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GEOTECHNICAL STUDY
JASON CAMPBELL PROJECT
DEL MONTE RD AND CALPAC AVE
SPANISH FORK, UTAH

Project No. 090228

March 30, 2008

Prepared For:

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Prepared By:

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1.0 INTRODUCTION

This report presents the results of a geotechnical study for a proposed residential development to be located on the southwest side of Del Monte Road, west of Calpac Avenue in Spanish Fork, Utah. The general location of the site is shown on Figure No. 1, *Vicinity Map*, at the end of this report.

The purposes of this study were to 1) evaluate the subsurface soil conditions at the site, 2) assess the engineering characteristics of the subsurface soils, and 3) 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 investigation, field and laboratory soil testing, engineering analysis, and the preparation of this report.

2.0 CONCLUSIONS

The following is a brief summary of our findings and conclusions:

a. At the locations of TP-1, TP-3, TP-4, and TP-12 we encountered fill consisting of debris (asphalt, concrete, metal, wood, etc.) extending 9½ to 11 feet below the surface. Lesser amounts of sandy/gravelly fill and disturbed soil (1 to 1½ feet) were encountered on the surface at the locations of TP-5, TP-7, and TP-10. At the remaining test pit locations we encountered Sandy Silt (ML), Silty Sand (SM), Poorly Graded Sand with silt (SP-SM) and occasional Gravel (GM) layers extending to the bottom of the test pits. Groundwater was not encountered within the depths explored.

b. Subsurface soils were not saturated and estimated to be in a medium dense/stiff state. Based upon these conditions we estimate a low liquefaction potential for the native soils we observed.

c. The fill materials observed on the site at several test pit (TP-1, 3,4 12) locations are unsuitable for structural support and should be completely removed from below foundation, floor slab, exterior concrete flatwork, and pavement areas.

d. All footings should bear entirely on undisturbed uniform native sand soils, or entirely on a minimum 18 inches of structural fill placed on undisturbed native soils. A maximum bearing capacity of 1,500 psf may be used for design of footings constructed on native soils, and 2,000 psf for footing constructed on structural fill. More details regarding foundation design can be found in Section 10.0 of this report.

e. We also observed conditions (oil drums) at the site that indicate a Phase I environmental assessment may be warranted.

These findings and conclusions should not be relied upon without reading and consulting this entire report for a more detailed description of the geotechnical evaluation and recommendations contained herein.

3.0 PROPOSED CONSTRUCTION

We understand that the proposed structures will predominately consist of single family residences, but there will also be a few multi-family structures constructed. We have based our recommendations in this report on the assumption that foundation loads for the proposed structures will not exceed 6,000 pounds per linear foot for bearing walls, 100,000 pounds for column loads, and 200 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 residences; that exterior concrete flatwork will be placed in the form of curb, gutter, and sidewalks; and that asphalt concrete paved roads will be constructed.

4.0 GENERAL SITE DESCRIPTION

At the time of our subsurface investigation the site was an old sand/gravel pit with equipment, oil drums, and other materials and debris on the surface. The ground surface at the site shows considerable variation as a result of the removal and importation of material. The site was bounded on the northwest by State Highway 164, on the northeast by Del Monte

Road, on the southeast by Calpac Avenue and State Highway 198, and on the west by scattered residences.

5.0 SUBSURFACE EXPLORATION

Under the direction of a qualified member of our geotechnical staff, subsurface explorations were conducted at the site on March 18, 2009 by excavating twelve exploratory test pits to depths of about 9 to 11 feet below the existing ground surface using a rubber tire backhoe. The approximate locations of the test pits are shown on Figure No. 2, *Site Plan and Location of Test Pits*. Graphical representations and detailed descriptions of the soils encountered are shown on Figure Nos. 3 through 14, *Test Pit Log* at the end of this report. The stratification lines shown on the logs represent the approximate boundary between soil units; the actual transition may be gradual. Due to potential natural variations inherent in soil deposits, care should be taken in interpolating between and extrapolating beyond exploration points. A key to the symbols and terms on the logs is presented on Figure No. 15, *Legend.*

The soils exposed in the test pits were classified by visual examination in the field following the guidelines of the Unified Soil Classification System (USCS). Disturbed bag samples of the native soils were collected in the test pits where native soils were encountered. 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

Selected soil samples collected in the test pits 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 tests, one-dimensional consolidation tests, liquid and plastic limits determinations, mechanical gradation analyses, And a California Bearing Ratio (CBR) test. The following table summarizes the laboratory test results, which are also included on the attached test pit logs at the respective sample depths, and on Figure No. 16, *California Bearing Ratio Test.*

Table No. 1: Laboratory Test Results

TEST PIT NO.	DEPTH (feet)	NATURAL MOISTURE (%)	GRAIN SIZE DISTRIBUTION (%)			SOIL TYPE
			GRAVEL (+ #4)	SAND	SILT/ CLAY (- #200)	
TP-2	10	28	0	40	60	ML
TP-5	2½	9	36	28	36	GM
TP-5	10	14	0	48	52	ML
TP-6	6	10	0	74	26	SM
TP-7	9½	23	0	59	41	SM
TP-8	7	9	3	84	13	SM
TP-9	8	7	0	87	13	SM
TP-10	6	9	29	54	17	SM
TP-11	1	3	16	79	5	SP-SM

7.0 SUBSURFACE CONDITIONS

7.1 Soil Types

Fill material consisting of construction debris extending to the maximum depths explored (9½ to 11 feet) and beyond, was encountered in Test Pits 1, 3, 4 and 12. Approximately 1 to 1½ feet of sandy/gravelly fill and disturbed soil was encountered on the surface at the locations of Test Pits 5, 7, and 10. Below the fill in TP-5, 7, and 10, and from the surface at the locations of TP-2, 6, 8, 9, and 11 we encountered Layers of Sandy Silt (ML), Silty Sand (SM), Poorly Graded Sand with silt (SP-SM), and occasionally Silty Gravel with sand (GM), extending to the bottom of the test pits at approximately 10 to 11 feet below the ground surface. The silt soils were estimated to have stiff consistency, and the sand and gravel soils were estimated to be in a medium dense state.

7.2 Groundwater Conditions

Groundwater was not encountered within the depths explored. Groundwater levels will fluctuate in response to the season, precipitation and snow melt, irrigation, and other on and off-site influences. Precisely quantifying these fluctuations would require long term monitoring.

8.0 SITE GRADING

8.1 General Site Grading

Unsuitable soils and vegetation should be removed from below foundation, floor slab, exterior concrete flatwork, and pavement areas. Unsuitable soils consist of topsoil, organic soils, undocumented fill, debris, soft, loose, or disturbed native soils, and any other inapt materials. We encountered significant amounts of undocumented fill consisting mostly of debris, extending to over 10½ feet in depth at some of the test pit locations, and other fill or disturbed soils extending 12 to 18 inches in depth at other test pit locations. The fill should be completely removed regardless of the depth or extent of the fill. Any topsoil encountered on other portions of the site (including soil with roots larger than about ¼ inch in diameter) should also be completely removed, along with any other unsuitable soils that may be encountered.

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. We anticipate that significant portions of the site will require grading fills once the existing fill is removed. If more than 5 feet of fill will be placed above the existing site surface elevations (to raise site grades), Earthtec should be notified so that we may assess potential settlement and make additional recommendations if needed. Such recommendations may include placing the fill several weeks prior to construction to allow settlement to occur.

8.2 Temporary Excavations

For temporary excavations less than 5 feet in depth into the native soils or into structural fill, slopes should not be made steeper than ½H:1V (Horizontal:Vertical). Temporary excavations extending up to 10 feet in depth should not be made steeper than 1H:1V. If groundwater seepage or other unstable conditions are encountered in excavations, flatter slopes, shoring, or bracing may be required.

8.3 Fill Material

Native soils generally do not appear suitable for use as structural fill due to higher fines contents, however the native sand soils in the areas of Test Pits 8, 9 and 10 may be suitable for use as structural fill because the fines contents are lower. Excavated native soils may also be stockpiled for use as fill in landscape areas. We recommend that a professional engineer or geologist verify that the structural fill to be used on this project meets our requirements, given below.

Regular structural fill should consist of imported material or excavated soils meeting the following requirements:

Maximum particle size:	4 inches
Percent retained on the 3/4 inch sieve (coarse gravel):	30 maximum
Percent passing the No. 200 sieve (fines):	15 maximum
Liquid Limit of fines:	35 maximum
Plasticity Index of fines:	15 maximum

In some situations, particles larger than 4 inches and/or more than 30% coarse gravel may be acceptable, however, compaction and compaction testing may be more difficult. As a result more strict quality control measures than normally used may be required. Such measures may include using thinner lifts, and increased or full time observation of fill placement.

Utility trenches below residences and pavements should be backfilled with structural fill. In other areas, utility trenches may be backfilled with the native soil. Depending on the fines content, native soils may be time consuming to compact due to more difficulty controlling the moisture content needed to obtain optimum compaction. All backfill soil should meet the following requirements:

Maximum particle size:	4 inches
Liquid Limit of fines:	35 maximum
Plasticity Index of fines:	15 maximum

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 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 areas not supporting structural loads:	90%
Less than 5 feet of fill below foundations, flatwork and pavements:	95%
Five or more feet of fill below foundations, flatwork and pavements:	98%

Generally, placing and compacting fill at a moisture content within 2% 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 early testing is recommended to demonstrate that placement and compaction methods are achieving the required compaction. It is the contractor's responsibility to ensure that fill materials and compaction efforts are consistent so that tested areas are representative of the entire fill.

8.5 Stabilization

Some layers of silt were encountered in the test pits, as well as sand soils with higher fines contents. 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 18 inches. Removal and replacement to a greater depth may be required.

For granular material, we recommend using angular well-graded gravel, such as pit run, or crushed rock with a maximum particle size of 4 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 500X 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 18 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 Faulting

Based upon published data, no known faults traverse the site. No surficial evidence of faulting was observed during our field investigation. The nearest mapped[1] fault trace is the Wasatch Fault located about 2½ miles southeast of the site.

9.2 Liquefaction Potential

The site is located within an area which has been mapped by the Utah Geological Survey[2] as having low liquefaction potential. Liquefaction is a phenomenon where a soil loses intergranular strength due to an increase in soil pore water pressures during a dynamic event such as an earthquake. The potential for liquefaction is based on several factors, including 1) the grain size distribution of the soil, 2) the plasticity of the fine fraction of the soil (material passing the No. 200 sieve), 3) relative density of the soil, 4) earthquake strength (magnitude) and duration, and 5) overburden pressures. In addition, the soils must be saturated for liquefaction to occur. As a part of this investigation, the potential for liquefaction to occur in the soils we encountered was assessed.

Loose, saturated sands are most susceptible to liquefaction, but soft, sensitive silt soils also have the potential to experience failure and movement during a seismic event. Subsurface soils were composed of unsaturated silts estimated to be of stiff consistency, and unsaturated sands and gravels to be in a medium dense state. In our opinion these conditions support the mapped low liquefaction potential designation.

[1] Hecker, S., 1993, Quaternary Faults and Folds, Utah, Utah Geologic Survey, Bulletin 127.

[2] Liquefaction Potential Map, Utah Geological Survey, Public Information Series 28. 1994.

9.3 IBC Site Classification

The Site Class definitions in the International Building Code (IBC) are based upon the soil properties in the upper 100 feet of the soil profile. These properties are determined from SPT 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." Based upon the native soils encountered in the test pits we recommend using Site Class D.

The site is located at approximately 40.086 degrees latitude and -111.661 degrees longitude. Using Site Class D, the design spectral response acceleration parameters are 0.869 *g* for S_{DS} (short period) and 0.542 *g* for S_{D1} (one-second period). The intermediate values from the IBC used to obtain these design parameters are contained in Table Nos. 2 and 3 below.

Table No. 2: Design Acceleration for Short Period

S_S	F_a	S_{MS}	S_{DS}
1.304 g	1.0	1.304 g	0.869 g

S_S = Mapped spectral acceleration for short periods from Figure 1615(5)
F_a = Site coefficient from Table 1615.1.2(1)
$S_{MS} = F_a \cdot S_s$ = Maximum considered earthquake spectral response accelerations for short periods
$S_{DS} = ⅔S_{MS}$ = Five-percent damped design spectral response acceleration at short periods

Table No. 3: Design Acceleration for 1 Second Period

S_1	F_v	S_{M1}	S_{D1}
0.542 g	1.5	0.813 g	0.542 g

S_1 = Mapped spectral accelerations for 1-second period from Figure 1615(6)
F_v = Site coefficient from Table 1615.1.2(2)
$S_{M1} = F_v \cdot S_1$ = Maximum considered earthquake spectral response accelerations for 1-second period
$S_{D1} = ⅔S_{MS}$ = Five-percent damped design spectral response acceleration at 1 second period

10.0 FOUNDATIONS

10.1 General

The foundation recommendations presented in this report are based on the soil conditions encountered in the test pits, 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 are significantly different, we should be notified in order to re-evaluate our design parameters and estimates (higher loads may cause more settlement), and to provide additional recommendations if necessary.

We recommend that foundations be constructed entirely on firm, undisturbed, uniform native soils, or entirely on a minimum 18 inches of structural fill placed on undisturbed native soils. For design of conventional strip and spread footings, the following parameters are recommended:

1. Lightly loaded spread footings founded on native soils should provide adequate support for the proposed structures, and may be designed using a maximum allowable bearing capacity of 2,000 pounds per square foot. If a higher bearing capacity is needed, footings may be founded on a minimum 18 inches of structural fill and designed using a maximum allowable bearing capacity of 2,500 pounds per square foot. These bearing pressures may be increased by 33 percent for transient loadings.

2. Continuous and spot footings should be uniformly loaded and should have a minimum width of 20 and 30 inches, respectively.

3. Exterior footings should be placed below frost depth which is determined by local building codes. Generally 30 inches of cover is adequate for this site. Interior footings, not subject to frost, should extend at least 18 inches below the lowest adjacent grade.

4. Foundation walls on continuous footings should be well reinforced. We suggest a minimum amount of steel equivalent to that required for a simply supported span of 12 feet.

5. 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.

6. Footing excavations should be observed by the geotechnical engineer prior to placement of the footings 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.

10.2 Estimated Settlement

If the proposed foundations are properly designed and constructed using the parameters provided above, we estimate the risk of total settlement exceeding 1 inch and differential settlement exceeding ½ inch for a 25-foot span will be low. Additional settlement or movement could occur during an earthquake due to ground shaking, if more than 5 feet of fill is placed above the existing site surface, or if foundation soils are allowed to become wetted.

10.3 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 dependant 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 occur at about 1/3 the height of the wall, while for seismic conditions the resultant forces occur at about 0.6 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 34 degree friction angle and a dry unit weight of 125 pounds per cubic foot.

Table No. 4: Lateral Earth Pressures

CONDITION	LATERAL PRESSURE COEFFICIENT	EQUIVALENT FLUID PRESSURE (pcf)
Active	0.28	35
At-Rest (Rankine)	0.44	55
Passive (Rankine)	3.54	440

These pressure values are based on drained conditions. 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.

Resistance to sliding may incorporate the friction acting along the base of foundations, which may be computed using a coefficient of friction of 0.45 for native soils and 0.70 for structural fill meeting the recommendations presented herein. These values may be increased by one-third for transient wind and seismic loads.

The pressure and coefficient values presented above are ultimate; therefore an appropriate factor of safety may need to be applied to these values for design purposes. The appropriate factor of safety will depend on the design condition and should be determined by the project structural engineer.

11.0 FLOOR SLABS

To facilitate construction, act as a capillary break, and aid in distributing floor loads we recommend that all at-grade slabs and exterior flatwork be underlain by 4 inches of free-draining granular material such as "pea" gravel or ¾- to 1-inch minus clean gravel supported on firm native soils or structural fill.

To help control normal shrinkage and stress cracking the floor slabs should have the following features:

1. Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints;
2. Frequent crack control joints; and
3. 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 MOISTURE CONTROL AND 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. We recommend the following:

1. 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.**
2. The ground surface should be graded to drain away from the building in all directions. We recommend a minimum fall of 6 inches in the first 10 feet.

3. 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.

4. Sprinklers should be aimed away from foundation walls. Sprinkler systems should be well maintained, checked for leaks frequently, and repaired promptly.

5. Any additional precautions which may become evident during construction.

13.0 PAVEMENT RECOMMENDATIONS

We assume that asphalt concrete paved residential streets will be constructed as part of the project. We have based our pavement design on the near surface native silt soils encountered in some of the test pits. A sample of these soils was collected near the location of TP-11 and a California Bearing Ratio (CBR) test was performed. Test results indicate a CBR value of value of 20.

For the residential streets we anticipate the traffic volume will be about 200 vehicles a day or less, consisting of mostly cars and pickup trucks, 4 school buses per day, with some delivery trucks, and a weekly garbage truck. Based upon the site plan provided to our office it appears that Del Monte Road will be realigned as part of the project. We anticipate this road will be a collector street and experience a higher traffic volume which could include heavy truck traffic. We have assumed 500 vehicles per day with 2% heavy trucks. Based on these parameters and the Spanish Fork City Standards (June 2002), we recommend the minimum asphalt pavement section presented in the table below.

Table No. 5: Pavement Section Design

ROAD	ASPHALT THICKNESS (in)	COMPACTED ROADBASE THICKNESS (in)	COMPACTED SUBBASE THICKNESS (in)
Interior residential	2½	8	0*
Del Monte realignment	3	8	0*

* Stabilization may be required

If the interior residential roads will be required to support construction traffic, more than an occasional semi-tractor truck, or more traffic than listed above for either road, our office should be notified so that we can re-evaluate the pavement section recommendations. The following also apply:

1. The subgrade is prepared by proof rolling to a firm, non-yielding surface and soft areas are stabilized as discussed in Section 8.1;
2. Site grading fills below the pavements meet structural fill material and placement requirements as defined in Section 8.2;
3. Asphaltic concrete, aggregate base, and sub-base should meet should meet Spanish Fork requirements.
4. Aggregate base and sub-base is compacted to at least 95 percent of maximum dry density (ASTM D 1557); and
5. Asphaltic concrete is compacted to at least 96 percent of the laboratory Marshal Mix design density (ASTM D 1559).

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.

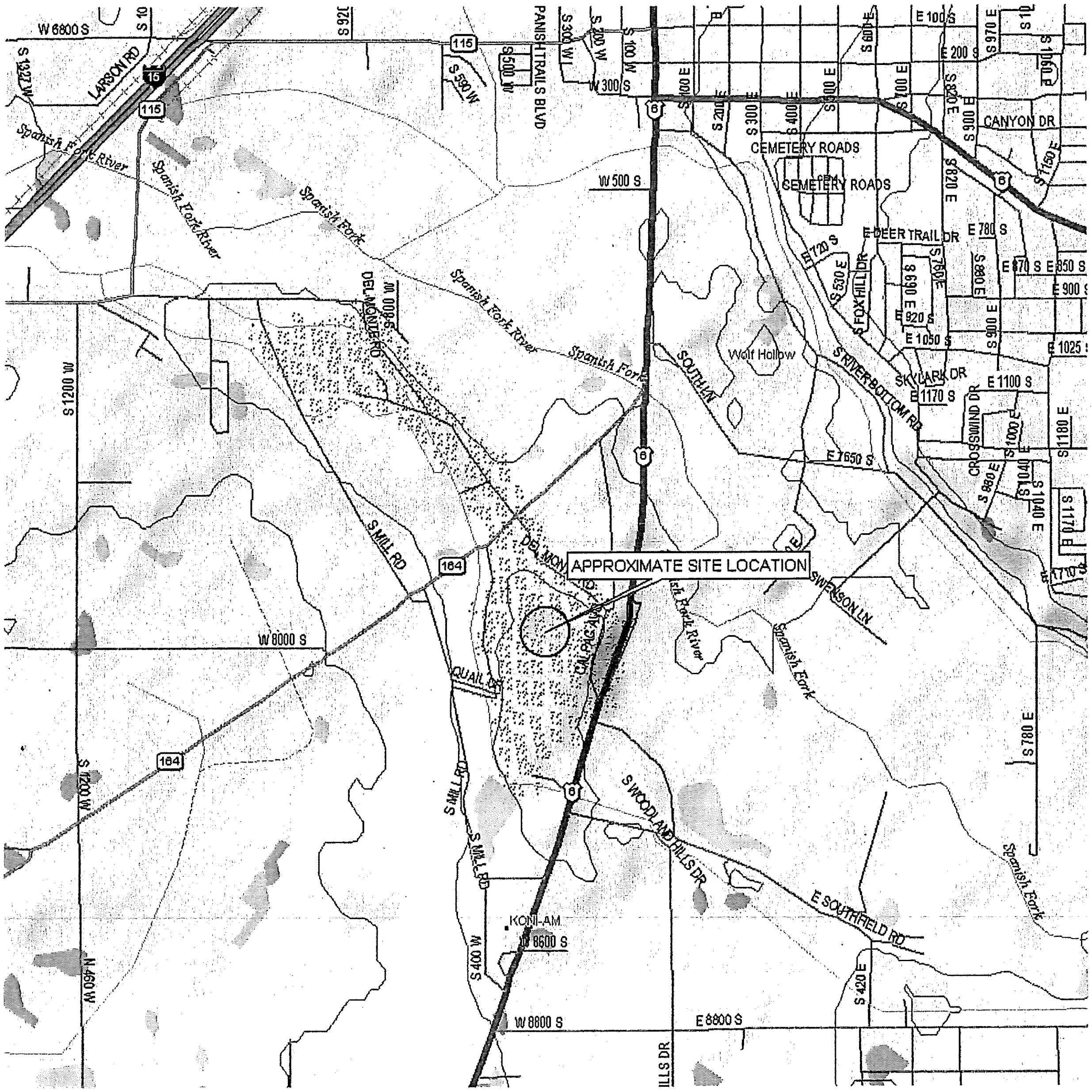
The geotechnical study as presented in this report was conducted within the limits prescribed by our client, with the usual thoroughness and competence of the engineering profession in the area. No other warranty or representation, either expressed or implied, is intended in our proposals, contracts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

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).

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

VICINITY MAP

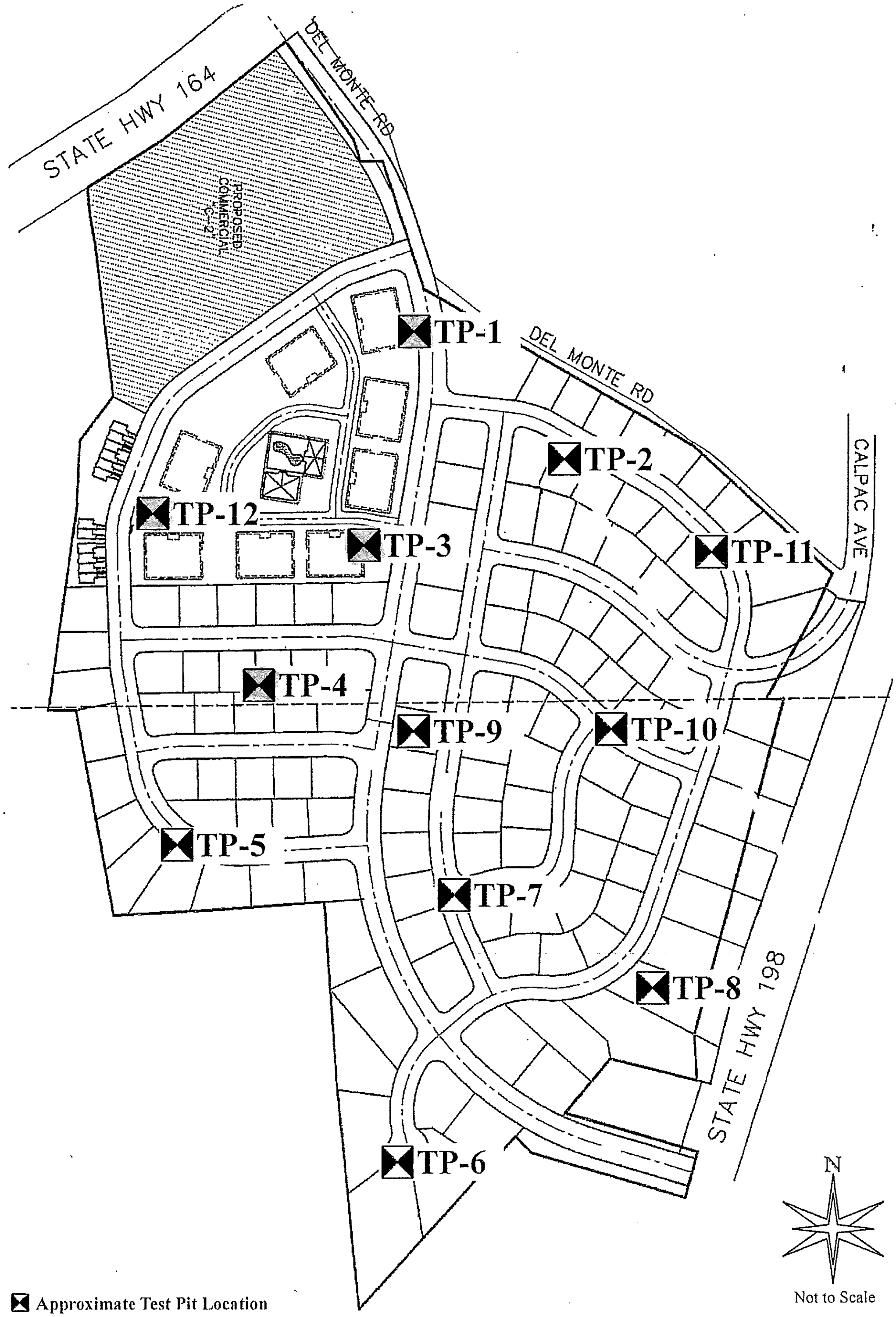
JASON CAMPBELL PROJECT



PROJECT NO.: 090228	Earthtec Engineering Inc.	FIGURE NO.: 1

SITE PLAN & LOCATION OF TEST PITS

JASON CAMPBELL PROJECT



PROJECT NO.: 090228	Earthtec Engineering Inc.	FIGURE NO.: 2

TEST PIT LOG

NO.: TP- 1

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–10.5			FILL: Debris (asphalt, concrete, bricks, metal, wood, wire).									
10.5–12			Bottom at approximately 10.5 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 3

LOG OF TESTPIT 090228 LOGS.GPJ EARTHTEC.GDT 3/26/09

TEST PIT LOG
NO.: TP- 2

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽:

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼:

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–10.5		ML	Sandy SILT, thinly bedded, trace gravel, stiff, slightly moist, brown.									
10				X	28				0	40	60	
10.5			Bottom at approximately 10.5 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 4

TEST PIT LOG
NO.: TP- 3

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–11			FILL: Debris (asphalt, concrete, bricks, metal, wood, wire).									
11–12			Bottom at approximately 11 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 5

LOG OF TESTPIT 090228 LOGS.GPJ EARTHTEC.GDT 3/26/09

TEST PIT LOG

NO.: TP- 4

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–10			FILL: Debris (asphalt, concrete, bricks, metal, wood, wire).									
10–12			Bottom at approximately 10 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 6

LOG OF TESTPIT 090228 LOGS.GPJ EARTHTEC.GDT 3/26/09

TEST PIT LOG
NO.: TP- 5

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
					TEST RESULTS							
0–1.5			FILL: Sand, gravel, disturbed soils.									
1.5–5		GM	SILTY GRAVEL with sand, medium dense, slightly moist, dark brown.	X	9				36	28	36	
5–10.5		ML	Sandy SILT, stiff; slightly moist, light brown.	X	14				0	48	52	
10.5–12			Bottom at approximately 10.5 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 7

TEST PIT LOG

NO.: TP- 6

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽:

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼:

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–11		SM	SILTY SAND, medium dense, moist, light brown.									
~6				X	10				0	74	26	
11–12			Bottom at approximately 11 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 8

TEST PIT LOG

NO.: TP- 7

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1			FILL: Sand, gravel, disturbed soils.									
1–10		SM	SILTY SAND, medium dense, moist, light brown.									
10				X	23				0	59	41	
10–12			Bottom at approximately 10 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 9

LOG OF TESTPIT 090228 LOGS.GPJ EARTHTEC.GDT 3/26/09

TEST PIT LOG
NO.: TP- 8

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽:

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼:

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–10		SM	SILTY SAND, thinly bedded, some gravel, medium dense, moist, light brown to brown.									
~7.5				X	9				3	84	13	
10–12			Bottom at approximately 10 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 10

TEST PIT LOG

NO.: TP- 9

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–10		SM	SILTY SAND, trace gravel, medium dense, moist, brown.									
8				X	7				0	87	13	
10–12			Bottom at approximately 10 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 11

LOG OF TESTPIT 090228 LOGS.GPJ EARTHTEC.GDT 3/26/09

TEST PIT LOG
NO.: TP-10

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1.5			FILL: Sand, gravel, disturbed soils.									
1.5–10.5		SM	SILTY SAND with gravel, medium dense, moist, light brown.									
6				X	9				29	54	17	
10.5			Bottom at approximately 10.5 feet.									

Notes: No groundwater encountered.

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

TEST PIT LOG
NO.: TP-11

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ∇ :

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼ :

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–9		SP-SM	POORLY GRADED SAND wih silt and gravel, thinly bedded, medium dense, moist, brown.	X (1–2 ft)	3				16	79	5	CBR
9–12			Bottom at approximately 9 feet.									

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.: 090228

Earthtec Engineering Inc.

FIGURE NO.: 13

LOG OF TESTPIT 090228 LOGS.GPJ EARTHTEC.GDT 3/31/09

TEST PIT LOG

NO.: TP-12

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
LOCATION: Refer to Figure 2.
OPERATOR: Halls
EQUIPMENT: RTB
DEPTH TO WATER; INITIAL ▽:

PROJECT NO.: 090228
DATE: 03/18/09
ELEVATION: NM
LOGGED BY: S.H.
AT COMPLETION ▼:

Depth (Ft.)	Graphic Log	USCS	Description	Samples	Water Cont. (%)	Dry Dens. (pcf)	LL	PI	Gravel (%)	Sand (%)	Fines (%)	Other Tests
0–1			FILL: Roadbase.									
1–9.5			FILL: Debris (asphalt, concrete, bricks, metal, wood, wire).									
9.5			Bottom at approximately 9.5 feet.									
12												

Notes: No groundwater encountered.

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

LEGEND

PROJECT: Jason Campbell Project
CLIENT: Northern Engineering
DATE: 03/18/09
LOGGED BY: S.H.

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

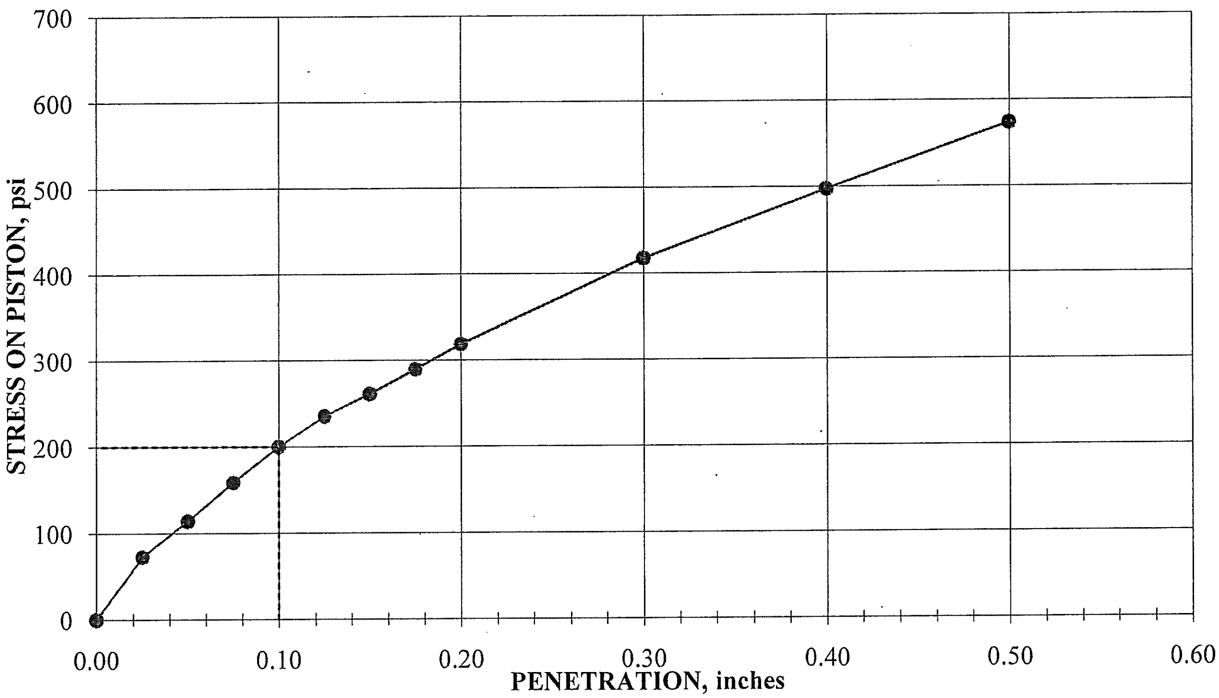
WATER SYMBOLS

- ∇ 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.: 090228 | Earthtec Engineering Inc. | **FIGURE NO.:** 15

CALIFORNIA BEARING RATIO TEST



Project:	**Jason Campbell**
Compaction Method:	**ASTM D698 Method C**
Sample Identification:	**TP-11 @ 1'**
Maximum Dry Density, pcf:	**103.9**
Optimum Moisture Content, %:	**15.1**
Dry Density Before Soaking, pcf:	**102.9**
Dry Density After Soaking, pcf:	---
Relative Compaction, %:	**99**
Moisture Content Before Compaction, %:	**2.9**
Moisture Content At Compaction, %:	**15.1**

Quantities;	Gravel, %:	**16**
	Sand, %:	**79**
	Silt/Clay, %:	**5**
Liquid Limit:		---
Plasticity Index:		---
Material Description:		**POORLY GRADED SAND with silt (SP-SM)**
Surcharge Weight, lb:		**10**
Soaking Period, hr:		**96**
Swell, %:		**0.0**

CBR Value, %: **20.0**

PROJECT NO.: 090228	Earthtec Engineering Inc.	**FIGURE NO.:** 16