GEOTECHNICAL INVESTIGATION, PROPOSED RESIDENTIAL DEVELOPMENT, WEST OF EAST AVENUE AND APPROXIMATELY 500 FEET NORTH OF FOOTHILL BOULEVARD, APN 1100-191-04-000, CITY OF RANCHO CUCAMONGA, CALIFORNIA

Prepared For:

STRATHAM HOMES
2201 Dupont Drive, Suite 300
Irvine, California 92612

Project No. 11406.001

October 5, 2016

Leighton and Associates, Inc.
A LEIGHTON GROUP COMPANY

Leighton and Associates, Inc.
A LEIGHTON GROUP COMPANY

October 5, 2016

Project No. 11406.001

To: Stratham Homes
2201 Dupont Drive, Suite 300
Irvine, California 92612

Attention: Mr. Brandon Roth

Subject: Geotechnical Investigation, Proposed Residential Development, West of East Avenue and Approximately 500 Feet North of Foothill Boulevard, APN 1100-191-04-000, City of Rancho Cucamonga, California

In accordance with your authorization, Leighton and Associates, Inc. has conducted this geotechnical investigation for the proposed residential development located west of East Avenue and approximately 500 feet north of Foothill Boulevard (APN 1100-191-04-000) in the City of Rancho Cucamonga, California. The purpose of this study has been to evaluate the general geotechnical conditions at the site with respect to the proposed development and provide preliminary geotechnical recommendations for design and construction.

Based on this investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. The most significant geotechnical issues at the site are those related to the potential for strong seismic shaking and potentially compressible soils. Good planning and design of the project can limit the impact of these constraints. This report presents our preliminary findings, conclusions, and geotechnical recommendations for the project.

10532 Acacia Street, Suite B-6 ▪ Rancho Cucamonga, CA 91730-5455
909.484.2205 ▪ 909.484.2170 Fax

We appreciate the opportunity to work with you on the development of this project. If you have any questions regarding this report, please call us at your convenience.

Respectfully submitted,

LEIGHTON AND ASSOCIATES, INC.

Jason D. Hertzberg, GE 2711
Principal Engineer

Philip A. Buchiarelli, CEG 1715
Principal Geologist

JMD/SGO/rsm

Distribution: (1) Electronic Copy to the Addressee

TABLE OF CONTENTS

Section Page

TABLE OF CONTENTS

Section | Page

Figures

Appendices

1.0 INTRODUCTION

1.1 Site Location and Description

The site is approximately 11 acres in area and is located on the west side of East Avenue and approximately 500 feet north of Foothill Boulevard in the City of Rancho Cucamonga, California (see Figure 1). According to the San Bernardino County Assessor's office, the Assessor Parcel Number (APN) of the site is 1053-091-010-000.

The site is relatively flat and drains towards the southwest. The property is currently vacant and undeveloped with existing Southern California Edison High Voltage powerlines and Southern California Gas easements in the approximate northeastern half of the site (see Figure 4). To the northwest of the site is a Metropolitan Water District Southern California easement, to the northeast (beyond East Avenue) is a parking lot, to the east (also beyond East Avenue) are existing residences, and to the south is a Chino Basin Watermaster municipal facility and vacant land. An aerial photograph from 1959 shows that the site was previously used for agricultural crops.

1.2 Proposed Development

A conceptual plan but no grading plans for the proposed development were available during our investigation. Based on the 60-scale "East Avenue, Rancho Cucamonga, CA Conceptual Site Plan – Townhomes" by Architects Orange, dated September 8, 2016, we understand a residential development consisting of 14 multi-family residential buildings consisting of a total of 88 units with associated parkways, parking lots, and a dog park are planned for the site.

1.3 Purpose of Investigation

The purpose of this study has been to evaluate the general geotechnical conditions at the site with respect to the proposed development and provide preliminary geotechnical recommendations for design and construction. We assume that minor cuts and fills will be required to achieve design grade.

Our geotechnical exploration included hollow-stem auger soil borings, laboratory testing and geotechnical analysis to evaluate existing subsurface conditions and develop the recommendations contained in this report. We also conducted infiltration testing to evaluate general infiltration characteristics at the locations and depths tested for water quality facility design.

1.4 Scope of Investigation

The scope of our study has included the following tasks:

- Background Review: We reviewed available, relevant geotechnical and geologic maps and reports and aerial photographs available from our in-house library. This included a review of geotechnical reports previously prepared for the site.

- Utility Coordination: We contacted Underground Service Alert (USA) prior to excavating borings and test pits so that utility companies could mark utilities onsite.

- Field Exploration: Our field investigation included drilling, logging, and sampling four hollow-stem auger borings (LB-1 through LB-4) at representative locations in the area of the proposed improvements. Each of these borings were drilled to depths ranging from approximately 21.5 feet to 51.5 feet below the existing ground surface (bgs). Encountered earth materials were logged in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D 2488). Relatively undisturbed soil samples were obtained at selected intervals within these borings using both a California ring-lined sampler and a Standard Penetration Test (SPT) split-spoon sampler. Sampling resistance blow counts were obtained by dropping a 140-pound automatic hammer through a 30-inch free fall onto a sampling rod anvil. A 2-inch outside diameter SPT sampler was driven 18 inches without an inner liner (though the sampler can accommodate a liner, as is typical of these samplers in this area) and the number of blows was recorded for each 6 inches of penetration (ASTM D 1586). Representative bulk soil samples were also collected at shallow depths. Logs of the geotechnical borings are presented in Appendix B. Approximate boring locations are shown on the accompanying *Exploration and Test Location Map*, Figure 4.

  Twelve well permeameter tests were conducted within borings (WP-1 and WP-12) to evaluate general infiltration characteristics of the subsurface soils at the depths and locations tested. The well permeameter tests were conducted based on the USBR-89 method. Tests were conducted at depths of 4.8 to 15.0 feet bgs to estimate the infiltration rate.

All excavations were backfilled with the soil cuttings. Logs of the geotechnical borings are presented in Appendix B and the well permeameter test results are presented in Appendix D. Approximate boring and well permeameter test locations are shown on the accompanying *Exploration and Test Location Map*, Figure 4.

- <u>Geotechnical Laboratory Testing:</u> Geotechnical laboratory tests were conducted on selected relatively undisturbed and bulk soil samples obtained during our field investigation. This laboratory testing program was designed to evaluate engineering characteristics of site soils. Laboratory tests conducted during this investigation include:

  - In situ moisture content and dry density
  - Maximum dry density and optimum moisture content
  - Sieve analysis and hydrometer for grain-size distribution
  - Water-soluble sulfate concentration
  - Resistivity, chloride content and pH

  The in situ moisture content and dry density test results are shown on the boring logs, Appendix B. The other laboratory test results are presented in Appendix C.

- <u>Engineering Analysis</u>: Data obtained from our background review, field exploration and geotechnical laboratory testing was evaluated and analyzed to develop geotechnical conclusions and provide preliminary recommendations presented in this report.

- <u>Report Preparation</u>: Results of our preliminary geotechnical investigation have been summarized in this report, presenting our findings, conclusions and preliminary geotechnical recommendations for design and construction of the proposed development.

2.0 FINDINGS

2.1 Regional Geologic Conditions

The site is located in the north-central portion of the Chino Basin in the northern area of the Peninsular Ranges Geomorphic Province. The Chino Basin is a broad valley bounded by the San Gabriel and San Bernardino Mountains to the north, the Puente Hills to the southwest, and the Jurupa Hills to the southeast. The site is underlain by early and middle Holocene alluvial fan deposits (see Figure 2). The subject property is located approximately 4.5 miles south of the Cucamonga Fault Zone and approximately 6.8 miles southwest of the San Bernardino section of the San Jacinto Fault Zone (see Figure 3).

2.2 Subsurface Soil Conditions

Based upon our review of pertinent geotechnical literature and our subsurface exploration, the site is underlain by alluvial fan deposits. The alluvial soil encountered within our excavations generally consisted of combinations of silty sand, sand, gravel with coarse sand, and minor amounts of clayey silt. The silty sand were described as loose to medium dense and contained approximately 15 percent fines with trace gravel typically up to 0.5 inch in dimension. Layers of sand encountered in the borings typically were medium dense to very dense, coarse-grained with gravel up to 2 inches in dimension. Gravel was encountered in the borings at depths of approximately 15 or 20 feet below the surface. The gravel was described as dense to very dense, angular to sub angular, with dimensions up to 2.5 inches. Although cobbles and boulders were not observed, we cannot rule out their presence in the near-surface, as the borings were 8 to 10 inches in diameter with a 4-inch hollow stem opening.

The in-situ dry density of the soils encountered in our borings ranged from 108.3 pcf to 131.2 pcf with moisture content ranging from 0.9 to 2.8 percent. More detailed descriptions of the subsurface soil are presented on the boring logs (Appendix B).

2.2.1 Compressible and Collapsible Soil

Soil compressibility refers to a soil's potential for settlement when subjected to increased loads as from a fill surcharge. Based on our investigation, the near surface alluvial soil encountered is generally considered slightly to moderately compressible. Partial removal and recompaction of this material under shallow foundations is recommended to reduce the potential for adverse total and differential settlement of the proposed improvements.

Collapse potential refers to the potential settlement of a soil under existing stresses upon being wetted. Due to the nature of the soil and the high-energy deposition environment of soil deposits in the region, we anticipate collapse potential to be minor. Collapse potential is not typically a concern for the area.

2.2.2 Expansive Soils

Expansive soils contain significant amounts of clay particles that swell considerably when wetted and shrink when dried. Foundations constructed on these soils are subjected to large uplifting forces caused by the swelling. Without proper measures taken, heaving and cracking of building foundations and slabs-on-grade could result.

Soils observed in our exploratory borings consisted of granular materials (silty sand, coarse sand with gravel, and gravel with coarse sand). These soils are expected to have very low expansion potential.

2.2.3 Sulfate Content

Water-soluble sulfates in soil can react adversely with concrete. However, concrete in contact with soil containing sulfate concentrations of less than 0.1 percent by weight is considered to have negligible sulfate exposure based on the American Concrete Institute (ACI) publication 318-14, Section 19.3 (ACI, 2014), adopted by the 2013 CBC (Section 1904A.2).

A near-surface soil sample was tested during this investigation for soluble sulfate content. The results of these tests indicate a sulfate content of approximately 0.03 percent by weight, indicating negligible sulfate exposure. As such, the soils exposed at pad grade are not expected to pose a significant potential for sulfate reaction with concrete.

2.2.4 Resistivity, Chloride and pH

Soil corrosivity to ferrous metals can be estimated by the soil's electrical resistivity, chloride content and pH. In general, soil having a minimum resistivity between 1,000 and 2,000 ohm-cm is considered corrosive, and soil having a minimum resistivity less than 1,000 ohm-cm is considered severely corrosive. Soil with a chloride content of 500 parts-per-million (ppm) or more is considered corrosive to ferrous metals.

As a screening for potentially corrosive soil, a representative soil sample was tested during this investigation to determine its minimum resistivity, chloride content, and pH. The tests indicated a minimum resistivity of 4160 ohm-cm, chloride content of 10 ppm, and pH of 6.5. Based on the minimum resistivity, the onsite soil is considered moderately corrosive to ferrous metals.

2.3 Groundwater

Groundwater was not encountered in our borings excavated to a maximum depth of 51.5 feet below the existing ground surface (bgs). The Chino Basin Watermaster reported groundwater levels onsite on the order of 500 feet bgs both in the Fall of 2006 and the Spring of 2012. Measurement from a nearby well for the Chino Basin Watermaster indicated the highest groundwater level of approximately 575 feet bgs from March 2011 through May 2016. Based on these sources, groundwater has historically been deep, and shallow groundwater is not expected to impact the site.

2.4 Infiltration Testing

Twelve well permeameter tests (WP-1 through WP-12) were conducted to evaluate infiltration characteristics at specific locations and depths at the site (see Figure 4 for locations). The well permeameter tests were conducted at depths between approximately 4.8 to 15.0 feet below the ground surface.

Well permeameter tests are useful for field measurements of soil infiltration rates, and are suited for testing when the design depth of the basin or chamber is deeper than current existing grades. It should be noted that this is a clean-water, small-scale test, and that correction factors need to be applied. The test consists of excavating a boring to the depth of the test. Since these soils readily caved, temporary perforated casing was lowered into the borings through the hollow-stem augers, and then the augers were removed. Soils typically collapsed to within several feet of the surface upon auger removal. A float valve, lowered into the boring inside the temporary casing, adds water stored in barrels at the top of the hole to the boring as water infiltrates into the soil, while maintaining a relatively constant water head in the boring. The incremental infiltration rate as measured during intervals of the test is defined as the incremental flow rate of water infiltrated, divided by the surface area of the infiltration interface. The test was conducted based on the USBR 7300-89 test method.

2.5 Faulting and Seismicity

Our review of available in-house literature indicates that there are no known active faults traversing the site. The closest known active or potentially active fault is the Cucamonga fault, located approximately 4.5 miles north of the site.

The principal seismic hazard that could affect the site is ground shaking resulting from an earthquake occurring along several major active or potentially active faults in southern California. The known regional active and potentially active faults that could produce the most significant ground shaking at the site include the Cucamonga Fault, the San Bernardino section of the San Jacinto Fault Zone, the San Jose Fault, the Southern branch and the San Bernardino section of the San Andreas Fault Zone, and the Sierra Madre Fault Zone (Blake, 2000).

Based on ASCE 7-10 Equation 11.8-1, the site-specific Peak Horizontal Ground Acceleration (PGA_M) is 0.55g. As an added check, PGA and hazard deaggregation were also estimated using the United States Geological Survey's (USGS) 2008 Interactive Deaggregations utility. The results of this analysis indicate that the predominant modal earthquake has a PGA of 0.84g with magnitude of approximately 6.6 (M_W) at a distance on the order of 7 kilometers for the Maximum Considered Earthquake (2% probability of exceedance in 50 years); results are included in Appendix E. Based on this, the corresponding PGA for the design earthquake (2/3 of the MCE) is 0.56g. This is not an exhaustive site-specific analysis, yet is useful in evaluating the general seismic potential at the site as an added check. Based on the above, we have selected a PGA of 0.56g for seismic analysis of the onsite soils.

2.6 Secondary Seismic Hazards

In general, secondary seismic hazards for sites in the region could include soil liquefaction, earthquake-induced settlement, lateral displacement, landsliding, and earthquake-induced flooding. The potential for secondary seismic hazards at the site is discussed below.

2.6.1 Liquefaction Potential

Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during severe ground shaking. Liquefaction is associated primarily with loose (low density), saturated, fine-to-medium grained, cohesionless soils. As the shaking action of an earthquake progresses, the soil grains are rearranged and the soil densifies within a short period of time. Rapid densification of the soil results in a buildup of pore-water pressure. When the pore-water pressure approaches the total overburden pressure, the soil reduces greatly in strength and temporarily behaves similarly to a fluid. Effects of liquefaction can include sand boils, settlement, and bearing capacity failures below structural foundations.

The site has not been mapped by the State of California or the County of San Bernardino for liquefaction potential.

Based on our study, current groundwater levels are deeper than 51.5 feet bgs and historical groundwater levels are on the order of 500 feet bgs. As such, the potential for liquefaction at the site is very low.

2.6.2 Seismically Induced Settlement

Seismically induced settlement consists of dry dynamic settlement (above groundwater) and liquefaction-induced settlement (below groundwater). During a strong seismic event, seismically induced settlement can occur within loose to moderately dense sandy soil due to reduction in volume during, and shortly after, an earthquake event. Settlement caused by ground shaking is often nonuniformly distributed, which can result in differential settlement.

We have performed analyses to estimate the potential for seismically induced settlement using the method of Tokimatsu and Seed (1987), and based on Martin and Lew (1999), considering the maximum considered earthquake (MCE) peak ground acceleration (PGA_M). The results of our analyses suggest that the onsite soils are susceptible to less than 1.0 inch of seismic settlement based on the MCE. Differential settlement due to seismic loading is assumed to be less than ½ inch over a horizontal distance of 40 feet based on the MCE. This level of seismic settlement does not present a significant risk for building collapse.

2.6.3 Seismically Induced Landslides

The site is generally level without significant slopes. This site is not considered susceptible to static slope instability or seismically induced landslides.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Based on this investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. No severe geologic or soils related issues were identified that would preclude development of the site for the proposed improvements. The most significant geotechnical issues at the site are those related to the potential for strong seismic shaking and potentially compressible soils. Good planning and design of the project can limit the impact of these constraints. Remedial recommendations for these and other geotechnical issues are provided in the following sections.

Although not identified during this investigation, abandoned septic tanks, seepage pits, or other buried structures, trash pits, or items related to past site uses may be present. If such items were encountered during grading, they would require further evaluation and special consideration.

3.1 General Earthwork and Grading

All grading should be performed in accordance with the General Earthwork and Grading Specifications presented in Appendix F, unless specifically revised or amended below or by future recommendations based on final development plans.

3.1.1 Site Preparation

Prior to construction, the site should be cleared of vegetation, trash and debris, which should be disposed of offsite. Any underground obstructions should be removed as should large tress and their root systems. Resulting cavities should be properly backfilled and compacted. Efforts should be made to locate existing utility lines. Those lines should be removed or rerouted if they interfere with the proposed construction, and the resulting cavities should be properly backfilled and compacted. Trees should be removed.

3.1.2 Overexcavation and Recompaction

To reduce the potential for adverse differential settlement of the proposed improvements, the underlying subgrade soil should be prepared in such a manner that a uniform response to the applied loads is achieved.

For structures with shallow foundations, we recommend that all uncontrolled artificial fill onsite be removed. Our exploratory borings indicated that the uncontrolled artificial fill is between 2.5 and 5 feet thick across the site. Alluvial soils should also be overexcavated and recompacted to a minimum depth of 3 feet below the bottom of the proposed footings or 5 feet below existing grade, whichever is deeper. Overexcavation and recompaction should extend a minimum horizontal distance of 5 feet from perimeter edges of the proposed footings.

Local conditions may require that deeper overexcavation be performed; such areas should be evaluated by Leighton during grading.

Areas outside these overexcavation limits planned for asphalt or concrete pavement, flatwork, and site walls, and areas to receive fill should be overexcavated to a minimum depth of 24 inches below the existing ground surface or 24 inches below the proposed subgrade, whichever is deeper.

After completion of the overexcavation, and prior to fill placement, the exposed surfaces should be scarified to a minimum depth of 6 inches, moisture conditioned to or slightly above optimum moisture content, and recompacted to a minimum 90 percent relative compaction, relative to the ASTM D 1557 laboratory maximum density.

These recommendations should be reviewed once a grading plan is available.

3.1.3 Fill Placement and Compaction

The onsite soil is suitable for use as compacted structural fill, provided it is free of debris and oversized material (greater than 8 inches in largest dimension). Any soil to be placed as fill, whether onsite or imported material, should be reviewed and possibly tested by Leighton.

All fill soil should be placed in thin, loose lifts, moisture conditioned, as necessary, and compacted to a minimum 90 percent relative compaction. Relative compaction should be determined in accordance with ASTM Test Method D1557. Aggregate base for pavement should be compacted to a minimum of 95 percent relative compaction.

3.1.4 Import Fill Soil

If import soil is to be placed as fill, it should be geotechnically accepted by Leighton. Preferably at least 3 working days prior to proposed import to the site, the contractor should provide Leighton pertinent information of the proposed import soil, such as location of the soil, whether stockpiled or native in place, and pertinent geotechnical reports if available. We recommend that a Leighton representative visit the proposed import site to observe the soil conditions and obtain representative soil samples. Potential issues may include soil that is more expansive than onsite soil, soil that is too wet, soil that is too rocky or too dissimilar to onsite soils, oversize material, organics, debris, etc.

3.1.5 Shrinkage and Subsidence

The change in volume of excavated and recompacted soil varies according to soil type and location. This volume change is represented as a percentage increase (bulking) or decrease (shrinkage) in volume of fill after removal and recompaction. Subsidence occurs as in-place soil (e.g., natural ground) is moisture-conditioned and densified to receive fill, such as in processing an overexcavation bottom. Subsidence is in addition to shrinkage due to recompaction of fill soil. Field and laboratory data used in our calculations included laboratory-measured maximum dry densities for soil types encountered at the subject site, the measured in-place densities of soils encountered and our experience. We preliminarily estimate the following earth volume changes will occur during grading:

Table 1 - Shrinkage and Subsidence

Shrinkage	Approximately 15 +/- 5 percent
Subsidence (overexcavation bottom processing)	Approximately 0.15 foot

The level of fill compaction, variations in the dry density of the existing soils and other factors influence the amount of volume change. Some adjustments to earthwork volume should be anticipated during grading of the site.

3.1.6 Rippability and Oversized Material

Oversized material (rock or rock fragments greater than 8 inches in dimension) was not observed during our investigation. Although cobbles and boulders were not observed in our borings, we cannot rule out their presence in the near-surface, as the borings were 8 to 10 inches in diameter with a 4-inch hollow stem opening. Because each of the borings encountered gravel at depths around 15 or 20 feet bgs, deep excavations should consider oversize materials at this depth.

3.2 Recommendations for Foundations

Based on our investigation, conventional shallow foundations may be used to support the loads of 1- to 3-story concrete, masonry and/or wood-frame structures. Overexcavation and recompaction of the footing subgrade soil should be performed as detailed in Section 3.1. If taller structures are planned additional evaluation should be provided based on the proposed design.

3.2.1 Minimum Embedment and Width

Footings for one to three-story structures should have a minimum embedment depth in accordance with California Building Code (CBC) requirements, with a minimum width of 24 and 15 inches for isolated and continuous footings, respectively.

3.2.2 Allowable Bearing

An allowable bearing pressure of 2,000 pounds-per-square-foot (psf) may be used, based on the minimum embedment depth and width above. This allowable bearing value may be increased by 300 psf per foot increase in depth or width to a maximum allowable bearing pressure of 4,000 psf. If additional allowable bearing pressure is needed, this should be evaluated on a case-by-case basis. These allowable bearing pressures are for total dead load and sustained live loads. Footing reinforcement should be designed by the structural engineer, but as a minimum, footings should have one No. 4 rebar top and bottom.

3.2.3 Lateral Load Resistance

Soil resistance available to withstand lateral loads on a shallow foundation is a function of the frictional resistance along the base of the footing and the passive resistance that may develop as the face of the structure tends to move into the soil. The frictional resistance between the base of the foundation and the subgrade soil may be computed using an allowable coefficient of friction of 0.35. The passive resistance may be computed using an allowable equivalent fluid pressure of 250 pounds per cubic foot (pcf), assuming there is constant contact between the footing and undisturbed soil. Friction and passive pressure may be combined without reduction, provided the footings can move laterally sufficiently to develop passive pressure (approximately ¼ inch); otherwise, friction alone should be assumed.

3.2.4 Increase in Bearing and Friction - Short Duration Loads

The allowable bearing pressure and coefficient of friction values may be increased by one-third when considering loads of short duration, such as those imposed by wind and seismic forces.

3.2.5 Settlement Estimates

The recommended allowable bearing pressure is generally based on a total allowable, post-construction settlement of 1½ inches. Differential settlement due to static loading is estimated at ¾ inch over a horizontal distance of 30 feet. Since settlement is a function of footing sustained load, size and contact bearing pressure, differential settlement can be expected between adjacent columns or walls where a large differential loading condition exists.

3.3 Recommendations for Slabs-On-Grade

Slabs-on-grade should be designed by the structural engineer in accordance with the current CBC for a soil with a very low expansion potential. Where conventional light floor loading conditions exist, the following minimum recommendations should be used. More stringent requirements may be required by local agencies, the structural engineer, the architect, or the CBC. Laboratory testing should be conducted at the end of rough grading to evaluate the expansion index of near-surface subgrade soils. Slabs-on-grade should have the following minimum recommended components:

- Subgrade Moisture Conditioning: The subgrade soil should be moisture conditioned to 2 percentage points above optimum moisture content to a minimum depth of 12 inches prior to placing the moisture barrier, steel or concrete.

- Concrete and Structural Design Thickness: Slabs-on-grade should be designed by the structural engineer, but should be at least 4 inches thick (this is referring to the actual minimum thickness, not the nominal thickness). Reinforcing steel should be designed by the structural engineer, but as a minimum (for conventionally reinforced slabs) should be No. 3 rebar placed at 18 inches on center, each direction, mid-depth in the slab.

  Minor cracking of the concrete as it cures, due to drying and shrinkage is normal and should be expected. However, cracking is often aggravated by a high water/cement ratio, high concrete temperature at the time of placement, small nominal aggregate size, aggregate that is not sufficiently clean, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. Low-slump concrete can reduce the potential for shrinkage cracking. Additionally, reinforcement in slabs and foundations can generally reduce the potential for shrinkage cracking. The structural engineer should consider these and other pertinent concrete design and construction considerations in slab design and specifications.

3.3.1 Slab Underlayment for Moisture Vapor Retarding

Because moisture vapor from the underlying soils will be transmitted through slabs-on-grade without preventive measures, slab underlayment for moisture vapor retarding should be designed by qualified professionals (such as the structural engineer and/or architect) where control of moisture vapor transmission through slabs is considered important to this project (such as where moisture-sensitive floor coverings or equipment are planned). Slab underlayment typically includes a moisture vapor retarder membrane (such as 10-mil thick or greater), underlain by a capillary break and provisions for protection of the vapor retarder during construction. The structural engineer and/or architect should specify pertinent slab and concrete design parameters, such as whether a sand blotter layer should be placed over the vapor retarder.

Moisture retarders can reduce, but not eliminate moisture vapor rise from the underlying soils up through the slab. Moisture retarders should be designed and constructed in accordance with applicable American Concrete Institute, Portland Cement Association, Post-Tensioning Institute, ASTM International, and California Building Code requirements and guidelines.

Leighton does not practice in the field of moisture vapor transmission evaluation/mitigation, since this does not fall under the geotechnical discipline. Therefore, we recommend that a qualified person, such as the flooring subcontractor, structural engineer, and/or architect, be consulted to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. That person (or persons) should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structures as deemed appropriate. In addition, the recommendations in this report and our services in general are not intended to address mold prevention, since we, along with geotechnical consultants in general, do not practice in the area of mold prevention. If specific recommendations are desired, a professional mold prevention consultant should be contacted.

3.4 Seismic Design Parameters

Seismic parameters presented in this report should be considered during project design. In order to reduce the effects of ground shaking produced by regional seismic events, seismic design should be performed in accordance with the most recent edition of the California Building Code (CBC). The following data should be considered for the seismic analysis of the subject site:

2013 CBC Categorization/Coefficient	Design Value
Site Longitude (decimal degrees)	-117.5158
Site Latitude (decimal degrees)	34.1082
Site Class Definition (ASCE 7 Table 20.3-1)	D
Mapped Spectral Response Acceleration at 0.2s Period, S_s (Figure 1613.3.1(1))	1.500 g
Mapped Spectral Response Acceleration at 1s Period, S_1 (Figure 1613.3.1(2))	0.600 g
Short Period Site Coefficient at 0.2s Period, F_a (Table 1613.3.3(1))	1.0
Long Period Site Coefficient at1s Period, F_v (Table 1613.3.3(2))	1.5
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS} (Eq. 16-37)	1.500 g
Adjusted Spectral Response Acceleration at 1s Period, S_{M1} (Eq. 16-38)	0.900 g
Design Spectral Response Acceleration at 0.2s Period, S_{DS} (Eq. 16-39)	1.000 g
Design Spectral Response Acceleration at 1s Period, S_{D1} (Eq. 16-40)	0.600 g

3.5 Retaining Walls

We recommend that retaining walls be backfilled with very low expansive soil and constructed with a backdrain in accordance with the recommendations provided on Figure 5, *Retaining Wall Backfill and Subdrain Detail*. Using expansive soil as retaining wall backfill will result in higher lateral earth pressures exerted on the wall and are, therefore, not recommended. Based on these recommendations, the following parameters may be used for the design of conventional retaining walls.

Table 1 - Retaining Wall Design Parameters

Static Equivalent Fluid Pressure (pcf)	
Condition	Level Backfill
Active (drained)	35
At-Rest (drained, compacted fill backfill)	55
Passive (ultimate)	340 (Max. 5,000 psf)

The above values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design.

Cantilever walls that are designed to yield at least 0.001H, where H is equal to the wall height, may be designed using the active condition. Rigid walls and walls braced at the top should be designed using the at-rest condition.

Passive pressure is used to compute soil resistance to lateral structural movement. In addition, for sliding resistance, a frictional resistance coefficient of 0.35 may be used at the concrete and soil interface. The lateral passive resistance should be taken into account only if it is ensured that the soil providing passive resistance, embedded against the foundation elements, will remain intact with time. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of the soil over the wall footing.

In addition to the above lateral forces due to retained earth, surcharge due to improvements, such as an adjacent structure or traffic loading, should be considered in the design of the retaining wall. Loads applied within a 1:1 projection from the surcharging structure on the stem of the wall should be considered in the design. A third of uniform vertical surcharge-loads should be applied at the surface as a horizontal pressure on cantilever (active) retaining walls, while half of uniform vertical surcharge-loads should be applied as a horizontal pressure on braced (at-rest) retaining walls. To account for automobile parking surcharge, we suggest that a uniform horizontal pressure of 100 psf (for restrained walls) or 70 psf (for cantilever walls) be added for design, where autos are parked within a horizontal distance behind the retaining wall less than the height of the retaining wall stem.

We recommend that the wall designs for walls 6 feet tall or taller be checked seismically using an *additive seismic* Equivalent Fluid Pressure (EFP) of 15 pcf, which is added to the EFP. The *additive seismic* EFP should be applied at the retained midpoint.

Conventional retaining wall footings should have a minimum width of 24 inches and a minimum embedment of 12 inches below the lowest adjacent grade. An allowable bearing pressure of 2,500 psf may be used for retaining wall footing design, based on the minimum footing width and depth. This bearing value may be increased by 250 psf per foot increase in width or depth to a maximum allowable bearing pressure of 4,000 psf.

Retaining walls greater than 6 feet in height should be evaluated by Leighton on a case-by-case basis.

3.6 Pavement Design

Based on the design procedures outlined in the current Caltrans Highway Design Manual, and using an assumed design R-value of 50, flexible pavement sections may consist of the following for the Traffic Indices indicated. Final pavement design should be based on the Traffic Index determined by the project civil engineer and R-value testing provided near the end of grading.

Asphalt Pavement Section Thickness, Type I Subgrade Soil			
Traffic Index	Asphaltic Concrete (AC) Thickness (inches)	Class 2 Aggregate Base Thickness (inches)	Total Pavement Section Thickness (inches)
5	3	4	7
6	3	4.5	7.5
7	4	4.5	8.5

All pavement construction should be performed in accordance with the Standard Specifications for Public Works Construction or Caltrans Specifications. Field observations and periodic testing, as needed during placement of the base course materials, should be undertaken to ensure that the requirements of the standard specifications are fulfilled.

Prior to placement of aggregate base, the subgrade soil should be processed to a minimum depth of 6 inches, moisture-conditioned, as necessary, and recompacted to a minimum of 90 percent relative compaction. Aggregate base should be moisture conditioned, as necessary, and compacted to a minimum of 95 percent relative compaction.

If the pavement is to be constructed prior to construction of the structures, we recommend that the full depth of the pavement section be placed in order to support heavy construction traffic.

3.7 Infiltration Testing

For the upper 10 feet of onsite alluvial soils that are sandy with a moderately low fines content, we preliminarily recommend an unfactored (small-scale) infiltration rate of 3.0 inches per hour. For the coarser onsite alluvial soils 10 feet bgs and deeper that are sandy and gravelly with a low fines content, we preliminarily recommend an unfactored (small-scale) infiltration rate of 7.0 inches per hour. These measured rates are applicable only at the specific locations and depths tested. Infiltration rates are anticipated to vary across the site and at various depths. The incremental infiltration rate as measured during intervals of the test is defined as the incremental flow rate of water infiltrated, divided by the surface area of the infiltration interface. We recommend that a correction factor/safety factor be applied to the infiltration rate in conformance with San Bernardino County guidelines, since monitoring of actual facility performance has shown that actual infiltration rates are lower than for small-scale tests. The small-scale infiltration rate should be divided by a correction factor of at least 2 for buried chambers and at least 3 for open basins, but the correction/safety factor may be higher based on project-specific aspects in conformance with *San Bernardino County Stormwater Program Technical Guidance Document for Water Quality Management Plans (WQMP)* for basin design aspects.

The infiltration rates described herein are for a clean, unsilted infiltration surface in native, sandy alluvial soil. These values may be reduced over time as silting of the basin or chamber occurs. Furthermore, if the basin or chamber bottom is allowed to be compacted by heavy equipment, this value is expected to be significantly reduced. Infiltration of water through soil is highly dependent on such factors as grain size distribution of the soil particles, particle shape, fines content, clay content, and density. Small changes in soil conditions, including density, can cause large differences in observed infiltration rates. Infiltration is not suitable in compacted fill.

It should be noted that during periods of prolonged precipitation, the underlying soils tend to become saturated to greater and greater depths/extents. Therefore, infiltration rates tend to decrease with prolonged rainfall. It is difficult to extrapolate longer-term, full-scale infiltration rates from small-scale tests, and as such, this is a significant source of uncertainty in infiltration rates.

3.7.1 Additional Review and Evaluation

Infiltration rates are anticipated to vary significantly based on the location and depth. Infiltration concepts should be discussed with Leighton as infiltration plans are being developed. Leighton should review all infiltration plans, including locations and depths of proposed facilities and overflows. Further testing may be required depending on the design of infiltration facilities, particularly considering their type, depth and location.

3.7.2 General Design Considerations

The periodic flow of water carrying sediments into the basin or chamber, plus the introduction of wind-blown sediments and sediments from erosion of the basin side walls, can eventually cause the bottom of the basin or chamber to accumulate a layer of silt, which has the potential of significantly reducing the overall infiltration rate of the basin or chamber. Therefore, we recommend that significant amounts of silt/sediment not be allowed to flow into the facility within stormwater, especially during construction of the project and prior to achieving a mature landscape on site. We recommend that an easily maintained, robust silt/sediment removal system be installed to pretreat storm water before it enters the infiltration facility.

As infiltrating water can seep within the soil strata nearly horizontally for long distances, it is important to consider the impact that infiltration facilities can have on nearby subterranean structures, such as basement walls or open excavations, whether onsite or offsite, and whether existing or planned. Any such nearby features should be identified and evaluated as to whether infiltrating water can impact these. Such features should be brought to Leighton's attention as they are identified.

Infiltration facilities should not be constructed adjacent to or under buildings. Setbacks should be discussed with Leighton during the planning process.

Infiltration facilities should be constructed with spillways or other appropriate means that would cause overfilling to not be a concern to the facility or nearby improvements.

For buried chambers, control/access manhole covers should not contain holes or should be screened to prevent mosquitos from entering the cambers.

3.7.3 Additional Design Considerations (Particularly to Open Basins)

If open basins are planned, additional evaluation may be needed, as the soils that will be exposed at the bottom of the basin are critical to the basin's success. Soils at the bottom of buried chambers are also important, but not as critical to their success, provided the infiltration chamber cuts through sufficiently granular soils.

In general, the rate of infiltration reduces as the head of water in the infiltration facility reduces, and it also reduces with prolonged periods of infiltration. As such, water typically infiltrates much faster near the beginning of and/or immediately after storm events than at times well after a storm when the water level in the facility has receded, since the infiltration rate is then slower due to both lower head and longer overall duration of infiltration. In open basins with compacted or silty bottoms, this could be problematic, in that, even if the basin had already infiltrated significant amounts of storm water, the lower several inches or feet of water could remain in the basin for an extended period of time, creating a prolonged open-water safety concern and potential for mosquitos. In a buried/covered infiltration chamber, these conditions would be of less concern.

Parks or play/recreation areas should not be constructed within basin bottoms or below the spillway level.

For open basins and swales, vegetation within the basin bottoms and sides is expected to help reduce erosion and help maintain infiltration rates.

Estimating infiltration rates, especially based on small-scale testing, is inexact and indefinite, and often involves known and unknown soil complexities, potentially resulting in a condition where actual infiltration rates of the completed facility are significantly less than design rates. In open infiltration basins, this could create nuisance water in the basin. As such, enhancements may be needed after completion of the basin if prolonged or frequent standing water is experienced. A potential basin enhancement, if needed, might be to install infiltration trenches or borings in the basin bottom to capture and infiltrate low flows and to help speed infiltration during/after storms; specific recommendations, such as minimum trench/boring depth and media backfill material, would be developed based on conditions observed. Such a contingency should be anticipated for open basins.

3.7.4 Construction Considerations

We recommend that Leighton evaluate the infiltration facility excavations, to confirm that granular, undisturbed alluvium is exposed in the bottoms and sides. Additional excavation or evaluation may be required if silty or clayey soils are exposed.

It is critical to infiltration that the basin or chamber bottom not be allowed to be compacted during construction or maintenance; rubber-tired equipment and vehicles should not be allowed to operate on the bottom. We recommend that at least the bottom 3 feet of the basins or chambers be excavated with an excavator or similar.

If fill material is needed to be placed in the basin, such as due to removal of uncontrolled artificial fill, the fill material should be select and free-draining sand, and should be observed and evaluated by Leighton.

3.7.5 Maintenance Considerations

The infiltration facilities should be routinely monitored, especially before and during the rainy season, and corrective measures should be implemented as/when needed. Things to check for include proper upkeep, proper infiltration, absence of accumulated silt, and that de-silting filters/features are clean and functioning. Pretreatment desilting features should be cleaned and maintained per manufacturers' recommendations. Even with measures to prevent silt from flowing into the infiltration facility, accumulated silt may need to be removed occasionally as part of maintenance.

3.8 Temporary Excavations

All temporary excavations, including utility trenches, retaining wall excavations and other excavations should be performed in accordance with project plans, specifications and all OSHA requirements, and the current edition of the California Construction Safety Orders, latest edition.

No surcharge loads should be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater from the top of the slope, unless the cut is shored appropriately. Excavations that extend below an imaginary plane inclined at 45 degrees below the edge of any adjacent existing site foundation should be properly shored to maintain support of the adjacent structures.

Cantilever shoring should be designed based on the active fluid pressure presented in the retaining wall section. If excavations are braced at the top and at specific design intervals, the active pressure may then be approximated by a rectangular soil pressure distribution with the pressure per foot of width equal to 25H, where H (feet) is equal to the depth of the excavation being shored.

During construction, the soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor should be responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Close coordination between the competent person and Leighton Consulting should be maintained to facilitate construction while providing safe excavations.

3.9 Trench Backfill

Utility-type trenches onsite can be backfilled with onsite material, provided it is free of debris, significant organic material and oversized material (greater than 3 inches for trench backfill within 3 feet of a pipe, and 6 inches for trench backfill above).

Prior to backfilling the trench, pipes should be bedded and shaded in a granular material that has a sand equivalent of 30 or greater. We recommend that open-graded crushed rock or similar material not be used as bedding material, unless special provisions are implemented to limit the migration of surrounding soil into the open-graded material, including surrounding the open-graded material with filter fabric (Mirafi 140N or equivalent). The bedding material should extend 12 inches above the top of the pipe. The bedding/shading sand should be densified in-place by mechanical means, or in areas where the trench walls and bottom soil are sandy and have a minimum sand equivalent of 15, the bedding sand may be jetted. Bedding sand should be placed in accordance with the Standard Specifications for Public Works Construction – Greenbook (Public Works Standard, Inc.), current edition.

The native soil fill should be placed in loose layers, moisture conditioned, as necessary, and mechanically compacted using a minimum standard of 90 percent relative compaction based on ASTM D 1557. The thickness of layers should be based on the compaction equipment used in accordance with the current Greenbook.

3.10 Surface Drainage

Inadequate control of runoff water and/or poorly controlled irrigation can cause the onsite soils to expand and/or shrink, producing heaving and/or settlement of foundations, flatwork, walls, and other improvements. Maintaining adequate surface drainage, proper disposal of runoff water, and control of irrigation should help reduce the potential for future soil moisture problems.

Positive surface drainage should be designed to be directed away from foundations and toward approved drainage devices, such as gutters, paved drainage swales, or watertight area drains and collector pipes.

Surface drainage should be provided to prevent ponding of water adjacent to the structures. In general, the area around the buildings should slope away from the building. We recommend that unpaved landscaped areas adjacent to the buildings be avoided. Roof runoff should be carried to suitable drainage outlets by watertight drain pipes or over paved areas.

3.11 Sulfate Attack and Corrosion Protection

Based on the results of laboratory testing, concrete structures in contact with the onsite soil will have negligible exposure to water-soluble sulfates in the soil. Therefore, common Type II cement may be used for concrete construction. Concrete should be designed in accordance with ACI 318-14, Section 19.3 (ACI, 2014), adopted by the 2013 CBC (Section 1904A.2).

Based on our laboratory testing, the onsite soil is considered moderately corrosive to ferrous metals. Typical corrosion protection of underground metallic utilities should be provided. Corrosion information presented in this report should be provided to your underground utility contractors.

3.12 Additional Geotechnical Services

The preliminary geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited subsurface explorations and limited laboratory testing. Our preliminary geotechnical recommendations provided in this report are based on information available at the time the report was prepared and may change as plans are developed. Additional geotechnical investigation and analysis may be required based on final improvement plans. Leighton should review the site and grading plans when available and comment further on the geotechnical aspects of the project. Geotechnical observation and testing should be conducted during excavation and all phases of grading operations. Our conclusions and preliminary recommendations should be reviewed and verified by Leighton during construction and revised accordingly if geotechnical conditions encountered vary from our preliminary findings and interpretations.

Geotechnical observation and testing should be provided:

- After completion of site clearing.
- During overexcavation of compressible soil.
- During compaction of all fill materials.
- After excavation of all footings and prior to placement of concrete.
- During utility trench backfilling and compaction.
- During pavement subgrade and base preparation.
- When any unusual conditions are encountered.

4.0 LIMITATIONS

This report was based in part on data obtained from a limited number of observations, site visits, soil excavations, samples, and tests. Such information is, by necessity, incomplete. The nature of many sites is such that differing soil or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, our findings, conclusions, and recommendations presented in this report are based on the assumption that Leighton and Associates, Inc. will provide geotechnical observation and testing during construction.

This report was prepared for the sole use of Stratham Homes for application to the design of the proposed residential development in accordance with generally accepted geotechnical engineering practices at this time in California.

See the GBA insert on the following page for important information about this geotechnical engineering report.

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

Project: 11406.001	Eng/Geol:
Scale:1 " = 2,000 '	Date: September 2016

Base Map: ESRI ArcGIS Online 2016
Thematic Information: Leighton
Author: Leighton Geomatics (asakowicz)

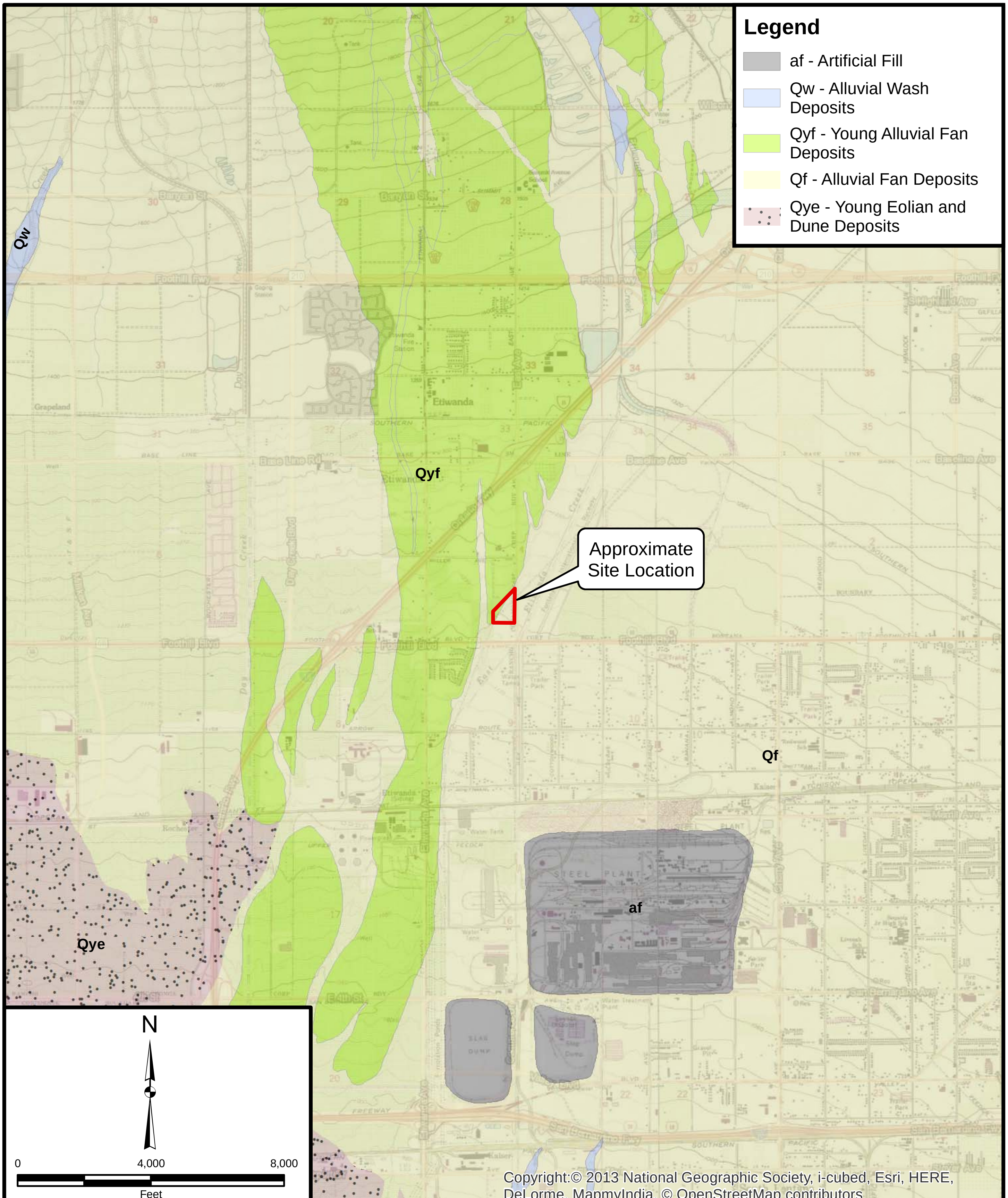
SITE LOCATION MAP

Stratham Homes
Proposed East Avenue Residential Development
Rancho Cucamonga, Califonria

Figure 1

Leighton

Map Saved as V:\Drafting\11406\001\Maps\11406-001_F01_SLM_2016-09-14.mxd on 9/14/2016 11:44:04 AM



Project: 11406.001	Eng/Geol:
Scale:1 " = 4,000 '	Date: September 2016

Base Map: "Geologic map of the San Bernardino and Santa Ana 30' x 60' quads," CA. Morton and Miller, USGS, 2006
Thematic Information: Leighton, USGS
Author: Leighton Geomatics (asakowicz)

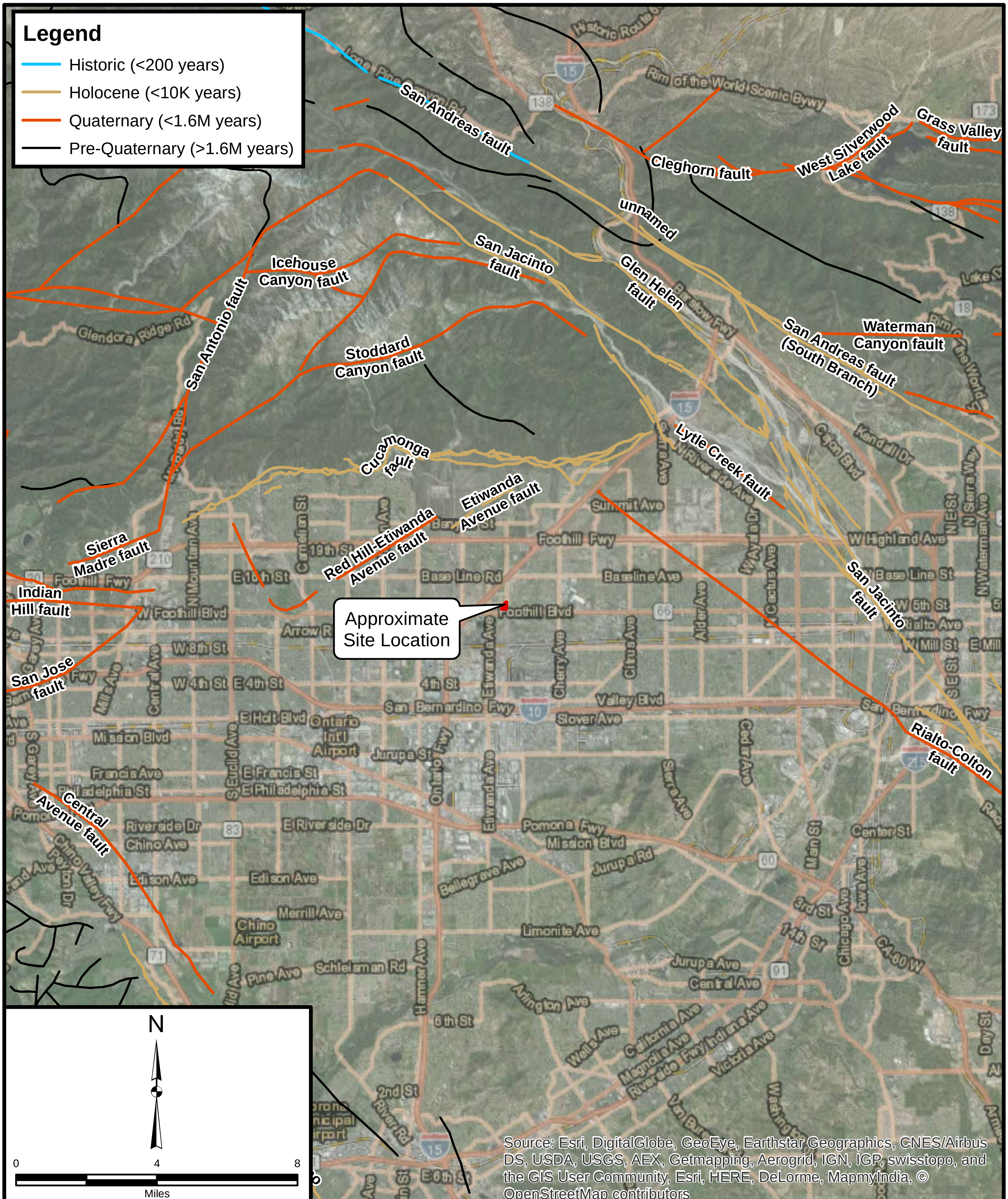
REGIONAL GEOLOGY MAP

Stratham Homes
Proposed East Avenue Residential Development
Rancho Cucamonga, Califonria

Figure 3

Leighton

Map Saved as V:\Drafting\11406\001\Maps\11406-001_F02_RGM_2016-09-14.mxd on 9/14/2016 11:42:23 AM



Project: 11406.001	Eng/Geol:	
Scale:1 " = 4 miles	Date: September 2016	

Base Map: ESRI ArcGIS Online 2016
Thematic Information: Leighton, Bryant, W. A. (compiler), 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0: CGS
Author: Leighton Geomatics (asakowicz)

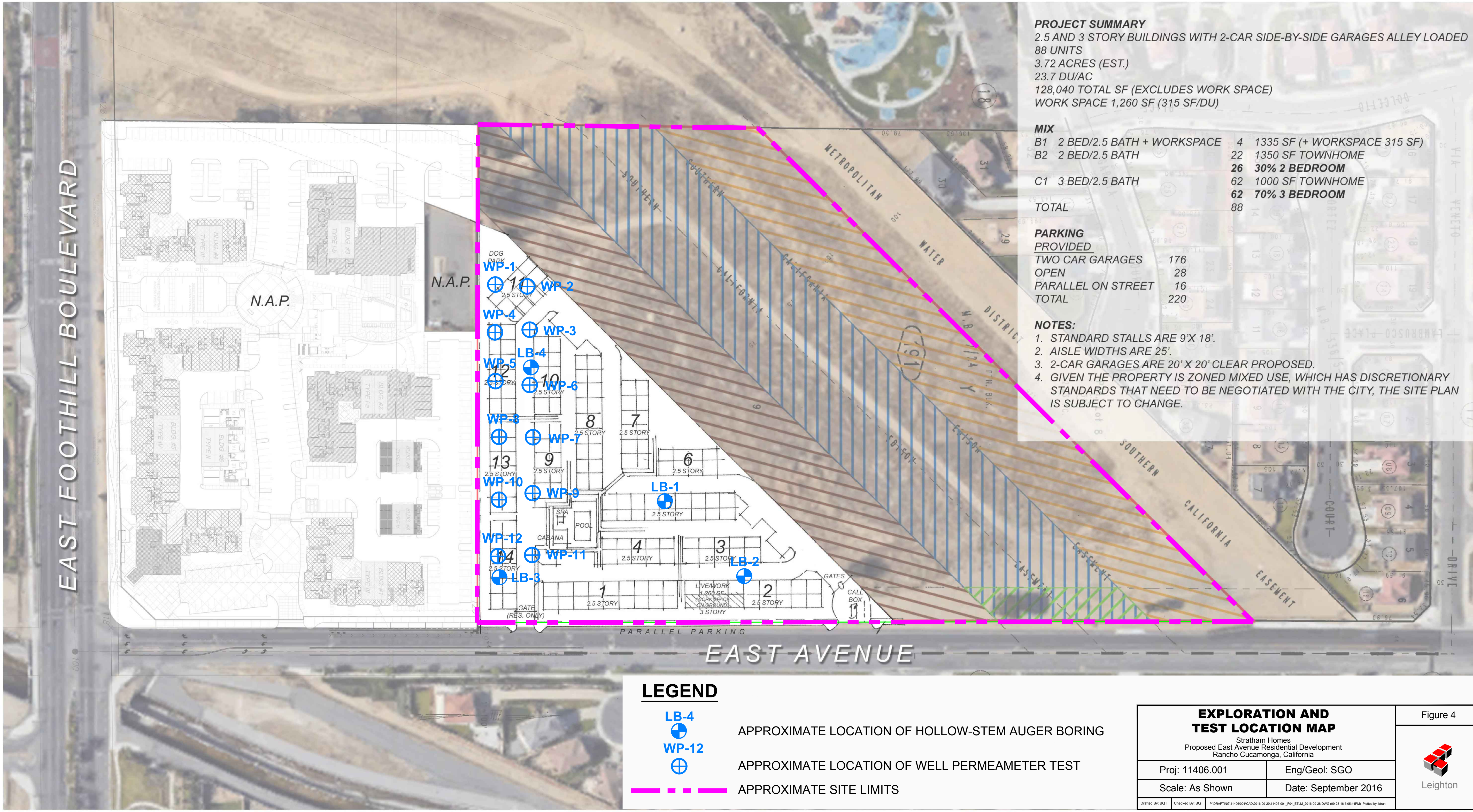
REGIONAL FAULT MAP

Stratham Homes
Proposed East Avenue Residential Development
Rancho Cucamonga, Califonria

Figure 3

Leighton

Map Saved as V:\Drafting\11406\001\Maps\11406-001_F03_RFM_2016-09-14.mxd on 9/14/2016 11:10:04 AM



0 30' 60' 90' 120'

SCALE: 1" = 60'-0"

EAST AVENUE RANCHO CUCAMONGA, CA.

CONCEPTUAL SITE PLAN - TOWNHOMES

JOB NO: 2016-371
DATE: 09-08-2016

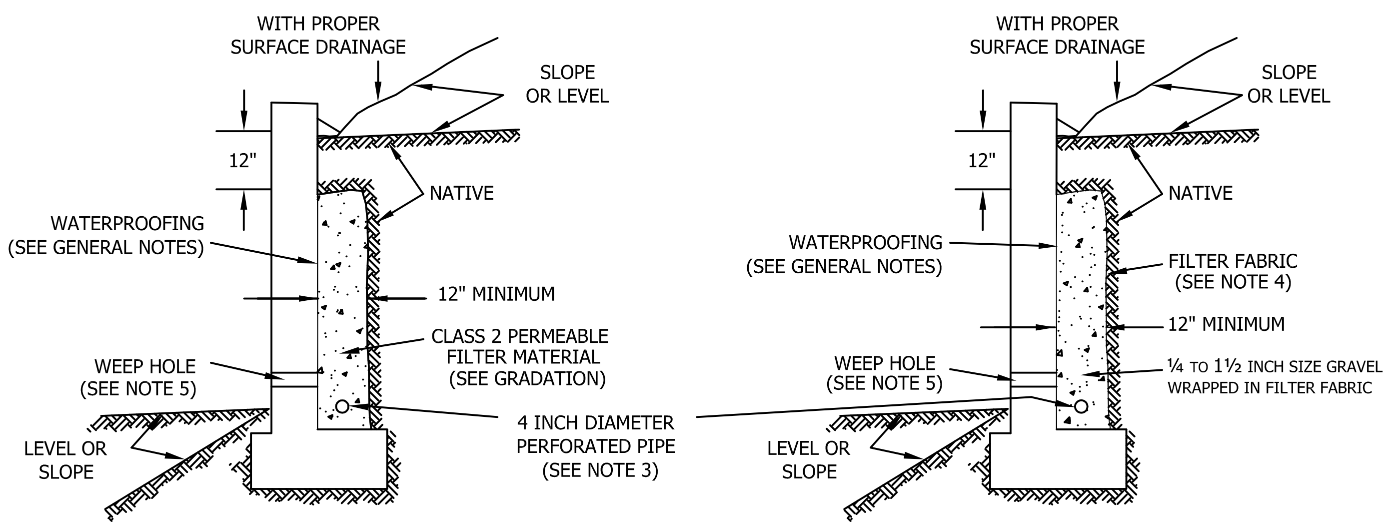
STRATHAM HOMES
2201 DUPONT DRIVE SUITE 300
IRVINE, CA 92612 (949) 883-1554

ARCHITECTS ORANGE
144 NORTH ORANGE STREET
ORANGE, CA 92866 (714) 639-9860

SUBDRAIN OPTIONS AND BACKFILL WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤50

OPTION 1: PIPE SURROUNDED WITH CLASS 2 PERMEABLE MATERIAL

OPTION 2: GRAVEL WRAPPED IN FILTER FABRIC



Class 2 Filter Permeable Material Gradation
Per Caltrans Specifications

Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

GENERAL NOTES:

* Waterproofing should be provided where moisture nuisance problem through the wall is undesirable.
* Water proofing of the walls is not under purview of the geotechnical engineer
* All drains should have a gradient of 1 percent minimum
*Outlet portion of the subdrain should have a 4-inch diameter solid pipe discharged into a suitable disposal area designed by the project engineer. The subdrain pipe should be accessible for maintenance (rodding)
*Other subdrain backfill options are subject to the review by the geotechnical engineer and modification of design parameters.

Notes:
1) Sand should have a sand equivalent of 30 or greater and may be densified by water jetting.
2) 1 Cu. ft. per ft. of 1/4- to 1 1/2-inch size gravel wrapped in filter fabric
3) Pipe type should be ASTM D1527 Acrylonitrile Butadiene Styrene (ABS) SDR35 or ASTM D1785 Polyvinyl Chloride plastic (PVC), Schedule 40, Armco A2000 PVC, or approved equivalent. Pipe should be installed with perforations down. Perforations should be 3/8 inch in diameter placed at the ends of a 120-degree arc in two rows at 3-inch on center (staggered)
4) Filter fabric should be Mirafi 140NC or approved equivalent.
5) Weephole should be 3-inch minimum diameter and provided at 10-foot maximum intervals. If exposure is permitted, weepholes should be located 12 inches above finished grade. If exposure is not permitted such as for a wall adjacent to a sidewalk/curb, a pipe under the sidewalk to be discharged through the curb face or equivalent should be provided. For a basement-type wall, a proper subdrain outlet system should be provided.
6) Retaining wall plans should be reviewed and approved by the geotechnical engineer.
7) Walls over six feet in height are subject to a special review by the geotechnical engineer and modifications to the above requirements.

RETAINING WALL BACKFILL AND SUBDRAIN DETAIL FOR WALLS 6 FEET OR LESS IN HEIGHT

WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤50

Leighton

Figure 5

P:Drafting\templates\details\retain-wall-backfill-and subdrain.dwg (7/00)

APPENDIX A

REFERENCES

APPENDIX A

References

American Concrete Institute (ACI), 2014, Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318-14), an ACI Standard.

American Society of Civil Engineers (ASCE), ASCE Standard/SEI 7-10, an ASCE Standard, 2010.

California Building Standards Commission, 2013, 2013 California Building Code, California Code of Regulations, Title 24, Part 2, Volume 2 of 2, Based on 2012 International Building Code, Effective January 1, 2014.

California Department of Water Resources, California Statewide Groundwater Elevation Monitoring (CASGEM) Online System – Public Portal, https://www.casgem.water.ca.gov/OSS/(S(xxu4244n4xwympjdvgt3bppi))/GIS/PopViewMap.aspx?Public=Y, accessed September 19, 2016.

California Geological Survey (formerly California Division of Mines and Geology), 2000, CD-ROM containing digital images of Official Maps of Alquist-Priolo Earthquake Fault Zones that affect the Southern Region, DMG CD 2000-003 2000.

California Geological Survey (CGS; formerly California Division of Mines and Geology, CDMG), 1998, *Seismic Hazard Zone Report for the Los Angeles 7.5-Minute Quadrangle, Los Angeles County, California*, Seismic Hazard Zone Report 029.

Chino Basin Watermaster, 2007, Depth to Groundwater Contours, Chino Basin, Fall 2006, Figure 1, Produced by Wildermuth Environmental, Inc., July 20, 2007.

Chino Basin Watermaster, 2012, Groundwater Elevation Contours in Spring 2012, Shallow Aquifer System, Exhibit 18, 2012 State of the Basin, Produced by Wildermuth Environmental, Inc., November 30, 2012.

Martin, G. R., and Lew, M., ed., 1999, "Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction Hazards in California," Southern California Earthquake Center, dated March 1999.

Morton, D.M., Miller, F.K., 2006, Geologic Map of the San Bernardino and Santa Ana 30'x60' Quadrangles, California, U.S. Geological Survey: Open File Report OF-2006-1217, scale 1:100,000.

Public Works Standard, Inc., 2012, Greenbook, Standard Specifications for Public Works Construction: BNI Building News, Anaheim, California.

San Bernardino County, 2010, Geologic Hazard Overlays – FH27 C, Ontario, <http://www.sbcounty.gov/Uploads/lus/GeoHazMaps/FH27C_20100309.pdf>.

United States Geological Survey (USGS), 2011, Ground Motion Parameter Calculator, Seismic Hazard Curves and Uniform Hazard Response Spectrum, Java Application, Version 5.1.0, February 10, 2011, downloaded from http://earthquake.usgs.gov /hazards/designmaps/ javacalc.php

Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.C., Marcuson, W.F. III, Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., Stokoe, K.H. II, 2001, "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils", Journal of Geotechnical and Geoenvironmental Engineering, Vol. 127, No. 10, October 2001.

APPENDIX B

GEOTECHNICAL BORING LOGS

Leighton

GEOTECHNICAL BORING LOG LB1

Project No.	11406.001	**Date Drilled**	9-1-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1					@Surface: silty sand, dry grass	
				R-1	5 6 10	110.7	2.5	SM	@2.5' SILTY SAND with trace gravel, brown, dry, nonplastic, trace rootlets, 0.25" gravel, non-cemented, ~15% fines (field estimate), loose	
	5			R-2	9 12 18	115.7	1.4	SW	@5' SAND with gravel, gray, dry, coarse sand, nonplastic, decomposed granitics, fractured rock, 1" average gravel, medium dense	
	10			S-3 B-2	8 9 18				@10' SAND with trace gravel, grayish brown, dry, coarse sand, nonplastic, fractured rock, medium dense	
	15			R-4	20 38 50	123.7	1.2		@15' SAND with gravel, grayish brown, slightly moist, coarse sand, nonplastic, decomposed granitics, fractured rock, 1" average and 2" max gravel size, very dense	
	20			S-5 B-3	20 23 26			GW	@20' GRAVEL with sand, gray, slightly moist, coarse sand, nonplastic, fractured rock, dense	
	25			R-6	28 30 38			SW	@25' SAND with gravel, grayish brown, slightly moist, medium to coarse sand, angular, nonplastic, dense	
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG LB1

Project No.	11406.001	**Date Drilled**	9-1-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			S-7	14 18 20				@30' SAND, light brown, slightly moist, coarse sand, nonplastic, dense	
	35			R-8	27 44 50/5"				@35' SAND with gravel, light brown, slightly moist, coarse sand, nonplastic, 1" max gravel size, very dense	
	40			S-9	16 17 21			SP	@40' SAND with trace gravel, light brown, slightly moist, medium sand, nonplastic, 0.25" gravel, dense	
	45			R-10	47 50/5"			SW	@45' SAND with gravel, grayish brown, moist, coarse sand, subangular, nonplastic, 1" max gravel size, very dense	
	50			S-11	8 12 17			SM	@50' CLAYEY SILT, brown, moist, low plasticity, very stiff	
									Total depth of 51.5 feet No groundwater encountered Backfilled with soil cuttings	
	55									
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG LB2

Project No.	11406.001	**Date Drilled**	9-1-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1					@Surface: silty sand and some dry grass	
				R-1	4 5 6	108.3	1.9	SM	@2.5' SILTY SAND with gravel, light brown, dry, fine to medium sand, subrounded, nonplastic, 0.5" max gravel size, ~10% fines (field estimate), loose	
	5			R-2	8 10 25		1.7		@5' SAME, only 4 rings of recovery, one 2" rock, (disturbed sample), medium dense	
	10			S-3	10 11 10			SW	@10' SAND with gravel, grayish brown, dry, coarse sand, subangular, nonplastic, 0.5" average gravel size, medium dense	
	15			R-4 B-2	28 50/5"	131.2	1.1	GW	@15' GRAVEL with sand, gray, slightly moist, coarse sand, angular, nonplastic, fractured rock, very dense	
	20			S-5	48 50/5"			SM	@20' SILTY SAND with gravel, brown, moist, medium to coarse sand, nonplastic, 0.5" average gravel size, ~10% fines (field estimate), very dense	
									Total depth of 20.8 feet No groundwater encountered Backfilled with soil cuttings	
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG LB3

Project No.	11406.001	**Date Drilled**	9-1-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1					@Surface: silty sand with dry grass	
				R-1	4 6 8		1.1		@2.5' SAND with some gravel, gray, dry, medium to coarse sand, nonplastic, 0.13" max gravel size, loose	
	5			R-2	6 11 15		2.8		@5' SILTY SAND with some gravel, light brown, dry, fine to medium sand, nonplastic, ~15% fines (field estimate), trace rootlets, 0.13" max gravel size, medium dense	
	10			S-3	9 9 13				@10' SAND with gravel, grayish brown, moist, coarse sand, nonplastic, 0.5" max gravel size, medium dense	
	15			R-4 B-2	16 26 32		0.9		@15' GRAVEL with sand, gray, dry, coarse sand, subangular, nonplastic, 1.5" max gravel size, dense	
	20			S-5	28 39 49				@20' SAME, very dense	
	25			R-6	50/5"				@25' No recovery, very dense	
									Total depth of 25.4 feet No groundwater encountered Backfilled with soil cuttings	
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB4

Project No.	11406.001	**Date Drilled**	9-1-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0			B-1					@Surface: silty sand, dry grass	CR, MD
				R-1	5 13 19	111.1	2.5	SM	@2.5' SILTY SAND with trace gravel, light brown, dry, fine sand, nonplastic, ~15% fines (field estimate), trace rootlets, medium dense	
	5			R-2	50/5"				@5' SAME, 2.5" fractured rock in sampler tip, only 6 rings of recovery, very dense	
	10			S-3	14 16 20			SW	@10' SAND with gravel, light brown, slightly moist, coarse sand, nonplastic, 1" max gravel size, dense	
	15			R-4	42 44 45	112.5	1.7	GW	@15' GRAVEL with sand, gray, moist, coarse sand, angular, nonplastic, fractured rock, 2.5" max gravel size, very dense	
	20			S-5 B-2	23 35 50/5"				@20' SAME, 1" max gravel size, very dense	
	25			R-6	18 36 50/5"			SM	@25' SILTY SAND, light brown, moist, fine sand, nonplastic, ~25% fines (field estimate), very dense	
									Total depth of 26.4 feet No groundwater encountered Backfilled with soil cuttings	
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG WP 1

Project No.	11406.001	**Date Drilled**	9-1-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	12 10 12			SW	@13.5' SAND with gravel, light brown, moist, coarse sand, subangular, nonplastic, 1" max gravel size, medium dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG WP 2

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	15 32 27			GW	@13.5' GRAVEL with sand and trace fines, grayish brown, moist, coarse sand, nonplastic, 1" max gravel size, dense	SA, H
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4.5' bgs	
	20									
	25									
	30									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG WP 3

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	16 24 24				@13.5' No recovery, dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG WP 4

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	11 14 17			GW	@13.5' GRAVEL with sand, light brown, dry, coarse sand, subangular, nonplastic, dense	SA
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG WP 5

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								@Surface: silty sand and dead leaves	
	5									
	10									
				S-1	19 31 38			SW	@13.5' SAND with gravel and trace fines, grayish brown, moist, coarse sand, subangular, nonplastic, 1" max gravel size, fractured rock, very dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4' bgs	
	20									
	25									
	30									

SOIL DESCRIPTION note: *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG WP 6

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	15 19 16				@13.5' No recovery, dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG WP 7

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	18 34 23			SW	@13.5' SAND with gravel with trace fines, grayish brown, moist, coarse sand, subangular, nonplastic, 1" max gravel size, fractured rock, very dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4' bgs	
	20									
	25									
	30									

SOIL DESCRIPTION: This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG WP 8

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	12 11 12			SM	@13.5' SAND with gravel and trace fines, grayish brown, slightly moist, coarse sand, nonplastic, 1" max gravel size, fractured rock, medium dense	SA
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 4' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG WP 9

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	8 14 21			SW	@13.5' SAND with gravel, grayish brown, dry, coarse sand, subangular, nonplastic, 1" max gravel size, fractured rock, dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 3' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG WP10

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								@Surface: silty sand and dry grass	
				S-1	2 4 2			SM	@3.5' SILTY SAND, brown, dry, medium sand, nonplastic, ~10% fines (field estimate), trace rootlets, loose	SA, H
	5								Total depth of 5 feet No groundwater encountered Set pipe within 10" auger Backfilled around pipe to 2' bgs	
	10									
	15									
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG WP11

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	19 18 26			SW	@13.5' SAND with gravel and trace fines, grayish brown, dry, coarse sand, nonplastic, 1" max gravel size, fractured rock, dense	
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 2.5' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG WP12

Project No.	11406.001	**Date Drilled**	9-2-16
Project	Stratham Homes R.C.	**Logged By**	BER
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	11"
Drilling Method	Hollow-Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~1200"
Location	See Figure 2	**Sampled By**	BER

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								@Surface: silty sand and dry grass	
	5									
	10									
				S-1	14 24 26			SW	@13.5' SAND with gravel and trace fines, grayish brown, dry, coarse sand, nonplastic, 1" max gravel size, fractured rock, dense	SA, H
	15								Total depth of 15 feet No groundwater encountered Set pipe within 10" auger Caved around pipe to 3.5' bgs	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

APPENDIX C

LABORATORY TEST RESULTS

Leighton

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Stratham Homes/Rancho Cucamonga	Tested By:	O. Figueroa	Date:	09/20/16
Project No.:	11406.001	Input By:	J. Ward	Date:	09/22/16
Boring No.:	LB-4	Depth (ft.):	0-5		
Sample No.:	B-1				
Soil Identification:	Olive brown silty sand (SM)				

Preparation Method: [X] Moist [ ] Dry — [X] Mechanical Ram [ ] Manual Ram

Mold Volume (ft³) 0.03330 — *Ram Weight = 10 lb.; Drop = 18 in.*

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3808	3879	3896			
Weight of Mold (g)	1829	1829	1829			
Net Weight of Soil (g)	1979	2050	2067			
Wet Weight of Soil + Cont. (g)	408.9	437.8	453.2			
Dry Weight of Soil + Cont. (g)	385.9	404.8	411.2			
Weight of Container (g)	38.9	38.6	51.8			
Moisture Content (%)	6.63	9.01	11.69			
Wet Density (pcf)	131.0	135.7	136.8			
Dry Density (pcf)	122.9	124.5	122.5			

Maximum Dry Density (pcf) 124.5 **Optimum Moisture Content (%)** 9.0

PROCEDURE USED

[X] **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

[ ] **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

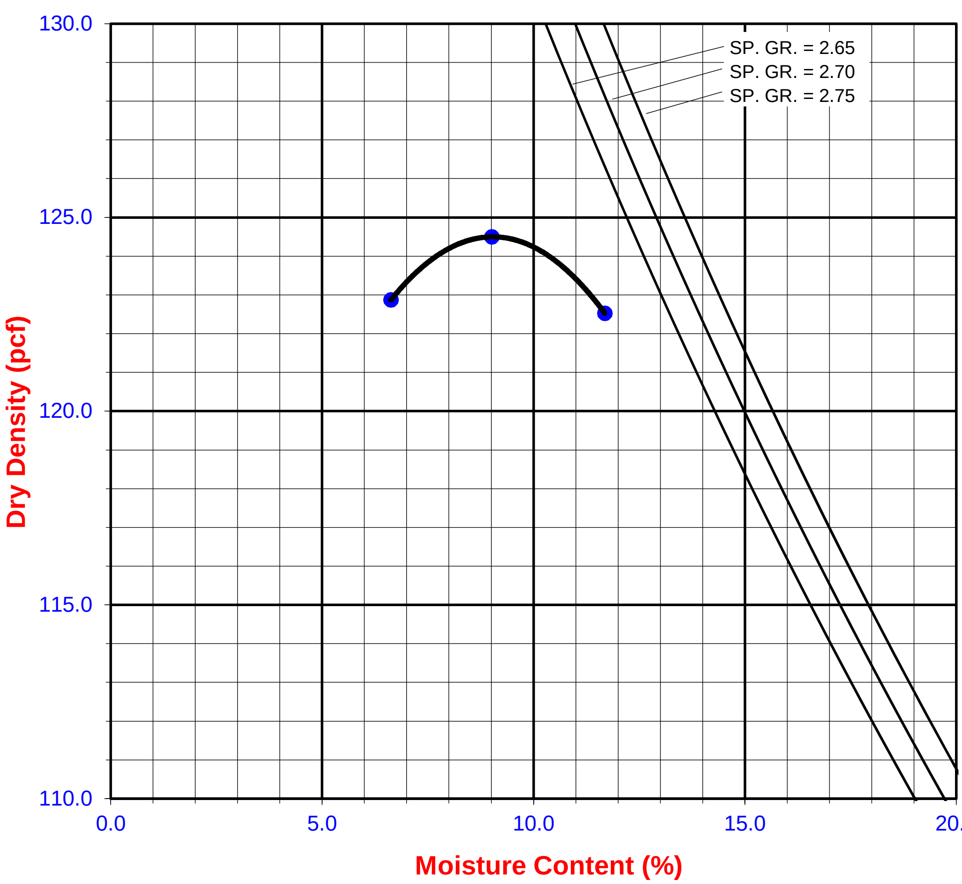
[ ] **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Stratham Homes/Rancho Cucamonga | Tested By: G. Berdy | Date: 09/14/16

Project No.: 11406.001 | Data Input By: J. Ward | Date: 09/22/16

Boring No.: WP-2

Sample No.: S-1 | Depth (feet): 13.5

Soil Identification: Olive poorly-graded sand with silt and gravel (SP-SM)g

		Soil Type
% Gravel	42	(SP-SM)g
% Sand	46	
% Fines	12	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	98.84	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	98.84	155.70
Wt.of Air-Dry Soil + Cont. (g)	771.40	Wt. of Container No.___ (g)	1.00	67.18	76.36
Wt. of Container	249.72	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	521.68	Wt. of Dry Soil (g)			79.34

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	119.65	77.1
3/8"	175.82	66.3
No. 4	220.54	57.7
No. 10	273.90	47.5
Pan		

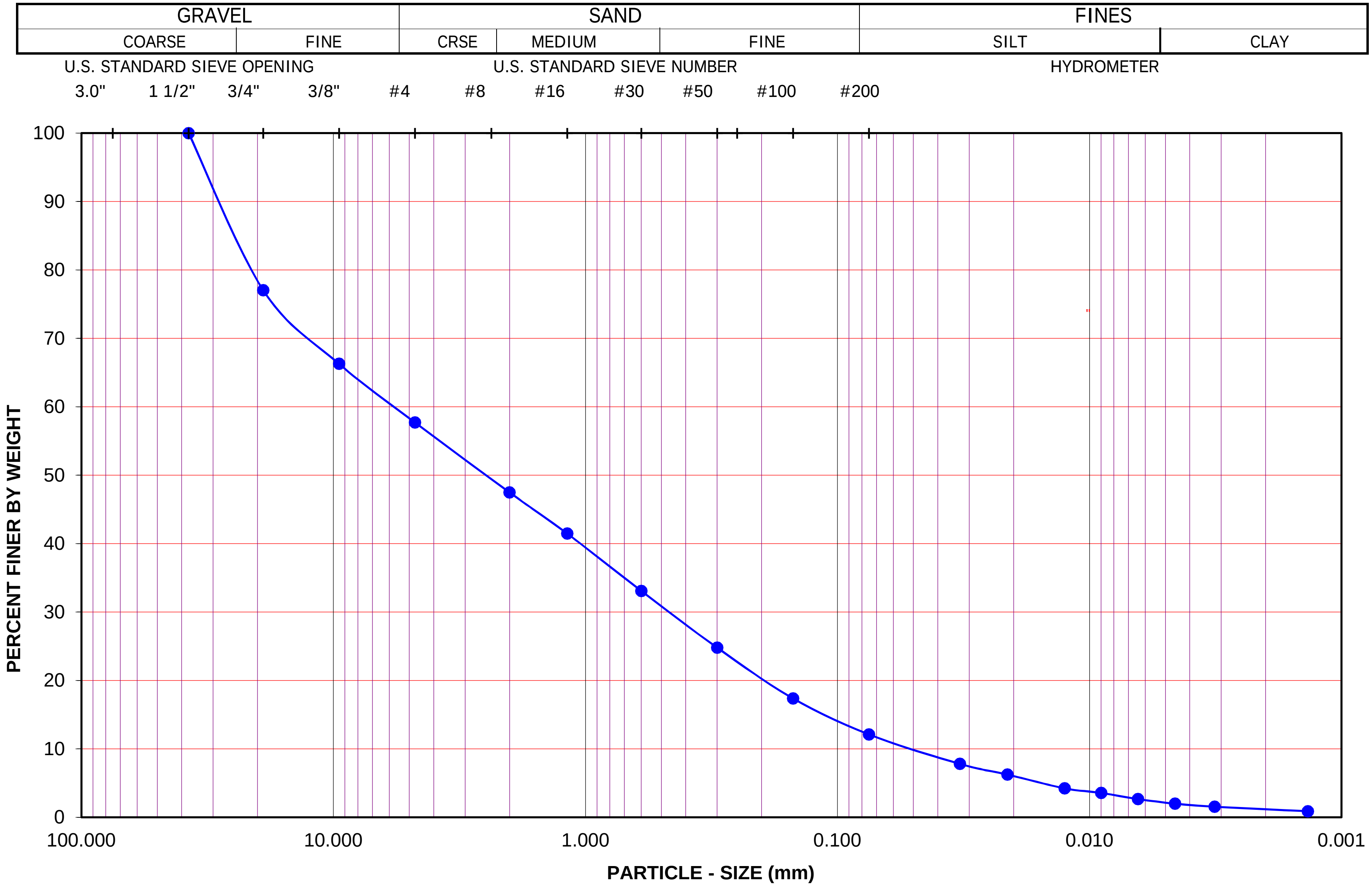
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	47.5
No. 16	13.37	87.3	41.5
No. 30	31.95	69.7	33.1
No. 50	50.35	52.2	24.8
No. 100	66.78	36.6	17.4
No. 200	78.48	25.5	12.1
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 105.39 Wt. of Dry Soil (g) 105.39

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
15-Sep-16	9:22	0		8.0			
	9:24	2	21.4	8.0	25.5	7.8	0.0327
	9:27	5	21.4	8.0	22.0	6.3	0.0212
	9:37	15	21.4	8.0	17.5	4.2	0.0126
	9:52	30	21.4	8.0	16.0	3.6	0.0090
	10:22	60	21.3	8.0	14.0	2.7	0.0064
	11:22	120	21.2	8.0	12.5	2.0	0.0046
	13:32	250	21.0	8.0	11.5	1.6	0.0032
16-Sep-16	9:22	1440	20.6	8.0	10.0	0.9	0.0014



Project Name: Stratham Homes/Rancho Cucamonga

Project No.: 11406.001

Boring No.: WP-2 Sample No.: S-1

Depth (feet): 13.5 Soil Type : (SP-SM)g

Soil Identification: Olive poorly-graded sand with silt and gravel (SP-SM)g

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 42 : 46 : 12

Sep-16

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Stratham Homes/Rancho Cucamonga	Tested By:	G. Berdy	Date:	09/14/16
Project No.:	11406.001	Data Input By:	J. Ward	Date:	09/22/16
Boring No.:	WP-10				
Sample No.:	S-1	Depth (feet):	3.5		
Soil Identification:	Olive silty sand (SM)				

		Soil Type
% Gravel	**2**	**SM**
% Sand	**81**	
% Fines	**17**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	147.67	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	147.60	164.59
Wt.of Air-Dry Soil + Cont. (g)	634.71	Wt. of Container No.___ (g)	1.00	67.91	76.36
Wt. of Container	248.78	Moisture Content (%)	0.00	0.09	
Dry Wt. of Soil (g)	385.93	Wt. of Dry Soil (g)			88.23

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	1.27	99.7
No. 4	9.02	97.7
No. 10	18.19	95.3
Pan		

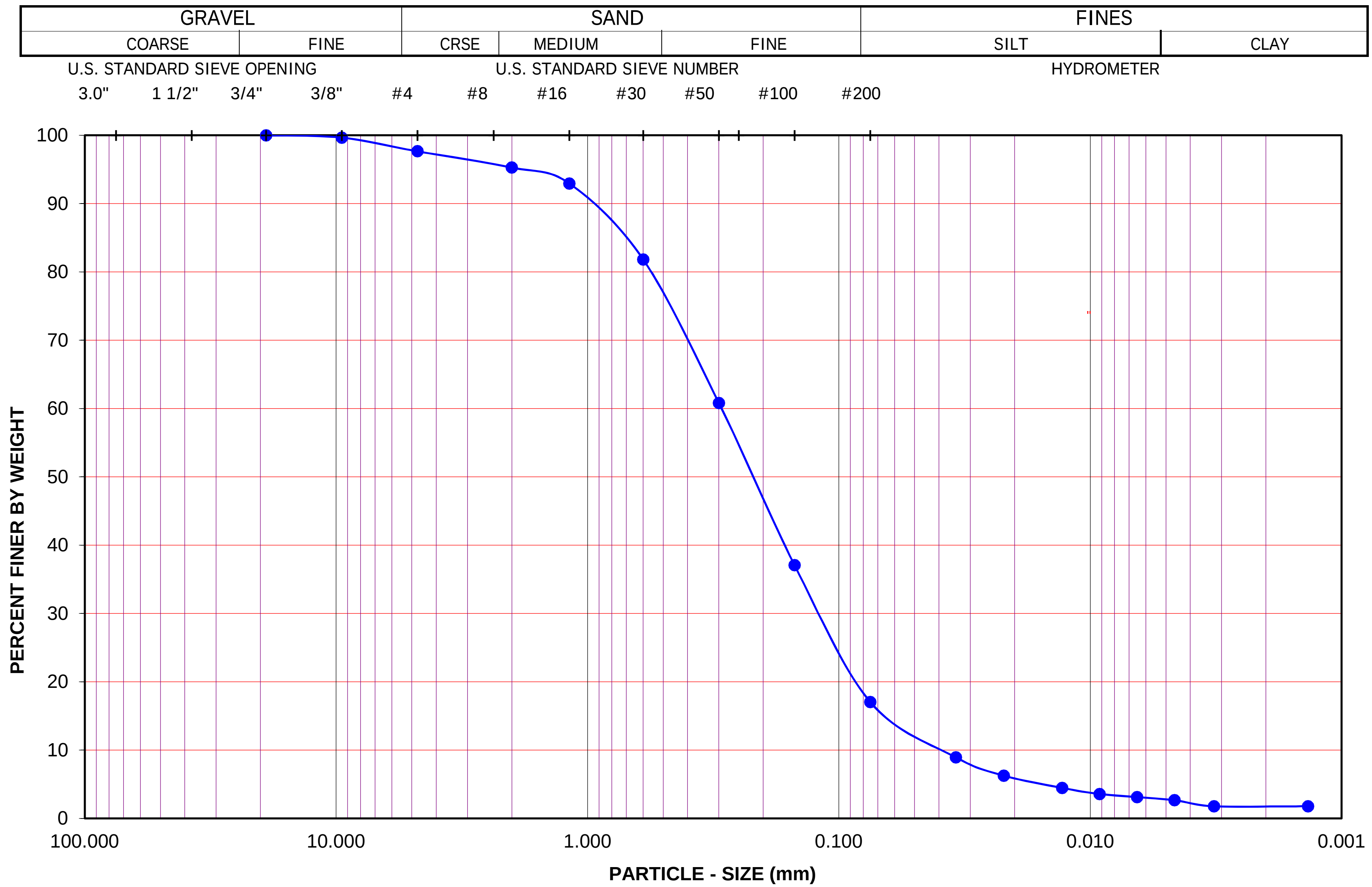
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	95.3
No. 16	2.59	97.5	92.9
No. 30	14.90	85.9	81.8
No. 50	38.16	63.8	60.8
No. 100	64.43	38.9	37.1
No. 200	86.61	17.9	17.1
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 105.58 Wt. of Dry Soil (g) 105.49

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
15-Sep-16	9:26	0		8.0			
	9:28	2	21.5	8.0	18.0	9.0	0.0342
	9:31	5	21.4	8.0	15.0	6.3	0.0221
	9:41	15	21.5	8.0	13.0	4.5	0.0129
	9:56	30	21.4	8.0	12.0	3.6	0.0092
	10:26	60	21.3	8.0	11.5	3.1	0.0065
	11:26	120	21.2	8.0	11.0	2.7	0.0046
	13:36	250	21.0	8.0	10.0	1.8	0.0032
16-Sep-16	9:26	1440	20.6	8.0	10.0	1.8	0.0014



Project Name: Stratham Homes/Rancho Cucamonga

Project No.: 11406.001

Boring No.: WP-10 | Sample No.: S-1

Depth (feet): 3.5 | Soil Type : SM

Soil Identification: Olive silty sand (SM)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 2 : 81 : 17

Sep-16

Leighton

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Stratham Homes/Rancho Cucamonga | Tested By: G. Berdy | Date: 09/14/16

Project No.: 11406.001 | Data Input By: J. Ward | Date: 09/22/16

Boring No.: WP-12

Sample No.: S-1 | Depth (feet): 13.5

Soil Identification: Olive silty sand with gravel (SM)g

		Soil Type
% Gravel	28	(SM)g
% Sand	57	
% Fines	15	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	86.65	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	86.65	155.75
Wt.of Air-Dry Soil + Cont. (g)	653.47	Wt. of Container No.___ (g)	1.00	60.90	75.87
Wt. of Container	252.19	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	401.28	Wt. of Dry Soil (g)			79.88

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	41.54	89.6
3/8"	77.60	80.7
No. 4	114.21	71.5
No. 10	157.03	60.9
Pan		

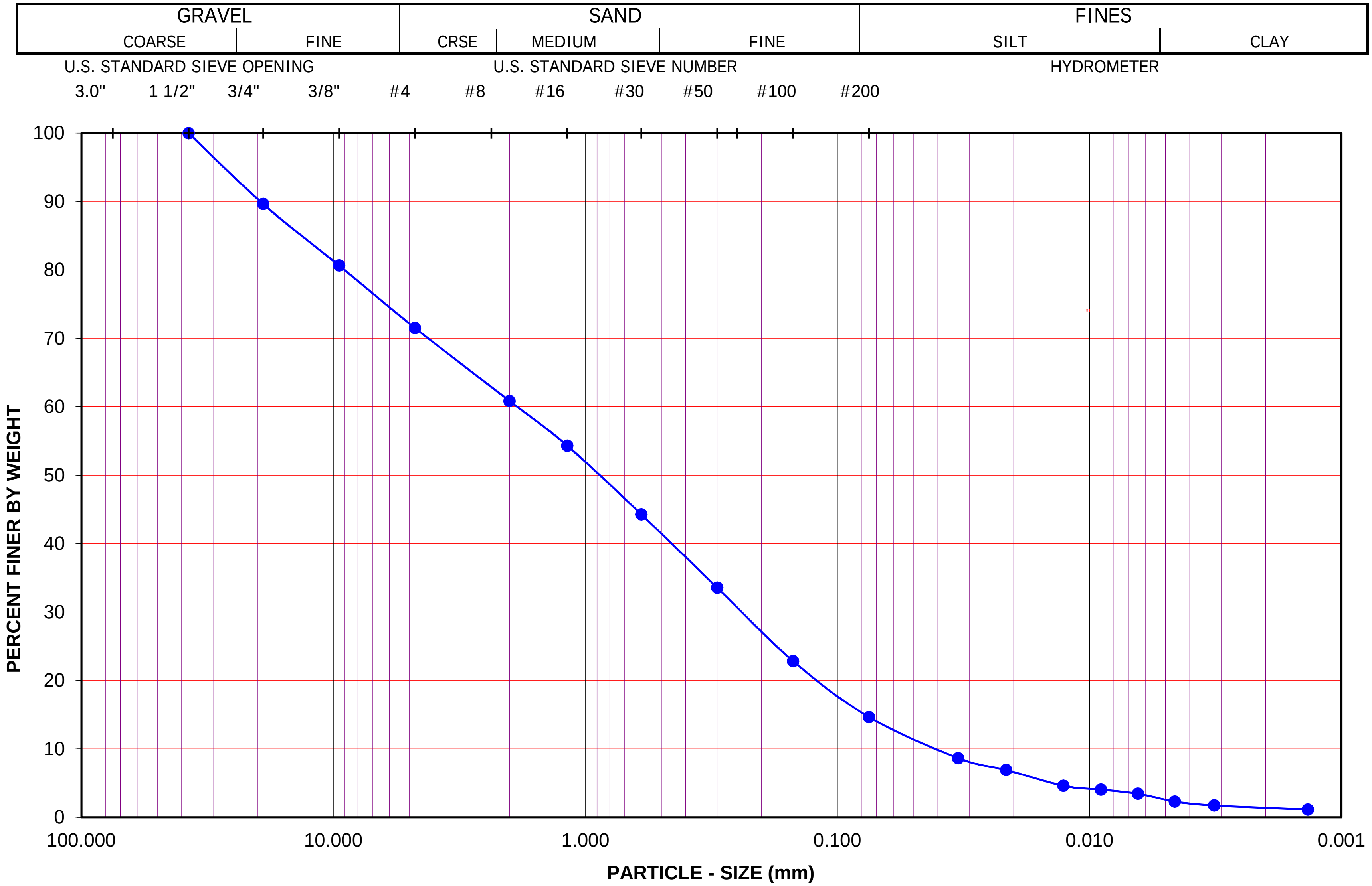
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	60.9
No. 16	11.23	89.2	54.3
No. 30	28.46	72.8	44.3
No. 50	46.85	55.1	33.6
No. 100	65.26	37.5	22.8
No. 200	79.27	24.1	14.7
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 104.45 Wt. of Dry Soil (g) 104.45

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
15-Sep-16	9:30	0		8.0			
	9:32	2	21.5	8.0	23.0	8.7	0.0332
	9:35	5	21.5	8.0	20.0	6.9	0.0214
	9:45	15	21.5	8.0	16.0	4.6	0.0127
	10:00	30	21.4	8.0	15.0	4.0	0.0090
	10:30	60	21.4	8.0	14.0	3.5	0.0064
	11:30	120	21.2	8.0	12.0	2.3	0.0046
	13:40	250	21.0	8.0	11.0	1.7	0.0032
16-Sep-16	9:30	1440	20.7	8.0	10.0	1.2	0.0014



Project Name: Stratham Homes/Rancho Cucamonga

Project No.: 11406.001

Boring No.: WP-12 Sample No.: S-1

Depth (feet): 13.5 Soil Type : (SM)g

Soil Identification: Olive silty sand with gravel (SM)g

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 28 : 57 : 15

Sep-16

Leighton

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS

ASTM D 6913

Project Name:	Stratham Homes/Rancho Cucamonga	Tested By:	A. Santos	Date:	09/13/16
Project No.:	11406.001	Checked By:	J. Ward	Date:	09/22/16
Boring No.:	WP-4	Depth (feet):	13.5		
Sample No.:	S-1				
Soil Identification:	Brown poorly-graded sand with silt and gravel (SP-SM)g				

		Moisture Content of Total Air - Dry Soil	
Container No.:	PHD	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	643.4	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	215.3	Wt. of Container No.______ (g)	1.00
Dry Wt. of Soil (g)	428.1	Moisture Content (%)	0.00

After Wet Sieve	Container No.	PHD
	Wt. of Dry Soil + Container (g)	606.7
	Wt. of Container (g)	215.3
	Dry Wt. of Soil Retained on # 200 Sieve (g)	391.4

U. S. Sieve Size (in.)	U. S. Sieve Size (mm.)	Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
1 1/2"	37.5		
1"	25.0	0.0	100.0
3/4"	19.0	54.8	87.2
1/2"	12.5	95.1	77.8
3/8"	9.5	116.0	72.9
#4	4.75	164.3	61.6
#8	2.36	204.8	52.2
#16	1.18	247.1	42.3
#30	0.600	291.6	31.9
#50	0.300	334.0	22.0
#100	0.150	369.0	13.8
#200	0.075	390.5	8.8
PAN			

GRAVEL: **38 %**

SAND: **53 %**

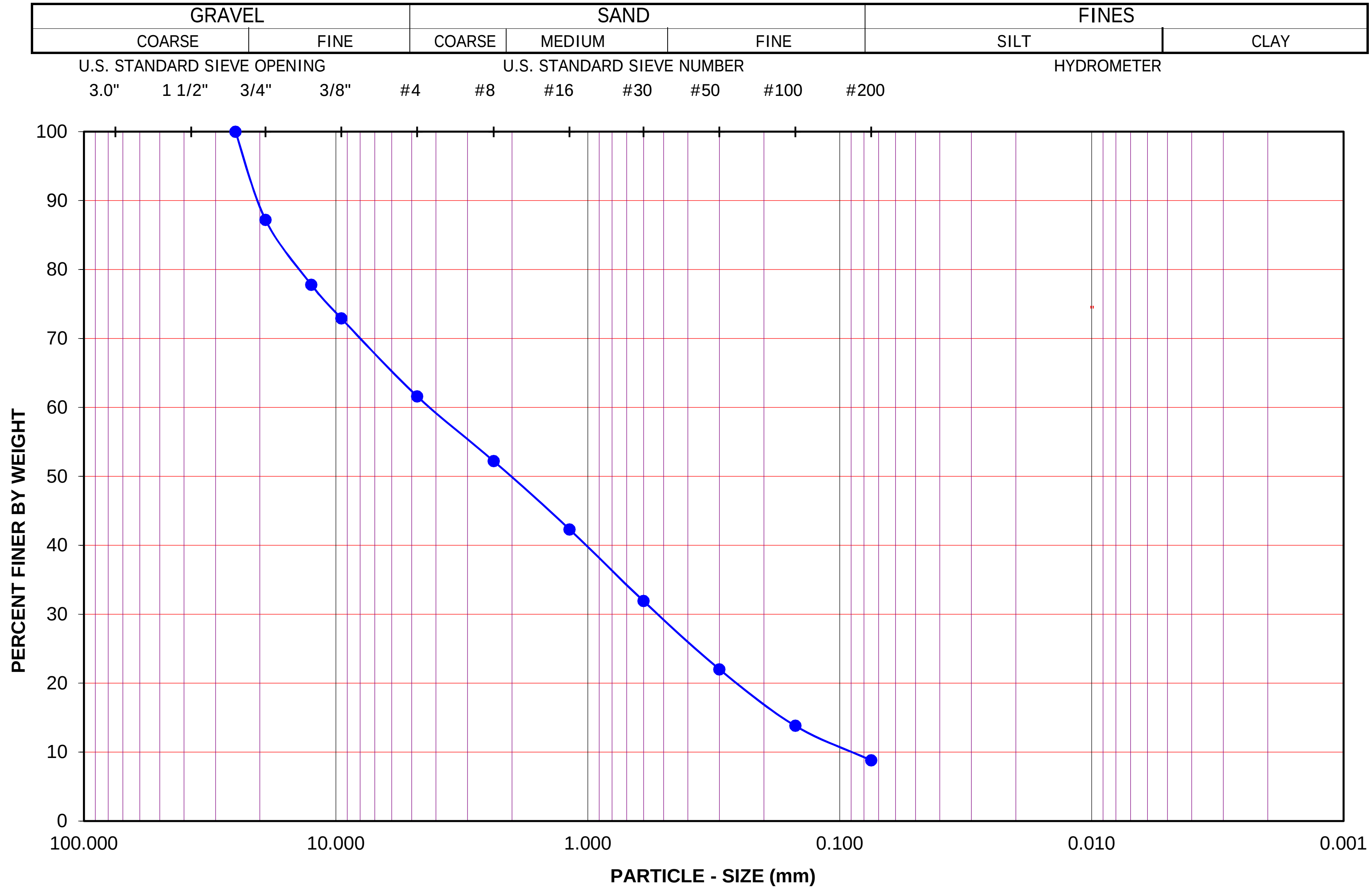
FINES: **9 %**

GROUP SYMBOL: **(SP-SM)g**

Cu = D60/D10 = 47.78

Cc = $(D30)^2/(D60*D10)$ = 0.73

Remarks:



Project Name: Stratham Homes/Rancho Cucamonga

Project No.: 11406.001

Boring No.: WP-4 Sample No.: S-1

Depth (feet): 13.5 Soil Type : (SP-SM)g

Soil Identification: Brown poorly-graded sand with silt and gravel (SP-SM)g

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 38 : 53 : 9

09/22/16

Leighton

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS

ASTM D 6913

Project Name:	Stratham Homes/Rancho Cucamonga	Tested By:	A. Santos	Date:	09/13/16
Project No.:	11406.001	Checked By:	J. Ward	Date:	09/22/16
Boring No.:	WP-8	Depth (feet):	13.5		
Sample No.:	S-1				
Soil Identification:	Brown poorly-graded sand with silt and gravel (SP-SM)g				

		Moisture Content of Total Air - Dry Soil	
Container No.:	DR	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	492.4	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	218.5	Wt. of Container No.______ (g)	1.00
Dry Wt. of Soil (g)	273.9	Moisture Content (%)	0.00

After Wet Sieve	Container No.	DR
	Wt. of Dry Soil + Container (g)	464.5
	Wt. of Container (g)	218.5
	Dry Wt. of Soil Retained on # 200 Sieve (g)	246.0

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
1 1/2"	37.5		
1"	25.0	0.0	100.0
3/4"	19.0	31.3	88.6
1/2"	12.5	65.4	76.1
3/8"	9.5	79.7	70.9
#4	4.75	103.5	62.2
#8	2.36	122.9	55.1
#16	1.18	147.0	46.3
#30	0.600	175.8	35.8
#50	0.300	204.8	25.2
#100	0.150	228.9	16.4
#200	0.075	245.5	10.4
PAN			

GRAVEL: **38 %**

SAND: **52 %**

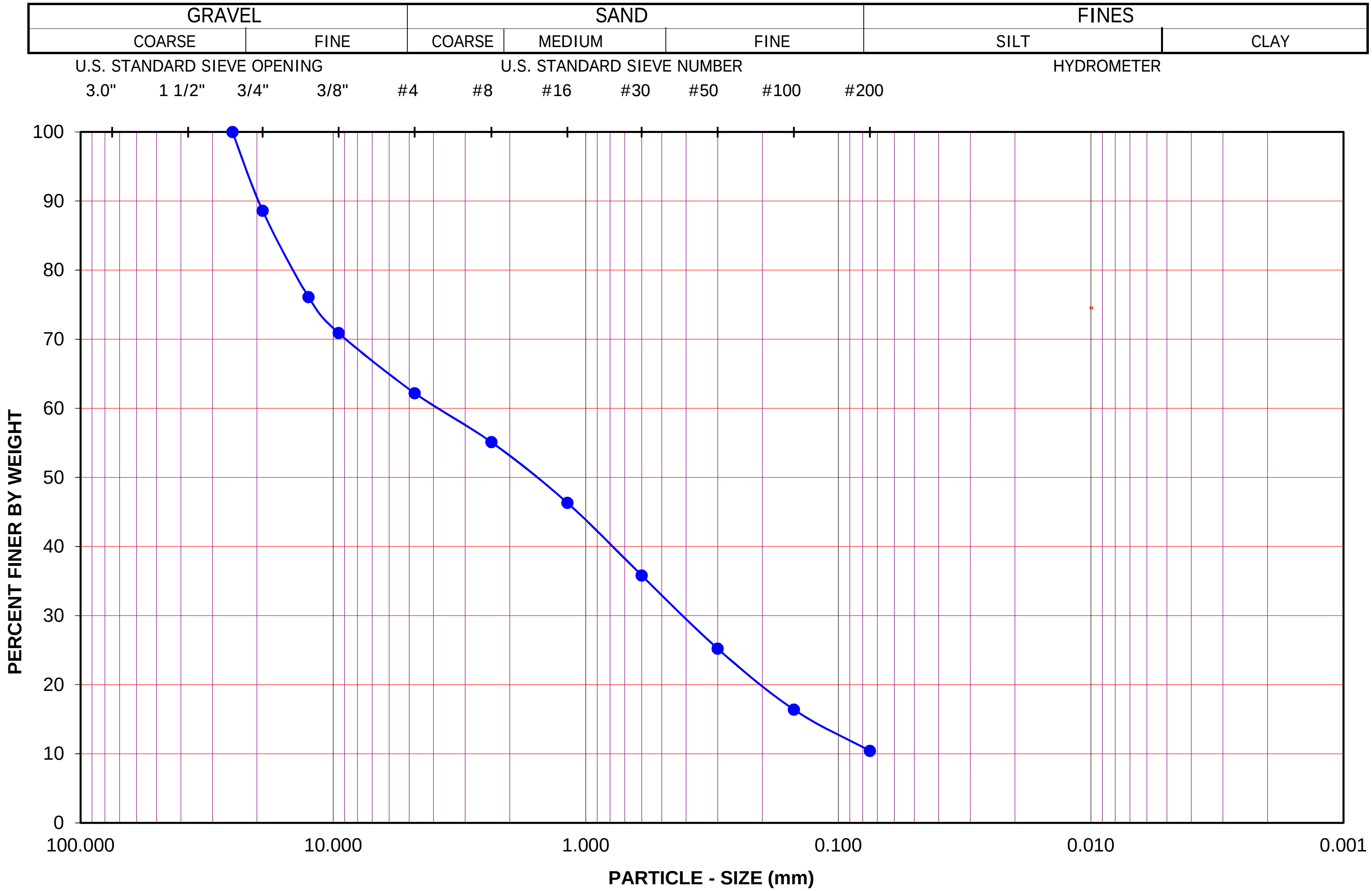
FINES: **10 %**

GROUP SYMBOL: **(SP-SM)g**

Cu = D60/D10 = 54.29

Cc = $(D30)^2/(D60*D10)$ = 0.66

Remarks:



Project Name: Stratham Homes/Rancho Cucamonga

Project No.: 11406.001

Boring No.: WP-8 Sample No.: S-1

Depth (feet): 13.5 Soil Type : (SP-SM)g

Soil Identification: Brown poorly-graded sand with silt and gravel (SP-SM)g

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 38 : 52 : 10

09/22/16

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Leighton

Project Name:	Stratham Homes/Rancho Cucamonga	Tested By :	G. Berdy	Date:	09/14/16
Project No. :	11406.001	Data Input By:	J. Ward	Date:	09/22/16

Boring No.	LB-4			
Sample No.	B-1			
Sample Depth (ft)	0-5			
Soil Identification:	Olive brown SM			
Wet Weight of Soil + Container (g)	225.71			
Dry Weight of Soil + Container (g)	223.16			
Weight of Container (g)	68.33			
Moisture Content (%)	1.65			
Weight of Soaked Soil (g)	100.23			

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	91			
Crucible No.	24			
Furnace Temperature (°C)	860			
Time In / Time Out	10:00/10:45			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	17.0835			
Wt. of Crucible (g)	17.0789			
Wt. of Residue (g) (A)	0.0046			
PPM of Sulfate (A) x 41150	189.29			
PPM of Sulfate, Dry Weight Basis	**192**			

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30			
ml of AgNO3 Soln. Used in Titration (C)	0.3			
PPM of Chloride (C -0.2) * 100 * 30 / B	10			
PPM of Chloride, Dry Wt. Basis	**10**			

pH TEST, DOT California Test 643

pH Value	**6.47**			
Temperature °C	21.1			

SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Stratham Homes/Rancho Cucamonga	Tested By :	G. Berdy Date: 09/16/16
Project No. :	11406.001	Data Input By:	J. Ward Date: 09/22/16
Boring No.:	LB-4	Depth (ft.) :	0-5
Sample No. :	B-1		

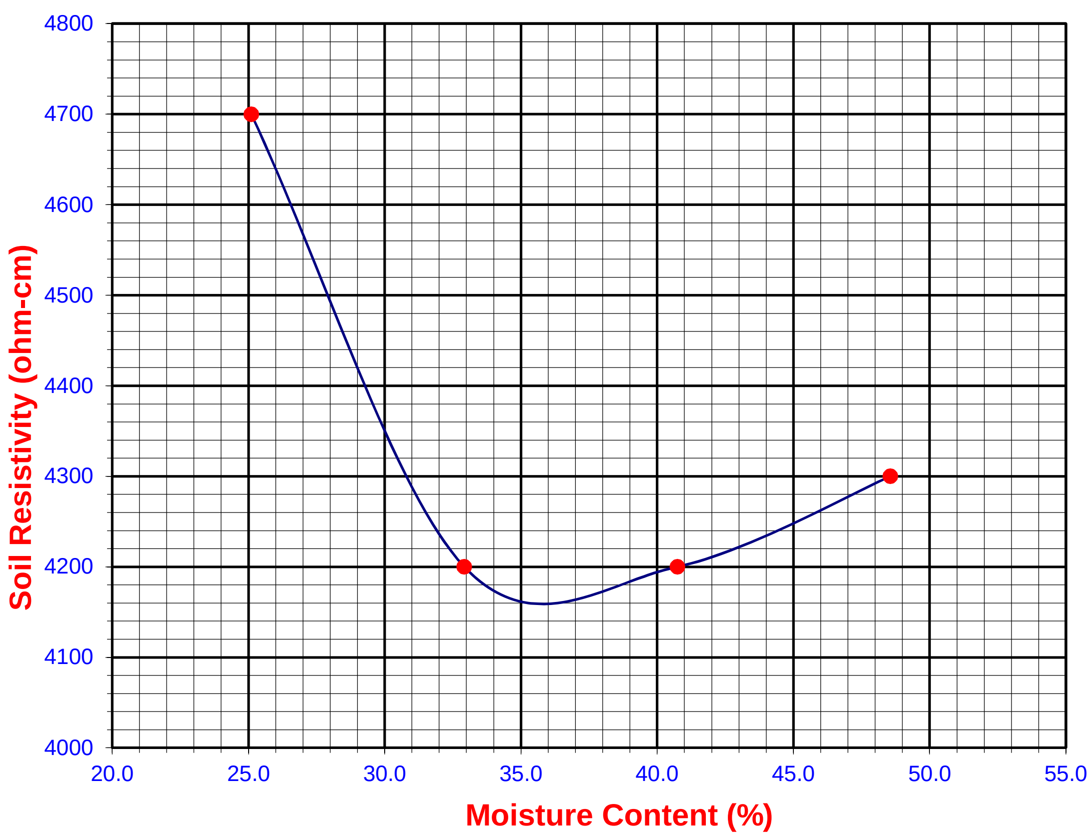
Soil Identification:* Olive brown SM

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	25.10	4700	4700
2	40	32.92	4200	4200
3	50	40.74	4200	4200
4	60	48.56	4300	4300
5				

Moisture Content (%) (MCi)	1.65
Wet Wt. of Soil + Cont. (g)	225.71
Dry Wt. of Soil + Cont. (g)	223.16
Wt. of Container (g)	68.33
Container No.	
Initial Soil Wt. (g) (Wt)	130.00
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
4160	**35.8**	**192**	**10**	**6.47**	**21.1**



APPENDIX D

WELL PERMEAMETER TEST RESULTS

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406
Exploration #/Location: *WP-1*
Depth Boring drilled to (ft): 15
Tested by: JDO
USCS Soil Type in test zone:
Weather (start to finish)
Liquid Used/pH:
Measured boring diameter 12 in. 6 Well Radius, "r"
Approx Depth to GW below GS 100 ft
Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 148.89
Average depth of water in well, "h" (in.): 31.112
approx. h/r: 5.2
Tu (Fig. 8): 87.6 ft
Tu>3h?: yes, OK

	ft	in.	Total (in.)
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180
Pilot Tube stickup (+ is above ground)	0. ft	6.5 in.	6.5
Depth to top of sand outside of casing from top of pilot tube			
Depth to top of float assembly from top of pilot tube	10. ft	10. in.	130
Float Assembly ID	E		
Float assembly Extension length (in.)		30	

123.5 Depth below GS (in.)

Diameter 22.5
No. of Su 1
Total Area 397.4

Field Data | **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/7/2016	Start time: 11:57																			
9/7/16	11:57	32.125	12.9		78.6															
9/7/16	11:59	30.375	12.91		83.4		2	2	148.4	31.6	31.58	16	695	-1427	-732	-366	-21955	0.8	-2.82	**-24.82**
9/7/16	12:10	26.75	12.94		80.4		11	13	148.8	31.2	-0.36	31	1441	16	1457	132	7947	0.8	1.64	**5.07**
9/7/16	12:26	16.875	12.91		82.7		16	29	148.4	31.6	0.36	31	3924	-16	3908	244	14655	0.8	2.89	**9.12**
9/7/16	12:35	12	12.92		82.2		9	38	148.5	31.5	-0.12	32	1937	5	1943	216	12952	0.8	2.59	**8.07**
9/7/16	12:39	32.5	12.95		78.6			42	148.9	31.1										
9/7/16	12:50	26	12.96		79.8		11	53	149.0	31.0	-0.12	31	2583	5	2589	235	14119	0.8	2.97	**9.17**
9/7/16	13:01	20	12.95		81.1		11	64	148.9	31.1	0.12	31	2384	-5	2379	216	12976	0.8	2.67	**8.30**
9/7/16	13:10	31.625	12.98		79.5			73	149.3	30.7										
9/7/16	13:21	25.75	12.95		80.5		11	84	148.9	31.1	0.36	31	2335	-16	2318	211	12646	0.8	2.61	**8.17**
9/7/16	13:35	17.875	12.95		82.0		14	98	148.9	31.1	0	31	3130	0	3130	224	13412	0.8	2.73	**8.48**
9/7/16	13:44	31.5	12.95		80.8			107	148.9	31.1										
9/7/16	13:54	26	12.95		81.3		10	117	148.9	31.1	0	31	2186	0	2186	219	13114	0.8	2.69	**8.36**
9/7/16	14:09	18.25	12.94		82.2		15	132	148.8	31.2	0.12	31	3080	-5	3074	205	12298	0.8	2.48	**7.75**
9/7/16	14:14	31	12.95		80.1			137	148.9	31.1										
9/7/16	14:32	20.875	12.95		83.0		18	155	148.9	31.1	0	31	4024	0	4024	224	13412	0.8	2.70	**8.39**
9/7/16	14:43	15.125	12.95		84.2		11	166	148.9	31.1	0	31	2285	0	2285	208	12464	0.8	2.48	**7.70**
9/7/16	14:53	31.125	12.93		82.4			176	148.7	31.3										
9/7/16	15:04	25.375	12.95		82.9		11	187	148.9	31.1	-0.24	31	2285	11	2296	209	12523	0.8	2.53	**7.81**
9/7/16	15:19	17.5	12.99		84.0		15	202	149.4	30.6	-0.48	31	3130	22	3151	210	12605	0.8	2.58	**7.86**
9/7/16	15:23	15.75	12.98		84.2		4	206	149.3	30.7	0.12	31	695	-5	690	173	10351	0.8	2.09	**6.47**
9/7/16	15:40	28.375	12.94		82.4			223	148.8	31.2										
9/7/16	15:54	20.875	12.95		83.2		14	237	148.9	31.1	-0.12	31	2981	5	2986	213	12797	0.8	2.57	**7.97**
9/7/16	16:04	15.75	12.95		84.0		10	247	148.9	31.1	0	31	2037	0	2037	204	12220	0.8	2.44	**7.56**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406

Exploration #/Location: *WP-2*

Depth Boring drilled to (ft): 15

Tested by: JDO

USCS Soil Type in test zone:

Weather (start to finish)

Liquid Used/pH:

Measured boring diameter 12 in. 6 Well Radius, "r"

Approx Depth to GW below GS 100 ft

Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 142.94

Average depth of water in well, "h" (in.): 37.058

approx. h/r: 6.2

Tu (Fig. 8): 88.1 ft

Tu>3h?: yes, OK

	ft	in.	*Total (in.)*	
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180	
Pilot Tube stickup (+ is above ground)	0. ft	2. in.	2	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	9. ft	8. in.	116	114 Depth below GS (in.)
Float Assembly ID	B			
Float assembly Extension length (in.)		30		

Diameter 22.5

No. of Su 1

Total Area 397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/7/2016	Start time: 11:47																			
9/7/16	**11:47**	32	12.3		79.8															
9/7/16	11:51	20.75	12.24		80.4		4	4	144.9	35.1	35.12	18	4471	-1587	2884	721	43253	0.8	4.99	**46.18**
9/7/16	11:57	16.375	12.20		79.7		6	10	144.4	35.6	0.48	35	1739	-22	1717	286	17170	0.8	2.93	**9.91**
9/7/16	11:59	14.625	12.2		79.8		2	12	144.4	35.6	0	36	695	0	695	348	20864	0.8	3.57	**11.95**
9/7/16	12:09	27	12.2		79.9			22	144.4	35.6										
9/7/16	12:22	18.375	12.08		84.9		13	35	143.0	37.0	1.44	36	3428	-65	3363	259	15519	0.8	2.35	**8.26**
9/7/16	12:31	13.125	12.22		81.6		9	44	144.6	35.4	-1.68	36	2086	76	2162	240	14415	0.8	2.47	**7.96**
9/7/16	12:37	31	12.0		79.6			50	142.0	38.0										
9/7/16	12:42	27.5	12.13		79.8		5	55	143.6	36.4	-1.56	37	1391	71	1461	292	17537	0.8	2.93	**9.64**
9/7/16	12:52	21.5	12.2		81.6		10	65	144.4	35.6	-0.84	36	2384	38	2422	242	14534	0.8	2.45	**8.07**
9/7/16	13:02	15.25	12.08		81.8		10	75	143.0	37.0	1.44	36	2484	-65	2419	242	14512	0.8	2.27	**7.98**
9/7/16	13:06	29.875	11.95		79.5			79	141.4	38.6										
9/7/16	13:19	22.25	11.95		82.1		13	92	141.4	38.6	0	39	3030	0	3030	233	13986	0.8	2.07	**7.24**
9/7/16	13:33	13.875	12.2		82.9		14	106	144.4	35.6	-3	37	3328	136	3464	247	14845	0.8	2.51	**7.90**
9/7/16	13:40	32	12.2		80.7			113	144.4	35.6										
9/7/16	13:56	20.125	12.02		83.1		16	129	142.2	37.8	2.16	37	4719	-98	4622	289	17331	0.8	2.58	**9.31**
9/7/16	14:07	14.125	12.02		83.6		11	140	142.2	37.8	0	38	2384	0	2384	217	13006	0.8	1.96	**6.76**
9/7/16	14:18	29.875	12.16		80.4			151	143.9	36.1										
9/7/16	14:30	22.5	12.2		82		12	163	144.4	35.6	-0.48	36	2931	22	2953	246	14763	0.8	2.47	**8.20**
9/7/16	14:46	13.125	12.23		83.6		16	179	144.8	35.2	-0.36	35	3726	16	3742	234	14032	0.8	2.34	**7.74**
9/7/16	14:49	30.125	11.92		82.2			182	141.0	39.0										
9/7/16	15:02	22.25	12.02		83.6		13	195	142.2	37.8	-1.2	38	3130	54	3184	245	14695	0.8	2.23	**7.53**
9/7/16	15:17	13.25	11.95		84.2		15	210	141.4	38.6	0.84	38	3577	-38	3539	236	14155	0.8	2.04	**7.24**
9/7/16	15:22	10.5	11.98		84.4		5	215	141.8	38.2	-0.36	38	1093	16	1109	222	13310	0.8	1.95	**6.76**
9/7/16	15:42	29.125	11.92		82.8			235	141.0	39.0										
9/7/16	15:52	23	12.13		80.2		10	245	143.6	36.4	-2.52	38	2434	114	2548	255	15288	0.8	2.56	**8.26**
9/7/16	16:06	14.875	11.98		82		14	259	141.8	38.2	1.8	37	3229	-81	3148	225	13490	0.8	2.00	**7.21**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project:	11406	Initial estimated Depth to Water Surface (in.):	143.2
Exploration #/Location:	*WP-3*	Average depth of water in well, "h" (in.):	36.8
Depth Boring drilled to (ft):	15	approx. h/r:	6.1
Tested by:	JDO	Tu (Fig. 8):	88.1 ft
USCS Soil Type in test zone:		Tu>3h?:	yes, OK
Weather (start to finish)			
Liquid Used/pH:			
Measured boring diameter	12 in.	6 Well Radius, "r"	
Approx Depth to GW below GS	100 ft		
Well Prep:	straight drill to TD		

	ft	in.	Total (in.)	
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180	
Pilot Tube stickup (+ is above ground)	0. ft	11. in.	11	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	2. in.	122	111 Depth below GS (in.)
Float Assembly ID	A			
Float assembly Extension length (in.)		34		

Diameter	36
No. of Su	1
Total Area	1017

Field Data **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/7/2016	Start time: 11:45																			
9/7/16	**11:45**	16.875	12.95		80.0															
9/7/16	11:48	7.5	12.85		79.9	too fast	3	3	143.2	36.8	36.8	18	9538	-1663	7875	2625	157490	0.8	17.16	**162.49**

template updated: 3/8/16

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project:	11406	
Exploration #/Location:	*WP-4*	
Depth Boring drilled to (ft):	15	
Tested by:	JDO	
USCS Soil Type in test zone:		
Weather (start to finish)		
Liquid Used/pH:		
Measured boring diameter	12	in. — 6 Well Radius, "r"
Approx Depth to GW below GS	100	ft
Well Prep:	straight drill to TD	

Initial estimated Depth to Water Surface (in.):	0
Average depth of water in well, "h" (in.):	180
approx. h/r:	30.0
Tu (Fig. 8):	100.0 ft
Tu>3h?:	yes, OK

	ft	*in.*	*Total (in.)*	
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180	
Pilot Tube stickup (+ is above ground)	1. ft	3. in.	15	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	0. in.	120	105 Depth below GS (in.)
Float Assembly ID	A			
Float assembly Extension length (in.)		34		

Diameter	36
No. of Su	1
Total Area	1017

Field Data / **Calculations**

Date	Time	**Water Level in Supply Barrel (in.)**	**Depth to WL in Boring (measured from top of pilot tube)**		Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3)			Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	**Infiltration Rate [flow/surf area] (in./hr) (FS=1)**
Start Date	Start time:		**ft**	**in.**									from supply	from Δh	Total					
9/7/2016	12:03																			
9/7/16	**12:03**	31.5	12.45		80.0															
						too fast to record														

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406

Exploration #/Location: *WP-5*
Depth Boring drilled to (ft): 15
Tested by: JDO
USCS Soil Type in test zone:
Weather (start to finish)
Liquid Used/pH:
Measured boring diameter 12 in. 6 Well Radius, "r"
Approx Depth to GW below GS 100 ft
Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 141.44
Average depth of water in well, "h" (in.): 38.058
approx. h/r: 6.3
Tu (Fig. 8): 88.2 ft
Tu>3h?: yes, OK

	ft	in.	Total (in.)
Depth to Bot of well (or top of soil over Bentonite)	14. ft	11.5 in.	180
Pilot Tube stickup (+ is above ground)	0. ft	-6.5 in.	-6.5
Depth to top of sand outside of casing from top of pilot tube			
Depth to top of float assembly from top of pilot tube	9. ft	9.5 in.	118
Float Assembly ID	B		
Float assembly Extension length (in.)		30	

124 Depth below GS (in.)

Diameter 22.5
No. of Su 1
Total Area 397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/8/2016	Start time: 8:47																			
9/8/16	**8:47**	25.875	12.05		74.3															
9/8/16	8:53	17.5	11.45		74.5		6	6	143.9	35.6	35.6	18	3328	-1609	1719	287	17193	0.9	2.10	**19.53**
9/8/16	8:57	10.5	11.41		74.8		4	10	143.4	36.1	0.48	36	2782	-22	2760	690	41402	0.9	7.37	**25.09**
9/8/16	8:59	30	11.35		73.9			12	142.7	36.8										
9/8/16	9:09	13.75	11.23		74.1		10	22	141.3	38.2	1.44	38	6458	-65	6393	639	38357	0.9	6.28	**22.49**

template updated: 3/8/16

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406
Exploration #/Location: *WP-6*
Depth Boring drilled to (ft): 15
Tested by: JDO
USCS Soil Type in test zone:
Weather (start to finish)
Liquid Used/pH:
Measured boring diameter: 12 in. — 6 Well Radius, "r"
Approx Depth to GW below GS: 100 ft
Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 169.13
Average depth of water in well, "h" (in.): 10.869
approx. h/r: 1.8
Tu (Fig. 8): 85.9 ft
Tu>3h?: yes, OK

	ft	in.	Total (in.)	
Depth to Bot of well (or top of soil over Bentonite)	15. ft		180	
Pilot Tube stickup (+ is above ground)	0. ft	-3. in.	-3	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	3. in.	123	126 Depth below GS (in.)
Float Assembly ID	E			
Float assembly Extension length (in.)		30		

Diameter: 22.5
No. of Su: 1
Total Area 397.4

Field Data — **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/8/2016	Start time: 8:49																			
9/8/16	8:49	24.875	14.8		71.3															
9/8/16	8:54	21.0	14.72		72.6		5	5	179.6	0.4	0.36	0	1540	-16	1524	305	18284	0.9	307.88	**139.43**
9/8/16	9:01	16.25	14.6		72.8		7	12	178.2	1.8	1.44	1	1888	-65	1823	260	15622	0.9	62.80	**92.60**
9/8/16	9:03	31.625	14.58		71.0			14	178.0	2.0										
9/8/16	9:10	26.875	14.51		72.3		7	21	177.1	2.9	0.84	2	1888	-38	1850	264	15855	0.9	56.49	**70.71**
9/8/16	9:15	23.75	14.55		72.8		5	26	177.6	2.4	-0.48	3	1242	22	1264	253	15163	0.9	82.75	**65.02**
9/8/16	9:27	17.0	14.56		73.8		12	38	177.7	2.3	-0.12	2	#REF!	5				0.9		
9/8/16	9:38	30.125	14.1		73.4			49	172.4	7.6										
9/8/16	9:47	23.75	13.92		74.0		9	58	170.0	10.0	2.4	9	2533	-108	2425	269	16167	0.9	15.01	**32.70**
9/8/16	9:50	17.0	14.22		74.4		3	61	173.6	6.4	-3.6	8	2682	163	2845	948	56904	0.9	121.55	**120.65**
9/8/16	10:02	14.125	13.6		74.6		12	73	166.2	13.8	7.44	10	1143	-336	806	67	4031	0.9	2.16	**7.27**
9/8/16	10:05	29.75	13.65		75.0			76	166.8	13.2										
9/8/16	10:15	24.25	13.57		76.2		10	86	165.8	14.2	0.96	14	2186	-43	2142	214	12854	0.9	8.08	**17.81**
9/8/16	10:23	20.0	13.63		76.4		8	94	166.6	13.4	-0.72	14	1689	33	1722	215	12911	0.9	9.04	**17.71**
9/8/16	10:32	14.75	13.55		76.2		9	103	165.6	14.4	0.96	14	2086	-43	2043	227	13620	0.9	8.38	**18.60**
9/8/16	10:34	31.125	13.45		74.5			105	164.4	15.6										
9/8/16	10:43	26.875	13.46		75.0		9	114	164.5	15.5	-0.12	16	1689	5	1694	188	11296	0.9	6.60	**14.30**
9/8/16	10:56	21.0	13.71		76.2		13	127	167.5	12.5	-3	14	2335	136	2470	190	11402	0.9	9.37	**15.52**
9/8/16	11:07	15.5	13.62		78.0		11	138	166.4	13.6	1.08	13	2186	-49	2137	194	11656	0.9	7.53	**16.44**
9/8/16	11:14	12.125	13.72		78.3		7	145	167.6	12.4	-1.2	13	1341	54	1395	199	11961	0.8	9.24	**16.87**
9/8/16	11:16	30.875	13.71		75.2			147	167.5	12.5										
9/8/16	11:26	26.5	13.69		77.4		10	157	167.3	12.7	0.24	13	1739	-11	1728	173	10367	0.9	7.49	**15.12**
9/8/16	11:39	20.75	13.49		78.2		13	170	164.9	15.1	2.4	14	2285	-108	2177	167	10046	0.8	5.47	**13.38**
9/8/16	11:49	16.375	13.52		78.9		10	180	165.2	14.8	-0.36	15	1739	16	1755	175	10530	0.8	6.27	**13.11**
9/8/16	12:00	11.75	13.81		79.8		11	191	168.7	11.3	-3.48	13	1838	157	1995	181	10883	0.8	9.95	**15.02**
9/8/16	12:02	32.0	13.81		77.9			193	168.7	11.3										
9/8/16	12:14	27.125	13.63		78.8		12	205	166.6	13.4	2.16	12	1937	-98	1840	153	9199	0.8	5.77	**13.40**
9/8/16	12:23	23.5	13.59		80.4		9	214	166.1	13.9	0.48	14	1441	-22	1419	158	9459	0.8	5.84	**12.45**
9/8/16	12:33	19.5	13.61		81.2		10	224	166.3	13.7	-0.24	14	1590	11	1600	160	9603	0.8	6.13	**12.43**
9/8/16	12:43	15.125	13.63		81.9		10	234	166.6	13.4	-0.24	14	1739	11	1749	175	10497	0.8	6.80	**13.68**
9/8/16	12:46	31.0	13.63		79.1			237	166.6	13.4										
9/8/16	13:00	25.125	13.72		81.2		14	251	167.6	12.4	-1.08	13	2335	49	2384	170	10215	0.8	7.60	**13.98**
9/8/16	13:18	18.0	13.49		83.4		18	269	164.9	15.1	2.76	14	2832	-125	2707	150	9023	0.8	4.59	**11.45**

template updated: 3/8/16

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project:	11406	Initial estimated Depth to Water Surface (in.):	150.65
Exploration #/Location:	*WP-7*	Average depth of water in well, "h" (in.):	28.848
Depth Boring drilled to (ft):	15	approx. h/r:	4.4
Tested by:	JDO	Tu (Fig. 8):	87.4 ft
USCS Soil Type in test zone:		Tu>3h?:	yes, OK
Weather (start to finish)			
Liquid Used/pH:			
Measured boring diameter	13 in.	6.5 Well Radius, "r"	
Approx Depth to GW below GS	100 ft		
Well Prep:	straight drill to TD		

	ft	in.	Total (in.)	
Depth to Bot of well (or top of soil over Bentonite)	14. ft	11.5 in.	180	
Pilot Tube stickup (+ is above ground)	0. ft	6. in.	6	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	5. in.	125	119 Depth below GS (in.)
Float Assembly ID	F			
Float assembly Extension length (in.)		34		

Diameter	22.5
No. of Su	1
Total Area	397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date	Start time:																			
9/8/2016	8:50																			
9/8/16	**8:50**	23.5	13.68		73.5															
9/8/16	8:55	16	13.15		74.4		5	5	151.8	27.7	27.7	14	2981	-1469	1511	302	18134	0.9	2.90	**23.16**
9/8/16	9:05	30.875	13.01		73.8			15	150.1	29.4										
9/8/16	9:12	16.875	13.11		74.3		7	22	151.3	28.2	-1.2	29	5564	64	5627	804	48234	0.9	12.04	**32.94**
9/8/16	9:17	6.875	13.05		74.7		5	27	150.6	28.9	0.72	29	3974	-38	3936	787	47230	0.9	11.10	**32.32**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406

Exploration #/Location:	WP-8
Depth Boring drilled to (ft):	15
Tested by:	JDO
USCS Soil Type in test zone:	
Weather (start to finish)	
Liquid Used/pH:	
Measured boring diameter	12 in.
Approx Depth to GW below GS	100 ft
Well Prep:	straight drill to TD

6 Well Radius, "r"

Initial estimated Depth to Water Surface (in.):	141.38
Average depth of water in well, "h" (in.):	38.623
approx. h/r:	6.4
Tu (Fig. 8):	88.2 ft
Tu>3h?:	yes, OK

	ft	in.	Total (in.)	
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180	
Pilot Tube stickup (+ is above ground)	0. ft	1. in.	1	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	2. in.	122	121 Depth below GS (in.)
Float Assembly ID	D			
Float assembly Extension length (in.)		34		

Diameter	22.5
No. of Su	1
Total Area	397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	Vol Change from Δh	Vol Change Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date: 9/8/2016	Start time: 8:52																			
9/8/16	8:52	22.375	12.31		73.5															
9/8/16	8:56	17.25	12.35		74.1		4	4	147.2	32.8	32.8	16	2037	-1482	554	139	8314	0.9	1.14	**10.18**
9/8/16	9:07	32.5	12.3		73.5			15	146.6	33.4										
9/8/16	9:13	24.5	12.36		74.2		6	21	147.3	32.7	-0.72	33	3179	33	3212	535	32118	0.9	6.73	**21.14**
9/8/16	9:18	17.75	12.33		74.9		5	26	147.0	33.0	0.36	33	2682	-16	2666	533	31995	0.9	6.48	**20.97**
9/8/16	9:23	11.875	12.31		75.2		5	31	146.7	33.3	0.24	33	2335	-11	2324	465	27887	0.9	5.57	**18.06**
9/8/16	9:35	30.625	12.26		73.5			43	146.1	33.9										
9/8/16	9:46	17.875	12.2		74.2		11	54	144.9	35.1	1.2	34	5067	-54	5013	456	27342	0.9	5.09	**17.31**
9/8/16	9:55	8	12.11		75.0		9	63	144.3	35.7	0.6	35	3924	-27	3897	433	25982	0.9	4.69	**15.89**
9/8/16	10:00	31	12.1		74.4			68	144.2	35.8										
9/8/16	10:13	17.125	12.11		74.9		13	81	144.3	35.7	-0.12	36	5514	5	5519	425	25474	0.9	4.62	**15.46**
9/8/16	10:21	9	12.09		75.4		8	89	144.1	35.9	0.24	36	3229	-11	3218	402	24136	0.9	4.30	**14.53**
9/8/16	10:26	31.125	12.12		73.9			94	144.4	35.6										
9/8/16	10:36	21.75	12.19		74.4		10	104	145.3	34.7	-0.84	35	3726	38	3764	376	22582	0.9	4.32	**14.01**
9/8/16	10:41	16	12.19		74.8		5	109	145.3	34.7	0	35	2285	0	2285	457	27421	0.9	5.18	**17.11**
9/8/16	10:47	10.75	12.17		75.2		6	115	145.0	35.0	0.24	35	2086	-11	2076	346	20755	0.9	3.86	**12.84**
9/8/16	10:50	31.75	12.19		74.3			118	145.3	34.7										
9/8/16	11:00	21.125	12.1		75.6		10	128	144.2	35.8	1.08	35	4222	-49	4174	417	25042	0.9	4.44	**15.24**
9/8/16	11:10	11.5	12.12		76.2		10	138	144.4	35.6	-0.24	36	3825	11	3836	384	23015	0.9	4.13	**13.75**
9/8/16	11:13	31.125	12.13		75.1			141	144.6	35.4										
9/8/16	11:23	21	12.12		77.0		10	151	144.4	35.6	0.12	36	4024	-5	4018	402	24110	0.9	4.27	**14.32**
9/8/16	11:33	11.5	12.11		77.5		10	161	144.3	35.7	0.12	36	3775	-5	3770	377	22620	0.9	3.96	**13.31**
9/8/16	11:35	31.5	12.2		76.4			163	145.4	34.6										
9/8/16	11:45	22.25	12.15		76.8		10	173	144.8	35.2	0.6	35	3676	-27	3649	365	21893	0.9	3.93	**13.25**
9/8/16	11:55	11.5	12.07		77.2		10	183	143.8	36.2	0.96	36	4272	-43	4229	423	25372	0.9	4.35	**14.97**
9/8/16	12:04	27.875	12:13		77.7			192	5.1	174.9										
9/8/16	12:13	18.75	12.11		79.5		9	201	144.3	35.7	-139.2	105	3626	6292	9918	1102	66121	0.8	18.07	**13.55**
9/8/16	12:23	9.875	12.14		80.2		10	211	144.7	35.3	-0.36	36	3527	16	3543	354	21260	0.8	3.67	**12.15**
9/8/16	12:30	31.125	12.05		77.0			218	143.6	36.4										
9/8/16	12:40	22	12.1		78.3		10	228	144.2	35.8	-0.6	36	3626	27	3653	365	21921	0.8	3.80	**12.62**
9/8/16	12:50	12.125	12.12		79.2		10	238	144.4	35.6	-0.24	36	3924	11	3935	394	23611	0.8	4.08	**13.59**
9/8/16	12:58	31.25	12.1		77.5			246	144.2	35.8										
9/8/16	13:17	14.75	12.15		74.4		19	265	144.8	35.2	-0.6	36	6557	27	6584	347	20793	0.9	3.89	**12.78**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406

Exploration #/Location: *WP-9*

Depth Boring drilled to (ft): 15

Tested by: JDO

USCS Soil Type in test zone:

Weather (start to finish)

Liquid Used/pH:

Measured boring diameter 12 in. — 6 Well Radius, "r"

Approx Depth to GW below GS 100 ft

Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 152.83

Average depth of water in well, "h" (in.): 27.169

approx. h/r: 4.5

Tu (Fig. 8): 87.3 ft

Tu>3h?: yes, OK

	ft	in.	Total (in.)	
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180	
Pilot Tube stickup (+ is above ground)	0. ft	4.5 in.	4.5	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	4. in.	124	119.5 Depth below GS (in.)
Float Assembly ID	D			
Float assembly Extension length (in.)		34		

Diameter 22.5

No. of Su 1

Total Area 397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date	Start time:																			
9/9/2016	9:20																			
9/9/16	**9:29**	27	13.19		77.9															
9/9/16	9:37	18	13.18		78		8	17	153.7	26.3	26.34	13	3577	-1190	2386	298	17896	0.9	3.09	**25.00**
9/9/16	9:44	10.375	13.11		78.4		7	24	152.8	27.2	0.84	27	3030	-38	2992	427	25648	0.8	6.56	**19.37**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project:	11406	Initial estimated Depth to Water Surface (in.):	36.234
Exploration #/Location:	*WP-10*	Average depth of water in well, "h" (in.):	21.766
Depth Boring drilled to (ft):	5	approx. h/r:	3.6
Tested by:	JDO	Tu (Fig. 8):	97.0 ft
USCS Soil Type in test zone:		Tu>3h?:	yes, OK
Weather (start to finish)			
Liquid Used/pH:			
Measured boring diameter	12 in.	6 Well Radius, "r"	
Approx Depth to GW below GS	100 ft		
Well Prep:	straight drill to TD		

	ft	in.	Total (in.)
Depth to Bot of well (or top of soil over Bentonite)	4. ft	10. in.	58
Pilot Tube stickup (+ is above ground)	3. ft	2.5 in.	38.5
Depth to top of sand outside of casing from top of pilot tube			
Depth to top of float assembly from top of pilot tube	2. ft	6.5 in.	30.5 (-8 Depth below GS (in.))
Float Assembly ID	B		
Float assembly Extension length (in.)		30	

Diameter	22.5
No. of Su	1
Total Area	397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date	Start time:																			
9/9/2016	9:28																			
9/9/16	9:28	30.5	6.82		76.1															
9/9/16	9:36	27	6.71		76.8		8	8	42.0	16.0	15.98	8	1391	-722	669	84	5015	0.9	1.62	**10.46**
9/9/16	9:42	22.75	5.71		77.1		6	14	30.0	28.0	12	22	1689	-542	1147	191	11466	0.9	2.50	**10.49**
9/9/16	9:55	17	6.01		77.4		13	27	33.6	24.4	-3.6	26	2285	163	2448	188	11298	0.9	3.59	**8.81**
9/9/16	10:04	14.75	5.92		77.8		9	36	32.5	25.5	1.08	25	894	-49	845	94	5636	0.9	1.59	**4.57**
9/9/16	10:12	13.25	5.89		78.2		8	44	32.2	25.8	0.36	26	596	-16	580	72	4349	0.8	1.20	**3.42**
9/9/16	10:14	31.375	6.02		75.5	refilled		46	33.7	24.3										
9/9/16	10:24	24.375	6.43		75.9		10	56	38.7	19.3	-4.92	22	2782	222	3004	300	18025	0.9	8.32	**16.86**
9/9/16	10:32	21	6.2		76.3		8	64	36.3	21.7	2.4	21	1341	-108	1233	154	9246	0.9	3.24	**9.06**
9/9/16	10:42	18.25	6.31		76.8		10	74	37.2	20.8	-0.96	21	1093	43	1136	114	6818	0.9	2.65	**6.44**
9/9/16	10:52	13	6.11		77.9		10	84	34.8	23.2	2.4	22	2086	-108	1978	198	11867	0.9	3.73	**10.75**
9/9/16	10:57	31.625	6.32		76.2	refilled		89	37.3	20.7										
9/9/16	11:07	23.625	6.01		76.9		10	99	33.6	24.4	3.72	23	3179	-168	3011	301	18067	0.9	5.28	**16.21**
9/9/16	11:28	10.25	6.42		78.2		21	120	38.5	19.5	-4.92	22	5315	222	5538	264	15822	0.8	7.03	**14.31**
9/9/16	11:31	31.625	6.4		77	refilled		123	38.3	19.7										
9/9/16	11:42	22.875	6.36		78		11	134	37.8	20.2	0.48	20	3477	-22	3456	314	18849	0.9	7.36	**18.56**
9/9/16	11:52	16.75	6.22		78.3		10	144	36.1	21.9	1.68	21	2434	-76	2358	236	14149	0.8	4.85	**13.26**
9/9/16	12:02	10.875	6.24		78.5		10	154	36.4	21.6	-0.24	22	2335	11	2346	235	14074	0.8	5.02	**12.77**
9/9/16	12:10	6.5	6.32		79		8	162	37.3	20.7	-0.96	21	1739	43	1782	223	13365	0.8	5.10	**12.36**
9/9/16	12:36	28.625	6.25		77.4	refilled		188	36.5	21.5										
9/9/16	12:46	21.75	6.29		78.2		10	198	37.0	21.0	-0.48	21	2732	22	2754	275	16523	0.8	6.17	**15.35**
9/9/16	12:56	14	6.31		78.6		10	208	37.2	20.8	-0.24	21	3080	11	3091	309	18544	0.8	6.98	**17.40**
9/9/16	13:08	8.125	6.31		78.8		12	220	37.2	20.8	0	21	2335	0	2335	195	11674	0.8	4.37	**10.98**
9/9/16	13:14	29.875	6.28		78.4	refilled		226	36.9	21.1										
9/9/16	13:24	22.5	6.22		78.6		10	236	36.1	21.9	0.72	22	2931	-33	2898	290	17390	0.8	6.02	**15.92**
9/9/16	13:34	15.5	6.24		78.8		10	246	36.4	21.6	-0.24	22	2782	11	2793	279	16756	0.8	5.96	**15.15**
9/9/16	13:43	10	6.28		79.2		9	255	36.9	21.1	-0.48	21	2186	22	2207	245	14716	0.8	5.39	**13.44**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406

Exploration #/Location: *WP-11*

Depth Boring drilled to (ft): 15

Tested by: JDO

USCS Soil Type in test zone:

Weather (start to finish)

Liquid Used/pH:

Measured boring diameter 12 in. 6 Well Radius, "r"

Approx Depth to GW below GS 100 ft

Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 149.04

Average depth of water in well, "h" (in.): 30.963

approx. h/r: 5.2

Tu (Fig. 8): 87.6 ft

Tu>3h?: yes, OK

	ft	in.	Total (in.)
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180
Pilot Tube stickup (+ is above ground)		3. in.	3
Depth to top of sand outside of casing from top of pilot tube			
Depth to top of float assembly from top of pilot tube	10. ft	4. in.	124
Float Assembly ID	F		
Float assembly Extension length (in.)		34	

121 Depth below GS (in.)

Diameter 22.5

No. of Su 1

Total Area 397.4

Field Data / **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/9/2016	Start time: 9:30																			
9/9/16	9:30	25.375	12.63		79															
9/9/16	9:38	16.25	12.65		80.4		8	8	148.8	31.2	31.2	16	3626	-1410	2216	277	16622	0.8	2.24	**19.62**
9/9/16	9:49	12.375	12.67				11	19	149.0	31.0	-0.24	31	1540	11	1551	141	8459	0.8	1.77	**5.45**

Results of Well Permeameter, from USBR 7300-89 Method.

Leighton

Project: 11406

Exploration #/Location: *WP-12*

Depth Boring drilled to (ft): 15

Tested by: JDO

USCS Soil Type in test zone:

Weather (start to finish)

Liquid Used/pH:

Measured boring diameter 12 in. 6 Well Radius, "r"

Approx Depth to GW below GS 100 ft

Well Prep: straight drill to TD

Initial estimated Depth to Water Surface (in.): 144.52

Average depth of water in well, "h" (in.): 35.483

approx. h/r: 5.9

Tu (Fig. 8): 88.0 ft

Tu>3h?: yes, OK

	ft	in.	Total (in.)	
Depth to Bot of well (or top of soil over Bentonite)	15. ft	0. in.	180	
Pilot Tube stickup (+ is above ground)		2.5 in.	2.5	
Depth to top of sand outside of casing from top of pilot tube				
Depth to top of float assembly from top of pilot tube	10. ft	3.5 in.	124	121 Depth below GS (in.)
Float Assembly ID	C			
Float assembly Extension length (in.)		34		

Diameter 22.5

No. of Su[1

Total Area 397.4

Field Data | **Calculations**

Date	Time	Water Level in Supply Barrel (in.)	Depth to WL in Boring (measured from top of pilot tube) ft	in.	Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3) from supply	from Δh	Total	Flow (in^3/ min)	q, Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Perme-ability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)
Start Date 9/9/2016	Start time: 9:33																			
9/9/16	9:33	23.5	12.24		79.1															
9/9/16	9:40	17.125	12.27		80		7	7	144.7	35.3	35.26	18	2533	-1594	940	134	8056	0.8	0.93	**8.61**
9/9/16	9:46	13.5	12.22		80.9		6	13	144.1	35.9	0.6	36	1441	-27	1413	236	14135	0.8	2.35	**8.00**
9/9/16	9:54	8	12.24		81.3		8	21	144.4	35.6	-0.24	36	2186	11	2197	275	16474	0.8	2.77	**9.24**
9/9/16	10:01	31.5	12.32		76.8			28	145.3	34.7										
9/9/16	10:11	25	12.27		77.1		10	38	144.7	35.3	0.6	35	2583	-27	2556	256	15336	0.9	2.74	**9.23**
9/9/16	10:21	18.125	12.2		77.3		10	48	143.9	36.1	0.84	36	2732	-38	2694	269	16165	0.9	2.78	**9.52**
9/9/16	10:31	11.625	12.21		78.4		10	58	144.0	36.0	-0.12	36	2583	5	2589	259	15531	0.8	2.66	**8.94**
9/9/16	10:34	32.125	12.3		77.2	refilled		61	145.3	34.7										
9/9/16	10:44	26.375	12.29		78.2		10	71	145.0	35.0	0.36	35	2285	-16	2269	227	13613	0.8	2.43	**8.11**
9/9/16	10:54	20	12.22		78.7		10	81	144.1	35.9	0.84	35	2533	-38	2495	250	14973	0.8	2.55	**8.72**
9/9/16	11:04	13.75	12.24		79		10	91	144.4	35.6	-0.24	36	2484	11	2495	249	14968	0.8	2.59	**8.62**
9/9/16	11:06	30.25	12.26		78	refilled		93	144.6	35.4										
9/9/16	11:16	23.75	12.22		79		10	103	144.1	35.9	0.48	36	2583	-22	2561	256	15369	0.8	2.62	**8.88**
9/9/16	11:26	17.25	12.29		79.6		10	113	145.0	35.0	-0.84	35	2583	38	2621	262	15727	0.8	2.78	**9.07**
9/9/16	11:36	12	12.27		80.3		10	123	144.7	35.3	0.24	35	2086	-11	2076	208	12453	0.8	2.15	**7.18**
9/9/16	11:39	31.625	12.22		80	refilled		126	144.1	35.9										
9/9/16	11:50	25.125	12.22		80		11	137	144.1	35.9	0	36	2583	0	2583	235	14090	0.8	2.38	**8.00**
9/9/16	12:00	19	12.24		80.2		10	147	144.4	35.6	-0.24	36	2434	11	2445	244	14670	0.8	2.50	**8.33**
9/9/16	12:06	29.75	12.21		79	refilled		153	144.0	36.0										
9/9/16	12:15	24.75	12.24		79.4		9	162	144.4	35.6	-0.36	36	1987	16	2003	223	13355	0.8	2.30	**7.65**
9/9/16	12:25	19.125	12.2		79.8		10	172	143.9	36.1	0.48	36	2235	-22	2214	221	13282	0.8	2.22	**7.56**
9/9/16	12:38	30.375	12.28		78.4	refilled		185	144.9	35.1										
9/9/16	12:48	25	12.3		78.8		10	195	145.1	34.9	-0.24	35	2136	11	2147	215	12881	0.8	2.30	**7.58**
9/9/16	12:58	19.125	12.31		79		10	205	145.2	34.8	-0.12	35	2335	5	2340	234	14041	0.8	2.51	**8.28**
9/9/16	13:13	10.5	12.24		80.0		15	220	144.4	35.6	0.84	35	3428	-38	3390	226	13559	0.8	2.30	**7.83**
9/9/16	13:16	31.125	12.34		78.1	refilled		223	145.6	34.4										
9/9/16	13:26	26.375	12.3		78.4		10	233	145.1	34.9	0.48	35	1888	-22	1866	187	11196	0.8	2.00	**6.68**
9/9/16	13:36	20.75	12.28		78.6		10	243	144.9	35.1	0.24	35	2235	-11	2225	222	13347	0.8	2.36	**7.87**
9/9/16	13:45	15.75	12.24		79.3		9	252	144.4	35.6	0.48	35	1987	-22	1965	218	13102	0.8	2.25	**7.59**

APPENDIX E

SUMMARY OF SECONDARY SEISMIC HAZARD ANALYSIS

Leighton

Design Maps Summary Report

User–Specified Input

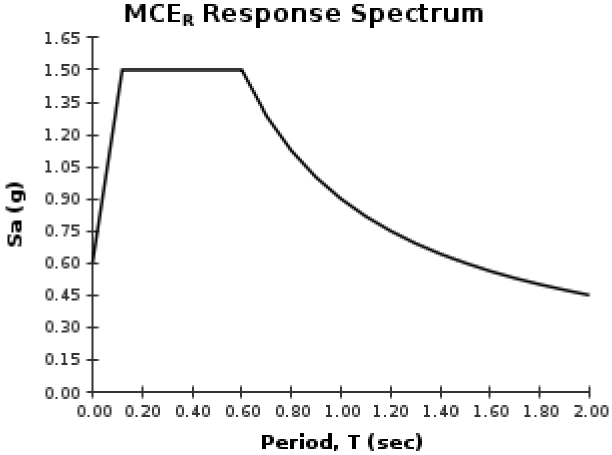
Report Title	Stratham Rancho Cucamonga Tue September 13, 2016 16:39:38 UTC
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	34.1082°N, 117.5158°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

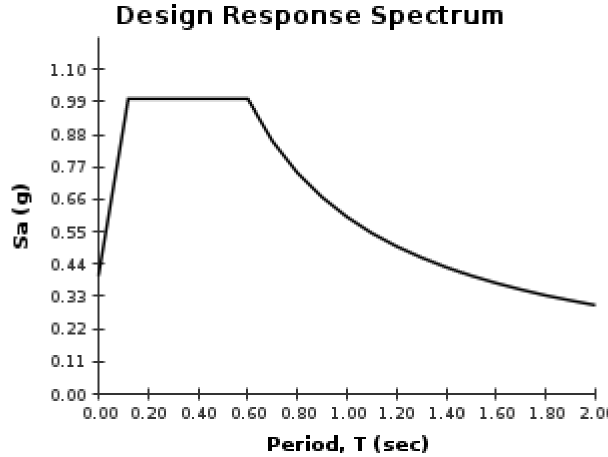
$S_S =$ 1.500 g	$S_{MS} =$ 1.500 g	$S_{DS} =$ 1.000 g
$S_1 =$ 0.600 g	$S_{M1} =$ 0.900 g	$S_{D1} =$ 0.600 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

Design Maps Detailed Report

ASCE 7-10 Standard (34.1082°N, 117.5158°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1] S_S = 1.500 g

From Figure 22-2 [2] S_1 = 0.600 g

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4–1: Site Coefficient F_a

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	$\boxed{1.0}$
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.500 g, F_a = 1.000

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	$\boxed{1.5}$
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.600 g, F_v = 1.500

Equation (11.4–1): $S_{MS} = F_aS_S = 1.000 \times 1.500 = 1.500$ g

Equation (11.4–2): $S_{M1} = F_vS_1 = 1.500 \times 0.600 = 0.900$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

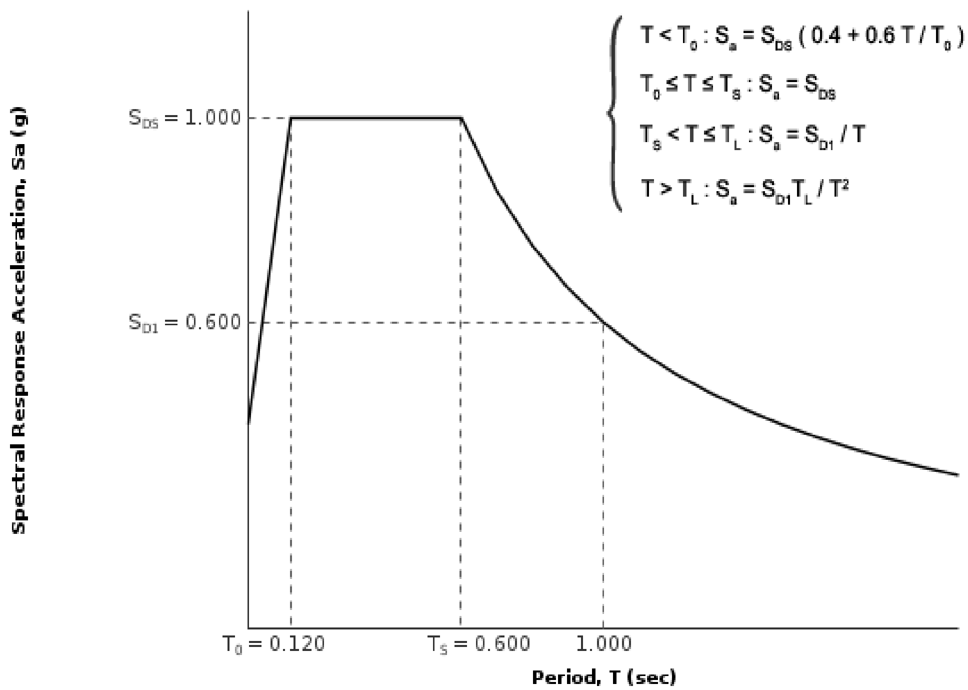
Equation (11.4–3): $S_{DS} = ⅔\ S_{MS} = ⅔ \times 1.500 = 1.000$ g

Equation (11.4–4): $S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.900 = 0.600$ g

Section 11.4.5 — Design Response Spectrum

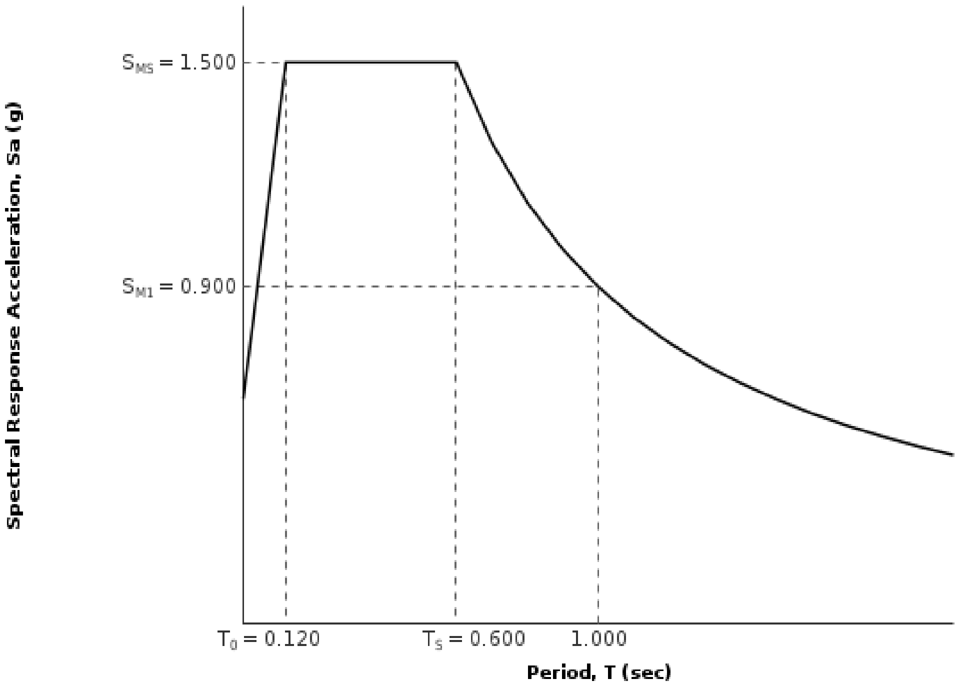
From Figure 22-12 [3] T_L = 12 seconds

Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4] PGA = 0.548

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.548 = 0.548$ g

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.548 g, F_{PGA} = 1.000

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] C_{RS} = 1.076

From Figure 22-18 [6] C_{R1} = 1.054

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.000 g, Seismic Design Category = D

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.600 g, Seismic Design Category = D

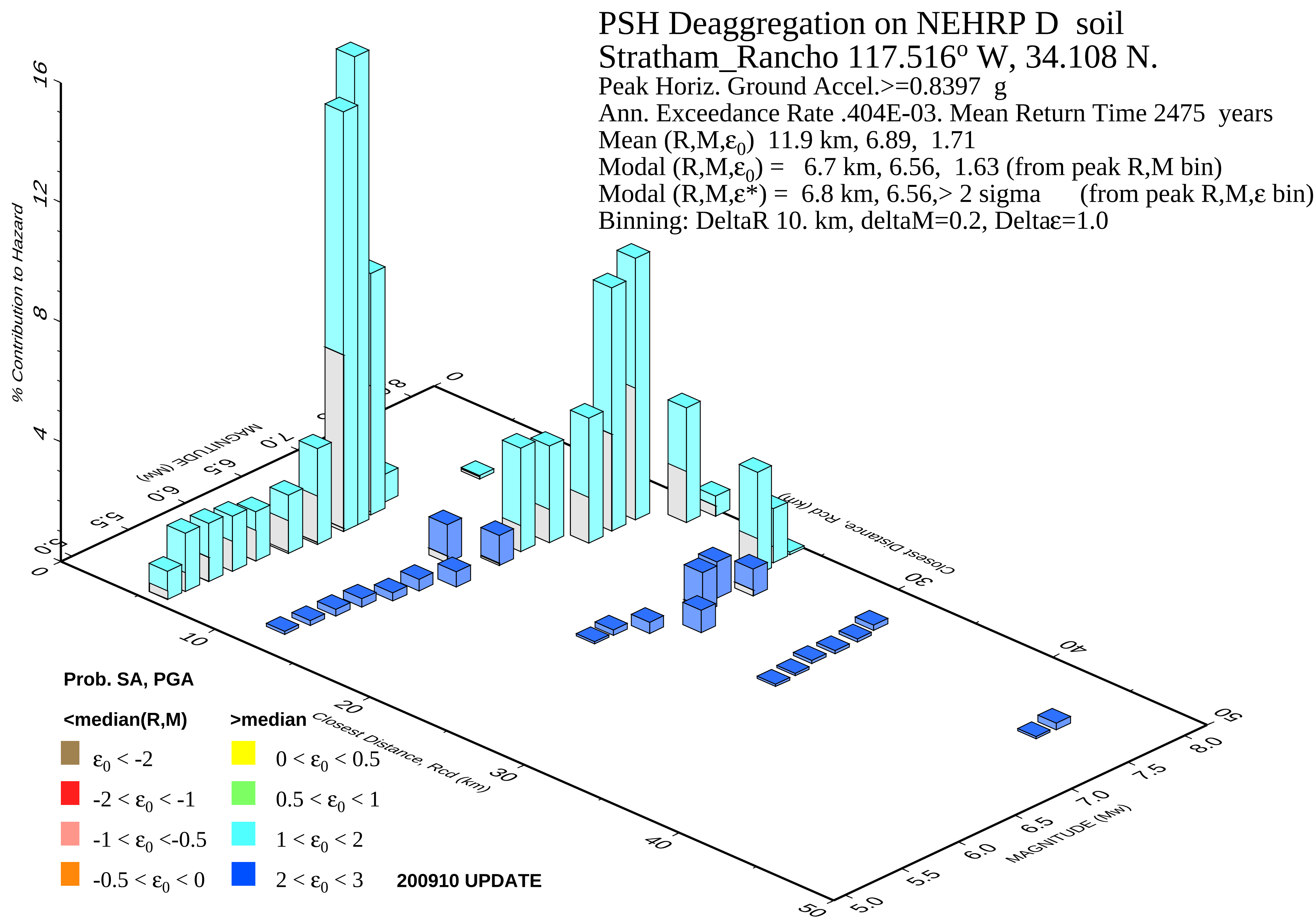
Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ “the more severe design category in accordance with Table 11.6-1 or 11.6-2” = D

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 22-1*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf



GMT 2016 Sep 12 23:18:24 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 275. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

Liquefaction Susceptibility Analysis: SPT Method

Based on Youd and Idriss (2001), Martin and Lew (1999).

Project: Stratham Rancho Cuamonga

Leighton

Project No.: 11406.001

Sep 2016

General Boring Information:

Boring No.	Existing GW Depth (ft)	Design GW Depth (ft)	Design Fill Height (ft)	Ground Surface Elev (ft)	
LB-1	100	100			-100
LB-2	100	100			-100
LB-3	100	100			-100
LB-4	100	100			-100

General Parameters:

a_{max} =	0.56g	(PGA_M)
M_W =	6.6	
MSF eq:	1	(Idriss, 2001)
MSF =	1.39	
Hammer Efficiency =	84	%
C_E =	1.40	
C_B =	1	
$C_{S(SPT)}$ =	1.2	
$C_{S(ring)}$ =	1	
Rod Stickup (feet) =	3	
Ring sample correction =	0.65	

Summary of Liquefaction Susceptibility Analysis: SPT Method

Liquefaction Method: Youd and Idriss (2001). Seismic Settlement Method: Tokimatsu and Seed (1987) and Martin and Lew (1999).

Project: Stratham Rancho Cuamonga
Project No.: 11406.001

Leighton 0.56 (PGA_M)

Boring No.	Approx. Layer Depth (ft)	SPT Depth (ft)	Approx Layer Thick-ness (ft)	Plasticity ("n"=non susc. to liq.)	Estimated Fines Cont (%)	γ_t (pcf)	N_m or B (blows/ft)	Sampler Type (enter 2 if mod CA Ring)	Cs	N_m (corrected for Cs and ring->SPT) (blows/ft)	Exist σ_{vo}' (psf)	$(N_1)_{60}$	$(N_1)_{60CS}$	**$CRR_{7.5}$**	Design σ_{vo}' (psf)	$CSR_{7.5}$	CSR_M	**Liquefaction Factor of Safety**	$(N_1)_{60CS}$ (for Settle-ment) (blows/ft)	Dry Sand Strain (%) (Tok/ Seed 87) (%)	Sat Sand Strain (%) (Tok/ Seed 87) (%)	Seismic Sett. of Layer (in.)	**Cummulative Seismic Settlement** (in.)
LB-1	0 to 4	2.5	4		15	120	16	2	1	10.4	300	18.6	22.0	0.241	300	0.36	0.26	**NonLiq**	22.0	0.05		0.02	0.2
LB-1	4 to 8	5	4		0	120	30	2	1	19.5	600	34.8	34.8	>Range	600	0.36	0.26	**NonLiq**	34.8	0.05		0.02	0.1
LB-1	8 to 13	10	5		0	120	27		1.2	32.4	1200	50.9	50.9	>Range	1200	0.36	0.26	**NonLiq**	50.9	0.01		0.01	0.1
LB-1	13 to 18	15	5		0	120	88	2	1	57.2	1800	73.3	73.3	>Range	1800	0.35	0.25	**NonLiq**	73.3	0.01		0.01	0.1
LB-1	18 to 23	20	5		0	120	49		1.2	58.8	2400	72.9	72.9	>Range	2400	0.35	0.25	**NonLiq**	72.9	0.01		0.01	0.1
LB-1	23 to 28	25	5		0	120	68	2	1	44.2	3000	49.0	49.0	>Range	3000	0.34	0.25	**NonLiq**	49.0	0.02		0.01	0.1
LB-1	28 to 33	30	5		0	120	38		1.2	45.6	3600	48.6	48.6	>Range	3600	0.34	0.24	**NonLiq**	48.6	0.02		0.01	0.1
LB-1	33 to 38	35	5		0	120	100	2	1	65.0	4200	64.2	64.2	>Range	4200	0.32	0.23	**NonLiq**	64.2	0.02		0.01	0.1
LB-1	38 to 43	40	5		0	120	38		1.2	45.6	4800	42.1	42.1	>Range	4800	0.31	0.22	**NonLiq**	42.1	0.02		0.01	0.1
LB-1	43 to 48	45	5		0	120	100	2	1	65.0	5400	56.6	56.6	>Range	5400	0.29	0.21	**NonLiq**	56.6	0.02		0.01	0.0
LB-1	48 to 52	50	5		15	120	29		1.2	34.8	6000	28.7	32.6	>Range	6000	0.28	0.20	**NonLiq**	32.6	0.07		0.04	0.0
LB-2	0 to 4	2.5	4		10	120	11	2	1	7.2	300	12.8	13.9	0.149	300	0.36	0.26	**NonLiq**	13.9	0.19		0.09	0.1
LB-2	4 to 8	5	4		10	120	35	2	1	22.8	600	40.6	42.4	>Range	600	0.36	0.26	**NonLiq**	42.4	0.01		0.01	0.0
LB-2	8 to 13	10	5		0	120	21		1.2	25.2	1200	39.6	39.6	>Range	1200	0.36	0.26	**NonLiq**	39.6	0.05		0.03	0.0
LB-2	13 to 18	15	5		0	120	100	2	1	65.0	1800	83.3	83.3	>Range	1800	0.35	0.25	**NonLiq**	83.3	0.01		0.01	0.0
LB-2	18 to 22	20	5		10	120	100		1.2	120.0	2400	148.9	153.0	>Range	2400	0.35	0.25	**NonLiq**	153.0	0.01		0.00	0.0
LB-3	0 to 4	2.5	4		0	120	14	2	1	9.1	300	16.2	16.2	0.173	300	0.36	0.26	**NonLiq**	16.2	0.10		0.05	0.1
LB-3	4 to 8	5	4		15	120	26	2	1	16.9	600	30.2	34.1	>Range	600	0.36	0.26	**NonLiq**	34.1	0.05		0.02	0.1
LB-3	8 to 13	10	5		0	120	22		1.2	26.4	1200	41.4	41.4	>Range	1200	0.36	0.26	**NonLiq**	41.4	0.02		0.01	0.0
LB-3	13 to 18	15	5		0	120	58	2	1	37.7	1800	48.3	48.3	>Range	1800	0.35	0.25	**NonLiq**	48.3	0.01		0.01	0.0
LB-3	18 to 23	20	5		0	120	88		1.2	105.6	2400	131.0	131.0	>Range	2400	0.35	0.25	**NonLiq**	131.0	0.01		0.01	0.0
LB-3	23 to 27	25	5		0	120	100	2	1	65.0	3000	72.1	72.1	>Range	3000	0.34	0.25	**NonLiq**	72.1	0.02		0.01	0.0
LB-4	0 to 4	2.5	4		15	120	32	2	1	20.8	300	37.1	41.4	>Range	300	0.36	0.26	**NonLiq**	41.4	0.01		0.00	0.0
LB-4	4 to 8	5	4		15	120	100	2	1	65.0	600	116.0	124.1	>Range	600	0.36	0.26	**NonLiq**	124.1	0.01		0.00	0.0
LB-4	8 to 13	10	5		0	120	36		1.2	43.2	1200	67.8	67.8	>Range	1200	0.36	0.26	**NonLiq**	67.8	0.01		0.01	0.0
LB-4	13 to 18	15	5		0	120	89	2	1	57.9	1800	74.1	74.1	>Range	1800	0.35	0.25	**NonLiq**	74.1	0.01		0.01	0.0
LB-4	18 to 23	20	5		0	120	100		1.2	120.0	2400	148.9	148.9	>Range	2400	0.35	0.25	**NonLiq**	148.9	0.01		0.01	0.0
LB-4	23 to 27	25	5		25	120	100	2	1	65.0	3000	72.1	84.7	>Range	3000	0.34	0.25	**NonLiq**	84.7	0.01		0.01	0.0

APPENDIX F

GENERAL EARTHWORK AND GRADING SPECIFICATIONS

Leighton

GENERAL EARTHWORK AND GRADING SPECIFICATIONS FOR ROUGH GRADING

Table of Contents

1.0 <u>General</u>

1.1 <u>Intent</u>: These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 <u>The Geotechnical Consultant of Record</u>: Prior to commencement of work, the owner shall employ the Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultants shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after it has been cleared for receiving fill but before fill is placed, bottoms of all "remedial removal" areas, all key bottoms, and benches made on sloping ground to receive fill.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to determine the attained level of compaction. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor: The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The

Contractor shall be solely responsible for performing the grading in accordance with the plans and specifications.

The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "spreads" of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing: Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

2.2 Processing: Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Overexcavation: In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching: Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

2.5 Evaluation/Acceptance of Fill Areas: All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General: Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 Oversize: Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import: If importing of fill material is required for grading, proposed import material shall meet the requirements of Section 3.1. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers: Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill Moisture Conditioning: Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557-91).

4.3 Compaction of Fill: After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557-91). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes: In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557-91.

4.5 Compaction Testing: Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 Frequency of Compaction Testing: Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 Compaction Test Locations: The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

7.1 Safety: The Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

7.2 Bedding and Backfill: All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

7.3 Lift Thickness: Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

7.4 Observation and Testing: The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.