PRELIMINARY GEOTECHNICAL ENGINEERING AND GEOLOGIC HAZARD REPORT
PROPOSED HIGH SCHOOL – GIRD ROAD PROPERTY, APN: 124-340-34-00
FALLBROOK AREA, SAN DIEGO COUNTY, CALIFORNIA

Prepared for

BONSALL UNIFIED SCHOOL DISTRICT
31505 Old River Road
Bonsall, California 92003

Project No. 11279.001

April 22, 2016

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Bonsall Unified School District
31505 Old River Road
Bonsall, California 92003

Attention: Mr. David Metcalf, Director of Facilities, Maintenance and Transportation

Subject: Preliminary Geotechnical Engineering and Geologic Hazard Report
Proposed High School – Gird Road Property, APN: 124-340-34-00
Bonsall Unified School District
Fallbrook Area, San Diego County, California

In accordance with your request and authorization, we have performed a geotechnical engineering and geologic hazards report for the proposed High School located on the west side of Gird Road approximately 1700 feet north west of the intersection of Pala Road (Highway 76) and Gird Road, APN: 124-340-34-00, in the Fallbrook area of San Diego County, California. This report summarizes our geotechnical findings, conclusions and recommendations regarding the proposed improvements. Based on the results of our exploration, it is our opinion that the site is suitable for the proposed improvements provided the recommendations included in this report are implemented during design and construction phases of development. Once site development/project plans become available, an update geologic hazard report should be prepared to comply with the California Geologic Survey (CGS), Note 48.

If you have any questions regarding this report, please do not hesitate to contact the undersigned. We appreciate this opportunity to be of service on this project.

Respectfully submitted,

LEIGHTON CONSULTING, INC.

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1.0 INTRODUCTION

1.1 Purpose and Scope

This geotechnical engineering and geologic hazards report is for the proposed new High School, located approximately 1700 feet northwest of the intersection of Pala Road (Highway 76) and Gird Road (APN: 124-340-34-00), Fallbrook Area, San Diego County, California (*see Figure 1, Site Location Map*). Our scope of services included the following:

- Review of available site-specific geologic information listed in the references at the end of this report.
- A site reconnaissance and excavation of ten (10) geotechnical borings. Approximate locations of these exploratory borings are depicted on Plate 1.
- Geotechnical laboratory testing of selected soil samples obtained from this exploration. Test procedures and results are presented in Appendix B.
- Geotechnical engineering analyses performed or as directed by a California registered Geotechnical Engineer (GE) and reviewed by a California Certified Engineering Geologist (CEG).
- Preparation of this report which presents our geotechnical conclusions and recommendations regarding the proposed structures.

This report is not intended to be used as an environmental assessment (Phase I or other), or foundation and/or grading plan review.

1.2 Site and Project Description

The proposed High School (Gird Road) site is approximately 50 acres of vacant land located approximately 1700 feet northwest of the intersection of Pala Road (Highway 76) and Gird Road in the Fallbrook area of San Diego County, California (See Figure 1). The site coordinates are 33.3221˚ N Latitude and 117.1960˚ W Longitude and APN: 124-340-34-00. While a grading plan is not available, we anticipate moderate site grading, with cuts and fills on the order of ± 30 feet to achieve finished grades, plus proposed remedial grading.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

Our field exploration for the proposed high school consisted of the excavation of ten exploratory borings within accessible areas of the site to provide basis for preliminary ground preparation and foundation design of the proposed campus. During excavation, in-situ undisturbed (Cal Ring) and disturbed/bulk samples were collected from the exploration borings for further laboratory testing and evaluation. Approximate locations of these exploratory borings are depicted on the *Boring Location Plan* (Geotechnical Map, Plate 1). Sampling was conducted by a staff geologist/engineer from our firm. After logging and sampling, the excavations were loosely backfilled with spoils generated during excavation and bentonite chips in borings which encountered groundwater. The exploration logs are included in Appendix A.

2.2 Laboratory Testing

Laboratory tests were performed on representative bulk samples to provide a basis for development of remedial earthwork and geotechnical design parameters. Selected samples were tested to determine the following parameters: maximum dry density and optimum moisture, particle size, expansion index, swell or collapse potential, in-situ moisture and density, potential of hydrogen (pH), electrical resistivity, and water-soluble sulfate and chloride content. The results of our laboratory testing are presented in Appendix B.

2.3 Evaluation of Aerial Photographs

A detailed review of vertical, sequential, stereo aerial photograph pairs was conducted using a magnified stereoscope to identify possible geomorphic evidence of landslide and faulting. Various aerial photos taken between 1972 and 1998 were reviewed. A listing of photographs is presented at the end of References, before Appendix A. Geomorphic features contained in the historic photos were enhanced through the use of a magnifying stereoscope. No indications of landslide, slope instability or faulting were observed.

3.0 GEOTECHNICAL AND GEOLOGIC FINDINGS

3.1 Regional Geology

The project site is located within the Peninsular Ranges Province, which is characterized by northwest trending elongated mountain ranges and valleys. The Peninsular Ranges Province is divided into three major fault bounded tectonic blocks within the San Andreas Fault System, which consist of (from west to east): Santa Ana, Perris, and San Jacinto Blocks. The study area is located within the coastal subprovince of the Peninsular Ranges Geomorphic Province, near the western edge of the southern California batholith. The topography at the edge of the batholith changes from the rugged landforms developed on the batholith to the more subdued landforms, similar to those of the softer sedimentary formations of the coastal plain. Weathering, erosion and regional tectonic uplift created the valleys and ridges of the area. The ranges are tectonically and seismically active and include parts of four major northwest-striking, right-lateral strike slip Pacific and North American plate boundary fault zones. These include the Elsinore fault zone to the east, the Newport-Inglewood-Rose Canyon offshore fault zone on the west and the Coronado Bank fault and San Diego Trough fault zone to the southwest.

As mapped by the USGS (2005), the natural geologic units on the subject property include; young alluvial deposits and older alluvial flood-plain deposits as depicted on the *Regional Geologic Map*, (Figure 2).

3.2 Site Specific Geology

Our field exploration, observations, and review of the pertinent literature indicate that the site is underlain by young alluvial and older alluvial materials at depth. A relatively thin veneer of topsoil fill mantles the site. Undocumented fill soil was encountered within boring LB-1 and may be present at other areas across the site. The following is a summary of the geologic conditions based on our exploratory borings and test pits. These units are discussed in the following sections.

3.2.1 Undocumented Fill

Approximately 2.5 feet of undocumented fill soil was encountered in boring LB-1 located in the northeast portion of the site. As encountered, the fill soil consisted of moist, silty sand. Undocumented fill was not encountered in the remainder of our geotechnical borings; however areas of undocumented fill may be present throughout the site. This unit is not considered suitable for the support of structures or engineered fill and should be removed and recompacted in accordance with the recommendations of this report.

3.2.2 Young Alluvium

Quaternary-age young alluvial soils were encountered in our borings located in the lower elevation portions of the site (LB-1, LB-3, LB-5 and LB-10) to depths ranging from 5.0 feet (LB-5) to the maximum depth of exploration, 51.5 feet, (LB-1) below ground surface (BGS). As encountered, these alluvial soils consist of dry to wet, loose to dense, silty sands and sandy clays with varying amounts of gravel.

- ***Relative Density***: The alluvium is generally loose to medium dense in the upper 10 to 15 feet in most areas with an average N-value on the order of 5 to 15 blows/foot. At depths greater than 15 feet, the alluvium is generally medium dense with an average N-value on the order of 10 to 25. Based on the results of the laboratory testing on representative samples, the relative density/compaction of the upper 10 feet of alluvium varies from 75 percent to 90 percent as calculated per ASTM Method 1557.
- ***Expansion Potential***: The results of the laboratory testing on representative samples indicate that these materials are expected to possess very low to medium expansion potential (EI<90). The more expansive soils (EI>51) are expected to be localized and associated with interbedded silt and clay layers at depth greater than 10 feet.
- ***Collapse Potential:*** The 'hydro-collapse' potential was evaluated in the laboratory on representative soil samples in accordance with the consolidation test procedure per ASTM D4546. The test specimens were inundated with water at confining pressures of 2 kips per square-foot, approximating those pressures that may be exerted after completion of grading. The test results indicate that the potential for "hydro-collapse" is generally lower than 2 percent (low trouble) in the upper 15 feet.

3.2.3 Older Alluvium

Older alluvium was encountered in our borings located in higher elevations of the site (LB-2, LB-4, LB-6, LB-7, LB-8 and LB-9) and beneath the young alluvium in two of our borings in the lower elevations areas (LB-4 and LB-10) at depths of approximately 5 and 10 feet BGS, respectively. According to USGS maps, this unit is comprised of older alluvial flood plain deposits. This formation appears to be slightly weathered within the depth explored and consisted of dense to very dense, silty sand with varying amounts of gravel. The results of the laboratory testing on representative samples indicate that these materials are expected to possess very low to medium expansion potential (EI<90).

3.3 Groundwater and Surface Water

No standing or surface water was observed on the site at the time of our field exploration. Groundwater was encountered during this investigation at a depth of

28.2 feet (EL ~ 237) in LB-1 and 10.5 feet (EL ~ 230) in LB-3. Historic groundwater data, as indicated on the Department of Water Resources website for well number 333156N1171969W001, located approximately ¼ mile southwest of the site adjacent the San Luis Rey River, reflect a maximum groundwater elevation of 203 feet (about 11 feet deep) in July 2012.

3.4 Regional Faulting and Fault Activity

The subject site, like the rest of Southern California, is located within a seismically active region as a result of being located near the active margin between the North American and Pacific tectonic plates. The principal source of seismic activity is movement along the northwest-trending regional fault systems such as the San Andreas, San Jacinto, and Elsinore Fault Zones. Based on published geologic maps, this site is not located within a currently designated Alquist-Priolo Earthquake Fault Zone (see Figure 3). The nearest known active fault is the Temecula Segment of the Elsinore Fault Zone located approximately 10 miles northeast of the site. The Julian Segment of the Elsinore Fault Zone is located approximately 11 miles east of the site. Major quakes (>5.5 Mw) within 30 miles of the site in the last 150 years (per CGS and USGS Websites, April 2016), is presented in table below:

Table 1. Major Quakes (>5.5 Mw) in the last 150 years

Date	Moment Magnitude (Mw)	Approx. Distance from Site (mi)	General Location
1885-09-13	5.8	17	Rincon
1910-05-15	6.0	29	Lake Elsinore

3.5 Ground Shaking

The seismic coefficients provided below are based on an interactive tool/program available on USGS website (version 3.1.0, last updated July 2013). Based on ASCE 7 as the Design Code Reference Document and site Class D, the seismic coefficients for this site are as listed in the following table:

Table 2. 2013 CBC Seismic Coefficients

CBC Categorization/Coefficient	Value
Site Longitude (decimal degrees)	-117.1960
Site Latitude (decimal degrees)	33.3221
Site Class Definition	D
Mapped Spectral Response Acceleration at 0.2s Period, S_s	1.171 g
Mapped Spectral Response Acceleration at 1s Period, S_1	0.456 g
Short Period Site Coefficient at 0.2s Period, F_a	1.031
Long Period Site Coefficient at 1s Period, F_v	1.544
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS}	1.208 g
Adjusted Spectral Response Acceleration at 1s Period, S_{M1}	0.704 g
Design Spectral Response Acceleration at 0.2s Period, S_{DS}	0.806 g
Design Spectral Response Acceleration at 1s Period, S_{D1}	0.469 g

Since this site is assigned a Seismic Design Category D (S_1<0.75), a site-specific ground motion analysis is not required per CGS Note 48. As such, the above site-specific seismic coefficients following this USGS general procedure presented in Table 1 above should be used in design. The results of this analysis also indicate that the adjusted Peak Ground Acceleration (PGA_M) for this site is 0.465g. The seismic Parameters using the USGS Interactive Deaggregation website indicate a PGA of 0.508g and mean modal magnitude of 7.8 Mw, which were used for the liquefaction analysis. The USGS summary reports are included in Appendix C.

3.6 Secondary Seismic Hazards

Ground shaking can induce "secondary" seismic hazards such as liquefaction, dynamic densification, differential subsidence along ground fissures, seiches and tsunamis, as discussed in the following subsections:

3.6.1 Dynamic Settlement (Liquefaction and Dry Settlement)

Based on County of San Diego Data maps, the property is adjacent a liquefaction susceptibility area (see Figure 5). Liquefaction-induced settlement is considered a geologic hazard at this site due to the presence of shallow groundwater (>50 feet). Additionally, based on our dry-settlement analysis using the peak ground acceleration (0.51g) and moment magnitude of 7.8, the total dynamic settlement resulting from a design level earthquake is expected to be approximately than 2¼ inches on this site. The dynamic-induced differential settlement is expected to be less 1 inch in a 40-foot horizontal distance.

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3.6.2 Lateral Spreading

Due to the depth to and thickness of liquefiable layers interbedded with non-liquefiable clay, evaluations based on recommendations by Youd and Garris (1995) indicate that the site is not likely to experience surface manifestations of liquefaction including lateral spreading.

3.6.3 Ground Rupture

Ground rupture is generally considered most likely to occur along pre-existing active (Holocene) faults. Our review of data gathered during this study indicates no sign of through-going (Holocene) faults within the property. As such, the potential of damage due to ground surface-fault-rupture within the property is considered very low.

3.6.4 Seiches, Tsunamis, Inundation Due to Large Water Storage Facilities

Due to the great distance to large bodies of water, the possibility of seiches and tsunamis impacting the site is considered remote. This report does not address conventional flood hazard risk.

3.6.5 Rock Falls

The potential for rock fall due to either erosion or seismic ground shaking is considered non-existent at this site.

3.6.6 Slope Stability and Landslides

Due to the dense granular nature of the site soils and moderate relief across the site, the risk of deep-seated slope failure on this site or adjacent sites is considered very low. The site is not considered susceptible to seismically induced landslides. Additional slope stability analysis of planned slopes should be performed when grading plans become available.

3.6.7 Dam Inundation/Flood Hazard

This report does not address conventional flood hazard risk associated with this site. However, the site is not within a County of San Diego designated 100 year or 500 year Floodplain. The site is not within a County of San Diego Designated Dam Inundation Area; although the Red Mountain Reservoir Dam Inundation Area follows Live Oak Creek approximately 300 east of Gird Road.

3.6.8 Subsidence

Based on the results of our subsurface evaluation and lack of evidence of differential subsidence and associated ground fissuring, we consider the potential for differential subsidence and ground fissuring on this site to be very low.

3.6.9 Rippability

Based on our review of the geotechnical explorations, we anticipate that the older alluvium to be rippable with conventional heavy earth moving equipment in good operating conditions (Caterpillar D8) to the depths explored. If deeper excavations are planned, additional evaluation should be performed.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

The proposed high school development appears feasible from a geotechnical viewpoint provided that the following preliminary recommendations are incorporated into the design and construction phases of development. Additional site evaluation should be performed when grading plans and structure locations become available.

4.2 Earthwork

For preliminary design and planning considerations, earthwork should be performed in accordance with the following preliminary recommendations and the *Earthwork and Grading Specifications* included in Appendix D of this report. In case of conflict, the following recommendations should supersede those in Appendix D. The contract between the Owner and the earthwork contractor should be worded such that it is the responsibility of the contractor to place fill properly and in accordance with recommendations presented in this report, including the guide specifications in Appendix D, notwithstanding the testing and observation of the geotechnical consultant.

4.2.1 Site Preparation and Remedial Grading

Prior to grading, the proposed structural improvement areas (i.e. all-structural fill areas, pavement areas, buildings, etc.) of the site should be cleared of surface and subsurface obstructions. Heavy vegetation, roots and debris should be disposed of offsite. Although not anticipated, water wells, septic tanks and cesspools, if encountered, should be removed or abandoned in accordance with the San Diego County Department of Environmental Health guidelines. Voids created by removal of buried material should be backfilled with properly compacted soil in general accordance with the recommendations of this report. Preliminary remedial grading recommendations are provided as follows:

- **Building Footprints:** In planned fill areas underlying proposed buildings, the upper 7 to 10 feet of existing soil (alluvium), or 3 to 5 feet of older alluvium should be removed and compacted. In planned cut areas, the exposed subgrade should be removed/overexcavated a minimum of 3 feet below bottom of footings/slab-on-grade to provide a uniform fill blanket. In addition, all undocumented fill encountered within the proposed building removal areas should be removed and compacted. Over-excavation and recompaction should extend a minimum horizontal distance equal to the depth removed from perimeter edges of proposed buildings. Fill depth differential within a building foot print should not be greater 1/3 the maximum fill depth. If such a condition is anticipated, it should be mitigated by deepening the overexcavation of shallower fill portion of the building pad. Localized areas of deeper removals/over-excavation may be required depending on the actual conditions encountered pending verification by our field representative during grading to confirm suitable bottom.

- **Non-Building Areas (Flatwork/Pavement/Playfields):** A minimum over-excavation and recompaction of 5-feet below existing grade (alluvium) or 3-feet below proposed subgrade elevation (in cut areas), whichever is deeper, should be performed. The bottom of the removal should be proof-rolled with heavy equipment to identify yielding subgrade conditions (for additional removal, if necessary) under the observation of the geotechnical consultant.

After completion of the recommended removal of existing surficial soil and prior to fill placement, the exposed surface should be scarified to a minimum depth of 8-inches, moisture conditioned as necessary to near optimum moisture content and recompacted using heavy compaction equipment to an unyielding condition. All structural fill within the building footprints should be compacted throughout to 90 percent of the ASTM D 1557 laboratory maximum density, at or slightly above optimum moisture.

4.2.2 Suitability of Site Soils for Fills

Organic rich topsoil and vegetation layers, root zones, and similar surface materials should be striped and stockpiled for either reuse in landscape surface areas or removed from the site. Existing fill, younger alluvium, and older alluvium should be considered suitable for re-use as compacted fills provided the recommendations contained herein are followed. If cobbles/boulders larger than 6-inches in largest diameter and expansive soils (EI>51) are encountered, these materials should not be placed with the upper 5 feet of subgrade soils. Expansive clays have been identified within the anticipated removal depth; therefore, care should be taken during grading to place expansive soil in areas deeper than 5 feet.

4.2.3 Import Soils

Import soils and/or borrow sites, if needed, should be evaluated by us prior to import. Import soils should be uncontaminated, granular in nature, free of organic material (loss on ignition less-than 2 percent), have very low expansion potential (with an Expansion Index less than 21) and have a low corrosion impact to the proposed improvements.

4.2.4 Utility Trenches

Utility trenches should be backfilled with compacted fill in accordance with the *Standard Specifications for Public Works Construction,* ("Greenbook"), 2015 Edition. Fill material above the pipe zone should be placed in lifts not exceeding 8 inches in uncompacted thickness and should be compacted to at least 90 percent relative compaction (ASTM D 1557) by mechanical means only. Site soils may generally be suitable as trench backfill provided these soils are screened of rocks over 1½ inches in diameter and organic matter. The upper 6 inches of backfill in all pavement areas should be compacted to at least 95 percent relative compaction.

Where granular backfill is used in utility trenches adjacent moisture sensitive subgrades and foundation soils, we recommend that a cut-off "plug" of impermeable material be placed in these trenches at the perimeter of buildings, and at pavement edges adjacent to irrigated landscaped areas. A "plug" can consist of a 5-foot long section of clayey soils with more than 35-percent passing the No. 200 sieve, or a Controlled Low Strength Material (CLSM) consisting of one sack of Portland-cement plus one sack of bentonite per cubic-yard of sand. CLSM should generally conform to the *Standard Specifications for Public Works Construction,* ("Greenbook"), 2015 Edition. This is intended to reduce the likelihood of water permeating trenches from landscaped areas, then seeping along permeable trench backfill into the building and pavement subgrades, resulting in wetting of moisture sensitive subgrade earth materials under buildings and pavements.

Excavation of utility trenches should be performed in accordance with the project plans, specifications and the *California Construction Safety Orders* (2006 Edition or more current). The contractor should be responsible for providing a "competent person" as defined in Article 6 of the *California Construction Safety Orders*. Contractors should be advised that sandy soils (such as fill generated from portions of the onsite alluvium) could make excavations particularly unsafe if all safety precautions are not properly implemented. In addition, excavations at or near the toe of slopes and/or parallel to slopes may be highly unstable due to the increased driving force and load on the trench wall. Spoil piles from the excavation(s) and construction equipment should be kept away from the sides of the trenches. Leighton Consulting, Inc. does not consult in the area of safety engineering.

4.2.5 Shrinkage

The volume change of excavated onsite materials upon recompaction is expected to vary with materials, density, in situ moisture content, location and compaction effort. The in-place and compacted densities of soil materials vary and accurate overall determination of shrinkage is difficult to estimate. Therefore, we recommend that site grading include, if possible, a balance area or ability to adjust import or export quantities to accommodate some variation. For planning purposes, we recommend that the following average shrinkage factors be applied:

Depth	Shrinkage (%)
0 to 5 feet	12 to 22
5 to 15 feet	10 to 18

In addition, due to the past agricultural uses of the surface soils, a subsidence value of 0.2 feet should be applied to the existing topographic surface elevations. In addition, a subsidence factor of 0.10 feet should be applied to the soils below the removal bottoms due to recompaction and surcharging.

4.2.6 Drainage

All drainage should be directed away from structures and pavements by means of approved permanent/temporary drainage devices. Adequate storm drainage of any proposed pad should be provided to avoid wetting of foundation soils. Irrigation adjacent to buildings should be avoided when possible. As an option, sealed-bottom planter boxes and/or drought resistant vegetation should be used within 5-feet of buildings.

4.2.6.1 Subdrainage

Subdrains will be necessary in fill over cut keyways and deeper canyon fill areas if sufficient cover is maintained, 10 feet measured from top of finished grade to top of subdrain. Fills generally saturate near geologic contacts and the subdrains should outlet this excess water to suitable discharge areas. Contacts on fill over cut slopes which daylight cut material can present seepage problems once irrigation of the slopes and upper pads begins. The subdrains within the fill over cut keyways should mitigate this seepage problem. Subdrain details are provided in Appendix C. Canyon subdrains up to 500 lineal feet should consist of 6-inch diameter perforated pipe. Canyon subdrains greater than 500 feet should consist of 8-inch pipe. A 20-foot section of non-perforated pipe should be placed at the outlet location. The connection between the perforated and non-perforated pipe should be sealed with a minimum 6-inch thick, concrete cut-off wall placed a minimum of 2 feet beyond the perimeter of the gravel “burrito”. All outlets should be protected with a concrete apron and cover. Subdrain pipe may be schedule 40 PVC (or equal) placed in accordance with Appendix C.

4.2.7 Slope Design and Construction

For preliminary design purposes, all fill and cut slopes should be designed and constructed at 2:1 (horizontal:vertical) or flatter. Manufactured slopes are considered grossly stable for static and pseudostatic conditions to a maximum height of 25 feet. Cut slopes should be observed by an engineering geologist during grading to verify soil materials and structure to determine if remedial measures, if needed.

Keys should be constructed at the toe of all fill slopes located on existing or cut grade as depicted in Appendix C. Compaction of each fill lift should extend out to the face of fill slope. The outer portion of fill slopes should be either overbuilt by 2 feet (minimum) and trimmed back to the finished slope configuration or compacted in vertical increments of 5 feet (maximum) by a weighted sheepsfoot roller as the fill is placed. The slope face should then be track-walked by dozers of appropriate weight to achieve the final slope configuration and compaction to the slope face.

Slope faces are inherently subject to erosion, particularly if exposed to rainfall and irrigation. Landscaping and slope maintenance should be conducted as soon as possible in order to increase long-term surficial stability. Berms should be provided at the top of fill slopes. Drainage should be directed such that surface runoff on the slope face is minimized

4.3 Foundation Design

Shallow spread footings bearing on newly placed and properly compacted fill are anticipated for the proposed structures.

4.3.1 Design Parameters – Spread/Continuous Shallow Footings

Conventional spread/continuous shallow footings appear to be feasible to support the proposed structures. Footings should be embedded at least 12-inches below lowest adjacent grade for the proposed structures. Footing embedments should be measured from lowest adjacent finished grade, considered as the top of interior slabs-on-grade or the finished exterior grade, excluding landscape topsoil, whichever is lower. Footings located adjacent to utility trenches or vaults should be embedded below an imaginary 1:1 (horizontal:vertical) plane projected upward and outward from the bottom edge of the trench or vault, up towards the footing.

- **Bearing Capacity**: A net allowable bearing capacity of 2,500 pounds per square foot (psf) may be used for design assuming that footings have a minimum base width of 18 inches for continuous wall footings and a minimum bearing area of 3 square feet (1.75-ft by 1.75-ft) for pad foundations. The bearing pressure value may be increased by 500 psf for each additional foot of embedment or each additional foot of width to a maximum vertical bearing value of 4,000 psf. These bearing values may also be increased by one-third when considering short-term seismic or wind loads. All continuous perimeter or interior footings should be reinforced with at least one No. 5 bar placed both top and bottom.

- **Lateral Loads**: Lateral loads may be resisted by friction between the footings and the supporting subgrade. A maximum allowable frictional resistance of 0.45 may be used for design. In addition, lateral resistance may be provided by passive pressures acting against foundations poured neat against properly compacted granular fill. We recommend that an allowable passive pressure based on an equivalent fluid pressure of 300 pounds-per-cubic-foot (pcf) be used in design. These friction and passive values have already been reduced by a factor-of-safety of 1.5.

4.3.2 Settlement Estimates

For settlement estimates, we assumed that column loads will be no larger than 90 kips, with bearing wall loads not exceeding 5 kips per foot of wall. If greater column or wall loads are required and/or more fill than what is anticipated (<10 feet), we should re-evaluate our foundation recommendation, and re-calculate settlement estimates.

Buildings located on compacted fill soil (as recommended in Section 4.2.1) should be designed in anticipation of 2-inch of total static settlement and 1-inch of static differential settlement within a 40 foot horizontal run. A dynamic differential settlement of 1-inch over a horizontal distance of 40 feet should also be considered.

4.4 Retaining Walls

Retaining wall earth pressures are a function of the amount of wall yielding horizontally under load. If the wall can yield enough to mobilize full shear strength of backfill soils, then the wall can be designed for "active" pressure. If the wall cannot yield under the applied load, the shear strength of the soil cannot be mobilized and the earth pressure will be higher. Such walls should be designed for "at rest" conditions. If a structure moves toward the soils, the resulting resistance developed by the soil is the "passive" resistance. Retaining walls backfilled with non-expansive soils should be designed using the following equivalent fluid pressures:

Table 3. Retaining Wall Design Earth Pressures (Static, Drained)

Loading Conditions	Equivalent Fluid Density (pcf)	
	Level Backfill	2:1 Backfill
Active	38	55
At-Rest	60	74
Passive*	300	110 (2:1, sloping down)

* This assumes level condition in front of the wall will remain for the duration of the project, not to exceed 4,500 psf at depth.

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Unrestrained (yielding) cantilever walls should be designed for the active equivalent-fluid weight value provided above for very low expansive soils that are free draining. In the design of walls restrained from movement at the top (non-yielding) such as basement or elevator pit/utility vaults, the at-rest equivalent fluid weight value should be used. Total depth of retained earth for design of cantilever walls should be measured as the vertical distance below the ground surface measured at the wall face for stem design, or measured at the heel of the footing for overturning and sliding calculations. Should a sloping backfill other than a 2:1 (horizontal:vertical) be constructed above the wall (or a backfill is loaded by an adjacent surcharge load), the equivalent fluid weight values provided above should be re-evaluated by us on an individual case basis. Non-standard wall designs should also be reviewed by us prior to construction to check that the proper soil parameters have been incorporated into the wall design.

All retaining walls should be provided with appropriate drainage. The outlet pipe should be sloped to drain to a suitable outlet. Wall backfill should be non-expansive (EI ≤ 20) sands compacted by mechanical methods to a minimum of 90 percent relative compaction (ASTM D 1557). Clayey site soils should not be used as wall backfill. Walls should not be backfilled until wall concrete attains the design compressive strength and/or as determined by the Structural Engineer that the wall is structurally capable of supporting backfill. Lightweight compaction equipment should be used, unless otherwise approved by the Structural Engineer.

For retaining walls less than 10 feet in height, incremental seismic loads need not be considered. However, for walls retaining more than 10 feet in height, an incremental seismic load applied as a uniform pressure of 13 psf can be used. This pressure is in addition to the static earth pressures presented above.

4.5 Vapor Retarder

It has been a standard of care to install a moisture retarder underneath all slabs where moisture condensation is undesirable. Moisture vapor retarders may retard but not totally eliminate moisture vapor movement from the underlying soils up through the slabs. Moisture vapor transmission may be additionally reduced by use of concrete additives. Leighton Consulting, Inc., does not practice in the field of moisture vapor transmission evaluation/mitigation. Therefore, we recommend that a qualified person/firm be engaged/consulted with to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. This person/firm should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate.

4.6 Footing Setbacks

We recommend a minimum horizontal setback distance from the face of slopes for all structural footings (including retaining and decorative walls, building footings, etc.). This distance is measured from the outside bottom edge of the footing horizontally to the slope face (or to the face of a retaining wall) and should be a minimum of H/2, where H is the slope height (in feet). The setback should not be less than 7 feet and need not be greater than 15 feet.

The soils within the structural setback area may possess poor lateral stability and improvements (such as retaining walls, decks, sidewalks, fences, pavements, etc.) constructed within this setback area may be subject to lateral movement and/or differential settlement. Potential distress to such improvements may be mitigated by providing a deepened footing or a pier and grade-beam foundation system to support the improvement. The deepened footing should meet the setback as described above.

4.7 Sulfate Attack

The results of our laboratory testing indicate that the onsite soils have negligible soluble sulfate content or less than 2,000 ppm. Common Type II cement or similar may be used for design of concrete structures in contact with the onsite soils. Further testing should be performed during site grading to confirm soluble-sulfate content in onsite soils.

Based on our laboratory testing, the onsite soil is considered corrosive to moderately corrosive to ferrous metals. Ferrous pipe buried in moist to wet site earth materials should be avoided by using high-density polyethylene (HDPE) or other non-ferrous pipe when possible. Ferrous pipe can be protected by polyethylene bags, tape or coatings, di-electric fittings or other means to separate the pipe from wet on-site soils. If buried ferrous pipes are planned for the project, further testing of import and possibly site soil corrosivity could be performed and specific recommendations for corrosion protection may need to be provided by a qualified corrosion engineer.

4.8 Preliminary Pavement Design

Our preliminary pavement design is based on an assumed R-value of 17 (silty sand materials) obtained from our laboratory testing and the guidelines included in Caltrans Highway Design Manual. For planning and estimating purposes, the pavement sections are calculated based on Traffic Indexes (TI) as indicated in Table below:

Table 4. Preliminary Asphalt Pavement Sections

General Traffic Condition	Design Traffic Index (TI)	Asphalt Concrete (inches)	Aggregate Base (inches)
Automobile Parking Lanes	4.5	3.0	6.0
	5.0	3.0	8.0
Truck/Bus Access Driveways	6.0	3.5	10.5
	6.5	4.0	11.0

Appropriate Traffic Index (TI) should be selected or verified by the project civil engineer or traffic engineering consultant and appropriate R-value of the subgrade soils will need to be verified after completion of rough grading to finalize the pavement design. Pavement design and construction should also conform to applicable local, county and industry standards. The Caltrans pavement section design calculations were based on a pavement life of approximately 20 years with a normal amount of flexible pavement maintenance.

Where applicable, we recommend that a minimum of 8.5 inches of PCC pavement over 6 inches of aggregate base be used, in high impact load areas or if to be subjected to truck traffic. The PCC pavement may be placed directly on a compacted subgrade with an R-Value of 40 or higher. The PCC pavement should be adequately reinforced to prevent shrinkage cracking and have a minimum of 28-day flexural strength of 650 psi. Other requirements of Caltrans Standard Specifications regarding mixing and placing of concrete should be followed.

The upper 8 inches of the subgrade soils should be moisture-conditioned to near optimum moisture content, compacted to at least 95 percent relative compaction (ASTM D1557) and kept in this condition until the pavement section is constructed. Minimum relative compaction requirements for aggregate base should be 95 percent of the maximum laboratory density as determined by ASTM D1557. If applicable, aggregate base should conform to the “Standard Specifications for Public Works Construction” (Greenbook) current edition or Caltrans Class 2 aggregate base.

If pavement areas are adjacent to heavily watered landscape areas, some deterioration of the subgrade load bearing capacity may result. Moisture control measures such as deepened curbs or other moisture barrier materials may be used to prevent the subgrade soil from becoming saturated. The use of concrete cutoff or edge barriers should be considered when pavement is planned adjacent to either open (unfinished) or irrigated landscaped areas.

5.0 GEOTECHNICAL CONSTRUCTION SERVICES

Geotechnical review is of paramount importance in engineering practice. Poor performances of many foundation and earthwork projects have been attributed to inadequate construction review. We recommend that Leighton Consulting, Inc. be provided the opportunity to review the grading plan and foundation plan(s) prior to bid.

Reasonably-continuous construction observation and review during site grading and foundation installation allows for evaluation of the actual soil conditions and the ability to provide appropriate revisions where required during construction. Geotechnical conclusions and preliminary recommendations should be reviewed and verified by Leighton Consulting, Inc. during construction, and revised accordingly if geotechnical conditions encountered vary from our findings and interpretations. Geotechnical observation and testing should be provided:

- After completion of site demolition and clearing,
- During over-excavation of compressible soil,
- During cut slope excavation
- During compaction of all fill materials,
- After excavation of all footings and prior to placement of concrete,
- During utility trench backfilling and compaction, and
- When any unusual conditions are encountered.

Additional geotechnical exploration and analysis should be performed based on final development plans. We should review grading (civil) and foundation (structural) plans, and comment further on geotechnical aspects of this project.

6.0 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 we (Leighton Consulting, Inc.) will provide geotechnical observation and testing during construction as the Geotechnical Engineer of Record for this project.

This report was prepared for the sole use of Bonsall Unified School District and their design team, for application to design the Proposed High School – Gird Road Property, APN: 124-340-34-00, in accordance with generally accepted geotechnical engineering practices at this time in California. In addition, since this is a public school project, our report may be subject to review by the California Geological Survey (CGS) and/or the California Division of the State Architect (DSA). As such, we recommend that geologic/geotechnical data in this report be only used in the design of this project after review and approval by CGS. Any premature (before CGS approval) or unauthorized use of or reliance on this report constitutes an agreement to defend and indemnify Leighton Consulting, Inc. from and against any liability which may arise as a result of such use or reliance, regardless of any fault, negligence, or strict liability of Leighton Consulting, Inc.

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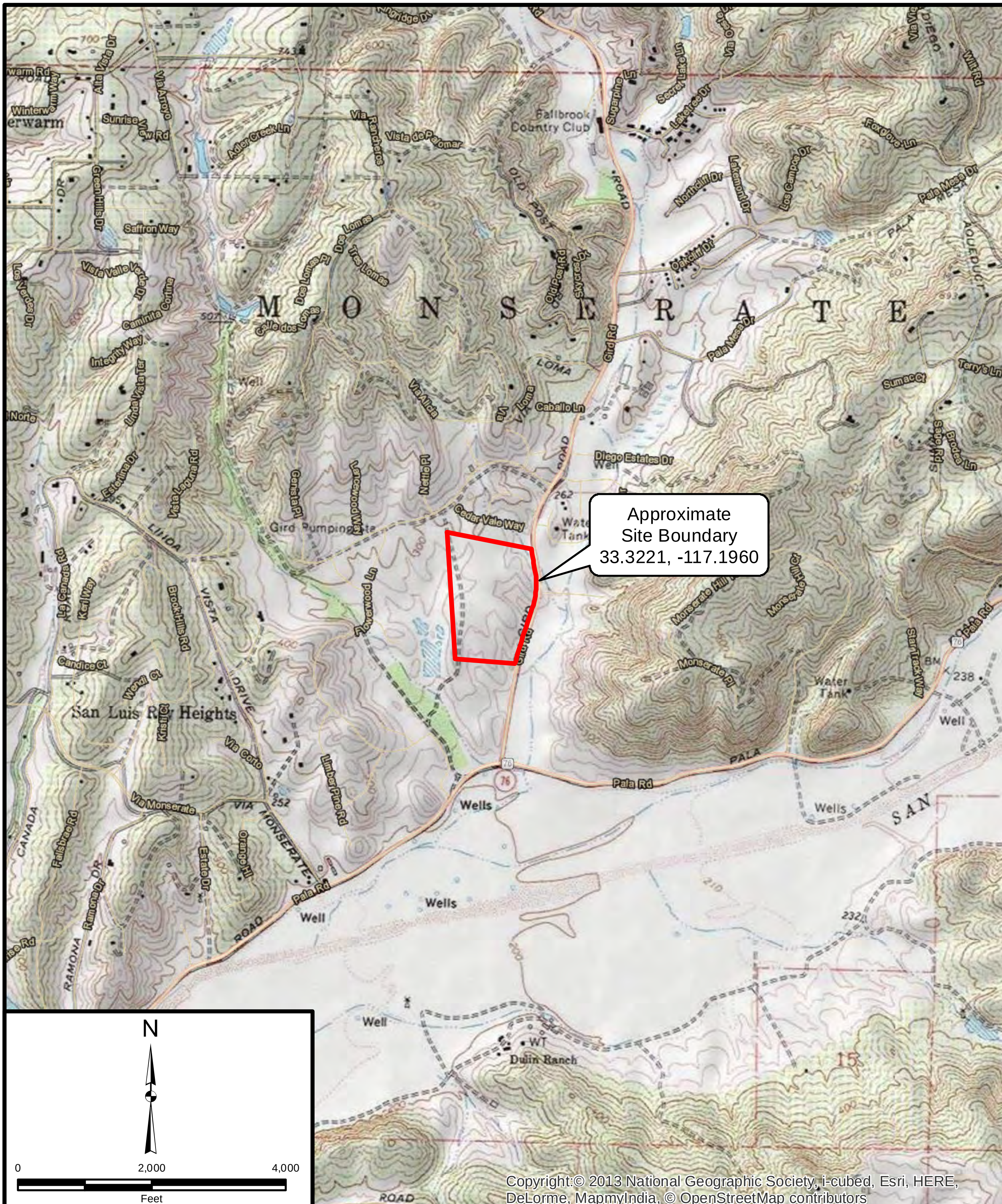
Aerial Photographs Reviewed

Flight Date	Photograph No.
04/06/1972	107-4-3, -4
08/02/1978	210-20B-3, -4, -5
04/09/1980	FCSD-4-8, -9
01/14/1988	SD-4-4, -5
10/30/1993	C98-6-35, -36, -37
07/09/1998	C120-6-99, -100, -101



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Scale: 1 " = 2,000 '	Date: April 2016

Base Map: Bing Maps, 2016
Thematic Information: Leighton
Author: Leighton Geomatics (mmurphy)

SITE LOCATION MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Figure 1

Leighton

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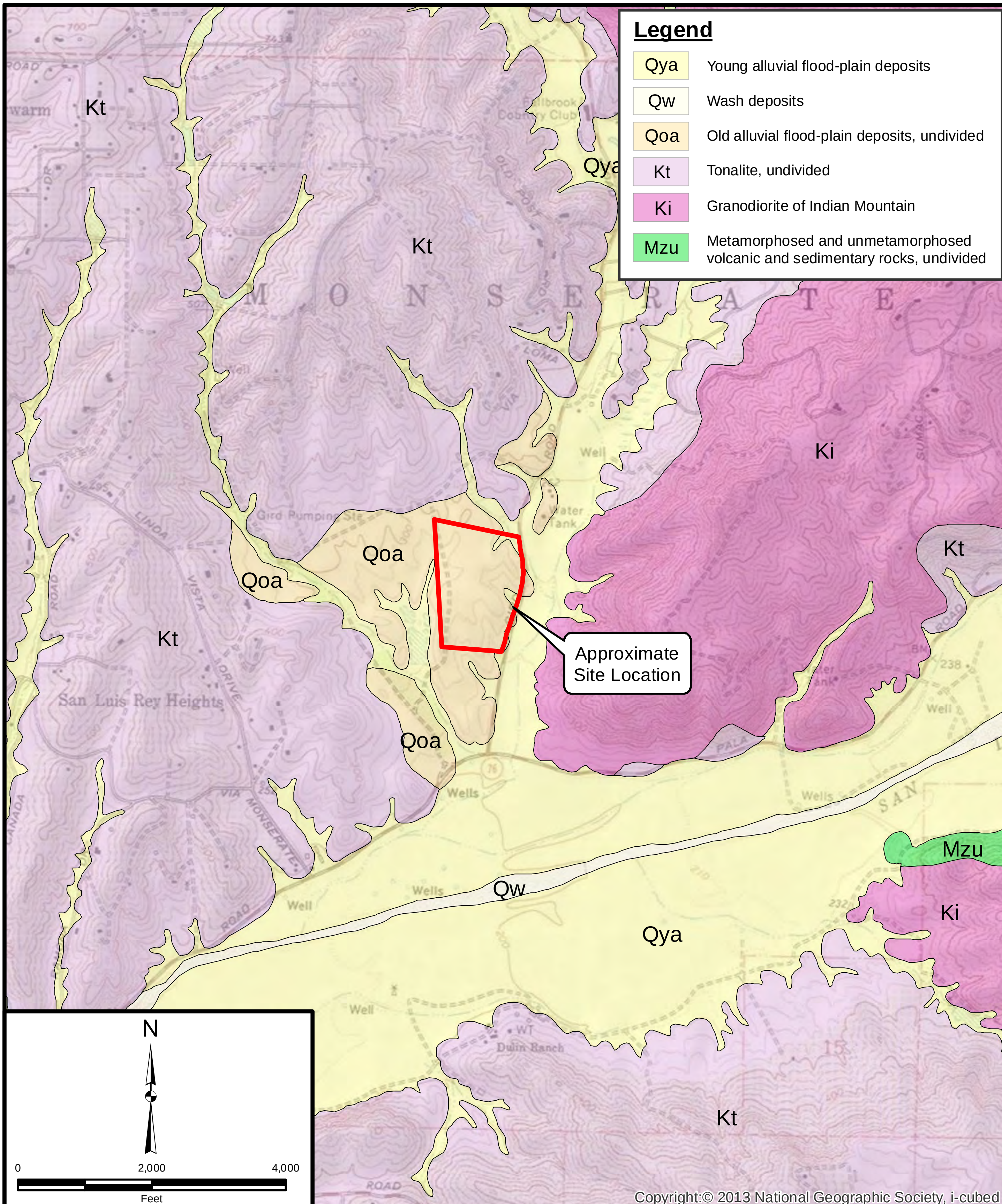

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Scale: 1 " = 2,000 '	Date: April 2016

Base Map: ESRI ArcGIS Online 2016
Geology: Geologic Map of the Oceanside 30'x60' Quadrangle, California, Version 1.0 by Michael P. Kennedy and Siang S. Tan, 2005.
Author: Leighton Geomatics (mmurphy)

REGIONAL GEOLOGY MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Figure 2

Leighton

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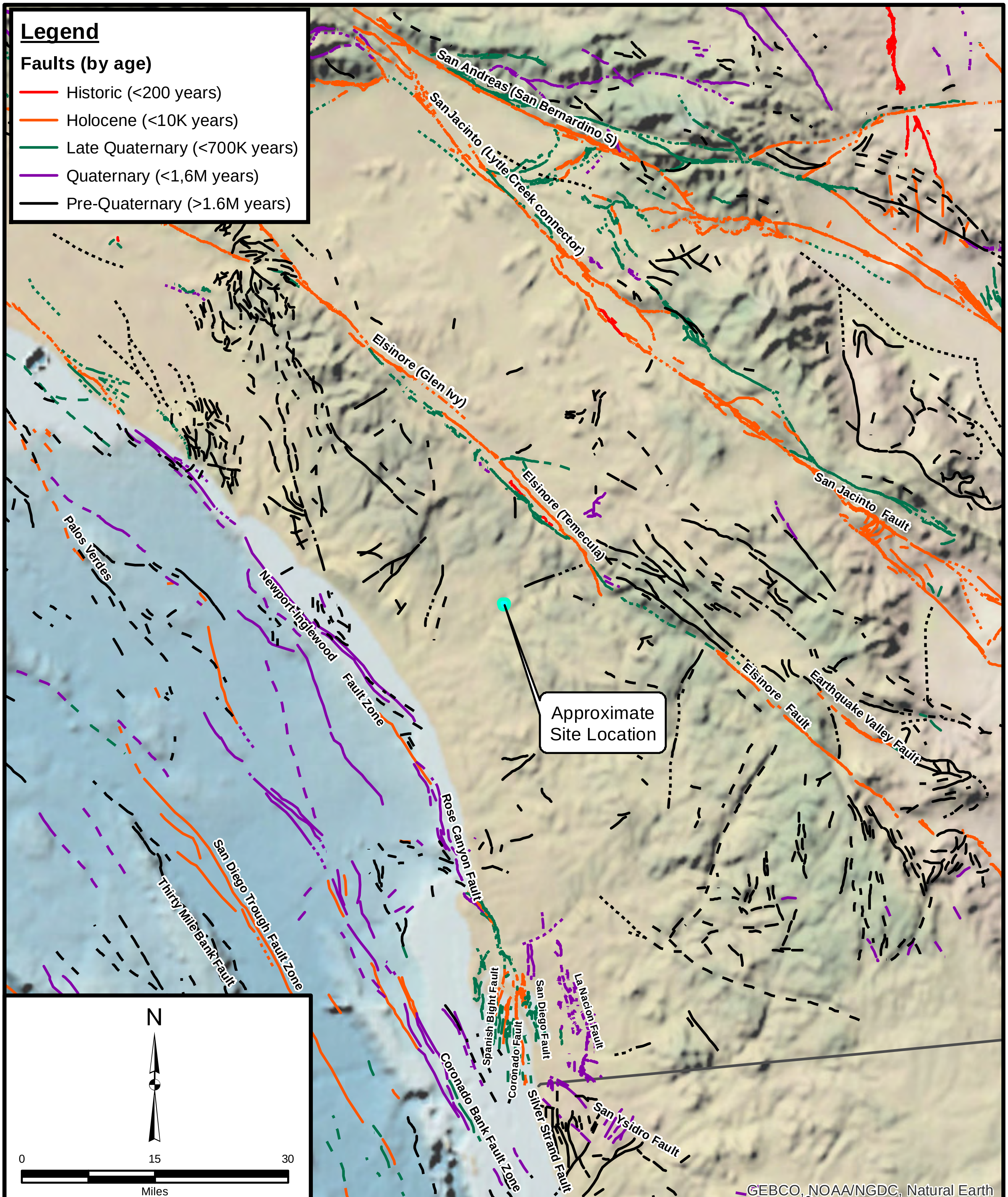

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Scale: 1 " = 15 miles	Date: April 2016

Base Map: ESRI Resource Center 2016
Thematic Info: Leighton, USGS, NCEDC
Author: Geomatics (mmurphy)

REGIONAL FAULT MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Figure 3

Leighton

Map Saved as V:\Drafting\11279\001\Maps\11279-001_F03_RFM_2016-04-05A.mxd on 4/5/2016 11:15:03 AM

Project: 11279.001	Eng/Geol: KEC/RFR
Scale: 1 " = 1 miles	Date: April 2016

Base Map: Bing Maps, 2016
Thematic Information: Leighton, CA DWR, FEMA
Author: Leighton Geomatics (mmurphy)

FLOOD HAZARD ZONE MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Figure 4

Leighton

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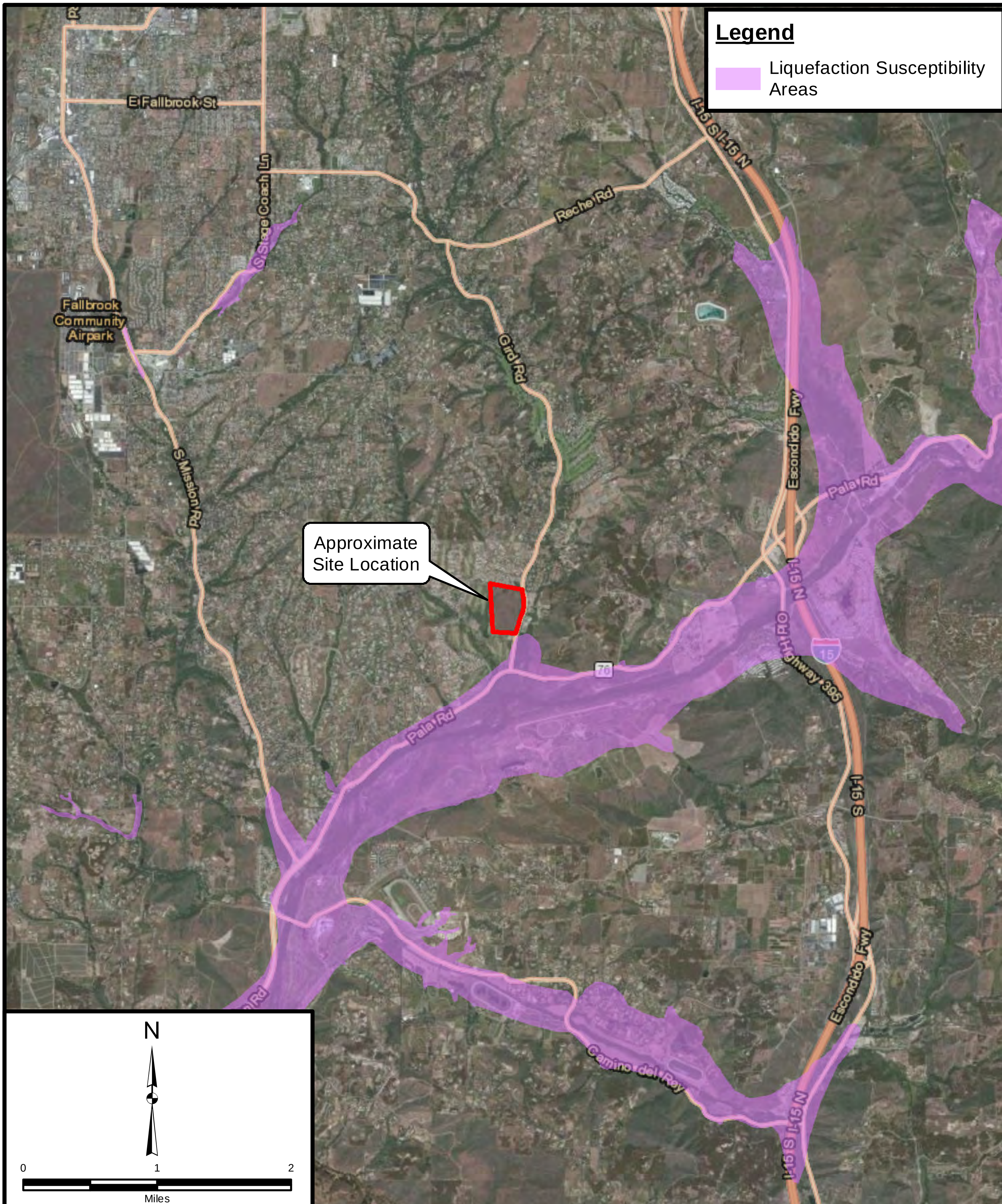

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Scale: 1 " = 1 mile	Date: April 2016

Base Map: Bing Maps, 2016
Thematic Information: Leighton, County of San Diego
Author: Leighton Geomatics (mmurphy)

SEISMIC HAZARD MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Figure 5

Leighton

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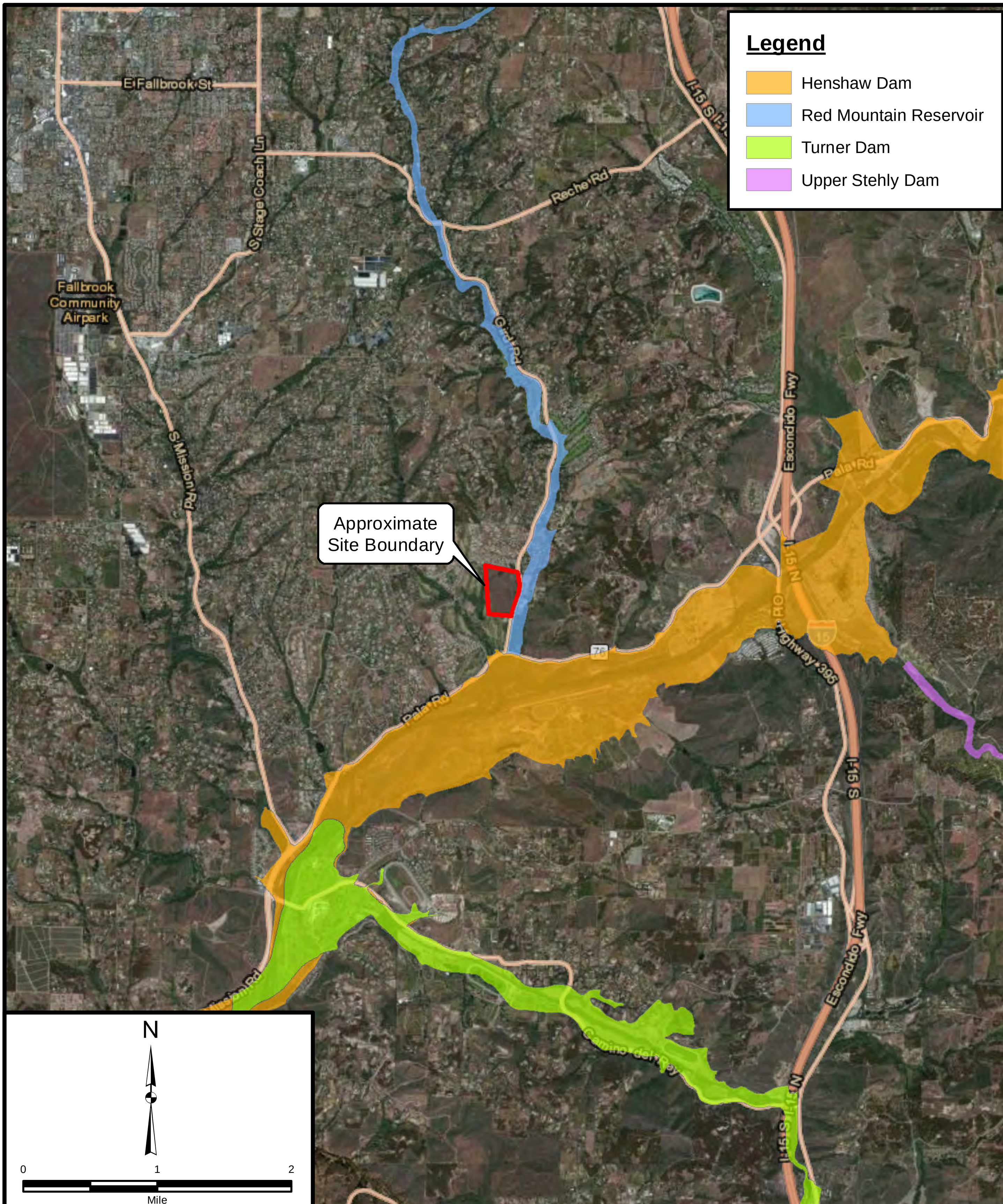

Project: 11279.001	Eng/Geol: KEC/RFR
Scale: 1 " = 1 miles	Date: April 2016

Base Map: Bing Maps, 2016
Thematic Information: Leighton, CA DWR
Author: Leighton Geomatics (mmurphy)

DAM INUNDATION ZONE MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Figure 6

Leighton

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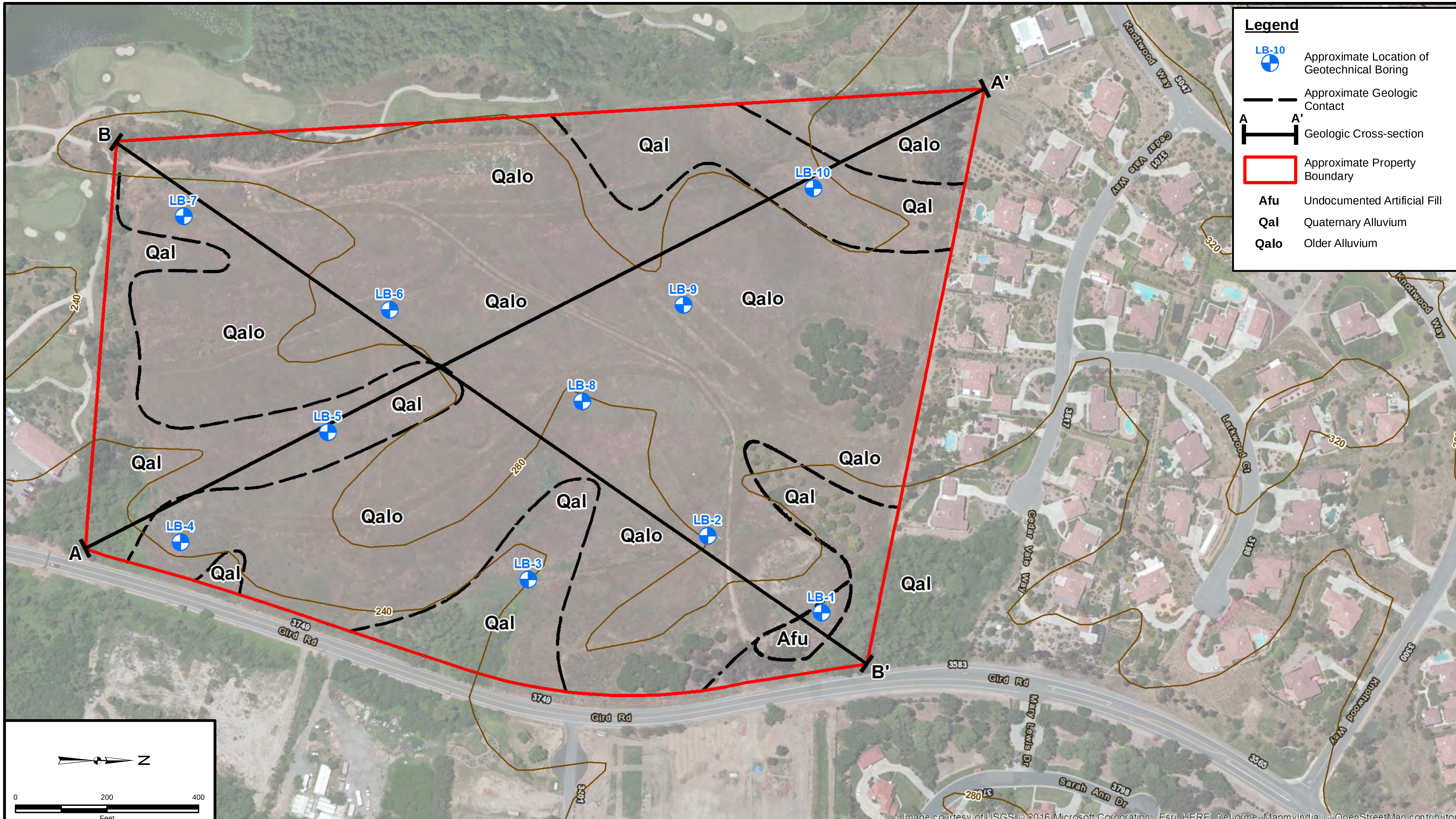

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Scale: 1 " = 200 '	Date: April 2016

Base Map: Bing Maps, 2016
Thematic Information: Leighton
Author: Leighton Geomatics (mmurphy)

GEOTECHNICAL MAP

Bonsall Unified School District
Gird Road High School Site
Bonsall, California

Plate 1

Leighton

Map Saved as V:\Drafting\11279\001\Maps\11279-001_P01_GM_2016-04-05.mxd on 4/21/2016 10:03:19 AM

APPENDIX A

LOGS OF EXPLORATORY BORINGS

Encountered earth materials were continuously logged and sampled in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D 2488). During drilling, bulk and relatively undisturbed ring-lined split-barrel driven earth material samples were obtained from our borings for geotechnical laboratory testing and classification. Drive-samples were driven with a 140-pound auto-hammer falling 30-inches. Samples were transported to our in-house Temecula laboratory for geotechnical testing. After logging and sampling, our borings were backfilled with spoils generated during drilling.

The attached subsurface exploration logs and related information depict subsurface conditions only at the locations indicated and at the particular date designated on these logs. Subsurface conditions at other locations may differ from conditions occurring at these logged locations. Passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on these logs represent an approximate boundary between sampling intervals and soil types; and transitions may be gradual.

GEOTECHNICAL BORING LOG LB-1

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~265'
Location	See Boring Location Map	**Sampled By**	JTD

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				SM	**Undocumented Artificial Fill (Afu)**; SILTY SAND, dark brown, moist, fine to coarse grained sand	
				R-1	8 17 18	104	15	SM	**Quaternary Alluvium (Qal)**; SILTY SAND, medium dense, brown, dry to moist, fine grained sand, few pinhole voids, CO = -0.62%	CO
	5			R-2	13 14 12	111	12	SW-SM	Well-graded SAND with SILT, medium dense, reddish brown, moist, fine to medium grained sand	
								CL	SANDY Lean CLAY, dark brown, moist, fine to medium grained sand	
	10			R-3	7 10 15	112	18	SM	SILTY SAND, medium dense, dark grayish brown to dark yellowish brown, moist, fine to medium grained sand, trace clay	
	15			R-4	14 23 37	113	18	CL	SANDY Lean CLAY, hard, dark grayish brown to dark yellowish brown, moist, fine to coarse grained sand	
	20			S-1	11 15 17			SC-SM	SILTY, CLAYEY SAND, dense, dark yellowish brown, moist, fine to medium grained sand, 37% -200	-200, AL
	25			R-5	10 12 19	116	16	SM	SILTY SAND, medium dense, dark yellowish brown, moist, fine to medium grained sand	
	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 LB-1

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~265'
Location	See Boring Location Map	**Sampled By**	JTD

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
	30			S-2	4 4 5			CL	Lean CLAY with SAND, stiff, dark grayish brown, moist to wet, very fine grained sand, sampler wet @ 30', 71% -200	-200
	35			R-6	7 9 12	111	19		SANDY Lean CLAY, stiff, dark grayish brown, wet, fine to coarse grained sand	
	40			S-3	5 6 12				SANDY Lean CLAY, stiff, dark grayish brown, wet, fine to coarse grained sand	
								SM	SILTY SAND, medium dense, dark grayish brown, wet, fine grained sand	
	45			S-4	5 4 10				SILTY SAND, medium dense, dark brown, wet, fine to medium grained sand, water added at 45', 35% -200	-200
								CL	SANDY Lean CLAY, stiff, dark grayish brown, wet, very fine to fine grained sand	
	50			S-5	6 7 12				Lean CLAY with SAND, very stiff, dark grayish brown, wet, very fine to fine sand, water added @ 50'	AL, SA
									Drilled to 51.5' Sampled to 51.5' Groundwater at 28.2' Backfilled with bentonite	
	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 LB-2

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~280'
Location	See Boring Location Map	**Sampled By**	JTD

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				SM	**Older Alluvium (Qalo)**; SILTY SAND with GRAVEL, brown, dry to moist, fine to coarse grained sand with fine gravel, EI = 68, RV = 10	EI, RV
								SC-SM	SILTY, CLAYEY SAND, reddish brown, moist, fine to medium grained sand	
	5			R-1	20 37 50/5"			SM	SILTY SAND, dense, reddish brown, moist, fine to medium grained sand	
									SILTY SAND, dark reddish brown, moist, fine to medium grained sand	
	10			R-2	24 32 33				SILTY SAND, dense, dark grayish brown, moist, fine to coarse grained sand	
	15			R-3	11 14 20				SILTY SAND, medium dense, grayish brown, moist, fine to coarse grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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 LB-3

Project No. 11279.001
Project BUSD Gird Road
Drilling Co. Pacific Drilling
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Boring Location Map

Date Drilled 3-29-16
Logged By JTD
Hole Diameter 8"
Ground Elevation ~240'
Sampled By JTD

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				SM	**Quaternary Alluvium (Qal)**; SILTY SAND, dark brown, dry to moist, fine to medium grained sand	CR
				R-1	10 10 11	118	7		SILTY SAND, medium dense, dark reddish brown, moist, fine to medium grained sand, few pinhole voids, CO = -1.16%	CO
	5			R-2	4 7 10			SC	CLAYEY SAND, medium dense, dark reddish brown, moist, fine to coarse grained sand, trace pinhole voids	
									CLAYEY SAND, dark grayish brown, moist, fine to coarse grained sand	
	10			R-3	3 7 11			CL	SANDY Lean CLAY, stiff, dark grayish brown, moist to wet, very fine to medium grained sand, no recovery, resample with SPT	
	15			R-4	9 12 15			SC	CLAYEY SAND, medium dense, dark grayish brown, wet, fine to coarse grained sand	
	20			S-1	7 13 12			CL	SANDY Lean CLAY with GRAVEL, very stiff, dark grayish brown, wet, fine grained sand, with gravel to 1"	
									Drilled to 21.5' Sampled to 21.5' Groundwater at 10.5' Backfilled with bentonite	
	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 LB-4

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~245'
Location	See Boring Location Map	**Sampled By**	JTD

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							SM	**Older Alluvium (Qalo)**; SILTY SAND with GRAVEL, brown, moist, fine to coarse grained sand with fine gravel	
									SILTY SAND, yellowish brown, moist, fine to medium grained sand	
	5			R-1	12 15 20	118	2	SW	Well-graded SAND with GRAVEL, medium dense, light brown, dry to moist, fine to coarse grained sand with fine gravel	
								SW-SM	Well-graded SAND with SILT and GRAVEL, yellowish brown, moist, fine to coarse grained sand with fine gravel	
	10			R-2	7 13 18			SW	Well-graded SAND with GRAVEL, medium dense, grayish brown, dry to moist, fine to coarse grained sand with fine gravel	
	15			R-3	17 27 30			SM	SILTY SAND, dense, dark grayish brown, moist, fine to coarse grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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 LB-5

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~260'
Location	See Boring Location Map	**Sampled By**	JTD

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				SM	**Quaternary Alliuvum (Qal)**; SILTY SAND, brown, dry to moist, fine to medium grained sand, EI = 8, RV = 17	EI, RV
									SILTY SAND, dark reddish brown, moist, fine to medium grained sand	
	5			R-1	12 19 34			SC	**Older Alluvium (Qalo)**; CLAYEY SAND, dense, dark reddish brown, moist, fine to coarse grained sand	
	10			R-2	12 16 25				CLAYEY SAND, medium dense, dark reddish brown, moist, fine to coarse grained sand	
	15			R-3	10 12 20				CLAYEY SAND, medium dense, dark reddish brown, moist, fine to coarse grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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

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GEOTECHNICAL BORING LOG LB-6

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~285'
Location	See Boring Location Map	**Sampled By**	JTD

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							SM	**Older Alluvium (Qalo)**; SILTY SAND, grayish brown, dry to moist, fine to medium grained sand	
									SILTY SAND, dark yellowish brown, moist, fine to medium grained sand	
	5			R-1	17 19 35				SILTY SAND, dense, dark yellowish brown, moist, fine to medium grained sand	
	10			R-2	15 16 22			SC-SM	SILTY, CLAYEY SAND, medium dense, dark grayish brown to dark yellowish brown, moist, fine to coarse grained sand	
	15			R-3	12 16 25			SP	Poorly graded SAND, medium dense, dark grayish brown, dry to moist, fine grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	20									
	25									
	30									

SAMPLE TYPES:	TYPE OF TESTS:		
B BULK SAMPLE	-200 % FINES PASSING	DS DIRECT SHEAR	SA SIEVE ANALYSIS
C CORE SAMPLE	AL ATTERBERG LIMITS	EI EXPANSION INDEX	SE SAND EQUIVALENT
G GRAB SAMPLE	CN CONSOLIDATION	H HYDROMETER	SG SPECIFIC GRAVITY
R RING SAMPLE	CO COLLAPSE	MD MAXIMUM DENSITY	UC UNCONFINED COMPRESSIVE STRENGTH
S SPLIT SPOON SAMPLE	CR CORROSION	PP POCKET PENETROMETER	
T TUBE SAMPLE	CU UNDRAINED TRIAXIAL	RV R VALUE	

GEOTECHNICAL BORING LOG LB-7

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~270'
Location	See Boring Location Map	**Sampled By**	JTD

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				SM	**Older Alluvium (Qalo)**; SILTY SAND, brown, dry to moist, fine to coarse grained sand, MD = 136.0 @ 7.2%	MD, DS
									SILTY SAND, yellowish brown, moist, fine to medium grained sand	
	5			R-1	12 15 23	123	12	SC-SM	SILTY, CLAYEY SAND, medium dense, grayish brown, moist, fine to coarse grained sand	
	10			R-2	14 18 14			SW-SM	Well-graded SAND with SILT, medium dense, dark grayish brown, dry to moist, fine to coarse grained sand	
	15			R-3	11 14 27			SM	SILTY SAND, medium dense, dark yellowish brown, moist, fine grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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

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GEOTECHNICAL BORING LOG LB-8

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~280'
Location	See Boring Location Map	**Sampled By**	JTD

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							SM	<u>**Older Alluvium (Qalo)**</u>; SILTY SAND, brown, dry to moist, fine to medium grained sand	
									SILTY SAND, dark yellowish brown, moist, fine to medium grained sand	
	5			R-1	40 38 45				SILTY SAND, very dense, brown, dry to moist, fine to coarse grained sand	CR, DS
	10			R-2	16 24 33			SP-SM	Poorly graded SAND with SILT, dense, grayish brown, dry to moist, fine grained sand	
	15			R-3	21 32 43			SM	SILTY SAND, very dense, dark reddish brown, moist, fine to coarse grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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

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GEOTECHNICAL BORING LOG LB-9

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~290'
Location	See Boring Location Map	**Sampled By**	JTD

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							SM	**Older Alluvium (Qalo)**; SILTY SAND, brown, dry to moist, fine to medium grained sand	
									SILTY SAND, dark yellowish brown, moist, fine to medium grained sand	
	5			R-1	11 9 14			SP-SM	Poorly graded SAND with SILT, medium dense, dark reddish brown, moist, fine grained sand	
	10			R-2	20 19 21			SM	SILTY SAND, medium dense, dark reddish brown, moist, fine grained sand	
	15			R-3	10 16 38			SC-SM	SILTY, CLAYEY SAND, dense, dark reddish brown, moist, fine to medium grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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

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GEOTECHNICAL BORING LOG LB-10

Project No.	11279.001	**Date Drilled**	3-29-16
Project	BUSD Gird Road	**Logged By**	JTD
Drilling Co.	Pacific Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	~275'
Location	See Boring Location Map	**Sampled By**	JTD

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				SM	**Quaternary Alluvium (Qal)**; SILTY SAND, brown, dry to moist, fine to medium grained sand, MD = 135.2 @ 7.8%	MD
				R-1	4 4 5	109	5		SILTY SAND, loose, dark brown, moist, fine to medium grained sand	
	5			R-2	6 9 15			SC-SM	SILTY, CLAYEY SAND, medium dense, dark reddish brown to dark brown, moist, fine to coarse grained sand	
	10			R-3	14 16 23			SC-SM	**Older Alluvium (Qalo)**; SILTY, CLAYEY SAND, medium dense, dark reddish brown, moist, fine to medium grained sand	
	15			R-4	9 18 22				SILTY, CLAYEY SAND, medium dense, dark reddish brown to dark grayish brown, moist, fine to medium grained sand	
									Drilled to 16.5' Sampled to 16.5' Groundwater not encountered Backfilled with cuttings	
	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		

APPENDIX B

RESULTS OF GEOTECHNICAL LABORATORY TESTING

Boring No.	LB-1	LB-1	LB-1	LB-1	LB-1	LB-1	LB-3	LB-4
Sample No.	R-1	R-2	R-3	R-4	R-5	R-6	R-1	R-1
Depth (ft.)	2.5	5.0	10.0	15.0	25.0	35.0	2.5	5.0
Sample Type	RING	RING	RING	RING	RING	RING	RING	RING
Visual Soil Classification	**TOP: SM BOTTOM: SM**	**TOP: SW-SM BOTTOM: SW-SM**	**TOP: SM BOTTOM: SM**	**TOP: s(CL) BOTTOM: s(CL)**	**TOP: SM BOTTOM: SM**	**TOP: s(CL) BOTTOM: s(CL)**	**TOP: SM BOTTOM: SM**	**TOP: SM BOTTOM: SM**
Pocket Penetrometer								
Weight Soil + Rings / Tube (gm.)	1134.0	1164.6	1221.5	1023.6	1243.5	1018.6	1180.5	1134.8
Weight of Rings / Tube (gm.)	267.0	267.0	267.0	222.5	267.0	222.5	267.0	267.0
Average Length (in.)	6.0	6.0	6.0	5.0	6.0	5.0	6.0	6.0
Average Diameter (in.)	2.416	2.416	2.416	2.416	2.416	2.416	2.416	2.416
Wet. Wt. of Soil + Cont. (gm.)	293.6	271.2	351.2	238.5	335.4	331.0	163.8	302.1
Dry Wt. of Soil + Cont. (gm.)	260.1	247.7	303.9	210.3	294.0	286.5	155.2	297.3
Weight of Container (gm)	39.0	50.3	38.7	50.1	38.8	51.0	38.9	50.5
Container No.:	A-7	BB	A-12	LL	101	25	A-29	F
Wet Density (pcf)	120	124	132	133	135	132	127	120
Moisture Content (%)	**15**	**12**	**18**	**18**	**16**	**19**	**7**	**2**
Dry Density (pcf)	**104**	**111**	**112**	**113**	**116**	**111**	**118**	**118**
Degree of Saturation (%)	66	62	96	97	98	99	46	12

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MOISTURE & DENSITY of SOILS

ASTM D 2216 & ASTM D 2937

Project Name:	BSUSD-Grid Rd HS		
Project No.:	11279.0001		
Client Name:	Bonsall Unified School District		
Tested By:	M. Vinet	Date:	04/08/16

Boring No.	LB-7	LB-10							
Sample No.	R-1	R-1							
Depth (ft.)	5.0	2.5							
Sample Type	RING	RING							
Visual Soil Classification	**TOP:** **SM** **BOTTOM:** **SM**	**TOP:** **SM** **BOTTOM:** **SM**							
Pocket Penetrometer									
Weight Soil + Rings / Tube (gm.)	1261.5	1094.4							
Weight of Rings / Tube (gm.)	267.0	267.0							
Average Length (in.)	6.0	6.0							
Average Diameter (in.)	2.416	2.416							
Wet. Wt. of Soil + Cont. (gm.)	303.5	274.0							
Dry Wt. of Soil + Cont. (gm.)	275.5	263.2							
Weight of Container (gm)	38.3	49.6							
Container No.:	A-1	9							
Wet Density (pcf)	138	115							
Moisture Content (%)	**12**	**5**							
Dry Density (pcf)	**123**	**109**							
Degree of Saturation (%)	87	25							

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MOISTURE & DENSITY of SOILS

ASTM D 2216 & ASTM D 2937

Project Name:	BSUSD-Grid Rd HS
Project No.:	11279.0001
Client Name:	Bonsall Unified School District
Tested By:	M. Vinet
Date:	04/08/16

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	BUSD-Grid Rd HS	Tested By :	A. Hill	Date:	4/9/16
Project No.:	11279.001	Input By :	M. Vinet	Date:	4/13/16
Exploration No.:	LB-7	Depth (ft.)	0 - 5.0		
Sample No. :	B-1				
Soil Identification:	Silty Sand (SM), brown.				

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

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

Moisture Added (ml)	0	50	100	150		
TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	6249	6416	6449	6360		
Weight of Mold (g)	4243	4243	4243	4243		AS REC'D
Net Weight of Soil (g)	2006	2173	2206	2117		MOISTURE
Wet Weight of Soil + Cont. (g)	688.9	1094.2	899.2	1064.7		1536.5
Dry Weight of Soil + Cont. (g)	665.9	1037.7	838.8	990.7		1477.2
Weight of Container (g)	136.9	163.0	136.3	289.6		163.5
Moisture Content (%)	4.3	6.5	8.6	10.6		4.5
Wet Density (pcf)	132.8	143.9	146.0	140.2		
Dry Density (pcf)	127.3	135.1	134.5	126.8		

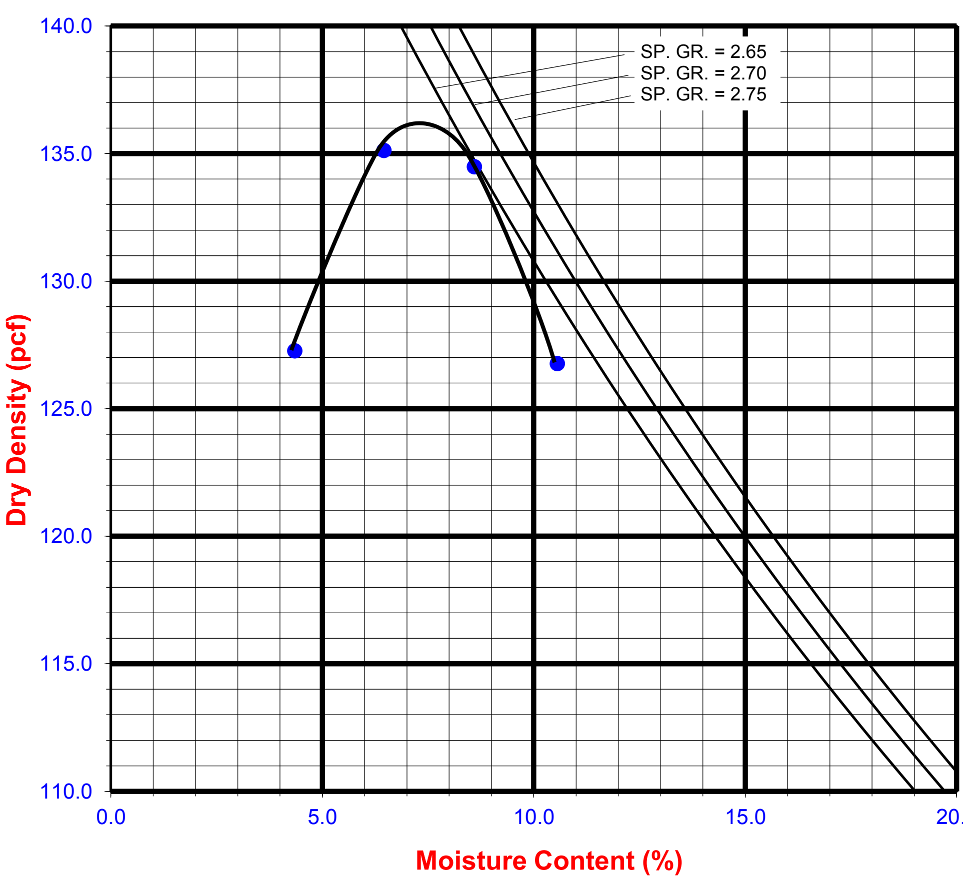
Maximum Dry Density (pcf) **136.0** **Optimum Moisture Content (%)** **7.2**

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

Compaction A; LB-7, B-1 (3-29-16)

Leighton

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name:	BUSD-Grid Rd HS	Tested By : A. Hill	Date: 4/11/16
Project No.:	11279.001	Input By : M. Vinet	Date: 4/13/16
Exploration No.:	LB-10	Depth (ft.) 0 - 5.0	
Sample No. :	B-1		
Soil Identification:	Silty Sand (SM), brown.		

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

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

Moisture Added (ml)	0	50	100	150		
TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	6274	6367	6443	6380		
Weight of Mold (g)	4243	4243	4243	4243		AS REC'D
Net Weight of Soil (g)	2031	2124	2200	2137		MOISTURE
Wet Weight of Soil + Cont. (g)	958.6	734.0	813.8	807.3		1750.0
Dry Weight of Soil + Cont. (g)	927.5	700.2	766.4	741.2		1695.4
Weight of Container (g)	136.9	118.4	163.3	81.4		312.4
Moisture Content (%)	3.9	5.8	7.9	10.0		3.9
Wet Density (pcf)	134.5	140.6	145.6	141.5		
Dry Density (pcf)	129.4	132.9	135.0	128.6		

Maximum Dry Density (pcf) 135.2 **Optimum Moisture Content (%)** 7.8

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

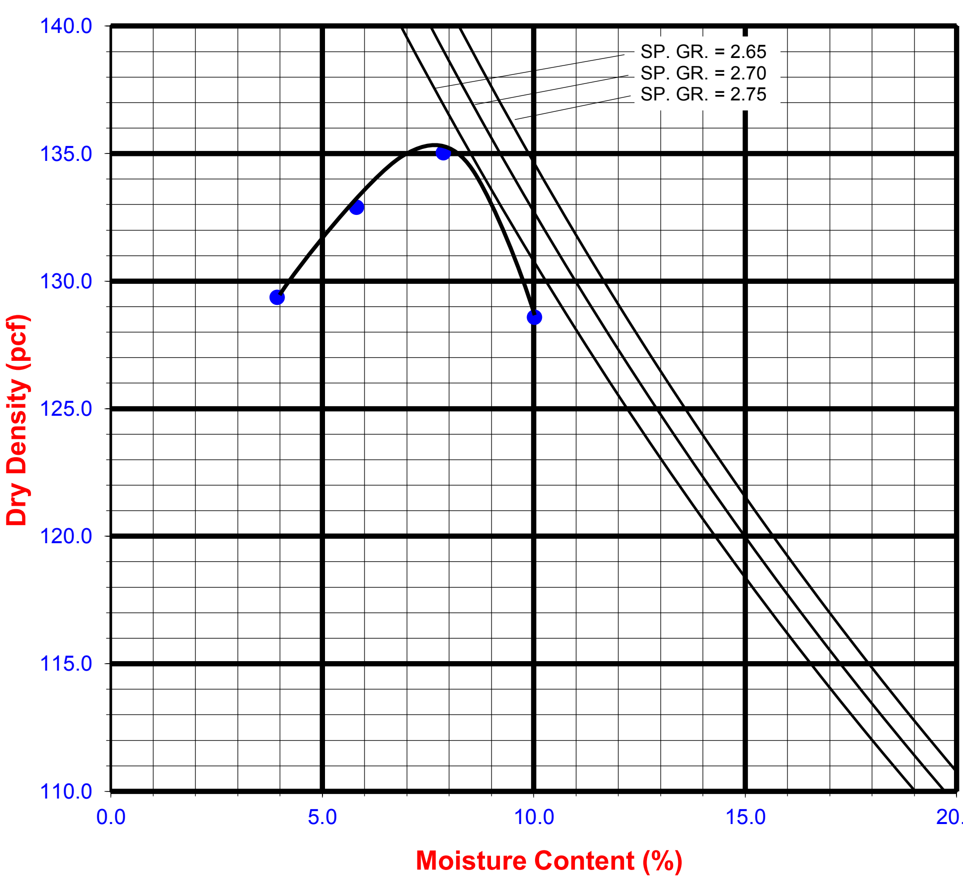
[ ] **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



Compaction A; LB-10, B-1 (3-29-16)

EXPANSION INDEX of SOILS
ASTM D 4829

Leighton

Project Name:	BUSD-Grid Rd HS	Tested By:	A. Hill	Date:	4/8/16
Project No. :	11279.001	Checked By:	M. Vinet	Date:	4/13/16
Boring No.:	LB-2	Depth:	0 - 5.0		
Sample No. :	B-1	Location:	N/A		
Sample Description:	Sandy Lean Clay s(CL), brown.				

Dry Wt. of Soil + Cont. (gm.)	3563.9
Wt. of Container No. (gm.)	0.0
Dry Wt. of Soil (gm.)	3563.9
Weight Soil Retained on #4 Sieve	47.1
Percent Passing # 4	98.7

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0675
Wt. Comp. Soil + Mold (gm.)	622.8	657.1
Wt. of Mold (gm.)	209.7	209.7
Specific Gravity (Assumed)	2.70	2.70
Container No.	9	9
Wet Wt. of Soil + Cont. (gm.)	509.7	657.1
Dry Wt. of Soil + Cont. (gm.)	485.7	380.0
Wt. of Container (gm.)	209.7	209.7
Moisture Content (%)	8.7	17.7
Wet Density (pcf)	124.6	126.4
Dry Density (pcf)	114.6	107.4
Void Ratio	0.471	0.570
Total Porosity	0.320	0.363
Pore Volume (cc)	66.2	80.2
Degree of Saturation (%) [S meas]	**49.9**	**84.0**

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h.

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
4/8/16	10:30	1.0	0	0.5000
4/8/16	10:40	1.0	10	0.4998
	Add Distilled Water to the Specimen			
4/9/16	7:00	1.0	1220	0.5675
4/9/16	8:00	1.0	1280	0.5675

Expansion Index (EI meas) =	((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	67.7
Expansion Index (Report) =	Nearest Whole Number or Zero (0) if Initial Height is > than Final Height	**68**

Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	BUSD-Grid Rd HS	Tested By:	A. Hill	Date:	4/8/16
Project No. :	11279.001	Checked By:	M. Vinet	Date:	4/13/16
Boring No.:	LB-5	Depth:	0 - 5.0		
Sample No. :	B-1	Location:	N/A		
Sample Description:	Silty Sand (SM), brown.				

Dry Wt. of Soil + Cont.	(gm.)	4056.2
Wt. of Container No.	(gm.)	0.0
Dry Wt. of Soil	(gm.)	4056.2
Weight Soil Retained on #4 Sieve		58.2
Percent Passing # 4		98.6

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0077
Wt. Comp. Soil + Mold (gm.)	632.9	653.7
Wt. of Mold (gm.)	208.5	208.5
Specific Gravity (Assumed)	2.70	2.70
Container No.	6	6
Wet Wt. of Soil + Cont. (gm.)	455.7	653.7
Dry Wt. of Soil + Cont. (gm.)	433.7	393.3
Wt. of Container (gm.)	155.7	208.5
Moisture Content (%)	7.9	13.2
Wet Density (pcf)	128.0	133.3
Dry Density (pcf)	118.6	117.7
Void Ratio	0.421	0.432
Total Porosity	0.296	0.302
Pore Volume (cc)	61.3	62.9
Degree of Saturation (%) [S meas]	**50.7**	**82.5**

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h.

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
4/8/16	10:00	1.0	0	0.5000
4/8/16	10:10	1.0	10	0.5000
	Add Distilled Water to the Specimen			
4/9/16	7:00	1.0	1250	0.5077
4/9/16	8:00	1.0	1310	0.5077

Expansion Index (EI meas) =	((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	7.7
Expansion Index (Report) =	Nearest Whole Number or Zero (0) if Initial Height is > than Final Height	**8**

Rev. 03-08

R-VALUE TEST RESULTS

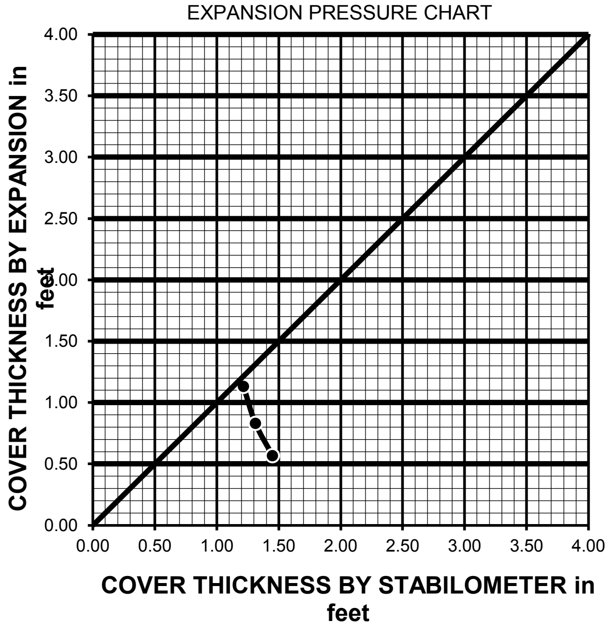
ASTM D 2844

Project Name:	BUSD-Grid Rd HS	Date:	4/11/16
Project Number:	11279.001	Technician:	M. Vinet
Boring Number:	LB-2	Depth (ft.):	0 - 5.0
Sample Number:	B-1	Sample Location:	N/A
Sample Description:	Sandy Lean Clay s(CL), brown.		

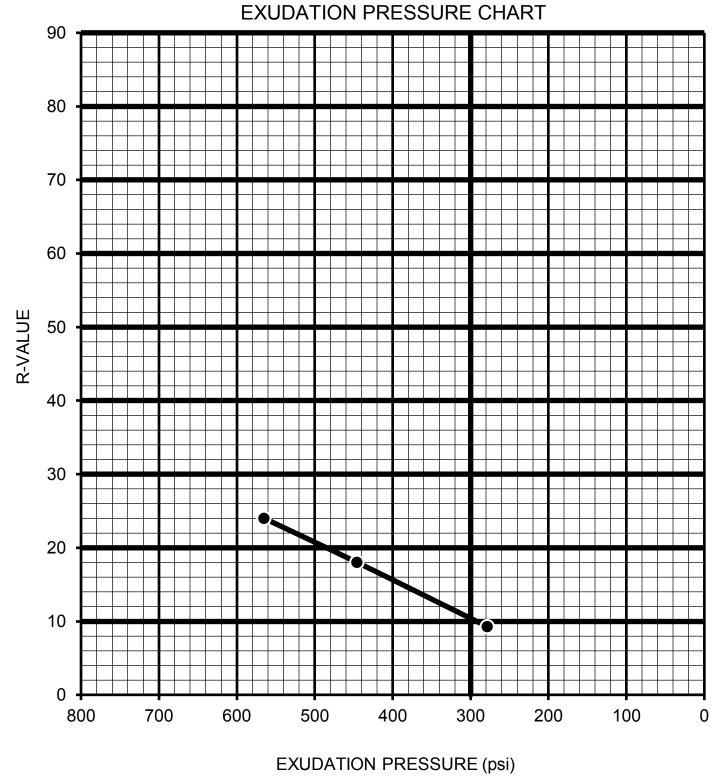
TEST SPECIMEN	A	B	C
MOISTURE AT COMPACTION %	12.2	13.3	14.3
HEIGHT OF SAMPLE, Inches	2.43	2.52	2.54
DRY DENSITY, pcf	122.3	118.4	115.2
COMPACTOR AIR PRESSURE, psi	125	95	70
EXUDATION PRESSURE, psi	565	446	278
EXPANSION, Inches x 10exp-4	30	22	15
STABILITY Ph 2,000 lbs (160 psi)	112	120	137
TURNS DISPLACEMENT	3.30	3.77	4.10
R-VALUE UNCORRECTED	25	18	9
R-VALUE CORRECTED	24	18	9

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	1.22	1.31	1.45
EXPANSION PRESSURE THICKNESS, ft.	1.13	0.83	0.57

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	25
R-VALUE BY EXUDATION:	10
EQUILIBRIUM R-VALUE:	10

Rev. 08-04

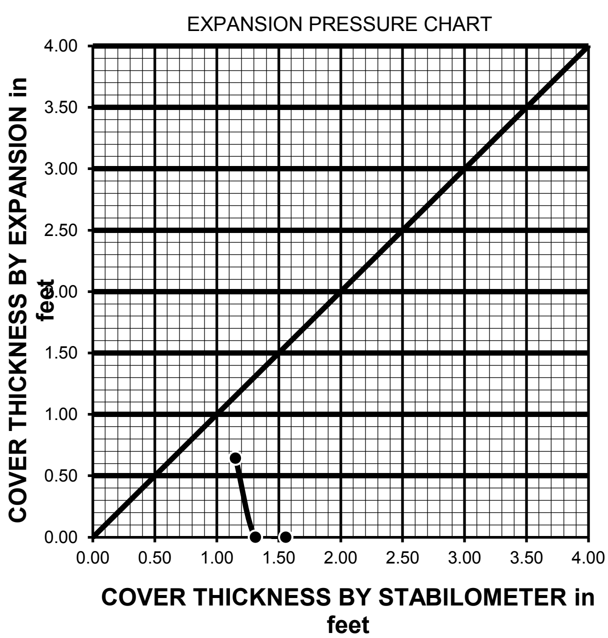
R-VALUE TEST RESULTS

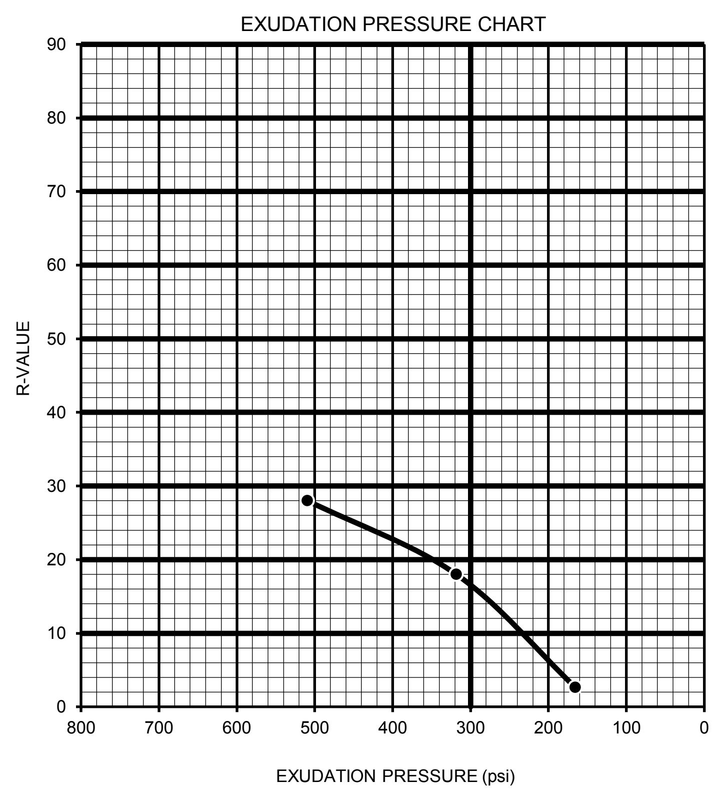
ASTM D 2844

Project Name:	BUSD-Grid Rd HS	Date:	4/11/16
Project Number:	11279.001	Technician:	M. Vinet
Boring Number:	LB-5	Depth (ft.):	0 - 5.0
Sample Number:	B-1	Sample Location:	N/A
Sample Description:	Silty Sand (SM), brown.		

TEST SPECIMEN	A	B	C
MOISTURE AT COMPACTION %	9.6	10.7	12.8
HEIGHT OF SAMPLE, Inches	2.43	2.57	2.51
DRY DENSITY, pcf	130.7	127.5	122.0
COMPACTOR AIR PRESSURE, psi	250	120	25
EXUDATION PRESSURE, psi	509	318	165
EXPANSION, Inches x 10exp-4	17	0	0
STABILITY Ph 2,000 lbs (160 psi)	96	120	152
TURNS DISPLACEMENT	3.80	4.10	4.82
R-VALUE UNCORRECTED	30	17	3
R-VALUE CORRECTED	28	18	3

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	1.15	1.31	1.56
EXPANSION PRESSURE THICKNESS, ft.	0.64	0.00	0.00





R-VALUE BY EXPANSION:	34
R-VALUE BY EXUDATION:	17
EQUILIBRIUM R-VALUE:	17

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS
ASTM D 6913

Leighton

Project Name:	BUSD-Grid Rd HS	Tested By:	AJH	Date:	04/08/16
Project No.:	11279.001	Checked By:	MRV	Date:	04/13/16
Exploration No.:	LB-1	Depth (feet):	50.0		
Sample No.:	S-5				
Soil Identification:	Sandy Silty Clay s(CL-ML), brown.				

		Moisture Content of Total Air - Dry Soil	
Container No.:	123	Wt. of Air-Dry Soil + Cont. (g)	1007.7
Wt. of Air-Dried Soil + Cont.(g)	1007.7	Wt. of Dry Soil + Cont. (g)	1007.7
Wt. of Container (g)	699.7	Wt. of Container No.______ (g)	699.7
Dry Wt. of Soil (g)	308.0	Moisture Content (%)	0.0

After Wet Sieve	Container No.	123
	Wt. of Dry Soil + Container (g)	848.6
	Wt. of Container (g)	699.7
	Dry Wt. of Soil Retained on # 200 Sieve (g)	148.9

U. S. Sieve Size (in.)	U. S. Sieve Size (mm.)	Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
3"	75.000		100.0
1"	25.000		100.0
3/4"	19.000		100.0
1/2"	12.500		100.0
3/8"	9.500		100.0
#4	4.750	0.0	100.0
#8	2.360	3.9	98.7
#16	1.180	9.6	96.9
#30	0.600	20.0	93.5
#50	0.300	42.3	86.3
#100	0.150	83.6	72.9
#200	0.075	144.0	53.2
PAN			

GRAVEL: **0 %**

SAND: **47 %**

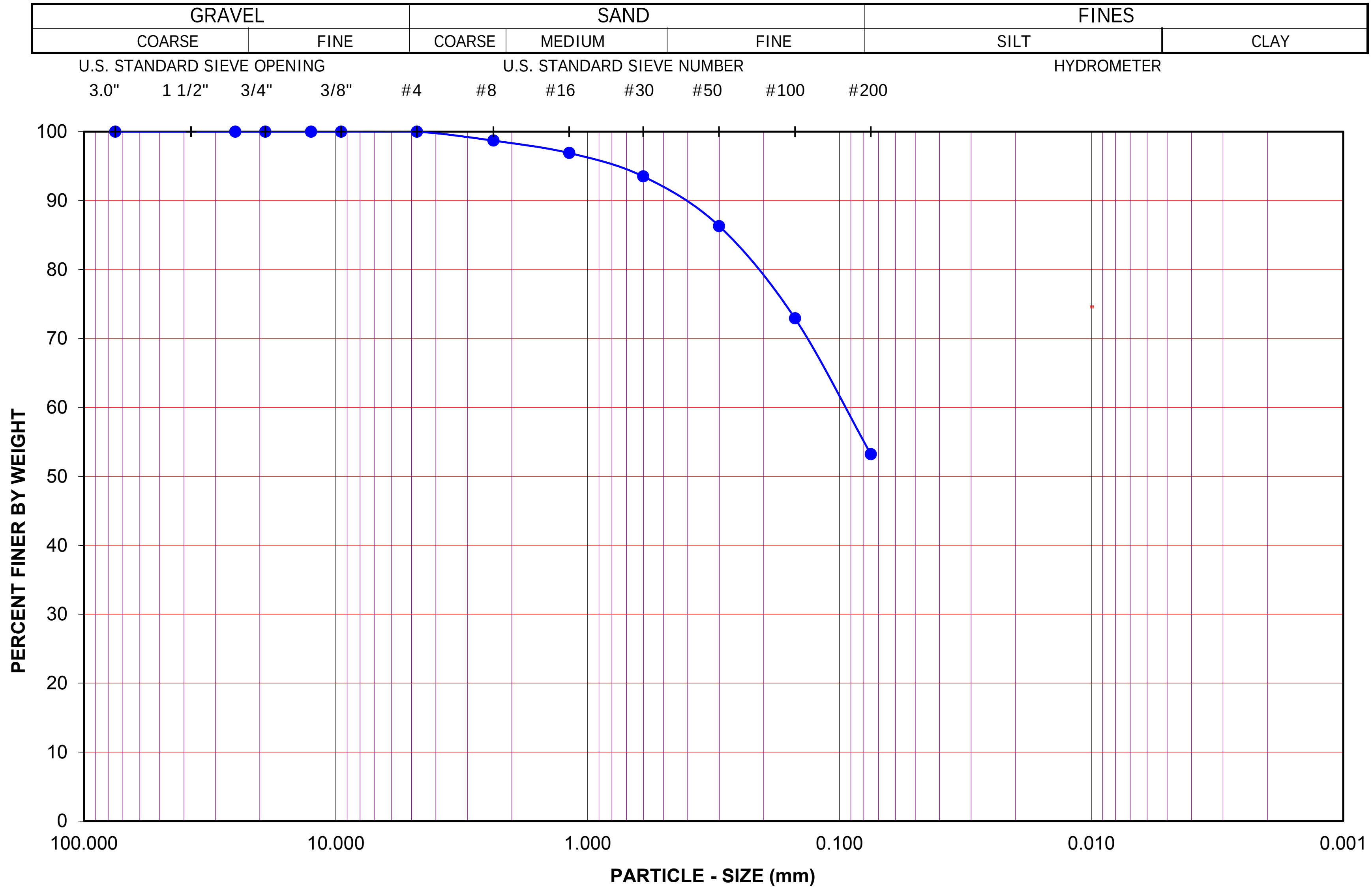
FINES: **53 %**

GROUP SYMBOL: **s(CL-ML)**

Cu = D60/D10 = N/A

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

Remarks:



Project Name: BUSD-Grid Rd HS

Project No.: 11279.001

Exploration No.: LB-1 Sample No.: S-5

Depth (feet): 50.0 Soil Type : s(CL-ML)

Soil Identification: Sandy Silty Clay s(CL-ML), brown.

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 0 : 47 : 53

Apr-16

Sieve; LB-1, S-5 (3-29-16)

Boring No.	LB-1	LB-1	LB-1					
Sample No.	S-1	S-2	S-4					
Depth (ft.)	20.0	30.0	45.0					
Sample Type	SPT	SPT	SPT					
Visual Soil Classification	SM	(CL)s	SM					
Moisture Correction								
Wet Weight of Soil + Container (gm.)	985.7	981.5	1022.8					
Dry Weight of Soil + Container (gm.)	985.7	981.5	1022.8					
Weight of Container (gm)	666.3	673.0	699.8					
Moisture Content (%)	0.0	0.0	0.0					
Container No.:	M	B	123					
Sample Dry Weight Determination								
Weight of Sample + Container (gm.)	985.7	981.5	1022.8					
Weight of Container (gm.)	666.3	673.0	699.8					
Weight of Dry Sample (gm.)	319.4	308.5	323.0					
Container No.:	M	B	123					
After Wash								
Dry Weight of Sample + Container (gm)	868.6	762.6	911.3					
Weight of Container (gm)	666.3	673.0	699.8					
Dry Weight of Sample (gm)	202.3	89.6	211.5					
% Passing No. 200 Sieve	**37**	**71**	**35**					
% Retained No. 200 Sieve	63	29	65					

PERCENT PASSING No. 200 SIEVE
ASTM D 1140

Leighton

Project Name: BUSD-Grid Rd HS
Project No.: 11279.001
Client Name: Bonsall Unified School District
Tested By: A. Hill Date: 4/7/16

Rev. 08-04

ATTERBERG LIMITS
ASTM D 4318

Leighton

Project Name:	BUSD-Grid Rd HS	Tested By:	M. Vinet	Date:	4/13/16
Project No. :	11279.001	Input By:	M. Vinet	Date:	4/13/16
Boring No.:	LB-1	Checked By:	M. Vinet	Date:	4/13/16
Sample No.:	S-1	Depth (ft.)	20.0		
Sample Description:	Silty Sand (SM), brown.				

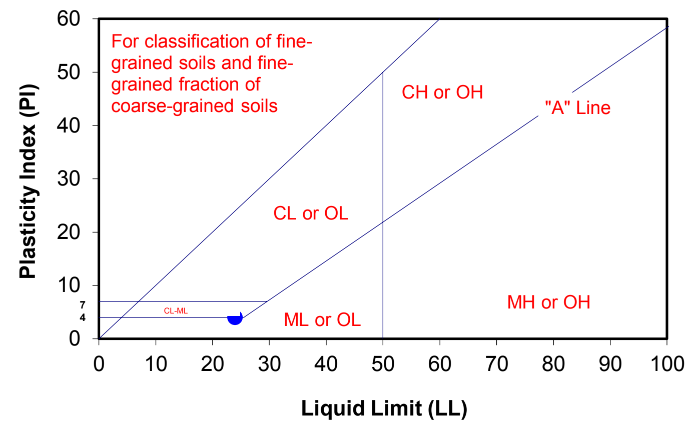
	PLASTIC LIMIT		LIQUID LIMIT			**IN-SITU
TEST NO.	1	2	1	2	3	MOISTURE
Number of Blows [N]			15	21	29	
Wet Wt. of Soil + Cont. (gm)	24.770	22.782	28.250	29.780	24.516	**
Dry Wt. of Soil + Cont. (gm)	22.947	21.311	25.345	26.670	22.441	**
Wt. of Container (gm)	13.801	13.640	13.531	13.574	13.532	**
Moisture Content (%) [Wn]	19.9	19.2	24.6	23.7	23.3	**

Liquid Limit	**24**
Plastic Limit	**20**
Plasticity Index	**4**
Classification	**ML**

PI at "A" - Line = 0.73(LL-20) = 2.92

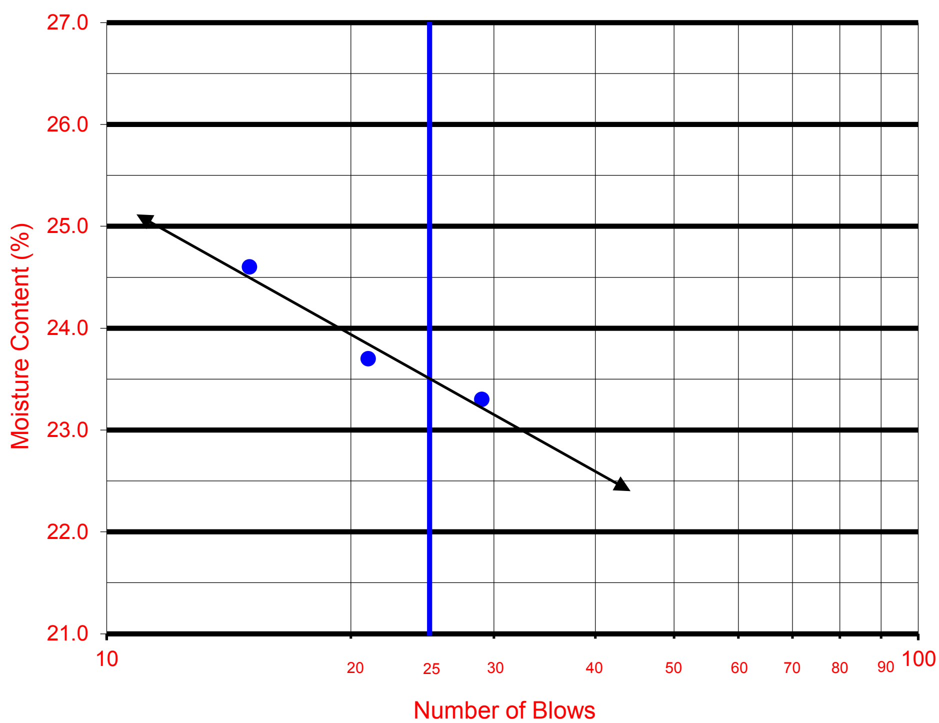
One - Point Liquid Limit Calculation

LL =Wn(N/25) $^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [x] Dry Preparation
  Multipoint - Dry
- [x] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



Rev. 08-04

ATTERBERG LIMITS

ASTM D 4318

Project Name:	BUSD-Grid Rd HS	Tested By:	M. Vinet	Date:	4/13/16
Project No. :	11279.001	Input By:	M. Vinet	Date:	4/13/16
Boring No.:	LB-1	Checked By:	M. Vinet	Date:	4/13/16
Sample No.:	S-5	Depth (ft.)	50.0		

Sample Description: Sandy Silty Clay s(CL-ML), brown.

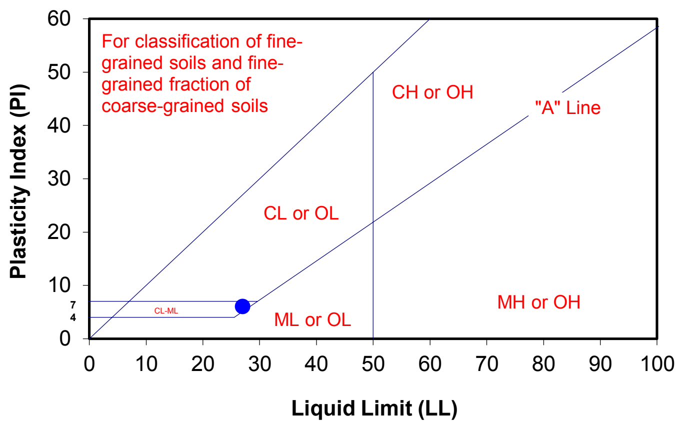
	PLASTIC LIMIT		LIQUID LIMIT			**IN-SITU
TEST NO.	1	2	1	2	3	MOISTURE
Number of Blows [N]			15	23	33	
Wet Wt. of Soil + Cont. (gm)	19.672	21.693	36.646	31.725	32.100	**
Dry Wt. of Soil + Cont. (gm)	18.604	20.285	31.572	27.858	28.367	**
Wt. of Container (gm)	13.632	13.679	13.648	13.629	14.041	**
Moisture Content (%) [Wn]	21.5	21.3	28.3	27.2	26.1	**

Liquid Limit	**27**
Plastic Limit	**21**
Plasticity Index	**6**
Classification	**CL-ML**

PI at "A" - Line = 0.73(LL-20) = 5.11

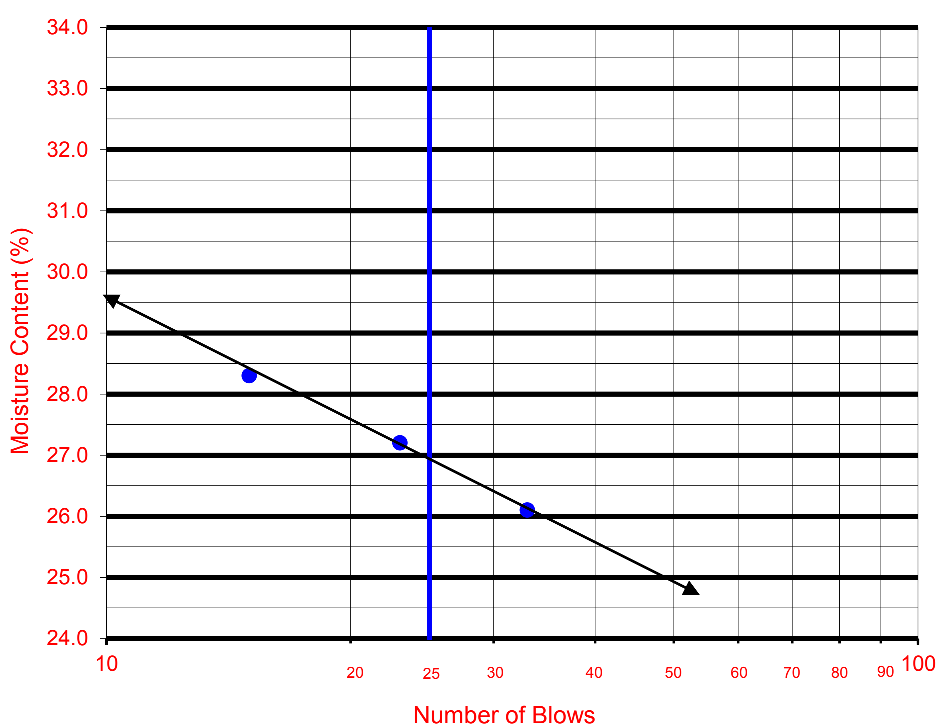
One - Point Liquid Limit Calculation

LL =Wn(N/25) $^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [x] Dry Preparation
  Multipoint - Dry
- [x] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



Rev. 08-04

One-Dimensional Swell or Settlement Potential of Cohesive Soils
(ASTM D 4546) -- Method 'B'

Leighton

Project Name:	BUSD-Grid Rd HS	Tested By: M. Vinet	Date: 4/8/16
Project No.:	11279.001	Checked By: M. Vinet	Date: 4/13/16
Boring No.:	LB-1	Sample Type: IN SITU	
Sample No.:	R-1	Depth (ft.) 2.5	

Sample Description: Silty Sand (SM), brown.

Source and Type of Water Used for Inundation: Arrowhead (Distilled)

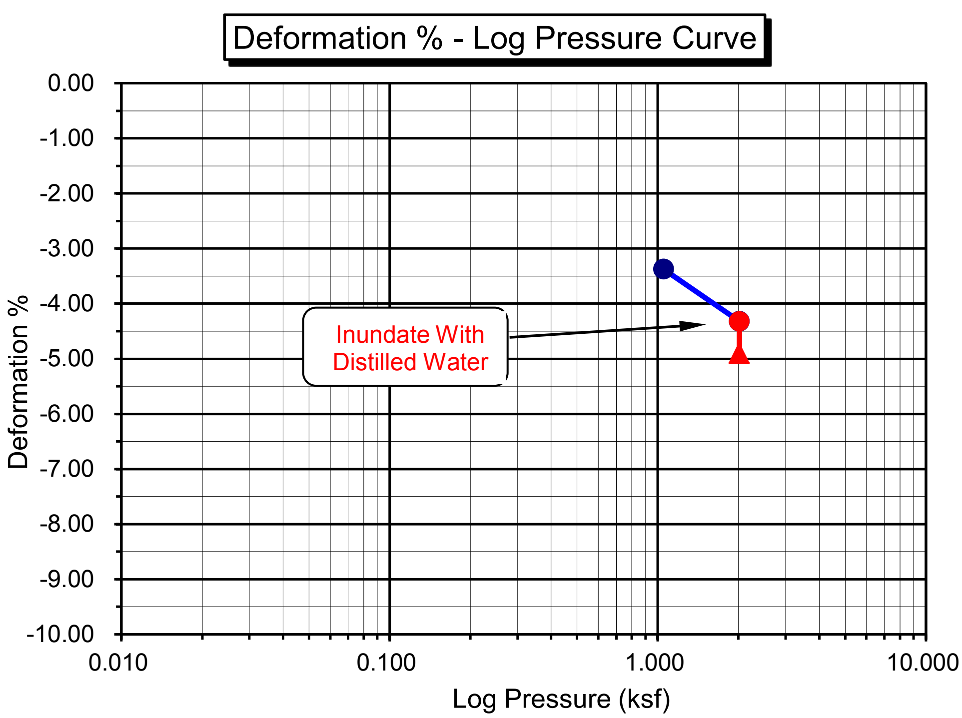
** Note: Loading After Wetting (Inundation) not Performed Using this Test Method.

Initial Dry Density (pcf):	107.7
Initial Moisture (%):	12.6
Initial Height (in.):	1.0000
Initial Dial Reading (in):	0.0500
Inside Diameter of Ring (in):	2.416

Final Dry Density (pcf):	113.3
Final Moisture (%) :	18.4
Initial Void ratio:	0.5651
Specific Gravity (assumed):	2.70
Initial Degree of Saturation (%):	60.0

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
1.050	0.0837	0.9663	0.00	-3.37	0.5124	-3.37
2.013	0.0932	0.9568	0.00	-4.32	0.4975	-4.32
H2O	0.0991	0.9509	0.00	-4.91	0.4883	-4.91

Percent Swell / Settlement After Inundation = -0.62



Rev. 01-10

One-Dimensional Swell or Settlement Potential of Cohesive Soils
(ASTM D 4546) -- Method 'B'

Leighton

Project Name: BUSD-Grid Rd HS
Project No.: 11279.001
Boring No.: LB-3
Sample No.: R-1
Sample Description: Silty Sand (SM), brown.

Tested By: M. Vinet Date: 4/8/16
Checked By: M. Vinet Date: 4/13/16
Sample Type: IN SITU
Depth (ft.) 2.5

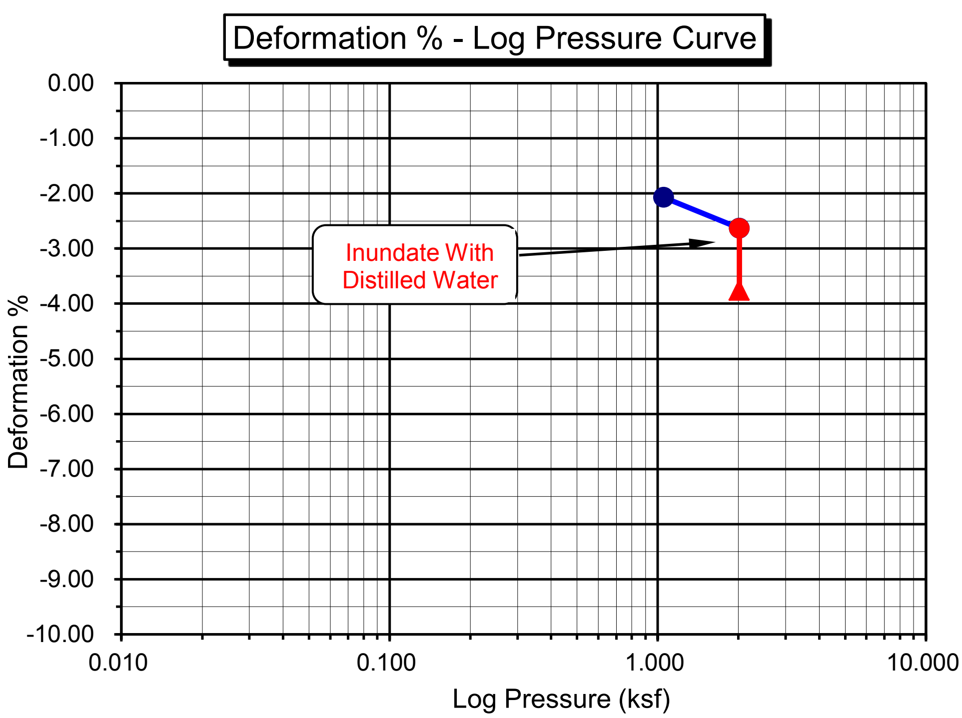
Source and Type of Water Used for Inundation: Arrowhead (Distilled)
** Note: Loading After Wetting (Inundation) not Performed Using this Test Method.

Initial Dry Density (pcf):	117.9
Initial Moisture (%):	8.2
Initial Height (in.):	1.0000
Initial Dial Reading (in):	0.0500
Inside Diameter of Ring (in):	2.416

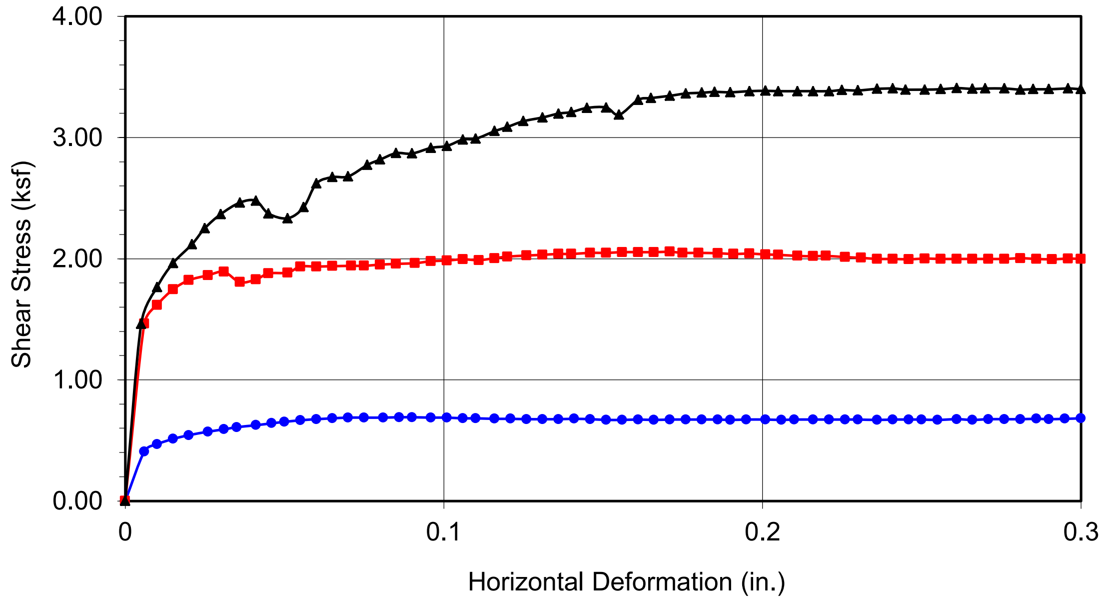
Final Dry Density (pcf):	122.5
Final Moisture (%) :	13.5
Initial Void ratio:	0.4295
Specific Gravity (assumed):	2.70
Initial Degree of Saturation (%):	51.7

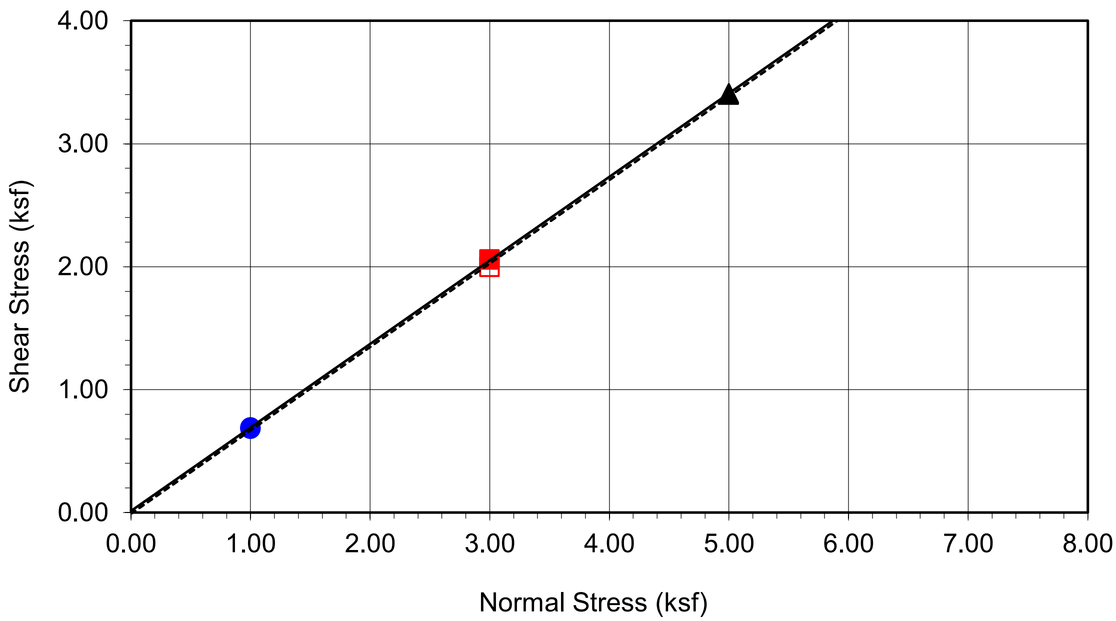
Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
1.050	0.0707	0.9793	0.00	-2.07	0.3999	-2.07
2.013	0.0763	0.9737	0.00	-2.63	0.3919	-2.63
H_2O	0.0876	0.9624	0.00	-3.76	0.3757	-3.76

Percent Swell / Settlement After Inundation = -1.16



Rev. 01-10





Boring No.	**LB-7**
Sample No.	**B-1**
Depth (ft)	**0 - 5.0**
Sample Type:	REMOLD

Soil Identification:
Silty Sand (SM), brown.

Strength Parameters

	C (psf)	ϕ (°)
Peak	14	34
Ultimate	-11	34

Normal Stress (kip/ft²)	1.000	3.000	5.000
Peak Shear Stress (kip/ft²)	● 0.691	■ 2.057	▲ 3.408
Shear Stress @ End of Test (ksf)	○ 0.682	□ 1.998	△ 3.399
Deformation Rate (in./min.)	0.0033	0.0033	0.0033
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.00	6.73	6.73
Dry Density (pcf)	122.7	123.0	123.0
Saturation (%)	50.5	49.0	49.0
Soil Height Before Shearing (in.)	0.9880	0.9875	0.9710
Final Moisture Content (%)	12.9	12.6	12.8

Leighton

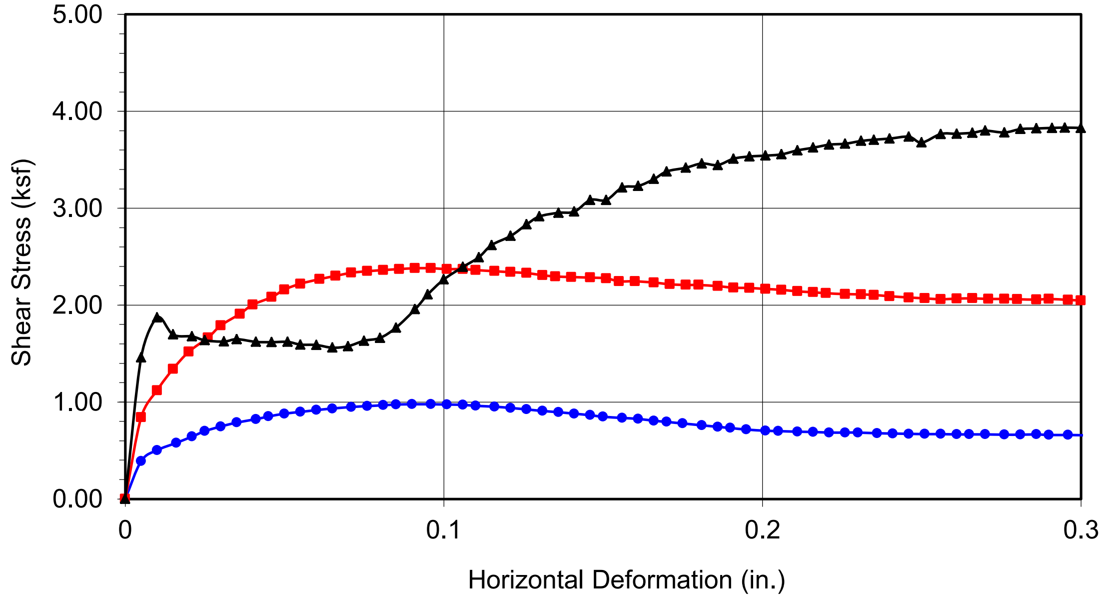
DIRECT SHEAR TEST RESULTS

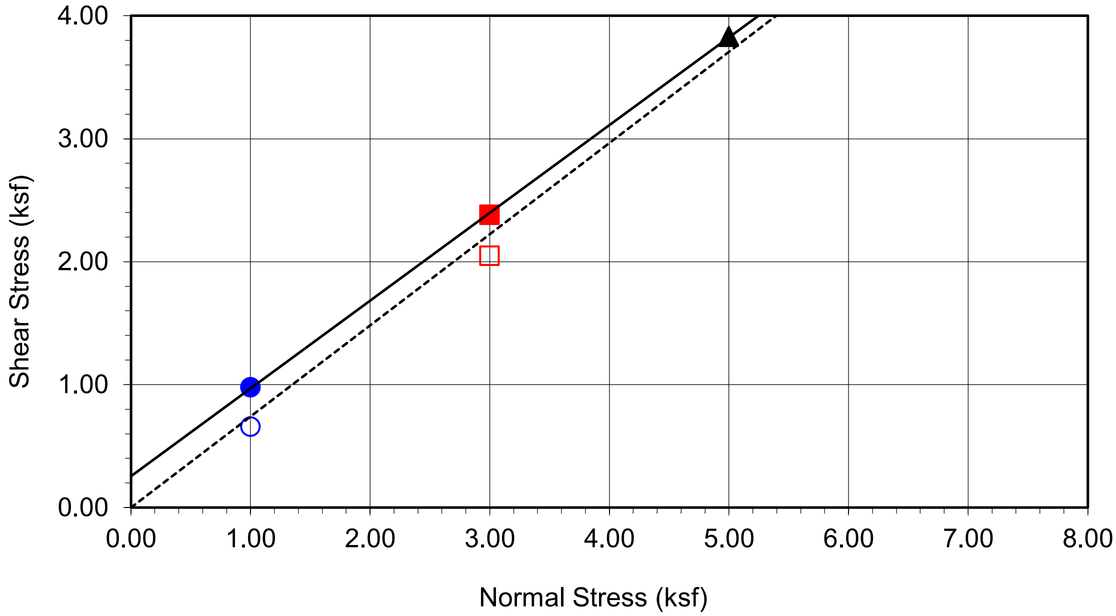
Consolidated Drained - ASTM D 3080

Project No.: 11279.001

BUSD-Grid Rd HS

04-16





Boring No.	**LB-8**
Sample No.	**R-1**
Depth (ft)	**5**
Sample Type:	Ring

Soil Identification:
Silty Sand (SM), brown.

Strength Parameters

	C (psf)	ϕ (°)
Peak	255	36
Ultimate	0	37

Normal Stress (kip/ft²)	1.000	3.000	5.000
Peak Shear Stress (kip/ft²)	● 0.977	■ 2.381	▲ 3.832
Shear Stress @ End of Test (ksf)	○ 0.657	□ 2.048	△ 3.829
Deformation Rate (in./min.)	0.0033	0.0033	0.0033
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.26	7.26	7.26
Dry Density (pcf)	112.4	116.9	120.1
Saturation (%)	39.2	44.3	48.6
Soil Height Before Shearing (in.)	0.9675	0.9660	0.9650
Final Moisture Content (%)	16.4	14.4	15.0

Leighton

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11279.001

BUSD-Grid Rd HS

04-16

Copy of Direct Shear; LB-8, R-1 (3-29-16)

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Leighton

Project Name:	BUSD/Gird Road HS	Tested By :	G. Berdy	Date:	04/08/16
Project No. :	11279.001	Data Input By:	J. Ward	Date:	04/12/16

Boring No.	LB-3	LB-8		
Sample No.	B-1	R-1		
Sample Depth (ft)	0-5	5.0		
Soil Identification:	Dark brown SC	Dark brown SM		
Wet Weight of Soil + Container (g)	218.32	106.13		
Dry Weight of Soil + Container (g)	208.34	104.17		
Weight of Container (g)	57.76	67.18		
Moisture Content (%)	6.63	5.30		
Weight of Soaked Soil (g)	100.04	100.36		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	27	51		
Crucible No.	23	20		
Furnace Temperature (°C)	860	860		
Time In / Time Out	10:00/10:40	10:00/10:40		
Duration of Combustion (min)	40	40		
Wt. of Crucible + Residue (g)	18.4286	21.2352		
Wt. of Crucible (g)	18.4266	21.2338		
Wt. of Residue (g) (A)	0.0020	0.0014		
PPM of Sulfate (A) x 41150	82.30	57.61		
PPM of Sulfate, Dry Weight Basis	**88**	**61**		

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	15	15		
ml of AgNO3 Soln. Used in Titration (C)	0.6	0.5		
PPM of Chloride (C -0.2) * 100 * 30 / B	80	60		
PPM of Chloride, Dry Wt. Basis	**86**	**63**		

pH TEST, DOT California Test 643

pH Value	**6.39**	**7.49**		
Temperature °C	22.0	21.9		

SOIL RESISTIVITY TEST
DOT CA TEST 643

Leighton

Project Name:	BUSD/Gird Road HS	Tested By :	G. Berdy	Date:	04/08/16
Project No. :	11279.001	Data Input By:	J. Ward	Date:	04/12/16
Boring No.:	LB-3	Depth (ft.) :	0-5		
Sample No. :	B-1				

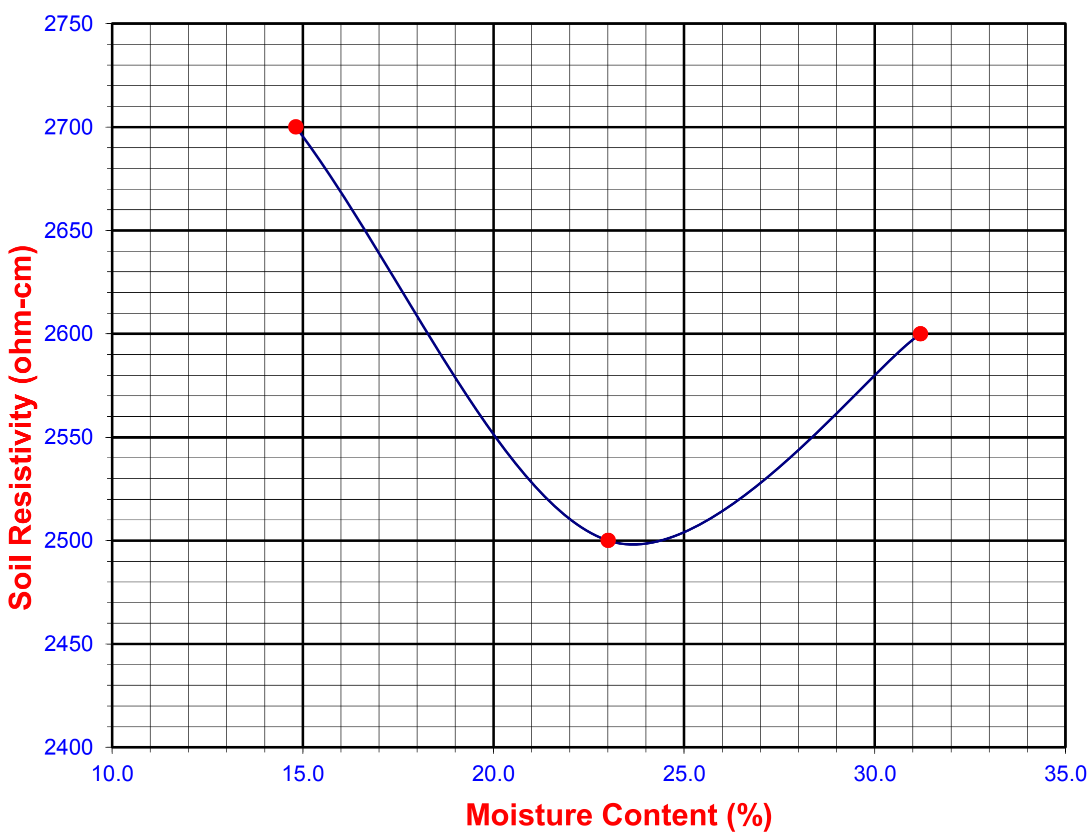
Soil Identification:* Dark brown SC

*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	10	14.82	2700	2700
2	20	23.01	2500	2500
3	30	31.20	2600	2600
4				
5				

Moisture Content (%) (MCi)	6.63
Wet Wt. of Soil + Cont. (g)	218.32
Dry Wt. of Soil + Cont. (g)	208.34
Wt. of Container (g)	57.76
Container No.	
Initial Soil Wt. (g) (Wt)	130.17
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	Soil pH: Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2498	**23.7**	**88**	**86**	**6.39**	**22.0**



SOIL RESISTIVITY TEST
DOT CA TEST 643

Leighton

Project Name:	BUSD/Gird Road HS	Tested By :	G. Berdy	Date:	04/11/16
Project No. :	11279.001	Data Input By:	J. Ward	Date:	04/12/16
Boring No.:	LB-8	Depth (ft.) :	5.0		
Sample No. :	R-1				

Soil Identification:* Dark brown SM

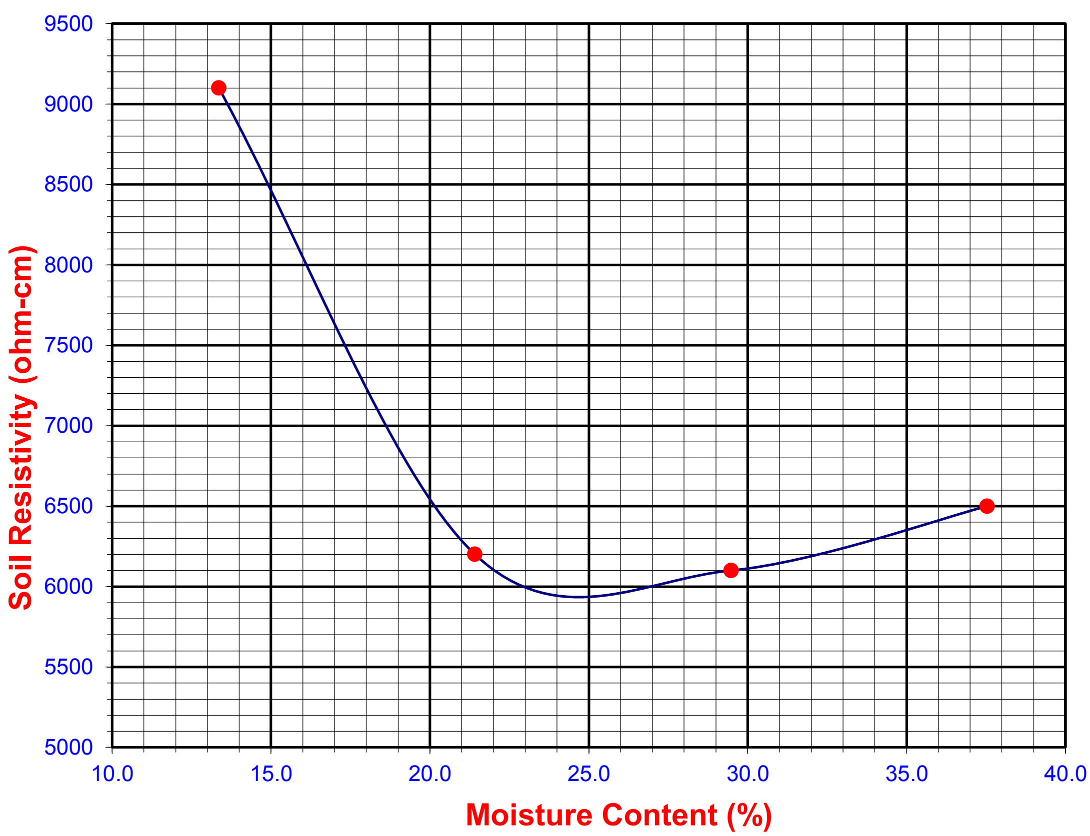
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	13.36	9100	9100
2	20	21.42	6200	6200
3	30	29.48	6100	6100
4	40	37.54	6500	6500
5				

Moisture Content (%) (MCi)	5.30
Wet Wt. of Soil + Cont. (g)	106.13
Dry Wt. of Soil + Cont. (g)	104.17
Wt. of Container (g)	67.18
Container No.	
Initial Soil Wt. (g) (Wt)	130.65
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	Soil pH: Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
5930	**24.7**	**61**	**63**	**7.49**	**21.9**



APPENDIX C

LIQUEFACTION ANALYSIS

USGS Design Maps Summary Report

User–Specified Input

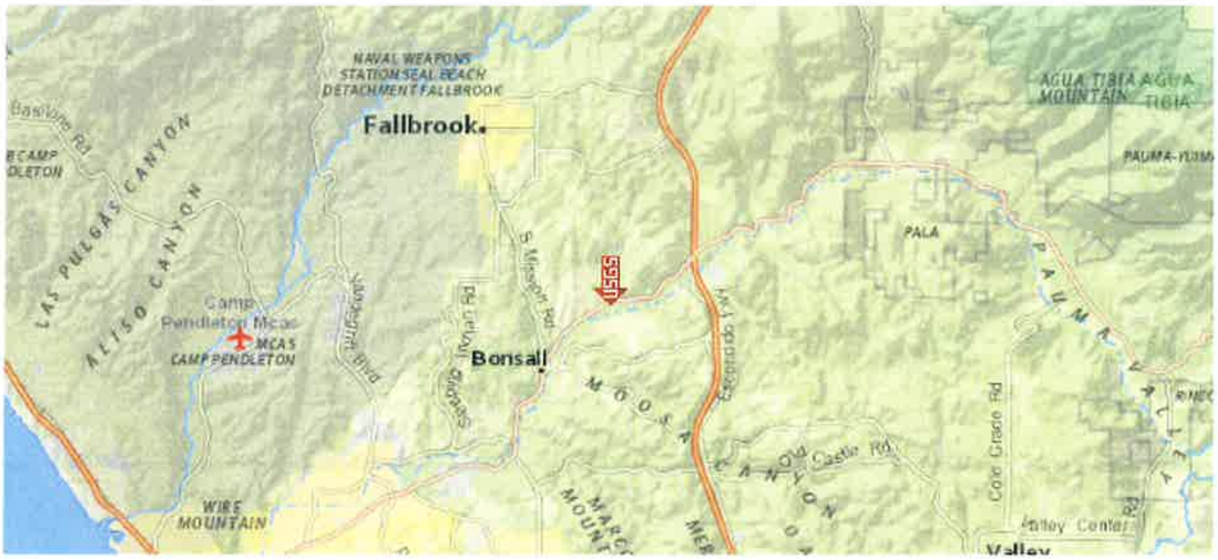
Report Title BUSD Gird Road
Fri April 1, 2016 15:47:54 UTC

Building Code Reference Document ASCE 7-10 Standard
(which utilizes USGS hazard data available in 2008)

Site Coordinates 33.3221°N, 117.196°W

Site Soil Classification Site Class D – "Stiff Soil"

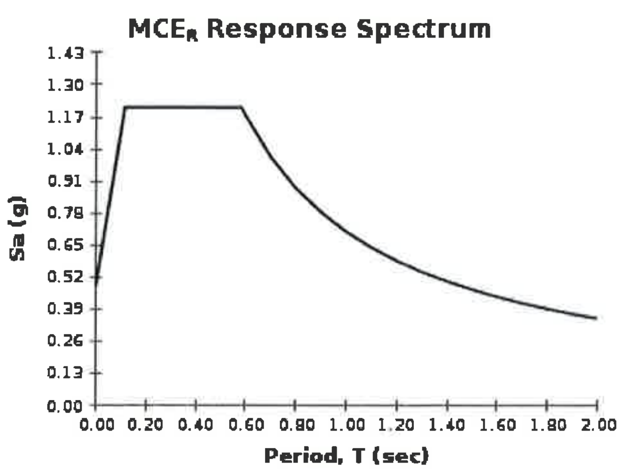
Risk Category I/II/III

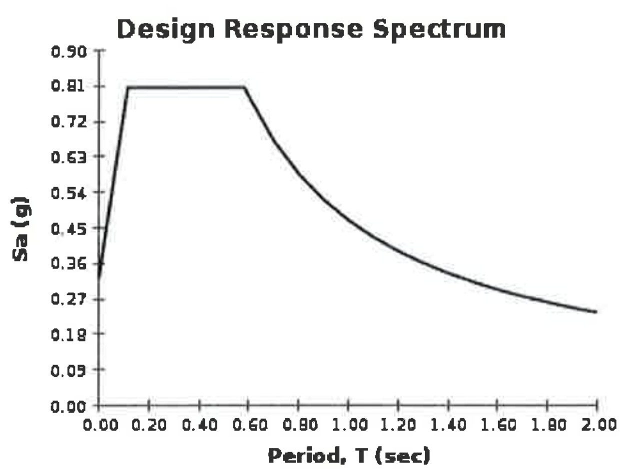


USGS–Provided Output

S_S =	1.171 g	S_{MS} =	1.208 g	S_{DS} =	0.806 g
S_1 =	0.456 g	S_{M1} =	0.704 g	S_{D1} =	0.469 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.





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

USGS Design Maps Detailed Report

ASCE 7-10 Standard (33.3221°N, 117.196°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] $S_S = 1.171$ g

From Figure 22-2 [2] $S_1 = 0.456$ 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 $w \geq 40\%$, 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				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
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	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 = 1.171 g, F_a = 1.031

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
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	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 = 0.456 g, F_v = 1.544

Equation (11.4–1): $S_{MS} = F_aS_S = 1.031 \times 1.171 = 1.208$ g

Equation (11.4–2): $S_{M1} = F_vS_1 = 1.544 \times 0.456 = 0.704$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

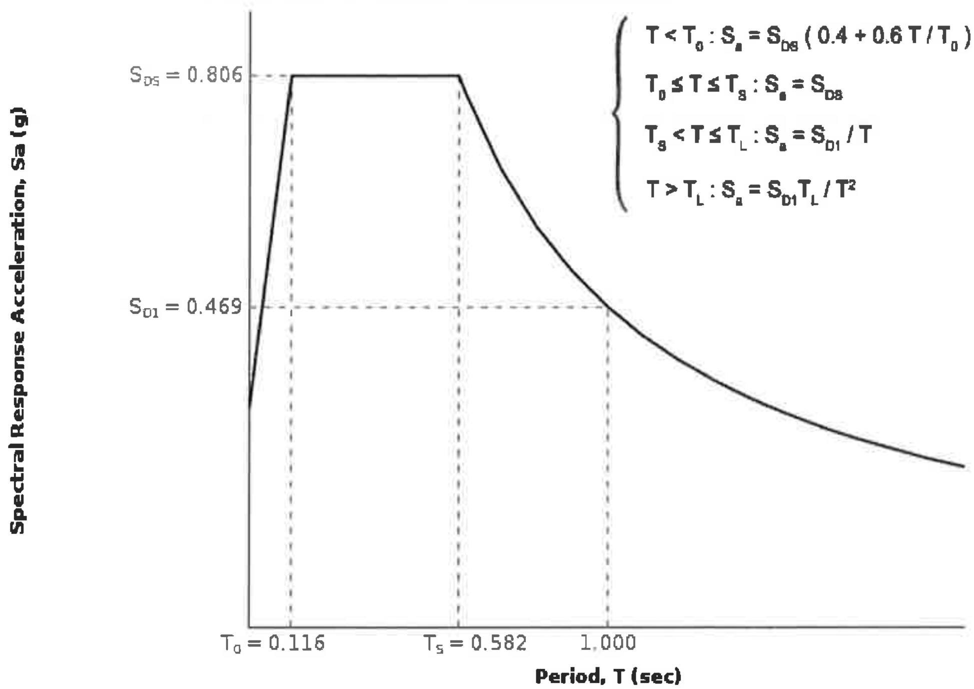
Equation (11.4–3): $S_{DS} = ⅔ S_{MS} = ⅔ \times 1.208 = 0.806$ g

Equation (11.4–4): $S_{D1} = ⅔ S_{M1} = ⅔ \times 0.704 = 0.469$ g

Section 11.4.5 — Design Response Spectrum

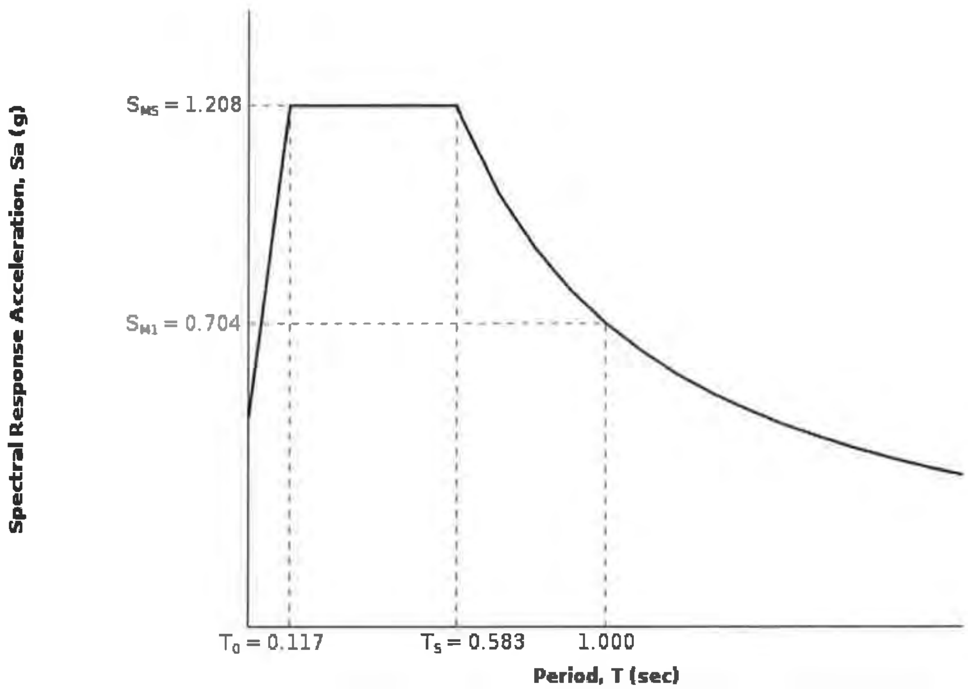
From Figure 22-12 [3] $T_L = 8$ seconds

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 = 0.438

Equation (11.8-1): $PGA_M = F_{PGA}PGA = 1.062 \times 0.438 = 0.465$ 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 = 0.438 g, F_{PGA} = 1.062

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} = 1.021

From Figure 22-18 [6] C_{R1} = 1.046

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} = 0.806 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} = 0.469 g, Seismic Design Category = D

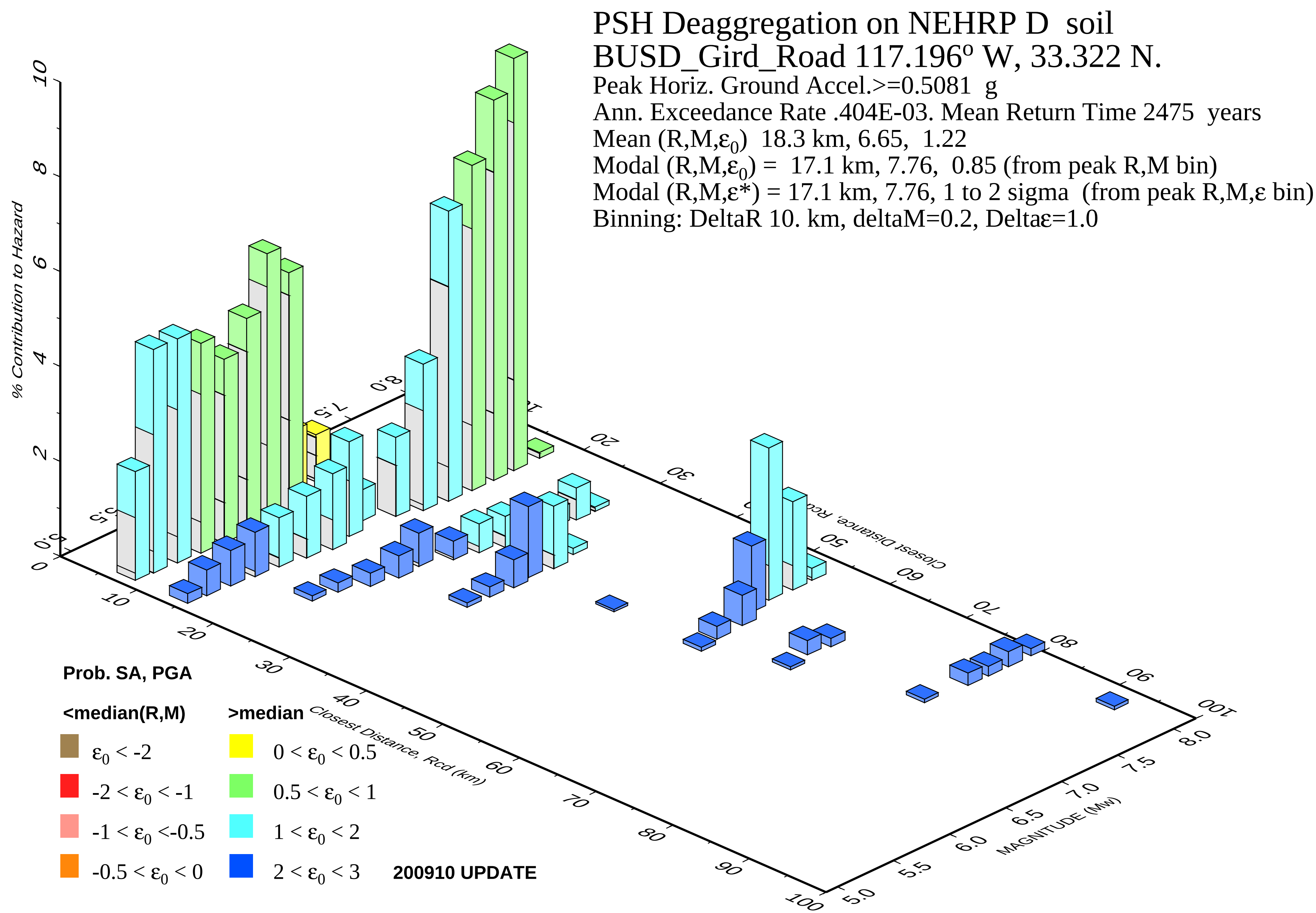
Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

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



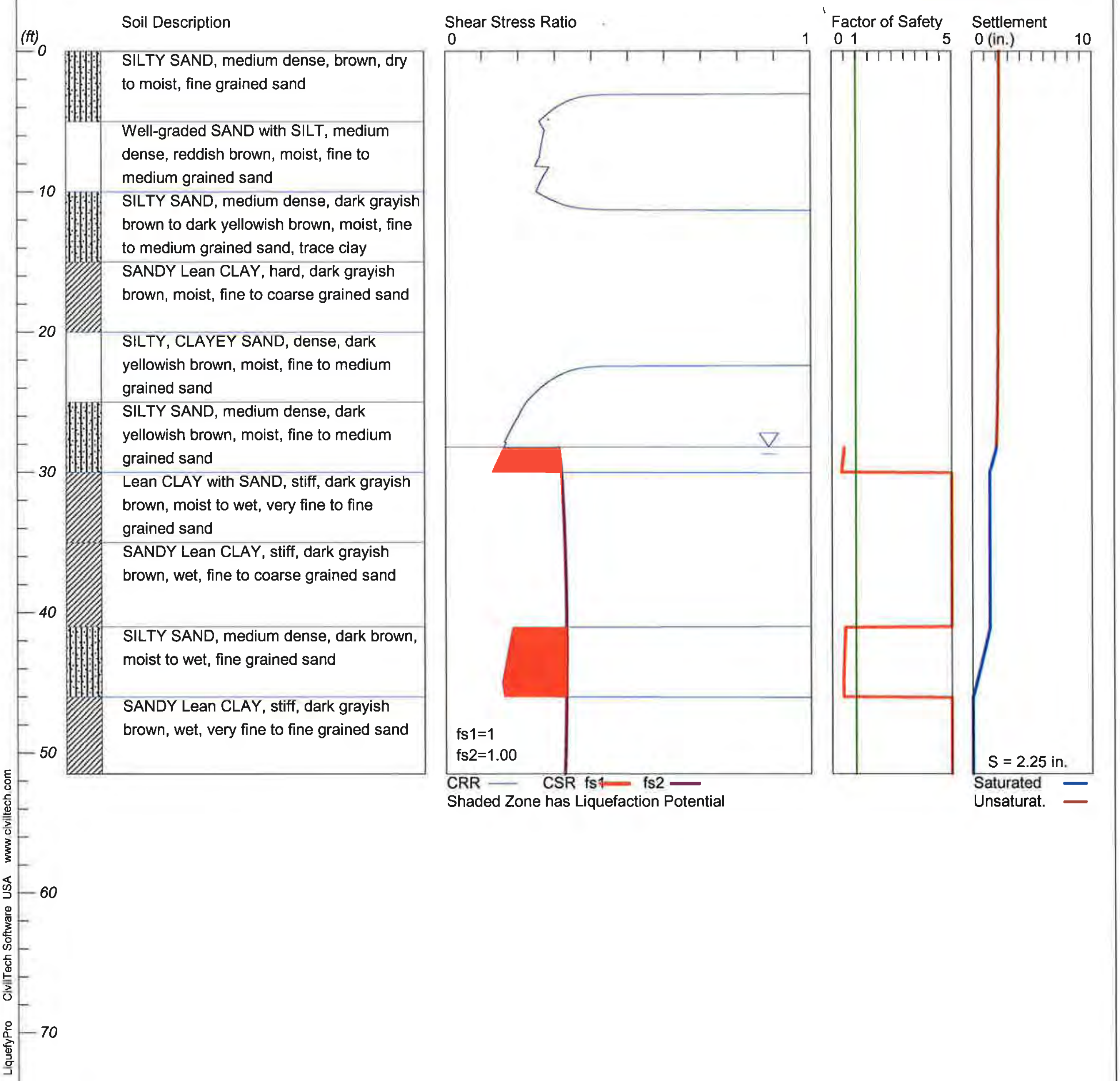
GMT 2016 Apr 1 16:48:31 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 300. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

DRY SETTLEMENT ANALYSIS

BUSD Gird Road

Hole No.=LB-1 Water Depth=28.2 ft

Magnitude=7.8
Acceleration=0.51g



****
LIQUEFACTION ANALYSIS CALCULATION DETAILS

****

Font: Courier New, Regular, Size 8 is recommended for this report.
Licensed to , 4/1/2016 12:03:16 PM

Input File Name: P:\Leighton - Infocus\11000 - 11999\11279 Bonsall USD Grid Rd HS\001 Prelim - GeoHaz\Analyses\Liquefaction\LB-1 Liquifaction.liq
Title: BUSD Gird Road
Subtitle:

Input Data:
Surface Elev.=
Hole No.=LB-1
Depth of Hole=51.50 ft
Water Table during Earthquake= 28.20 ft
Water Table during In-Situ Testing= 28.20 ft
Max. Acceleration=0.51 g
Earthquake Magnitude=7.80
No-Liquefiable Soils: CL, OL are Non-Liq. Soil
1. SPT or BPT Calculation.
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Idriss/Seed
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
6. Hammer Energy Ratio, Ce = 1
7. Borehole Diameter, Cb= 1
8. Sampling Method, Cs= 1
9. User request factor of safety (apply to CSR) , User= 1
Plot two CSR (fs1=1, fs2=User)
10. Average two input data between two Depths: Yes*
* Recommended Options

In-Situ Test Data:

Depth ft	SPT	Gamma pcf	Fines %
0.00	21.00	128.00	40.00
5.00	15.60	132.00	20.00
10.00	15.00	128.00	50.00
15.00	36.00	114.00	NoLiq
20.00	32.00	130.00	50.00
25.00	18.60	128.00	40.00
30.00	9.00	114.00	NoLiq
35.00	12.60	114.00	NoLiq
40.00	18.00	116.00	NoLiq
45.00	14.00	116.00	80.00
50.00	19.00	114.00	NoLiq

Output Results:
Calculation segment, dz=0.050 ft
User defined Print Interval, dp=1.00 ft

Peak Ground Acceleration (PGA), a_max = 0.51g

CSR Calculation:

Depth ft	gamma pcf	sigma atm	gamma' pcf	sigma' atm	rd	mZ g	a(z) g	CSR	x	fs1 =CSRfs
0.00	128.00	0.000	128.00	0.000	1.00	0.000	0.510	0.33	1.00	0.33
1.00	128.80	0.061	128.80	0.061	1.00	0.000	0.510	0.33	1.00	0.33
2.00	129.60	0.122	129.60	0.122	1.00	0.000	0.510	0.33	1.00	0.33
3.00	130.40	0.183	130.40	0.183	0.99	0.000	0.510	0.33	1.00	0.33
4.00	131.20	0.245	131.20	0.245	0.99	0.000	0.510	0.33	1.00	0.33
5.00	132.00	0.307	132.00	0.307	0.99	0.000	0.510	0.33	1.00	0.33
6.00	131.20	0.369	131.20	0.369	0.99	0.000	0.510	0.33	1.00	0.33
7.00	130.40	0.431	130.40	0.431	0.98	0.000	0.510	0.33	1.00	0.33
8.00	129.60	0.493	129.60	0.493	0.98	0.000	0.510	0.33	1.00	0.33
9.00	128.80	0.554	128.80	0.554	0.98	0.000	0.510	0.32	1.00	0.32
10.00	128.00	0.614	128.00	0.614	0.98	0.000	0.510	0.32	1.00	0.32
11.00	125.20	0.674	125.20	0.674	0.97	0.000	0.510	0.32	1.00	0.32
12.00	122.40	0.733	122.40	0.733	0.97	0.000	0.510	0.32	1.00	0.32
13.00	119.60	0.790	119.60	0.790	0.97	0.000	0.510	0.32	1.00	0.32
14.00	116.80	0.846	116.80	0.846	0.97	0.000	0.510	0.32	1.00	0.32
15.00	114.00	0.900	114.00	0.900	0.97	0.000	0.510	0.32	1.00	0.32
16.00	117.20	0.955	117.20	0.955	0.96	0.000	0.510	0.32	1.00	0.32
17.00	120.40	1.011	120.40	1.011	0.96	0.000	0.510	0.32	1.00	0.32
18.00	123.60	1.069	123.60	1.069	0.96	0.000	0.510	0.32	1.00	0.32
19.00	126.80	1.128	126.80	1.128	0.96	0.000	0.510	0.32	1.00	0.32
20.00	130.00	1.188	130.00	1.188	0.95	0.000	0.510	0.32	1.00	0.32
21.00	129.60	1.250	129.60	1.250	0.95	0.000	0.510	0.32	1.00	0.32
22.00	129.20	1.311	129.20	1.311	0.95	0.000	0.510	0.31	1.00	0.31
23.00	128.80	1.372	128.80	1.372	0.95	0.000	0.510	0.31	1.00	0.31
24.00	128.40	1.433	128.40	1.433	0.94	0.000	0.510	0.31	1.00	0.31
25.00	128.00	1.493	128.00	1.493	0.94	0.000	0.510	0.31	1.00	0.31
26.00	125.20	1.553	125.20	1.553	0.94	0.000	0.510	0.31	1.00	0.31

27.00	122.40	1.612	122.40	1.612	0.94	0.000	0.510	0.31	1.00	0.31
28.00	119.60	1.669	119.60	1.669	0.93	0.000	0.510	0.31	1.00	0.31
29.00	116.80	1.725	54.40	1.703	0.93	0.000	0.510	0.31	1.00	0.31
30.00	114.00	1.779	51.60	1.728	0.93	0.000	0.510	0.32	1.00	0.32
31.00	114.00	1.833	51.60	1.752	0.92	0.000	0.510	0.32	1.00	0.32
32.00	114.00	1.887	51.60	1.776	0.91	0.000	0.510	0.32	1.00	0.32
33.00	114.00	1.941	51.60	1.801	0.91	0.000	0.510	0.32	1.00	0.32
34.00	114.00	1.995	51.60	1.825	0.90	0.000	0.510	0.33	1.00	0.33
35.00	114.00	2.049	51.60	1.850	0.89	0.000	0.510	0.33	1.00	0.33
36.00	114.40	2.103	52.00	1.874	0.88	0.000	0.510	0.33	1.00	0.33
37.00	114.80	2.157	52.40	1.899	0.87	0.000	0.510	0.33	1.00	0.33
38.00	115.20	2.211	52.80	1.924	0.86	0.000	0.510	0.33	1.00	0.33
39.00	115.60	2.266	53.20	1.949	0.86	0.000	0.510	0.33	1.00	0.33
40.00	116.00	2.320	53.60	1.974	0.85	0.000	0.510	0.33	1.00	0.33
41.00	116.00	2.375	53.60	1.999	0.84	0.000	0.510	0.33	1.00	0.33
42.00	116.00	2.430	53.60	2.025	0.83	0.000	0.510	0.33	1.00	0.33
43.00	116.00	2.485	53.60	2.050	0.82	0.000	0.510	0.33	1.00	0.33
44.00	116.00	2.540	53.60	2.075	0.82	0.000	0.510	0.33	1.00	0.33
45.00	116.00	2.594	53.60	2.101	0.81	0.000	0.510	0.33	1.00	0.33
46.00	115.60	2.649	53.20	2.126	0.80	0.000	0.510	0.33	1.00	0.33
47.00	115.20	2.704	52.80	2.151	0.79	0.000	0.510	0.33	1.00	0.33
48.00	114.80	2.758	52.40	2.176	0.78	0.000	0.510	0.33	1.00	0.33
49.00	114.40	2.812	52.00	2.200	0.78	0.000	0.510	0.33	1.00	0.33
50.00	114.00	2.866	51.60	2.225	0.77	0.000	0.510	0.33	1.00	0.33
51.00	114.00	2.920	51.60	2.249	0.76	0.000	0.510	0.33	1.00	0.33

CSR is based on water table at 28.20 during earthquake

CRR Calculation from SPT or BPT data:

Depth ft	SPT	Cebs	Cr	sigma' atm	Cn	(N1)60	Fines %	d(N1)60	(N1)60f	CRR7.5
0.00	21.00	1.00	0.75	0.000	1.70	26.78	40.00	10.36		

37.13	2.00								
	1.00	19.92	1.00	0.75	0.061	1.70	25.40	36.00	10.08
35.48	2.00								
	2.00	18.84	1.00	0.75	0.122	1.70	24.02	32.00	8.94
32.96	2.00								
	3.00	17.76	1.00	0.75	0.183	1.70	22.64	28.00	7.69
30.33	2.00								
	4.00	16.68	1.00	0.75	0.245	1.70	21.27	24.00	6.47
27.73	0.34								
	5.00	15.60	1.00	0.75	0.307	1.70	19.89	20.00	5.19
25.08	0.28								
	6.00	15.48	1.00	0.75	0.369	1.65	19.10	26.00	6.73
25.83	0.30								
	7.00	15.36	1.00	0.75	0.431	1.52	17.54	32.00	7.83
25.37	0.29								
	8.00	15.24	1.00	0.75	0.493	1.42	16.29	38.00	8.26
24.54	0.28								
	9.00	15.12	1.00	0.85	0.554	1.34	17.27	44.00	8.45
25.73	0.29								
	10.00	15.00	1.00	0.85	0.614	1.28	16.27	50.00	8.25
24.52	0.28								
	11.00	19.20	1.00	0.85	0.674	1.22	19.88	60.20	8.98
28.85	0.37								
	12.00	23.40	1.00	0.85	0.733	1.17	23.24	70.40	9.65
32.88	2.00								
	13.00	27.60	1.00	0.85	0.790	1.13	26.40	80.60	10.28
36.68	2.00								
	14.00	31.80	1.00	0.85	0.846	1.09	29.39	90.80	10.88
40.27	2.00								
	15.00	36.00	1.00	0.95	0.900	1.05	36.04	NoLiq	12.21
48.25	2.00								
	16.00	35.20	1.00	0.95	0.955	1.02	34.22	NoLiq	11.84
46.06	2.00								
	17.00	34.40	1.00	0.95	1.011	0.99	32.50	NoLiq	11.50
44.00	2.00								
	18.00	33.60	1.00	0.95	1.069	0.97	30.88	NoLiq	11.18
42.05	2.00								
	19.00	32.80	1.00	0.95	1.128	0.94	29.34	NoLiq	10.87
40.21	2.00								
	20.00	32.00	1.00	0.95	1.188	0.92	27.89	NoLiq	10.58
38.46	2.00								
	21.00	29.32	1.00	0.95	1.250	0.89	24.92	48.00	9.98
34.90	2.00								
	22.00	26.64	1.00	0.95	1.311	0.87	22.10	46.00	9.42
31.52	2.00								
	23.00	23.96	1.00	0.95	1.372	0.85	19.43	44.00	8.89
28.32	0.35								
	24.00	21.28	1.00	0.95	1.433	0.84	16.89	42.00	8.38
25.27	0.29								
	25.00	18.60	1.00	0.95	1.493	0.82	14.46	40.00	7.89
22.35	0.24								
	26.00	16.68	1.00	0.95	1.553	0.80	12.72	52.20	7.54
20.26	0.22								
	27.00	14.76	1.00	0.95	1.612	0.79	11.05	64.40	7.21
18.25	0.20								
	28.00	12.84	1.00	1.00	1.669	0.77	9.94	76.60	6.99
16.93	0.18								
	29.00	10.92	1.00	1.00	1.703	0.77	8.37	88.80	6.67
15.04	0.16								
	30.00	9.00	1.00	1.00	1.728	0.76	6.85	NoLiq	6.37
13.22	0.14								
	31.00	9.72	1.00	1.00	1.752	0.76	7.34	NoLiq	6.47
13.81	0.15								

32.00	10.44	1.00	1.00	1.776	0.75	7.83	NoLiq	6.57	14.40	0.16
33.00	11.16	1.00	1.00	1.801	0.75	8.32	NoLiq	6.66	14.98	0.16
34.00	11.88	1.00	1.00	1.825	0.74	8.79	NoLiq	6.76	15.55	0.17
35.00	12.60	1.00	1.00	1.850	0.74	9.26	NoLiq	6.85	16.12	0.17
36.00	13.68	1.00	1.00	1.874	0.73	9.99	NoLiq	7.00	16.99	0.18
37.00	14.76	1.00	1.00	1.899	0.73	10.71	NoLiq	7.14	17.85	0.19
38.00	15.84	1.00	1.00	1.924	0.72	11.42	NoLiq	7.28	18.70	0.20
39.00	16.92	1.00	1.00	1.949	0.72	12.12	NoLiq	7.42	19.54	0.21
40.00	18.00	1.00	1.00	1.974	0.71	12.81	NoLiq	7.56	20.37	0.22
41.00	17.20	1.00	1.00	1.999	0.71	12.16	NoLiq	7.43	19.60	0.21
42.00	16.40	1.00	1.00	2.025	0.70	11.53	92.60	7.31	18.83	0.20
43.00	15.60	1.00	1.00	2.050	0.70	10.90	88.40	7.18	18.08	0.19
44.00	14.80	1.00	1.00	2.075	0.69	10.27	84.20	7.05	17.33	0.19
45.00	14.00	1.00	1.00	2.101	0.69	9.66	80.00	6.93	16.59	0.18
46.00	15.00	1.00	1.00	2.126	0.69	10.29	84.20	7.06	17.35	0.19
47.00	16.00	1.00	1.00	2.151	0.68	10.91	NoLiq	7.18	18.09	0.20
48.00	17.00	1.00	1.00	2.176	0.68	11.52	NoLiq	7.30	18.83	0.20
49.00	18.00	1.00	1.00	2.200	0.67	12.13	NoLiq	7.43	19.56	0.21
50.00	19.00	1.00	1.00	2.225	0.67	12.74	NoLiq	7.55	20.29	0.22
51.00	19.00	1.00	1.00	2.249	0.67	12.67	NoLiq	7.53	20.20	0.22

CRR is based on water table at 28.20 during In-Situ Testing

Factor of Safety, - Earthquake Magnitude= 7.80:

Depth ft	sigC' atm	CRR7.5	x Ksig	=CRRv	x MSF	=CRRm	CSRfs	F.S.=CRRm/CSRfs
0.00	0.00	2.00	1.00	2.00	0.90	1.81	0.33	5.00
1.00	0.04	2.00	1.00	2.00	0.90	1.81	0.33	5.00
2.00	0.08	2.00	1.00	2.00	0.90	1.81	0.33	5.00
3.00	0.12	2.00	1.00	2.00	0.90	1.81	0.33	5.00
4.00	0.16	0.34	1.00	0.34	0.90	0.30	0.33	5.00
5.00	0.20	0.28	1.00	0.28	0.90	0.26	0.33	5.00
6.00	0.24	0.30	1.00	0.30	0.90	0.27	0.33	5.00
7.00	0.28	0.29	1.00	0.29	0.90	0.26	0.33	5.00
8.00	0.32	0.28	1.00	0.28	0.90	0.25	0.33	5.00
9.00	0.36	0.29	1.00	0.29	0.90	0.27	0.32	5.00
10.00	0.40	0.28	1.00	0.28	0.90	0.25	0.32	5.00
11.00	0.44	0.37	1.00	0.37	0.90	0.33	0.32	5.00
12.00	0.48	2.00	1.00	2.00	0.90	1.81	0.32	5.00

13.00	0.51	2.00	1.00	2.00	0.90	1.81	0.32	5.00	
14.00	0.55	2.00	1.00	2.00	0.90	1.81	0.32	5.00	
15.00	0.59	2.00	1.00	2.00	0.90	2.00	0.32	5.00	^
16.00	0.62	2.00	1.00	2.00	0.90	2.00	0.32	5.00	^
17.00	0.66	2.00	1.00	2.00	0.90	2.00	0.32	5.00	^
18.00	0.69	2.00	1.00	2.00	0.90	2.00	0.32	5.00	^
19.00	0.73	2.00	1.00	2.00	0.90	2.00	0.32	5.00	^
20.00	0.77	2.00	1.00	2.00	0.90	2.00	0.32	5.00	^
21.00	0.81	2.00	1.00	2.00	0.90	1.81	0.32	5.00	
22.00	0.85	2.00	1.00	2.00	0.90	1.81	0.31	5.00	
23.00	0.89	0.35	1.00	0.35	0.90	0.32	0.31	5.00	
24.00	0.93	0.29	1.00	0.29	0.90	0.26	0.31	5.00	
25.00	0.97	0.24	1.00	0.24	0.90	0.22	0.31	5.00	
26.00	1.01	0.22	1.00	0.22	0.90	0.20	0.31	5.00	
27.00	1.05	0.20	1.00	0.20	0.90	0.18	0.31	5.00	
28.00	1.08	0.18	0.99	0.18	0.90	0.16	0.31	5.00	
29.00	1.11	0.16	0.99	0.16	0.90	0.15	0.31	0.46	*
30.00	1.12	0.14	0.99	0.14	0.90	0.13	0.32	0.40	*
31.00	1.14	0.15	0.98	0.15	0.90	2.00	0.32	5.00	^
32.00	1.15	0.16	0.98	0.15	0.90	2.00	0.32	5.00	^
33.00	1.17	0.16	0.98	0.16	0.90	2.00	0.32	5.00	^
34.00	1.19	0.17	0.98	0.16	0.90	2.00	0.33	5.00	^
35.00	1.20	0.17	0.97	0.17	0.90	2.00	0.33	5.00	^
36.00	1.22	0.18	0.97	0.18	0.90	2.00	0.33	5.00	^
37.00	1.23	0.19	0.97	0.19	0.90	2.00	0.33	5.00	^
38.00	1.25	0.20	0.97	0.20	0.90	2.00	0.33	5.00	^
39.00	1.27	0.21	0.97	0.20	0.90	2.00	0.33	5.00	^
40.00	1.28	0.22	0.96	0.21	0.90	2.00	0.33	5.00	^
41.00	1.30	0.21	0.96	0.20	0.90	2.00	0.33	5.00	^
42.00	1.32	0.20	0.96	0.19	0.90	0.18	0.33	0.53	*
43.00	1.33	0.19	0.96	0.19	0.90	0.17	0.33	0.51	*
44.00	1.35	0.19	0.95	0.18	0.90	0.16	0.33	0.49	*
45.00	1.37	0.18	0.95	0.17	0.90	0.15	0.33	0.47	*
46.00	1.38	0.19	0.95	0.18	0.90	0.16	0.33	0.49	*
47.00	1.40	0.20	0.95	0.18	0.90	2.00	0.33	5.00	^
48.00	1.41	0.20	0.94	0.19	0.90	2.00	0.33	5.00	^
49.00	1.43	0.21	0.94	0.20	0.90	2.00	0.33	5.00	^
50.00	1.45	0.22	0.94	0.21	0.90	2.00	0.33	5.00	^
51.00	1.46	0.22	0.94	0.20	0.90	2.00	0.33	5.00	^

* F.S.<1: Liquefaction Potential Zone. (If above water table: F.S.=5)
^ No-liquefiable Soils or above Water Table.
(F.S. is limited to 5, CRR is limited to 2,   CSR is limited to 2)

CPT convert to SPT for Settlement Analysis:
Fines Correction for Settlement Analysis:

Depth ft	Ic	qc/N60	qc1 atm	(N1)60	Fines %	d(N1)60	(N1)60s
0.00	-	-	-	37.13	40.00	0.00	37.13
1.00	-	-	-	35.48	36.00	0.00	35.48
2.00	-	-	-	32.96	32.00	0.00	32.96
3.00	-	-	-	30.33	28.00	0.00	30.33
4.00	-	-	-	27.73	24.00	0.00	27.73
5.00	-	-	-	25.08	20.00	0.00	25.08
6.00	-	-	-	25.83	26.00	0.00	25.83
7.00	-	-	-	25.37	32.00	0.00	25.37
8.00	-	-	-	24.54	38.00	0.00	24.54
9.00	-	-	-	25.73	44.00	0.00	25.73
10.00	-	-	-	24.52	50.00	0.00	24.52
11.00	-	-	-	28.85	60.20	0.00	28.85
12.00	-	-	-	32.88	70.40	0.00	32.88

13.00	-	-	-	36.68	80.60	0.00	36.68
14.00	-	-	-	40.27	90.80	0.00	40.27
15.00	-	-	-	48.25	NoLiq	0.00	48.25
16.00	-	-	-	46.06	NoLiq	0.00	46.06
17.00	-	-	-	44.00	NoLiq	0.00	44.00
18.00	-	-	-	42.05	NoLiq	0.00	42.05
19.00	-	-	-	40.21	NoLiq	0.00	40.21
20.00	-	-	-	38.46	NoLiq	0.00	38.46
21.00	-	-	-	34.90	48.00	0.00	34.90
22.00	-	-	-	31.52	46.00	0.00	31.52
23.00	-	-	-	28.32	44.00	0.00	28.32
24.00	-	-	-	25.27	42.00	0.00	25.27
25.00	-	-	-	22.35	40.00	0.00	22.35
26.00	-	-	-	20.26	52.20	0.00	20.26
27.00	-	-	-	18.25	64.40	0.00	18.25
28.00	-	-	-	16.93	76.60	0.00	16.93
29.00	-	-	-	15.04	88.80	0.00	15.04
30.00	-	-	-	13.22	NoLiq	0.00	13.22
31.00	-	-	-	13.81	NoLiq	0.00	13.81
32.00	-	-	-	14.40	NoLiq	0.00	14.40
33.00	-	-	-	14.98	NoLiq	0.00	14.98
34.00	-	-	-	15.55	NoLiq	0.00	15.55
35.00	-	-	-	16.12	NoLiq	0.00	16.12
36.00	-	-	-	16.99	NoLiq	0.00	16.99
37.00	-	-	-	17.85	NoLiq	0.00	17.85
38.00	-	-	-	18.70	NoLiq	0.00	18.70
39.00	-	-	-	19.54	NoLiq	0.00	19.54
40.00	-	-	-	20.37	NoLiq	0.00	20.37
41.00	-	-	-	19.60	NoLiq	0.00	19.60
42.00	-	-	-	18.83	92.60	0.00	18.83
43.00	-	-	-	18.08	88.40	0.00	18.08
44.00	-	-	-	17.33	84.20	0.00	17.33
45.00	-	-	-	16.59	80.00	0.00	16.59
46.00	-	-	-	17.35	84.20	0.00	17.35
47.00	-	-	-	18.09	NoLiq	0.00	18.09
48.00	-	-	-	18.83	NoLiq	0.00	18.83
49.00	-	-	-	19.56	NoLiq	0.00	19.56
50.00	-	-	-	20.29	NoLiq	0.00	20.29
51.00	-	-	-	20.20	NoLiq	0.00	20.20

(N1)60s has been fines corrected in liquefaction analysis, therefore d(N1)60=0.
Fines=NoLiq means the soils are not liquefiable.

Settlement of Saturated Sands:
Settlement Analysis Method: Ishihara / Yoshimine

Depth	CSRsf	/ MSF*	=CSRm	F.S.	Fines	(N1)60s	Dr	ec	dsz	dsp	S
ft					%		%	%	in.	in.	in.
51.45	0.33	1.00	0.33	5.00	NoLiq	20.17	70.84	0.000	0.0E0	0.000	0.000
51.00	0.33	1.00	0.33	5.00	NoLiq	20.20	70.90	0.000	0.0E0	0.000	0.000
50.00	0.33	1.00	0.33	5.00	NoLiq	20.29	71.05	0.000	0.0E0	0.000	0.000
49.00	0.33	1.00	0.33	5.00	NoLiq	19.56	69.75	0.000	0.0E0	0.000	0.000
48.00	0.33	1.00	0.33	5.00	NoLiq	18.83	68.43	0.000			

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0.0E0   0.000   0.000
        47.00   0.33    1.00    0.33    5.00    NoLiq   18.09   67.08   0.000
0.0E0   0.000   0.000
        46.00   0.33    1.00    0.33    0.49    84.20   17.35   65.72   2.456
1.5E-2  0.015   0.015
        45.00   0.33    1.00    0.33    0.47    80.00   16.59   64.32   2.542
1.5E-2  0.300   0.315
        44.00   0.33    1.00    0.33    0.49    84.20   17.33   65.69   2.458
1.5E-2  0.300   0.615
        43.00   0.33    1.00    0.33    0.51    88.40   18.08   67.06   2.375
1.4E-2  0.290   0.904
        42.00   0.33    1.00    0.33    0.53    92.60   18.83   68.43   2.291
1.4E-2  0.280   1.184
        41.00   0.33    1.00    0.33    5.00    NoLiq   19.60   69.81   0.000
0.0E0   0.256   1.440
        40.00   0.33    1.00    0.33    5.00    NoLiq   20.37   71.21   0.000
0.0E0   0.000   1.440
        39.00   0.33    1.00    0.33    5.00    NoLiq   19.54   69.72   0.000
0.0E0   0.000   1.440
        38.00   0.33    1.00    0.33    5.00    NoLiq   18.70   68.20   0.000
0.0E0   0.000   1.440
        37.00   0.33    1.00    0.33    5.00    NoLiq   17.85   66.65   0.000
0.0E0   0.000   1.440
        36.00   0.33    1.00    0.33    5.00    NoLiq   16.99   65.06   0.000
0.0E0   0.000   1.440
        35.00   0.33    1.00    0.33    5.00    NoLiq   16.12   63.42   0.000
0.0E0   0.000   1.440
        34.00   0.33    1.00    0.33    5.00    NoLiq   15.55   62.35   0.000
0.0E0   0.000   1.440
        33.00   0.32    1.00    0.32    5.00    NoLiq   14.98   61.24   0.000
0.0E0   0.000   1.440
        32.00   0.32    1.00    0.32    5.00    NoLiq   14.40   60.09   0.000
0.0E0   0.000   1.440
        31.00   0.32    1.00    0.32    5.00    NoLiq   13.81   58.91   0.000
0.0E0   0.000   1.440
        30.00   0.32    1.00    0.32    0.40    NoLiq   13.22   57.69   2.969
0.0E0   0.000   1.440
        29.00   0.31    1.00    0.31    0.46    88.80   15.04   61.36   2.721
1.6E-2  0.322   1.763
        28.25   0.31    1.00    0.31    0.51    79.65   16.43   64.02   2.560
1.5E-2  0.237   2.000
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        Settlement of Saturated Sands=2.000 in.
        qc1 and (N1)60 is after fines correction in liquefaction analysis
        dsz is per each segment, dz=0.05 ft
        dsp is per each print interval,  dp=1.00 ft
        S is cumulated settlement at this depth

        Settlement of Unsaturated Sands:
        Depth   sigma'  sigC'   (N1)60s CSRsf   Gmax    g*Ge/Gm  g_eff   ec7.5   Cec
ec      dsz     dsp     S
        ft      atm     atm                     atm                      %
%       in.     in.     in.
```

```
        28.20   1.68    1.09    16.53   0.31    1189.45 4.4E-4  0.1440  0.1816  1.12
0.2031  2.44E-3 0.002   0.002
        28.00   1.67    1.08    16.93   0.31    1194.82 4.3E-4  0.1396  0.1708  1.12
0.1909  2.29E-3 0.009   0.012
        27.00   1.61    1.05    18.25   0.31    1204.04 4.2E-4  0.1248  0.1384  1.12
```

0.1547	1.86E-3	0.042	0.054							
	26.00	1.55	1.01	20.26	0.31	1223.69	4.0E-4	0.1091	0.1056	1.12
0.1181	1.42E-3	0.032	0.086							
	25.00	1.49	0.97	22.35	0.31	1239.83	3.8E-4	0.0961	0.0819	1.12
0.0916	1.10E-3	0.025	0.111							
	24.00	1.43	0.93	25.27	0.31	1265.03	3.5E-4	0.0834	0.0605	1.12
0.0676	8.12E-4	0.019	0.130							
	23.00	1.37	0.89	28.32	0.31	1285.82	3.3E-4	0.0732	0.0454	1.12
0.0507	6.09E-4	0.014	0.144							
	22.00	1.31	0.85	31.52	0.31	1302.60	3.2E-4	0.0649	0.0341	1.12
0.0382	4.58E-4	0.011	0.155							
	21.00	1.25	0.81	34.90	0.32	1315.66	3.0E-4	0.0579	0.0254	1.12
0.0283	3.40E-4	0.008	0.162							
	20.00	1.19	0.77	38.46	0.32	1325.19	2.8E-4	0.0519	0.0182	1.12
0.0204	0.00E0	0.006	0.168							
	19.00	1.13	0.73	40.21	0.32	1310.18	2.7E-4	0.0659	0.0208	1.12
0.0233	0.00E0	0.000	0.168							
	18.00	1.07	0.69	42.05	0.32	1294.55	2.6E-4	0.0592	0.0187	1.12
0.0209	0.00E0	0.000	0.168							
	17.00	1.01	0.66	44.00	0.32	1278.30	2.5E-4	0.0535	0.0169	1.12
0.0189	0.00E0	0.000	0.168							
	16.00	0.95	0.62	46.06	0.32	1261.43	2.4E-4	0.0484	0.0153	1.12
0.0171	0.00E0	0.000	0.168							
	15.00	0.90	0.59	48.25	0.32	1243.91	2.3E-4	0.0441	0.0139	1.12
0.0156	0.00E0	0.000	0.168							
	14.00	0.85	0.55	40.27	0.32	1135.18	2.4E-4	0.0472	0.0149	1.12
0.0167	2.00E-4	0.004	0.172							
	13.00	0.79	0.51	36.68	0.32	1063.41	2.4E-4	0.0472	0.0186	1.12
0.0208	2.50E-4	0.004	0.176							
	12.00	0.73	0.48	32.88	0.32	987.63	2.4E-4	0.0473	0.0232	1.12
0.0259	3.11E-4	0.006	0.182							
	11.00	0.67	0.44	28.85	0.32	906.97	2.4E-4	0.0478	0.0288	1.12
0.0322	3.86E-4	0.007	0.189							
	10.00	0.61	0.40	24.52	0.32	820.13	2.4E-4	0.0489	0.0369	1.12
0.0412	4.95E-4	0.009	0.198							
	9.00	0.55	0.36	25.73	0.32	791.12	2.3E-4	0.0423	0.0299	1.12
0.0335	4.01E-4	0.009	0.206							
	8.00	0.49	0.32	24.54	0.33	734.60	2.2E-4	0.0456	0.0343	1.12
0.0384	4.61E-4	0.009	0.215							
	7.00	0.43	0.28	25.37	0.33	694.92	2.0E-4	0.0394	0.0284	1.12
0.0318	3.82E-4	0.008	0.223							
	6.00	0.37	0.24	25.83	0.33	647.04	1.9E-4	0.0358	0.0252	1.12
0.0282	3.38E-4	0.007	0.231							
	5.00	0.31	0.20	25.08	0.33	584.29	1.7E-4	0.0319	0.0234	1.12
0.0261	3.14E-4	0.006	0.237							
	4.00	0.24	0.16	27.73	0.33	539.54	1.5E-4	0.0263	0.0168	1.12
0.0188	2.25E-4	0.005	0.242							
	3.00	0.18	0.12	30.33	0.33	480.67	1.3E-4	0.0232	0.0130	1.12
0.0145	1.74E-4	0.004	0.246							
	2.00	0.12	0.08	32.96	0.33	402.84	1.0E-4	0.0199	0.0097	1.12
0.0108	1.30E-4	0.003	0.249							
	1.00	0.06	0.04	35.48	0.33	291.48	6.9E-5	0.0113	0.0048	1.12
0.0053	6.40E-5	0.002	0.251							
	0.00	0.00	0.00	37.13	0.33	3.80	8.7E-7	0.0010	0.0004	1.12
0.0004	5.23E-6	0.001	0.252							

Settlement of Unsaturated Sands=0.252 in.
dsz is per each segment, dz=0.05 ft
dsp is per each print interval, dp=1.00 ft
S is cumulated settlement at this depth

Total Settlement of Saturated and Unsaturated Sands=2.252 in.
Differential Settlement=1.126 to 1.486 in.

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft; Settlement = in.

---

1 atm (atmosphere) = 1.0581 tsf(1 tsf = 1 ton/ft2 = 2 kip/ft2)
1 atm (atmosphere) = 101.325 kPa(1 kPa = 1 kN/m2 = 0.001 Mpa)

SPT	Field data from Standard Penetration Test (SPT)
BPT	Field data from Becker Penetration Test (BPT)
qc	Field data from Cone Penetration Test (CPT) [atm (tsf)]
fs	Friction from CPT testing [atm (tsf)]
Rf	Ratio of fs/qc (%)
gamma	Total unit weight of soil
gamma'	Effective unit weight of soil
Fines	Fines content [%]
D50	Mean grain size
Dr	Relative Density
sigma	Total vertical stress [atm]
sigma'	Effective vertical stress [atm]
sigC'	Effective confining pressure [atm]
rd	Acceleration reduction coefficient by Seed
a_max.	Peak Ground Acceleration (PGA) in ground surface
mZ	Linear acceleration reduction coefficient X depth
a_min.	Minimum acceleration under linear reduction, mZ
CRRv	CRR after overburden stress correction, CRRv=CRR7.5 * Ksig
CRR7.5	Cyclic resistance ratio (M=7.5)
Ksig	Overburden stress correction factor for CRR7.5
CRRm	After magnitude scaling correction CRRm=CRRv * MSF
MSF	Magnitude scaling factor from M=7.5 to user input M
CSR	Cyclic stress ratio induced by earthquake
CSRfs	CSRfs=CSR*fs1 (Default fs1=1)
fs1	First CSR curve in graphic defined in #9 of Advanced page
fs2	2nd CSR curve in graphic defined in #9 of Advanced page
F.S.	Calculated factor of safety against liquefaction F.S.=CRRm/CSRsf
Cebs	Energy Ratio, Borehole Dia., and Sampling Method Corrections
Cr	Rod Length Corrections
Cn	Overburden Pressure Correction
(N1)60	SPT after corrections, (N1)60=SPT * Cr * Cn * Cebs
d(N1)60	Fines correction of SPT
(N1)60f	(N1)60 after fines corrections, (N1)60f=(N1)60 + d(N1)60
Cq	Overburden stress correction factor
qc1	CPT after Overburden stress correction
dqc1	Fines correction of CPT
qc1f	CPT after Fines and Overburden correction, qc1f=qc1 + dqc1
qc1n	CPT after normalization in Robertson's method
Kc	Fine correction factor in Robertson's Method
qc1f	CPT after Fines correction in Robertson's Method
Ic	Soil type index in Suzuki's and Robertson's Methods
(N1)60s	(N1)60 after settlement fines corrections
CSRm	After magnitude scaling correction for Settlement calculation CSRm=CSRsf / MSF*
CSRfs	Cyclic stress ratio induced by earthquake with user inputed fs
MSF*	Scaling factor from CSR, MSF*=1, based on Item 2 of Page C.
ec	Volumetric strain for saturated sands
dz	Calculation segment, dz=0.050 ft
dsz	Settlement in each segment, dz
dp	User defined print interval

dsp	Settlement in each print interval, dp
Gmax	Shear Modulus at low strain
g_eff	gamma_eff, Effective shear Strain
g*Ge/Gm	gamma_eff * G_eff/G_max, Strain-modulus ratio
ec7.5	Volumetric Strain for magnitude=7.5
Cec	Magnitude correction factor for any magnitude
ec	Volumetric strain for unsaturated sands, ec=Cec * ec7.5
NoLiq	No-Liquefy Soils

References:

1. NCEER Workshop on Evaluation of Liquefaction Resistance of Soils. Youd, T.L., and Idriss, I.M., eds., Technical Report NCEER 97-0022.
SP117. Southern California Earthquake Center. Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California. University of Southern California. March 1999.
2. RECENT ADVANCES IN SOIL LIQUEFACTION ENGINEERING AND SEISMIC SITE RESPONSE EVALUATION, Paper No. SPL-2, PROCEEDINGS: Fourth International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, San Diego, CA, March 2001.
3. RECENT ADVANCES IN SOIL LIQUEFACTION ENGINEERING: A UNIFIED AND CONSISTENT FRAMEWORK, Earthquake Engineering Research Center, Report No. EERC 2003-06 by R.B Seed and etc. April 2003.

Note: Print Interval you selected does not show complete results. To get complete results, you should select 'Segment' in Print Interval (Item 12, Page C).

APPENDIX D

EARTHWORK AND GRADING SPECIFICATIONS

APPENDIX D

EARTHWORK AND GRADING SPECIFICATIONS

TABLE OF CONTENTS

STANDARD DETAILS

D-1.0 GENERAL

D-1.1 Intent

These Earthwork and Grading Guide Specifications are for grading and earthwork shown on the current, approved grading plan(s) and/or indicated in the Leighton Consulting, Inc. geotechnical report(s). These Guide Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the project-specific recommendations in the geotechnical report shall supersede these Guide Specifications. Leighton Consulting, Inc. shall provide geotechnical observation and testing during earthwork and grading. Based on these observations and tests, Leighton Consulting, Inc. may provide new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

D-1.2 Role of Leighton Consulting, Inc.

Prior to commencement of earthwork and grading, Leighton Consulting, Inc. shall meet with the earthwork contractor to review the earthwork contractor's work plan, to schedule sufficient personnel to perform the appropriate level of observation, mapping and compaction testing. During earthwork and grading, Leighton Consulting, Inc. shall observe, map, and document subsurface exposures to verify geotechnical design assumptions. If observed conditions are found to be significantly different than the interpreted assumptions during the design phase, Leighton Consulting, Inc. shall inform the owner, recommend appropriate changes in design to accommodate these observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include (1) natural ground after clearing to receiving fill but before fill is placed, (2) bottoms of all "remedial removal" areas, (3) all key bottoms, and (4) benches made on sloping ground to receive fill.

Leighton Consulting, Inc. shall observe moisture-conditioning and processing of the subgrade and fill materials, and perform relative compaction testing of fill to determine the attained relative compaction. Leighton Consulting, Inc. shall provide *Daily Field Reports* to the owner and the Contractor on a routine and frequent basis.

D-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 Guide Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing grading and backfilling in accordance with the current, approved plans and specifications.

The Contractor shall inform the owner and Leighton Consulting, Inc. of changes in work schedules at least one working day in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that Leighton Consulting, Inc. is aware of all grading operations.

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

D-2.0 PREPARATION OF AREAS TO BE FILLED

D-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 Leighton Consulting, Inc.. Care should be taken not to encroach upon or otherwise damage native and/or historic trees designated by the Owner or appropriate agencies to remain. Pavements, flatwork or other construction should not extend under the “drip line” of designated trees to remain.

Leighton Consulting, Inc. shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 3 percent of organic materials (by dry weight: ASTM D 2974-00). 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.

D-2.2 Processing

Existing ground that has been declared satisfactory for support of fill, by Leighton Consulting, Inc., shall be scarified to a minimum depth of 6 inches (15 cm). Existing ground that is not satisfactory shall be overexcavated as specified in the following Section D-2.3. 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.

D-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 Leighton Consulting, Inc. during grading. All undocumented fill soils under proposed structure footprints should be excavated

D-2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), (>20 percent grade) the ground shall be stepped or benched. The lowest bench or key shall be a minimum of 15 feet (4.5 m) wide and at least 2 feet (0.6 m) deep, into competent material as evaluated by Leighton Consulting, Inc.. Other benches shall be excavated a minimum height of 4 feet (1.2 m) into competent material or as otherwise recommended by Leighton Consulting, Inc.. Fill placed on ground sloping flatter than 5:1 (horizontal to vertical units), (<20 percent grade) shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

D-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 Leighton Consulting, Inc. as suitable to receive fill. The Contractor shall obtain a written acceptance (*Daily Field Report*) from Leighton Consulting, Inc. prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

D-3.0 FILL MATERIAL

D-3.1 Fill Quality

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by Leighton Consulting, Inc. 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 Leighton Consulting, Inc. or mixed with other soils to achieve satisfactory fill material.

D-3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 6 inches (15 cm), shall not be buried or placed in fill unless location, materials and placement methods are specifically accepted by Leighton Consulting, Inc.. 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 feet (3 m) measured vertically from finish grade, or within 2 feet (0.61 m) of future utilities or underground construction.

D-3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section D-3.1, and be free of hazardous materials ("contaminants") and rock larger than 3-inches (8 cm) in largest dimension. All import soils shall have an Expansion Index (EI) of 20 or less and a sulfate content no greater than (≤) 500 parts-per-million (ppm). A representative sample of a potential import source shall be given to Leighton Consulting, Inc. at least four full working days before importing begins, so that suitability of this import material can be determined and appropriate tests performed.

D-4.0 FILL PLACEMENT AND COMPACTION

D-4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill, as described in Section D-2.0, above, in near-horizontal layers not exceeding 8 inches (20 cm) in loose thickness. Leighton Consulting, Inc. may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers, and only if the building officials with the appropriate jurisdiction approve. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

D-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 D 1557.

D-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 as determined by ASTM Test Method D 1557. For fills thicker than 15 feet (4.5 m), the portion of the fill deeper than 15 feet below proposed finish grade shall be compacted to 95 percent of the ASTM D 1557 laboratory maximum density. 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.

D-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 (1 to 1.2 m) in fill elevation, or by other methods producing satisfactory results acceptable to Leighton Consulting, Inc.. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of the ASTM D 1557 laboratory maximum density.

D-4.5 Compaction Testing

Field-tests for moisture content and relative compaction of the fill soils shall be performed by Leighton Consulting, Inc.. Location and frequency of tests shall be at our field representative(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).

D-4.6 Compaction Test Locations

Leighton Consulting, Inc. shall document the approximate elevation and horizontal coordinates of each density test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that Leighton Consulting, Inc. can determine the test locations with sufficient accuracy. Adequate grade stakes shall be provided.

D-5.0 EXCAVATION

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by Leighton Consulting, Inc. during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by Leighton Consulting, Inc. 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 Leighton Consulting, Inc. prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by Leighton Consulting, Inc..

D-6.0 TRENCH BACKFILLS

D-6.1 Safety

The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations. Work should be performed in accordance with Article 6 of the *California Construction Safety Orders*, 2003 Edition or more current.

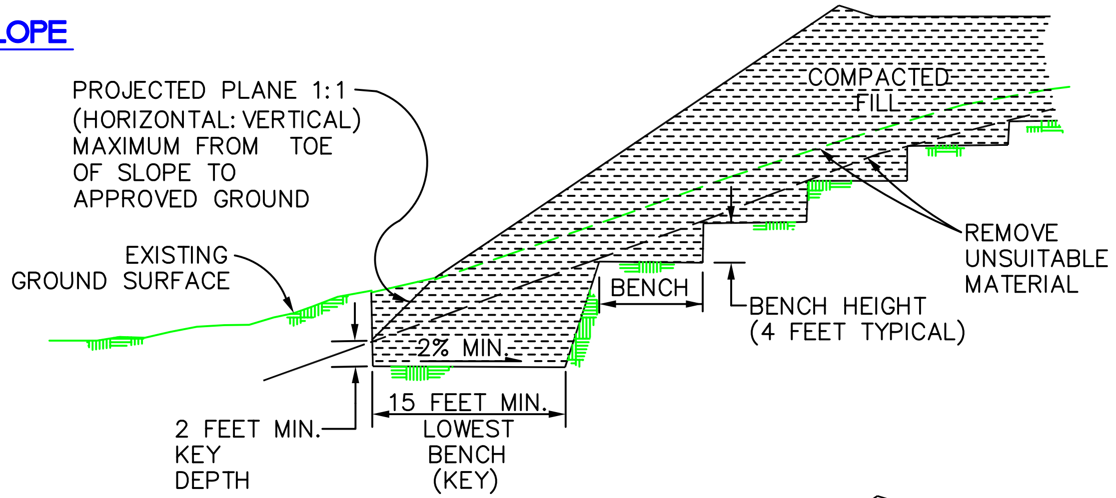
D-6.2 Bedding and Backfill

All bedding and backfill of utility trenches shall be performed 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). Bedding shall be placed to 1-foot (0.3 m) over the top of the conduit, and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of relative compaction (ASTM D 1557) from 1 foot (0.3 m) above the top of the conduit to the surface. Jetting of the bedding around the conduits shall be observed by Leighton Consulting, Inc. and backfill above the pipe zone (bedding) shall be observed and tested by Leighton Consulting, Inc..

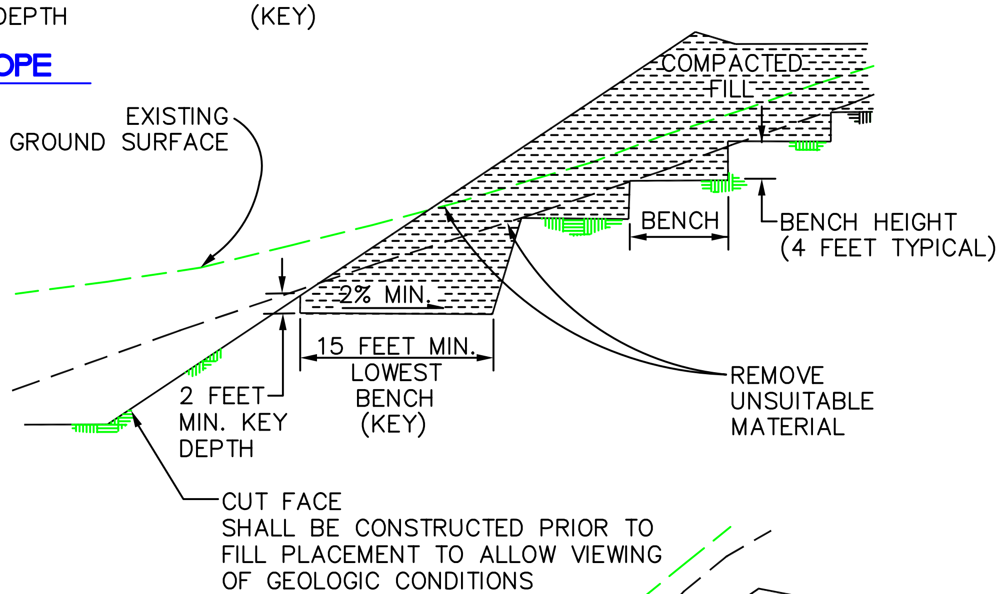
D-6.3 Lift Thickness

Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to Leighton Consulting, Inc. that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method, and only if the building officials with the appropriate jurisdiction approve.

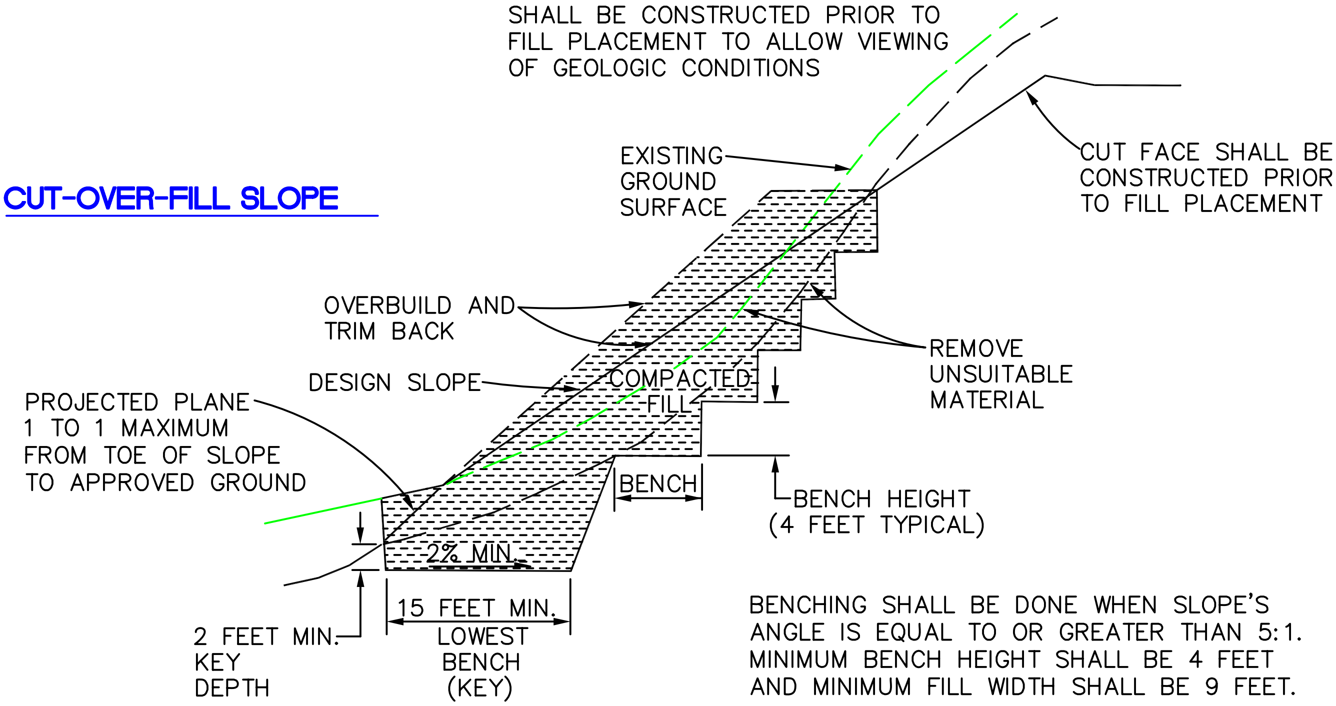
FILL SLOPE



FILL-OVER-CUT SLOPE

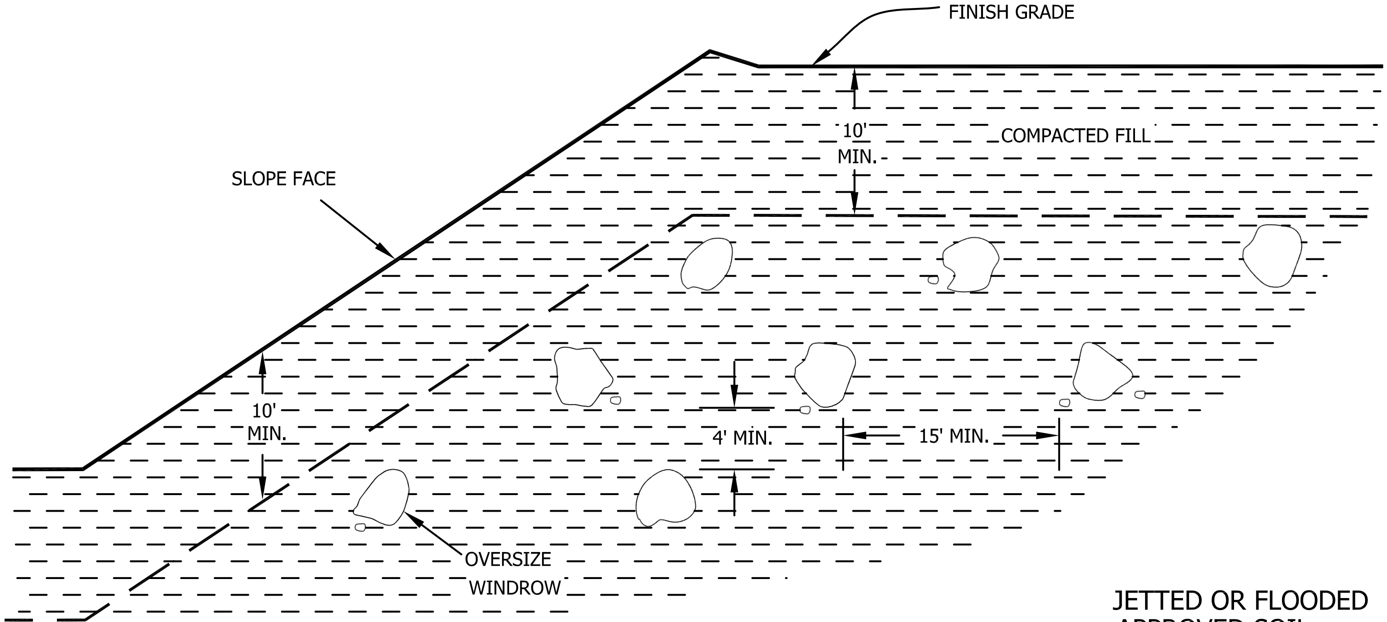


CUT-OVER-FILL SLOPE

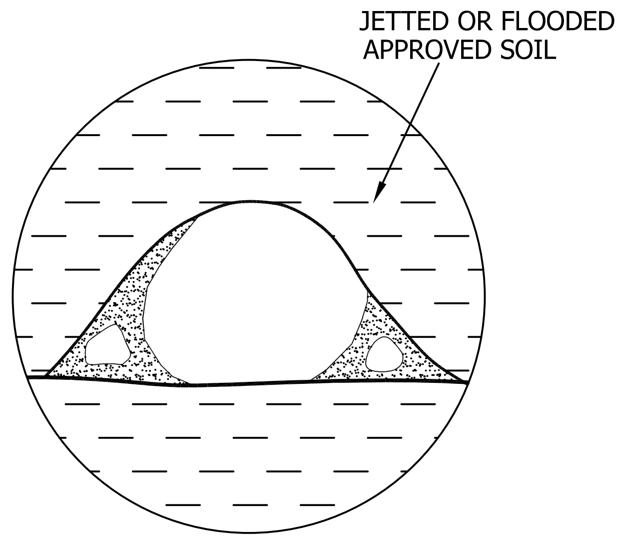


BENCHING SHALL BE DONE WHEN SLOPE'S ANGLE IS EQUAL TO OR GREATER THAN 5:1. MINIMUM BENCH HEIGHT SHALL BE 4 FEET AND MINIMUM FILL WIDTH SHALL BE 9 FEET.

KEYING AND BENCHING	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS A	Leighton

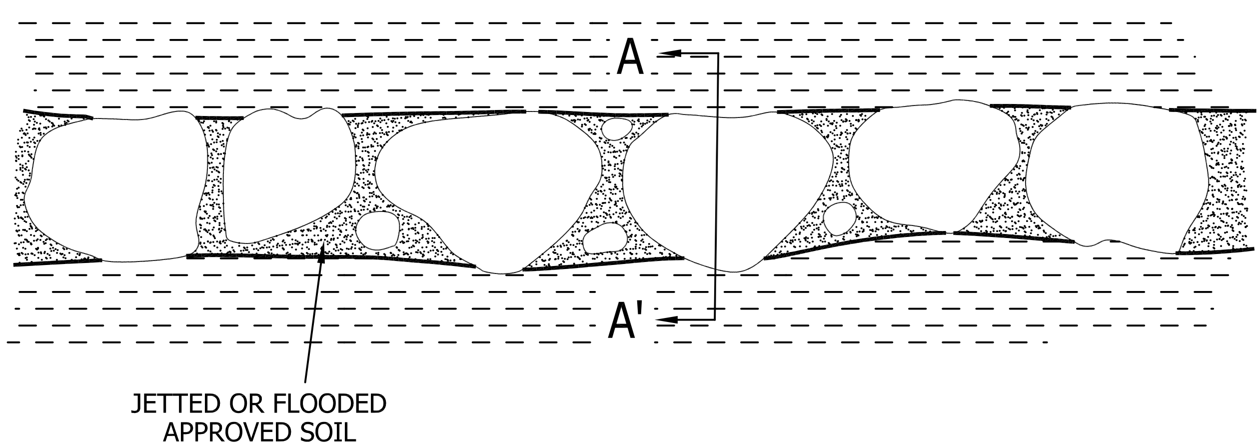


- Oversize rock is larger than 8 inches in largest dimension.
- Backfill with approved soil jetted or flooded in place to fill all the voids.
- Do not bury rock within 10 feet of finish grade.
- Windrow of buried rock shall be parallel to the finished slope face.

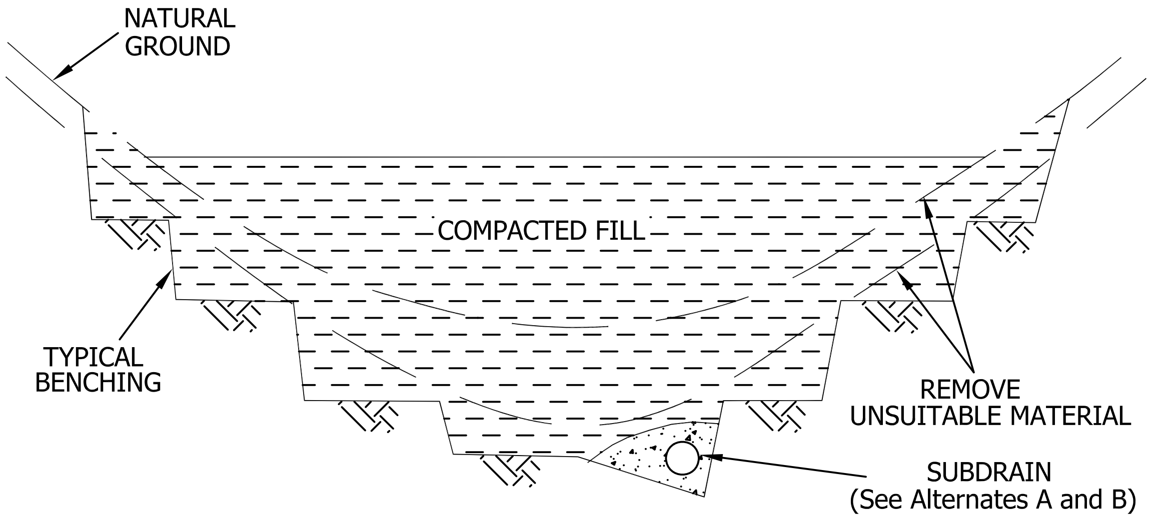


SECTION A-A'

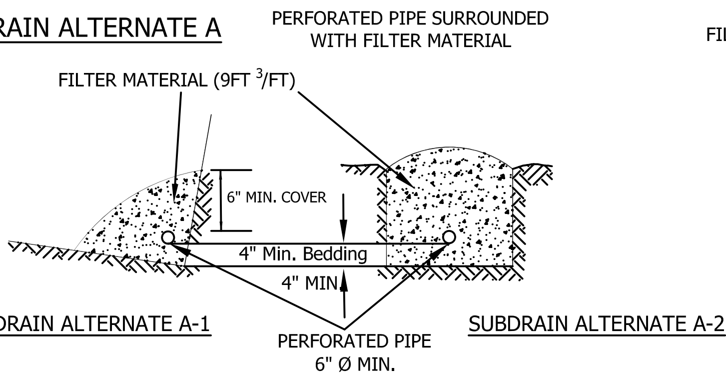
PROFILE ALONG WINDROW



OVERSIZE ROCK DISPOSAL	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS B	Leighton



SUBDRAIN ALTERNATE A

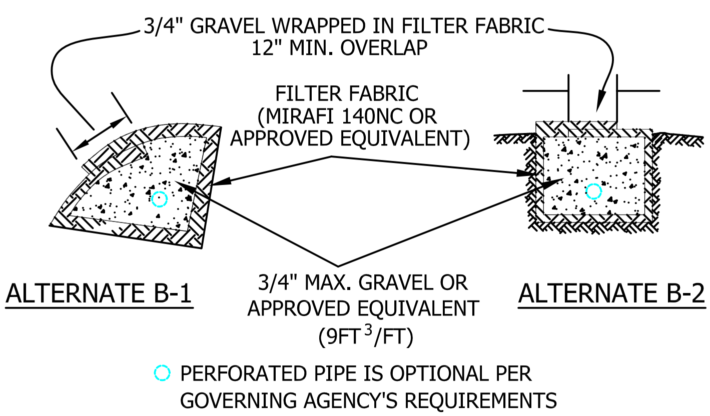


FILTER MATERIAL

FILTER MATERIAL SHALL BE CLASS 2 PERMEABLE MATERIAL PER STATE OF CALIFORNIA STANDARD SPECIFICATION, OR APPROVED ALTERNATE. CLASS 2 GRADING AS FOLLOWS:

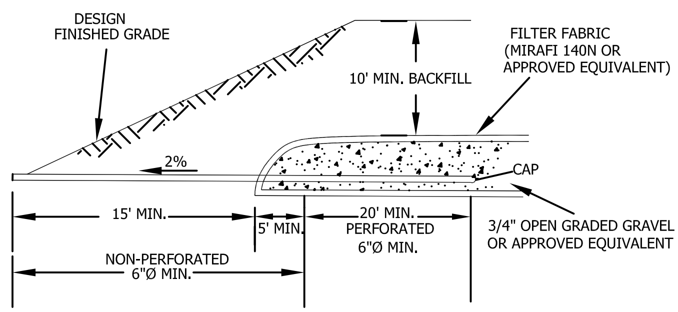
Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

SUBDRAIN ALTERNATE B



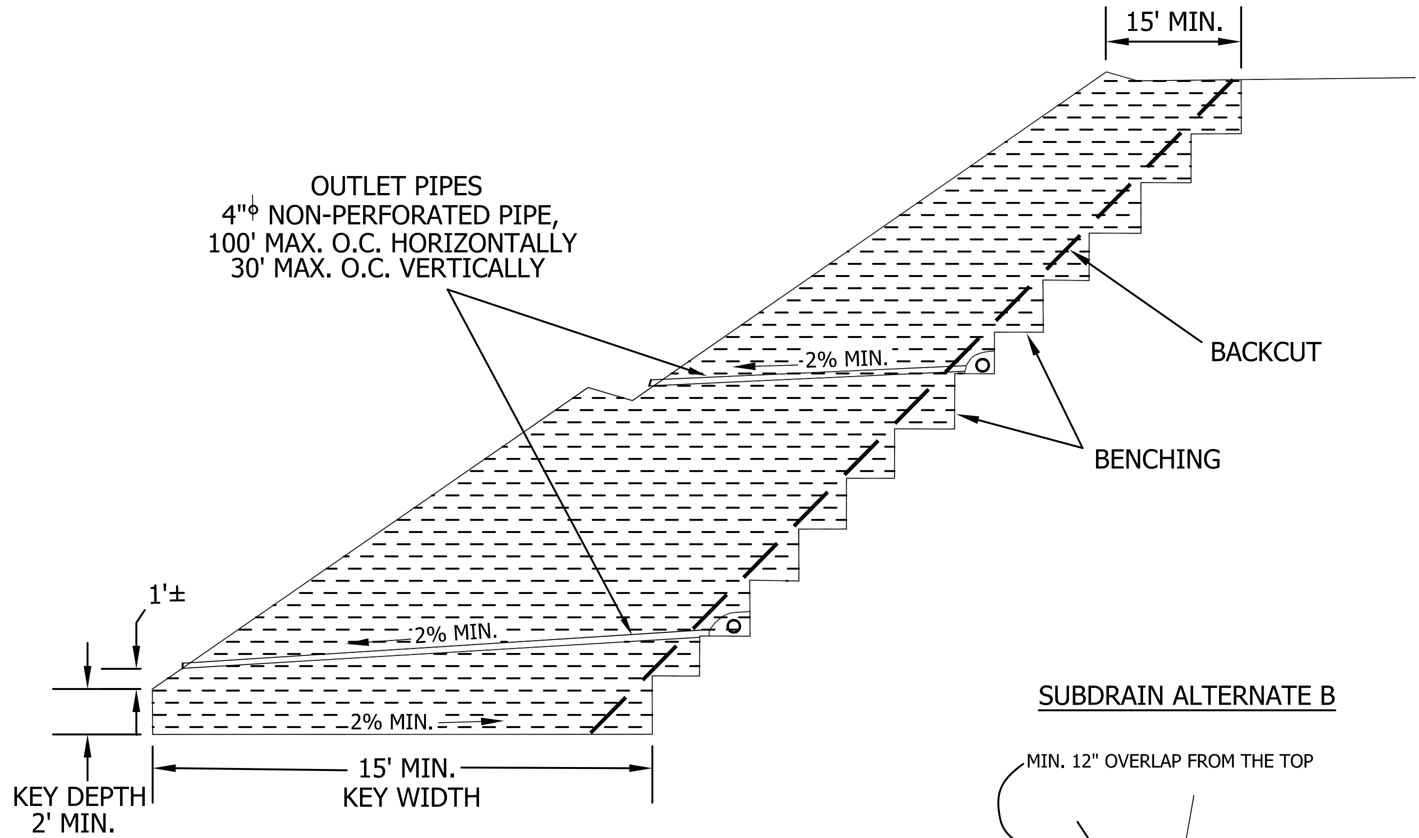
PERFORATED PIPE IS OPTIONAL PER GOVERNING AGENCY'S REQUIREMENTS

DETAIL OF CANYON SUBDRAIN TERMINAL

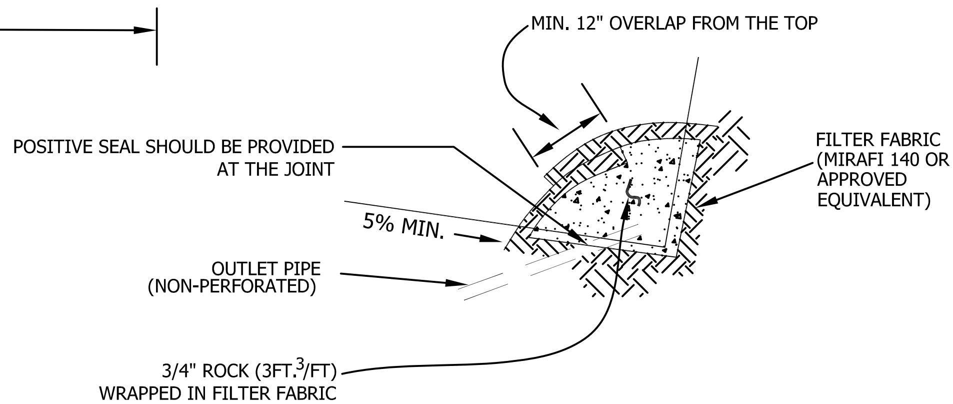


CANYON SUBDRAIN	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS C	Leighton

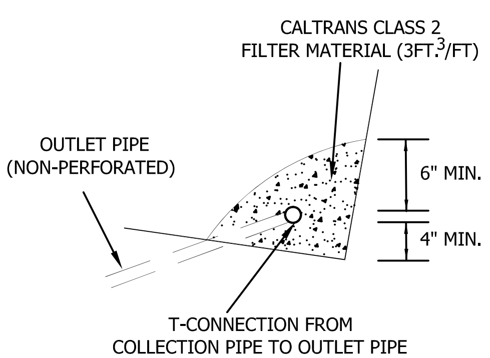
P:Drafting\templates\details\canyon_drains.dwg (7/00)



SUBDRAIN ALTERNATE B



SUBDRAIN ALTERNATE A



- SUBDRAIN INSTALLATION - Subdrain collector pipe shall be installed with perforations down or, unless otherwise designated by the geotechnical consultant. Outlet pipes shall be non-perforated pipe. The subdrain pipe shall have at least 8 perforations uniformly spaced per foot. Perforation shall be 1/4" to 1/2" if drilled holes are used. All subdrain pipes shall have a gradient at least 2% towards the outlet.
- SUBDRAIN PIPE - Subdrain pipe shall be ASTM D2751, ASTM D1527 (Schedule 40) or SDR 23.5 ABS pipe or ASTM D3034 (Schedule 40) or SDR 23.5 PVC pipe.
- All outlet pipe shall be placed in a trench and, after fill is placed above it, rodded to verify integrity.

BUTTRESS OR REPLACEMENT FILL SUBDRAINS	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS D	Leighton

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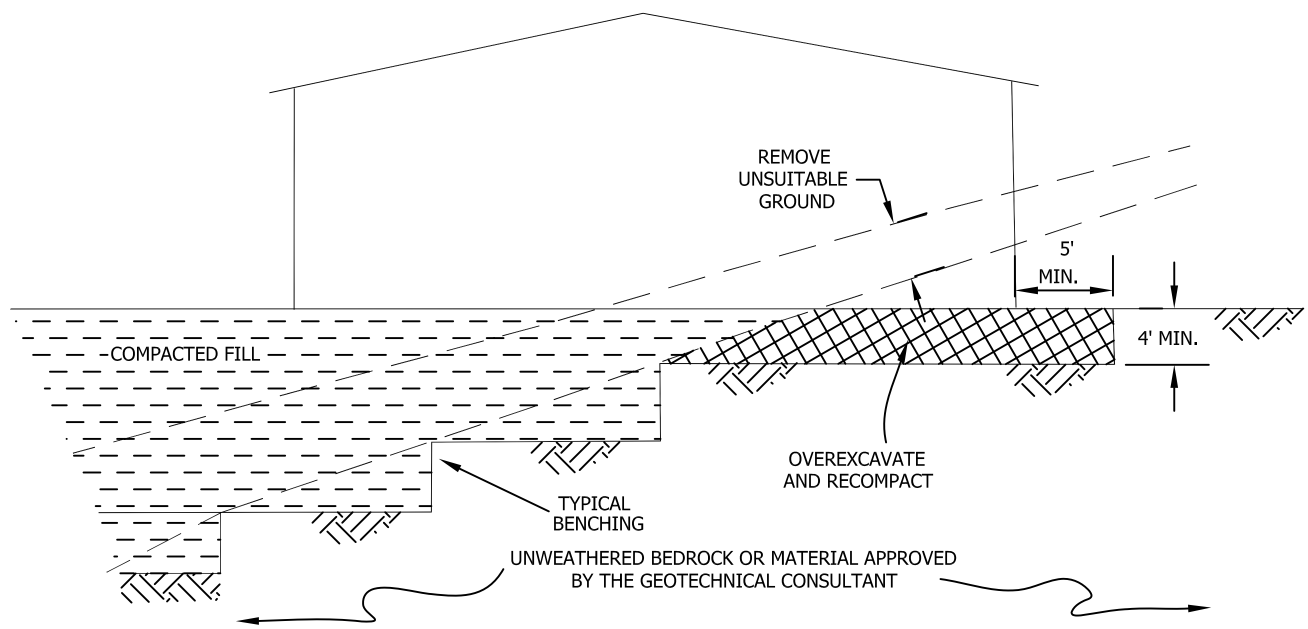
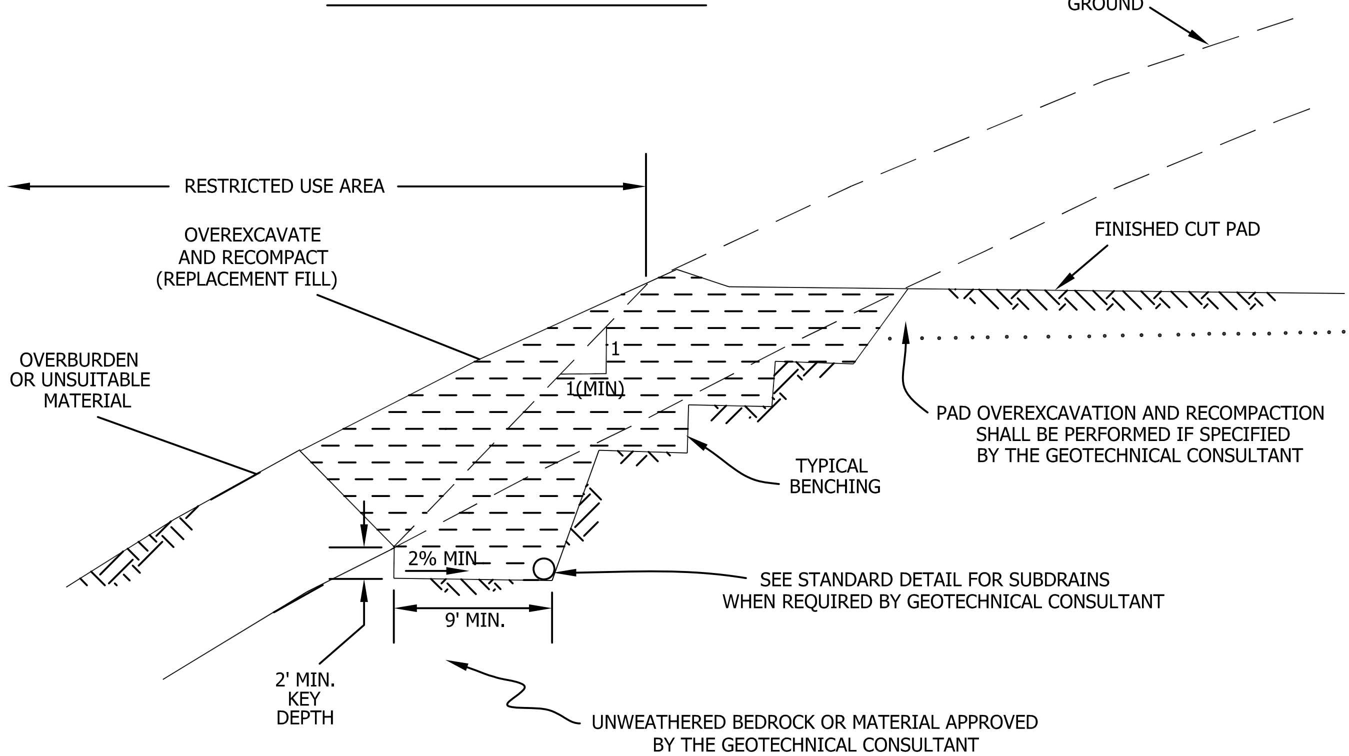
CUT-FILL TRANSITION LOT OVEREXCAVATION



SIDE HILL FILL FOR CUT PAD



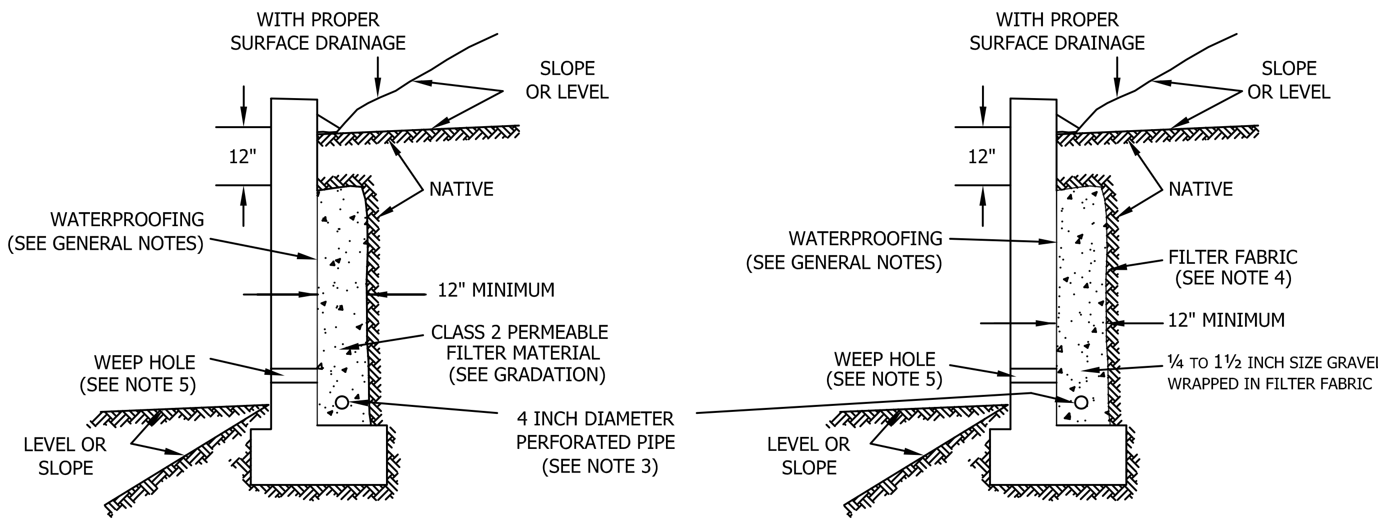
TRANSITION LOT FILLS AND SIDE HILL FILLS	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS E	Leighton

P:Drafting\templates\details\transition_fills.dwg (7/00)

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