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Geotechnical Study
Fenster Phase 3 Subdivision
5500 West 560 North
Weber County, Utah

Project No. 187071

October 24, 2018

Prepared For:

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

ATTACHED FIGURES

APPENDIX A

1.0 EXECUTIVE SUMMARY

This entire report presents the results of Earthtec Engineering's completed geotechnical study for the Fenster Phase 3 Subdivision in Weber County, Utah. This executive 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 subject property is approximately 17 acres and is proposed to be subdivided to 13 residential lots. The proposed structures will consist of conventionally framed and one- to two-story, slab-on-grade buildings. We anticipate foundation loads for the proposed structures will not exceed 5,000 pounds per linear foot for bearing wall, 20,000 pounds for column loads, and 100 pounds per square foot for floor slabs. (see Section 3)
- Our field exploration included one (1) boring and six (6) test pits to depths of 8 to 51½ feet below the existing ground surface. Groundwater was encountered at depths of approximately 6 feet below the existing ground surface. (see Section 5)
- The native clay soils have a negligible potential for expansion (heave) and a slight potential for compressibility under increased moisture contents and anticipated load conditions. (see Section 6)
- The subsurface soils encountered generally consisted of topsoil overlying near-surface soft to very stiff clay and loose to dense sand. All topsoil should be removed beneath the entire building footprints, exterior flatwork, and pavements prior to construction. (see Section 7)
- The silty clay and sand layers between depths of 20 to 36 feet have a "High" potential for liquefaction during a moderate to large earthquake event; should these layers liquefy, we estimate that up to 7 inches of liquefaction-induced settlement and up to one foot of liquefaction-induced lateral movements could occur. (see Section 9).
- Conventional strip and spread footings may be used to support the structures, with foundations placed entirely on a minimum of 18 inches of properly placed, compacted, and tested structural fill extending to undisturbed native soils. (see Section 10)
- Minimum roadway section consists of 3 inches of asphalt over 8 inches of road-base. Areas that are soft or deflect under construction traffic should be removed and replaced with granular material or structural fill. (see Section 13)

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 5500 West 560 North in Weber County, Utah. The general location of the site is shown on Figure No. 1, *Vicinity Map* and Figure No. 2, *Aerial Photograph Showing Location of Boring and Test Pits*, 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. Kenny Palmer of Lakeview Farms 1, LLC, consists of developing the approximately 17-acre existing parcel into 13 residential lots. The proposed structures will consist of conventionally framed and one- to two-story, slab-on-grade buildings. We have based our recommendations in this report that anticipated foundation loads for the proposed structures will not exceed 5,000 pounds per linear foot for bearing wall, 20,000 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, and sidewalks, 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 was an undeveloped agricultural field vegetated with residual grass from a recent harvest. We observed a dirt road and an irrigation ditch at the time of field exploration. The ground surface appears to be relatively flat, we anticipate less than 3 feet of cut and fill may be required for site grading. The lot was bounded on the north and south by agricultural fields, on the east by the Weber River, and on the west by residential lots of Fenster Phases 1 and 2 subdivisions.

4.2 Geologic Setting

The subject property is located near the eastern shore of the Great Salt Lake in a valley between the Great Salt Lake Basin and the Wasatch Mountain Range. The valley and Great Salt Lake Basin were formed by extensional tectonics during the Tertiary and Quaternary geologic periods. The valley and Great Salt Lake Basin, and much of western Utah, were previously covered by Lake Bonneville, a large, Pleistocene age, fresh water lake that reached a high-stand surface elevation of approximately 5,170 feet above sea level. The Great Salt Lake is a remnant of Lake Bonneville. The valleys and lake basin to the west of the Wasatch Range have been partially filled with several thousand feet of lake (lacustrine) sediment during Lake Bonneville time, and post-Bonneville (Holocene) deltaic, lacustrine, alluvial, and colluvial deposits. The Wasatch Mountains to the east of the subject property are comprised of the early Proterozoic Farmington Canyon Complex consisting primarily of schist and gneiss. The surficial geology at the location of the subject site has been mapped as “Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene) – Sand, silt, clay, and gravel in channels, flood plains, and terraces typically less than 16 feet (5 m) above river and stream level” by Adolph Yonkee and Mike Lowe (2016)[1].

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 18 and 19, 2018 by the boring of one (1) boring and the excavation of six (6) test pits to depths of 8 to 51½ feet below the existing ground surface using a a truck-mounted hydraulic drill rig and a rubber-tire backhoe. The approximate locations of the boring and the excavation of six (6) test pit are shown on Figure No. 2, *Aerial Photograph Showing Location of Boring and Test Pits*. Graphical representations and detailed descriptions of the soils encountered are shown on Figure Nos. 3 through 9, *Boring and Test Pit*

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[1] Utah Geological Survey OFR 653: Interim geologic map of the Ogden 30' x 60' quadrangle, Weber, Box Elder, Cache, Davis, Morgan, Rich, and Summit Counties, Utah, and Uinta County, Wyoming by James C. Coogan and Jon K. King 2016.

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. 10, *Legend*.

Samples of the subsurface soils were collected in the borings at depth intervals of approximately 2½ to 5 feet. Relatively undisturbed samples were collected by pushing thin-walled “Shelby” tubes into undisturbed soils below the augers. Disturbed samples were collected with a 1⅜ inch inside diameter split spoon sampler. The split spoon sampler was driven 18 inches into undisturbed soil with a 140-pound hammer free-falling through a distance of 30 inches. The blows required to drive the sampler through the final 12 inches of penetration is called the “N-value” or “blow count,” and is recorded as “blows per foot” on the attached boring logs at the respective sample depths. The blow count provides a reasonable indication of the in-place relative density of sandy soils but provides only a limited indication of the relative stiffness of cohesive (clayey) materials, since the penetration resistance for these soils is a function of the moisture content.

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 Ogden, 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 content, dry density test, liquid and plastic limits determinations, mechanical (partial) gradation analyses, and one-dimensional consolidation tests. The table below summarizes the laboratory test results, which are also included on the attached *Boring and Test Pit Logs* at the respective sample depths, on Figure Nos. 3 through 9, *Consolidation-Swell Test,* on Figure No. 11 and 12.

Table 1: Laboratory Test Results

Boring and Test Pit No.	Depth (ft.)	Natural Moisture (%)	Natural Dry Density (pcf)	Atterberg Limits		Grain Size Distribution (%)			Soil Type
				Liquid Limit	Plasticity Index	Gravel (+ #4)	Sand	Silt/Clay (- #200)	
B-1	5	16	---	33	11	0	31	69	CL
B-1	20	27	---	---	---	0	99	1	SP
B-1	35	---	---	24	5	---	---	---	CL-ML
TP-1	6	---	---	34	12	---	---	---	CL
TP-2	8	28	99	52	26	0	2	98	CH
TP-3	6	15	---	---	---	0	54	46	SM
TP-4	8	---	---	23	4	---	---	---	CL-ML
TP-5	6	21	100	41	18	0	16	84	CL

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

A laboratory water-soluble sulfate test was performed on a representative sample obtained during our field exploration. Water soluble sulfate testing indicated a value of 166 parts per million. Based on this result, the risk of sulfate attack to concrete appears to be “moderate” according to American Concrete Institute standards. Therefore, we recommend that Type II Portland cement 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 one foot in depth at the boring and test pit locations. Below the fill we encountered layers of clay, silt, and sand extending to depths of 8 to 51½ feet below the existing ground surface. Graphical representations and detailed descriptions of the soils encountered are shown on Figure Nos. 3 through 9, *Boring and Test Pit Log* at the end of this report. Based on the blow counts obtained and our experience and observations during field exploration, the clay and silt soils ranged from soft to very stiff in consistency and the sand soils visually had a relative density varying from loose to dense.

It should be considered that small diameter soil borings were used during the course of our subsurface exploration. Variation in topsoil depths may occur at the site.

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7.2 Groundwater Conditions

Groundwater was encountered at depths of approximately 6 feet below the existing ground surface. 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, 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 C soils.

8.3 Fill Material Composition

The native soils are not suitable for use as placed and compacted structural fill. Excavated soils, including clay and silt, may be stockpiled for use as fill in landscape areas.

Structural fill is defined as fill material that will ultimately be subjected to any kind of structural loading, such as those imposed by footings, floor slabs, pavements, etc. We recommend that a professional engineer or geologist verify that the structural fill to be used on this project meets

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

the requirements, stated below. We recommend that structural fill consist of imported sandy/gravelly soils meeting the following requirements in the table below:

Table 2: 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

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. Note that most local governments and utility companies require Type A-1-a or A-1-b (AASHTO classification) soils (which overall is stricter than our recommendations for structural fill) be used as backfill above utilities in certain areas. In other areas or situations, utility trenches may be backfilled with the native soil, but the contractor should be aware that native clay and silt soils (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. All backfill soil should have a maximum particle size of 4 inches, a maximum Liquid Limit of 35 and a maximum Plasticity Index of 15.

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

Table 3: 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

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%
• Greater than 5 feet 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 layers of clay and silt 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 residential structures should be designed in accordance with the 2015 International Residential Code (IRC). The IRC designates this area as a seismic design class D_1.

The site is located at approximately 41.269 degrees latitude and -112.107 degrees longitude from the approximate center of the site. The IRC site value for this property is 0.820g. The design spectral response acceleration parameters are given below.

Table 4: Design Acceleration for Short Period

S_S	F_a	Site Value (S_{DS})
		2/3 S_S*F_a
1.211g	1.015	0.820g

S_S = Mapped spectral acceleration for short periods
F_a = Site coefficient from Table 1613.3.3(1)
$S_{DS} = ⅔S_{MS} = ⅔ (F_a \cdot S_s)$ = 5% damped design spectral response acceleration for short periods

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 or immediately adjacent to the site and the site is not located within local fault study zones. The nearest mapped fault trace is the Wasatch Fault located about 8 miles east of the site.

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[3] U.S. Geological Survey, Quaternary Fault and Fold Database of the United States, November 3, 2010

9.3 Liquefaction Potential

According to current liquefaction maps[4] for Weber County, the site is located within an area designated as "High" 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. As part of this study and a separate geotechnical study for Fenster Phase 2, the potential for liquefaction to occur in the soils we encountered was assessed using Youd *et al*[5] and Boulanger & Idriss[6]. A 50-foot boring (B-1), as shown in Figure 2, was drilled to aid with estimating potential liquefaction-induced movements were evaluated using Tokimatsu & Seed[7] and Youd, Hansen & Bartlett[8].

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 were composed of clay, silt and sand soils. Our analysis indicates that approximately up to 7 inches of liquefaction-induced settlement and possibly up to one foot of lateral spreading could occur in the vicinity of B-1 during a moderate to large earthquake event. The liquefaction potential at the site can be mitigated using one of the following alternatives:

- Densify the liquefiable soils by installing aggregate piers on a grid pattern below the building and extending at least 5 feet beyond the perimeter footings.
- Densify the liquefiable soils by installing grouted columns in a grid pattern below the building and extending at least 5 feet beyond the perimeter footings.
- Connect/tie all footings together using reinforced grade beams and connect reinforced slabs to the footings so that the building will react as a cohesive unit. This may result in some tilting of the building due to differential liquefaction-induced movements. The building may also move laterally due to lateral spreading.

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

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[4] Utah Geological Survey, Liquefaction-Potential Map for a Part of Weber County, Utah, Public Information Series 28, August 1994

[5] Youd, T.L. (Chair), Idriss, I.M. (Co-Chair), and 20 other authors, 2001, Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, October 2001, p. 817-833.

[6] Boulanger, R.W. and Idriss, I.M., 2006, Liquefaction Susceptibility Criteria for Silts and Clays, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, November 2006, p. 1413-1426.

[7] Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlements in Sands due to Earthquake Shaking, Journal of Geotechnical Engineering, ASCE, p. 861-878.

[8] Youd, T.L., Hansen, C.M. and Bartlett, S.F., 2002, Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, December 2002, p. 1007-1017.

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 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 a minimum of 18 inches of properly placed, compacted, and tested structural fill extending to undisturbed native soils. For foundation design we recommend the following:

- Footings founded on a minimum of 18 inches of structural fill may be designed using a maximum allowable bearing capacity of 1,500 pounds per square foot. The values for vertical foundation pressure can be increased by one-third for wind and seismic conditions per Section 1806.1 when used with the Alternative Basic Load Combinations found in Section 1605.3.2 of the 2015 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 footing construction to evaluate whether suitable bearing soils have been exposed and whether excavation bottoms are free of loose or disturbed soils.
- Due to shallow groundwater encountered at the site, lowest floor slab depths should be limited to 3 feet below existing site grades. This is intended to provide a minimum of 3 feet of separation between the observed groundwater condition and the bottom of the floor slab. 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 loading conditions are greater than anticipated in Section 3, 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 30° friction angle and a dry unit weight of 120 pcf.

Table 5: Lateral Earth Pressures (Static and Dynamic)

Condition	Case	Lateral Pressure Coefficient	Equivalent Fluid Pressure (pcf)
Active	Static	0.33	40
	Seismic	0.49	59
At-Rest	Static	0.50	60
	Seismic	0.71	85
Passive	Static	3.00	360
	Seismic	3.95	474

*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 0.55 for structural fill or clean gravel meeting the recommendations presented herein. Concrete or masonry walls shall be selected and constructed in accordance to the provision of 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

Due to shallow groundwater encountered at the site, lowest floor slab depths should be limited to 3 feet below existing site grades. This is intended to provide a minimum of 3 feet of separation between the observed groundwater condition and the bottom of the floor slab.

Concrete floor slabs and exterior flatwork may be supported on 8 inches of properly placed and compacted 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 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 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 130 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 should 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. 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

Groundwater or indicators of past groundwater levels were encountered/observed at a depth of 6 feet below the existing ground surface. Due to the presence of shallow groundwater throughout property, basements for residences may be difficult to construct. The depth of basements will depend greatly on-site grading and drainage. Based on current site conditions, basements may be constructed no deeper than 3 feet below existing site grades. Basement depths can be increased if a land drain system is constructed for the subdivision. The depth of the land drain will then control the allowable depth of the basements. Additionally, we recommend that a perimeter foundation drain be utilized for each structure. The information below should be used during the design and installation of the perimeter foundation drain:

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 lean clay (CL) and silt (ML) which are not a Group 1 soils. The recommendations presented below should be followed during design and construction of the foundation drains:

- A perforated 4-inch minimum diameter pipe should be enveloped in at least 12 inches of free-draining gravel and placed adjacent to the perimeter footings. The perforations should be oriented such that they are not located on the bottom side of the pipe, as much as possible. The free-draining gravel should consist of primarily ¾- to 2-inch size gravel having less than 5 percent passing the No. 4 sieve and should be wrapped with a separation fabric such as Mirafi 140N or equivalent.
- The highest point of the perforated pipe bottom should be equal to the bottom elevation of the footings. The pipe should be uniformly graded to drain to an appropriate outlet (storm drain, land drain, other gravity outlet, etc.) or to one or more sumps where water can be removed by pumping.
- A perforated 4-inch minimum diameter pipe should be installed in all window wells and connected to the foundation drain.
- To facilitate drainage beneath basement floor slabs we recommend that the minimum thickness of free-draining fill beneath the slabs be increased to at least 10 inches (approximately equal to the bottom of footing elevations). A separation fabric such as Mirafi 140N or equivalent should be placed beneath the free-draining gravel. Connections should be made to allow any water beneath the slabs to reach the perimeter foundation drain.
- The drain system should be periodically inspected and clean-outs should be installed for the foundation drain to allow occasional cleaning/purging, as needed. Proper drain operation depends on proper construction and maintenance.

13.0 PAVEMENT RECOMMENDATIONS

We understand that asphalt paved residential streets will be constructed as part of the development. The native soils encountered beneath the fill and topsoil during our field exploration were predominantly composed of silts. We estimate that a California Bearing Ratio (CBR) value of 3 is appropriate for these soils. If the fill material and 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 200 vehicles a 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, and the procedures and typical design inputs outlined in the UDOT Pavement Design Manual (1998), we recommend the minimum asphalt pavement section presented below.

Table 6: Pavement Section Recommendations

Asphalt Thickness (in)	Compacted Roadbase Thickness (in)	Compacted Subbase Thickness (in)
3	8*	0

* Stabilization may be required

If the pavement will be required to support construction traffic, 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.
- 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).
- 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 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.

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

Frank F.

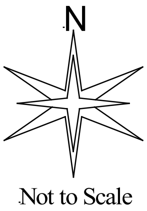
PROFESSIONAL ENGINEER
No. 5567049-2202
TIMOTHY ALLAN
MITCHELL
Electronically generated on
10/24/2018
STATE OF UTAH

Frank Namdar, P.G., E.I.T.
Project Engineer

Timothy A. Mitchell, P.E.
Geotechnical Engineer

VICINITY MAP

FENSTER PHASE 3 SUBDIVISION
5500 WEST 560 NORTH
WEBER COUNTY, UTAH



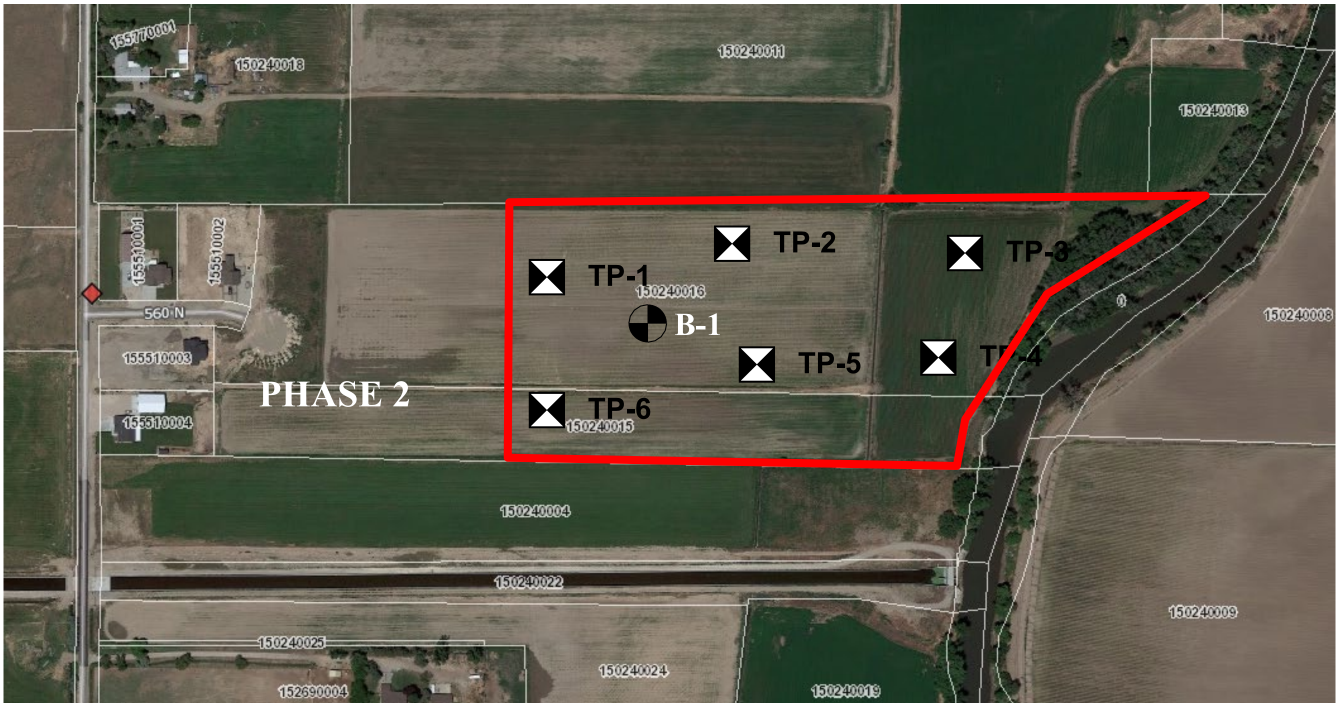
PROJECT NO.: 187071

EARTHTEC ENGINEERING

FIGURE NO.: 1

AERIAL PHOTOGRAPH SHOWING LOCATION OF BORING AND TEST PITS

FENSTER PHASE 3 SUBDIVISION
5500 WEST 560 NORTH
WEBER COUNTY, UTAH



☒ **Approximate Test Pit Location**

⊕ **Approximate Boring Location**

N

Not to Scale

PROJECT NO.: 187071

EARTHTEC ENGINEERING

FIGURE NO.: 2

BORING LOG

NO.: B-1

PROJECT: Fenster Phase 3 Subdivision
CLIENT: Lakeview Farms 1, LLC
LOCATION: See Figure 2
OPERATOR: Great Basin Drilling
EQUIPMENT: Mobile B-53
DEPTH TO WATER; INITIAL ▽ : 6 ft.

PROJECT NO.: 187071
DATE: 09/18/18
ELEVATION: Not Determined
LOGGED BY: F. Namdar
AT COMPLETION ▼ :

Depth (Ft.) 0	Graphic Log	USCS	Description	Samples	TEST RESULTS Blows per foot	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
			TOPSOIL, lean clay, moist, dark brown										
3		CL	Sandy Lean CLAY; stiff (estimated), very moist, dark brown										
6		SM	▽ Silty SAND, dense (estimated), moist, brown			16		33	11	0	31	69	
		CL	Lean CLAY; medium stiff, moist, brown		6								
9													
					7								
12													
15					4								
18													
		SP	Poorly Graded SAND; loose, wet, charcoal gray										
21					5	27				0	99	1	
24		CL	Lean CLAY; medium stiff (estimated), moist, brown										
		SP	Poorly Graded SAND; very loose, wet, charcoal gray		2								
27		CL-ML	Silty CLAY; soft, bluish gray, wet										

Notes: Groundwater encountered at 6 feet below surrounding surface.

Tests Key

CBR = California Bearing Ratio
C = Consolidation
R = Resistivity/Nitrates/PH
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

FIGURE NO.: 3a

BORING LOG

NO.: B-1

PROJECT: Fenster Phase 3 Subdivision
CLIENT: Lakeview Farms 1, LLC
LOCATION: See Figure 2
OPERATOR: Great Basin Drilling
EQUIPMENT: Mobile B-53
DEPTH TO WATER; INITIAL ∇ **:** 6 ft.

PROJECT NO.: 187071
DATE: 09/18/18
ELEVATION: Not Determined
LOGGED BY: F. Namdar
AT COMPLETION ▼ **:**

Depth (Ft.) 27	Graphic Log	USCS	Description	Samples	TEST RESULTS								
					Blows per foot	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
	▥	CL-ML	Silty CLAY; soft, bluish gray, wet										
30				◣	2								
33													
36				◣	2			24	5				
39	▨	CL	Lean CLAY; soft, wet, bluish gray										
42				◣	2								
45	░	SP	Poorly Graded SAND; loose (estimated), wet, charcoal gray										
	▨	CL	Lean CLAY; stiff, wet, bluish gray	◣	13								
48	▥	ML	Sandy SILT; very stiff, wet, bluish gray										
51				◣	17								
54			MAXIMUM DEPTH EXPLORED APPROXIMATELY 51½ FEET										

Notes: Groundwater encountered at 6 feet below surrounding surface.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity/Nitrates/PH
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

FIGURE NO.: 3b

BORING LOG

NO.: TP-1

PROJECT: Fenster Subdivision Phase 3
PROJECT NO.: 187071
CLIENT: Lakeview Farms 1, LLC
DATE: 10/19/18
LOCATION: See Figure 2
ELEVATION: Not Determined
OPERATOR: C.E. Butters Construction
LOGGED BY: F. Namdar
EQUIPMENT: Rubber-tire Backhoe
DEPTH TO WATER; INITIAL ∇ : 6 ft.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	TEST RESULTS								
					Blows per foot	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0	░		TOPSOIL; lean clay, slightly moist, dark brown, organics										
	▨		Lean CLAY; very stiff to stiff (estimated), slightly moist, some sand lenses from 4' to 8', brown										
3	▨												
	▨			■									
	▨	CL											
6	▨		∇ ... wet	■		16		34	12				
	▨			■									
9	▨												
			MAXIMUM DEPTH EXPLORED APPROXIMATELY 10 FEET										
12													
15													

Notes: No groundwater encountered.

Tests Key

CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

FIGURE NO.: 4

BORING LOG

NO.: TP-2

PROJECT: Fenster Subdivision Phase 3
CLIENT: Lakeview Farms 1, LLC
LOCATION: See Figure 2
OPERATOR: C.E. Butters Construction
EQUIPMENT: Rubber-tire Backhoe
DEPTH TO WATER; INITIAL ▽ : 6 ft.

PROJECT NO.: 187071
DATE: 10/19/18
ELEVATION: Not Determined
LOGGED BY: F. Namdar
AT COMPLETION ▼ :

Depth (Ft.) 0	Graphic Log	USCS	Description	Samples	TEST RESULTS								
					Blows per foot	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
			TOPSOIL; lean clay, slightly moist, dark brown, organics										
			Lean CLAY; very stiff (estimated), dry, brown										
3													
		CL		■									
6		▽	... very moist	■									
			Fat CLAY; very stiff (estimated), very moist, brown										
		CL		■		28	99	52	26	0	2	98	C
9													
			Lean CLAY; very stiff (estimated), very moist, brown	■									
		CL											
12			MAXIMUM DEPTH EXPLORED APPROXIMATELY 12 FEET										
15													

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

FIGURE NO.: 5

BORING LOG

NO.: TP-3

PROJECT: Fenster Subdivision Phase 3
CLIENT: Lakeview Farms 1, LLC
LOCATION: See Figure 2
OPERATOR: C.E. Butters Construction
EQUIPMENT: Rubber-tire Backhoe
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 187071
DATE: 10/19/18
ELEVATION: Not Determined
LOGGED BY: F. Namdar
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	TEST RESULTS								
					Blows per foot	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL; lean clay, slightly moist, dark brown, organics										
		SP-SM	Poorly Graded SAND with silt; medium dense (estimated), slightly moist, brown										
	▨	CL	Sandy Lean CLAY; stiff (estimated), moist, brown										
3													
				▮									
		SM	Silty SAND; medium dense (estimated), moist, brown										
6													
				▮		15				0	54	46	
				☒									
9													
12			MAXIMUM DEPTH EXPLORED APPROXIMATELY 12 FEET										
15													

Notes: No groundwater encountered.

Tests Key

CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

Earthtec Engineering

FIGURE NO.: 6

TEST PIT LOG

NO.: TP-4

PROJECT: Fenster Subdivision Phase 3
CLIENT: Lakeview Farms 1, LLC
LOCATION: See Figure 2
OPERATOR: C.E. Butters Construction
EQUIPMENT: Rubber-tire Backhoe
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 187071
DATE: 10/19/18
ELEVATION: Not Determined
LOGGED BY: F. Namdar
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	TEST RESULTS							
					Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL; lean clay, slightly moist, dark brown, organics									
1		CL	Lean CLAY, stiff (estimated), moist, brown									
2		SP-SM	Poorly Graded SAND with silt; medium dense (estimated), slightly moist, brown	☒								
4				☒								
7		CL-ML	Silty CLAY, stiff (estimated), very moist, light brown									
8				■			23	4				
12			MAXIMUM DEPTH EXPLORED APPROXIMATELY 12 FEET									
15												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

Earthtec Engineering

FIGURE NO.: 7

BORING LOG

NO.: TP-5

PROJECT: Fenster Subdivision Phase 3
CLIENT: Lakeview Farms 1, LLC
LOCATION: See Figure 2
OPERATOR: C.E. Butters Construction
EQUIPMENT: Rubber-tire Backhoe
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 187071
DATE: 10/19/18
ELEVATION: Not Determined
LOGGED BY: F. Namdar
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	TEST RESULTS								
					Blows per foot	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL; lean clay, slightly moist, dark brown, organics										
		CL	Lean CLAY; very stiff (estimated), slightly moist, brown										
3		ML	Sandy SILT; stiff (estimated), moist, brown										
				■									
		CL	Lean CLAY with sand; stiff (estimated), moist, brown										
6				■		21	100	41	18	0	16	84	C
				■									
9		SM	Silty SAND; medium dense (estimated), moist, brown										
			MAXIMUM DEPTH EXPLORED APPROXIMATELY 10 FEET										
12													
15													

Notes: No groundwater encountered.

Tests Key

CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

FIGURE NO.: 8

TEST PIT LOG

NO.: TP-6

PROJECT: Fenster Subdivision Phase 3
PROJECT NO.: 187071
CLIENT: Lakeview Farms 1, LLC
DATE: 10/19/18
LOCATION: See Figure 2
ELEVATION: Not Determined
OPERATOR: C.E. Butters Construction
LOGGED BY: F. Namdar
EQUIPMENT: Rubber-tire Backhoe
DEPTH TO WATER; INITIAL ▽ : 6 ft.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	TEST RESULTS							
					Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0			TOPSOIL; lean clay, slightly moist, dark brown, organics									
1	▨	CL	Lean CLAY; stiff to very stiff (estimated), very moist, brown, some silt and sand lenses									
2	▨			■								
3	▨											
4	▨			■								SS
5	▨											
6	▨	▽		■								
7	▨											
8			MAXIMUM DEPTH EXPLORED APPROXIMATELY 8 FEET									
9												
10												
11												
12												
13												
14												
15												

Notes: No groundwater encountered.

Tests Key
CBR = California Bearing Ratio
C = Consolidation
R = Resistivity
DS = Direct Shear
SS = Soluble Sulfates
UC = Unconfined Compressive Strength

PROJECT NO.: 187071

Earthtec Engineering

FIGURE NO.: 9

LEGEND

PROJECT: Fenster Subdivision Phase 3
CLIENT: Lakeview Farms 1, LLC
DATE: 10/19/18
LOGGED BY: F. Namdar

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

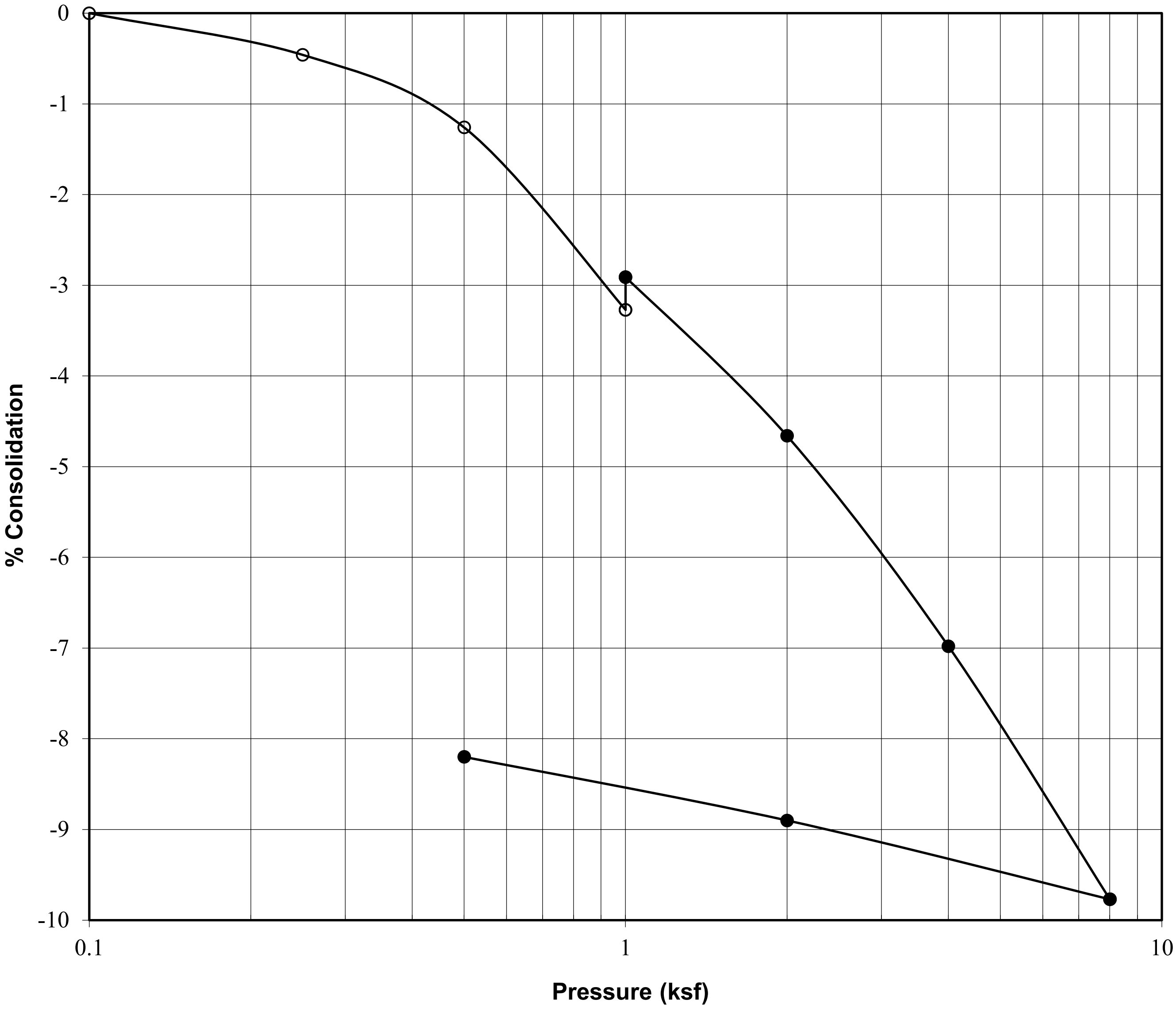
▼ Water level encountered at completion of field exploration

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.

PROJECT NO.: 187071

FIGURE NO.: 10

CONSOLIDATION - SWELL TEST

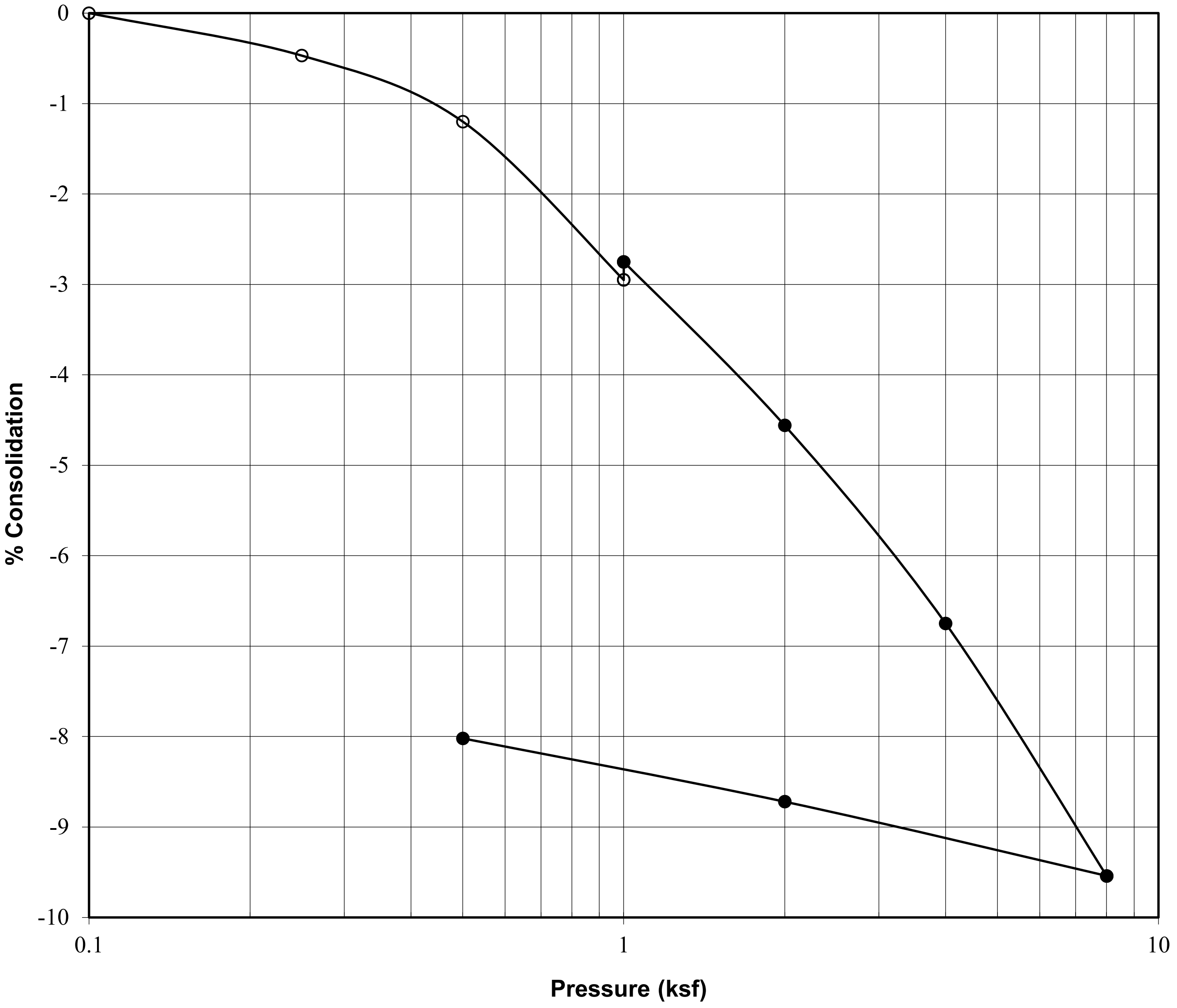


Project:	Fenster Phase 3
Location:	TP-2
Sample Depth, ft:	8
Description:	Block
Soil Type:	Fat CLAY (CH)
Natural Moisture, %:	28
Dry Density, pcf:	99
Liquid Limit:	52
Plasticity Index:	26
Water Added at:	1 ksf
Percent Swell:	0.4

PROJECT NO.: 187071

FIGURE NO.: 11

CONSOLIDATION - SWELL TEST



Project:	Fenster Phase 3
Location:	TP-5
Sample Depth, ft:	6
Description:	Block
Soil Type:	Lean CLAY with sand (CL)
Natural Moisture, %:	21
Dry Density, pcf:	100
Liquid Limit:	41
Plasticity Index:	18
Water Added at:	1 ksf
Percent Swell:	0.2

PROJECT NO.: 187071

EARTHTEC ENGINEERING

FIGURE NO.: 12

APPENDIX A

American West
ANALYTICAL LABORATORIES

3440 South 700 West
Salt Lake City, UT 84119

Phone: (801) 263-8686
Toll Free: (888) 263-8686
Fax: (801) 263-8687
e-mail: awal@awal-labs.com

web: www.awal-labs.com

Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

Client: Earthtec Engineering **Contact:** Frank Namdar
Project: Fenter Phase 2 / 187070
Lab Sample ID: 1809501-001
Client Sample ID: TP-6 @ 4'
Collection Date: 9/20/2018 1700h
Received Date: 9/24/2018 1007h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		9/25/2018 740h	SM4500-SO4-E	57.7	**166**	&

& - Analysis is performed on a 1:1 DI water extract for soils.