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GEOTECHNICAL STUDY
HARVEST PARK COMMERICAL
SOUTHWEST CORNER OF SPRING HILL DRIVE AND REDWOOD ROAD
SARATOGA SPRINGS, UTAH

Project No. 131422

September 26, 2013

Prepared For:

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1.0 EXECUTIVE SUMMARY

This report presents the results of our geotechnical study for Harvest Park Commercial development in Saratoga Springs, Utah. We understand the proposed projects as currently planned; will consist of one- two-story commercial buildings, including a parking lots and streets to provide access to the commercial buildings.

For the field exploration, we excavated a total of six (6) test pits to depths of approximately 12 feet below the existing ground surface. Groundwater was not encountered within the depths explored. The subsurface soils encountered generally consisted of topsoil followed by layers of medium stiff to stiff silt and clay and medium dense to very dense sand and gravel. The topsoil should be removed beneath the entire building footprint and beneath exterior flatwork and pavement areas. The native clay and silt soils have a high potential for collapse under increased moisture contents and anticipated load conditions.

Based on the results of our field exploration, laboratory testing and engineering analyses, it is our opinion that the subject site is suitable for the proposed development, provided the recommendations presented herein are followed and implemented during design and construction. Conventional strip and spread footings may be used to support the structure, with foundations placed entirely on native sand and gravel soils or entirely on 36 inches of properly placed and compacted structural fill.

This executive summary provides a general synopsis of our recommendations. Details of our findings, conclusions and recommendations are provided within the body of this report. Failure to consult with Earthtec Engineering regarding any changes made during design and/or construction of the project from those discussed in Section 3.0 relieves Earthtec Engineering from any liability arising from changed conditions at the site. We also strongly recommend that Earthtec Engineering observe the building excavations to verify the adequacy of our recommendations presented herein, and that Earthtec Engineering perform materials testing and special inspections for this project to provide consistency during construction.

2.0 INTRODUCTION

This report presents the results of our geotechnical study for the Harvest Park Commercial development to be located at the southwest corner of Spring Hill Drive and Redwood Road in Saratoga Springs, Utah. The general location of the site is shown on Figure 1, *Vicinity Map*, at the end of this report.

The purposes of this study were 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, asphalt roads, and asphalt paved parking.

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 consists of subdividing, developing, and constructing commercial buildings on approximately 7 acres. We anticipate that the structures will be steel framed and one to two stories in height. The structures will likely be founded on strip and spread footings using slab-on-grade construction. We have based our recommendations in this report on the assumption that foundation loads for the proposed structures will not exceed 5,000 pounds per linear foot for bearing walls, 50,000 pounds for column loads, and 100 pounds per square foot for floor slabs. If structural loads will be greater our office should be notified so that we may review our recommendations and, if necessary, make modifications.

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 parking areas will be constructed.

4.0 GENERAL SITE DESCRIPTION

At the time of our subsurface exploration the site was an undeveloped lot vegetated with grass, weeds, and brush. The ground surface appeared to slope downward to the south, with approximately a 4 percent grade, thus we anticipate less than 3 feet of cut and fill may be required for site grading. The south end of the property had been used as storage for boulders used in rock walls. The property was bounded on the north by Spring Hill Drive, on the east by Redwood Road, on the south by undeveloped commercial property, and on the west by residential apartment complexes.

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 10, 2013 by observing the excavation of six (6) exploratory test pits to depths of approximately 12 feet below the existing ground surface using a track-mounted excavator. The approximate locations of the test pits are shown on Figure 2, *Aerial Photograph Showing Location of Test Pits*. Graphical representations and detailed descriptions of the soils encountered are shown on Figures 3 through 8, *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 9, *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 Orem, 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 tests, liquid and plastic limits determinations, full gradation analyses, and one-dimensional consolidation tests. The table below summarizes the laboratory test results, which are also included on the attached *Test Pit Logs* at the respective sample depths, on Figures 10 and 11, *Consolidation-Swell Test,* and *Grain Size Distribution,* on Figures 12 and 13.

Table 1: Laboratory Test Results

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)	
TP-1	3	5		-	NP	43	50	7	SW-SM
TP-2	5	6				33	59	8	SW-SM
TP-3	6	11		38	24	3	33	64	CL
TP-4	2	6	95	31	15	4	25	71	CL
TP-5	4	7				43	37	20	GC
TP-6	5½	14		26	5	1	39	60	CL-ML
TP-6	8	12	72	22	6	2	35	63	CL-ML
TP-6	11	12				23	31	46	SM

* NP = Non-Plastic

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. This part of the consolidation test indicated high potential (approximately 4 percent) for collapse (settlement) under increased moisture contents and anticipated load conditions.

7.0 SUBSURFACE CONDITIONS

7.1 Soil Types

On the surface of the site, we encountered topsoil which we estimated to extend up to1½ feet in depth at the test pit locations. Below the topsoil we encountered layers of Well-Graded Sand with silt and gravel (SW-SM), Poorly Graded Gravel with silt and sand (GP-GM), Poorly Graded Sand with gravel (SP), Poorly Graded Gravel with sand (GP), Silty Sand (SM), Silty Gravel with sand (GM), Sandy Lean Clay (CL), Lean Clay with sand (CL), Clayey Gravel with sand (GC), Poorly Graded Sand with silt and gravel (SP-SM), Silt with sand (ML), Sandy Silty, Clay (CL-ML), Silty Sand with gravel (SM) extending approximately 12 feet below the existing ground surface. Based on our experience and observations during field exploration, the clay and silt soils visually ranged from medium stiff to stiff in consistency and the sand and gravel soils visually had a relative density varying from medium dense to very dense. Consolidation test results indicate the clay soils are moderately to highly compressible and have a high potential for collapse (settlement).

7.2 Groundwater Conditions

Groundwater was not encountered during our field exploration to the maximum depths explored of approximately 12 feet below the existing ground surface. Note that groundwater levels will fluctuate in response to the season, precipitation and 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.

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 foundation, floor slab, exterior concrete flatwork, and pavements. We encountered topsoil on the surface of the site which we estimated to extend up to approximately 1½ feet below the existing ground surface. 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 may also 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 Engineering should be notified so that we may assess potential settlement and make additional recommendations if needed. 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[1] requirements for Type C soils.

8.3 Fill Material Composition

The native well-graded sand, and native clayey gravel soils within the upper 8 feet in the vicinity of Test Pit 1, Test Pit 2, and Test Pit 5 appear to be suitable for use as structural fill,

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

provided the soil meets the structure fill recommendation below in Table 2. Excavated soils, including clays, 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, pavement, etc. We recommend that a professional engineer or geologist verify that the structural fill to be used on this project meets our requirements, given below. We recommend that structural fill consist of imported or native 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, more strict 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 recommendation 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 clayey/silty 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.

Where needed, 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 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%
- Between 5 and 10 feet of fill below structurally loaded areas: 98%

Generally, placing and compacting fill at a moisture content within ±2 percent of the optimum moisture content, as determined by ASTM D-1557, will facilitate compaction. Typically, the further the moisture content is 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 clays and silts were encountered during our field exploration. These 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 and/or partial loads, by working in dry times of the year, 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. The more angular and coarse the material, the thinner the lift that will be required. 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 CONSIDERATIONS

9.1 Seismic Design

The State of Utah has adopted the 2009 International Building Code (IBC) for seismic design and the structure should be designed in accordance with Chapter 16 of the IBC. The Site Class definitions in the IBC are based upon the soil properties in the upper 100 feet of the soil profile. These properties are determined from sampler blow counts, undrained shear strength values, and/or shear velocity measurements. The code states, "When the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the building official or geotechnical data determines that Site Class E or F soil is likely to be present at the site." Considering our experience in the vicinity of the site and based on the results of our field exploration, we recommend using Site Class D.

The site is located at approximately 40.401 degrees latitude and -111.921 degrees longitude. Using Site Class D, the design spectral response acceleration parameters are given below.

Table 4: Design Accelerations

S_S	F_a	S_{MS}	S_{DS}
1.074 g	1.07	1.149 g	0.766 g
S_1	F_v	S_{M1}	S_{D1}
0.441 g	1.559	0.687 g	0.458 g

S_S = Mapped spectral acceleration for short periods
S_1 = Mapped spectral acceleration for 1-second period
$S_{DS} = ⅔S_{MS} = ⅔ (F_a \cdot S_s)$ = 5% damped design spectral response acceleration for short periods
$S_{D1} = ⅔S_{MS} = ⅔ (F_v \cdot S_1)$ = 5% damped design spectral response acceleration for 1-second period

9.2 Faulting

Based upon published geologic maps[2], 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 part of a group of faults beneath Utah Lake located about 2¾ miles southeast of the property.

9.3 Liquefaction Potential

According to current liquefaction maps[3] for Utah County, the site is located within an area designated as "Low" in liquefaction potential. Liquefaction can occur when saturated subsurface soils below groundwater lose their intergranular 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 were composed of slight moist and moist soils with medium dense to very dense or medium stiff to stiff to the maximum depth explored. The soils encountered 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.

[2] U.S. Geological Survey, Quaternary Fault and Fold Database of the United States, November 3, 2010
[3] Utah Geological Survey, Liquefaction-Potential Map For A Part Of Utah County, Utah, Public Information Series 28, August 1994

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 Engineering 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 recompacted.

10.2 Strip/Spread Footings

We recommend that conventional strip and spread foundations be constructed entirely on a minimum of 36 inches of firm, undisturbed, uniform sand and gravel soils (i.e. completely on sand soils, or completely on gravel soils, etc.), or entirely on a minimum 36 inches of structural fill placed on undisturbed native soils. Foundations should not bear on native silts or clays. For foundation design we recommend the following:

- Footings founded on native sand or gravel soils may be designed using a maximum allowable bearing capacity of 2,500 pounds per square foot. Footings founded on a minimum 36 inches of structural fill 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 1806.1 when used with the Alternative Basic Load Combinations found in Section 1605.3.2 of the 2009 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.
- 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 are 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 an earthquake due to ground shaking, if more than 3 feet of grading fill is placed above the existing ground surface, and/or if foundation soils are allowed to become wetted.

10.4 Lateral Load Resistance

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 0.40 for native sands, and 0.55 for native gravels and structural fill meeting the recommendations presented herein. The values for lateral resistance 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 2009 International Building Code.

11.0 FLOOR SLABS AND FLATWORK

Concrete floor slabs and exterior flatwork may be supported on native gravel and sand soils or on 18 inches of properly placed and compacted structural fill 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 flatwork, we recommend placing a minimum 4 inches of roadbase material. Prior to placing the free-draining fill or roadbase materials, the native subgrade 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 subgrade reaction of 120 pounds per cubic inch. 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

Due to the collapse potential of native soils within the upper 4 feet, wetting of subsurface soils (including those below foundations) could result in adverse settlement. Accordingly, we recommend the following:

- Adequate compaction of foundation 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 downspouts designed to discharge well outside of the backfill limits, or at least 10 feet from foundations, whichever is greater.
- Sprinklers should be aimed away, and all sprinkler components (valves, lines, sprinkler heads) should be placed at least 5 feet from foundation walls. Sprinkler systems should be well maintained, checked for leaks frequently, and repaired promptly. Overwatering at any time should be avoided.
- Any additional precautions which may become evident during construction.

12.2 Subsurface Drainage

Groundwater was not encountered during our field exploration, thus it is our opinion that perimeter foundation drains are not needed for this project. However, if foundation drains are constructed for the proposed commercial buildings, 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.

- 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 (i.e. placing at least 10 inches of free-draining fill beneath footings).
- 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 streets will be constructed as part of the development. The native soils encountered beneath the topsoil during our field exploration were predominantly composed of sands and gravels with areas of clays and silts. We estimate that a California Bearing Ratio (CBR) value of 3 is appropriate for the clay and silt soils. Also, the near-surface native clay and silt soils are potentially collapsible, and over-excavation may be needed to minimize the potential settlement of pavements.

We anticipate the traffic volume will be about 6,000 vehicles a day or less for the roadway, consisting of mostly cars and pickup trucks, with a daily delivery trucks and garbage trucks for each lot in the commercial area. 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 5: Pavement Section Recommendations

Asphalt Thickness (in)	Compacted Roadbase Thickness (in)	Compacted Subbase Thickness (in)
4	14	18*
4	12	20*
4.5	12	18*
5	10	18*

* 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).

Due to high static loads imposed by trucks in loading and unloading areas and at dumpster locations, we recommend that a rigid pavement section for these areas of a minimum of six (6) inches of Portland Cement Concrete (PCC) over a minimum of twelve (12) inches of aggregate base material. The aggregate base material should meet local, APWA or UDOT requirements and should be compacted to local, APWA, or UDOT requirements, or to at least 95 percent of maximum dry density (ASTM D 1557).

14.0 GENERAL CONDITIONS

The exploratory data presented in this report was collected to provide geotechnical design recommendations for this project. The test pits 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 test pits may occur and 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 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, either expressed or implied, is intended in our proposals, contracts or reports.

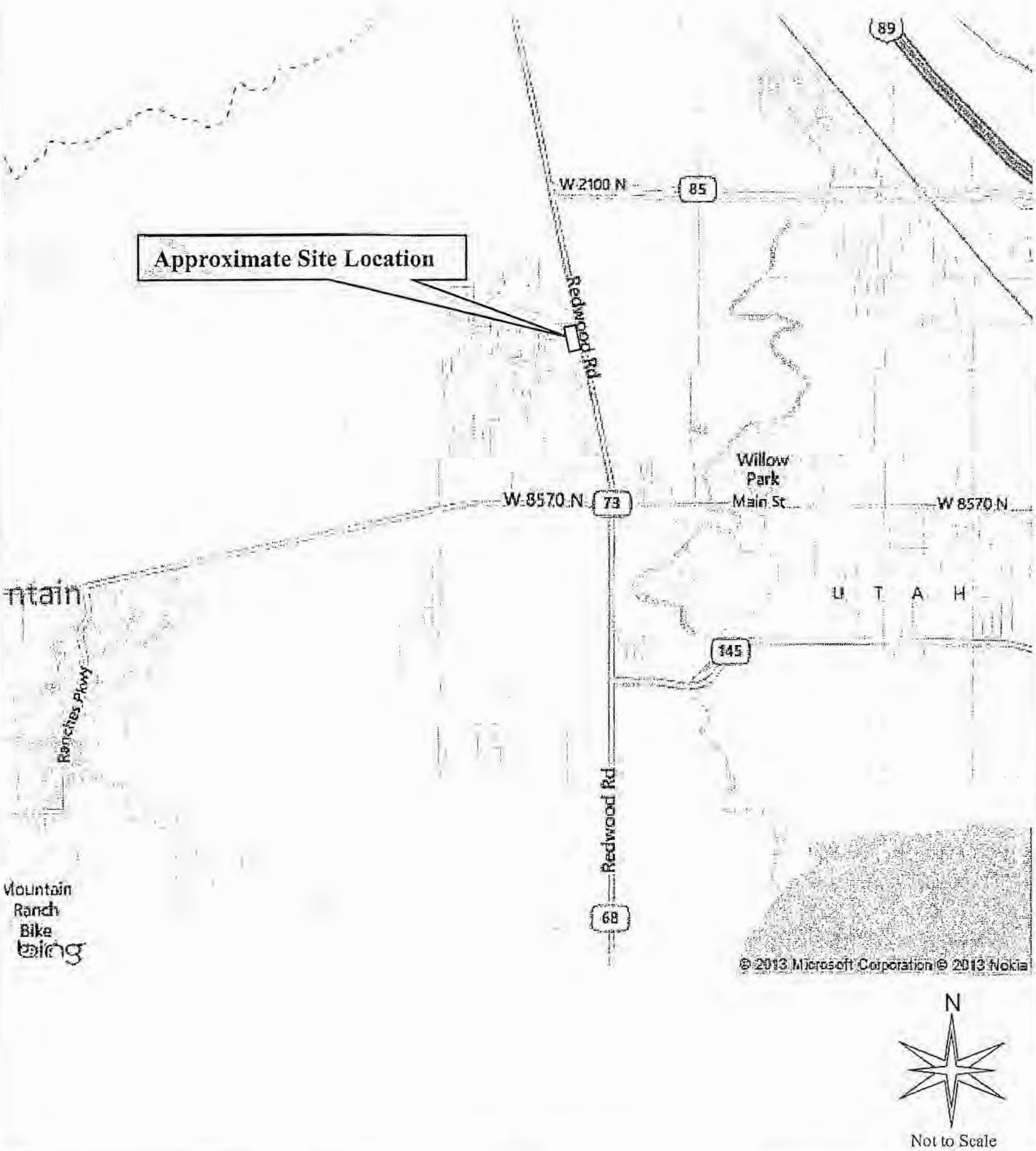
This geotechnical report is based on relatively limited subsurface explorations and laboratory testing. Subsurface conditions may differ in some locations of the site from those described herein, which may require additional analyses and possibly modified recommendations. Thus we strongly recommend consulting with Earthtec Engineering regarding any changes made during design and construction of the project from those discussed above in Section 3.0. Failure to consult with Earthtec Engineering regarding any such changes relieves Earthtec Engineering from any liability arising from changed conditions at the site.

For consistency, Earthtec Engineering 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 Engineering 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 Engineering 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 Engineering at your convenience.

VICINITY MAP

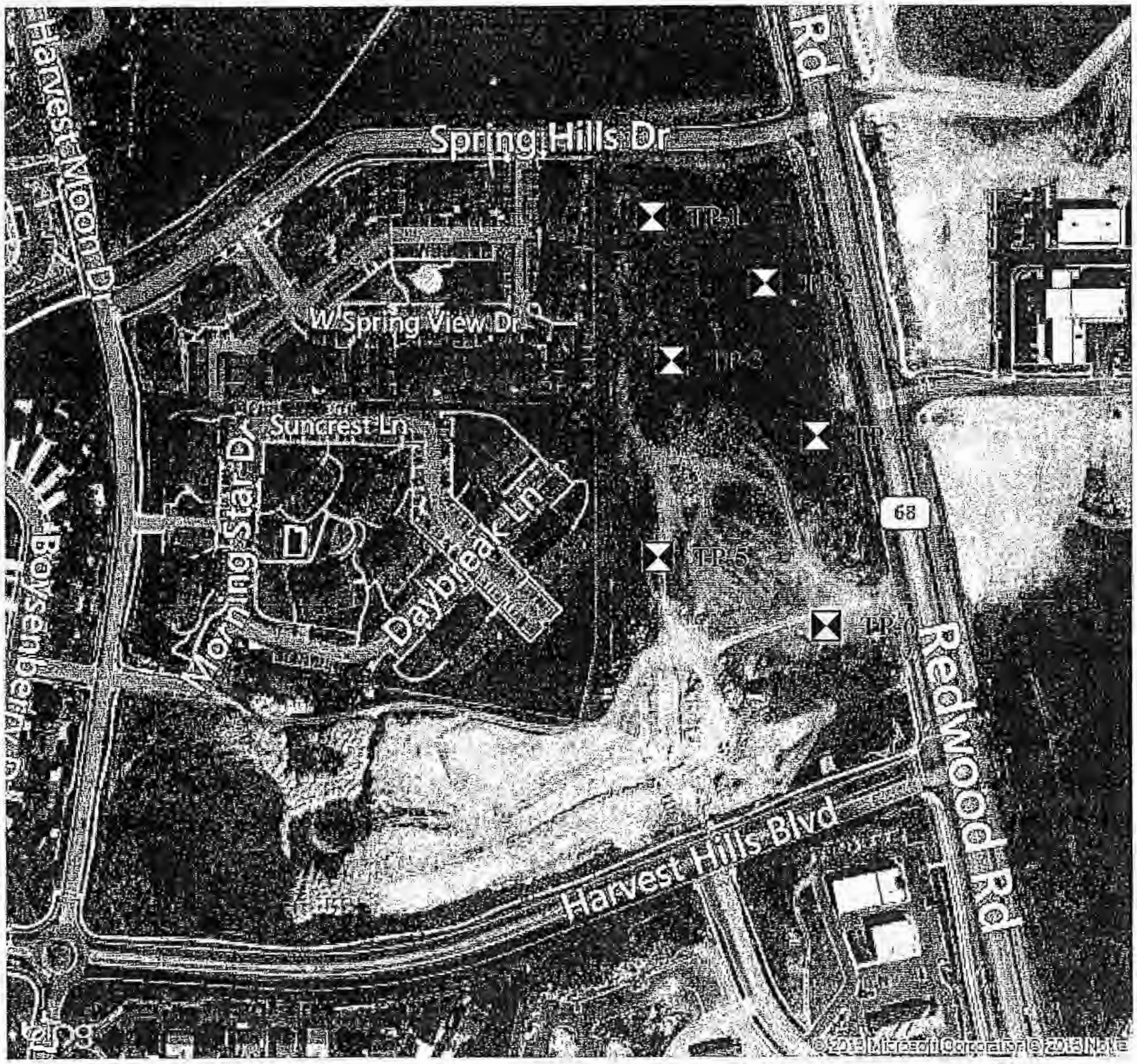
HARVEST PARK COMMERCIAL
SOUTHWEST CORNER OF SPRING HILL DRIVE AND REDWOOD ROAD
SARATOGA SPRINGS, UTAH



PROJECT NO.: 131422	Earthtec Engineering	FIGURE NO.: 1

AERIAL PHOTOGRAPH SHOWING LOCATION OF TEST PITS

HARVEST PARK COMMERCIAL
SOUTHWEST CORNER OF SPRING HILL DRIVE AND REDWOOD ROAD
SARATOGA SPRINGS, UTAH



Approximate Test Pit Location

N

Not to Scale

PROJECT NO.: 131422		FIGURE NO.: 2

TEST PIT LOG

No.: TP-1

PROJECT: Harvest Park Commerical
CLIENT: ATC Investments
LOCATION: See Figure 2.
OPERATOR: Provided by Cleint
EQUIPMENT: Trackhoe
DEPTH TO WATER; INITIAL ∇: Not Encountered

Project No.: 131422
Date: 9/10/2013
Elevation: Not taken
Logged By: C. Allred
AT COMPLETION ▼: Not Encountered

Depth (ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Pocket Penet. (tsf)	Other Tests
					TEST RESULTS								
1			TOPSOIL, consisting of silt and sand, roots throughout, moist, brown.										
2, 3			Well-Graded SAND with silt and gravel, dense to very dense (estimated), slight moist, brown, cemented material starting at 1.5 feet and ending at 3.5 feet.										
				X	5		-	NP	43	50	7		
4, 5, 6, 7		SW-SM											
8			Poorly Graded GRAVEL with silt and sand, dense (estimated), moist, brown, rock up to 1.5 feet in diameter.										
				X									
9, 10		GP-GM											
11		SP	Poorly Graded SAND with gravel, dense (estimated), moist, brown.										
				X									
12													
13			Maximum depth explored of approximately 12 feet.										

Notes: Groundwater was not encountered during field investigation.

Test Keys
CBR = California Bearing Ratio
C = Consolidation
P = Percolation

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 3

TEST PIT LOG

No.: TP-2

PROJECT:	Harvest Park Commerical	**Project No.:**	131422
CLIENT:	ATC Investments	**Date:**	9/10/2013
LOCATION:	See Figure 2.	**Elevation:**	Not taken
OPERATOR:	Provided by Cleint	**Logged By:**	C. Allred
EQUIPMENT:	Trackhoe		

DEPTH TO WATER; INITIAL ▽: Not Encountered **AT COMPLETION ▼:** Not Encountered

Depth (ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Pocket Penet. (tsf)	Other Tests
1			TOPSOIL, consisting of silt and sand, roots throughout, moist, brown.										
2–6		SW-SM	Well-Graded SAND with silt and gravel, dense to medium dense (estimated), slight moist, light brown.	X	6				33	59	8		
7–8		GP	Poorly Graded GRAVEL with sand, dense (estimated), moist, brown.	X									
9–11		SM	Silty SAND, dense (estimated), moist, red-brown, ligthly cemented.	X									
12		GP	Poorly Graded GRAVEL with sand, dense (estimated), moist, brown, lightly cemented.	X									
13			Maximum depth explored of approximately 12 feet.										

Notes: Groundwater was not encountered during field investigation.

Test Keys
CBR = California Bearing Ratio
C = Consolidation
P = Percolation

PROJECT NO.: 131422 | Earthtec Engineering | FIGURE NO.: 4

TEST PIT LOG

No.: TP-3

PROJECT:	Harvest Park Commerical	**Project No.:**	131422
CLIENT:	ATC Investments	**Date:**	9/10/2013
LOCATION:	See Figure 2.	**Elevation:**	Not taken
OPERATOR:	Provided by Cleint	**Logged By:**	C. Allred
EQUIPMENT:	Trackhoe		

DEPTH TO WATER; INITIAL ▽: Not Encountered **AT COMPLETION ▼:** Not Encountered

Depth (ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Pocket Penet. (tsf)	Other Tests
0–1.5			TOPSOIL, consisting of silt and sand, roots throughout, moist, brown.										
1.5–6		GM	Silty GRAVEL with sand, dense (estimated), slightly moist to dry, light brown.	X (approx. 3–3.5)									
6–12		CL	Sandy Lean CLAY, stiff (estimated), dry, light brown, some cobbles	■ (approx. 6)	11		38	24	3	33	64		
				X (approx. 9–9.5)									
12–13			Maximum depth explored of approximately 12 feet.										

Notes: Groundwater was not encountered during field investigation.

Test Keys
CBR = California Bearing Ratio
C = Consolidation
P = Percolation

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 5

TEST PIT LOG

No.: TP-4

PROJECT: Harvest Park Commerical
CLIENT: ATC Investments
LOCATION: See Figure 2.
OPERATOR: Provided by Cleint
EQUIPMENT: Trackhoe
DEPTH TO WATER; INITIAL ▽: Not Encountered

Project No.: 131422
Date: 9/10/2013
Elevation: Not taken
Logged By: C. Allred
AT COMPLETION ▼: Not Encountered

Depth (ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Pocket Penet. (tsf)	Other Tests
			TOPSOIL, consisting of silt, moist, brown.										
1–4		CL	Lean CLAY with sand, stiff (estimated), dry, light brown, moderate pinhole texture.	■	6	95	31	15	4	25	71		C
				■									
5–8		GP-GM	Poorly Graded GRAVEL with silt and sand, dense (estimated), moist to slight moist, brown, cobbles up to 1.5 feet in diameter.	☒									
9–11		SM	Silty SAND, very dense (estimated), slighty moist, red-brown, slightly cemented material.	■									
12		GP	Poorly Graded GRAVEL with sand, very dense (estimated), slightly moist, red-brown, moderately cemented material.										
13			Maximum depth explored of approximately 12 feet.										

Notes: Groundwater was not encountered during field investigation.

Test Keys
CBR = California Bearing Ratio
C = Consolidation
P = Percolation

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 6

TEST PIT LOG

No.: TP-5

PROJECT:	Harvest Park Commerical	**Project No.:**	131422
CLIENT:	ATC Investments	**Date:**	9/10/2013
LOCATION:	See Figure 2.	**Elevation:**	Not taken
OPERATOR:	Provided by Cleint	**Logged By:**	C. Allred
EQUIPMENT:	Trackhoe		

DEPTH TO WATER; INITIAL ▽: Not Encountered **AT COMPLETION** ▼: Not Encountered

Depth (ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Pocket Penet. (tsf)	Other Tests
					TEST RESULTS								
0–3		CL	Sandy Lean CLAY, medium stiff (estimated), slightly moist, brown.										
2				X									
3–9.5		GC	Clayey GRAVEL with sand, dense (estimated), slightly moist, light brown, lightly cemented.										
4.5				X	7				43	37	20		
9.5–12		SP-SM	Poorly Graded SAND with silt and gravel, medium dense (estimated), moist, brown.										
12				X									
12–13			Maximum depth explored of approximately 12 feet.										

Notes: Groundwater was not encountered during field investigation.

Test Keys
CBR = California Bearing Ratio
C = Consolidation
P = Percolation

PROJECT NO.: 131422 | Earthtec Engineering | FIGURE NO.: 7

TEST PIT LOG

No.: TP-6

PROJECT:	Harvest Park Commerical	**Project No.:**	131422
CLIENT:	ATC Investments	**Date:**	9/10/2013
LOCATION:	See Figure 2.	**Elevation:**	Not taken
OPERATOR:	Provided by Cleint	**Logged By:**	C. Allred
EQUIPMENT:	Trackhoe		

DEPTH TO WATER; INITIAL ∇: Not Encountered **AT COMPLETION ▼:** Not Encountered

Depth (ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Pocket Penet. (tsf)	Other Tests
					TEST RESULTS								
0–3.5		ML	SILT with sand, stiff (estimated), slightly moist to dry, gray-brown.	X (~3–3.5)									
3.5–8.5		CL-ML	Sandy SILTY, CLAY, stiff (estimated), moist to slightly moist, light brown.	X (~5–5.5)									
				■ (~5.5–6)	14		26	5	1	39	60		
				■ (~8–8.5)	12	72	22	6	2	35	63		C
8.5–12		SM	Silty SAND with gravel, medium dense (estimated), moist, light brown, lightly cemented.	X (~11–11.5)	12				23	31	46		
12–13			Maximum depth explored of approximately 12 feet.										

Notes: Groundwater was not encountered during field investigation.

Test Keys
CBR = California Bearing Ratio
C = Consolidation
P = Percolation

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 8

LEGEND

PROJECT: Harvest Park Commerical
CLIENT: ATC Investments

Date: 9/10/2013
Logged By: C. Allred

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR SOIL DIVISIONS			USCS SYMBOL	TYPICAL SOIL DESCRIPTIONS
COARSE GRAINED SOILS (More than 50% retained 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 Silt or Clay, May Contain Gravel and/or Sand
HIGHLY ORGANIC SOILS			PT	Peat, Primarily Organic Matter

SAMPLER DESCRIPTIONS

- SPLIT SPOON SAMPLE (1 3/8 inch inside daimeter)
- MODIFIED CALIFORNIA SAMPLE (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 field exploration

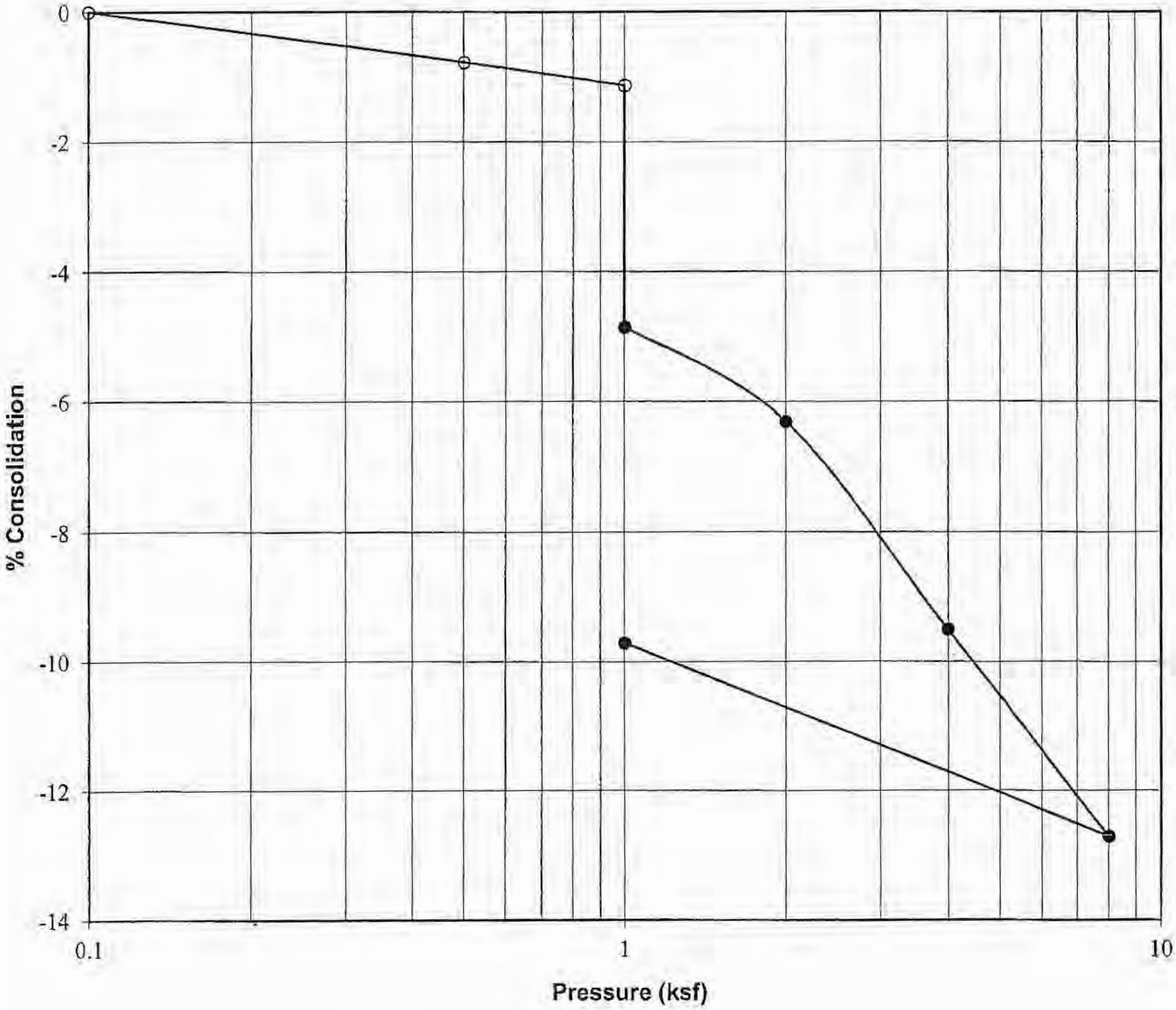
NOTES:
1. The logs are subject to the limitations, conclusions, and recommendations in this report.
2. results of test conducted on samles recovered are reported on the logs and any applicable graphs.
3. Strata lines on the logs represent approximate boundaries only. Actual transition may be gradual.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

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 9

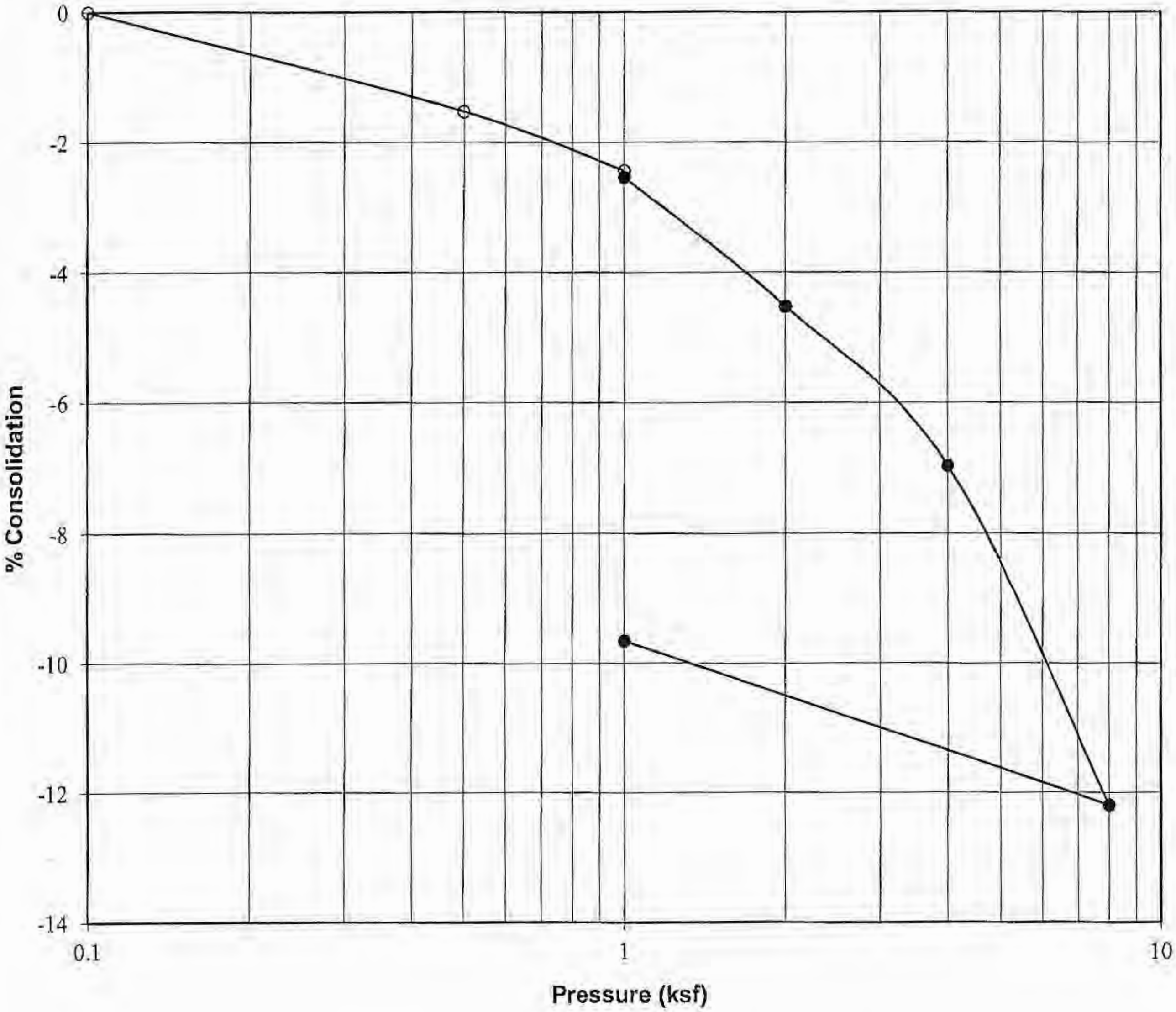
CONSOLIDATION - SWELL TEST



Project:	Harvest Park Commerical
Location:	TH-4
Sample Depth, ft:	2
Description:	Block
Soil Type:	Lean CLAY with sand (CL)
Natural Moisture, %:	6
Dry Density, pcf:	95
Liquid Limit:	31
Plasticity Index:	15
Water Added at:	1 ksf
Percent Collapse:	3.7

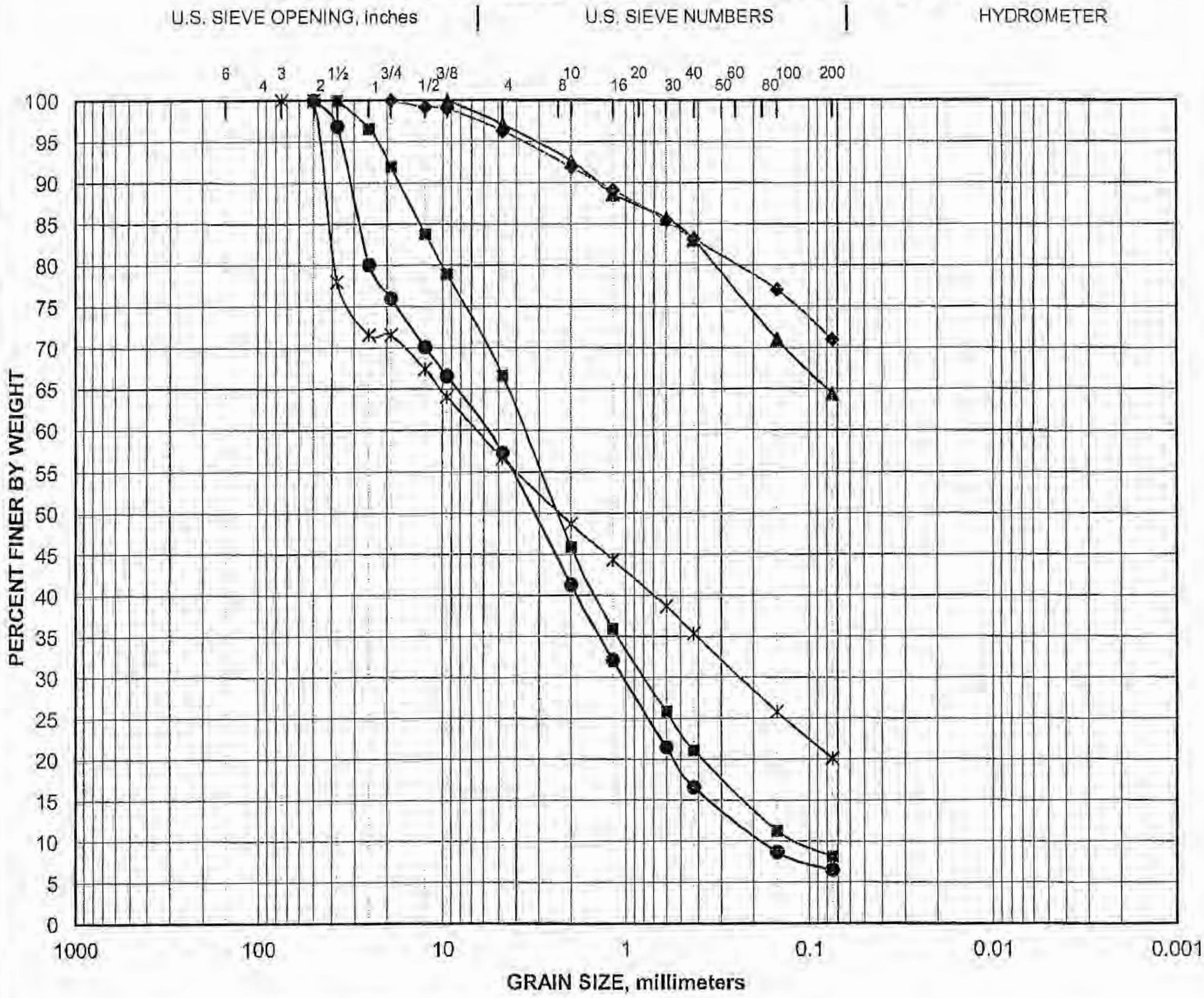
PROJECT NO.: 131422	Earthtec Engineering	FIGURE NO.: 10

CONSOLIDATION - SWELL TEST



Project:	Harvest Park Commerical
Location:	TP-6
Sample Depth, ft:	8
Description:	Block
Soil Type:	Sandy SILTY, CLAY (CL-ML)
Natural Moisture, %:	14
Dry Density, pcf:	72
Liquid Limit:	26
Plasticity Index:	5
Water Added at:	1 ksf
Percent Collapse:	0.1

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-1 @ 3 ft.	Well Graded SAND with silt and gravel (SW-SM)	5	-	NP	NP	1.0	33
■	TP-2 @ 5 ft.	Well Graded SAND with silt and gravel (SW-SM)	6				1.5	32
▲	TP-3 @ 6 ft.	Sandy Lean CLAY (CL)	11	38	14	24		
◆	TP-4 @ 2 ft.	Lean CLAY with sand (CL)	6	31	16	15		
x	TP-5 @ 4 ft.	Clayey GRAVEL with sand (GC)	7					

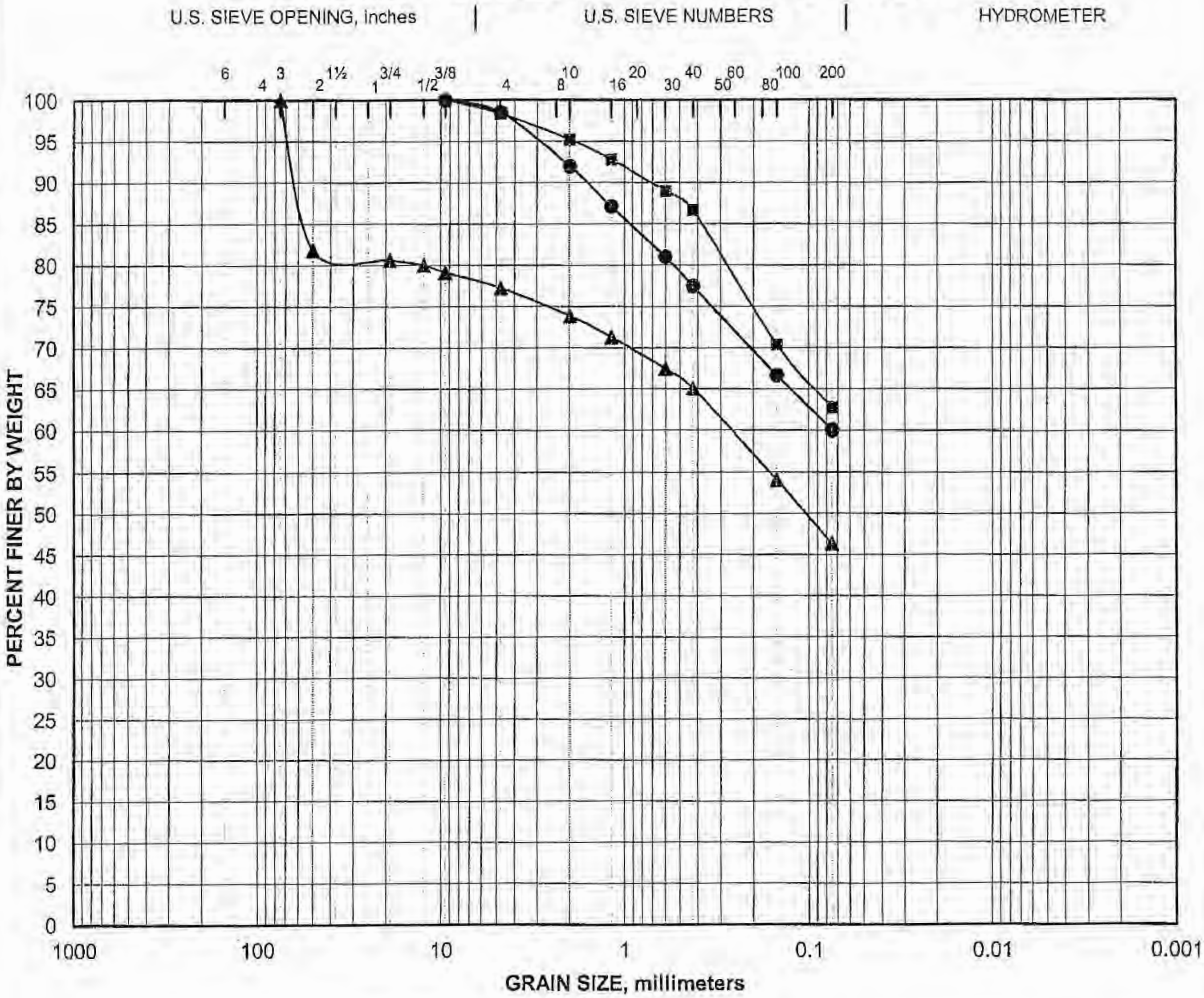
	Specimen Identification	D100	D85	D60	D30	D15	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-1 @ 3 ft.	50.0	28.2	5.81	1.03	0.344	0.178	43	50	7	
■	TP-2 @ 5 ft.	37.5	13.3	3.60	0.792	0.222	0.131	33	59	8	
▲	TP-3 @ 6 ft.	9.50	0.548					3	33	64	
◆	TP-4 @ 2 ft.	19.0	0.563					4	25	71	
x	TP-5 @ 4 ft.	75.0	41.1	6.51	0.236			43	37	20	

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 12

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● TP-6 @ 5.5 ft.	Sandy SILTY CLAY (CL-ML)	14	26	21	5		
■ TP-6 @ 8 ft.	Sandy SILTY CLAY (CL-ML)	12	22	16	6		
▲ TP-6 @ 11 ft.	Silty SAND with gravel (SM)	12					
◆							
x							

Specimen Identification	D100	D85	D60	D30	D15	D10	%Gravel	%Sand	%Silt	%Clay
● TP-6 @ 5.5 ft.	9.50	0.935					1	39	60	
■ TP-6 @ 8 ft.	9.50	0.382					2	35	63	
▲ TP-6 @ 11 ft.	75.0	53.7	0.263				23	31	46	
◆										
x										

PROJECT NO.: 131422

Earthtec Engineering

FIGURE NO.: 13