SOILS SOUTHWEST, INC.
SOILS, MATERIALS AND ENVIRONMENTAL ENGINEERING CONSULTANTS

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Report of Soils and Foundation Evaluations
Proposed the Crossing at Redlands
Planned Apartment Complex
9.54-acre Vacant Parcel (Zaheer Property) on West Lugonia Avenue
County of San Bernardino, California
APN: 0292-053-08

Project No. 16024-F
December 22, 2016

Prepared for:

The Crossing at Redlands, LLC
c/o Mr. Jim Mauge
74-478 Highway 111, Suite 378
Palm Desert, CA 92260

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Established 1984

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The Crossing at Redlands, LLC
74-478 Highway 111
Palm Desert, CA 92260

Attention: Mr. Jim Mauge

Subject: Report of Soils and Foundation Evaluations
Proposed the Crossing at Redlands Apartment Complex
9.54-acre Vacant Parcel (Zaheer Property) West Lugonia Avenue
County of San Bernardino, California

Reference: Conceptual Site Plan Alternate C dated 5-24-16 by UCR Group

Gentlemen:

Presented herewith is the Report of Soils and Foundation Evaluations conducted for the site of the proposed multiunit apartment complex to be developed on the 9.54-acre vacant parcel located on the north side of West Lugonia Avenue, County of San Bernardino, California.

In absence of detailed grading and development plan the recommendations included should be considered "preliminary", subject to revision following grading and development plans review.

Based on the investigations completed at this time, it is our opinion that the site soils encountered primarily consist of upper dry disturbed, loose, and compressible alluviums of consistency, overlying deposits of dry to damp, compressible silty gravelly sand and gravelly sand of moderate consistency to the depth explored. Based on USGS (California Geologic Survey) Bulletin 1898, Plate 4 it is understood that the site is not situated within an AP Special Studies Zone, and the site is considered not susceptible to earthquake induced soils liquefaction. Potential for geologic hazards, such as flooding, debris flow or landslides are considered remote.

Based on the evaluations completed at this time, it is our opinion that, from geotechnical viewpoint, the site should be considered suitable for the development proposed provided the recommendations described herein are considered in design and construction along with the recommendations as described in the current CBC. During grading use vibratory sheeps-foot roller may be warranted.

We offer no other warranty, expressed or implied.

Respectfully submitted,
Soils Southwest, Inc.

Moloy Gupta, RCE 31708

MOLOY K. GUPTA
NO. 31708 EXP. 12-31-16

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1.0 Introduction

1.1 Purpose and Scope of Work

This report presents the "preliminary" results of Soils and Foundation Evaluations conducted for the 9.54-acre vacant parcel located on the north side of West Lugonia Avenue , County of San Bernardino, California The soils/material descriptions included are based on visual observations as made during test explorations, supplemented by laboratory testing completed at this time. Being beyond scope of work, no geologic evaluations are included and none such should be considered necessary for the subject project site.

The recommendations contained reflect our best estimate of the soils conditions as encountered during field investigations conducted for the site. It is not to be considered as a warranty of the soils conditions for other areas or for the depths beyond the explorations advanced at this time.

The recommendations supplied should be considered valid and applicable following *final grading and development plans review* when prepared, along with the following conditions, in minimum, is observed:

i. Pre-grade meeting with contractor, public agency and soils engineer,
ii. Excavated bottom inspections and verifications by soils engineer prior to backfill placement,
iii. Continuous observations and testing during site preparation and structural fill soils placement,
iv. Observation and inspection of footing trenching prior to steel and concrete placement,
v. Plumbing trench backfill placement prior to concrete slab-on-grade placement,
vi. On and off-site utility trench backfill testing and verifications, and
vii. Consultations as required during construction, or upon your request

1.2 Site Description

Used in the past as citrus grove, the rectangular shaped parcel of 9.54-acre is currently vacant and unimproved. In general, the site is bounded by distribution warehouses on the north and west, by West Lugonia by a retention basin and undeveloped property on the east. Overall vertical relief within the property is currently unknown, but sheet flow from incidental rainfall estimated to flow towards the west and to the southwest. Except for scattered trees, isolated concrete debris, old concrete irrigation systems, and an old concrete machinery foundation, no other significant features pertaining to this investigation, were noted.

1.3 Proposed Development

No detailed grading and/or development plans are available for review. However, based on the referenced conceptual project layouts supplied, it is understood that the subject development, among others, will include at **least (4) detached three to four-story structures on-grade, along with an additional three (3) two to three story structures along the northern and western property limits supported by raised columns to accommodate on-grade parking underneath.** Use of conventional construction of wood-frame and stucco and concrete slab-on-grade, with continuous wall and isolated column foundations or other deepened wall or isolated pier footings with grade beams are anticipated. Associated construction of swimming pool, interior driveways, parking and off-site street improvements are expected to complete the project. Moderate site preparations and grading should be anticipated with the development planned.

1.4 Subsurface Investigation

Subsurface explorations included ten (10) exploratory geotechnical test borings (B-1 to B-10) by using a hollow-stem auger drill rig supplied and operated by California Pacific Drilling, advanced to maximum depth of 41 feet below grade. Prior to actual test excavations, an underground utility clearance was established with Underground Service Alert (USA) of Southern California to avoid possible subsurface life-line obstruction and their rupture. The approximate test boring locations are shown on the attached Plate 1. Following necessary soil sampling and in-situ testing, the exploratory test borings were backfilled with local soils using minimum compaction effort. Supplemental fill soils compactions may be warranted within the test boring areas as shown on the attached Plate 1.

During test excavations, representative bulk and undisturbed California ring samples were procured and Standard Penetration (SPT) blow-counts were recorded. Collected samples were subsequently sent to our laboratory for necessary geotechnical testing.

1.5 Laboratory Testing

Representative bulk and undisturbed site soils samples were tested in our laboratory to aid in the soils classification and to evaluate relevant engineering properties pertaining to the project requirements. In general, the laboratory testing included the following:

- In-situ moisture contents and dry density (ASTM Standard D2216)
- Maximum dry density and optimum moisture content (ASTM Standard D1557)
- Direct Shear (ASTM Standard D3080)
- Soil Consolidation (ASTM Standard D2435)
- Soil gradation analysis (ASTM Standard D422)

Description of the test results and test procedures used are provided in Appendix B.

o Based on the field investigation and laboratory testing, engineering analyses and evaluations were made on which to base our preliminary recommendations for design of foundations, slab-on-grade, paving and parking, site grading, utility trench backfill, site preparations and grading and monitoring during construction.

o Preparation of this report for initial use by the project design professionals. The recommendations supplied should be considered as “tentative” and may require substantial revision and/or upgrading following final development/grading plan review.

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2.0 Geotechnical Conditions

2.1 Local Soils Conditions

Based on the investigations completed it is our opinion that the soils encountered primarily consist of upper dry disturbed, loose, and compressible alluviums of variable consistency (SPT blowcounts 4 to 7), followed by dry and compressible silty gravelly sand and gravelly sand of moderate consistency to the maximum 41 feet depth explored. Based on USGS (California Geologic Survey) Plate 4 Bulletin 1898, it is understood that the site is not situated within an AP Special Studies Zone, and the site is not susceptible to earthquake induced potential for soils liquefaction. Historical shallowest groundwater is reported at about 125 feet below grade.

With low SPT blow-counts, the upper soils encountered are considered inadequate for directly supporting structural loadings without excessive differential settlements to foundations and concrete slab-on-grade. When, however, graded as recommended herein, the structural pads prepared should be suitable for load bearing structural support. Conventional construction may be considered for the development planned.

Laboratory shear tests conducted on the upper soils remolded to 90% indicate moderate shear strengths under increased moisture conditions. Results of the laboratory shear tests are provided in Plate B-1 of this report.

Consolidation tests conducted on similar remolded samples indicate "low" potential for compressibility under anticipated structural loadings. The results of the laboratory determined soils consolidation potential are shown on Plate B-2 in Appendix B.

Sandy silty and gravelly in nature, the site soils are considered "very low to low" in expansion characteristics, thereby requiring no special construction requirements other than those as recommended herein. Supplemental soil expansion testing, however, is recommended following mass grading completion to provide supplemental/revised foundation recommendations, if warranted.

2.2 Subsurface Variations

During grading, buried irrigation, debris, organic and others may be encountered. In addition, variations in soil strata, their continuity and orientations may be expected. Due to the nature and depositional characteristics of the natural soils encountered, care should be exercised in interpolating or extrapolating the subsurface soils conditions existing in between and beyond the test explorations conducted.

2.3 Excavatability

It is our opinion that the grading required for the project may be accomplished using conventional heavy-duty construction equipment. However, some difficulty may be expected during deep trenching due to soil caving. No blasting or jack-hammering is anticipated.

2.4 Soil Corrosivity

Since change in soil matrix is expected during site preparations and grading, no soil chemical analysis is initiated at this time to determine potentials for soils corrosivity to concrete and steel. Following mass grading completions evaluations on such will be made to determine, in minimum, pH, sulfate, chloride and resistivity. Results of such will be supplied, if and, when requested.

2.5 Groundwater

Groundwater was not encountered at the time of exploratory borings advanced to the maximum 46 feet below grade. Historically, the current groundwater level and the shallowest groundwater level recorded within the past fifteen years are described in the following groundwater table. Fluctuations in groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, altered natural drainage paths, and other factors not evident at the time the test borings completed.

For the planned development, it is our opinion that provisions should be maintained so as to dispose incidental surface runoff away from the individual structural pads, once constructed.

The following table lists the nearest well to the site as listed by the reporting agency.

GROUNDWATER TABLE	
Reporting Agency	San Bernardino Valley Water Conservation District/Western Municipal Water District
Well Number	01S/03W-21H006S
Well Name	Well #30A
Well Monitoring Agency	City of Redlands
Well Location: Township/Range/Section	T01S/R03W-21H006S
Current Depth to Water (Measured in feet)	192
Current Date Water was Measured	November, 2008
Depth to Water (Measured in feet) (Shallowest)	125
Date Water was Measured (Shallowest)	April 30, 1999

3.0 Faulting and Seismicity

3.1 Faulting and Seismicity

Based on the information published by the USGS (currently known as California Geologic Survey) Department of Conservation, State of California, it is understood that the site is *not* situated within an A-P Special Study Zone (*where a fault(s) runs through or adjacent to the site*), and in absence of shallow depth (less than 50') groundwater and with the gravelly sandy nature of the soils as encountered, the site soils are considered non-susceptible to soil liquefaction in event of a strong motion earthquake.

Considering Southern California is in a seismically risky area for building structures, it is not economically feasible to construct structures that are *totally* resistant to earthquake-related hazards. However, the implementation of the current CBC seismic design parameters, along with the recommendations for design and construction as provided herein, it is our opinion that seismically induced structural damage can be "reduced" to some acceptable tolerable limits. Seismically induced hazards such as liquefaction and liquefaction-induced settlements are discussed in the following sections. Potential for geologic hazards, such as flooding, debris flow or landslides are considered remote.

3.2 Direct or Primary Seismic Hazards

Surface ground rupture along with active fault zones and ground shaking represent primary or direct seismic hazards to structures. There are no known active or potentially active faults that pass through or towards the subject site, and the site is not situated within an AP Special Studies Zone. Per the 2013 current CBC, the site is considered within Seismic Zone 4. Thus, it is likely that during the life expectancy of the structures built, moderate to severe ground shaking may have some adverse effects on the structures built.

3.3 Induced or Secondary Seismic Hazards

In addition to ground shaking, effects of seismic activity may include surface rupture, flooding, land-sliding, lateral spreading, settlements and subsidence. Potential effects of such are described below.

3.4 Liquefaction

Liquefaction is caused by build-up of excess hydrostatic pressure in saturated cohesionless soils due to cyclic stress generated by ground shaking during an earthquake. The significant factors on which liquefaction potential of a soil deposit depends, among others include, soil type, relative soil density, intensity of earthquake, duration of ground shaking, and depth of ground water.

No groundwater was encountered during geotechnical test borings. Site soils primarily consist of upper disturbed, very loose, dry, fine to medium coarse sand, overlying natural deposits of silty fine sands and gravelly fine to medium coarse of moderate consistency with minor pebbles and rocks. Based on above, with the SPT blow-counts as recorded and with the historical groundwater table at a depth more than 50 feet, it is our opinion that *the site should be considered non-susceptible to soil liquefaction in event of a strong motion earthquake.*

3.5 Shallow Ground Rupture

The site is not situated within an AP Special Studies Zone. Based on review of existing geologic information, no major fault is noted to cross through or extends towards the site. The potential for surface rupture resulting from nearby fault movement is not known for certainty, but is considered “remote” due to the distance of the site to the nearby fault.

3.6 Flooding

Flooding hazards include tsunamis (seismic sea waves), Seiches, and failure of manmade reservoirs, tanks and aqueducts. The potential for these hazards is considered “remote” considering the inland site location and the distance to any nearby bodies of water.

3.7 Landslides

Seismically induced landslides and other slope failures are common occurrences during or soon after an earthquake. Considering the site and its adjacent being relatively flat, it is our opinion that potential for seismically induced landslides should be considered as “remote”.

3.8 Lateral Spreading

Seismically induced lateral spreading involves lateral movement of soils due to ground shaking. Lateral spreading is demonstrated by near vertical cracks with predominantly horizontal movement of the soil mass involved. The topography of the site being near level, it is our opinion that the potential for seismically induced lateral spreading should be considered as “remote”.

3.9 Seismically Induced Settlement and Subsidence

The site is situated at about 3.3 miles from the San Jacinto-San Bernardino fault capable of generating an earthquake magnitude M=6.7 and Peak Horizontal Ground Acceleration, PHGA of 0.652g. Considering the proximity of the earthquake fault as described, it is our opinion that potential for some total and differential settlements due to ground shaking may be expected. Considering the SPT blow-counts as recorded along with a Factor of Safety FS=1.3, earthquake induced total and differential settlements may be estimated to be within “tolerable” limits.

For reference, the results of the settlement analysis are provided in the later sections of this report.

3.10 Seismic Design Parameters

The design spectrum was developed based on the 2013 CBC. Site Coordinate, of 34.070860.°N, -117.220695°W were used to establish the seismic parameters as presented below.

3.11 Seismic Design Coefficients

The site is situated at about 3.33 km from the San Jacinto-San Bernardino fault. For foundation and structural design, the following seismic parameters are suggested based on the current 2013 CBC:

Recommended values are based upon USGS Design Maps Summary and Detailed Reports website for Mapped Acceleration Parameters, USGS 2008 National Seismic Hazard Maps-Fault Parameters, and the California Geologic Survey: Probabilistic Seismic Hazards Mapping and supplemental seismic parameters are provided in Appendix C of this report.

The following presents the seismic design parameters as based on available publications as currently published by the California Geological Survey and 2010 CBC.

TABLE 3.11A.1 Seismic Design Parameters

CBC Chapter 16	2010 ASCE 7-10 Standard Seismic Design Parameters	Recommended Values
1613A.5.2	Site Class	D
1613.5.1	The mapped spectral accelerations at short period	S_s
1613.5.1	The mapped spectral accelerations at 1.0-second period	S_1
1613A5.3(1)	Site Class B / Seismic Coefficient, S_s	1.850g
1613A5.3(2)	Site Class B / Seismic Coefficient, S_1	0.821 g
1613A5.3(1)	Site Class D / Seismic Coefficient, F_a	1.000 g
1613A5.3(2)	Site Class D / Seismic Coefficient, F_v	1.500 g
16A-37 Equation	Spectral Response Accelerations, $S_{Ms} = F_a S_s$	1.850 g
16A-38 Equation	Spectral Response Accelerations, $S_{M1} = F_v S_1$	1.232 g
16A-39 Equation	Design Spectral Response Accelerations, $S_{Ds} = 2/3 \times S_{Ms}$	1.233 g
16A-40 Equation	Design Spectral Response Accelerations, $S_{D1} = 2/3 \times S_{Ms}$	0.821 g

TABLE 3.11A.2 Seismic Source Type

Based on California Geological Survey-Probabilistic Seismic Hazard Assessment Peak Horizontal Ground Acceleration (PHGA) having a 10 percent probability of exceedance in a 50 year period is described as below:

Seismic Source Type	
Nearest Maximum Fault Magnitude	M>\=6.7
Peak Horizontal Ground Acceleration	0.652g

In design, vertical acceleration may be assumed to about 1/3 to 2/3 of the estimated horizontal ground accelerations described.

It should be noted that lateral force requirement in design by structural engineer should be intended to resist total structural collapse due to the described PHGA of 0.652g or greater. However, during life time use of the structure built, it is our opinion that some structural damage may be anticipated requiring some structural repairs. Adequate structural design and implementation of such in construction should be strictly observed. To minimize potentials for rupture during an earthquake, use of flexible lifelines for gas, water, electricity and others, are strongly suggested.

3.10 Slope Stability

In absence of slopes over 5 feet, no slope stability analysis is warranted.

4.0 Geotechnical Recommendations

4.1 General Evaluations

Based on field explorations, laboratory testing and subsequent engineering analysis, the following conclusions and recommendations are presented for the site under study:

(I) From geotechnical viewpoint, the site is considered grossly stable for the proposed development, provided the recommendations supplied herein are incorporated in design and construction. Foundation design should reflect considerations of the seismically induced PHGA as described.

(II) Because of the dry, disturbed, and compressible nature of the upper soils and upper fills as encountered, it is our opinion that for structural support, the load bearing soils should be reworked in form of subexcavations, followed by scarification, moisturization and their replacement to planned grades **compacted to minimum 95%.** In event new fill soils are required over the current grade surface such should be placed on the subgrade prepared as described.

(III) The subexcavation depth described in the following section should be considered as "minimum". During grading, localized deeper subexcavations may be required within areas underlain by buried debris, utilities and others. It will be the responsibility of the grading contractor to inform the project soils engineer of the presence of such debris or utilities such as septic tank etc.

(IV) In order to minimize potential differential settlements, it is recommended that structural footings should be established exclusively into engineered fills of local soils compacted to the minimum as recommended. Construction of footings and slabs straddling over cut/fill transition, shall be avoided.

(V) Structural design consideration should include probability for "moderate to high peak ground acceleration" from relatively active nearby earthquake faults. Implementing the seismic design parameters and procedures as outlined in the current CBC and as described earlier, however, can minimize the adverse effects of ground shaking for the structures proposed.

(VI) Although no groundwater was encountered, provisions should be maintained during construction to divert incidental rainfall away from the structural pads constructed.

(VII) It is our opinion that, if site preparations and grading are performed as recommended and as per the generally accepted construction practices and current CBC, the proposed development will not adversely affect the stability of the site, or it's adjacent.

4.1.1 Preparations for Structural Pads (Specific)

Considering the upper, dry and low density compressible soils with potential for high susceptibility to hydro-consolidation, or with the fills existing as described, it is recommended that no structural footings and/or paving shall be constructed bearing directly on the near surface soils existing. Additionally, no cut-fill transition conditions should be allowed underneath footings and slabs-on—grade. Additionally, no rocks larger that 6-inch in diameter should be allowed directly underneath load bearing foundations. Overnight "pre-saturation" prior to actual grading is recommended.

During grading, engineered fills of local soils, when used for structural support, should be compacted to minimum 95% of the soils Maximum Dry Density at about 2% to 3% over optimum moisture content as determined by the ASTM Standard D1557. Considering the presence of the underlying dry and compressible soils existing at depths, it is suggested that immediately prior to engineered fill soils placement for structural support, the excavated bottoms to receive fills should be compacted similarly to minimum 95%. During grading use of vibratory sheeps-foot roller may be warranted.

It is expected that the subject development will be constructed on grades prepared, either on:

(A) near existing grade surface, or
(B) on pads constructed by minor fill soils placement over the current grade surface, or
(C) by minor cuts to the grades currently existing, or
(D) by cut and fill grading technique as described below.

A> For the pads planned at near or on the existing grade surface, for load bearing support, site preparations should include, in minimum, a depth equal to (i) the designed footing embedment + 3-times the foundation width for continuous wall footings, and (ii) to the depth equal to the designed footing embedment + 2-times the width of isolated square footings, or (III) to the depth as required to expose the underlying moist and dense gravelly sandy natural soils, or to minimum 8 feet below the current grade surface, whichever is greater. *Additional subexcavations may be required adjacent to the development currently existing along the northern property limits.*

B> For the planned pads requiring new structural fill soils placement over existing grade surface, the site preparations prior to such placement should include subexcavations of the upper existing dry and low density soils to (i) a minimum 8 feet below the present grade surface, or (II) to the depth of the underlying moist and dense gravelly sandy natural soils, (iii) or to the depth as required to maintain a minimum 4 feet thick compacted fill mat blanket below footing bottoms, whichever is greater.

C> For the pads requiring "cuts" to the present grades, the site preparations, following such cuts, may include further subexcavations to sufficient depth so as to maintain a minimum 4 feet thick compacted fill mat blanket below the planned footing bottoms, or to the depth as recommended by soils engineer during grading.

D> Within areas of cut/fill transition, it is recommended that following cuts to planned grade, the cut portions of the pads should be further subexcavated to about five feet, or to the depth as required to maintain a 4 feet thick compacted fill mat blanked underneath footings, whichever is greater. Site preparations should also include excavated soils replacement as engineered fills compacted to the minimum as described. Supplemental recommendations for cut/fill transition conditions are provided in later section of this report.

The subexcavation depths described should be considered as "approximate". Actual subexcavation depths should be determined by soils engineer during grading. The site grading should encompass, in minimum the planned building footprint areas and a lateral extent equal to the subexcavation depth, or to minimum five (5), whichever is greater. For reference, supplemental general mass grading recommendations may be referenced as provided in Section 5 of this report.

4.1.2 Structural Fill Material Requirements

(i) Non-expansive in nature, the local free of organic, debris and rocks larger than 6-inch in diameter, should be considered suitable for re-use as structural backfills.

(ii) Following mass-grading completion, representative site soils sampled expected in contact with footings and utilities and such should be laboratory tested to verify presence of Sulfate, pH, chloride and Resistivity. Based on the chemical test results, supplemental design recommendations may be warranted prior to further construction. Such chemical testing will be programmed, when requested by the addressee.

4.1.3 Cut/Fill Transition Pad Preparations (General)

Cut/fill transitions should be avoided to minimize potentials for differential settlements to footings and concrete slab-on-grade where required fill depth exceeds planned footing depth. Within areas of cut-fill transition, it is suggested that following necessary cut, the entire structural pad should be prepared so as to establish on uniform bearing compacted fill mat prepared in conformance to the general guidelines as described below.

Table 1.0 Pad Preparation Guideline for Cut/Fill Transition Areas

Fill Depth Required for Finish Grade (within low-lying areas)	Overexcavation Depth below Finish Grade (within cut areas)
Up to 5 feet	Equal Depth
5 to 10 feet	5 feet
Greater than 10 feet	One-half the maximum thickness of fill placed on the "fill" portion (20 feet maximum)

Cut portions should be over-excavated beyond the structural perimeter lines for a horizontal distance equal to the depth of over excavation or to a minimum distance of 5 feet, whichever is greater. Actual subexcavation depth should be determined by soils engineer during grading.

4. Structural Foundation Design

For structural support, it is assumed that conventional spread footings, continuous wall and isolated foundations will be considered based on the allowable soil bearing capacity and PHGA as described along with the applicable sections requirements of the current CBC.

In absence of detailed development plans, it is assumed that for conventional wood frame and stucco construction with concrete slab-on-grade will be used for the development proposed. Two to four-story constructions are expected supported by continuous wall and/or isolated spread footings founded exclusively into engineered fills compacted to minimum 95%.

For static loading conditions, with a Factor of Safety, F. S=3.0, allowable soil vertical bearing capacity may be estimated from the following equations:

Continuous Wall Footing: $q_{allowable} = 1500 + 880d + 400b$,
Isolated Square: $q_{allowable} = 3000 + 800d + 320b$,
Circular Footing: $q_{allowable} = 3000 + 880d + 480r$, where

$q_{allowable}$ = allowable soil vertical bearing capacity, in psf.
d= footing depth, min. 1.5 ft., b = footing Width, min. 1.25 ft., r=footing Radius: min. 2 ft.

The bearing capacities provided excludes anticipated foundation dead load. The soil bearing capacities may be increased for each additional footing depth and in width more than the minimum recommended. Total maximum vertical bearing capacity is recommended not to exceed 3500 psf and 4500 kips for continuous wall and isolated spread footings, respectively. If normal code requirements are applied, the above capacities may further be increased by an additional 1/3 for short duration of loading, which includes the effect of wind and seismic forces.

From geotechnical view-point, 15”x18”, 18”x24” and 24”x30” foundation dimensions may be considered for the two, three and four-story structures planned. Actual foundation dimensions (b, d & r), including foundation thickness *should be determined* by the project structural engineer based on the static and seismic design parameters supplied, along with adequate foundation thickness will be required as designed by structural engineer to resist “punching-shear” from superimposed structural loading.

From geotechnical view point, use of minimum reinforcements consisting of 2-#5 rebar placed near the top and 2-#5 rebar near bottom footings, are recommended. Additional reinforcements, if specified by project structural engineer, should be incorporated in construction.

Based on the laboratory determined soils consolidation characteristics, settlements to properly designed and constructed foundations supported exclusively into engineered fills of site soils or its equivalent or better, and carrying maximum assumed structural loadings of 45 kips and 4 klf for isolated pier and for wall foundations, respective, are expected to be within tolerable limits. Under static loading conditions, over a 40-ft. span, estimated total and differential settlements should be about 1 and 1/2-inch, respectively, when being supported by engineered fills of local soils compacted to minimum 95%. Considering the gravelly sandy soils as encountered, most of the elastic deformations, however, are expected to occur during construction.

To minimize potential differential settlements, use of footings straddling over cut/fill transition, shall be avoided. Considering dry gravelly nature, it is recommended that the excavated footing trenches should be sufficiently “moistened” immediately prior to concrete placement.

The footing depths described should be measured vertically from the lowest adjacent outside grade, and not from the finished pad grade or finished floor surface. Footing depths and dimensions shall be verified by soils engineer prior to footing-forming, rebar and concrete placement. It will be the contractor’s responsibly to arrange such verification by soils engineer. Structural design should conform to the minimum requirements of the current CBC Seismic Design requirements and the geotechnical parameters as described.

4.3 Concrete Slab-on-Grade

No concrete slabs, sidewalks and flatworks should be placed bearing directly on the surface soils existing. The prepared subgrades to receive footings should be adequate for concrete slab-on-grade placement. Considering the proximity of earthquake faults, 4-inch thick (nominal) concrete slabs reinforced with #3 rebar at 18-inch o/c is recommended, or as designed by the structural engineer based upon structural loading and requirements for the seismic design parameters and for the Peak Horizontal Ground Acceleration (PHGA) as described. Positive contact of the slabs with footings by using dowels or other similar means will be at the discretion of structural engineer.

For driveways, it is our opinion that concrete slabs should be 5-inch thick (net), placed over local gravelly sandy soils compacted to at least 95%. Actual driveway slab thickness and reinforcing, construction and expansion joint requirements should be incorporated as required by the project structural engineer.

Within moisture sensitive areas, concrete slabs should be underlain by 2-inch of compacted clean sand, followed by 6-mil thick vapor barrier such as commercially available StegoWrap , Visqueen or other approved covering, overlying an additional 2-inch thick sand having a Sand Equivalent, SE, of 30 or greater.

Subgrades to receive concrete should be "'dampened" as would be expected in any such concrete placement. Use of low-slump concrete is recommended. In addition, it is recommended that utility trenches underlying concrete slabs and driveways should be thoroughly backfilled with gravelly sandy soils mechanically compacted to minimum 90%. Concrete construction joint requirements should be supplied by the project structural engineer.

Finished slab subgrade verifications, including buried utility trench backfills, etc., should be verified by soils engineer immediately prior to vapor barrier placement. No water jetting should be allowed in an effort to compact utility trench backfills.

4.3.1 Concrete Curing

In order to minimize potential for excessive concrete shrinkage or cracking, concrete slabs shall be 'cured' by using water for at least 7 days or as determined by the structural engineer prior to structural load placement.

4.4 Resistance to Lateral Loads

Resistance to foundation lateral displacement can be achieved by friction acting at the base of foundation and by passive earth pressure. A coefficient of friction of 0.35 may be assumed with normal dead load forces for footing established on compacted fill.

An allowable passive lateral earth resistance of 250 pounds per square foot per foot of depth may be assumed for the sides of foundations poured against compacted fills. The maximum lateral passive earth pressure is recommended not to exceed 2500 pounds per square foot.

For design, lateral pressures from local soils when used as level backfill may be estimated from the following equivalent fluid density:

Table 3.0 Lateral Earth Pressures

CONDITIONS	EQUIVALENT FLUID WEIGHT(pcf)	
	Level Backfill	2:1 Backfill Sloping Upwards
Active	35	55
At Rest	60	73
Passive	250	-

4.5 Swimming Pool

For adequate support, it is recommended that swimming pool shell should be founded exclusively on underlying competent natural subgrade or on compacted engineered fills. No cut-fill transition conditions should be allowed for swimming pool vertical support.

For swimming pool shell design, the following criteria may be considered:

1. Swimming pool full, with no passive resistance;
2. Swimming pool empty, with lateral active pressures from surrounding soils;
3. Swimming pool full, with supported soil surrounding.

With soil vertical bearing capacity of 1800 psf, for design, lateral active pressures and passive resistance in form of "equivalent fluid density" from horizontal backfill, may be considered from the Table 2.0 described.

4.6 Site Preparations (general)

The site preparations within the planned structural pad and beyond should include removals of the surface debris, followed by subexcavations to the approximate depth and limits as described earlier in Section 4.1.1 of this report. Site preparations should also include stockpiling of the excavated soils and moisturization to about 2% to 3% over optimum moisture content, followed by excavated bottom recompaction prior to engineered fill soils placement in 6 to 8-inch thick (compacted) lifts compacted to 95% percent or better. Earth works described should be in accordance with the applicable grading recommendations as described herein and as provided in the current UBC.

It is expected that during grading Soils Southwest will be retained for mass grading observations and fill compaction testing. In event another geotechnical consultant is retained for the project, Soils Southwest will assume no responsibility, what-so-ever, for any structural distress or deficiency that may develop during life-time use of the structures built.

4.7 Shrinkage and Subsidence

It is our opinion that during grading the upper soils may be subjected to a volume change. Assuming a 90% relative compaction for structural fills and assuming an overexcavation and re-compaction depth as described, such volume change due to shrinkage may be on the order of 10 to 15 percent. Further volume change may be expected due to supplemental shrinkage during preparation of subgrade soils. For estimation purpose, such may be approximated to about 2-inch when conventional construction equipments are used.

4.8 Construction Consideration

4.8.1 Unsupported Excavation

Gravelly sandy site soils encountered are considered highly susceptible to caving. Temporary excavations up to 5 feet in depth may be made without rigorous lateral supports. Excavated surface should be "'wetted" during construction to minimize potential surface soil raveling. No surcharge loading should be allowed within an imaginary 1:1 line drawn upward from toe of temporary excavations.

4.8.2 Supported Excavations

If vertical excavations exceeding 5 feet in depths become warranted, such should be achieved using shoring to support sidewalls.

4.9 Soil Caving

Considering dry gravelly in nature, the site soils are considered "highly" susceptible to caving. Temporary excavations in excess of 5 feet should be made at a slope 2 to 1 (h:v), or flatter, and as per the construction guidelines provided by the Cal-Osha.

4.10 Structural Pavement Thickness (Tentative)

Flexible Off-Site Asphalt Paving during Street Widening

Anticipating change in soil-matrix following mass grading completion, no actual soil R-value determination is made at this time. However, based on estimated Traffic Index (TI) and on assumed soil R-value of 65, the following paving sections are supplied for estimation purposes. Prior to actual paving soil R-value should be determined on representative samples procured from the planned paving grade based on which actual paving sections will be supplied.For estimation purposes, the following tentative off-site paving sections may be considered.

Table 4 - Preliminary Pavement Design

Preliminary Asphalt Concrete (AC) Pavement Design (Off-Site)	
Assumed Traffic Index	7.0
R-value (assumed)	65
AC Thickness (inches)	4.0*
AB Thickness (inches)	6.5*

Notes: AC - Asphaltic Concrete, AB - Aggregate Base

** Should meet or exceed City of Rancho Cucamonga Minimum Thickness Requirements*

For a.c over base, a minimum upper 12-inch of the subgrade soils should be compacted to minimum 90%, or to the minimum recommendations as dictated by the local public agency.

	Private Sidewalks	Private Drives	Patios/Entryways	City Sidewalk/Curb and Gutters
Minimum Thickness (in.)	4 (nominal)	6 (full) over 5" Class II Base	4 (full)	City/Agency Standard
Pressoaking (+/-2% Optimum)	12 inches	12 inches	12 inches	City/Agency Standard
Reinforcement	—	No. 3 at 24 inches on centers	No. 3 at 24 inches on centers	City/Agency Standard
Thickness Edge	—	8" x 8"	8" x 8 "	City/Agency Standard
Crack Control	Saw cut or deep open tool joint to a minimum of 1/3 of concrete thickness	Saw cut or deep open tool joint to a minimum of 1/3 of concrete thickness	Saw cut or deep open tool joint to a minimum of 1/3 of concrete thickness	City/Agency Standard

Unless otherwise specified in this report or by the local public agency having jurisdiction, the following guidelines may be considered as reference for subgrade preparations for the paving described: Actual slab thickness should be provided by structural engineer

Type of Compaction	Minimum Required Compaction (%)
Sidewalks,Patios, Paths,Breezeways	90
Concrete Slab	90
Driveways, Parking Garage, Ramps	95
Street/Driveway Subgrade ***with*** base	95
Street/Drive Subgrade ***without*** base	95
Curb and Gutter/V-Gutter ***with*** base	90
Curb and Gutter/V-Gutter ***With*****out** base	95
Base and Asphalt	95

4.1.1 Slab-on-Grade Concrete for Passenger Vehicle Traffic:

No concrete slabs, sidewalks and flatworks should be placed bearing directly on the surface soils currently existing. The prepared subgrades to receive footings should be adequate for concrete slab-on-grade placement. The maximum density of the base material should be more than its supporting subgrade material.

For normal vehicular traffic, garage slab should be at least 6-inch thick (net), underlain by 5-inch thick Class II base compacted to minimum 95%, bearing on local sandy soils compacted similarly to 95% up to a depth of at least 2 feet below grade. Driveway and parking/garage slab reinforcing and construction and expansion joints etc. should be incorporated as required by the project structural engineer.

Within moisture sensitive areas, concrete slabs should be underlain by 2-inch of compacted clean sand, followed by 6-mil thick vapor barrier such as Stego-Wrap of Vis queen, overlying an additional 2-inch thick sand with Sand Equivalent, SE, of 30 or greater.

Subgrades to receive concrete should be “pre-moistened” as would be expected in any such concrete placement. Use of low-slump concrete is recommended. In addition, it is recommended that utility trenches underlying concrete slabs and driveways should be thoroughly backfilled with gravelly sandy soils mechanically compacted to minimum 90% (+2 feet below final grade) and 95% (0-2 feet below final grade) immediately prior to concrete pour.

4.12 Private Concrete Flatwork/Driveways

Concrete flatworks (such as walkways and driveways) have potential for cracking due to fluctuations in soil volume in relationship to moisture content changes. To prevent excessive cracking or lifting, concrete paving should meet the minimum guidelines as shown in the table below. It is our opinion that when designed and adequately constructed, the following guidelines may help to “reduce” potential for irregular cracking or edge lifting, but may not eliminate all concrete distress.

Concrete placement during severe weather conditions (high temperature or during high Santa Ana wind conditions) is not recommended to prevent potential for "warping". It is suggested that concrete used should have a slump not exceeding 4-inch, or as recommended by the project structural engineer. Concrete reinforcing and construction/expansion joints etc. should be supplied by the project structural engineer.

4.13 Boundary Wall/Retaining Wall

It is unknown if any retaining structure will be associated with development proposed. It is our opinion that retaining structure, if planned, should be designed based on following parameters:

Slope of Retained Material (H:V)	Equivalent Fluid Density, pcf	
	Clean Sand	Local Soil
level	30	35
2:1	42	55

Walls adjacent to traffic areas should be designed to resist a uniform lateral pressure of 100 pounds per square foot, which is a result of an assumed 300 pounds per square foot surcharge behind the walls due to normal traffic. If the traffic is kept back ten feet from the wall, the traffic surcharge may be neglected.

The design parameters do not include any hydrostatic pressure build-up. Consequently, installation of "'french-drain" behind retaining walls is recommended to minimize water pressure build-up behind retaining walls. Use of impervious material is preferred within upper the 18 inches of the backfills placed.

Backfill behind retaining wall should be compacted to a minimum 90 percent relative laboratory Maximum Dry Density as determined by the ASTM D15571 test method. Flooding and/or jetting behind wall should not be permitted. Local sandy soils may be used as backfill. Supplemental geotechnical specifications on such will be supplied following construction details review.

4.14 Utility Trench Backfill

Utility trench backfill within the structural pad and beyond should be placed in accordance with the following recommendations:

- Trench backfill should be placed in 6 to 8-inch thin lifts mechanically compacted to 90 percent or better of the laboratory maximum dry density for the soils used. Jetting is not recommended within utility trench backfill. Within streets, upper 2 feet of the trench backfill should be compacted to 95% or better.

- Exterior trenches along a foundation or a toe of a slope and extending below a 1:1 imaginary line projected from the outside bottom edge of the footing or toe of the slope should be compacted to 90 percent of the Maximum Dry Density for the soils used during backfill. Excavations should conform to the requirements of Cal-Osha

4.15 Pre-Construction Meeting

It is recommended that no clearing of the site or any grading operation be performed without the presence of a representative of this office. An on-site pre-grading meeting should be arranged between the soils engineer and the grading contractor prior to any construction.

4.16 Seasonal Limitations

No fill shall be placed, spread or rolled during unfavorable weather conditions. Where the work is interrupted by heavy rains, fill operations shall not be resumed until moisture conditions are considered favorable by the soils engineer.

4.17 Planters

In order to minimize potential differential settlement to foundations, use of planters requiring heavy irrigation *should be restricted from using adjacent to structural footings.* In event such becomes unavoidable, planter boxes with sealed bottoms, should be considered.

4.18 Landscape Maintenance

Only the amount of irrigation necessary to sustain plant life should be provided. Pad drainage should be directed towards streets and to other approved areas away from foundations. Slope areas should be planted with draught resistant vegetation. Over watering landscape areas could adversely affect the proposed site development during its life-time use.

4.19 Observations and Testing During Construction

Recommendations provided assume that structural footings and slab-on-grade be established exclusively into compacted fills. Excavated footings should be inspected, verified and certified by soils engineer prior to steel and concrete placement to ensure their sufficient embedment and proper bearing as recommended. Structural backfills discussed should be placed under direct observations and testing by this facility. Excess soils generated from footing excavations should be removed from pad areas and such should not be allowed on subgrades underlying concrete slab.

4.20 Plan Review

No precise grading or development plans are prepared and none such is available for review. Prior to actual mass grading, grading and foundation plans should be available so as to ensure applicability of the assumptions made in preparing this report. If during construction, conditions are observed different from those as presented, revised and/or supplemental recommendations will be required.

5.0 Earth Work/General Grading Recommendations

The project area is currently underlain with dry loose gravelly sandy soils with cobbles, rocks and minor boulders. Prior to grading commencement, it is suggested that all debris and loose stockpiles, if any, should be cleared and disposed off of-site to the satisfaction of soils engineer. In general, site preparations and grading for the project should include, in minimum the following:

Structural Backfill:

Local soils free of organic, debris and rocks larger than 6-inch in overall diameter should be considered suitable for reuse as structural backfill. Loose soils, formwork and debris should be removed prior to backfilling retaining walls. Local soils backfill should be placed and compacted in accordance with the recommended specifications provided below. Where space limitations do not allow conventional backfilling operations, special backfill materials and procedures may be required. Pea gravel or other select backfill can be used within limited space areas. Additional recommendations on such will be provided during construction.

Percentage Compaction during Mass Grading

With the presence of silty gravelly site soils as encountered and assuming moderately high dead load and seismic peak ground acceleration as described, it is our opinion that during mass grading and structural fill soils placement, a minimum 95% relative compaction should be maintained of the soils Maximum Dry Density as determined by the ASTM Standard D1557 with moisture content at about 2% to 3% above Optimum. With the gravelly sandy soils use of vibratory sheeps-foot roller is recommended. Similar compaction efforts should be used for the subgrades once excavated as described in this report.

Site Drainage:

Adequate positive drainage should be provided maintained away from structural pad in order to prevent water from ponding and to reduce potential percolation into backfill. A desirable slope for surface drainage is 2 percent in landscape areas and 1 percent in paved areas. Planters and landscaped areas adjacent to building perimeter should be adequately designed to minimize water filtration into subsoils. Considerations should be given to the use of closed planter bottoms, concrete slabs and perimeter subdrains where applicable.

Utility Trenches:

Buried utility conduits should be bedded and backfilled around the conduit in accordance with the project specifications. Where conduit underlies concrete slab-on-grade and pavement, the remaining trench backfill above the pipe should be placed and compacted as described.

General Grading Recommendations:

Recommended general specifications for surface preparation to receive fill and compaction for structural and utility trench backfill and others are presented below.

1. Areas to be graded, backfilled or paved, shall be grubbed, stripped and cleaned of all buried and undetected debris, structures, concrete, vegetation and other deleterious materials prior to grading.

2. Where compacted fill is to provide vertical support for foundations, all loose, soft and other incompetent soils should be removed to full depth of 5 to 8 feet or up to the depth as approved by soils engineer. The areas of such removal should extend at least 5 feet beyond the perimeter of exterior foundation limit or to the extent as approved by soils engineer during grading.

3. The recommended compaction for fills to support foundations and slab-on-grade is 95% of soil's Maximum Dry Density at or near Optimum Moisture Content. To minimize potential differential settlements to foundations and slabs straddling over cut and fill transition, cut portions following cut, should be further over-excavated and such be replaced as engineered fill compacted to at least 90% of the soil's Maximum Dry Density as described in this report.

   Utility trenches planned within building pad areas and beyond should be backfilled with granular material and such should be mechanically compacted to at least 90% as described.

4. Compaction for structural fills shall be determined relative to the maximum dry density as determined by ASTM D1557 compaction methods. All in-situ field density of compacted fill shall be determined by the ASTM D1556 standard methods or by other approved procedures.

5. All new imported soils, if required, shall be clean, granular, non-expansive material requiring prior approval by soils engineer.

6. During grading, fill soils shall be placed as thin layers, thickness of which following compaction shall not exceed six inches.

7. In accordance with the CBC; rock sizes greater than 12 inches (305 mm) and up to 24 inches (610 mm) in maximum dimension shall be three feet (914 mm) or more below grade, measured vertically. Rock sizes greater than 24 inches (610 mm) in maximum dimension shall be 10 feet (3048 mm) or more below grade, measured vertically.

8. No jetting and/or water tampering be considered for backfill compaction for utility trenches without prior approval of the soils engineer. For such backfill, hand tampering with fill layers of 8 to 12 inches in thickness or as approved by the soils engineer is recommended.

9. Any and all utility trenches at depth as well as cesspool and abandoned septic tank within building pad area and beyond, should either be completely excavated and removed from the site, or should be backfilled with gravel, slurry or by other material, as approved by soils engineer.

10. Any and all import soils if required during grading should be equivalent to the site soils or better. The soils engineer prior to their use should approve such.

11. Any and all grading required for pavement, side-walk or other facilities to be used by general public, should be constructed under direct observation of soils engineer or as required by the local public agencies.

12. A site meeting should be held between grading contractor and soils engineer prior to actual site preparations and grading. Two days of prior notice will be required for such meeting.

6.0 Closure

The conclusions and recommendations presented are based on the findings and observations made at the time of subsurface test explorations. However, in absence of detailed grading and/or development plan, the recommendations supplied should be considered as "preliminary". Supplemental investigations and/or additional recommendations may be warranted in event the site soils exposed during construction appear different from those as described earlier in this report.

Recommendations provided are based on assumptions that structural footings will be established exclusively into engineered fills of local soils or its equivalent or better imported soils. No footings and/or slabs are allowed straddling over cut/fill transition interface.

FOOTING TRENCH EXCAVATIONS AND SLAB SUBGRADES SHALL BE VERIFIED IMMEDIATELY PRIOR TO VAPORT BARRIER COVERING AND CONCRETE POUR. SOILS SOUTHWEST WILL ASSUME NO RESPONSIBILITY OF ANY FUTURE STRUCTURAL DISTRESS IN EVENT THE ABOVE CONDITIONS ARE NOT MET.

This office should review final grading and foundation plans when they become available. Footing excavations should be inspected prior to steel and concrete placement to ensure that foundations are founded into satisfactory soils and excavations are free of loose and disturbed materials. Similar subgrade verifications are recommended prior to concrete slab-on-grade placement.

A pregrading meeting between grading contractor and soils engineer is recommended prior to construction preferably at the site, to discuss the grading procedures to be implemented and other requirements described in this report to be fulfilled.

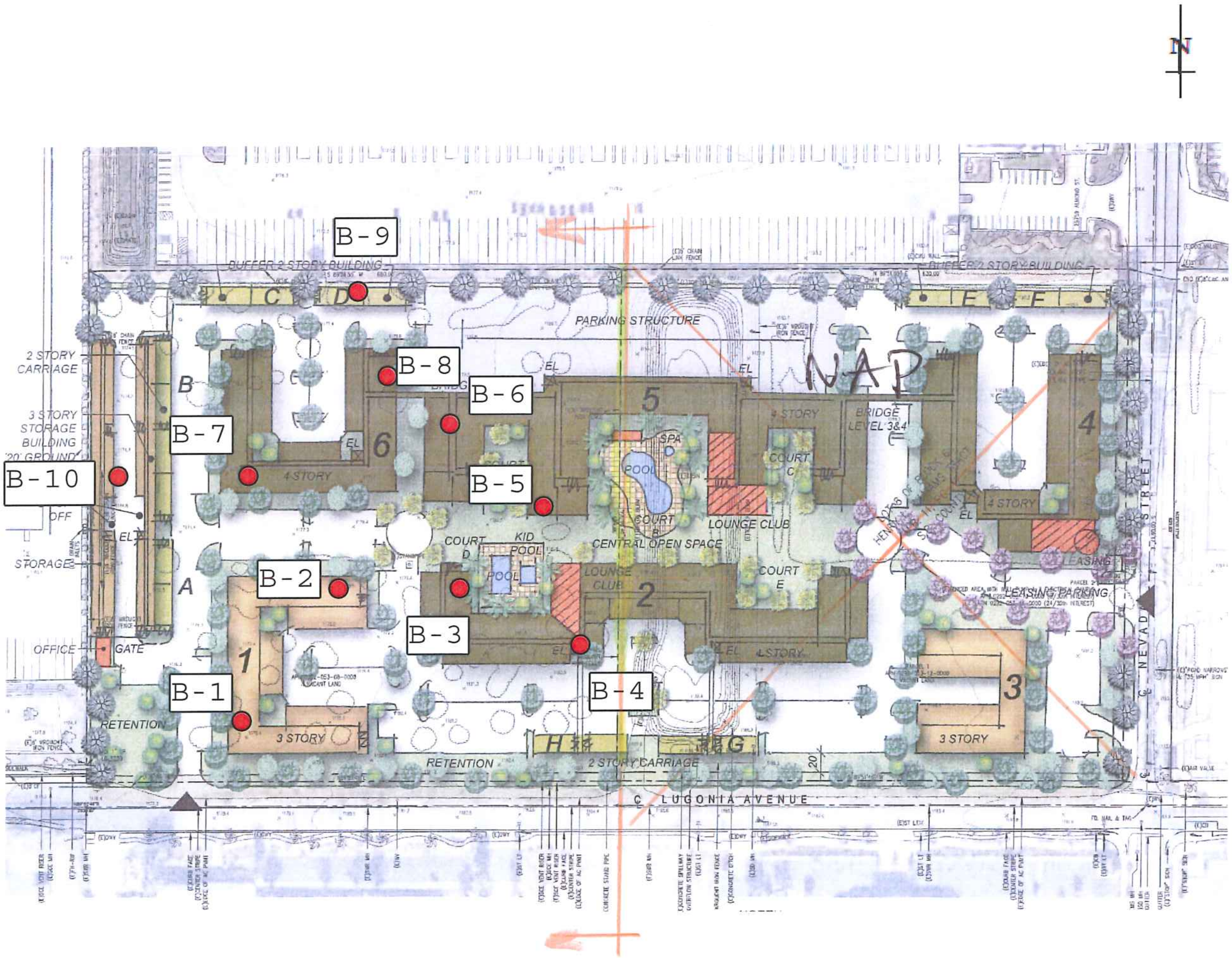
This report has been prepared exclusively for the use of the addressee for the project referenced in the context. It shall not be transferred or be used by other parties without a written consent by Soils Southwest, Inc. We cannot be responsible for use of this report by others without the necessary inspection and testing by our personnel.

Should the project be delayed beyond one year after the date of this report; the recommendations presented shall be reviewed to consider any possible change in site conditions.

The recommendations presented assume that necessary geotechnical observations and testing during mass grading and construction will be on continuous basis, or as deemed necessary by the project soils engineer. The field observations are considered a continuation of the geotechnical investigation performed. If another firm is retained for geotechnical observations and testing, our professional liability and responsibility shall be limited to the extent that Soils Southwest would not be the geotechnical engineer of record and a letter of Transfer of Responsibility should be provided from new geotechnical engineer as per the requirements of the current CBC.

PLOT PLAN AND TEST LOCATIONS

(Not to Scale)



Legend: ● B-1 Approximate Location of Test Boring

Plate 1

7.0 APPENDIX A

Field Explorations

Field evaluations included site reconnaissance and six test borings using a hollow-stem auger drill-rig. During site reconnaissance, the surface conditions were noted and test exploration locations were determined.

Soils encountered during explorations were logged and such were classified by visual observations in accordance with the generally accepted classification system. The field descriptions were modified, where appropriate, to reflect laboratory test results. Approximate test locations are shown on Plate 1.

Relatively undisturbed soils were sampled using a drive sampler lined with soil sampling rings. The split barrel steel sampler was driven into the bottom of test excavations at various depths. Soil samples were retained in brass rings of 2.5 inches in diameter and 1.00 inch in height. The central portion of each sample was enclosed in a close-fitting waterproof container for shipment to our laboratory. In addition to undisturbed sample, bulk soil samples were procured as described in the logs.

Logs of test explorations are presented in the following summary sheets that include the description of the soils and/or fill materials encountered.

LOG OF TEST EXPLORATIONS

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-1

Project: Redlands Crossing II (West End) **Job No.:** 16024-F
Logged By: John F. **Boring Diam.:** 8" HSA **Date:** 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SM			tilled weeds
	◣							SILTY SAND - light gray-brown, fine, occasional pebble, loose, dry - scattered rock fragments - (Max Density = 119 pcf @ 11.5%)
							5	
	■	2.1	99.9	84				
7	◪				SP			SAND - loose, fine to medium, pebbles, dry
							10	
	■	1.5	91.9	77	SM-ML			- loose, slightly silty, fine, dry
							15	
11	◪							- medium dense, fine to medium, pebble, dry
							20	
	■	1.7	103.3	87				
							25	
8	◪							- color change to light gray, traces of silt, dry, loose
							30	

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada Street
Redlands, California

Plate #

◣ Bulk/Grab sample ■ California sampler ◪ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-1

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
								- color change to light brown, traces of silt, fine, dry
							40	
	■	1.0	108.1	91	SP-SM			- dense, traces of silt,fine to medium coarse, pebbles, scattered rock fragments, dry
								- End of test boring @ 41.0 ft. - no bedrock - no groundwater
							45	
							50	
							55	
							60	
							65	
							70	

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-2

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SM			tilled weeds
								SILTY SAND - light gray-brown, fine, occasional pebble,loose, dry
							5	
							10	
6	◩				SM-ML			- color change to light gray, loose, traces of silt, scattered pebble, fine, dry
							15	
							20	
12	◩				VS			- color change to light gray brown, medium dense, fine to medium, pebble, dry
								- End of test boring @ 21.0 ft. - no bedrock - no groundwater
							25	
							30	

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location

Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada
Street
Redlands, California

Plate #

◪ Bulk/Grab sample ■ California sampler ◩ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-3

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP			tilled weeds
								SAND - light gray-brown, traces of silt, fine, pebble, loose, dry
							5	
	■	2.5	102	86	VS			SILT & SAND MIX - fine, occasional pebble, dry, loose
							10	
								- color change to light yellowish gray-brown, fine, dry, pebbles
							15	
	■	3.2	84.1	71				- loose, fine, dry
								- End of test boring @ 16.0 ft. - no bedrock - no groundwater
							20	
							25	
							30	

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada Street
Redlands, California

Plate #

◩ Bulk/Grab sample ■ California sampler ◪ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-4

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SM-ML			tilled weeds SAND - light gray-brown, slightly silty, fine, pebble, dry, loose
	■	2.1	102.2	86	VS		5	SILT-SAND MIX - fine, occasional pebble, dry, loose
	■				VS		10	- fine to medium, pebble, dry, loose - NO CALIFORNIA RING RECOVERY
7	◩						15	- color change to light yellowish gray brown, dry, loose
	■	1.0	105.2	88	SP		20	SAND - color change to light gray-brown, fine to medium, pebble, scattered rock fragments
12	◩				ML		25	SILT - medium dense, dry - End of test boring @ 26.0 ft. - no bedrock - no groundwater
							30	

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada Street
Redlands, California

Plate #

◥ Bulk/Grab sample ■ California sampler ◩ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-5

Project:	Redlands Crossing II (West End)	**Job No.:**	16024-F
Logged By: John F.	**Boring Diam.:** 8" HSA	**Date:**	6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP-SM			tilled weeds
								SAND - light gray-brown, traces of silt, fine, occasional pebble, loose, dry
	◣							
							5	
6	◪						10	- color change to light gray, fine to medium coarse, pebble, scattered rock fragments, dry, loose
							15	- medium dense, fine to medium, pebble, dry
14	◪						20	- color chang to light gray brown, fine to medium coarse, pebble, occasional rock fragments, scatttered rock 1/2" medium dense, dry
							25	
15	◪				VS		30	SILT and SAND MIX - fine, medium dense, dry

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada
Street
Redlands, California

Plate #

◣ Bulk/Grab sample ■ California sampler ◪ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-5

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
							40	- color change to light brown, traces of silt, fine, dry
19	◣				SP-SM			SAND - traces of silt, fine to medium, pebbles, dry, medium dense
								- End of test boring @ 41.0 ft. - no bedrock - no groundwater
							45	
							50	
							55	
							60	
							65	
							70	

Soils Southwest, Inc.
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LOG OF BORING B-6

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP-SM			tilled weeds
								SAND - light gray-brown, traces of silt, fine, occasional pebble,loose, dry
							5	- color change to light yellowish, gray brown, fine, dry
					VS			SILT & SAND MIX - color change to light gray fine, dry, loose
6	◪							
							10	
							15	
	■	1.0	102	86				
							20	- color chang to light gray brown
14	◪							
							25	SAND- medium dense, traces of silt, fine, dry
	■	1.2	101.6	85				
							30	
	■	2.3	95.8	80				
								- End of test boring @ 31.0 ft. - no bedrock - no groundwater

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada Street
Redlands, California

Plate #

◩	Bulk/Grab sample
■	California sampler
◪	Standard penetration test

Soils Southwest, Inc.
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Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-7

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP-SM			tilled weeds
								SAND - light gray-brown, traces of silt, fine, occasional pebble, loose,dry
5	◩						5	- color change to gray, traces of silt, fine, dry, loose
	■	5.6	92	77	VS		10	SILT and SAND MIX - color change to light gray brown, fine, occasional pebble, dry loose
							15	- medium dense, fine to medium, pebble, dry
8	◩							- loose, fine, dry
	■	0.6	95	80.0	SP		20	SAND - fine to medium, pebbles, scattered rock fragments, dry, loose
							25	
11	◩				VS		30	SILT and SAND MIX - fine, dry, low to medium dense

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada Street
Redlands, California

Plate #

◪ Bulk/Grab sample ■ California sampler ◩ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-7

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
							40	
14	◩							- color change to light brown to gray, fine, damp to moist, medium dense
								- End of test boring @ 41.0 ft. - no bedrock - no groundwater
							45	
							50	
							55	
							60	
							65	
							70	

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-8

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP-SM			tilled weeds SAND - light gray-brown, traces of silt, fine, occasional pebble, loose, dry
	◩				SM-ML		5	- color change to light brown, fine, occasional pebble, scattered rock fragments, dry
	■	1.0	107.1	90	VS		10	SAND- color change to light gray, fine to medium coarse, pebble, occasional rock fragments, dry
11	◪				GP-SP		15 20	- color change to light gray-brown, gravely, medium to medium coarse, pebble, occasional rock fragments, dry, low to medium dense.
	■	5.6	106.9	90	VS		25	SILTY SAND MIX - fine, dry, medium dense to dense
8	◪						30	- loose
								- End of test boring @ 31.0 ft. - no bedrock - no groundwater

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada
Street
Redlands, California

Plate #

◩ Bulk/Grab sample ■ California sampler ◪ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-9

Project: Redlands Crossing II (West End)

Job No.: 16024-F

Logged By: John F.

Boring Diam.: 8" HSA

Date: 6-1-2016

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP-SM			tilled weeds SAND - light gray-brown, traces of silt, fine, occasional pebble, scattered rock fragments, dry, loose
							5	
					SP		10	SAND- color change to light gray, fine to medium coarse, pebble, occasional rock fragments, scattered rock, dry, loose
6	◩							
							15	- fine to medium coarse
							20	
					VS			SILT and SAND MIX - fine, dry, medium dense
14	◩							
							25	
	■	3.6	92.1	77	SP-SM			SAND - color change to gray-brown, traces of silt, fine to medium, pebble
								- End of test boring @ 26.0 ft. - no bedrock - no groundwater
							30	

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada Street
Redlands, California

Plate #

◪ Bulk/Grab sample ■ California sampler ◩ Standard penetration test

Soils Southwest, Inc.
897 Via Lata, Suite N
Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING B-10

Project: Redlands Crossing II (West End)
Job No.: 16024-F
Logged By: John F.
Boring Diam.: 8" HSA
Date: 6-1-2016

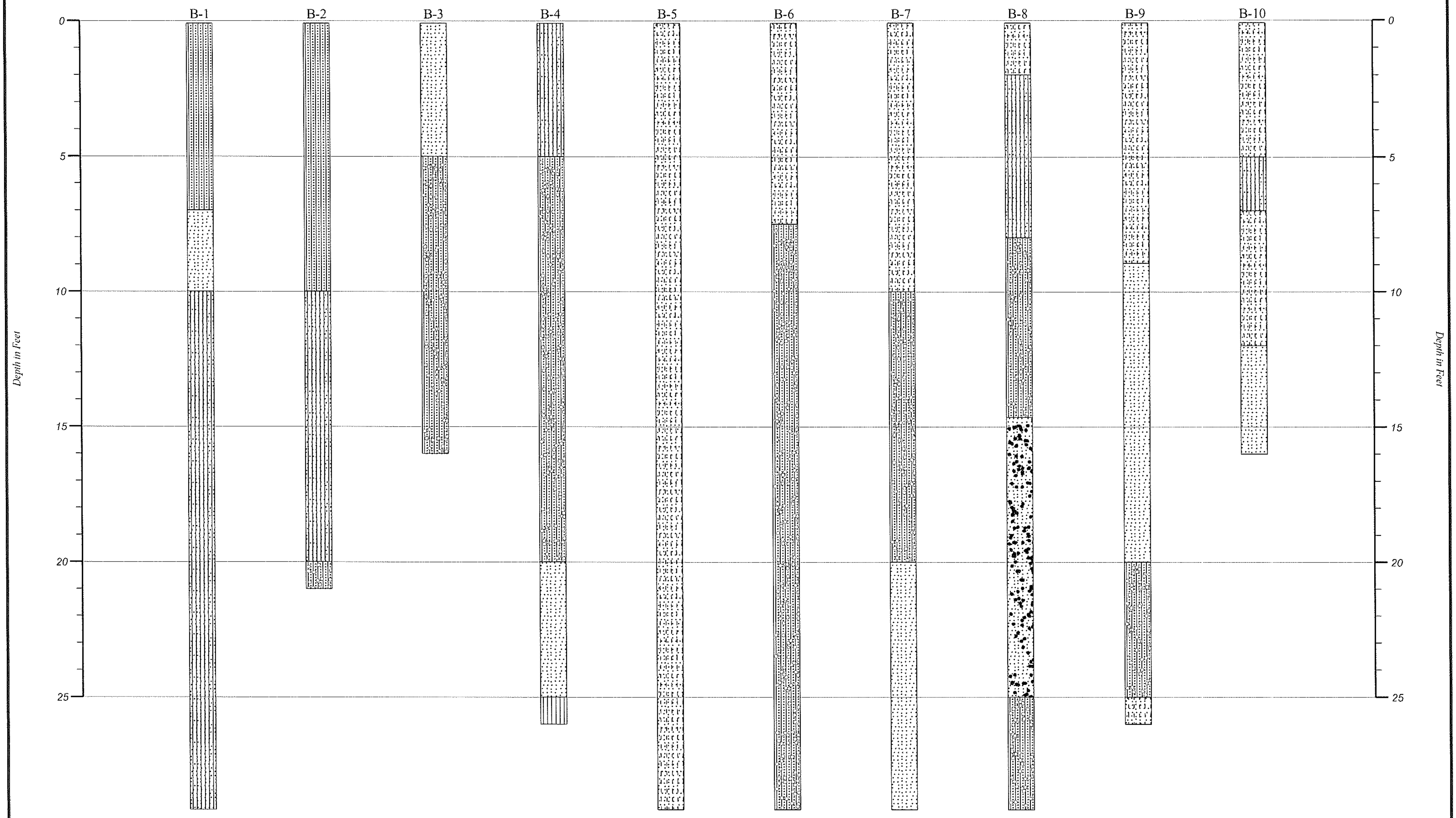
Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SP-SM			tilled weeds SAND - light gray-brown, traces of silt, fine, occasional pebble, dry, loose
							5	
	■	0.8	102.8	86	SM-ML			- slightly silty, fine, occasional pebble, dry, very loose
4	◪				SP-SM			- color change to light yellowish gray brown, traces of silt, fine, pebble, scattered rock fragments, dry
							10	
5	◪				SP			- fine to medium coarse, pebble, occasional rock fragments, damp, loose
							15	
	■	6.7	98.3	82				- slightly silty, fine to medium, pebble, occasional rock fragments, dry to damp, low to medium dense
								- End of test boring @ 16.0 ft. - no bedrock - no groundwater
							20	
							25	
							30	

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: n/a

Site Location
Proposed Multi-family Residential
West Lugonia Avenue w/o Nevada
Street
Redlands, California

Plate #

◥ Bulk/Grab sample ■ California sampler ◪ Standard penetration test



Plan View

<u>Strata symbols</u>

- Silty sand
- Poorly graded sand
- Poorly graded silty fine sand
- Variable sand and silt mix
- Silt
- Poorly graded sand with silt
- Poorly graded gravel and sand

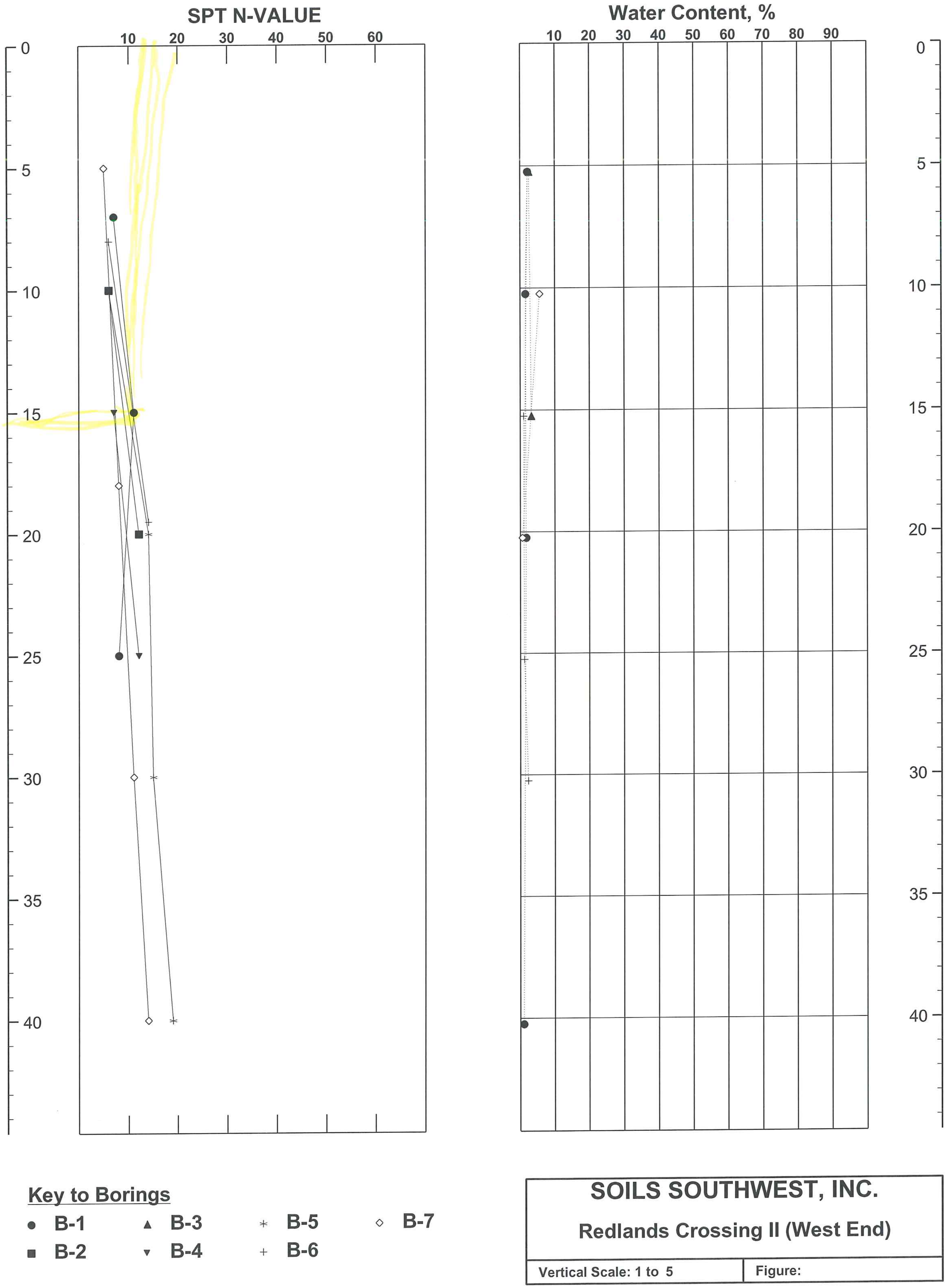
SOILS SOUTHWEST, INC.

GENERALIZED SOIL PROFILE

HORIZONTAL SCALE:	DRAWN BY/APPROVED BY	DATE DRAWN
VERTICAL SCALE: 1"=5'		6/6/2016

Redlands Crossing II (West End)

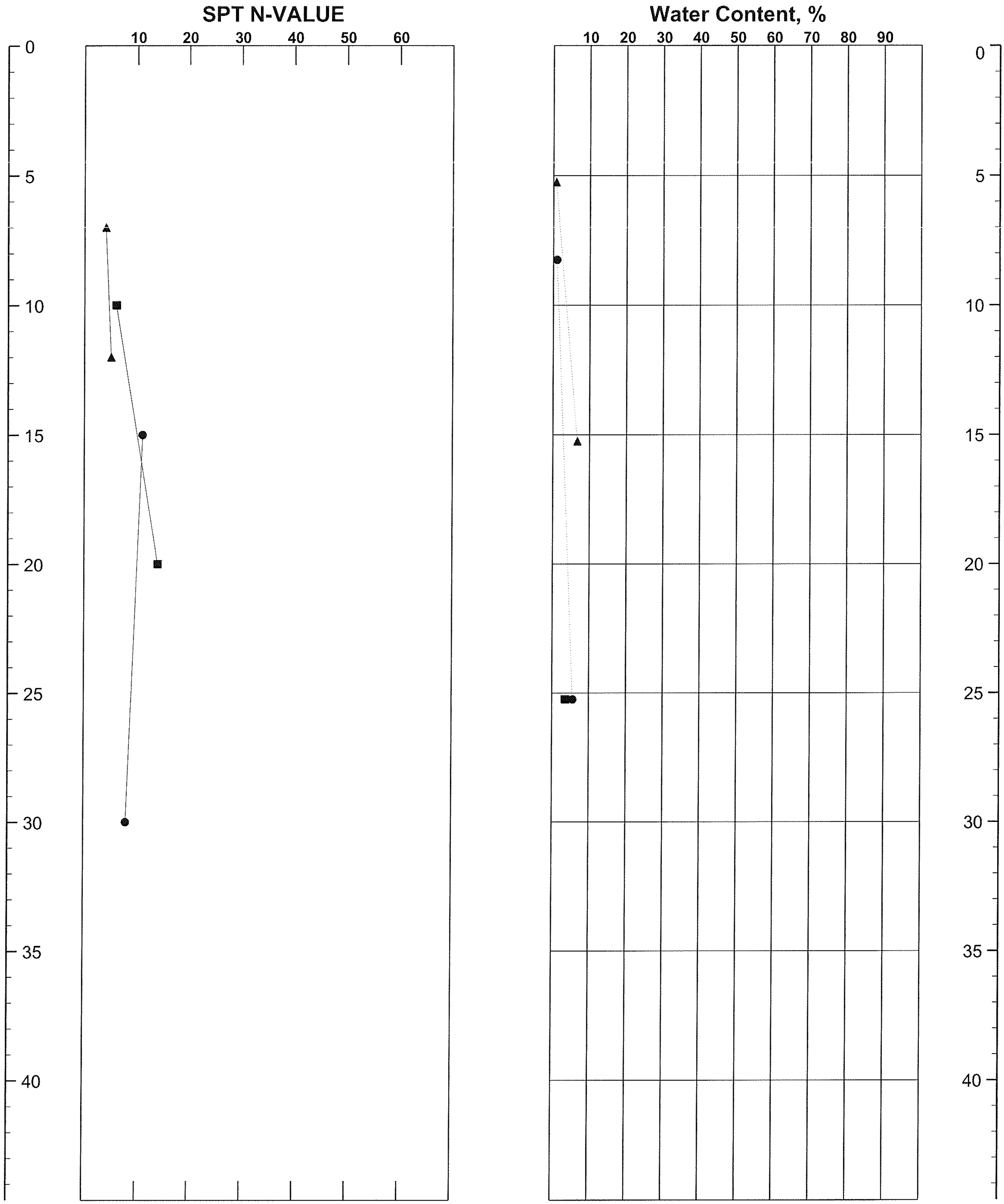
PROJECT NO. 16024-F	FIGURE NUMBER



SOILS SOUTHWEST, INC.

Redlands Crossing II (West End)

Vertical Scale: 1 to 5	Figure:



Key to Borings

● B-8 ▲ B-10

■ B-9

SOILS SOUTHWEST, INC.

Redlands Crossing II (West End)

Vertical Scale: 1 to 5	Figure:

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
▥	Silty sand
░	Poorly graded sand
▥	Poorly graded silty fine sand
▒	Poorly graded sand with silt
Soil Samplers	
◩	Bulk/Grab sample
■	California sampler
◪	Standard penetration test

Notes:

1. Exploratory borings were drilled on 6-1-2016 using a 4-inch diameter continuous flight power auger.

2. No free water was encountered at the time of drilling or when re-checked the following day.

3. Boring locations were taped from existing features and elevations extrapolated from the final design schematic plan.

4. These logs are subject to the limitations, conclusions, and recommendations in this report.

5. Results of tests conducted on samples recovered are reported on the logs.

8.0 APPENDIX B

Laboratory Test Programs

Laboratory tests were conducted on representative soils for the purpose of classification and for the determination of the physical properties and engineering characteristics. The number and selection of the types of testing for a given study are based on the geotechnical conditions of the site. A summary of the various laboratory tests performed for the project is presented below.

Moisture Content and Dry Density (D2937):

Data obtained from these test, performed on undisturbed samples are used to aid in the classification and correlation of the soils and to provide qualitative information regarding soil strength and compressibility.

Direct Shear (D3080):

Data obtained from this test performed at increased and field moisture conditions on relatively remolded soil sample is used to evaluate soil shear strengths. Samples contained in brass sampler rings, placed directly on test apparatus are sheared at a constant strain rate of 0.002 inch per minute under saturated conditions and under varying loads appropriate to represent anticipated structural loadings. Shearing deformations are recorded to failure. Peak and/or residual shear strengths are obtained from the measured shearing load versus deflection curve. Test results, plotted on graphical form, are presented on Plate B-1 of this section.

Consolidation (D2835):

Drive-tube samples are tested at their field moisture contents and at increased moisture conditions since the soils may become saturated during life-time use of the planned structure.

Data obtained from this test performed on relatively undisturbed and/or remolded samples, were used to evaluate the consolidation characteristics of foundation soils under anticipated foundation loadings. Preparation for this test involved trimming the sample, placing it in one inch high brass ring, and loading it into the test apparatus which contained porous stones to accommodate drainage during testing. Normal axial loads are applied at a load increment ratio, successive loads being generally twice the preceding.

Soil samples are usually under light normal load conditions to accommodate seating of the apparatus. Samples were tested at the field moisture conditions at a predetermined normal load. Potentially moisture sensitive soil typically demonstrated significant volume change with the introduction of free water. The results of the consolidation tests in graphical forms are attached.

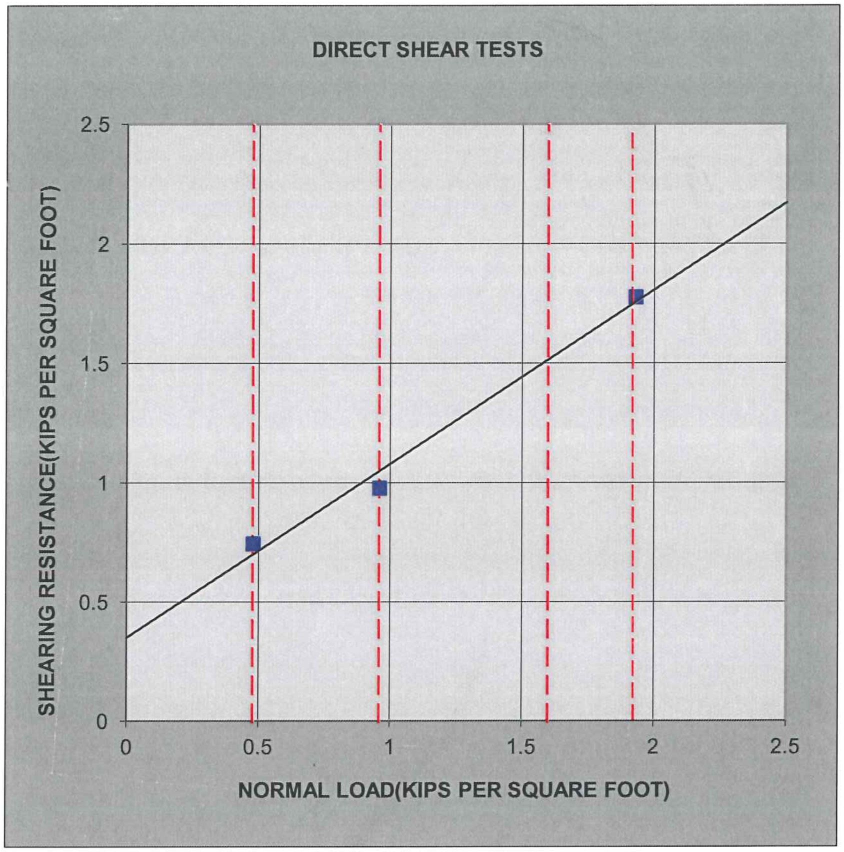
Laboratory Test Results

Table I: In-Situ Moisture-Density (ASTM D2937)

Test Boring No.	Sample Depth, ft.	Dry Density, pcf.	Moisture Content, %
1	5	100	2.1
1	10	92	1.5
1	20	103	2.7
1	40	108	1.0
3	5	102	2.5
3	15	84	3.2
4	5	102	2.0
4	20	105	1.0
6	15	102	1.0
6	25	102	1.2
6	30	96	2.3
7	10	92	5.6
7	20	95	0.6
8	8	107	1.0
8	25	107	5.6
9	25	92	3.6
10	5	103	0.8
10	15	98	6.7

Table II: Max. Density/Optimum Moisture Content (ASTM D1557-91)

Sample Location @ depth, ft.	Max. Dry Density, pcf	Optimum Moisture (%)
(A) B-1 @ 2-5	119	11.5

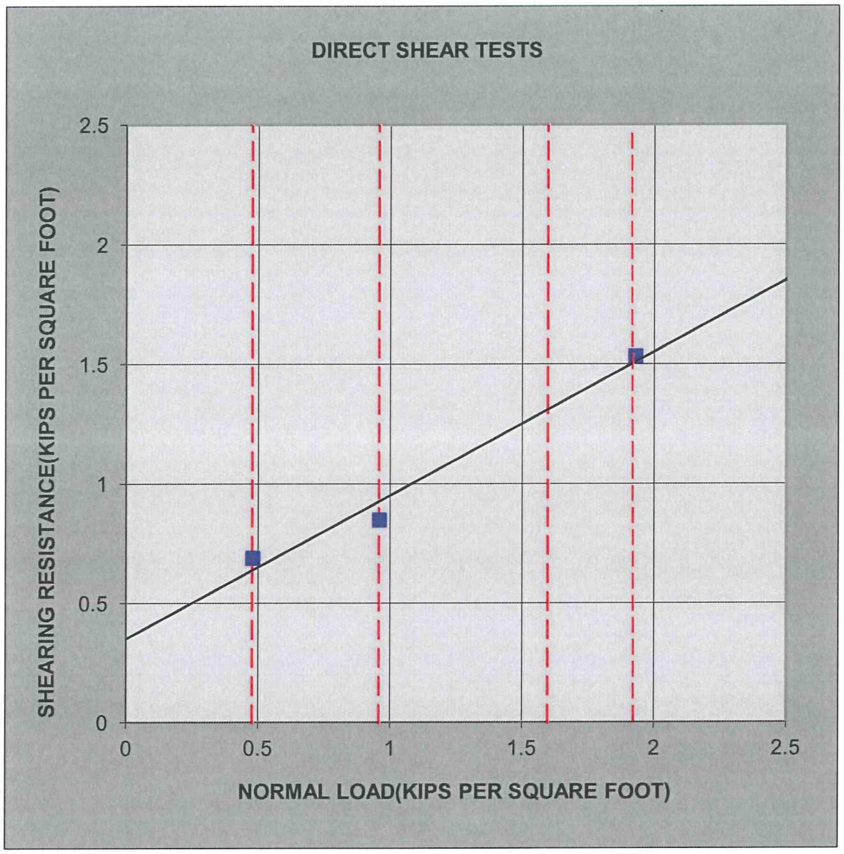


SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	B-1	2 to 5	Remolded to 90% Residual	350.40	36.08

Redlands Crossing II (West End)
W. Lugonia Avenue w/o Nevada St.
Redlands, California

PROJECT NO.	16024-F
PLATE	B-1

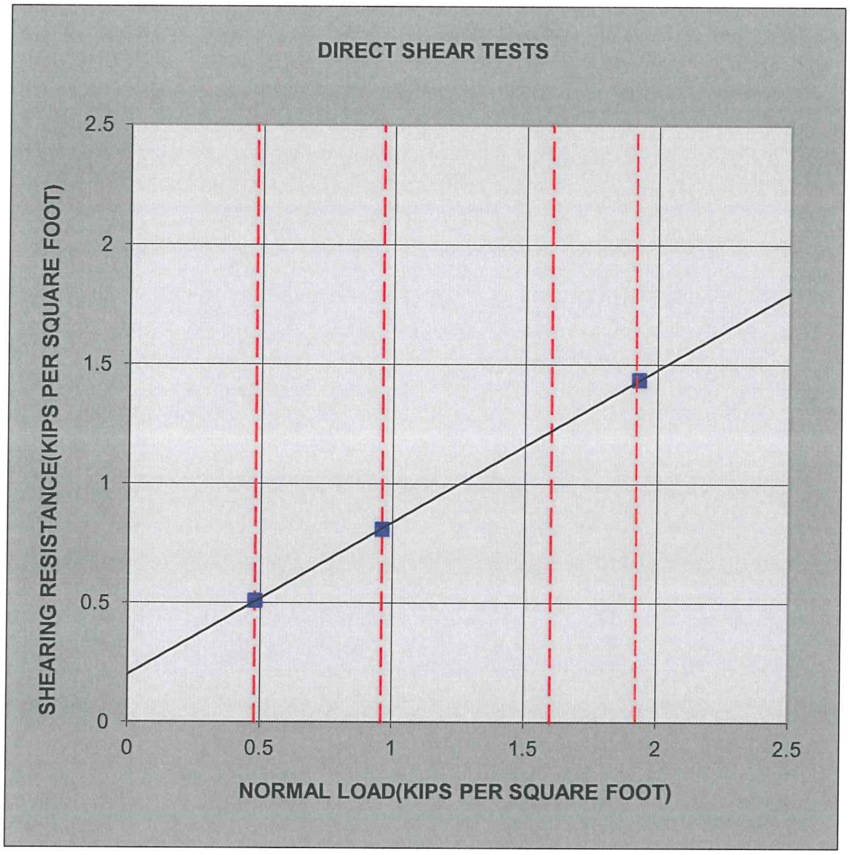
SOILS SOUTHWEST, INC.
Consulting Foundation Engineers



SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	B-1	10.0	Undisturbed (field moiture) Residual	350.24	30.99

Redlands Crossing II (West End) W. Lugonia Avenue w/o Nevada St. Redlands, California	PROJECT NO.	16024-F
	PLATE	B-1-1

SOILS SOUTHWEST, INC.
Consulting Foundation Engineers

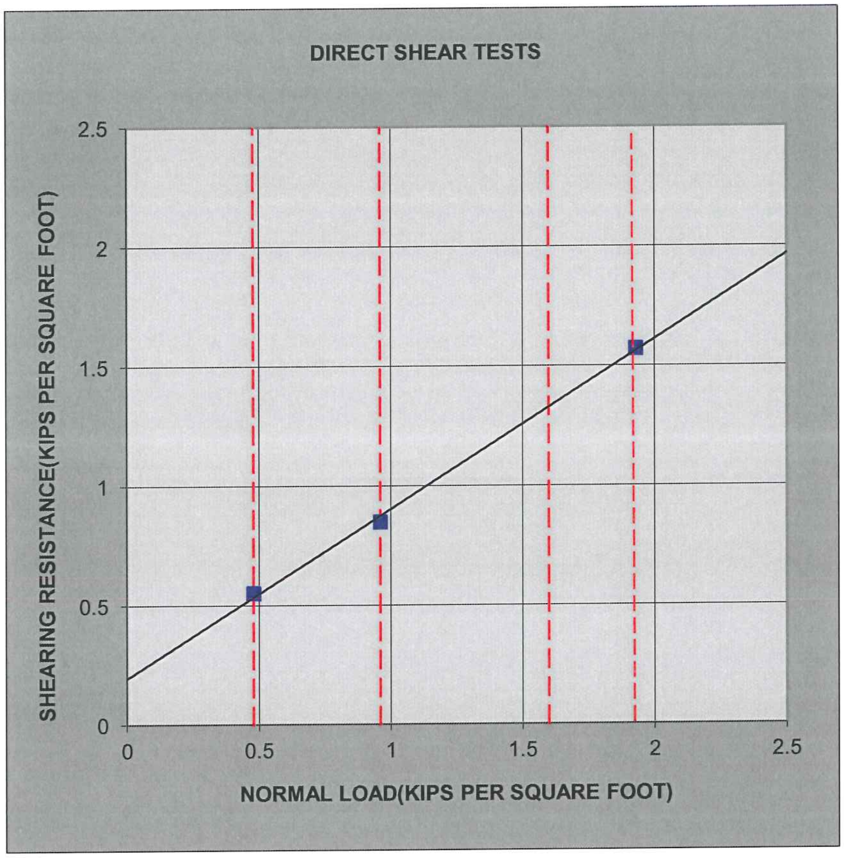


SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	B-3	5.0	Undisturbed (field moiture) Residual	200.13	32.61

Redlands Crossing II (West End)
W. Lugonia Avenue w/o Nevada St.
Redlands, California

PROJECT NO.	16024-F
PLATE	B-1-2

SOILS SOUTHWEST, INC.
Consulting Foundation Engineers



SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	B-6	30.0	Undisturbed (field moiture) Residual	195.11	35.33

Redlands Crossing II (West End)
W. Lugonia Avenue w/o Nevada St.
Redlands, California

PROJECT NO.	16024-F
PLATE	B-1-3

SOILS SOUTHWEST, INC.
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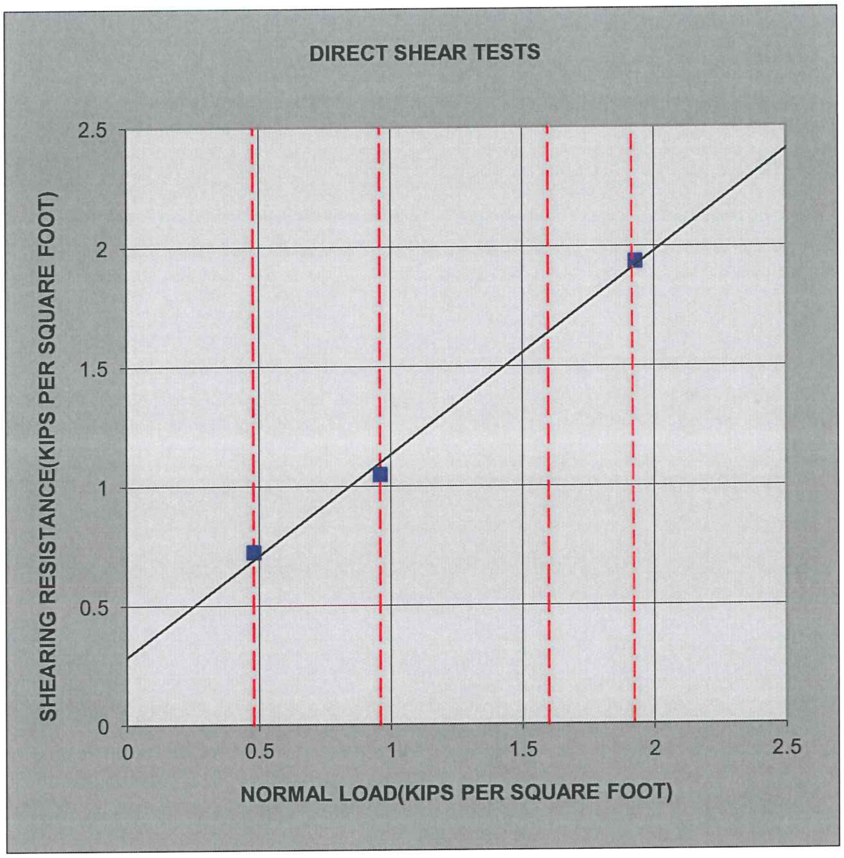

SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	B-8	25.0	Undisturbed (field moisture) Residual	285.07	40.30

Redlands Crossing II (West End)
W. Lugonia Avenue w/o Nevada St.
Redlands, California

PROJECT NO.	16024-F
PLATE	B-1-4

SOILS SOUTHWEST, INC.
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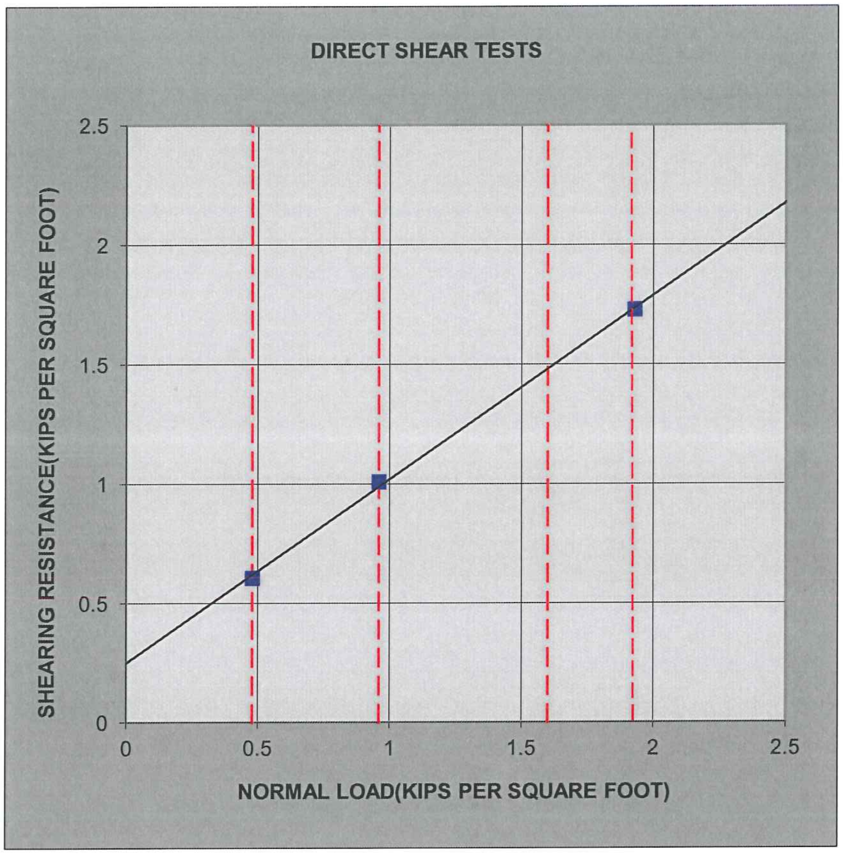

SYMBOL	LOCATION	DEPTH (FT)	TEST CONDITION	COHESION (psf)	FRICTION (degree)
■	B-10	15.0	Undisturbed (presaturated) Residual	250.42	37.60

Redlands Crossing II (West End) W. Lugonia Avenue w/o Nevada St. Redlands, California	PROJECT NO.	16024-F
	PLATE	B-1-5

SOILS SOUTHWEST, INC.

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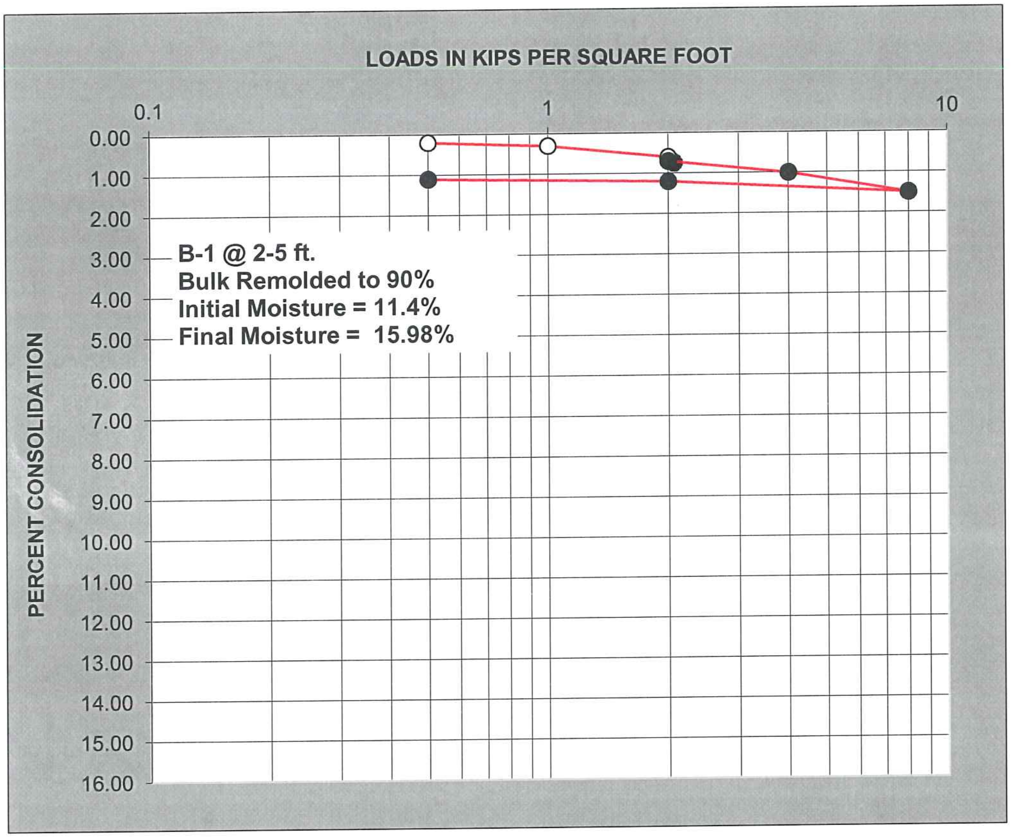
CONSOLIDATION TESTS

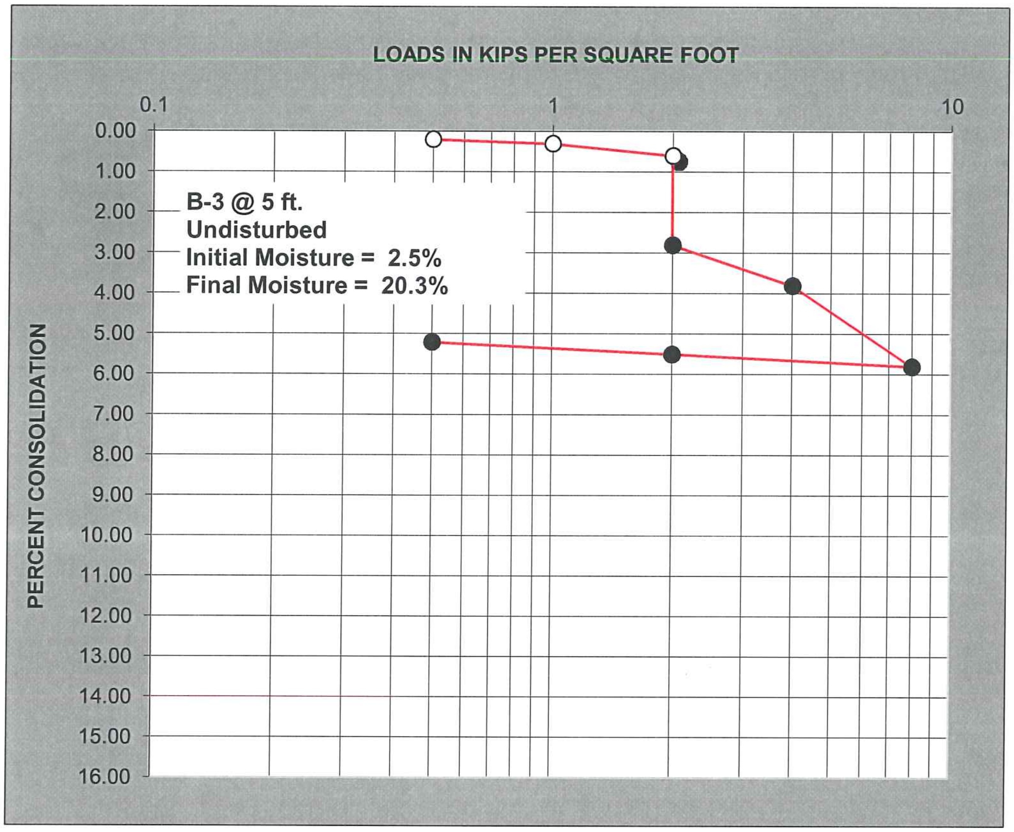


● **WATER PERMITTED TO CONTACT SAMPLE**

	PROJECT	Redlands Crossing II W. Lugonia Avenue/west of Nevada St. , Redlands		
	PROJECT NO.	16024-F	PLATE	B-2

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

CONSOLIDATION TESTS



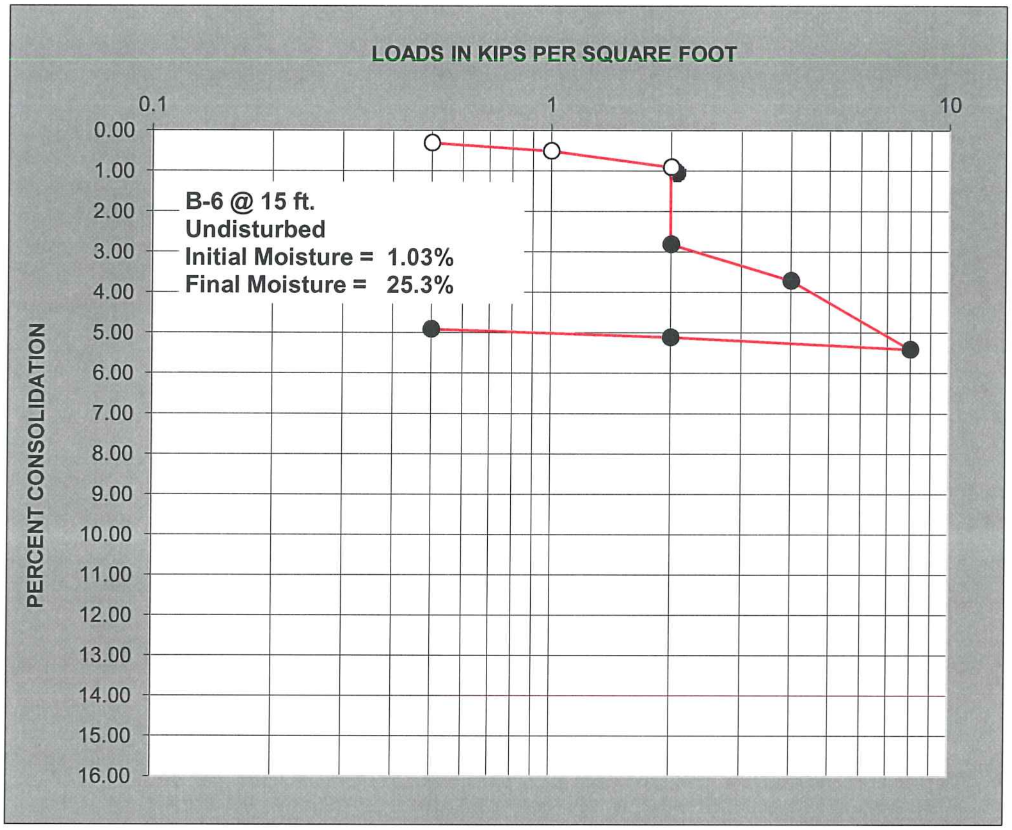
B-3 @ 5 ft.
Undisturbed
Initial Moisture = 2.5%
Final Moisture = 20.3%

● WATER PERMITTED TO CONTACT SAMPLE

PROJECT	Redlands Crossing II W. Lugonia Avenue/west of Nevada St. , Redlands			
PROJECT NO.	16024-F	PLATE	B-2-1	

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

CONSOLIDATION TESTS



B-6 @ 15 ft.
Undisturbed
Initial Moisture = 1.03%
Final Moisture = 25.3%

● **WATER PERMITTED TO CONTACT SAMPLE**

	PROJECT	Redlands Crossing II W. Lugonia Avenue/west of Nevada St. , Redlands		
	PROJECT NO.	16024-F	PLATE	B-2-2

SOILS SOUTHWEST INC.

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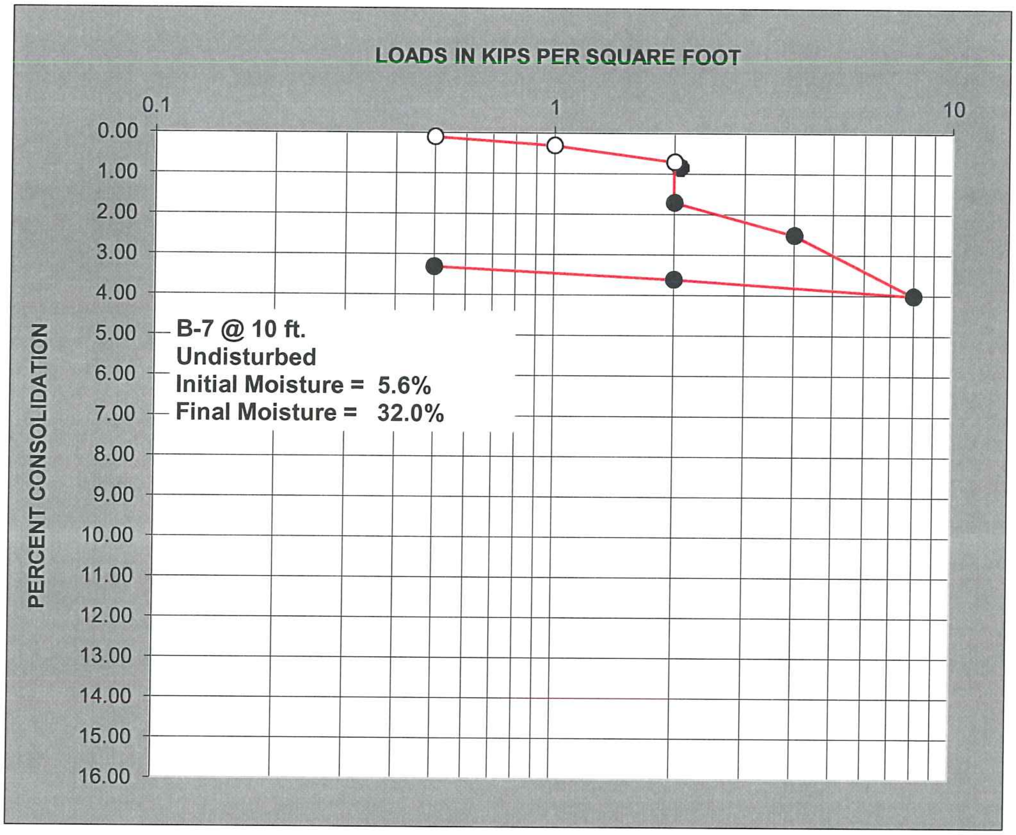
CONSOLIDATION TESTS

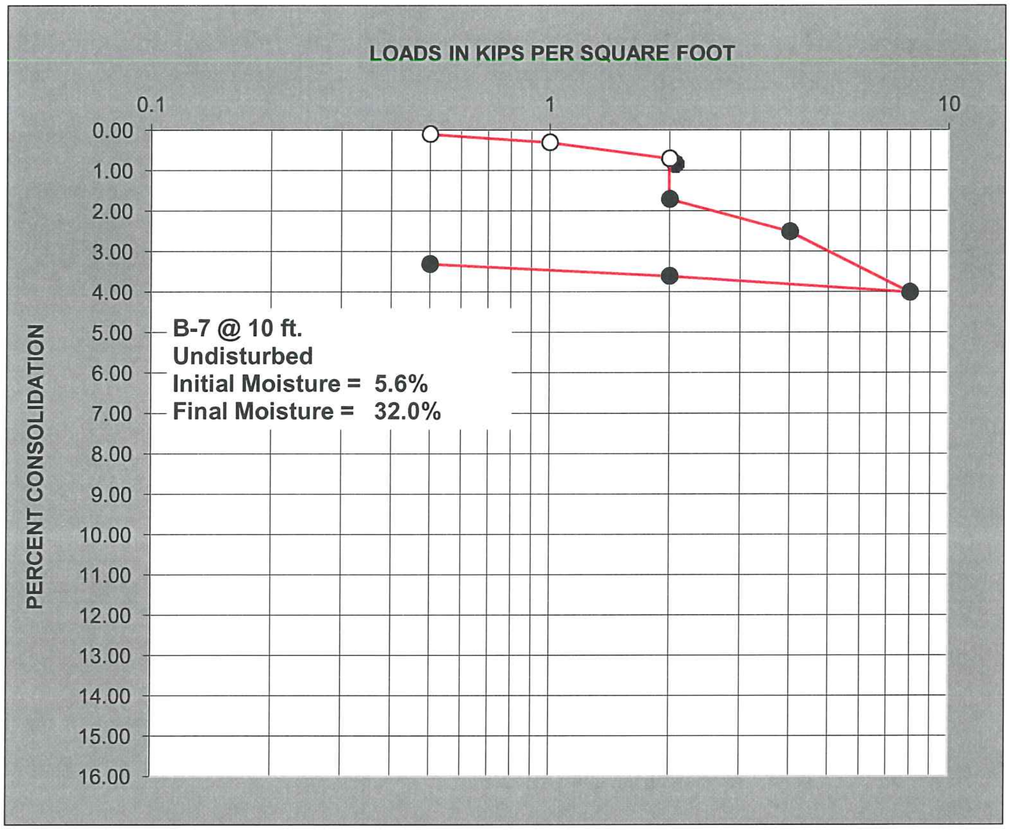


● **WATER PERMITTED TO CONTACT SAMPLE**

	PROJECT	Redlands Crossing II W. Lugonia Avenue/west of Nevada St. , Redlands		
	PROJECT NO.	16024-F	PLATE	B-2-3

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

CONSOLIDATION TESTS



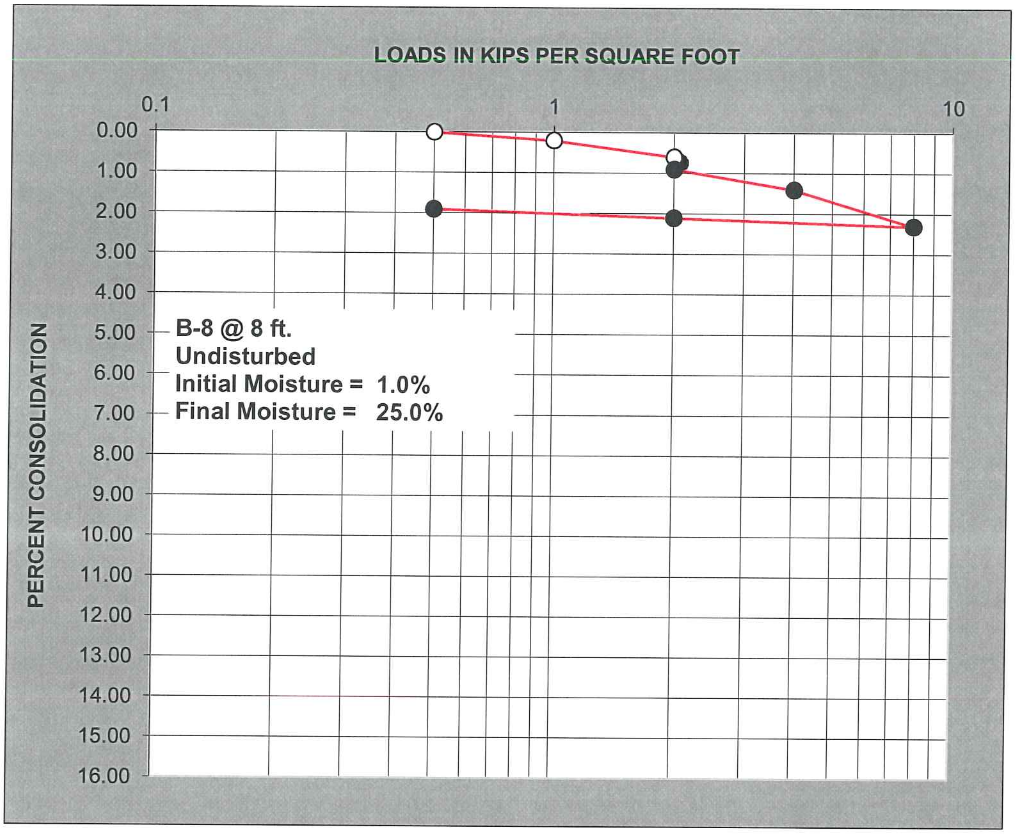
B-7 @ 10 ft.
Undisturbed
Initial Moisture = 5.6%
Final Moisture = 32.0%

● WATER PERMITTED TO CONTACT SAMPLE

PROJECT	Redlands Crossing II W. Lugonia Avenue/west of Nevada St. , Redlands			
PROJECT NO.	16024-F	PLATE	B-2-3	

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

CONSOLIDATION TESTS



● **WATER PERMITTED TO CONTACT SAMPLE**

	PROJECT	Redlands Crossing II W. Lugonia Avenue/west of Nevada St. , Redlands		
	PROJECT NO.	16024-F	PLATE	B-2-4

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

GRAIN SIZE DISTRIBUTION ASTM D422

Project: Redlands Crossing II/Mauge **Job #** 16024-F

Location: W. Lugonia Ave. w/o Nevada, Redlands **Boring No:** B-8 @2-5 **Sample No:** #3

Description of Soil: SILTY SANDS - fine, occasional pebble

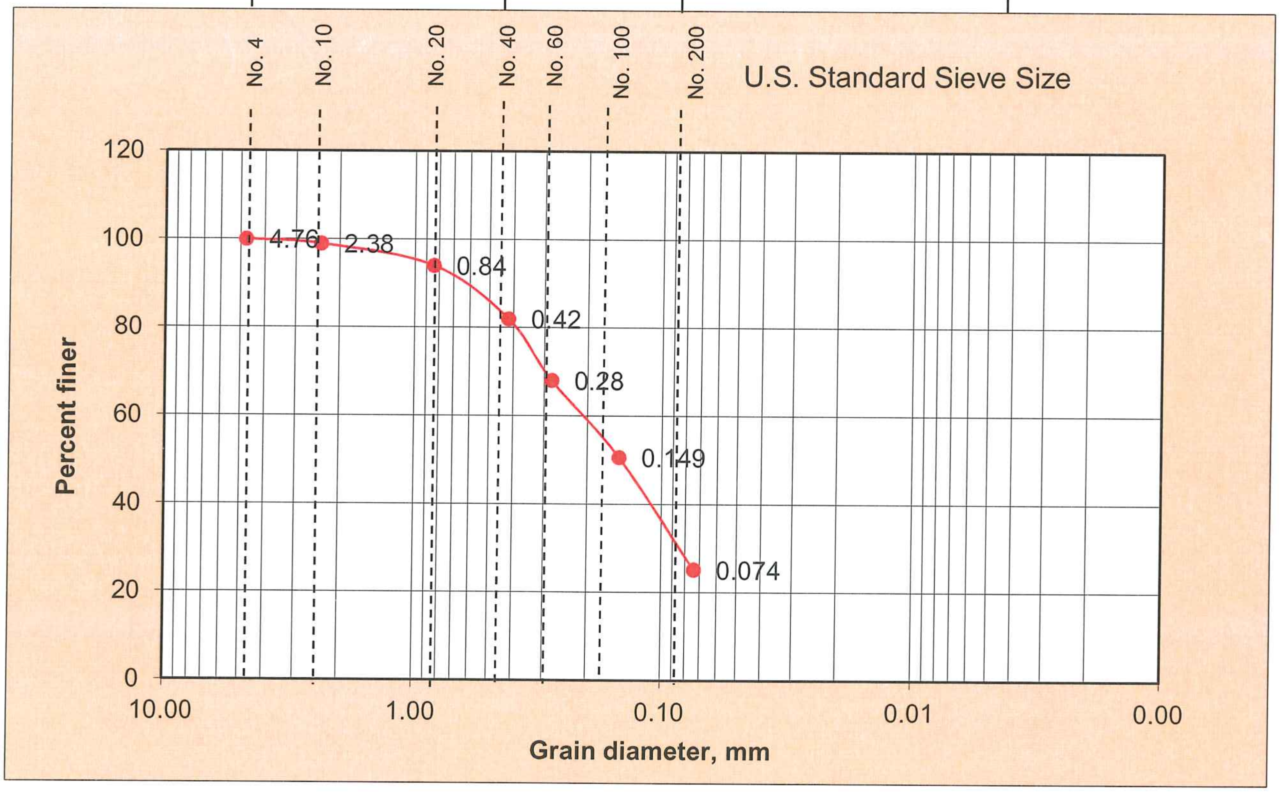
Date of Sample: 6/1/2016

Tested By: JF **Date of Testing:** 6/4/2016

Sieve No.	Sieve Openings in mm	Percent Finer
4	4.76	100.00
10	2.38	99.00
20	0.84	94.08
40	0.42	82.02
60	0.28	68.10
100	0.149	50.68
200	0.074	25.22

Grain Size	% Retained
Gravel	0
Med. to Crs	15
Fines	50
Silts	35

Gravel	Sand			
	Coarse to Medium	Fine	Silt	Clay



Visual Soil Description : SM - Silty sand/silt-sand mixtures, fine, occassional pebble light gray brown.

Soil Classification: SM

System: USC

SOILS SOUTHWEST INC.

Consulting Foundation Engineers

Table III: Direct Shear (ASTM D3080)

Test Boring & Sample Depth (ft)	Test Condition	Cohesion (PSF)	Friction (Degree)
B-1 @ 2-5	Remolded	350	36
B-1@ 10	Undisturbed (Field Moisture)	350	24
B-3 @5	Undisturbed (Field Moisture)	200	33
B-6 @ 30	Undisturbed (Field Moisture)	195	35
B-8 @25	Undisturbed (Field Moisture)	285	40
B-10 @15	Undisturbed (Presaturated)	250	38

APPENDIX C

Supplemental Seismic Design Parameters

As per 2013 CBC

State of California
Department of Conservation

Ground Motion Interpolator (2008)

Longitude: -117.220695

Latitude: 34.07086

VS30: 270 (180-1050 m/sec)

Return Period:

2% in 50 years 10% in 50 years

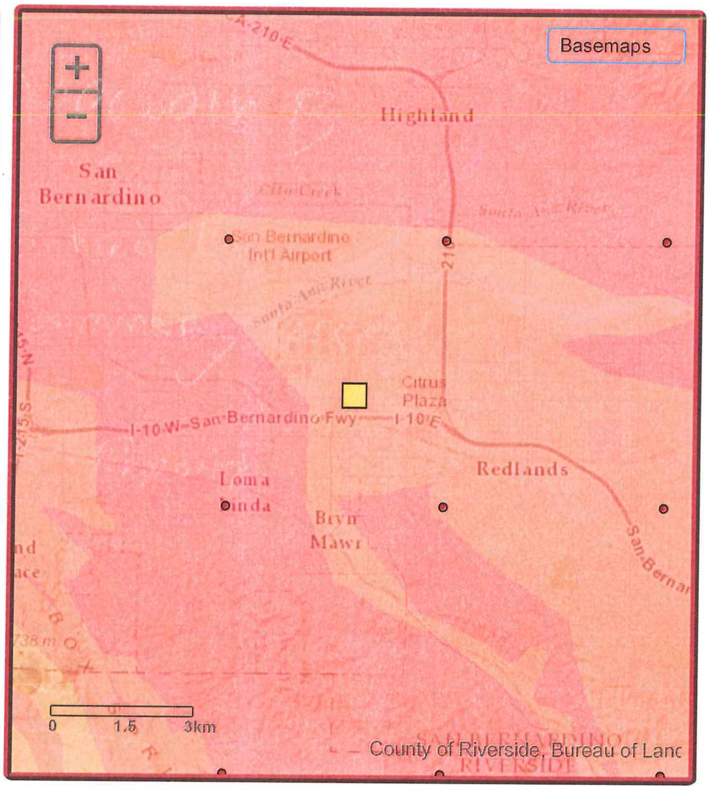
Spectral Acceleration:

PGA 0.2 second S A 1.0 second SA

Submit

Inputs:	**Result:**
-117.220695, 34.07086 vs30: 270 m/sec 10% in 50 years PGA	0.652 g

Information and Disclaimer



USGS Design Maps Summary Report

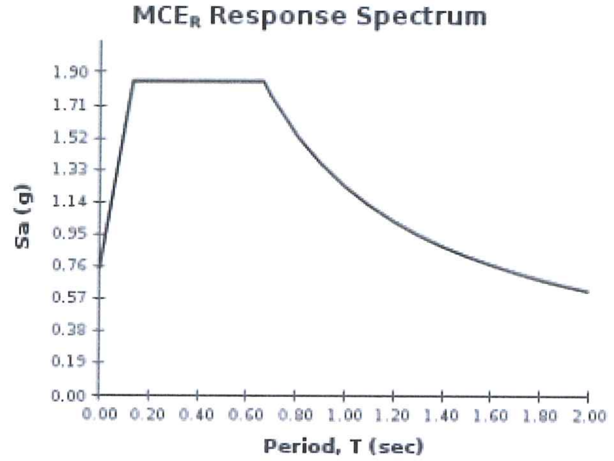
User–Specified Input

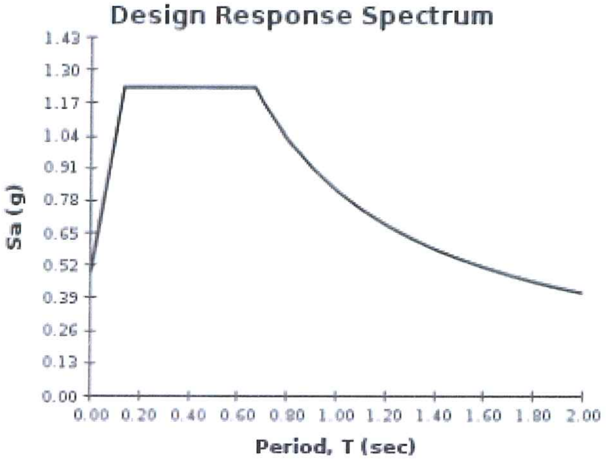
Report Title	Redlands Crossings II, West Lugonia Ave, Redlands Fri June 3, 2016 21:17:28 UTC
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	34.07086°N, 117.2207°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	1.850 g	S_{MS} =	1.850 g	S_{DS} =	1.233 g
S_1 =	0.821 g	S_{M1} =	1.232 g	S_{D1} =	0.821 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 (34.07086°N, 117.2207°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]	$S_S = 1.850$ g
From Figure 22-2 [2]	$S_1 = 0.821$ 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 = 1.850 g, F_a = 1.000

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
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 = 0.821 g, F_v = 1.500

Equation (11.4-1): $S_{MS} = F_aS_S = 1.000 \times 1.850 = 1.850$ g

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Equation (11.4-2): $S_{M1} = F_vS_1 = 1.500 \times 0.821 = 1.232$ g

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Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4-3): $S_{DS} = ⅔\, S_{MS} = ⅔ \times 1.850 = 1.233$ g

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Equation (11.4-4): $S_{D1} = ⅔\, S_{M1} = ⅔ \times 1.232 = 0.821$ g

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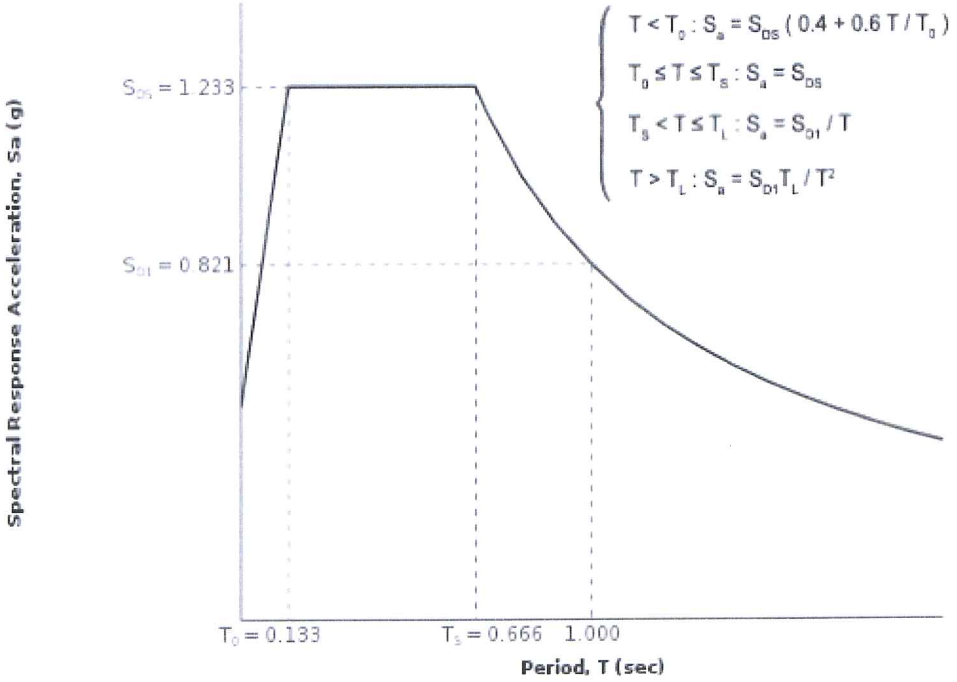
Section 11.4.5 — Design Response Spectrum

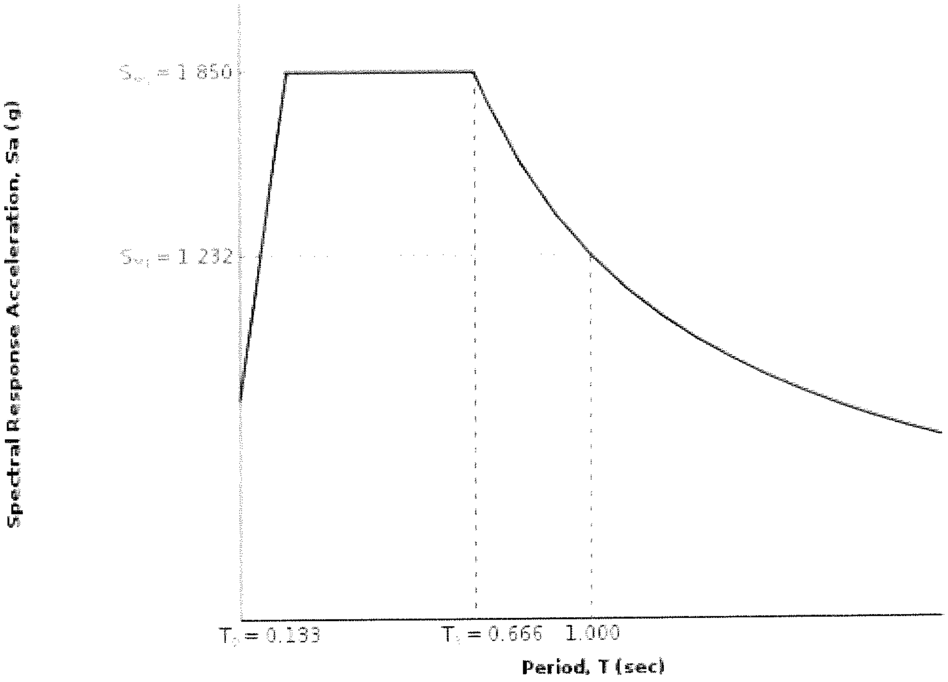
From Figure 22-12 [3] $T_L = 8$ seconds

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 = 0.722

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.722 = 0.722$ 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 = 0.722 g, F_{PGA} = 1.000

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

From Figure 22-17 [5] $C_{RS} = 1.024$

From Figure 22-18 [6] $C_{R1} = 0.978$

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
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.233 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
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.821 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" = E

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

PROFESSIONAL LIMITATIONS

Our investigation was performed using the degree of care and skill ordinarily exercised, under similar circumstances by other reputable Soils Engineers practicing in these general or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

The investigations are based on soil samples only, consequently the recommendations provided shall be considered "preliminary'. The samples taken and used for testing and the observations made are believed representative of site conditions; however, soil and geologic conditions can vary significantly between test excavations. If this occurs, the Project Soils Engineer must evaluate the changed conditions, and designs adjusted as required or alternate design recommended.

The report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are brought to the attention of the project architect and engineers. Appropriate recommendations should be incorporated into structural plans. The necessary steps should be taken to see that out such recommendations in field.

The findings of this report are valid as of this present date. However, changes in the conditions of a property can occur with the passage of time, whether they due to natural process or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur from legislation or broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by change outside of our control. Therefore, this report is subject to review and should be updated after a period of one year.

RECOMMENDED SERVICES

The review of grading plans and specifications, field observations and testing by a geotechnical representative of this office is integral part of the conclusions and recommendations made in this report. If Soils Southwest, Inc. (SSW) is not retained for these services, the Client agrees to assume SSW's responsibility for any potential claims that may arise during and after construction, or during the life-time use of the structure and its appurtenant.

The recommendations supplied should be considered valid and applicable, provided the following conditions, in minimum, are met:

i. Pre-grade meeting with contractor, public agency and soils engineer,
ii. Excavated bottom inspections and verification s by soils engineer prior to backfill placement,
iii. Continuous observations and testing during site preparation and structural fill soils placement,
iv. Observation and inspection of footing trenching prior to steel and concrete placement,
v. Subgrade verifications including plumbing trench backfills prior to concrete slab-on-grade placement,
vi. On and off-site utility trench backfill testing and verifications,
vii. Precise-grading plan review, and
viii. Consultations as required during construction, or upon your request.

In event the above conditions are not strictly fulfilled Soils Southwest will assume no responsibility for any structural distresses during life-time use of the development planned.