	Lean Clay, Inorganic, May Contain Gravel and/or Sand
			ML	Silt, Inorganic, May Contain Gravel and/or Sand
			OL	Organic Silt or Clay, May Contain Gravel and/or Sand
	SILTS AND CLAYS (Liquid Limit Greater than 50)		CH	Fat Clay, Inorganic, May Contain Gravel and/or Sand
			MH	Elastic Silt, Inorganic, May Contain Gravel and/or Sand
			OH	Organic Clay or Silt, May Contain Gravel and/or Sand
HIGHLY ORGANIC SOILS			PT	Peat, Primarily Organic Matter

SAMPLER DESCRIPTIONS

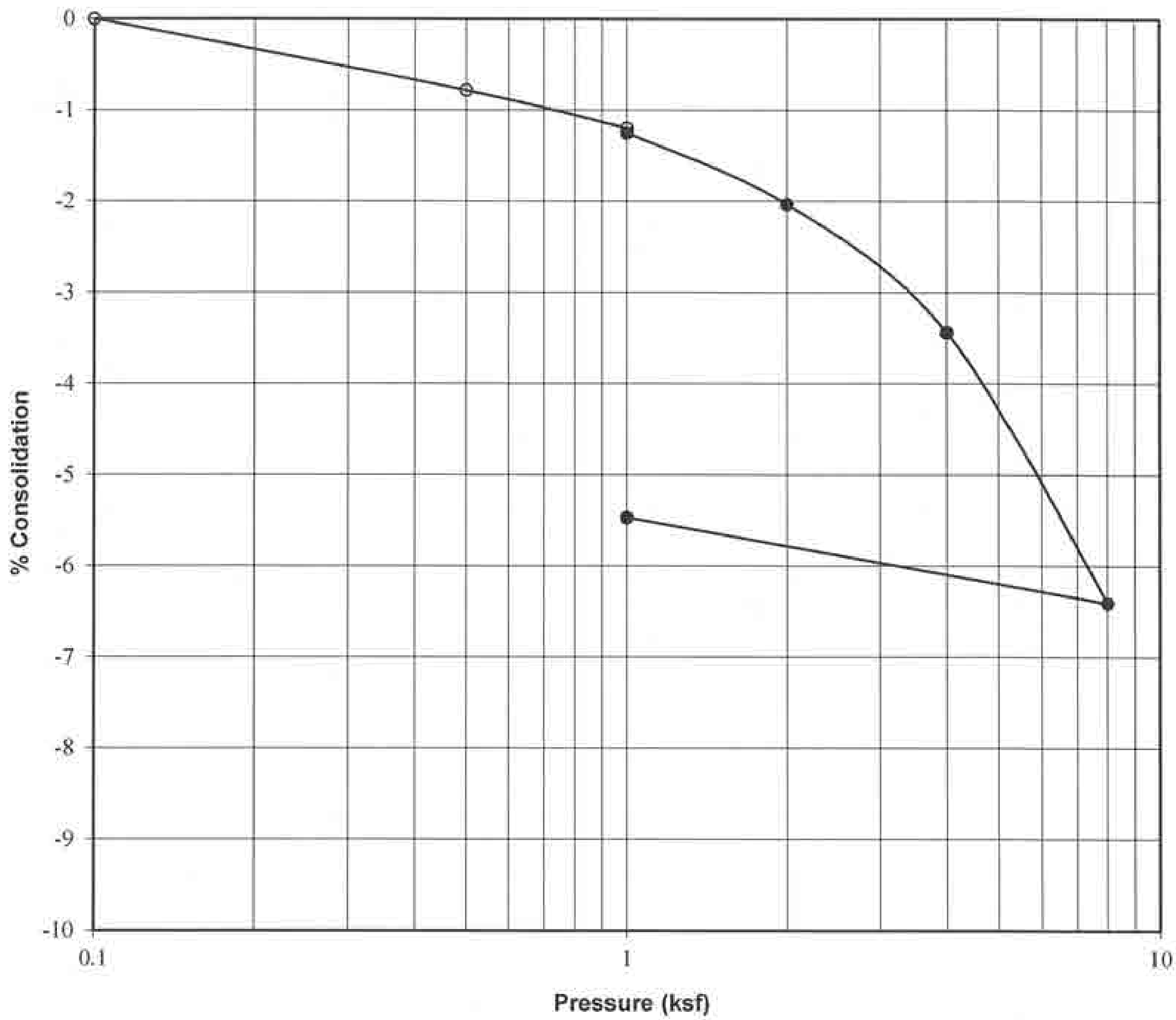
- SPLIT SPOON SAMPLER (1 3/8 inch inside diameter)
- MODIFIED CALIFORNIA SAMPLER (2 inch outside diameter)
- SHELBY TUBE (3 inch outside diameter)
- BLOCK SAMPLE
- BAG/BULK SAMPLE

WATER SYMBOLS

- ▽ Water level encountered during field exploration
- ▼ Water level encountered at completion of field exploration

NOTES:
1. The logs are subject to the limitations, conclusions, and recommendations in this report.
2. Results of tests conducted on samples recovered are reported on the logs and any applicable graphs.
3. Strata lines on the logs represent approximate boundaries only. Actual transitions may be gradual.
4. In general, USCS symbols shown on the logs are based on visual methods only: actual designations (based on laboratory tests) may vary.

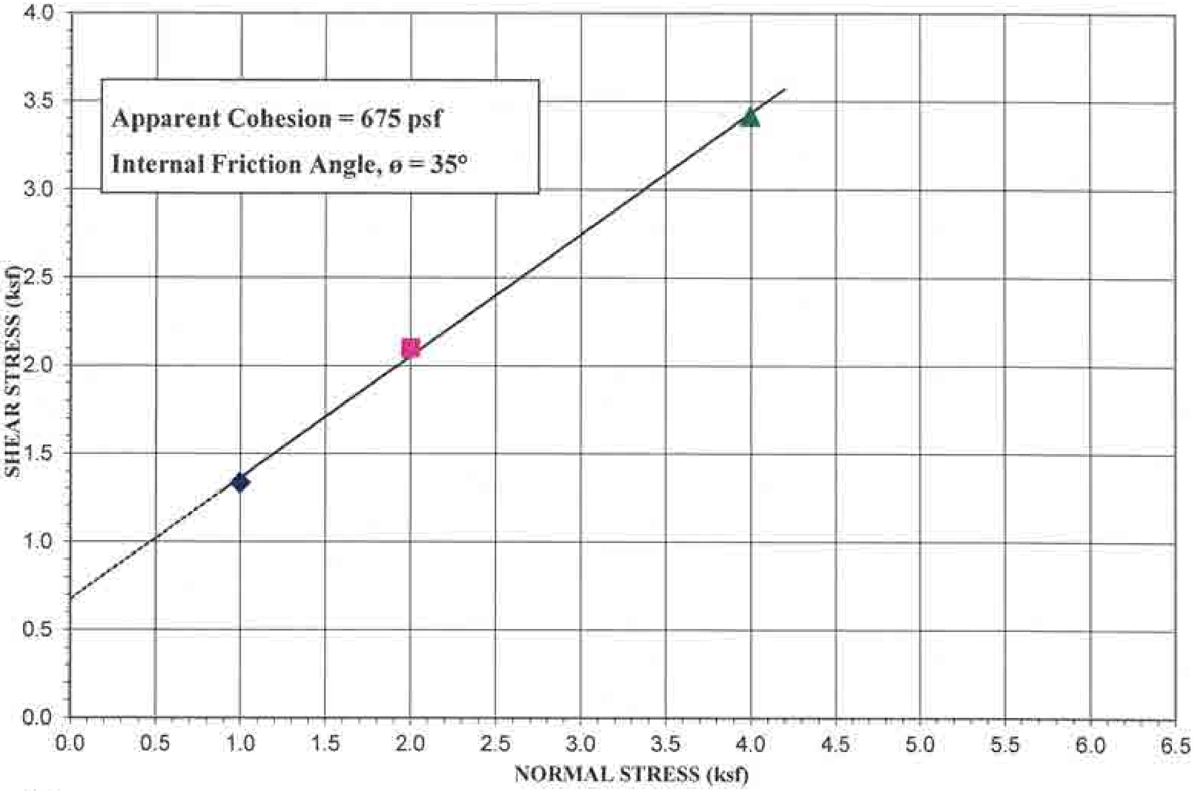
CONSOLIDATION - SWELL TEST

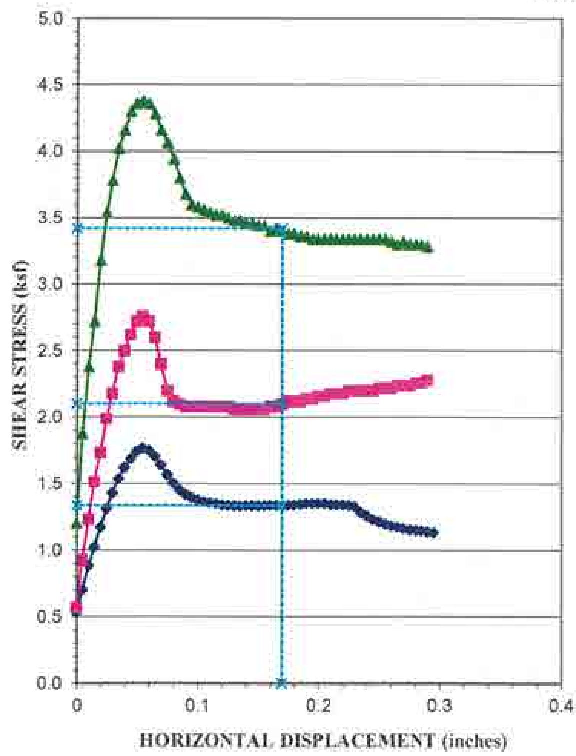


Project:	One O'clock Hill - Geotech
Location:	TP-9
Sample Depth, ft:	6½
Description:	Block
Soil Type:	Sandy Silty Clay (CL-ML)
Natural Moisture, %:	13
Dry Density, pcf:	98
Liquid Limit:	26
Plasticity Index:	4
Water Added at:	1 ksf
Percent Collapse:	0.1

PROJECT NO.: 219074	EARTHTEC ENGINEERING	**FIGURE NO.:** 14

DIRECT SHEAR TEST





Source: TP-4	Depth: 4.5 FT		
Type of Test:	Consolidated Drained/Saturated		
Test No. (Symbol)	1 (◆)	2 (■)	3 (▲)
Sample Type	Remolded		
Initial Height, in.	1	1	1
Diameter, in.	2.4	2.4	2.4
Dry Density Before, pcf			
Dry Density After, pcf	120.9	122.8	120.2
Moisture % Before			
Moisture % After	13.9	14.1	13.8
Normal Load, ksf	1.0	2.0	4.0
Shear Stress, ksf	1.34	2.10	3.42
Strain Rate	.00008640 IN/SEC		
Sample Properties			
Cohesion, psf	675		
Friction Angle, ϕ	35		
Liquid Limit, %	22		
Plasticity Index, %	NP		
Percent Gravel	3		
Percent Sand	39		
Percent Passing No. 200 sieve	58		
Classification	ML		

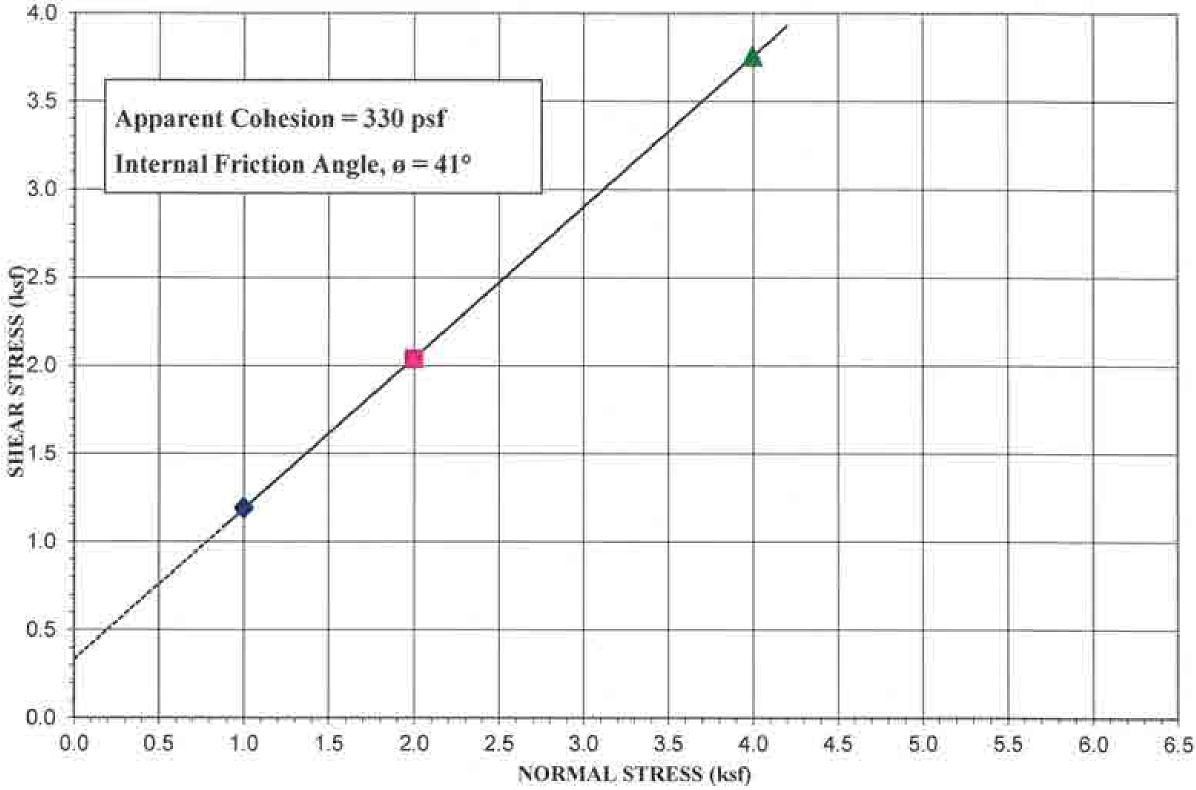
PROJECT: One O'clock Hill - Geotech

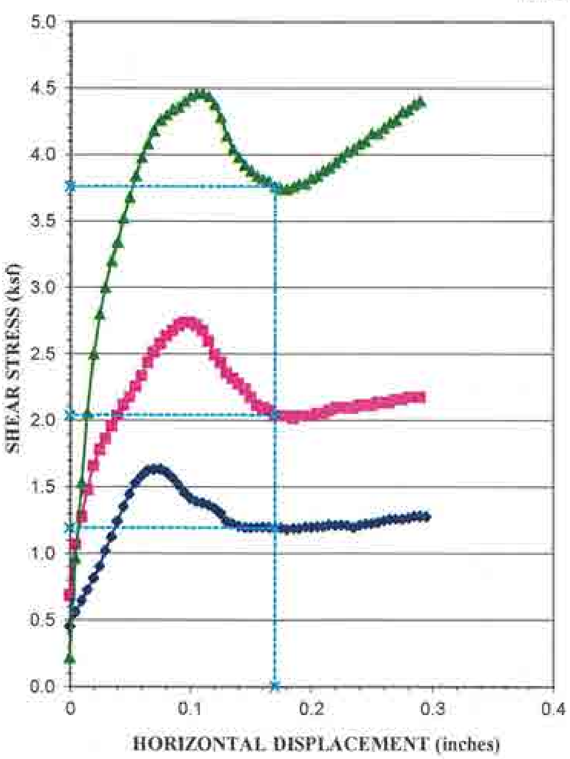
PROJECT NO.: 219074

Earthtec Engineering

FIGURE NO.: 15

DIRECT SHEAR TEST





Source: TP-9	Depth: 2.5 FT		
Type of Test:	Consolidated Drained/Saturated		
Test No. (Symbol)	1 (◆)	2 (■)	3 (▲)
Sample Type	Remolded		
Initial Height, in.	1	1	1
Diameter, in.	2.4	2.4	2.4
Dry Density Before, pcf			
Dry Density After, pcf	117.0	116.1	118.0
Moisture % Before			
Moisture % After	13.8	14.3	13.8
Normal Load, ksf	1.0	2.0	4.0
Shear Stress, ksf	1.19	2.04	3.76
Strain Rate	.00008640 IN/SEC		
Sample Properties			
Cohesion, psf	330		
Friction Angle, ϕ	41		
Liquid Limit, %	19		
Plasticity Index, %	NP		
Percent Gravel	62		
Percent Sand	26		
Percent Passing No. 200 sieve	12		
Classification	GP-GM		

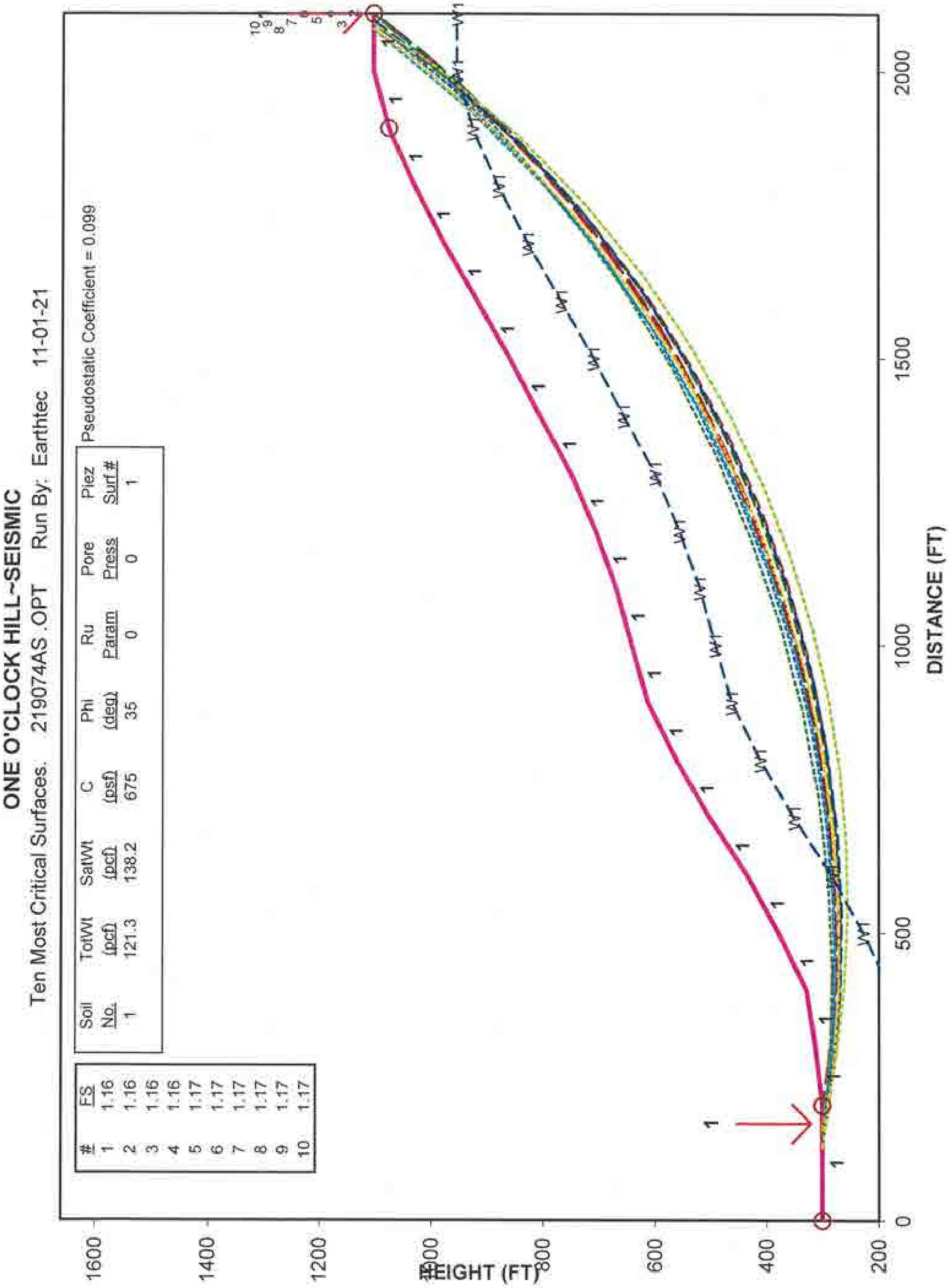
PROJECT: One O'clock Hill - Geotech

PROJECT NO.: 219074

Earthtec Engineering

FIGURE NO.: 16

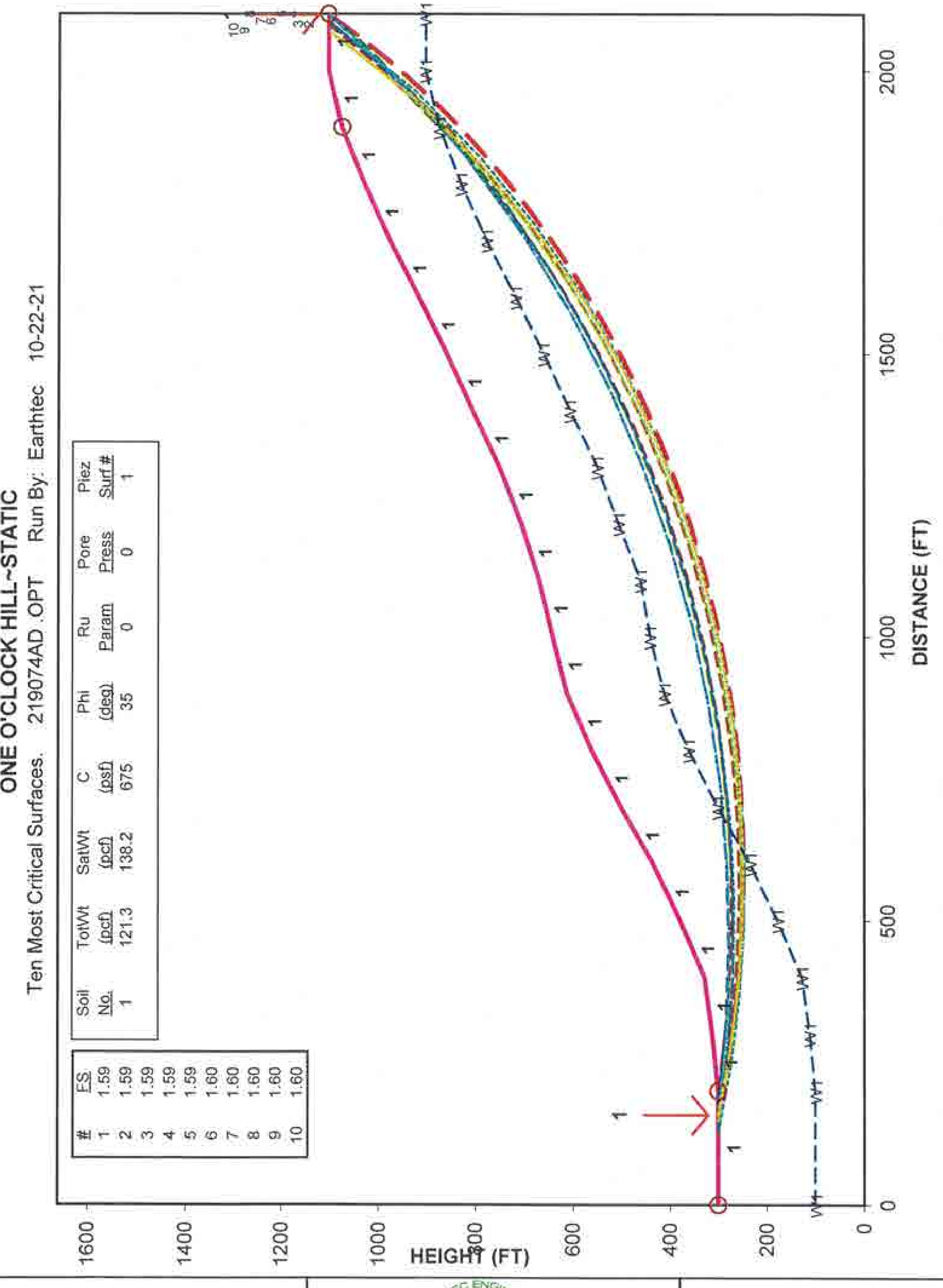
STABILITY RESULTS



PROJECT NO.: 219074

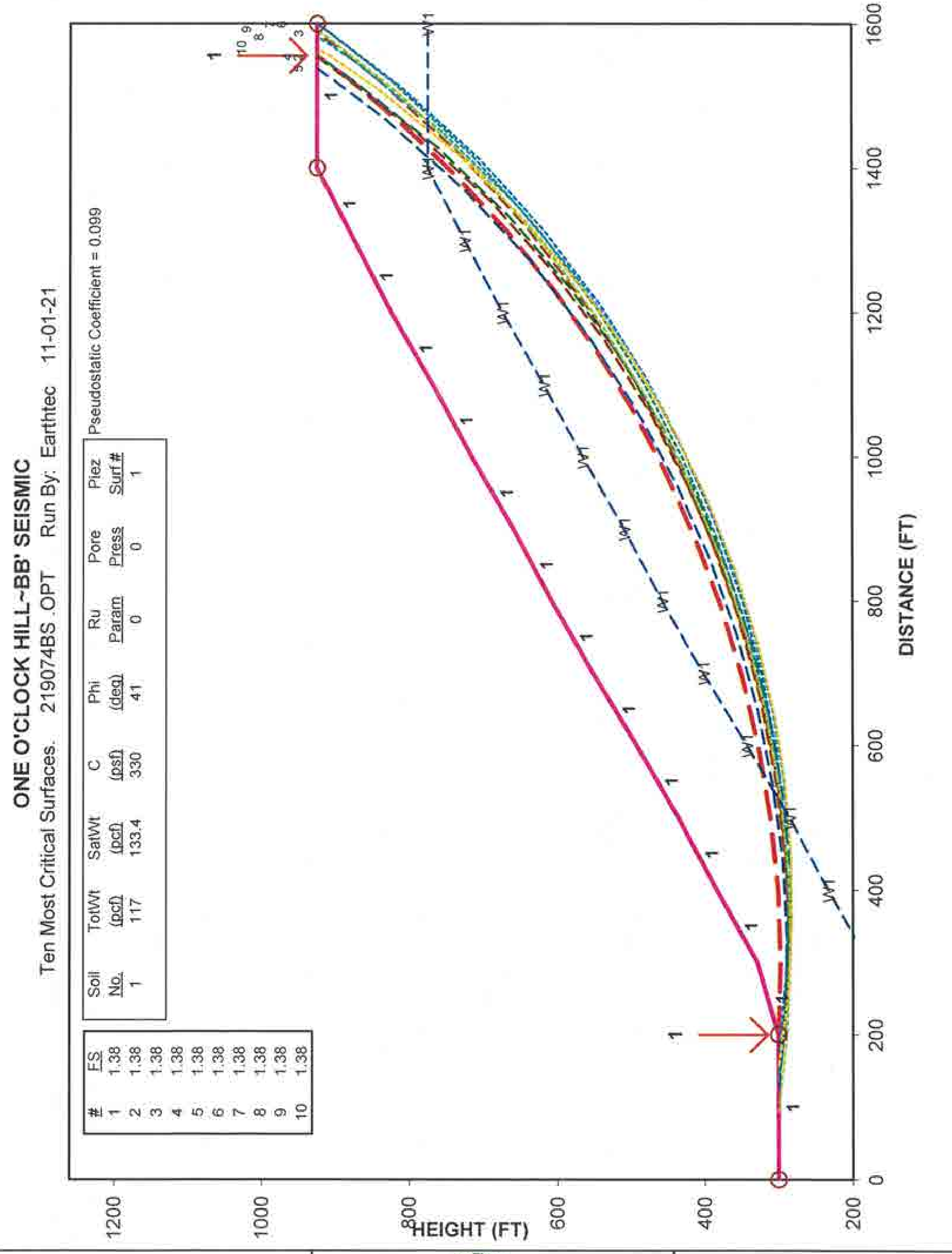
FIGURE NO.: 17

STABILITY RESULTS



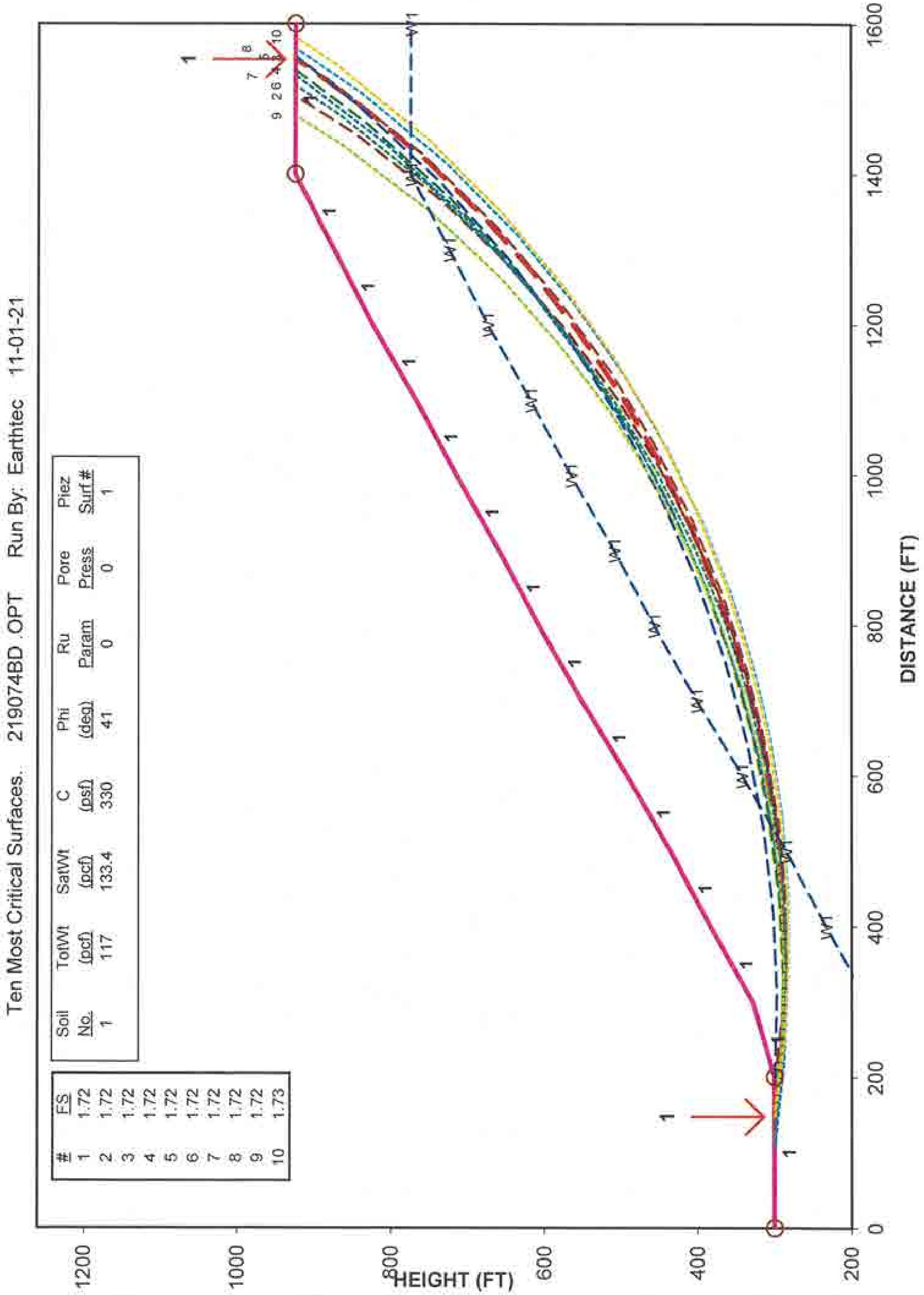
PROJECT NO.: 219074		FIGURE NO.: 18

STABILITY RESULTS



PROJECT NO.: 219074		FIGURE NO.: 19

STABILITY RESULTS



PROJECT NO.: 219074

FIGURE NO.: 20

APPENDIX A

Timpview Analytical Laboratories
A Chemtech-Ford, Inc. Affiliate
1384 West 130 South Orem, UT 84058 (801) 229-2282

Certificate of Analysis

Earth Tech, LLC (dba Earthtec)	**Work Order #:** 2111705
Jeremy Balleck	**PO# / Project Name:** 219074
1497 W 40 S	**Receipt:** 9/28/21 15:10
Lindon, UT 84042	**Batch Temp °C:** 28.6
DW System # :	**Date Reported:** 10/5/2021

Sample Name: **219074 TP-10 @ 2.5'**

Collected: 9/22/21 15:00 **Matrix:** Solid **Collected By:** M. Schedel

Parameter	Lab ID #	Method	Analysis Date / Time	Result	Units	MRL	Flags
Sulfate, Soluble (IC)	2111705-01	EPA 300.0	10/4/21	< 10	mg/kg dry	10	
Total Solids	2111705-01	SM 2540G	9/30/21	97.0	%	0.1	

Comment: One OClock Hill

Reviewed by: Joyce Applegate

Joyce Applegate, Project Manager

Analyses presented in this report were performed in accordance with the National Environmental Laboratory Accreditation Program by a Chemtech-Ford affiliate company, except where otherwise noted.

OSHPD

ONE O'CLOCK HILL - GEOTECH

Latitude, Longitude: 40.512663, -112.310694

Date	10/14/2021, 9:43:59 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Default (See Section 11.4.3)

Type	Value	Description
S_S	0.709	MCE_R ground motion. (for 0.2 second period)
S_1	0.257	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.874	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	0.583	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1.233	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.299	MCE_G peak ground acceleration
F_{PGA}	1.301	Site amplification factor at PGA
PGA_M	0.389	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	0.709	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.762	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.67	Factored deterministic acceleration value. (0.2 second)
S1RT	0.257	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.276	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	1.175	Factored deterministic acceleration value. (1.0 second)
PGAd	1.032	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.93	Mapped value of the risk coefficient at short periods
C_{R1}	0.933	Mapped value of the risk coefficient at a period of 1 s

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SURFACE FAULT RUPTURE HAZARDS STUDY ONE O'CLOCK HILL UT-36 AND SETTLEMENT CANYON ROAD TOOELE, UTAH

Project No. 219075

November 12, 2021

Prepared For:

Tooele 90 LLC
Attention: Mr. Shaun Johnson
6975 Union Park Ave., Ste 600
Cottonwood Heights, UT 84047

Prepared By:

EARTHTEC ENGINEERING
Lindon Office

LICENSED PROFESSIONAL GEOLOGIST
FARHANG F. NAMDAR
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STATE OF UTAH
11/16/2021

Frank Namdar, P.G., E.I.T.
Geologist

Michael S. Schedel
Staff Geologist

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FIGURES

APPENDIX A

1.0 INTRODUCTION

This report presents the results of a surface fault rupture hazards study for the subject site located in Tooele, Utah. We understand that a new residential subdivision is planned for construction on the site. The location of the subject site with respect to existing roadways is shown on Figure No. 1, *Vicinity Map*, at the end of this report.

The purposes of this investigation were to assess surface fault rupture and related hazards at the site and to provide recommendations for minimizing fault rupture hazards as warranted. The scope of work completed for this investigation included field reconnaissance, subsurface investigation (trenching), geologic analysis, and the preparation of this report in accordance with the Tooele City Zoning, General Plan & Master Plan Map Amendment Application Packet.

2.0 PROPOSED CONSTRUCTION & SCOPE OF WORK

We understand that the proposed project, as described to us by Mr. Shaun Johnson, consists of developing the approximately 38-acre existing group of parcels with the construction of a new residential subdivision. The proposed structures will consist of conventionally framed, one- to two-story, houses with basements. In addition, we anticipate that utilities will be installed to service the proposed buildings, exterior concrete flatwork will be placed in the form of curb, gutter, sidewalks, and residential streets will be constructed.

In addition to the geotechnical report prepared by Earthtec Engineering, a surface fault rupture hazard study is necessary to assess the potential for fault hazards in the area. According to published USGS geologic maps, a segment of the Oquirrh Fault Zone runs beneath or adjacent to the subject site. The purpose of this report and the field work conducted is to locate any fault traces related to the mapped fault and provide recommendations for hazard mitigation as it would pertain to fault hazards.

3.0 SITE CONDITIONS

At the time of our subsurface exploration the site consisted of three undeveloped parcels vegetated with native grasses, patches of small trees, and sagebrush. Large power line poles run northeast-southwest throughout the property, and a pump house is built on the northern section against the mountain slope with an asphalt driveway leading to it. An emergency two-track road exists running along the central run of powerlines and does not appear to be regularly maintained, according to local residents near the south end of the property. The entire property is fenced off, and the southern section is used as a horse pasture. The ground surface appears to be relatively flat past the edge of the mountain slopes. The lot was bounded on the northwest by UT-36 Highway, on the southeast by open mountainous land, on the southwest by open field, and on the northeast by Settlement Canyon Road.

4.0 GEOLOGIC AND TECTONIC SETTING

The subject property is located in the southeastern portion of Tooele Valley near the western slope of the Oquirrh Mountains. Tooele Valley is a deep, sediment-filled basin that is part of the Basin and Range Physiographic Province. The valley was formed by extensional tectonic processes during the Tertiary and Quaternary geologic time periods. The valley is bordered by the Oquirrh Mountains on the east and the Stansbury Mountains on the west. Much of northwestern Utah, including Tooele Valley, was previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, which borders Tooele Valley to the north, is a remnant of this ancient fresh-water lake

The Oquirrh Fault Zone is considered to be an "active" fault zone. An active fault zone is defined as one that has shown evidence of displacement during Holocene time (the past 10,000 years). The Oquirrh Fault Zone is a generally north-trending normal fault along the western base of the Oquirrh Mountains. The Oquirrh Mountains are the easternmost and highest of three distinctive north-south mountain ranges in the Basin and Range west of the high central part of the Wasatch Range. Surficial geology in Tooele Valley to the west is dominated by lake deposits and alluvium. Several buried faults that do not cut surficial deposits are postulated in the vicinity of the Oquirrh fault zone which may be older and not related to the fault zone. One such fault, the Occidental fault, may have been reactivated by Oquirrh fault zone activity (Solomon, 1996)[1].

In addition to the Oquirrh Fault Zone, the area has also been influenced geologically by Lake Bonneville, an ancient fresh-water lake which formerly covered the valleys of western Utah. The shoreline of the lake reached a maximum elevation of approximately 5,180 feet above sea level. Evidence of this shoreline, known as the Bonneville Level, and several others which formed as the lake level fluctuated or dropped, are visible at places along the foothills of the Oquirrh Mountain Range.

The surficial geology of much of the eastern margin of the valley has been mapped by Clark, et al., 2020[2]. A portion of this map, which includes the area of the subject site is attached as Figure No. 2a, *Surficial Geologic Map of the Site*. The surficial geology at the location of the subject site and adjacent properties contains the following geologic units which are mapped as "Younger fan alluvium, post-Lake Bonneville" (Map Unit Qafy), Holocene to Pleistocene "Lacustrine and alluvial deposits, undivided" (Map Unit Qla), "Colluvium and talus, Holocene to upper Pleistocene" (Map Unit Qmct), middle- to upper-Pleistocene "Older fan alluvium, pre-Lake Bonneville" (Map Unit Qafo), and "Oquirrh Group, Bingham Mine Formation. The bed rock units of the site area are upper member" (Map Unit IPobmu) dated from the upper Pennsylvanian, late to middle Eocene "Quartz latite porphyry dikes and sills" (Map Unit

---

[1] Black, B.D., McDonald, G.N., and Hecker, S., 1999, 2398 Oquirrh Fault Zone
[2] Clark, D.L., Oviatt, C.G., Dinter, D.A., 2020, Geologic Map of the Tooele 30'x60' Quadrangle*, Tooele, Salt Lake, and Davis Counties, Utah*; Utah Geological Survey, Open-File 284DM, Scale 1: 62,500.

Tiqlp), and Upper Pennsylvanian "Oquirrh Group, Bingham Mine Formation" (Map Unit IPobmu). These soil or deposits are described below:

Qafy **Younger fan alluvium, post-Lake Bonneville (Holocene to uppermost Pleistocene)** – Poorly sorted gravel, sand, silt, and clay; deposited by streams, debris flows, and flash floods on alluvial fans and in mountain valleys; merges with unit Qal; includes alluvium and colluvium in canyon and mountain valleys; may include areas of eolian deposits and lacustrine fine-grained deposits below the Bonneville shoreline; includes active and inactive fans younger than Lake Bonneville, but may also include some older deposits above the Bonneville shoreline.

Qmct **Colluvium and talus (Holocene to upper Pleistocene)** – Local accumulations of mixed colluvium and talus throughout the map area; common near Lake Bonneville shorelines; thickness up to 15 feet (5 m).

Qla **Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene**) – Sand, gravel, silt, and clay; consist of alluvial deposits reworked by lakes, lacustrine deposits reworked by streams and slopewash, and alluvial and lacustrine deposits that cannot be readily differentiated at map scale.

Qafo **Older fan alluvium, pre-Lake Bonneville (upper to middle? Pleistocene)** – Poorly sorted gravel, sand, silt, and clay; similar to unit Qafy, but forms higher level incised deposits that predate Lake Bonneville; includes fan surfaces of different levels; fans are incised by younger alluvial deposits and locally etched by Lake Bonneville.

Tiqlp **Quartz latite porphyry dikes and sills (late to middle Eocene)** – Medium-brown and light-greenishgray, hornblende-biotite quartz latite porphyry; hornblende is altered to phlogopite and/or chlorite within the Bingham pit area; distinguished from other latitic dikes and sills by the presence of relatively large quartz phenocrysts and higher percentage of aphanitic groundmass; groundmass usually contains considerable hornblende (KUCC, 2009); includes Raddatz porphyry dikes with large K-feldspar phenocrysts (Settlement Canyon area) (see Krahulec, 2005; new geochemical data in Clark and Biek, 2017), and the Andy Dike and apophyses at Bingham mine (KUCC, 2009); 40Ar/39Ar ages of 37.66 ± 0.08 and 37.72 ± 0.09 Ma (Deino and Keith, 1997), and U-Pb zircon age of 37.97 ± 0.11 Ma (von Quadt and others, 2011); also forms some small dikes (unmapped) east of Pass Canyon and near North Oquirrh thrust (Swensen and others, 1991) with K-Ar age of 36.5 ± 1.1 Ma (Moore, 1973); Raddatz dike has 40Ar/39Ar age of 39.4 ± 0.34 Ma (Kennecott in Krahulec, 2005).

IPobmu Oquirrh Group, Bingham Mine Formation, upper member (Upper Pennsylvanian, Virgilian-Missourian) – Light gray to tan, thinly color-banded and locally cross-bedded quartzite with interbedded thin, light- to medium-gray calcareous, fine-grained sandstone, limestone, and siltstone.

Clark & Others (2020) also mapped surface fault rupture segments within the Oquirrh Fault Zone. This implied fault rupture segment is shown on Figure No. 2 as dotted lines with the rod and ball pattern on the down-thrown side of the fault. As shown on Figure No. 2, the fault consists of a single southwest to northeast running implied fault trace which runs parallel to UT-36 at a distance of approximately 150 to 200 feet from the west boundary of the site. This implied fault trace is the only known fault trace in the vicinity and is mapped by Clark & Others (2020). According to the map, the exact location of the fault trace is not known, as no other contiguous line of this splay is mapped. This is extrapolated based on continuous geologic units and the orientation of the mapped normal fault in that area. Another map at Utah Geological Survey (UGS) website shows approximately located normal faults as continuances of the splay within the Oquirrh Fault Zone as close as 100 feet due southeast of the site along the base of the western slope of the Oquirrh Mountains. However, since we could not find the source documentation of these faults, we contacted UGS about the source of these faults. Mr. Don Clark on a phone conversation on November 15, 2021, mentioned that the faults drawn in 1980 map by Edwin Tooker of USGS in "Preliminary Geologic Map of Tooele Quadrangle", USGS OFR 80-623, are not accurate and are not confirmed by the more recent mapping interpretations. Therefore, it is our opinion that the main fault in the area is the implied fault mapped by Clark and others located on the west of the UT-36.

Low Light angle aerial photographs of the Oquirrh Fault Zone produced from 1936 to 1952 (exact date unknown) and 1970 at the location of the subject site and surrounding areas were reviewed as part of this study. The 1936 to 1952 and 1970 aerial photographs are shown in Figure Nos. 4a and 4b, respectively. The reviewed photographs do not show visible or prominent scarps and lineaments (i.e. vegetation lineaments, gullies, vegetation/soil contrasts, aligned springs and seeps, sag ponds, aligned or disrupted drainages, grabens, and/or displaced landforms such as shorelines, geologic units, etc.) adjacent to or on the subject site or its surroundings that correlate well with mapped faults. Hence, no surficial features that might indicate past surface fault rupture and related ground deformation were discernible on the subject site. No surficial features at the location of the short fault segment mapped crossing near the south edge of the subject lot are visible in the reviewed photographs.

In addition, in reviewing a LiDAR image from the area of the site, prominent scarps are not visible on the subject site nor on the adjacent hillslopes. We couldn't clearly see the mapped faults in the LiDAR image due to surface disturbance, drainages, trails, and residential and industrial development to the west of the subject lot where the implied fault trace is mapped. The LiDAR image of the site area is shown in Figure No. 5. *LiDAR Image of the Subject Site Area*.

5.0 EXPLORATION TRENCHING

5.1 Field Methods

To observe the subsurface deposits at the location of the subject site for evidence of past surface rupture and/or other related ground deformation related to faulting, three exploration trenches were excavated on the lot on September 20, 2021 and were observed and logged on September 23, 2021. The trenches were approximately 86 to 104 feet long, stretching 40 to 70 feet southeast of UT-36 pavement, oriented at northwest-southeast. The trenches extended to maximum depths of approximately 5 to 11 feet below the existing ground surface. The location of the exploration trenches on the site are shown on Figure No. 3, *Exploration Trenches & Setback Locations*. The exploration trenches (ET-1, ET-2, and ET-3) were excavated by Blaine Hone Excavating with a CAT 308 track-mounted excavator and were back-filled upon completion of the field work. The northeast wall of each trench was logged by an experienced geologist using standard tools and techniques. A representative log of the trench wall was produced and is included at the end of this report as Figure Nos. 6-8, *Exploration Trench Logs*.

The location and extent of the exploration trench at the site was chosen to provide as much coverage for the proposed structure based on the orientation of the faults in the vicinity of the site with the excavation equipment ability in mind. The active faults (less than 10,000 years old) in the area of the site would be evident in the Lake Bonneville sediments that cover the surficial deposits at the site. Figure No. 2, *Surficial Geologic Map of the Site*, shows the location of the entire run of the implied fault trace.

5.2 Subsurface Conditions

The soils encountered during our subsurface exploration are shown on Figure Nos. 6-8, *Exploration Trench Logs*. The exploration trenches exposed up to 1½ feet of organic rich Topsoil (Unit 1) at the surface. Below Unit 1, massive sand of Lake Bonneville sediments such as Unit 2 in ET-1 and reworking of variable impacts by the lake activities such as alluvium and colluvium of variable degrees as encountered in Unit 2 in ET-2 and ET-3 and in Unit 3 in ET-1 and ET-3. Below the reworked alluvium and colluvium by Lake Bonneville ET-2 exposed weathered bedrock in Unit 3 and Lake Bonneville shoreline sand and near shore fine sediments were exposed in Unit 3A of ET1 and in Unit 4 of ET-3. The detailed unit description can be found in trench logs in Figures 6-8. The age of the sediments exposed in trenches range from upper Pleistocene to Holocene. Bedrock exposed in ET-1 is most likely of upper Pennsylvanian in age.

No zones or planes of shearing or shifting or deformation that could be indicative of fault rupture were observed. Finer sands and silty clay of near shore Lake Bonneville were observed without any shifting along the entire trench in ET-1 and ET-3.

Based on our observations of the stratigraphic relationships of the soil units exposed in the exploration trenches, as well as the referenced geologic mapping by Clark & Others (2020) logged Unit 3 in ST-1 and Unit 4 in ET-3 are of sufficient age to have recorded any Holocene surface faulting events at the site. No evidence of fault rupture was observed in these soil units exposed in the trench. No other related tectonic or coseismic deformation was observed in the deposits exposed in the exploration trenches at the site. Absence of faulting in the exploration trench relates to the potential fault mapped in the area of the site. No faulting was observed, caused by the Implied fault, at the exploration trench location. Hence, the location of the mapped fault was not discovered at the site and the potential for the presence of the fault or its impact, if it exists, near UT-36, as mapped by Clark & Others (2020), still exists at the site. The impact of the potentially active fault to the structures during an earthquake could however be significant and could cause structural failure.

6.0 SUMMARY OF SURFACE FAULT RUPURE AND RELATED HAZARDS

6.1 Surface Fault Rupture

As discussed in the previous section, no evidence of past surface fault rupture was observed in the exposed deposits of the exploration trenches. The reworked alluvium and lacustrine sand and gravel deposits, and finer Lake Bonneville sediments observed in the trenches are deposits of upper Pleistocene to Holocene in age. Therefore, the exposed deposits are of sufficient age to show Holocene age (active) fault displacement.

As discussed in Section 4.0, implied fault trace has been mapped by Clark & Others (2020) on the Geologic Map of the Tooele Quadrangle near the northwest boundary of the subject lot (Figure No. 2). A LiDAR image of the area of the site was reviewed. An abrupt change of elevation, typically shown in LiDAR images by dark areas, can show location of faults as ground shifting, was not observed. The LiDAR image is shown in Figure No. 5, *LIDAR Image of the Subject Site Area*. The approximate location of the mapped fault is also shown on Figure No. 2, *Surficial Geologic Map of Site*. There are no significant surficial features, other than the ones noted above, on the site that would suggest the presence of the fault near the site, however, such features may have been erased by past development activities or erosion. Based on current guidelines for evaluating surface fault rupture hazards in Utah (Christenson et. al, 2003), it is our opinion that a minimum building setback from the southwest edge of the paved UT-36 road of 91.6 feet, 64.6 feet, 61.6 feet at the location of trench ET-1, ET-2, ET-3, respectively, would be conservatively appropriate. These distances were calculated by assuming 21.6-foot setback from the northwest end of each trench as shown on Figure No. 3.

According to Bowman and Lund (2016), Chapter 3 Guidelines for Evaluating Surface-Fault-Rupture Hazards in Utah, Fault Setback section, provides the following definition the for variable D to be used in the setback calculation formula: "D = Expected maximum fault displacement per earthquake (maximum vertical displacement) (feet) to be used in the fault setback formula." Bowman and Lund (2016) also states: "Fault displacement is the maximum vertical displacement measured for an individual surface-faulting earthquake at the site (not necessarily the displacement of the most recent surface-faulting event). If a range of displacements is possible (e.g., because of uncertainty in how geologic layers or contacts are correlated or projected into the fault zone), the largest possible displacement value should be used. If per-earthquake displacements cannot be measured on site, the maximum displacement based on paleoseismic data from nearby paleoseismic investigations on the fault or segment may be used. In the absence of nearby data, consult DuRoss (2008) and DuRoss and Hylland (2015) for the range of displacements measured on the central segments of the Wasatch fault zone. Lund (2005) reports limited displacement information for some other Utah Quaternary faults."

Measured net vertical displacement by Susan Olig, et al. (1996)[3] for the Oquirrh Mountain normal fault was 2.2 meter (7.2 feet). A study was also performed by researchers (Morey 1998) at the University of Utah that conducted a 3-D seismic experiment across the Oquirrh fault and was printed at Geophysical Journal International, Volume 138, Issue 1, July 1999, Pages 25–35: "Palaeoseismicity of the Oquirrh fault, Utah from shallow seismic tomography". It concluded that the maximum displacement was 2.04 meters (6.7 feet) by measuring the colluvial wedge to determine the displacement by the fault. As such, it is assumed that the fault is located beyond the southwestern end of the trenches near the southwestern property line. Based on current guidelines for evaluating surface fault rupture hazards in Utah (Christenson and others, 2003) and studies referenced above by Olig (1996, 1999) calculated minimum building setback from the southwestern end of the exploration trenches ET-1, ET-2, and ET-3 of 21.6 feet would be conservatively appropriate.
As such, the fault setback distance from the southeast edge of the UT-36 road pavement is located at 91.6 feet, 64.6 feet, and 61.6 feet, at the location of trenches ET-1, EY-2, and ET-3, respectively. The 21.6 feet setback distance from the northwest end of each trench is calculated using the formula below for upthrown block of the fault that applies to the subject lot, provided by Chapter 3 of "Guidelines for investigating geologic hazards and preparing engineering-geology reports, second edition, 2020, Utah Geological Survey Circular 128,":

[3] Olig S.S. Lund W.R. Black B.D. Mayes B.H., 1996 Paleoseismic investigation of the Oquirrh fault zone, Tooele County, Utah, Utah Geol. Surv. Spec. Study, 88, 22– 54

Upthrown block (Footwall): Because the fault setback is measured from the portion of the building closest to the fault, whether subgrade or at grade, the dip of the fault and depth of the subgrade portion of the structure are irrelevant in calculating the fault setback on the upthrown block. The fault setback for the upthrown side of the fault is calculated as:

S = U * (2D)

S = Fault setback distance within which buildings are not permitted (feet) = 21.6 ft
U = Criticality factor, based on IBC Risk Category (Table 13) = 1.5
D = Expected maximum fault displacement per earthquake (maximum vertical displacement) (feet) = 7.2 ft

A 21.6-foot setback from the southwestern end of each trench is shown on Figure No. 3, *Exploration Trench & Setback Locations*. A buildable area for development is also established by connecting the setback locations, as determined at each trench.

Surface fault rupturing during large magnitude earthquake events generally occurs along existing fault rupture planes. Although it does not appear that any existing faults cross through the subject site at the trench locations, there is always some inherent potential for new surface ruptures to form during future earthquake events in the Fault Zone. Performing a surface-faulting investigation and adherence to the investigation recommendations in these guidelines does not guarantee safety (Lund 2020, c-128). Significant uncertainty often remains due to limited paleoseismic data related to the practical limitations of conducting such investigations (epistemic uncertainty), and natural variability in the location, recurrence, and displacement of successive surface-faulting earthquakes (aleatory variability). Aleatory variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures.

For those reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. Damage to the structures from the vibratory component of ground shaking has typically been considered separately from structural loads resulting from permanent ground deformation in studies of earthquake impacts to structures. Lightly loaded foundations have rotated and developed a large "gap" underneath the foundation due to fault offset in the past and a wider foundation caused the fault movement to be spread throughout the structure and prevented significant fault diversion. A flexible foundation caused less fault diversion to occur (Oettle 2013). In a large earthquake due to nearby faults, a range of scenarios from a catastrophic failure to potential damages discussed above are possible for the houses and its occupants if on or offset from the fault location. Small deformation along a nearby fault may cause cracks in walls and basement floors.

6.2 Tectonic and Coseismic Deformation

In addition to ground deformation caused by surface fault rupture during a large magnitude earthquake event, other forms of tectonic and/or coseismic ground deformation can occur, especially within the fault zone. These types of deformation can include ground tilting, cracking, soil liquefaction, lateral spreading, subsidence, and slope failure. Based on our field observations as well as the reference geologic mapping reviewed for this study, there is a primary fault located to the northwest of the subject lot along the UT-36 road, as such, ground tilting and other coseismic deformation could impact the subject lot during future earthquake events.

We also recommend that the site-specific seismic design parameters be carefully be implemented in all new construction at the site per recommendations in the related geotechnical study conducted by Earthtec Engineering on the subject lot.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our observations and analyses, the area appears to be suitable for the planned construction from a surface fault rupture hazards perspective, provided the recommendations presented in this report are carefully followed and implemented. We recommend observing all footing excavations prior to installing the concrete footing forms, to verify that no surface rupture faults are located below the planned foundation expansion prior to construction.

As mentioned before, a potentially active fault in a roughly southeast-northwest orientation is mapped parallel to the UT-36 road at southwestern boundary of the lot. However, this fault is currently not in the area of development at the lot. The impact of this fault on the proposed improvement during an earthquake is relatively low.

It must also be understood that the site is located in a geologically/seismically sensitive area where there are inherent risks associated with development. The conclusions and recommendations presented in this report are intended to provide a factor of safety against surface fault rupture and related tectonic and seismic hazards sufficient to reduce the risk to human life. However, potential structural damage due to these natural hazards at the site cannot be totally mitigated due to the limitations and inherent level of uncertainty associated with analyzing and predicting such hazards. Therefore, by choosing to build and/or reside on the subject site, the property owners and/or residents should understand and accept the inherent risks associated with building and living in a geologically and seismically sensitive area.

8.0 LIMITATIONS

A significant limitation in this study precluded the exploration trenches to extend further southwest beyond their final points, as it would have extended into marked utility trenches and into the adjoining road. Also, trench ET-2 could not be excavated deeper due to presence of bedrock. The analysis and recommendations submitted in this report are based on the data obtained from the observation at the site and compilation of known geologic information. This information and the conclusions of this report should not be interpolated to adjacent properties without additional site-specific information. The study was prepared in accordance with the approved scope of work outlined in our proposal for the use and benefit of the Client and the information in this study may not be used by other person or entity without express written permission of Client.

9.0 GENERAL CONDITIONS

The exploratory observations and data presented in this report were collected to provide surface fault rupture hazards analysis for this project. The exploration trench may not be indicative of subsurface conditions outside the study area or between points explored and thus have a limited value in depicting subsurface conditions for contractor bidding. Variations from the conditions portrayed in the exploration trench may occur which may be sufficient to require modifications in the design. If during construction, conditions are different than presented in this report, please advise us so that the appropriate modifications can be made.

The surface fault rupture hazards study as presented in this report was conducted within the limits prescribed by our client and an approved scope of work, with the usual thoroughness and competence of the engineering geology profession in the area. No other warranty or representation, either expressed or implied, is intended in our proposals, contracts or reports.

We appreciate the opportunity of providing our services on this project. If we can answer questions or be of further service, please call.

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Olig S.S. Lund W.R. Black B.D. Mayes B.H., 1996 Paleoseismic investigation of the Oquirrh fault zone, Tooele County, Utah, Utah Geol. Surv. Spec. Study, 88, 22– 54.

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VICINITY MAP

ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH

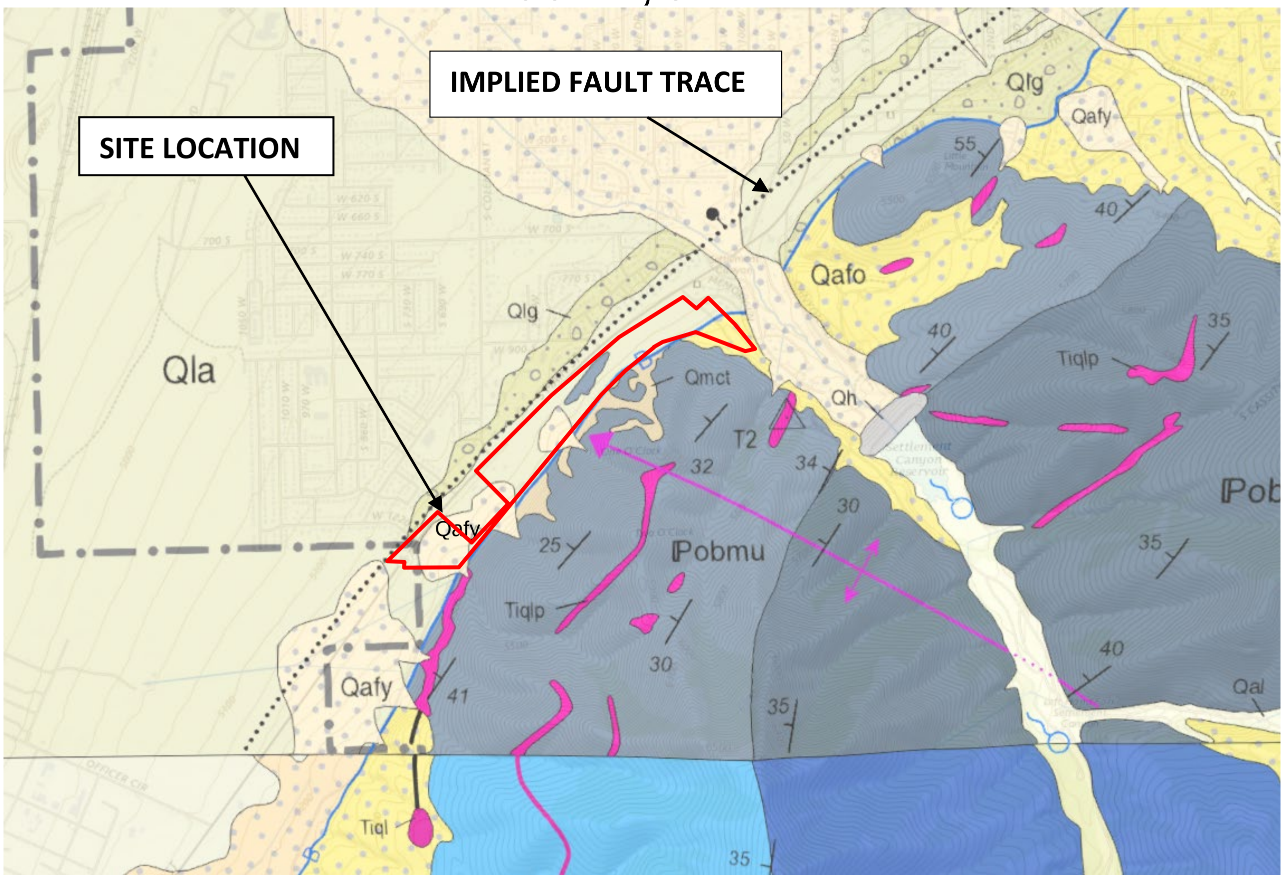
N

Not to Scale

PROJECT NO.: 219075		**FIGURE NO.:** 1

SURFICIAL GEOLOGIC MAP OF THE SITE

ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH

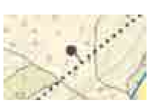


Geologic Map of the Tooele 30'x60' Quadrangle*, Tooele, Salt Lake, and Davis Counties, Utah*; Utah Geological Survey
Open-File 284DM, Scale 1: 62,500
By
Clark, D.L., Oviatt, C.G., Dinter, D.A., 2020

1 inch = 2200 feet

N

*Refer to text portion of the report for geologic unit's description

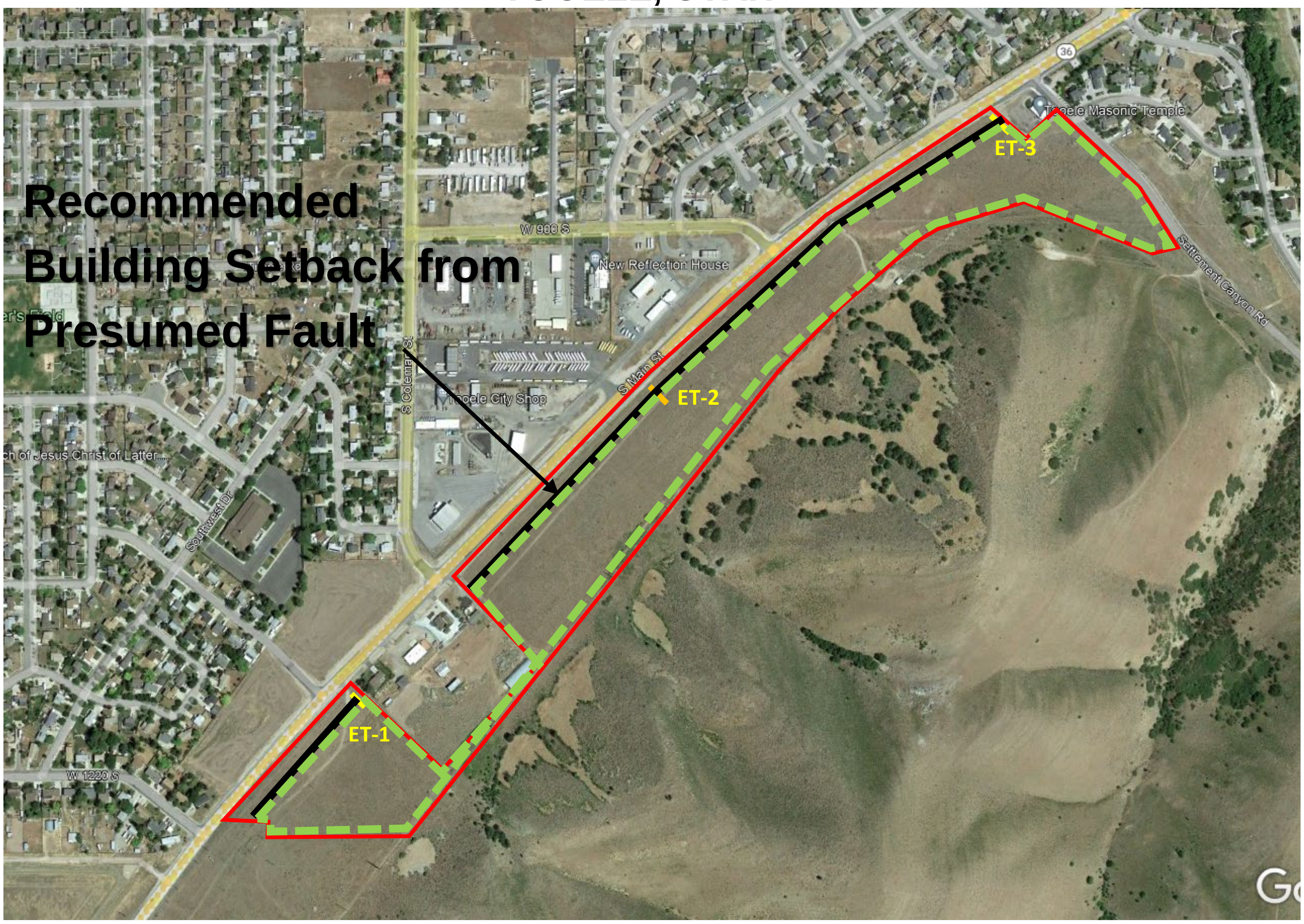


Normal Fault with Ball on the Downthrown Side

PROJECT NO.: 219075	EARTHTEC ENGINEERING	**FIGURE NO.:** 2

AERIAL PHOTOGRAPH SHOWING LOCATION OF FAULT RUPTURE HAZARD STUDY TRENCHES ET-1, 2, 3, FAULT SET BACK

ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



*Aerial Photo by Google

Scale: 1 inch = 830 Feet

Subject Lot Boundaries

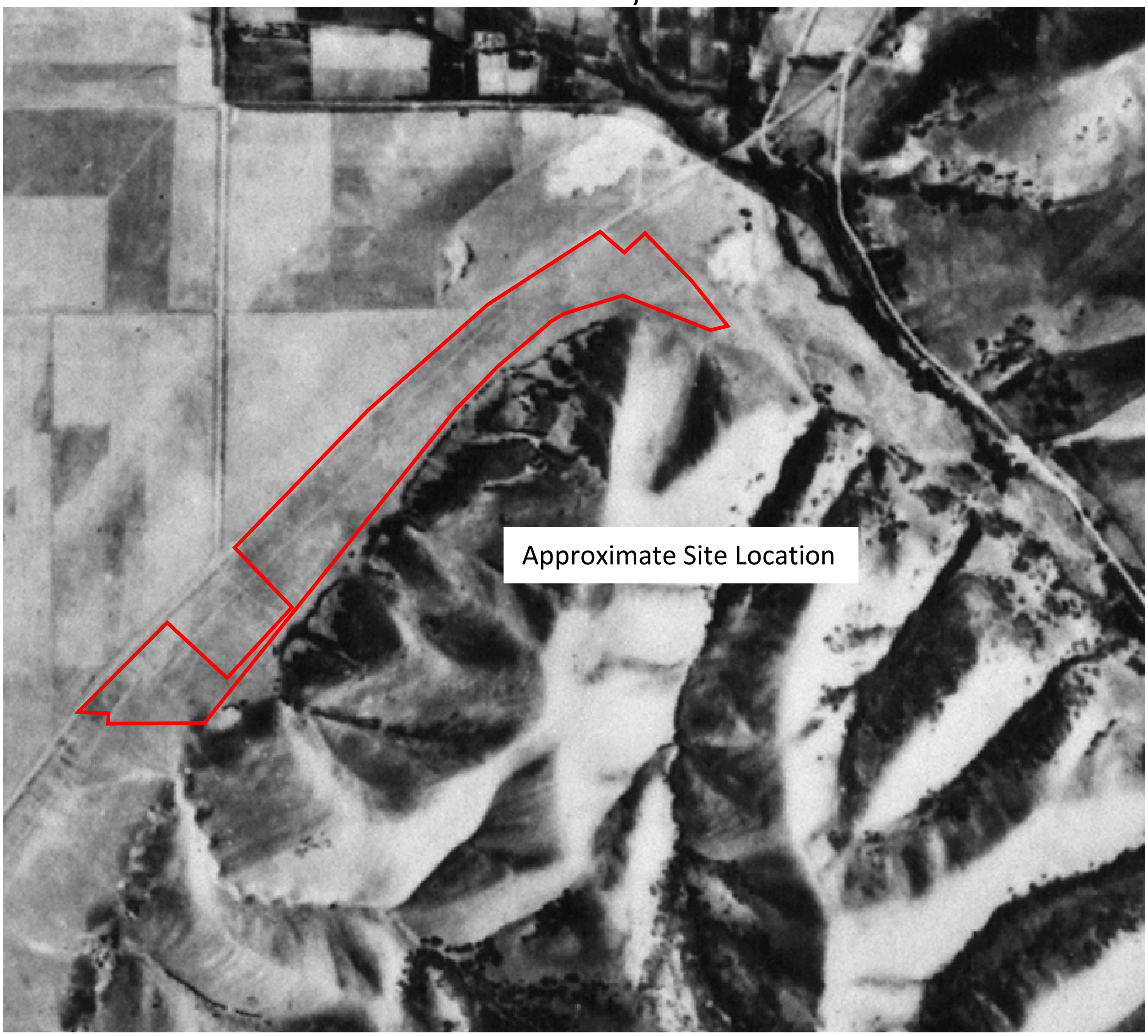
Fault Rupture Hazard Study Trenches

Buildable Area

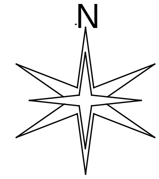
Set Back Line

PROJECT NO.: 219075		**FIGURE NO.:** 3

1936 TO 1952 AERIAL PHOTOGRAPH
ONE O'CLOCK HILL - FRHS
1825 EAST CENTER STREET
SPRINGVILLE, UTAH



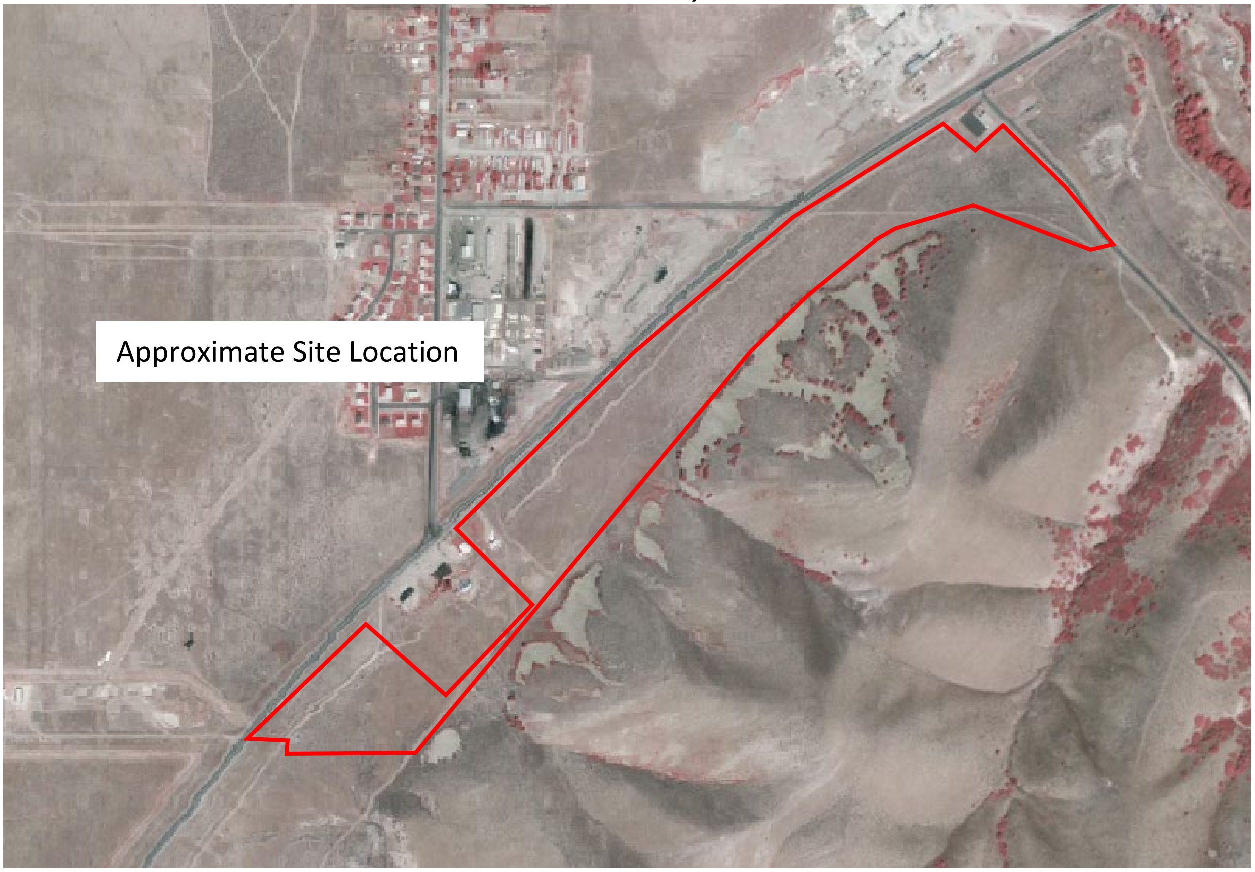
Name: SCS Scanned Historical Aerial Photographs from 1936 to 1952
Resolution: UNK
Scale: UNK
Source: UGS Scan



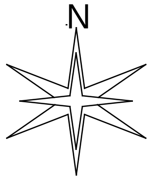
PROJECT NO.: 219075	EARTHTEC ENGINEERING	**FIGURE NO.:** 4a

1970's AERIAL PHOTOGRAPH

ONE O'CLOCK HILL - FRHS
1825 EAST CENTER STREET
SPRINGVILLE, UTAH



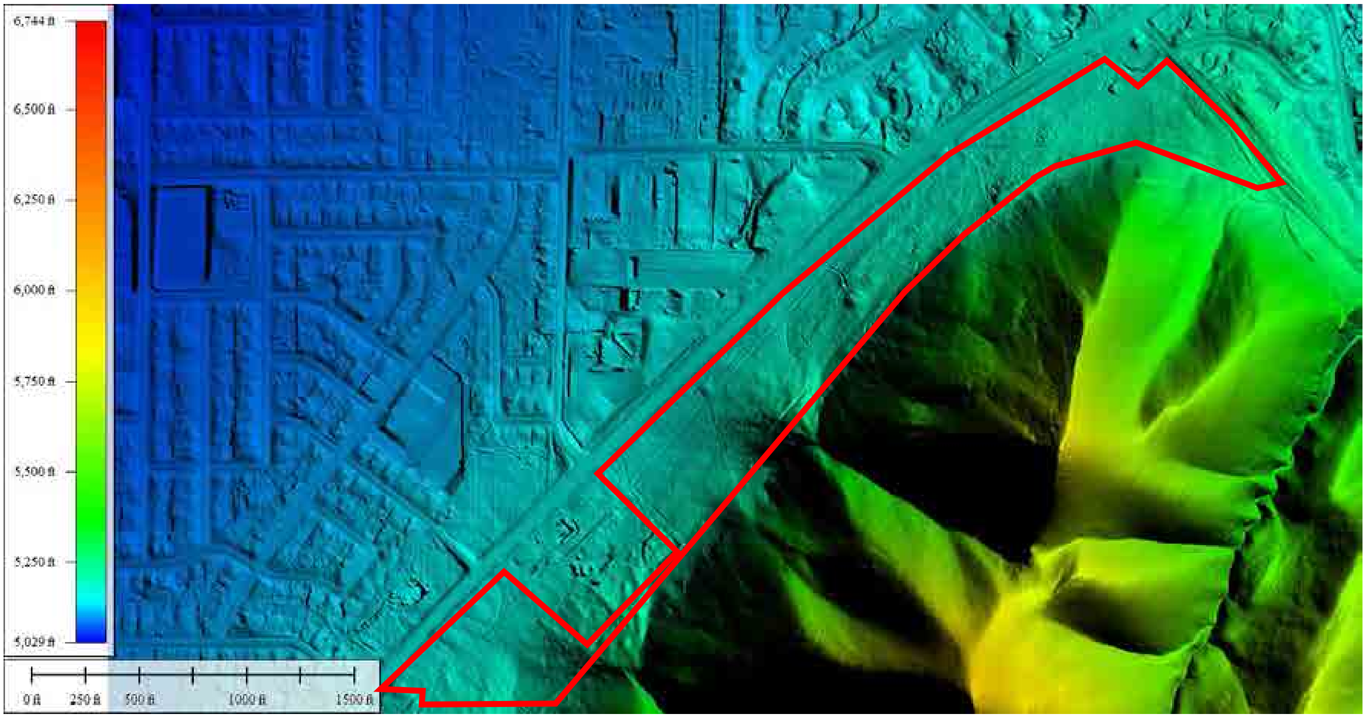
Name: 1 Meter RGB & CIR Digital Orthophotography from the 1970's
Resolution: 1 Meter
Scale: 1:31,760
Year Collected: 1970's
Source: UGS Scan
Note: Stitched together from two photos



PROJECT NO.: 219075	EARTHTEC ENGINEERING	**FIGURE NO.:** 4b

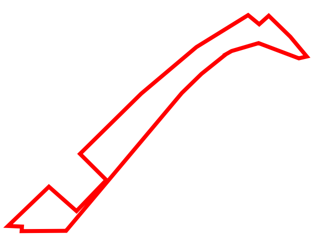
LIDAR IMAGE OF THE SUBJECT SITE AREA

LOT 29 SPRING OAKS - FRHS
1825 EAST CENTER STREET
SPRINGVILLE, UTAH

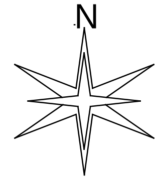


*Utah AGRC 1 Meter Bare Earth LiDAR DEM / DTM

Scale: 1 inch = 270 feet



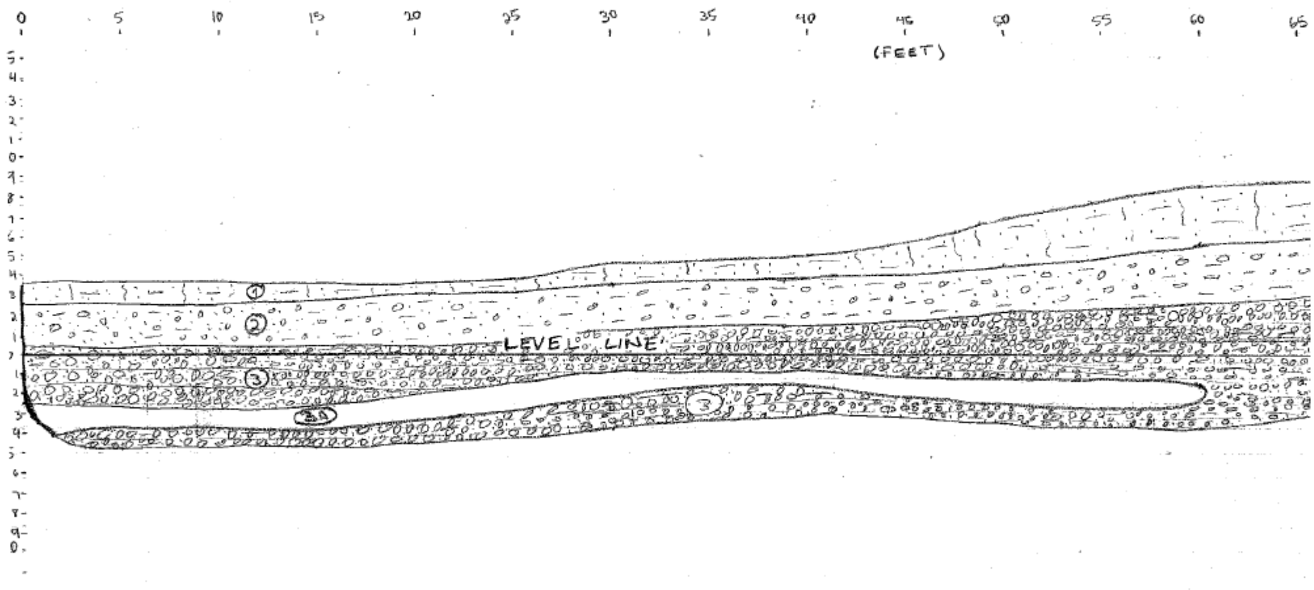
Site Location



Not to Scale

PROJECT NO.: 219026	Earthtec Engineering	FIGURE NO.: 5

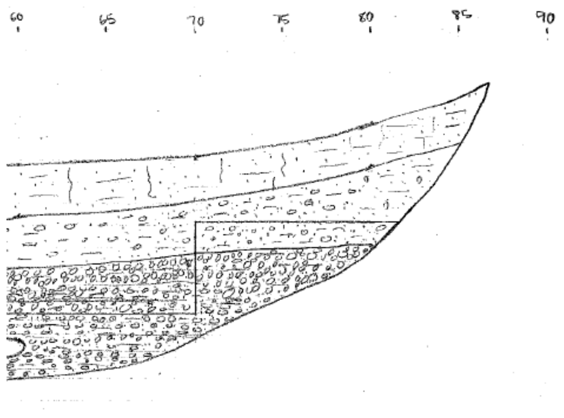
EXPLORATION TRENCH ET-1 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



Scale: 1 inch = 10 feet | Northeast Wall of Trench | Trend: N308°E

PROJECT NO.: 219075 | Earthtec Engineering | **FIGURE NO.: 6a**

EXPLORATION TRENCH ET-1 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



Scale: 1 inch = 10 feet

Northeast Wall of Trench

Trend: N308°E

PROJECT NO.: 219075

Earthtec Engineering

FIGURE NO.: 6b

EXPLORATION TRENCH ET-1 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND STTLEMENT CANYON ROAD
TOOELE, UTAH

Unit Descriptions

1) **Soil horizon A** – silty sand, brown, roots and organics, pinholes, low moisture

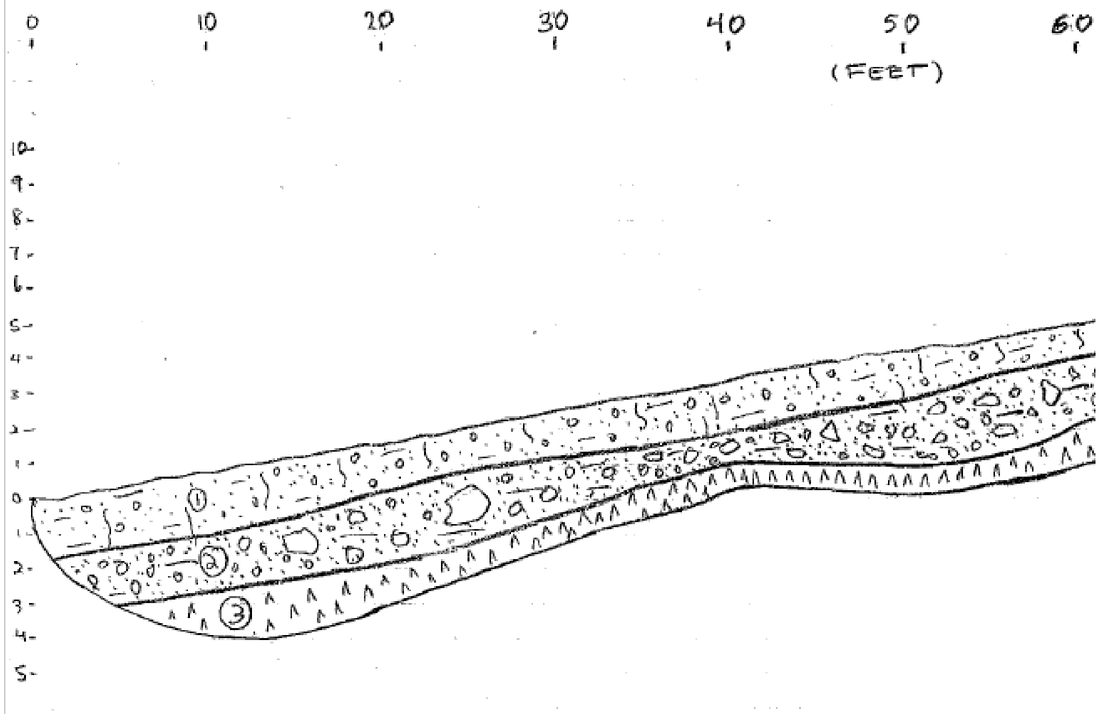
2) **Lake Bonneville Shoreline sand** – silty sand with gravel (SM), massive, sand matrix, 15% to 20% subangular to subrounded gravel, fine to coarse gravel, linear and mild calcite mottling, some roots diminished with depth, light brown to brown, very low moisture, poorly to moderately sorted, pinholes in fine sand pockets

3) **Alluvium Reworked by Lake Bonneville**– poorly graded gravel with silt and sand (GP-GM), massive, gravel matrix, laminar, very fine to coarse, subrounded to rounded gravel, fine to coarse sand, moderately to well sorted, tan to light brown, very low moisture

3A) **Lake Bonneville Near Shore** – poorly graded sand (SP), near shore very fine to fine sand, low energy environment, very well sorted, some ripple marks

PROJECT NO.: 219075	Earthtec Engineering	FIGURE NO.: 6c

EXPLORATION TRENCH ET-2 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



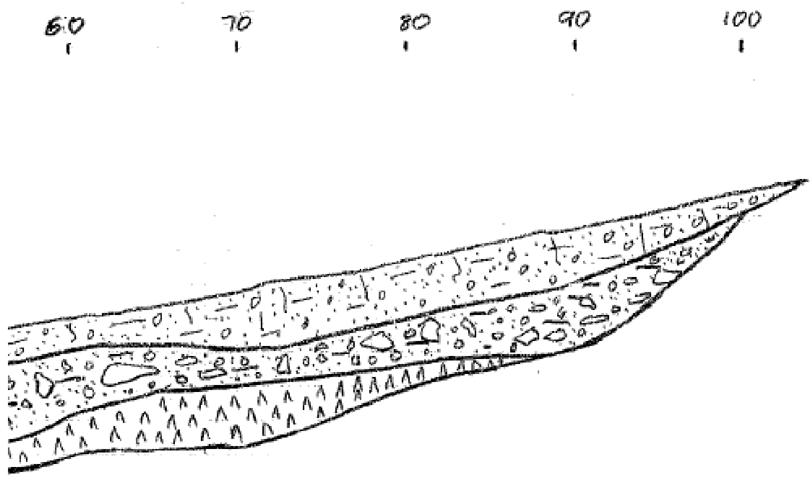
Scale: 1 inch = 10 feet

Northeast Wall of Trench

Trend: N326°E

PROJECT NO.: 219075	Earthtec Engineering	**FIGURE NO.: 7a**

EXPLORATION TRENCH ET-2 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



Scale: 1 inch = 10 feet

Northeast Wall of Trench

Trend: N326°E

PROJECT NO.: 219075

Earthtec Engineering

FIGURE NO.: 7b

EXPLORATION TRENCH ET-2 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND STTLEMENT CANYON ROAD
TOOELE, UTAH

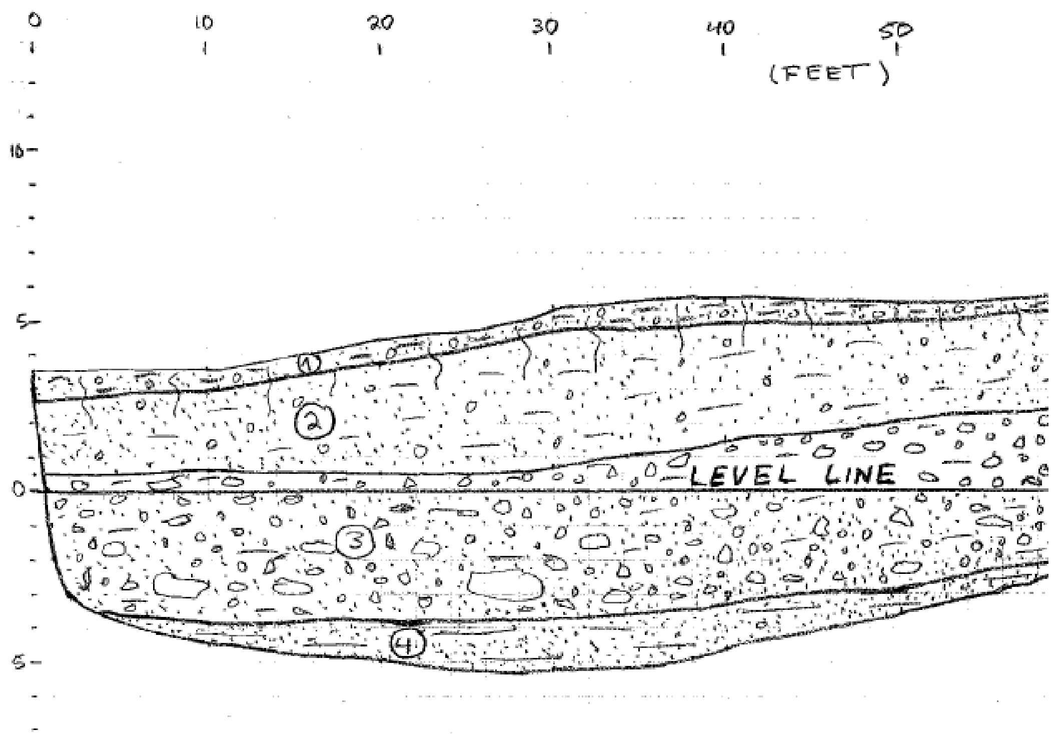
Unit Descriptions

1) **Soil horizon A** – silty sand with gravel, dark brown, roots and organics, pinholes, low moisture

2) **Colluvium** – poorly graded with gravel with sand, silt, cobble and boulder (GM), massive, medium to very coarse, subangular to subrounded gravel, massive, poorly sorted, approximately 75% clast, 25% soil, gravel and cobbles are mostly quartzite, some limestone, light brown to brown, roots diminishing with depth.

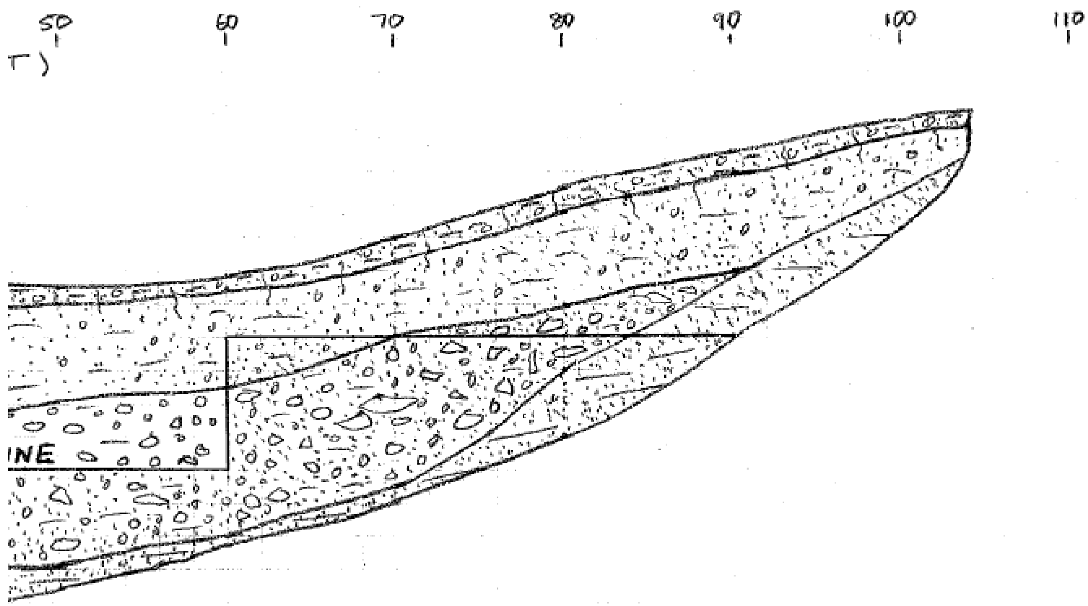
3) **Weathered Bedrock** – mainly quartzite, highly fractured, some calcite mottling on top, light tan to tan, difficult to determine the orientation.

EXPLORATION TRENCH ET-3 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



Scale: 1 inch = 10 feet | Northeast Wall of Trench | Trend: N329°E

EXPLORATION TRENCH ET-3 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND SETTLEMENT CANYON ROAD
TOOELE, UTAH



Scale: 1 inch = 10 feet

Northeast Wall of Trench

Trend: N329°E

PROJECT NO.: 219075

FIGURE NO.: 8b

EXPLORATION TRENCH ET-3 LOG
ONE O'CLOCK HILL - FRHS
UT-36 AND STTLEMENT CANYON ROAD
TOOELE, UTAH

Unit Descriptions

1) **Soil horizon A** – silty sand with gravel, dark brown, roots and organics, pinholes, low moisture

2) **Alluvium** – silty sand with gravel (SM), potentially reworked by Lake Bonneville activities, massive, 15%-20%, medium to very coarse, subangular to subrounded gravel, massive, poorly sorted, brown, roots diminishing with depth, very low moisture.

3) **Colluvium** – poorly graded with gravel with sand, silt, cobble and sparce boulder (GP-GM), massive, medium to very coarse, angular to subangular gravel with calcite mottling, 70% clast, 30% soil, massive, in sand matrix, moderately sorted, mostly limestone clasts, brown, roots diminishing with depth.

4) **Lacustrine Bonneville Sand (Qla)** – silty clayey sand (SC-SM), massive, some iron oxide stain, very well sorted, brown, moist.

APPENDIX A

Frank F. Namdar, P.G., E.I.T.

Utah DOPL – Professional Geologist 191486-2250

National Assessment Institute – Fundamentals of Engineering 1997

Work Experience-

Project Manager

Earthtec Engineering - Ogden, UT
August 2015 - Present
Geologist, Engineer-
*Prepared Geotechnical Investigation Reports
*Performed Geotechnical Investigations
*Performed Phase I & II Environmental Site Assessments
*Performed Geological Studies & Hazard Evaluations & reporting

Project Manager

Bingham Engineering, Inc. – Salt Lake City, UT
March 2003 - August 2015
Engineer, Geologist-
*Performed Phase I, II Environmental Site Assessments
*Performed Environmental Site Characterizations
*Performed Environmental Remedial Investigation
*Performed Remedial Actions
*Performed Geologic Hazard Studies
*Performed Geotechnical Studies
*Performed Environmental Sampling of indoor/outdoor Air, Soil, Surface and Ground Water
*Prepared Health & Safety Plans
*Performed Landfill Gas Testing
*Prepared NPDES Permit Compliance, reports, SWPPP, SPPP
*Performed Hazardous Materials Survey
*Performed Radiological Sampling, monitoring, Waste Characterizations, Human Health Risk Assessments, RI/FS, Remediations

Project Engineer

Summit Engineering Services – Salt Lake City, UT
March 2001 - February 2003
Engineer, Scientist
*Prepared environmental site assessment, subsurface investigation, quarterly monitoring reports, corrective action plan and feasibility studies on various remediation techniques related to underground storage tanks
*Operated and maintained groundwater and soil remediation systems related to USTs *Observed circular and H pile installation and performed
* Performed geotechnical analysis, design and recommendation, geological hazard evaluations and field explorations.

Project Engineer

Pentacore Resources – Salt Lake City, UT
August 2000 - March 2001
Engineer, Scientist

* Performed environmental engineering analysis, reports, research, field exploration and sampling, inspection, and AUTOCAD drawing for Phase I, Phase II, and RBCA projects
* Managed various environmental and Geotechnical projects
* Performed NPDES permit compliance, reports, site status monitoring reports and hazardous materials survey.
*Prepared Prepared NPDES Permit Compliance, reports, SWPPP, SPPP

Staff Engineer

Terracon – Salt Lake City, UT
May 1998 - August 2000
Engineer, Geologist

* Performed Geotechnical analysis, design and recommendations, geological hazard evaluations, field explorations, and laboratory testing for: commercial buildings along the Wasatch Front; Utilities and communication Towers in Utah, Idaho, and Wyoming; City, County and State Roads; Municipal Structures

Field Engineer

Maxim Technologies – Salt Lake City, UT
August 1993 - May 1998
Engineer, Geologist

*Performed Geotechnical analysis, soil design, field explorations, laboratory testing, and field construction inspections
*Prepared proposals and cost estimates and solicited potential clients for Geotechnical and construction inspections projects
* Performed environmental site assessments, groundwater modeling, field exploration, sampling, and UST removal and installations for various projects

Geologist

Airtech International, Inc. – Newport Beach, CA
October 1992 - December 1992
Environmental Geologist

* Prepared work plan for landfill soil gas sampling, and constructed test holes and monitoring wells for landfill soil gas and ground water sampling

Staff Engineer

Rogers & Associates Engineering Corporation – Salt Lake City, UT
January 1990 - December 1992
Environmental Engineer

*Performed ground water modeling, human health risk assessments
*Performed remediation investigations and feasibility studies

* Performed landfill performance assessments, and remediation and decommissioning for DOE, EPA and NRC projects
*Performed radiological monitoring and sampling to characterize NORM at a natural gas storage and distribution facility
*Performed site suitability and cost analysis, and possible subsurface geophysical options available for site evaluations for low level radioactive waste

<u>Geologist</u>

Sergent, Huskins, and Beckwidth– Salt Lake City, UT
March 1988 - December 1990
Geologist, Engineering Assistant
* Performed geological background documentation, map and aerial photograph research, geologic hazard evaluation, photogeologic study for Kern River Pipeline project. Performed geological mapping, field data and sample collection. Conducted various field and laboratory soils tests, inspected materials for construction projects and prepared daily and weekly reports.

Education-

University of Utah- Salt Lake City, UT
*Bachelor Degree – Geology 1990
University of Utah- Salt Lake City, UT
*Bachelor Degree – Geological Engineering 1992

1497 West 40 South
Lindon, Utah - 84042
Phone (801) 225-5711

840 West 1700 South #10
Salt Lake City, Utah - 84104
Phone (801) 787-9138

1596 W. 2650 S. #108
Ogden, Utah - 84401
Phone (801) 399-9516

November 16, 2021

Tooele 90 LLC
Attention: Mr. Shaun Johnson
6975 Union Park Ave., Ste 600
Cottonwood Heights, UT 84047

Re: Rockfall Hazard Evaluation
One O'clock Hill
Settlement Canyon Road and UT-36
Tooele, Utah
Job No: 219076

Gentlemen:

This letter summarizes the results of Earthtec Engineering's completed Rockfall Hazard Evaluation for the One O'clock Hill project in Tooele, Utah. The subject property is approximately 38 acres and is proposed to be developed with new single-family houses. See Figure No. 1, *Vicinity Map* for the location of the site.

Introduction

The subject site is undeveloped land that consist of three parcels. It is proposed for future development of new single-family houses. The subject site is included in the Utah Geological Survey (UGS) OFR-318[1], Plate 4H map, as a potential rockfall impact site (Appendix A). The steep slopes of Oquirrh Mountains to the south of the site are the subject of this study and these mountains trend from the southwest to the northeast. The geologic units at the site is mapped by Donald L. Clark, Charles G. Oviatt, and David A. Dinter[2] are presented in Figure 2, Geologic Map of the Site, and are described as the following:

Qafy **Younger fan alluvium, post-Lake Bonneville (Holocene to uppermost Pleistocene)** – Poorly sorted gravel, sand, silt, and clay; deposited by streams, debris flows, and flash floods on alluvial fans and in mountain valleys; merges with unit Qal; includes alluvium and colluvium in canyon and mountain valleys; may include areas of eolian deposits and lacustrine fine-grained deposits below the Bonneville shoreline; includes active and inactive fans younger than Lake Bonneville, but may also include some older deposits above the Bonneville shoreline.

Qmct **Colluvium and talus (Holocene to upper Pleistocene)** – Local accumulations of mixed colluvium and talus throughout the map area; common near Lake Bonneville shorelines; thickness up to 15 feet (5 m).

[1] Utah Geological Survey (UGS) open file report 318 Plate 4H: Rock-fall hazard and depth to ground water, Tooele quadrangle, Tooele County, Utah, 1995; Mapped by Kimm M. Harty and Bill D. Black

[2] Utah Geological Survey (UGS) open file report 284DM map: "Interim Geologic Map of the Tooele 30' x 60' Quadrangle, Tooele, Salt Lake, and Davis Counties, Utah, 2020, by Donald L. Clark, Charles G. Oviatt, and David A. Dinter.

Qla **Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene)** – Sand, gravel, silt, and clay; consist of alluvial deposits reworked by lakes, lacustrine deposits reworked by streams and slopewash, and alluvial and lacustrine deposits that cannot be readily differentiated at map scale.

Qafo **Older fan alluvium, pre-Lake Bonneville (upper to middle? Pleistocene)** – Poorly sorted gravel, sand, silt, and clay; similar to unit Qafy, but forms higher level incised deposits that predate Lake Bonneville; includes fan surfaces of different levels; fans are incised by younger alluvial deposits and locally etched by Lake Bonneville.

Tiqlp **Quartz latite porphyry dikes and sills (late to middle Eocene)** – Medium-brown and light-greenishgray, hornblende-biotite quartz latite porphyry; hornblende is altered to phlogopite and/or chlorite within the Bingham pit area; distinguished from other latitic dikes and sills by the presence of relatively large quartz phenocrysts and higher percentage of aphanitic groundmass; groundmass usually contains considerable hornblende (KUCC, 2009); includes Raddatz porphyry dikes with large K-feldspar phenocrysts (Settlement Canyon area) (see Krahulec, 2005; new geochemical data in Clark and Biek, 2017), and the Andy Dike and apophyses at Bingham mine (KUCC, 2009); 40Ar/39Ar ages of 37.66 ± 0.08 and 37.72 ± 0.09 Ma (Deino and Keith, 1997), and U-Pb zircon age of 37.97 ± 0.11 Ma (von Quadt and others, 2011); also forms some small dikes (unmapped) east of Pass Canyon and near North Oquirrh thrust (Swensen and others, 1991) with K-Ar age of 36.5 ± 1.1 Ma (Moore, 1973); Raddatz dike has 40Ar/39Ar age of 39.4 ± 0.34 Ma (Kennecott in Krahulec, 2005).

IPobmu **Oquirrh Group, Bingham Mine Formation, upper member (Upper Pennsylvanian, Virgilian-Missourian)** – Light gray to tan, thinly color-banded and locally cross-bedded quartzite with interbedded thin, light- to medium-gray calcareous, fine-grained sandstone, limestone, and siltstone.

Rock Fall Analysis Methodology

This rockfall study is focused on the west and middle parcel of the project (study area). The northeast parcel lacks evidence of past rockfalls and the source to present the potential for rockfalls at this time.

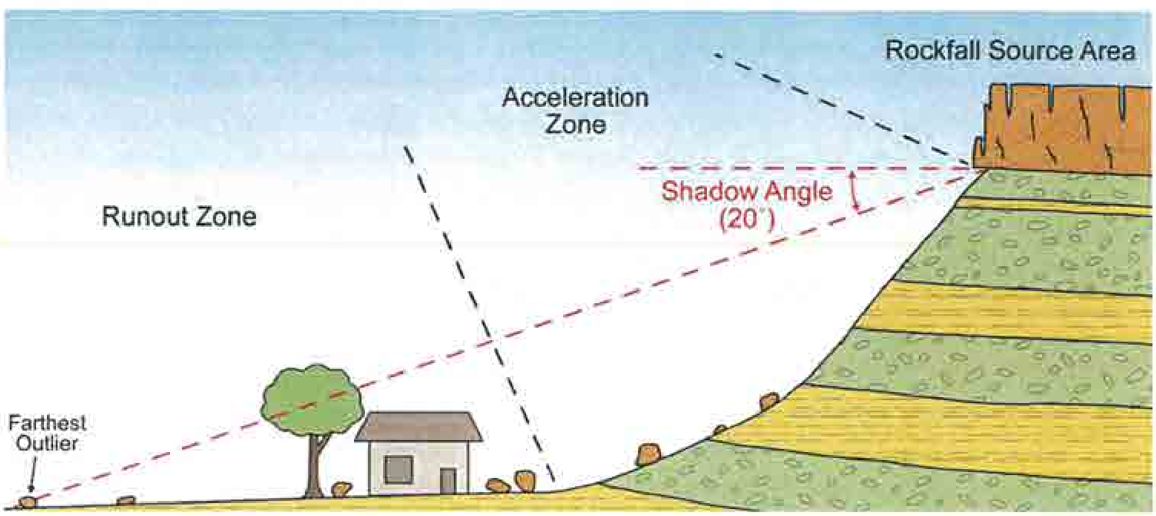
Iron County Code 17.59.030 (3) is being used for the rockfall analysis. Tooele County Code does not provide specific details for conducting a Rock Fall Study, this code was developed in conjunction with the State of Utah Geological Survey (UGS).

As described in Section 1.1 of Iron County Code 17.59.030 (3) for rockfall analysis:

Rock-fall geologic study areas are not mapped in Iron County at this time, but include locations at the base of rock and talus slopes that are susceptible to rock fall—evidence of past rock falls being the primary indictor. A twenty-two-degree shadow angle, extending from the base of the rock-fall source area, as depicted in the following diagram, shall be used to define the extent of a rock-fall geologic study area. (Note: Shadow angle is dependent on the type of rock involved, and the rock-fall hazard area determined by the geologist may be more or less than that captured by the twenty-two-degree shadow angle used to define the study area. However, twenty-two degrees is relatively conservative, and is deemed sufficient to capture most rock-fall hazard situations.)

A rock-fall geologic study area consists of three components: (1) a rock source, in general defined by bedrock geologic units that exhibit relatively consistent patterns of rock-fall susceptibility throughout the study area, (2) an acceleration zone, where rock fall debris detached from the source gain momentum as it travels downslope—this zone often includes a talus slope, which becomes less apparent with decreasing relative hazard and is typically absent where the hazard is low, and finally (3) a runout zone (rock-fall shadow zone), which includes gentler slopes where boulders have rolled or bounced beyond the base of the acceleration zone. (Lund, et al., 2008 in County Code 17.59.030 (3)).

Typical components of a rockfall path profile are presented below (modified from Lund, et al., 2008):



Prior to the start of field investigations, a search of available literature and maps were performed and the published geologic literature and maps relevant to the subject site were reviewed, with particular emphasis on information pertaining to the presence of known rockfall sources and the past history of the rockfalls at or near the subject site. The sources are referred to in this report.

Outcrop Evaluation
A professional geologist from Earthtec Engineering visited the site on October 18, 2021. Several areas of the site were observed to collect information regarding the presence of rockfall hazard

at the site, evidence of past rockfalls, surficial condition and topography of the site. The elevation at the peaks beyond the southeast boundary of the study area ranges from approximately 6,005 feet above sea level (ASL) at the peak of Two O'clock Hill and 5,844 feet ASL at the peak of One O'clock Hill, to approximately 5,200 feet ASL at the base of the mountains.

Several outcrops are visible on the steep slopes southeast of the study area. These outcrops have been mapped on the geologic map and have general northeast-southwest strike and dip 25 to 32 degrees to the northwest (Clark Oviatt, Dinter, 2017). The average slopes on the south portion of the study area and above are approximately 45-50% and consist of mostly fractured quartzite outcrops on the higher elevations (5500 feet to approximately 5,800 feet ASL). Large talus fields are observed across much of the northwest-facing slopes, including the entirety of One O'clock Hill and at elevations of 5,525 to 5,530 feet ASL on Two O'clock Hill. These quartzite taluses are generally angular with weathered surfaces and are less than 18-inches in diameter.

At the approximate high stand of Lake Bonneville elevation (5,200 feet ASL) colluvium, and at shallower portions alluvial sediments are observed. Below the elevation of approximately 5,200 feet ASL numerous boulders of up to 3 feet in diameter were observed. The boulders were comprised mainly of quartzite and were moderately weathered. The geologic unit named IPobmu appears to be the susceptible geologic unit and the source of the rockfall at the site and is evident in the outcrops. Some lichens were observed on most of the boulders. Boulders are concentrated at approximately 200 feet south of UT-36 on the surface of the alluvial field and along the slope of the mountains. Substantial soil deposits were present around the large boulders at the time of our investigation. The surface of the study area is generally covered moderately with grass, sage brush of up to 2 feet in height, and occasional short maple trees with maximum height of 10 feet. Outcrops on the slopes above the site contain boulders approximately 3 feet in diameter with some with soil deposits around them.

A shadow angle is the angle between a horizontal line and a line extending from the base of the rock source to the outer limit of the runout zone as defined by the farthest outlier rockfall debris at a site as shown in the figure above. A site-specific calculation of the shadow angles for One O'clock Hill and Two O'clock Hill were performed. For both, the shadow angle was calculated for outcroppings observed at approximately 5,620 feet ASL. The shadow angle for One O'clock Hill is 20 degrees. The shadow angle for Two O'clock Hill is 18 degrees. These angles are due to a consistently steep acceleration zone and an abruptly flat runout zone that reduces the extent of potential impacts to the development along UT-36.

For One O'clock Hill, the farthest outlier boulder was assumed to reach approximately 330 feet west of the Bonneville Shoreline, at approximately 5,185 feet ASL that appear to be at roughly the same elevation as the location of power line poles at the site. For Two O'clock Hill, the outer limits of the runout zone was assumed to be approximately 390 feet west of the Bonneville Shoreline, at approximately 5,167' ASL. These assumptions are made by observing the approximate location of the larger boulders that are found southeast of UT-36, their distribution, weathering, amount of soil deposited around the boulders and embedding, surface roughness and vegetation at the site. This also assumes undisturbed site conditions and is due to lack of available information regarding the age and frequency of existing boulders and lack of evidence of the farthest outlier clasts due to the development of the UT-36 and to the north of this highway. The location of this group of boulders, as they are lined up to south of the road, could also be the result of presence of Lake Bonneville as these clasts collide with the lake surface and dramatically reduce speed.

Rock Fall Analysis

This section documents the results of a rockfall analysis for the building areas presented in Figure No. 3, *Shadow Angle Determination*. Several outcrops are visible on both parcels. There are several talus fields below these outcrops. The property falls within the shadow angles of the outcrops.

Topographic (Figure No. 4, *Topographic and Shadow Angle Determination Location*) and visual analyses indicate that the likely trajectory for rock fall emanating from these outcrops would fall to the northwest of the hillslopes which will include the building areas along the southeast side of UT-36. The likelihood of rock fall emanating from these outcrops and impacts to the building areas is moderate as evidenced by the presence of boulders in those areas. While the likelihood of repeated rockfall that reach the development areas is low as evidenced by their age from weathering of some of the large boulders found southwest of the highway on the property, the risk of occasional boulder dislodge from the higher slopes above the site still exists.

Due to deep groundwater elevation, the groundwater does not impact the outcrops and does not contribute to the rockfall hazard at the subject site. The angular and planar nature of the rock fragments reduces the possibility of dislodged rocks from gaining momentum in acceleration zone. The potential for rockslide during an earthquake is also low to moderate due to shape of rock fragments and slope angle above the site, as most of the talus slopes appear to be stabilized by reaching a stable slope near the bottom of the mountains above the site, allowing at-rest position for these rock fragments at even 50% or higher grades. Vegetation established around the these talus slopes show that they are relatively old and currently stable. Slopewash is technically outside of the purview of a Rock Fall Analysis and is not described in the code; the slopes above the proposed building areas were evaluated in the geotechnical study in conjunction with this hazard evaluation. The amount of slopewash at the base of the slope in the relatively flat area of the site near the road is relatively low. This indicates that the slope has stabilized over time. Vegetation coverage on this slope is approximately 60% and includes sagebrush, grasses, and several patches of small maple trees. Presence of soil and vegetation produces surface roughness that reduces the potential of triggering a mass rockslide or dislodging other unstable boulders in the path.

According to Circular 1283 Utah Geological Survey 2020 Guidelines, Chapter 7: Guidelines for investigating geologic hazards and preparing engineering-geology reports:

Rockfall probability: A rockfall investigation, performed as described above, will establish the presence or absence of a rockfall hazard at a site and define a boundary beyond which the risk from future rockfalls is much reduced. However, determining (predicting) the exact timing of future rockfalls is not possible, and is not likely to become possible in the foreseeable future. As a general rule, the more rockfall debris on or at the base of a slope, the more frequent rockfalls are, and the higher the hazard. However, with sufficient data it is possible to estimate the probability

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[3] Lund, W.R., P.G., Knudsen, T. R., P.G., Guidelines for investigating geologic hazards and preparing engineering-geology reports, second edition; CHAPTER 7. GUIDELINES FOR EVALUATING ROCKFALL HAZARDS IN UTAH, Utah Geological Survey Circular 128, 2020

(x % chance in y years) of future rockfalls at a site. Conducting a probabilistic analysis requires information on both the number and timing of past rockfalls (Turner, 2012). Only a few areas in Utah have both a high rockfall hazard and a history of rockfall damage to structures to have produced a significant record of historical rockfalls. Rockville, Utah, is one such place, where six large rockfalls have occurred over the past 13 years (figure 48) (Knudsen, 2011; Lund and others, 2014), resulting in an average recurrence interval (average repeat time) for large rockfalls of 2.2 years. The annual probability of a large rockfall in Rockville based on the 13-year record is 46%. Three of the rockfalls struck and damaged inhabited structures, and one of the three caused two fatalities (figure 49). Such well-documented rockfall histories are rare, so in most instances, timing of past rockfalls must be determined by other means. In Yosemite National Park, Stock and others (2012a, 2012b) used cosmogenic beryllium-10 exposure ages to date the surfaces of rockfall boulders exposed to cosmogenic radiation for the first time following the rockfall. They integrated the number of identified rockfall events, rockfall timing data, and computer simulations of rockfall runout to develop a hazard boundary with a 10% probability of exceedance in 50 years for rockfall-susceptible areas of Yosemite Valley. Such detailed probabilistic rockfall-hazard investigations are costly both in terms of time and money and are beyond the scope of most rockfall investigations. However, a probabilistic rockfall investigation may be required when evaluating hazard and risk for high-value infrastructure or for areas of prolonged high human occupancy in rockfall-susceptible areas.

Rock Fall Mitigation

As noted in Circular 128 Utah Geological Survey 2020 Guidelines the Early recognition and avoidance of areas subject to rockfall are the most effective means of mitigating rockfall hazard.

Determining the boundary of the rockfall runout zone and siting all new buildings for human occupancy and IBC Risk Category II, III, and IV facilities (ICC, 2017a) outside that zone will substantially reduce rockfall risk. However, because the boundary of a rockfall runout zone seldom can be established with a high level of precision, the UGS recommends that structures for human occupancy or high-risk facilities be set back an appropriate distance from the runout-zone boundary to provide an additional factor of safety from rockfalls. Rockfall hazard is highly dependent on site geologic and topographic conditions; therefore, the UGS does not make a standard setback recommendation, but rather recommends that the engineering geologist in responsible charge of the rockfall investigation make and justify an appropriate setback based on the results of the site-specific hazard investigation. Where investigation results provide confidence in the runout-zone boundary, additional setback can be minimized. Where the boundary is uncertain, a larger setback is appropriate.

Many techniques are available to mitigate rockfall hazard. Rockfall mitigation is often conducted by specialized design-build manufacturers and/or contractors, often using proprietary techniques and/or materials. Circular 128 indicates that mitigation techniques include, but are not limited to:

- Rock stabilization by manually stabilizing rocks on the slopes above the site.
- Engineered structures to block the rocks that will typically dislodge during the spring-time in Utah due to freeze and thaw in the winter and rain in the spring.
- Modification of at-risk structures. In this case, built-in components in parking garage structures may be used as means of blockage.

Rock-stabilization methods are physical means of reducing the hazard at its source using rock bolts and anchors, steel mesh, scaling, or shotcrete on susceptible outcrops. Engineered catchment or deflection structures such as rockfall fences, berms, swales, or benches can be placed below source areas, or at-risk structures themselves can be designed to stop, deflect, retard, or retain falling rocks. Such methods, however, may increase rockfall hazard if not properly designed and maintained. Detailed information on rockfall mitigation techniques is given in "Part 3: Rockfall Mitigation" of *Rockfall Characterization and Control* (Turner and Schuster, 2012).

General Conditions

The information presented in this letter applies only to the study area defined earlier, on the subject site. It should be noted that site grading activities and changes in conditions at the site such as vibration and other man-made or natural events may produce higher hazard risks. The observations and recommendations presented in this letter were conducted within the limits prescribed by our client, with the usual thoroughness and competence of the engineering profession in this area at this time. No warranty or representation is intended in our proposals, contracts, reports, or letters.

Closure

We appreciate the opportunity of providing our services on this project. If we can answer questions or be of further service, please call.

Respectfully;
EARTHTEC ENGINEERING

LICENSED PROFESSIONAL GEOLOGIST
FARHANG F. NAMDAR
191486-2250
11/16/2021
STATE OF UTAH

Michael S. Schedel
Staff Geologist

Frank N. Namdar, P.G., E.I.T.
Project Geologist

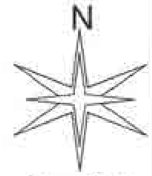
FN/ms

Attached:

Figure No. 1 *Vicinity Map*
Figure No. 2 *Geologic Map*
Figure No. 3 *Shadow Angle Determination*
Figure No. 4 *Topographic Map-Shadow Angle Determination Locations*

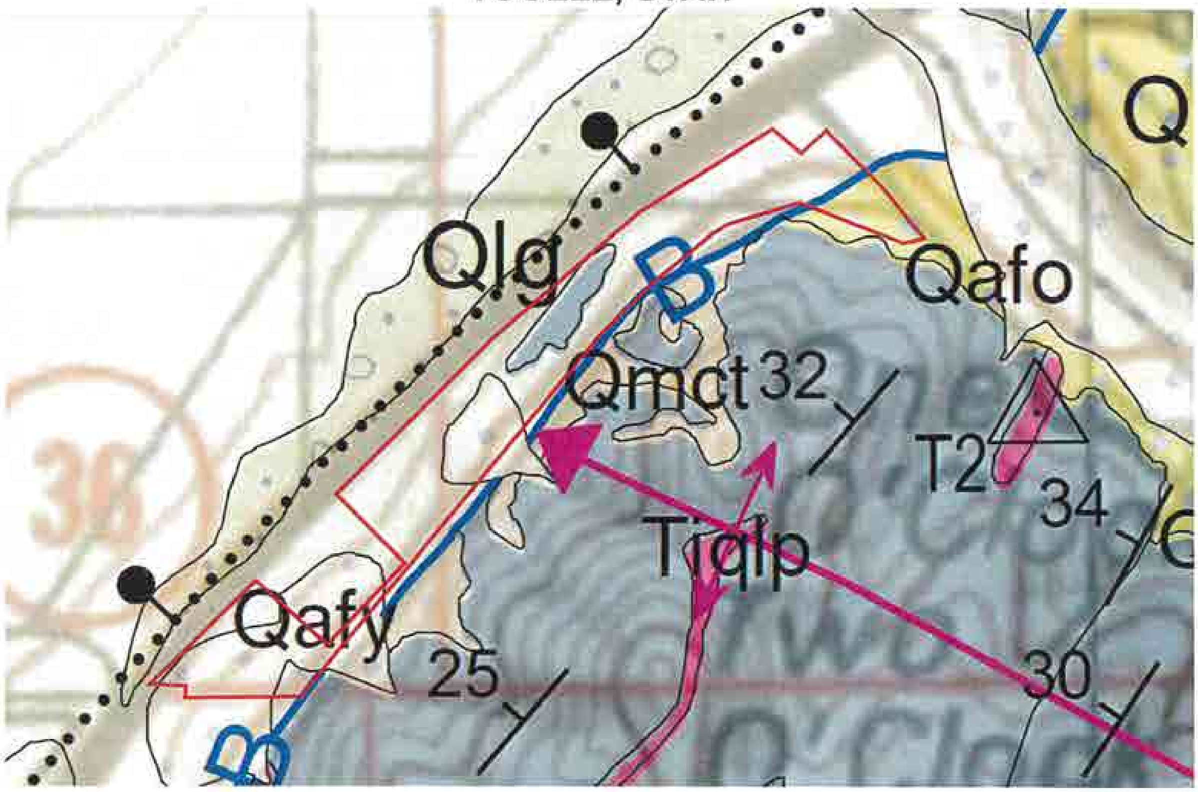
Appendix A Utah Geological Survey (UGS) OFR-318, Plate 4H map

VICINITY MAP
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAD AND UT-36
TOOELE, UTAH



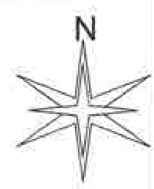
PROJECT NO.: 219076		**FIGURE NO.:** 1

GEOLOGIC MAP
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAN AND UT-36
TOOELE, UTAH



Utah Geological Survey (UGS) open file report 669 map: "Interim Geologic Map of the Tooele 30' x 60' Quadrangle, Tooele, Salt Lake, and Davis Counties, Utah, 2017, by Donald L. Clark, Charles G. Oviatt, and David A. Dinter.

IPobmu	**Oquirrh Group, Bingham Mine Formation, upper member (Upper Pennsylvanian, Virgilian-Missourian)** – Light-gray to tan, thinly color-banded and locally cross-bedded quartzite with interbedded thin, light- to medium-gray, calcareous, fine-grained sandstone, limestone, and siltstone; several of the thin calcareous units are locally important as marker beds; upper-lower member contact is placed at base of the Manefay limestone marker bed; unit is very similar to the lower member above the Commercial Limestone (Swensen, 1975); Virgilian and Missourian fusulinids (Triticites) are reported from the Markham Peak section (R.C. Douglass in Tooker and Roberts, 1970), and Welsh and James (1961) reported a Virgilian and Missourian age for the entire formation; 2200 feet (670 m) thick at the Bingham district (Swensen, 1975).
Tiqlp	**Quartz latite porphyry dikes and sills (late to middle Eocene)** – Medium-brown and light-greenish-gray, hornblendebiotite quartz latite porphyry; hornblende is altered to phlogopite and/or chlorite within the Bingham pit area; distinguished from other latitic dikes and sills by the presence of relatively large quartz phenocrysts and higher percentage of aphanitic groundmass; groundmass usually contains considerable hornblende (KUCC, 2009); includes Raddatz porphyry dikes with large K-feldspar phenocrysts (Settlement Canyon area) (see Krahulec, 2005; new geochemical data in Clark and Biek, 2017), and the Andy Dike and apophyses at Bingham mine (KUCC, 2009); 40Ar/39Ar ages of 37.66 ± 0.08 and 37.72 ± 0.09 Ma (Deino and Keith, 1997), and U-Pb zircon age of 37.97 ± 0.11 Ma (von Quadt and others, 2011); also forms some small dikes (unmapped) east of Pass Canyon and near North Oquirrh thrust (Swensen and Kennecott staff, 1991) with K-Ar age of 36.5 ± 1.1 Ma (Moore, 1973); Raddatz dike has 40Ar/39Ar age of 39.4 ± 0.34 Ma (Kennecott, unpublished age in Krahulec, 2005).

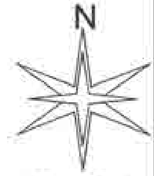


Not to Scale

PROJECT NO.: 219076	EARTHTEC ENGINEERING	**FIGURE NO.:** 2a

GEOLOGIC MAP
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAN AND UT-36
TOOELE, UTAH

Qafy	**Younger fan alluvium, post-Lake Bonneville (Holocene)** -- Poorly sorted gravel with sand, silt, and clay; deposited by streams, debris flows, and flash floods on alluvial fans and in mountain valleys; merges with unit Qal; includes alluvium and colluvium in canyon and mountain valleys; may include small areas of eolian deposits and lacustrine fine-grained deposits below the Bonneville shoreline; includes active and inactive fans younger than Lake Bonneville, but may also include some older deposits above the Bonneville shoreline; locally, unit Qafy spreads out on lake terraces and, due to limitations of map scale, is shown to abut Lake Bonneville shorelines; Qafy also drapes over, but does not completely conceal shorelines; thickness variable, to 50 feet (15 m) or more.
Qafo	**Older fan alluvium, syn- and pre-Lake Bonneville (upper to middle? Pleistocene)** -- Poorly sorted gravel with sand, silt, and clay; forms higher level deposits that are coeval with and predate Lake Bonneville; includes fan surfaces of different levels; fans are incised by younger alluvial deposits and locally etched by Lake Bonneville; may locally include small areas of lacustrine or eolian deposits, and younger alluvium; thickness variable, to 100 feet (30 m) or more.
Qlg	**Lacustrine gravel (Holocene to upper Pleistocene)** – Sandy gravel to boulders composed of locally derived rock fragments deposited in shore zones of Great Salt Lake and Lake Bonneville; clasts are typically well rounded and sorted; locally tufa-cemented (especially the Provo shoreline, figure 2) and draped on bedrock; thickness variable, to 100 feet (30 m) or more.
Qla	**Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene)** -- Unconsolidated deposits of sand, gravel, silt, and clay; consist of lacustrine deposits reworked by streams and slopewash, alluvial deposits reworked by lakes, and alluvial and lacustrine deposits that cannot be readily differentiated at map scale, thickness locally exceeds 30 feet (10 m).
Qmct	**Colluvium and Talus (Holocene to Upper Pleistocene)** – Local accumulations of mixed colluvium and talus throughout the maps area; common near Lake Bonneville shorelines; thickness up to 15 ft (5 m).



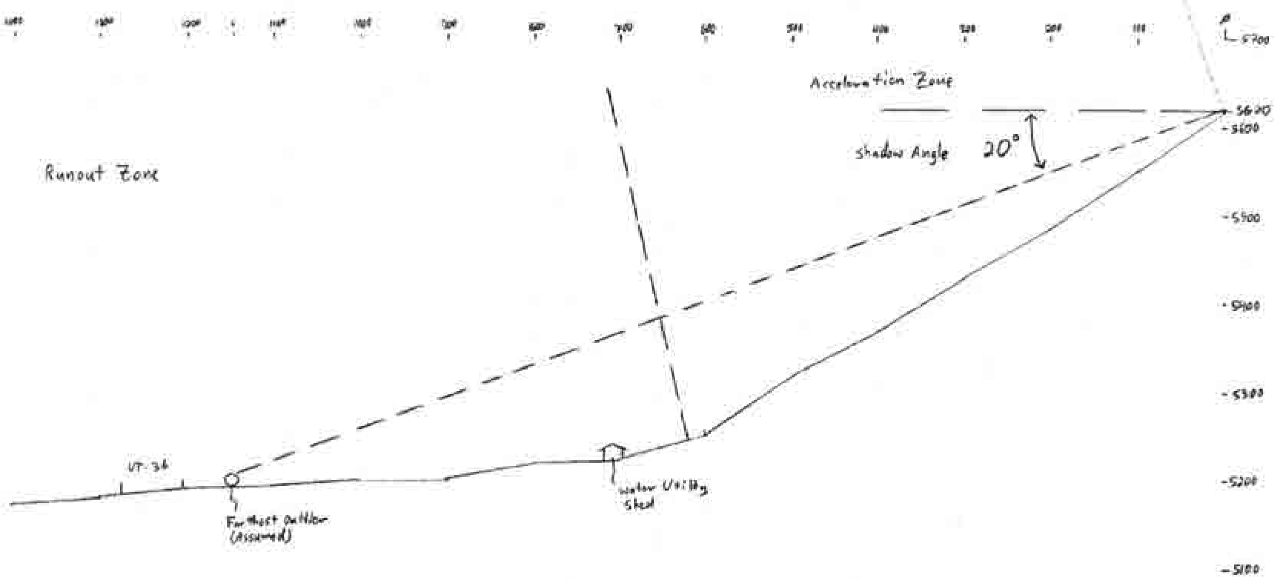
Not to Scale

PROJECT NO.: 219076

EARTHTEC ENGINEERING

FIGURE NO.: 2b

SHADOW ANGLE DETERMINATION
ONE O'CLOCK HILL
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAD AND UT-36
TOOELE, UTAH



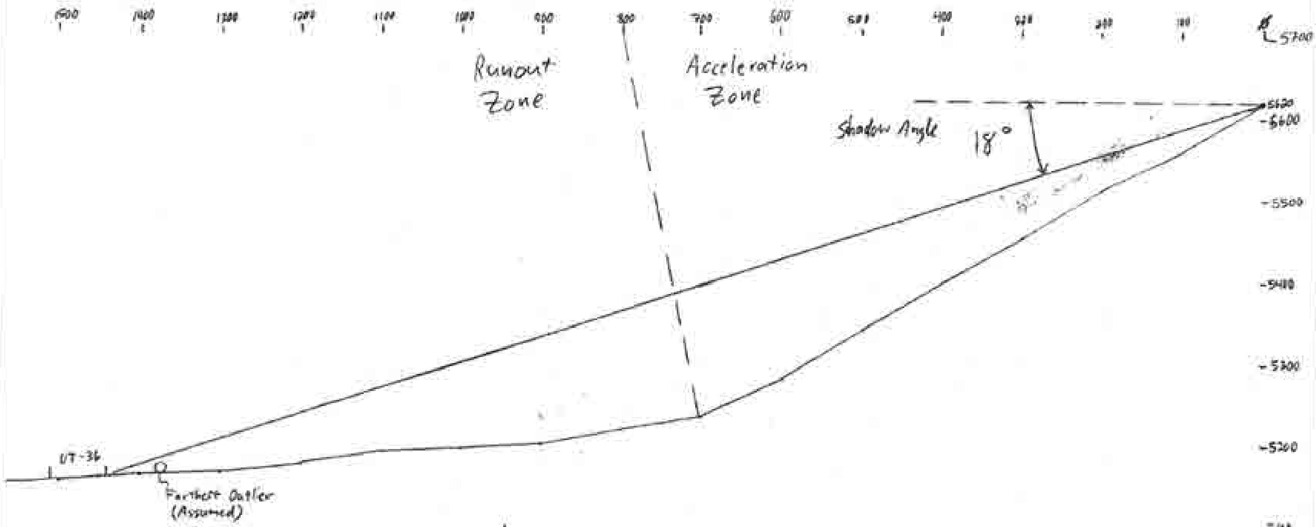
One O'clock Hill Shadow Angle

N

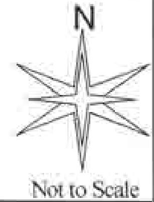
Not to Scale

PROJECT NO.: 219076		FIGURE NO.: 3a

SHADOW ANGLE DETERMINATION
TWO O'CLOCK HILL
ONE O'CLOCK HILL
SETTLEMENT CANYON ROAD AND UT-36
TOOELE, UTAH



Two O'clock Hill Shadow Angle



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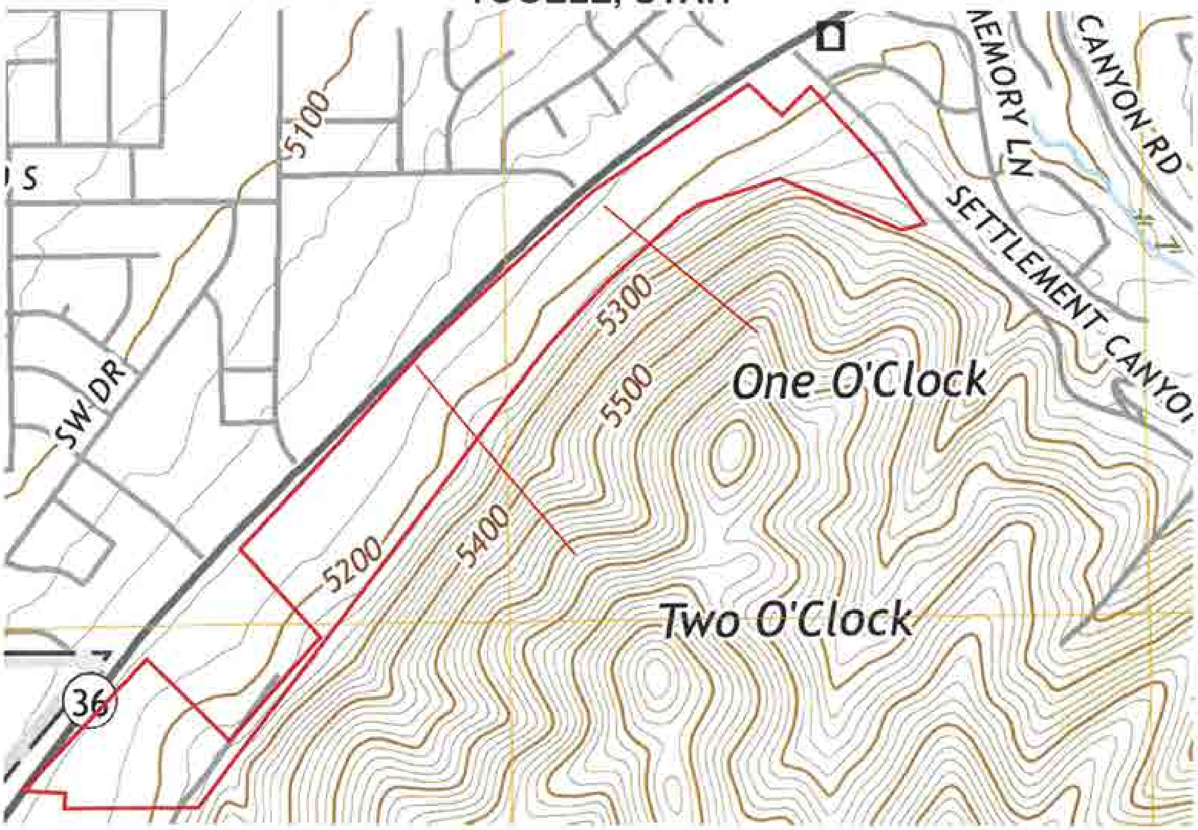
PROJECT NO.: 219076	EARTHTEC ENGINEERING	**FIGURE NO.:** 3b

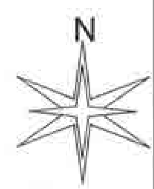
TOPOGRAPHIC MAP-SHADOW ANGLE DETERMINATION LOCATIONS

ONE O'CLOCK HILL
SETTLEMENT CANYON ROAD AND UT-36
TOOELE, UTAH



Utah AGRC Topographic Map

Shadow Angle Determination location



PROJECT NO.: 219076		**FIGURE NO.:** 4

APPENDIX A

ROCKY MOUNTAIN POWER
A PACIFICORP COMPANY

October 12, 2021

Shaun Johnson
SJ Company

Dear Mr. Johnson,

I am writing this letter to confirm our discussions about developing the One O Clock Hill subdivision in Tooele, Utah. Rocky Mountain Power is ok with placing the existing power line in the future park strip using the road and front yard setbacks as the 50 foot wide easement. On the northeast end of the development we would require a 50 foot right of way between the houses or re-align the road to make it part of the park strip also.

If I can be of further assistance feel free to contact me at (801) 220-2212.

Thank You,

Scott C. Burton
Sr. Project Sponsor
Rocky Mountain Power

CIVIL ENGINEERING
11038 N Highland Blvd
Suite 400
Highland Ut, 84003
office (801) 492-1277
cell (801) 616-1677
ken@bergcivil.com

Nov 29th, 2021

To: Tooele City Council

Re: One O'Clock Hill Development

Project Location: UT-36 and Settlement Canyon

Applicant: Tooele 90 LLC

Request: Approval of a Zoning Map Amendment to remove the Sensitive Area Overlay to portions of the proposed development.

Sensitive Areas Overlay

(1) The purpose of the Sensitive Area Overlay is to provide regulatory standards, guidelines, and criteria having the effect of minimizing flooding, erosion, destruction of natural plant and wildlife habitat, alteration of natural drainages, and other environmental hazards, and protecting the natural scenic character of the hillside and mountain areas. In support of this purpose and intent, this overlay recognizes the importance of the unique hillside and mountain areas of Tooele City to the scenic character, heritage, history, and identity of Tooele City and of adjoining areas of unincorporated Tooele County. In support of this purpose and intent, Tooele City finds that it is in the public interest to regulate the development of sensitive areas in a manner so as to minimize the adverse impacts of development on scenic open spaces and on sensitive or vulnerable organic and inorganic systems. (7-12-2.1)

(2) The standards, guidelines, and criteria established by the overlay are intended to support the purpose and intent of the overlay by working to accomplish the following:

a. To protect the public from the natural hazards of storm water runoff, erosion, and landslides. (7-12-2.2)

i. **APPLICANT RESPONSE**

1. **Storm Water Runoff –** All future development of the subject property is required to comply with city standards to construct facilities to convey and detain the runoff generated from a 25-year storm event with an outflow at a maximum of 0.2 cfs/ac. Additional requirements are to *1) construct facilities to divert surface water away from cut faces or sloping surfaces of fill. 2) protect natural drainage ways. 3) construction of detention basins to minimize peak flows.*

2. **Erosion –** All future development of the subject property is required to comply with city standards to construct facilities to minimized erosion as follows: *1) Construction of the development site to minimize disturbance during the wet times of the year – between Oct 15 and Mar 15. 2) Installation of erosion control measures and best management practices during construction to minimize erosion at the source.*

3. **Landslides, Rockfall Hazard, & Faults**– a Geotechnical Study of the subject property has prepared by Earthtec Engineering (see Appendix for full report). As part of the study, a slope stability analysis was performed for both the static and seismic conditions.

   The results indicated that the slope configuration at the proposed lot analyzed is stable under both modeled conditions.

   All future development of the subject property is required to comply with the recommendations of the geotechnical report with states: *1) if unretained cuts greater than 6 feet on the slope area are planned or retainage walls are required, we recommend that further analysis of the slope be performed.*

   A Rockfall Hazard Evaluation was performed by Earthtec Engineering to determine the hazard level. The report states *"The likelihood of rock fall emanating from these outcrops and impacts to the building area is* ***moderate*** *as evidenced by the presence of boulders in those areas. While the likelihood of repeated rockfall that reach the development areas is* ***low*** *as evidenced in their age from weathering of some of the large boulders found just south of the road on the property, the risk of an occasional boulder dislodge from the higher slopes above the site still exists."*

   The Surface Fault Rupture Hazard Study was performed by Earthtec to reviewed potential for active faulting and related earthquakes are present for the subject property. The report states *"Based on our observations and analyses, the area to be suitable for the planned construction from a surface fault rupture hazards perspective, provided the recommendations presented in this report are carefully followed and implemented. We recommend observing all footing excavations prior to installing the concrete footing forms, to verify that no surface rupture faults are located below the planned foundation."*

   Refer to Figure 3 that shows the Fault Trenches and setback line for buildable areas.

Recommendations

The geotechnical studies that have been performed for the proposed areas for development support the proposed zone change request to remove the Sensitive Area Overlay to the portion of the property to be developed.

Conclusion

I have reviewed these studies and the recommendations provided. The additional requirements can be included in the proposed development and site layout to mitigate the hazards detailed in the geotechnical studies. Additional plans, details and studies will be provided to the city for review as part of the Subdivision process.

Respectfully,

Ken R. Berg, PE

APPENDIX

Geotechnical Study – Earthtec Engineering Project No. 219074

Surface Fault Rupture Hazard Study - Earthtec Engineering Project No. 219075

Rockfall Hazard Evaluation - Earthtec Engineering Project No. 219076