

***PRELIMINARY GEOTECHNICAL EVALUATION  
PROPOSED 30-LOT RESIDENTIAL DEVELOPMENT  
APPROXIMATELY 8.8-ACRE SITE AT 301 WEST PALM AVENUE  
CITY OF REDLANDS, SAN BERNARDINO COUNTY, CALIFORNIA***

***DIVERSIFIED PACIFIC COMMUNITIES***

***February 15, 2019  
J.N. 18-430***

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**DIVERSIFIED PACIFIC COMMUNITIES**10621 Civic Center Drive  
Rancho Cucamonga, CA 91730

Attention: Mr. Nolan C. Leggio

**Subject: Preliminary Geotechnical Evaluation, Proposed 30-Lot Residential Development, Approximately 8.8-Acre Site at 301 West Palm Avenue, City of Redlands, San Bernardino County, California**

Dear Mr. Leggio:

In accordance with your request and authorization, **Petra Geosciences, Inc. (Petra)** is submitting this preliminary geotechnical investigation report for the proposed mixed-use residential/commercial development in the city of Redlands, California. This work was performed in general accordance with the scope of work outlined in our proposal dated January 7, 2019.

The purposes of our evaluation were to obtain available geotechnical and geologic information on the nature of current site conditions, to evaluate the potential geologic constraints that may affect development of the property, and to provide recommendations pertaining to site remedial grading and construction of anticipated site improvements. This report presents the results of our preliminary field exploration, limited laboratory testing, engineering judgment, opinions, conclusions and recommendations pertaining to geotechnical design aspects for the presumed site development. It is presumed the development will consist of lightly-loaded residential and/or commercial structures.

It has been a pleasure to be of service to you on this project. Should you have questions regarding the contents of this report or should you require additional information, please contact the undersigned.

Respectfully submitted,

**PETRA GEOSCIENCES, INC.**Grayson R. Walker, GE  
Principal Engineer

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**ATTACHMENTS**

FIGURE 1 – SITE LOCATION MAP

FIGURE 2 – GEOTECHNICAL MAP

APPENDIX A – FIELD EXPLORATION LOGS (BORINGS)

APPENDIX B – LABORATORY TEST PROCEDURES / LABORATORY DATA SUMMARY

APPENDIX C – PERCOLATION FIELD TEST DATA

**PRELIMINARY GEOTECHNICAL EVALUATION  
PROPOSED 30-LOT RESIDENTIAL DEVELOPMENT  
8.8-ACRE SITE AT 301 WEST PALM AVENUE, CITY OF REDLANDS, CALIFORNIA**

**INTRODUCTION**

**Petra Geosciences, Inc. (Petra)** is presenting herein the results of our preliminary geotechnical investigation for the proposed development of an approximately 8.8-acre property situated southeast of West Palm Avenue and northeast of Alvarado Street, in the city of Redlands, California. The purpose of this study was to obtain preliminary information on the general geologic and geotechnical conditions within the project area in order to provide conclusions and recommendations for the feasibility of the proposed project, and preliminary geotechnical recommendations for site grading and improvements. Our geotechnical evaluation included a review of geological maps and data for the site and surrounding area, drilling four exploratory borings, performing two field percolation tests, laboratory testing, and geologic and engineering analysis.

**SCOPE OF WORK**

The scope of our evaluation consisted of the following.

- Review of available published and unpublished data, concerning geologic and soil conditions within the site and nearby area, that could have an impact on the proposed development.
- Review readily available aerial photographs of the site and surrounding area.
- Coordinate with the local underground utility locating service (i.e., Underground Service Alert [USA]) to obtain an underground-utility clearance, prior to commencement of the subsurface exploration.
- Geotechnical drilling, logging, and sampling of four (4) exploratory soil borings utilizing a hollow-stem auger drill rig, plus two (2) additional borings for field percolation testing. Log and visually classify soil and materials encountered in our borings in accordance with the Unified Soil Classification System (USCS).
- Perform two falling-head percolation tests in the vicinity of proposed storm water infiltration facilities.
- Conduct laboratory testing of representative samples (bulk and undisturbed) obtained from the borings to determine their engineering properties.
- Engineering and geologic analysis of the research, field exploration findings and laboratory data with respect to the proposed site development.
- Preparation of this geotechnical report presenting the results of our evaluation and providing recommendations for the proposed site development in general conformance with the requirements of the 2016 California Building Code (2016 CBC), as well as in accordance with applicable state and local jurisdictional requirements.

## **LOCATION AND SITE DESCRIPTION**

The subject property is a square-shaped, approximately 8.8-acre parcel situated on the east corner of the intersection of West Palm Avenue and Alvarado Street in the city of Redlands, California. The site is bounded on the northeast and southeast by residential developments. The site location map, showing the general location of the site, is included as Figure 1. The site is currently occupied by an active citrus grove and several buildings, some of which will remain.

The existing structures on site consist of two single-family residences, one two-story and the other one-story, as well as a centrally located barn, a storage shed, and a single car detached garage. Site improvements consist of concrete driveways, planters, and irrigation systems.

The property is relatively flat, sloping gently to the west. Site elevations range from approximately 1,494 feet above mean sea level (msl) at the west corner to approximately 1,523 feet msl at the east corner.

## **PROPOSED DEVELOPMENT**

Based the preliminary study map Alternate E (Hick and Hartwick, Inc., 2018), the planned development will consist of approximately 30 new residential lots and appurtenant interior streets. We anticipate ancillary site improvements to include underground utilities, asphalt pavement, perimeter walls underground storm water facilities and/or retention basins and landscaping. The currently proposed grading will generally entail shallow cuts and fills on the order of 1 to 3 feet from existing grades, however maximum fills are on the order of 10 feet from current grades and maximum cuts are on the order of 6 feet from current grades. Cut and or fill slopes are anticipated to be constructed at 2:1 (h:v) gradients.

## **Literature and Aerial Photo Review**

Petra researched and reviewed available published and unpublished geologic data pertaining to regional geology, faulting and geologic hazards that may affect the site. The results of this review are included within this report.

Readily available online aerial imagery was reviewed to assess previous land use. Based on recent aerial imagery, the site has been utilized as a citrus grove with several residential structures for at least the past several decades.

## **Field Exploration and Testing**

A subsurface exploration program was conducted under the supervision of an engineering geologist from Petra on January 21, 2019. Subsurface exploration involved the drilling of four (4) exploratory borings,

designated B-1 through B-4, to depths of 26.2 to 51.5 feet below existing site grade. Two additional borings, designated P-1 and P-2 and ranging in depth from 10 to 13 feet below the ground surface, were drilled for the purpose of conducting falling-head percolation tests to determine infiltration rates. Drilling was performed with a track-mounted drill rig equipped with 6-inch outside diameter, hollow-stem augers. Earth materials encountered within the exploratory borings were classified and logged in accordance with the visual-manual procedures of the Unified Soil Classification System (USCS). The approximate locations of the exploratory and percolation test borings are shown on the attached Geotechnical Map, Figure 2. Descriptive logs of the borings are presented in Appendix A.

Subsurface exploration also included the collection of bulk samples and relatively undisturbed samples of soil materials for classification, laboratory testing and geotechnical engineering analyses. Bulk samples consisted of selected soil materials obtained from the exploratory borings. Relatively undisturbed samples were obtained using a 3-inch outside diameter modified California split-spoon soil sampler lined with brass rings. The soil samples were mechanically driven to a depth of 18 inches with successive 30-inch drops of a 140-pound automatic trip hammer and the number of blows required to drive the sampler for each 6-inch increment inches are noted in the boring logs in Appendix A. The driven core samples were placed in sealed containers and transported to Petra's laboratory for laboratory testing.

Standard Penetration Tests (SPT) were also performed at selected depth intervals in accordance with ASTM D1586. This method consists of mechanically driving an unlined, 2.0-inch outside diameter (OD) standard penetrometer split-barrel sampler 18 inches into the soil with successive 30-inch drops of the 140-pound automatic trip hammer. Blow counts are also noted on the exploration logs. Disturbed soil samples from the unlined standard split-spoon samplers were placed in sealed plastic bags and transported to our laboratory for testing.

### **Laboratory Testing**

Laboratory testing for selected samples of onsite soils materials included in-situ dry density and moisture content, maximum dry density and optimum moisture content, expansion index, consolidation potential, general soil corrosion potential (sulfate content, chloride content, pH/resistivity), and remolded shear strength. A description of laboratory test methods and laboratory testing are presented in Appendix B and the results of in-situ moisture content and dry density tests are summarized in the boring logs presented in Appendix A.

## **FINDINGS**

### **Regional Geologic Setting**

Geologically, the site lies within the northern portion of the Peninsular Ranges Geomorphic Province (CGS, 2002). The Peninsular Range Province extends from the tip of Baja California north to the Transverse Ranges Geomorphic Province and is characterized by northwest trending mountain ranges separated by subparallel fault zones. The San Bernardino Mountains, located on the north side of the valley, provides the boundary between the Peninsula Range Province and the Transverse Ranges Province. In general, the province is underlain primarily of plutonic rock of the Southern California Batholith. These rocks formed from the cooling of molten magma deep within the earth's crust. Intense heat associated with the plutonic magma metamorphosed the ancient sedimentary rocks into which the plutons intruded. The Peninsular Range Geomorphic Province is generally characterized by alluviated basins and elevated erosional surfaces.

### **Local Geology and Subsurface Soil Conditions**

The geologic map of the Redlands quadrangle (Morton & Cox, 2003) depict the subject property sitting near the central portion of a localized old alluvial fan deposits of the late to middle Pleistocene era generally surrounded by very old axial valley deposits of the middle to early Pleistocene era. Bedrock belonging to the San Timeteo formation is located several miles to the south/southwest. A general description of the units are provided below.

Young Alluvial Fan Deposits (map symbol Qyf) – Young Alluvial Fan of Holocene age is present at the surface or beneath the topsoil across the vast majority of the site. The upper 10 feet of these soils generally consist of interbedded silty sand and sands with minor interbeds of clayey sands. These materials were generally medium dense and moist. Below depths of 15 feet we generally encountered more coarse-grained interbedded poorly-graded sands and sands with silt that were generally medium dense with occasional zones that were dense.

Old Alluvial Fan Deposits (map symbol Qof) – Old Alluvial Fan of the middle to late Pleistocene is present beneath the young alluvial fan deposits across the entire site. Generally, the soils consist of silty sands to sands with trace slightly clayey sands. The materials were generally dense to very dense and moist.

### **Groundwater**

Groundwater was not encountered within our deep boring, drilled to a maximum depth of 51.5 feet below the ground surface (bgs). Recent groundwater levels are reported within a well approximately 6,000 feet to the northwest at approximately 199 feet bgs (California Department of Water Resources).

Based on our research within the nearby area, groundwater is not anticipated to affect the proposed development; however, as with any development, there is the possibility of localized perched water and minor seepage may occur in fill layers of differing permeability once site landscaping is installed and irrigation implemented.

### **Faulting**

Based on our review of published and unpublished geotechnical maps and literature pertaining to site geology, no active or potentially active faults are known to project through the site and the site does not lie within the bounds of an “Earthquake Fault Zone” as defined by the State of California in the Alquist-Priolo (AP) Earthquake Fault Hazard Zoning Act (Bryant and Hart, 2007). In addition, the site does not lie with a fault zone established by the County of San Bernardino. Our review shows the closest known active earthquake fault is the San Andreas Fault zone which lies approximately 5.4 miles (8.6 km) to the northeast (San Bernardino County, 2010). The potential for active fault rupture at the site is considered to be very low.

### **Secondary Seismic Effects**

Secondary effects of seismic activity normally considered as possible hazards to a site include several types of ground failure. Various general types of ground failures, which might occur as a consequence of severe ground shaking at the site, include ground subsidence, ground lurching and lateral spreading. The probability of occurrence of each type of ground failure depends on the severity of the earthquake, distance from faults, topography, subsoil and groundwater conditions, in addition to other factors. The subject property proposed for development exhibits level topography that is not prone to landsliding, and the potential for ground lurching and lateral spreading are considered very low. The potential for seismically-induced flooding due to tsunami or seiche (i.e., a wave-like oscillation of the surface of water in an enclosed basin) is considered negligible at this site.

### **Liquefaction and Seismically-Induced Settlement**

Liquefaction occurs when dynamic loading of a saturated sand or silt causes pore-water pressures to increase to levels where grain-to-grain contact is lost and the material temporarily behaves as a viscous fluid. Liquefaction can cause settlement of the ground surface, settlement and tilting of engineered structures, flotation of buoyant buried structures and fissuring of the ground surface. A common manifestation of liquefaction is the formation of sand boils, which are short-lived fountains of soil and water that emerge from fissures or vents and leave freshly deposited conical mounds of sand or silt on the ground surface.

San Bernardino County has identified located the subject property area within a low liquefaction susceptibility zone. Based on the lack of shallow groundwater encountered and the medium dense to very dense nature of the older alluvial fan deposits, the potential for manifestation of liquefaction and for seismic (i.e., dynamic) settlement, in the form of dry sand settlement, are anticipated to be very low.

### **Compressible Soils**

A geotechnical factor affecting the project site is the presence of shallow topsoil and unconsolidated, near-surface young alluvial fan deposits. Such materials in their present state are not considered suitable for support of fill or structural loads. Accordingly, these materials will require removal to competent alluvial deposits as observed by the geotechnical consultant and replacement as properly moisture-conditioned and compacted fill.

## **CONCLUSIONS AND RECOMMENDATIONS**

### **Development Feasibility**

Based on our preliminary field exploration, research and review of pertinent geologic literature, and preliminary laboratory testing, development of the project site is considered feasible for the proposed residential development from a geotechnical standpoint. The following geotechnical factors should be considered during the design process.

### **Seismic Shaking**

The site is located within an active tectonic area of southern California with several significant faults capable of producing moderate to strong earthquakes. The site will likely be subjected to very strong seismically related ground shaking during the anticipated life span of the project and structures within the site should therefore be designed and constructed to resist the effects of strong ground motion in accordance with the most current edition of the California Building Code, i.e. anticipated to be the 2016 CBC.

### **Remedial Grading**

Near-surface soils are loose and inconsistent due to their variable nature and are subject to static settlement due to dead and live loading conditions of structures and hydro-consolidation due to the introduction of water due to either the establishment of an irrigation system(s) or storm water control. Accordingly, remedial grading of the upper portions of the alluvial soils will be necessary for support of shallow foundations and engineered fills. In general, in all areas where structures are proposed, all existing

undocumented fill and near-surface compressible soils will need to be removed (over-excavated), to be placed as properly compacted fill.

### **Earthwork Recommendations**

#### **General Recommendations**

Earthwork should be performed in accordance with the Grading Code of the City of Redlands, in addition to the applicable provisions of the 2016 CBC. Grading should also be performed in accordance with the following site-specific recommendations prepared by Petra based on the proposed construction.

#### **Geotechnical Observations and Testing**

Prior to the start of earthwork, a meeting should be held at the site with the owner, contractor and geotechnical consultant to discuss the work schedule and geotechnical aspects of the grading. Earthwork, which in this instance will generally entail removal and re-compaction of loose existing soils to expose competent natural soils, should be accomplished under full-time observation and testing of the geotechnical consultant. A representative of the project geotechnical consultant should be present onsite during all earthwork operations to document proper placement and compaction of fills, as well as to document compliance with the other recommendations presented herein.

#### **Clearing and Grubbing**

All existing trees and vegetation within areas to be graded should be stripped and removed from the site. Clearing operations should also include the removal of any remaining irrigation pipes, trash, debris, vegetation and similar deleterious materials. Any cavities or excavations created upon removal of any unknown subsurface structure(s) should be cleared of loose soil, shaped to provide access for backfilling and compaction equipment and then backfilled with properly compacted fill. Due to the presence of a grove, following removal of the tree root balls, any remaining roots may need to be removed by hand (i.e. root pickers), during grading operations.

The project geotechnical consultant should provide periodic observation and testing services during clearing and grubbing operations to document compliance with the above recommendations. In addition, should unusual or adverse soil conditions or buried structures be encountered during grading that are not described herein, these conditions should be brought to the immediate attention of the project geotechnical consultant for corrective recommendations.

### **Geotechnical Observations**

Exposed bottom surfaces in remedial removal areas should be observed and approved by a representative of the project geotechnical consultant *prior to the placement of fill*. A representative of the project geotechnical consultant should also be present on site during major grading operations to document that proper placement and adequate compaction of fills has been achieved, as well as to observe compliance with the other recommendations presented herein. It is the grading contractor's responsibility to notify the project geotechnical consultant at least 24 hours prior to requiring observation (including excavation bottom verification).

### **Unsuitable Soil Removals and Bottom Processing**

Existing surficial undocumented fill and shallow native alluvial soils are considered unsuitable for support of proposed fills, structures, flatwork, pavement or other improvements and should be removed to underlying competent alluvial materials as approved by the project geotechnical consultant. The estimated depth of removal of alluvial soils is recommended to be approximately 3 feet below the existing ground surface in proposed building areas, but no less than 2 feet below the bottom-of-footings. Soil removals may need to be locally deeper depending upon the exposed conditions encountered during grading. Soil removals in street or landscaped areas are anticipated to be on the order of 2 feet below existing grade or proposed grade, whichever is deeper.

Prior to placing engineered fill, the exposed bottom surfaces in the removal areas should be approved by a representative of project geotechnical consultant. The exposed removal bottoms should be scarified to a minimum depth of 12 inches, moisture-conditioned to achieve at least 1 to 2 percent above optimum moisture content and compacted with a heavy construction equipment prior to placement of fill. Minimum compaction of the upper 12 inches of the removal bottom should meet or exceed 90 percent relative compaction with reference to ASTM D1557. The laboratory maximum dry density and optimum moisture content for each change in soil type should be determined in accordance with test method ASTM D1557.

### **Boundary Conditions**

Average remedial removals within the building pad areas of the subject site are anticipated to be on the order of 3 feet below the existing ground surface. Temporary backcut slopes adjacent to the tract boundaries should generally be restricted to a slope ratio of 1:1 (h:v) or flatter to protect adjacent offsite improvements (including pavement, sidewalks, walls, etc.) along the property boundaries. Depending on the actual horizontal extent of remedial grading that is achievable by the grading contractor, it is likely that a wedge

of unsuitable soil will remain in place along the site perimeter that will extend into the site to a horizontal distance equal to as much as twice the depth of remedial removals. Since new perimeter wall improvements may be proposed within this zone, such improvements may need to be designed and constructed with deepened and/or strengthened foundation systems designed to withstand relative movement that is likely to result from settlement of these likely compressible surficial soils. The use temporary shoring or slot cut techniques along perimeter of the site may also be considered.

### **Suitability of On-Site Materials for Use as Engineered Fill**

Based on our field observations and subsurface soil conditions encountered in our borings, the on-site soil materials would be suitable for use as engineered fill provided they are clean of construction debris or other deleterious materials. As with most remedial grading, the majority of soils exposed at or near the surface would require moisture-conditioning to near optimum moisture for use as engineered fill.

### **Excavation Characteristics**

The existing site soils are expected to be readily excavated with conventional earthmoving equipment.

### **Fill Placement**

Fill materials should be placed in approximately 6- to 8-inch thick loose lifts, watered or air-dried as necessary to achieve a moisture content of at least above optimum moisture condition, and then compacted in-place to a minimum relative compaction of no less than 90 percent. The laboratory maximum dry density and optimum moisture content for each change in soil type should be determined in accordance with ASTM D1557.

### **Temporary Excavations**

Temporary excavations varying up to a height of 5± feet below existing grades may be required to accommodate the recommended over-excavation of existing soft/loose alluvial soils. Based on the physical properties of the onsite soils, temporary excavations which are constructed exceeding 4 feet in height should be cut back to a ratio of 1:1 (h:v) or flatter for the duration of the over-excavation of unsuitable soil material and replacement as compacted fill, as well as placement of underground utilities. The temporary excavations should be observed by a representative of the project geotechnical consultant for evidence of potential instability. Depending on the results of these observations, revised slope configurations may be necessary. Other factors which should be considered with respect to the stability of the temporary slopes include construction traffic and/or storage of materials on or near the tops of the slopes, construction

scheduling, presence of nearby walls or structures on adjacent properties and weather conditions at the time of construction. Applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health act of 1970 and the Construction Safety Act should also be followed.

### **Import Soils for Grading**

If import soils are needed to achieve final design grades the soils should be free of deleterious materials, oversize rock and any hazardous materials. The soils should also be non-expansive and essentially non-corrosive and approved by the project geotechnical consultant *prior* to being brought onsite. The geotechnical consultant should visit the potential borrow site and conduct testing of the soil at least three days before the commencement of import operations.

### **Volumetric Changes - Shrinkage and Subsidence**

Volumetric changes in earth quantities will occur when onsite soils are excavated and replaced as properly compacted fill. Based on in-place densities of earth materials encountered during our evaluation, a shrinkage factor on the order of 15± percent may be anticipated during removal and recompaction. The actual shrinkage that will occur during grading will depend on the average degree of relative compaction achieved. A maximum subsidence of approximately 0.10 to 0.20 feet may be anticipated as a result of the scarification and recompaction of the exposed bottom surfaces within the removal areas.

The above estimates of shrinkage and subsidence are intended for use by project planners in estimating earthwork quantities and should not be considered absolute values. Contingencies should be made for balancing earthwork quantities based on actual shrinkage and subsidence that will occur during site grading.

## **Preliminary Foundation Design Considerations**

### **Expansive Soil Conditions**

Preliminary laboratory testing indicates that the soils in the upper 5 feet possess a very low expansion potential, classifying the material as non-expansive.

### **Foundation System**

In view of the anticipated post-grading soil conditions and the proposed development, Petra recommends using conventional slab-on-ground foundations for the proposed residential structures, however this should be confirmed with additional sampling and testing of near surface pad soils during site grading.

### **Allowable Soil Bearing Capacity**

A basic allowable soil bearing capacity of 1,500 pounds per square foot, including dead and live loads, may be utilized for design of 24-inch square pad footing and 12-inch-wide continuous footings founded at a minimum depth of 12 inches below the lowest adjacent final grade. This value may be increased by 20 percent for each additional foot of depth and by 10 percent for each additional foot of width to a maximum value of 2,500 pounds per square foot. Recommended allowable bearing values include both dead and live loads, and may be increased by one-third for short duration wind and seismic forces.

### **Footing Settlement**

Based on the allowable bearing values provided above, total settlement of the footings is anticipated to be less than 1 inch. Differential settlement is expected to be less than 0.5 inch over a horizontal span of 40 feet. The majority of settlement is likely to take place as footing loads are applied or shortly thereafter.

### **Lateral Resistance**

A passive earth pressure of 250 pounds per square foot per foot of depth, to a maximum value of 2,500 pounds per square foot, may be used to determine lateral bearing resistance for footings. In addition, a coefficient of friction of 0.30 times the dead load forces may be used between concrete and the supporting soils to determine lateral sliding resistance. The above values may be increased by one-third when designing for transient wind or seismic forces. It should be noted that the above values are based on the condition where footings are cast in direct contact with compacted fill or competent native soils. In cases where the footing sides are formed, all backfill placed against the footings upon removal of forms should be compacted to at least 90 percent of the applicable maximum dry density.

### **Slab-on-Ground Design and Construction Considerations**

The results of our preliminary laboratory test performed on one representative sample of near-surface soils within the site indicate that these material exhibit expansion potentials that are within the Very Low range (Expansion Index from 0 to 20). As such, the design of slabs-on-grade is considered to be non-expansive and exempt from the procedures outlined in Sections 1803.5.3 and 1808.6.2 of the 2016 CBC and may be performed using any method deemed rational and appropriate by the project structural engineer. However, the following minimum recommendations are presented herein for conditions where the project design team may require geotechnical engineering guidelines for design and construction of footings and slabs on-grade the project site.

*The design and construction recommendations that follow are based on the above soil conditions and may be considered for reducing the effects of variability in composition and behavior within the site soils and long-term differential settlement. These recommendations have been developed on the basis of the previous experience of this firm on projects with similar soil conditions. Although construction performed in accordance with these recommendations has been found to reduce post-construction movement and/or distress, they generally do not positively eliminate all potential effects of variability in soils characteristics and future settlement.*

*It should also be noted that the recommendations for reinforcement provided herein are performance-based and intended only as guidelines to achieve adequate performance under the anticipated soil conditions. The project structural engineer, architect and/or civil engineer should make appropriate adjustments to reinforcement type, size and spacing to account for internal concrete forces (e.g., thermal, shrinkage and expansion), as well as external forces (e.g., applied loads) as deemed necessary. Consideration should also be given to minimum design criteria as dictated by local building code requirements.*

### **Conventional Slabs-on-Ground**

Given the very low expansion potential exhibited by onsite soils, we recommend that footings and floor slabs be designed and constructed in accordance with the following minimum criteria.

#### **Footings**

1. Exterior continuous footings supporting one- and two-story structures should be founded at a minimum depth of 12 inches below the lowest adjacent final grade, respectively. Interior continuous footings may be founded at a minimum depth of 10 inches below the top of the adjacent finish floor slabs.
2. In accordance with Table 1809.7 of 2016 CBC for light-frame construction, all continuous footings should have minimum widths of 12 inches for one- and two-story construction. We recommend all continuous footings should be reinforced with a minimum of two No. 4 bars, one top and one bottom.
3. A minimum 12-inch-wide grade beam founded at the same depth as adjacent footings should be provided across garage entrances or similar openings (such as large doors or bay windows). The grade beam should be reinforced with a similar manner as provided above.
4. Interior isolated pad footings, if required, should be a minimum of 24 inches square and founded at a minimum depth of 12 inches below the bottoms of the adjacent floor slabs for one- and two-story buildings. Pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings.

5. Exterior isolated pad footings intended for support of roof overhangs such as second-story decks, patio covers and similar construction should be a minimum of 24 inches square and founded at a minimum depth of 18 inches below the lowest adjacent final grade. The pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings. Exterior isolated pad footings may need to be connected to adjacent pad and/or continuous footings via tie beams at the discretion of the project structural engineer.
6. The minimum footing dimensions and reinforcement recommended herein may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2016 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

#### Building Floor Slabs

1. Concrete floor slabs should be a minimum 4 inches thick and reinforced with No. 3 bars spaced a maximum of 24 inches on centers, both ways. Alternatively, the structural engineer may recommend the use of prefabricated welded wire mesh for slab reinforcement. For this condition, the welded wire mesh should be of sheet type (not rolled) and should consist of 6x6/W2.9xW2.9 WWF (per the Wire Reinforcement Institute, WRI, designation) or stronger. All slab reinforcement should be supported on concrete chairs or brick to ensure the desired placement near mid-depth. Care should be exercised to prevent warping of the welded wire mesh between the chairs in order to ensure its placement at the desired mid-slab position.

Slab dimension, reinforcement type, size and spacing need to account for internal concrete forces (e.g., thermal, shrinkage and expansion) as well as external forces (e.g., applied loads), as deemed necessary.

2. Living area concrete floor slabs and areas to receive moisture sensitive floor covering should be underlain with a moisture vapor retarder consisting of a minimum 10-mil-thick polyethylene or polyolefin membrane that meets the minimum requirements of ASTM E96 and ASTM E1745 for vapor retarders (such as Husky Yellow Guard®, Stego® Wrap, or equivalent). All laps within the membrane should be sealed, and at least 2 inches of clean sand should be placed over the membrane to promote uniform curing of the concrete. To reduce the potential for punctures, the membrane should be placed on a pad surface that has been graded smooth without any sharp protrusions. If a smooth surface cannot be achieved by grading, consideration should be given to lowering the pad finished grade an additional inch and then placing a 1-inch-thick leveling course of sand across the pad surface prior to the placement of the membrane.

*At the present time, some slab designers, geotechnical professionals and concrete experts view the sand layer below the slab (blotting sand) as a place for entrapment of excess moisture that could adversely impact moisture-sensitive floor coverings. As a preventive measure, the potential for moisture intrusion into the concrete slab could be reduced if the concrete is placed directly on the vapor retarder. However, if this sand layer is omitted, appropriate curing methods must be implemented to ensure that the concrete slab cures uniformly. A qualified materials engineer with experience in slab design and construction should provide recommendations for alternative methods of curing and supervise the construction process to ensure uniform slab curing. Additional steps would also need to be taken to prevent puncturing of the vapor retarder during concrete placement.*

3. Garage floor slabs should be a minimum 4 inches thick and reinforced in a similar manner as living area floor slabs. Garage slabs should also be poured separately from adjacent wall footings with a positive separation maintained using  $\frac{3}{4}$ -inch-minimum felt expansion joint material. To control the propagation of shrinkage cracks, garage floor slabs should be quartered with weakened plane joints. Consideration should be given to placement of a moisture vapor retarder below the garage slab, similar to that provided in Item 2 above, should the garage slab be overlain with moisture sensitive floor covering.
4. Presaturation of the subgrade below floor slabs will not be required; however, prior to placing concrete, the subgrade below all dwelling and garage floor slab areas should be thoroughly moistened to achieve a moisture content that is at least equal to or slightly greater than optimum moisture content. This moisture content should penetrate to a minimum depth of 12 inches below the bottoms of the slabs.
5. The minimum dimensions and reinforcement recommended herein for building floor slabs may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2016 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

#### **Soil Corrosivity**

As a screening level study, limited chemical and electrical tests were performed on one representative sample of onsite soils to identify potential corrosive characteristics of these soils. Additional sampling and testing of finish pad grades soils is recommended during future site grading. The following sections present the test results and an interpretation of current codes and guidelines that are commonly used in our industry as they relate to the adverse impact of chemical contents of the site soils and their associated moisture on various components of the proposed structures in contact with site soils.

A variety of test methods are available to quantify corrosive potential of soils for various elements of construction materials. Depending on the test procedures adopted, characteristics of the leachate that is used to extract the target chemicals from the soils and the test equipment; the results can vary appreciably for different test methods in addition to those caused by variability in soil composition. The testing procedures referred to herein are considered to be typical for our industry and have been adopted and/or approved by many public or private agencies. In drawing conclusions from the results of our chemical and electrical laboratory testing and providing mitigation recommendation to reduce the detrimental impact of corrosive site soils on various components of the structure in contact with site soils, heavy references were made to 2016 CBC and American Concrete Institute, 2011 Structural Concrete Building Code (ACI 318-11). Where relevant information was not available in these codes, references were made to guidelines developed by California Department of Transportation (Caltrans), mainly because their risk tolerance for highway bridges are considered comparable to those for residential or commercial structures

and that Post Tensioning Institute (PTI), in part, accepts and uses Caltrans' relevant corrosivity criteria for post-tensioned slabs on-grade.

It should be noted that Petra does not practice corrosion engineering; therefore, these preliminary test result and our opinion and engineering judgment provided herein should be considered as general guidelines only. Additional analyses would be warranted, especially, for cases where buried metallic building materials (such as copper and cast or ductile iron) in contact with site soils are planned for the project. In many cases, the project geotechnical engineer is not informed of these choices. Therefore, for conditions where such elements are considered, we recommend that the project design professionals (i.e., the architect and/or structural engineer) consider recommending a qualified corrosion engineer to conduct additional sampling and testing of near-surface soils during the final stages of site grading to provide a complete assessment of soil corrosivity. Recommendations to mitigate the detrimental effects of corrosive soils on buried metallic and other building materials that may be exposed to corrosive soils should be provided by the corrosion engineer as deemed appropriate.

#### Concrete in Contact with Site Soils

Soils containing soluble sulfates beyond certain threshold levels, as well as acidic soils are considered to be detrimental to long-term integrity of concrete placed in contact with such soils. For the purpose of this study, soluble sulfates ( $\text{SO}_4$ ) concentration in soils determined in accordance with California Test Method No. 417. Soil acidity, as indicated by hydrogen-ion concentration (pH), was determined in accordance with California Test Method No. 643.

The results of our limited in-house laboratory tests indicate that on-site soils contain a water-soluble sulfate content *0.01 percent by weight*. Based on Article 1904.1 of Section 1904 of the 2016 CBC, concrete that will be exposed to sulfates in site soil should be assigned exposure classes in accordance with the durability requirements of ACI 318. Based on the test results and in reference to Table 4.2.1 of ACI 318-11, an exposure class of **S0** is appropriate for onsite soils. Accordingly, a severity level of **Not Applicable** for exposure to sulfate may be expected for concrete placed in contact with the onsite soil materials. As such, Table 4.3.1 of ACI 318-11 provides that no restriction for cement type or maximum water-cement ratio for the fresh concrete would be required. However, this table indicates that the concrete minimum unconfined compressive strength should not be less than 2,500 psi.

Further, the results of limited in-house testing of a representative sample indicate that soils within the subject site are alkaline with respect to pH (a *pH of 7.3*). Based on this finding and according to Section

8.22.2 of Caltrans' 2003 Bridge Design Specifications (2003 BDS) requirements (which consider the combined effects of soluble sulfates and soil pH), a commercially available Type II Modified cement may be used.

The preliminary guidelines provided herein should be evaluated and confirmed, or modified, in its entirety by the project structural engineer and the contractor responsible for concrete placement for concrete used in exterior and interior footings, interior slabs on-ground, garage slabs walls foundation and concrete exposed to weather such as driveways, patios, porches, walkways, ramps, steps, curbs, etc.

#### Metals Encased in Concrete

Soils containing a soluble chloride concentration beyond a certain threshold level are considered corrosive to metallic elements such as reinforcement bars, tendons, cables, bolts, etc. that are encased in concrete that, in turn, is in contact with such soils. For the purpose of this study, soluble chlorides (Cl) in soils were determined in accordance with California Test Method No. 422.

Based on Article 1904.1 of Section 1904 of the 2016 CBC, concrete that will be exposed to chlorides from *“deicing chemicals, salt, saltwater, brackish water, seawater or spray from these sources, where concrete has steel reinforcement”* should be assigned exposure classes in accordance with the durability requirements of ACI 318. According to Table 4.2.1 of ACI 318-11, an exposure class of **C0** with a severity designation of **Not Applicable** is appropriate for reinforced concrete that remains dry or protected from moisture. Similarly, an exposure class of **C1** with a severity designation of **Moderate** is appropriate for reinforced concrete that is exposed to moisture but not to external sources of chlorides. And, lastly, an exposure class of **C2** with a severity designation of **Severe** is appropriate for reinforced concrete that is exposed to moisture and external sources of chlorides as enumerated above.

Based on our understanding of the project, it is our professional opinion that an exposure class of **C1** with a severity designation of **Moderate** is appropriate for a majority of reinforced concrete, to be placed at the site, that are in contact with site soils. It should be noted, however, that an exposure class of **C2** with a severity designation of **Severe** is more appropriate for reinforced concrete that is planned for pool walls and decking.

The results of our limited laboratory tests performed indicate that onsite soils contain a water-soluble chloride concentration of *420 milligrams per Liter (mg/L) or parts per million (ppm)*. Article 1904.2 of Section 1904 of the 2016 CBC requires that concrete mixtures conform to the most restrictive maximum water-cementitious material ratios, maximum cementitious admixture, minimum air-entrainment and

minimum specified concrete compressive strength requirements of ACI 318 based on the exposure classes assigned in Article 1904.1. No maximum water/cement ratio for the fresh concrete is prescribed by ACI 318 for class **C1** (or **Moderate** severity) exposure condition. However, Table 4.3.1 of ACI 318-11 indicates that concrete minimum unconfined compressive strength,  $f'_c$ , should not be less than 2,500 psi. For class **C2** (or **Severe**) exposure condition, Table 4.3.1 of ACI 318-11 requires that the maximum water/cement ratio of the fresh concrete should not exceed 0.40 and concrete minimum unconfined compressive strength,  $f'_c$ , should not be less than 5,000 psi.

It should be noted that another source of elevated chloride-ion concentration can be the chloride content of water that is used to prepare the fresh concrete at the plant. The protection against high chloride concentration in fresh concrete should therefore be provided by concrete suppliers for the project in accordance with Table 4.3.1 of ACI 318-11.

The guidelines provided herein should be evaluated and confirmed, or modified, in its entirety by the project structural engineer for reinforced concrete placement for concrete used in exterior and interior footings, interior slabs on-ground, garage slabs walls foundation and concrete exposed to weather such as driveways, patios, porches, walkways, ramps, steps, curbs, etc.

#### Metallic Elements in Contact with Site Soils

Elevated concentrations of soluble salts in soils tend to induce low level electrical currents in metallic objects in contact with such soils. This process promotes metal corrosion and can lead to distress to building metallic components that are in contact with site soils. The minimum electrical resistivity indicates the relative concentration of soluble salts in the soil and, therefore, can be used to estimate soil corrosivity with regard to metals. For the purpose of this evaluation, the minimum resistivity in soils is measured in accordance with California Test Method No. 643.

The minimum electrical resistivity for onsite soils was found to be *4,800 ohm-cm* based on limited testing. This indicates that on-site soils may be **Corrosive** to ferrous metals and copper. As such, any ferrous metal or copper components of the subject buildings (such as cast iron or ductile iron piping, copper tubing, etc.) that are expected to be placed in direct contact with site soils should be protected against detrimental effects of moderately corrosive soils. Such protection could include the use of galvanized tubing or coated pipes or wrapping or encasing these metallic objects in special protection wrappings or conduits, respectively. Should such elements be considered for buildings or site improvements, we recommend that a corrosion engineer to be consulted to provide appropriate recommendations for long term protection of metallic elements in contact with site soils.

### **Preliminary Infiltration Rates**

#### **Shallow Infiltration Test Results**

Falling head percolation tests were performed at two locations within the subject site to evaluate the infiltration rate of native alluvial soils at depths between 5 to 10 and 8 to 13 feet below existing grades. The borings for the percolation tests were drilled with a hollow-stem auger drill rig and the soils encountered in test borings consisted of interbedded loose to medium dense, silty fine- to medium-grained sand. The percolation tests were conducted in the lower 5± feet of the boreholes and the un-factored test results are summarized in Table 1. In view of the test data, the shallow subsurface native alluvium soils had very low test results (0.05 to 0.15 in./hr.) suggesting the site is relatively impermeable. Appendix C contains the field percolation test data sheets and conversion into the calculated infiltration rates.

**TABLE 1**

| Test No. | Approximate Test Location        | Test Zone Depth (ft) | Infiltration Rate, I <sub>t</sub> (in./hr.) |
|----------|----------------------------------|----------------------|---|
| P-1      | North site corner (see Figure 2) | 8-13                 | 0.05  |
| P-2      | South site corner (see Figure 2) | 5-10                 | 0.15  |

### **Post-Grading Considerations**

#### **Utility Trenches**

All utility trench backfill should be compacted to a minimum relative compaction of 90 percent. Trench backfill materials should be free of oversize rock and placed in lifts no greater than approximately 12 inches in thickness, watered or air-dried as necessary to achieve near optimum moisture conditions, and then mechanically compacted in place to a minimum relative compaction of 90 percent. A representative of the project geotechnical consultant should probe and test the backfills to verify adequate compaction.

As an alternative for shallow trenches where pipe or utility lines may be damaged by mechanical compaction equipment, such as under building floor slabs, clean sand having a sand equivalent (SE) value of 30 or greater may be utilized. The sand backfill materials should be watered to achieve near optimum moisture conditions and then tamped into place. No specific relative compaction will be required; however, observation, probing, and if deemed necessary, testing should be performed by a representative of the project geotechnical consultant to verify an adequate degree of compaction.

If clean, imported sand is to be used for backfill of exterior utility trenches, it is recommended that the upper 12 inches of trench backfill materials consist of properly compacted onsite soil materials. This is to mitigate infiltration of irrigation and rainwater into granular trench backfill materials.

Where an exterior and/or interior utility trench is proposed in a direction parallel to a building footing, the bottom of the trench should not extend below a 1:1 (horizontal to vertical) plane projected downward from the bottom edge of the adjacent footing. Where this condition occurs, the adjacent footing should be deepened or the utility constructed and the trench backfilled and compacted prior to footing construction. Where utility trenches cross under a building footing, these trenches should be backfilled with on-site soils at the point where the trench crosses under the footing to reduce the potential for water to migrate under the floor slabs.

### **Site Drainage**

Positive surface drainage systems consisting of a combination of sloped concrete flatwork/asphalt pavement, sheet flow gradients, swales and surface area drains (where needed) should be provided around the building and within the planter areas to collect and direct all surface waters to an appropriate drainage facility as determined by the project civil engineer. The ground surfaces of planter and landscape areas that are located within 10 feet of building foundations should be sloped at a minimum gradient of 5 percent away from the foundations and towards the nearest area drains. The ground surface of planter and landscape areas that are located more than 10 feet away from building foundations may be sloped at a minimum gradient of 2 percent away from the foundations and towards the nearest area drains.

Concrete flatwork surfaces that are located within 10 feet of building foundations should be inclined at a minimum gradient of one percent away from the building foundations and towards the nearest area drains. Concrete flatwork surfaces that are located more than 10 feet away from building foundations may be sloped at a minimum gradient of 1 percent towards the nearest area drains. Surface waters should not be allowed to collect or pond against building foundations and within the level areas of the site. All drainage devices should be properly maintained throughout the lifetime of the development. Future changes to site improvements, or planting and watering practices, should not be allowed to cause over-saturation of site soils adjacent to the structures.

### **Tentative Pavement Design Recommendations**

The final pavement section should be designed once rough grading has occurred and the R-Value of the resulting subgrade can be determined. For the purposes of this preliminary evaluation, we utilized an

assumed R-value of 50 and Traffic Indices (TI) of 5.0 and 5.5 for the interior streets and cul-de-sac. The following pavement sections have been computed in accordance with Caltrans design procedures and presented in the following table, Table 2.

**TABLE 2**  
**Preliminary Structural Pavement Section**

| Location            | Design R-value | Traffic Index | Pavement Section    |
|---------------------|----------------|---------------|---------------------|
| Streets 'A' and 'B' | 50             | 5.5           | 3 in. AC / 4 in. AB |
| Cul-de-Sac          | 50             | 5.0           | 3 in. AC / 4 in. AB |

Notes: AC = Asphalt Concrete    AB = Aggregate Base

Final pavement design recommendations should be provided based on sampling and testing at the completion of rough grading and the values of traffic indices that should be provided by the project civil engineer. The project civil engineer should confirm with the City before specifying any pavement section that may be less than the presumed minimum. Subgrade soils should be properly compacted, smooth, and non-yielding prior to pavement construction. The upper 12 inches of subgrade soils should be compacted to no less than 95 percent relative compaction with reference to ASTM D1557.

Aggregate base materials in paved areas should be Crushed Aggregate Base, Crushed Miscellaneous Base, or Processed Miscellaneous Base conforming to Section 200-2 of the Standard Specifications for Public Works Construction (Greenbook). The base materials should be brought to uniform moisture near optimum moisture then compacted to at least 95 percent of the applicable maximum density standard as determined per ASTM D1557. Asphaltic concrete materials, where utilized, and construction should conform to Section 203 of the Greenbook.

### **GRADING PLAN REVIEW**

This report is based on the information provided to us by the client as well as the tentative Study Map - Alternative E by Hicks and Hardwick, Inc. We recommend that our firm be retained to review the finalized grading plan when they become available. Additional recommendations and/or modification of the recommendations provided herein will be provided if necessary depending on the results of the grading plan review.

If additional or alternative improvements are considered in the future, our firm should be notified so that we may provide design recommendations. It is further recommended that we be engaged to review the final

design drawings, specifications and grading plan prior to any new construction. If we are not provided the opportunity to review these documents with respect to the geotechnical aspects of new construction and grading, it should not be assumed that the recommendations provided herein are wholly or in part applicable to the proposed construction.

### **REPORT LIMITATIONS**

This report is based on the project site, as we understand, and our preliminary subsurface exploration and geotechnical laboratory testing and analysis. The materials encountered on the project site and utilized in our laboratory evaluation are believed representative of the total area; however, soil materials and conditions can vary in characteristics between excavations, both laterally and vertically.

The conclusions and opinions contained in this report are based on the results of the described geotechnical evaluations and represent our professional judgment. This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and in the same time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes. In addition, this report should be reviewed and updated after a period of 1 year or if the site ownership or project concept changes from that described herein.

It has been a pleasure to be of service to you on this project. Should you have questions regarding the contents of this report or should you require additional information, please contact this office.

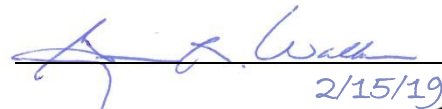
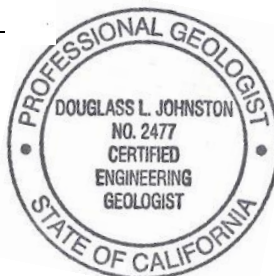
Respectfully submitted,

**PETRA GEOSCIENCES, INC.,**



Douglass Johnston  
Senior Associate Geologist  
CEG 2477

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2/15/19

Grayson R. Walker  
Principal Engineer  
GE 871



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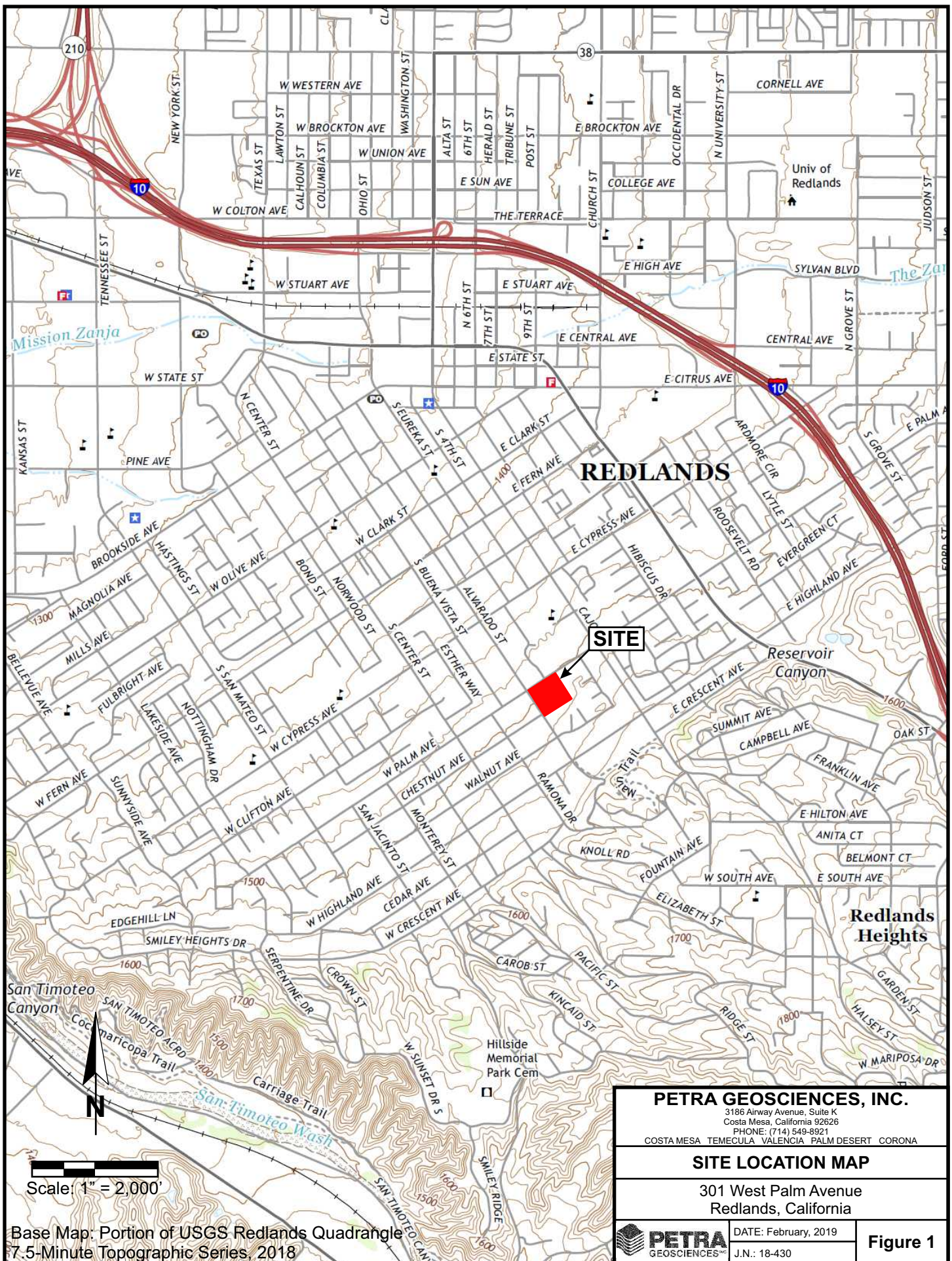
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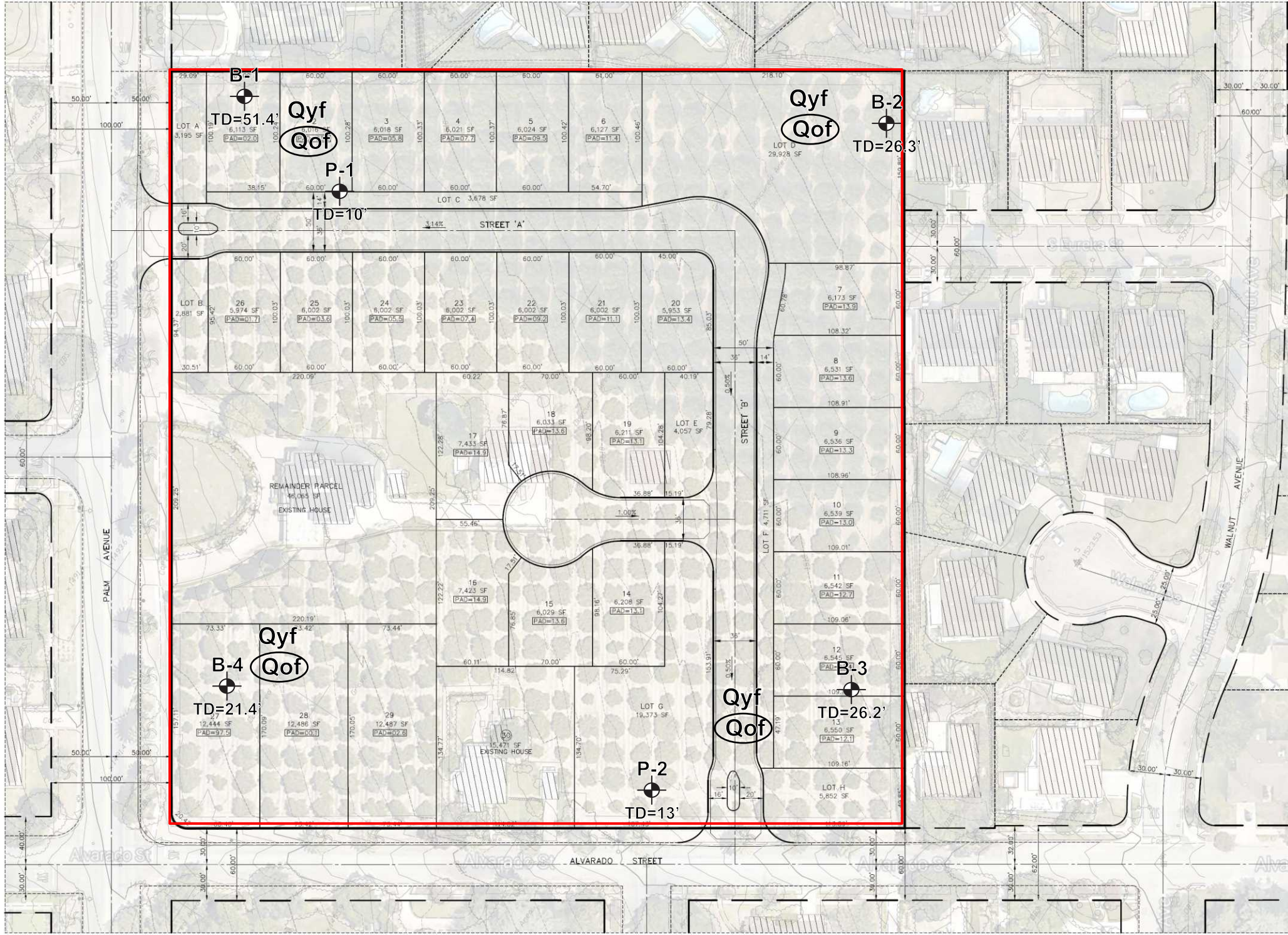
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## ***FIGURES***

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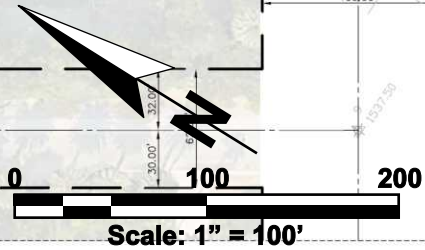
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**EXPLANATION**

- Qyf** Young Alluvial Fan Deposits
- Qof** Older Alluvial Fan Deposits  
Circled Where Buried
- B-4** Approximate Location Of Exploratory Boring  
TD = Total Depth
- P-2** Approximate Location of Percolation Boring  
TD = Total Depth
- Approximate Limits of Subject Site



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**GEOTECHNICAL MAP**

301 West Palm Avenue  
Redlands, California



DATE: February, 2019  
J.N.: 18-430

**Figure 2**

Base Map Reference: =Hicks & HArdwick Inc. 2018, Study Map - Alternative E, APN 0173-231-05 (301 West Palm Avenue), dated November 31.

# ***APPENDIX A***

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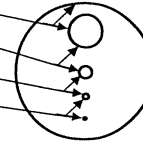
## ***FIELD EXPLORATION LOGS (BORINGS)***

# Key to Soil and Bedrock Symbols and Terms



| Unified Soil Classification System                                   |  |  |   |  |   |   |
|--|--|--|---|--|---|---|
| Coarse-grained Soils<br>> 1/2 of materials is larger than #200 sieve | The No. 200 U.S. Standard Sieve is about the smallest particle visible to the naked eye            | GRAVELS<br>more than half of coarse fraction is larger than #4 sieve | Clean Gravels<br>(less than 5% fines)   | GW   | Well-graded gravels, gravel-sand mixtures, little or no fines   |   |
|  |  |  | Gravels with fines  | GP   | Poorly-graded gravels, gravel-sand mixtures, little or no fines |   |
|  |  | SANDS<br>more than half of coarse fraction is smaller than #4 sieve  | Clean Sands<br>(less than 5% fines)   | GM   | Silty Gravels, poorly-graded gravel-sand-silt mixtures          |   |
|  |  |  | Sands with fines  | GC   | Clayey Gravels, poorly-graded gravel-sand-clay mixtures         |   |
|  |  | Fine-grained Soils<br>> 1/2 of materials is smaller than #200 sieve  | The No. 200 U.S. Standard Sieve is about the smallest particle visible to the naked eye | SILTS & CLAYS<br>Liquid Limit<br>Less Than 50                | SW  | Well-graded sands, gravelly sands, little or no fines   |
|  |  |  |   |  | SP  | Poorly-graded sands, gravelly sands, little or no fines |
|  |  |  |   |  | SM  | Silty Sands, poorly-graded sand-gravel-silt mixtures    |
|  |  |  |   | SILTS & CLAYS<br>Liquid Limit<br>Greater Than 50             | SC  | Clayey Sands, poorly-graded sand-gravel-clay mixtures   |
| ML   | Inorganic silts & very fine sands, silty or clayey fine sands, clayey silts with slight plasticity |  |   |  |   |   |
| CL   | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays  |  |   |  |   |   |
| Highly Organic Soils   | The No. 200 U.S. Standard Sieve is about the smallest particle visible to the naked eye            | SILTS & CLAYS<br>Liquid Limit<br>Greater Than 50                     | OL  | Organic silts & clays of low plasticity                      |   |   |
|  |  |  | MH  | Inorganic silts, micaceous or diatomaceous fine sand or silt |   |   |
|  |  |  | CH  | Inorganic clays of high plasticity, fat clays                |   |   |
|  |  |  | OH  | Organic silts and clays of medium-to-high plasticity         |   |   |
|  |  |  | PT  | Peat, humus swamp soils with high organic content            |   |   |

| Grain Size  |                     |                 |                                |
|-------------|---------------------|-----------------|--------------------------------|
| Description | Sieve Size          | Grain Size      | Approximate Size               |
| Boulders    | >12"                | >12"            | Larger than basketball-sized   |
| Cobbles     | 3 - 12"             | 3 - 12"         | Fist-sized to basketball-sized |
| Gravel      | coarse<br>3/4 - 3"  | 3/4 - 3"        | Thumb-sized to fist-sized      |
|             | fine<br>#4 - 3/4"   | 0.19 - 0.75"    | Pea-sized to thumb-sized       |
| Sand        | coarse<br>#10 - #4  | 0.079 - 0.19"   | Rock salt-sized to pea-sized   |
|             | medium<br>#40 - #10 | 0.017 - 0.079"  | Sugar-sized to rock salt-sized |
|             | fine<br>#200 - #40  | 0.0029 - 0.017" | Flour-sized to sugar-sized to  |
| Fines       | Passing #200        | <0.0029"        | Flour-sized and smaller        |



| Laboratory Test Abbreviations |                         |      |                                     |
|-------------------------------|-------------------------|------|-------------------------------------|
| MAX                           | Maximum Dry Density     | MA   | Mechanical (Particle Size) Analysis |
| EXP                           | Expansion Potential     | AT   | Atterberg Limits                    |
| SO4                           | Soluble Sulfate Content | #200 | #200 Screen Wash                    |
| RES                           | Resistivity             | DSU  | Direct Shear (Undisturbed Sample)   |
| pH                            | Acidity                 | DSR  | Direct Shear (Remolded Sample)      |
| CON                           | Consolidation           | HYD  | Hydrometer Analysis                 |
| SW                            | Swell                   | SE   | Sand Equivalent                     |
| CL                            | Chloride Content        | OC   | Organic Content                     |
| RV                            | R-Value                 | COMP | Mortar Cylinder Compression         |

| Modifiers |           |
|-----------|-----------|
| Trace     | < 1 %     |
| Few       | 1 - 5 %   |
| Some      | 5 - 12 %  |
| Numerous  | 12 - 20 % |

| Sampler and Symbol Descriptions |   |
|---------------------------------|---|
|                                 | Approximate Depth of Seepage              |
|                                 | Approximate Depth of Standing Groundwater |
|                                 | Modified California Split Spoon Sample    |
|                                 | Standard Penetration Test                 |
|                                 | Bulk Sample                               |
|                                 | Shelby Tube                               |
|                                 | No Recovery in Sampler                    |

| Bedrock Hardness |   |
|------------------|---|
| Soft             | Can be crushed and granulated by hand; "soil like" and structureless                                |
| Moderately Hard  | Can be grooved with fingernails; gouged easily with butter knife; crumbles under light hammer blows |
| Hard             | Cannot break by hand; can be grooved with a sharp knife; breaks with a moderate hammer blow         |
| Very Hard        | Sharp knife leaves scratch; chips with repeated hammer blows  |

## Notes:

Blows Per Foot: Number of blows required to advance sampler 1 foot (unless a lesser distance is specified). Samplers in general were driven into the soil or bedrock at the bottom of the hole with a standard (140 lb.) hammer dropping a standard 30 inches unless noted otherwise in Log Notes. Drive samples collected in bucket auger borings may be obtained by dropping non-standard weight from variable heights. When a SPT sampler is used the blow count conforms to ASTM D-1586

# EXPLORATION LOG

| Project: <b>301 West Palm Avenue</b>      |                |  |                       | Boring No.: <b>P-1</b>   |                  |                  |                            |                         |                       |
|---|----------------|--|-----------------------|--------------------------|------------------|------------------|----------------------------|-------------------------|-----------------------|
| Location: <b>Redlands</b>                 |                |  |                       | Elevation: <b>±1516'</b> |                  |                  |                            |                         |                       |
| Job No.: <b>18-430</b>                    |                | Client: <b>Diversified Pacific</b>   |                       | Date: <b>1/21/19</b>     |                  |                  |                            |                         |                       |
| Drill Method: <b>6" Hollow Stem Auger</b> |                | Driving Weight: <b>140lbs/30"</b>  |                       | Logged By: <b>KTM</b>    |                  |                  |                            |                         |                       |
| Depth<br>(Feet)                           | Lith-<br>ology | Material Description   | W<br>A<br>T<br>E<br>R | Samples                  |                  |                  | Laboratory Tests           |                         |                       |
|   |                |  |                       | Blows<br>per<br>6 in.    | C<br>o<br>r<br>e | B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 0   |                | <b>TOPSOIL</b><br>Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.<br><b>ALLUVIAL FAN DEPOSITS (Qal)</b><br>Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained sand. |                       |                          |                  |                  |                            |                         |                       |
| 5   |                |  |                       |                          |                  |                  |                            |                         |                       |
| 10  |                |  |                       |                          |                  |                  |                            |                         |                       |
| 15  |                | Total Depth= 13'<br>No groundwater encountered<br>Percolation pipe placed in boring with gravel<br>Presoak started at 8:20 AM.   |                       |                          |                  |                  |                            |                         |                       |
| 20  |                |  |                       |                          |                  |                  |                            |                         |                       |
| 25  |                |  |                       |                          |                  |                  |                            |                         |                       |
| 30  |                |  |                       |                          |                  |                  |                            |                         |                       |

# EXPLORATION LOG

| Project: <b>301 West Palm Avenue</b>      |                |  |                       | Boring No.: <b>P-2</b>   |                  |                  |                            |                         |                       |
|---|----------------|--|-----------------------|--------------------------|------------------|------------------|----------------------------|-------------------------|-----------------------|
| Location: <b>Redlands</b>                 |                |  |                       | Elevation: <b>±1514'</b> |                  |                  |                            |                         |                       |
| Job No.: <b>18-430</b>                    |                | Client: <b>Diversified Pacific</b>   |                       | Date: <b>1/21/19</b>     |                  |                  |                            |                         |                       |
| Drill Method: <b>6" Hollow Stem Auger</b> |                | Driving Weight: <b>140lbs/30"</b>  |                       | Logged By: <b>KTM</b>    |                  |                  |                            |                         |                       |
| Depth<br>(Feet)                           | Lith-<br>ology | Material Description   | W<br>A<br>T<br>E<br>R | Samples                  |                  |                  | Laboratory Tests           |                         |                       |
|   |                |  |                       | Blows<br>per<br>6 in.    | C<br>o<br>r<br>e | B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 0   |                | <b>TOPSOIL</b><br>Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.                                     |                       |                          |                  |                  |                            |                         |                       |
|   |                | <b>ALLUVIAL FAN DEPOSITS (Qal)</b><br>Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained sand.       |                       |                          |                  |                  |                            |                         |                       |
| 5   |                |  |                       |                          |                  |                  |                            |                         |                       |
| 10  |                | Total Depth= 10'<br>No groundwater encountered<br>Percolation pipe placed in boring with gravel<br>Presoak started at 9:00 AM. |                       |                          |                  |                  |                            |                         |                       |
| 15  |                |  |                       |                          |                  |                  |                            |                         |                       |
| 20  |                |  |                       |                          |                  |                  |                            |                         |                       |
| 25  |                |  |                       |                          |                  |                  |                            |                         |                       |
| 30  |                |  |                       |                          |                  |                  |                            |                         |                       |

# EXPLORATION LOG

| Project: 301 West Palm Avenue      |                |  | Boring No.: B-1       |                       |                  |                  |                            |                         |                       |
|------------------------------------|----------------|--|-----------------------|-----------------------|------------------|------------------|----------------------------|-------------------------|-----------------------|
| Location: Redlands                 |                |  | Elevation: ±1510'     |                       |                  |                  |                            |                         |                       |
| Job No.: 18-430                    |                | Client: Diversified Pacific  |                       | Date: 1/21/19         |                  |                  |                            |                         |                       |
| Drill Method: 6" Hollow Stem Auger |                | Driving Weight:  |                       | Logged By: KTM        |                  |                  |                            |                         |                       |
| Depth<br>(Feet)                    | Lith-<br>ology | Material Description   | W<br>A<br>T<br>E<br>R | Samples               |                  | Laboratory Tests |                            |                         |                       |
|                                    |                |  |                       | Blows<br>per<br>6 in. | C<br>o<br>r<br>e | B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 0                                  |                | TOPSOIL  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                | Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.                       |                       |                       |                  |                  |                            |                         |                       |
|                                    |                | YOUNG ALLUVIAL FAN DEPOSITS (Qyf)  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                | Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained sand.             |                       | 4                     |                  |                  | 12.3                       | 123.4                   | MAX, EI,<br>DSR       |
|                                    |                | Same as above.   |                       | 7                     |                  |                  |                            |                         |                       |
|                                    |                | Same as above with trace coarse-grained sand.  |                       | 12                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 13                    |                  |                  |                            |                         |                       |
| 5                                  |                |  |                       | 14                    |                  |                  | 11.1                       | 120.8                   |                       |
|                                    |                |  |                       | 20                    |                  |                  |                            |                         |                       |
|                                    |                | Becomes fine- to coarse-grained.   |                       | 10                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 16                    |                  |                  | 10.3                       | 117.8                   |                       |
|                                    |                |  |                       | 22                    |                  |                  |                            |                         |                       |
|                                    |                | Same as above with trace roots.  |                       | 10                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 9                     |                  |                  | 6.8                        | 109.8                   |                       |
|                                    |                |  |                       | 13                    |                  |                  |                            |                         |                       |
| 10                                 |                | Same as above with trace clay.   |                       | 6                     |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 9                     |                  |                  | 12.7                       | 117.1                   |                       |
|                                    |                |  |                       | 9                     |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
| 15                                 |                | OLD ALLUVIAL FAN DEPOSITS (Qof)  |                       | 20                    |                  |                  |                            |                         |                       |
|                                    |                | Sand with Silt (SP): Reddish-brown, moist, dense, fine- to coarse-grained sand, poorly graded. |                       | 36                    |                  |                  | 8.0                        | 126.2                   |                       |
|                                    |                |  |                       | 50                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
| 20                                 |                | Same as above.   |                       | 13                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 18                    |                  |                  | 6.6                        | 107.2                   |                       |
|                                    |                |  |                       | 27                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
| 25                                 |                | Same as above except very dense.   |                       | 16                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 29                    |                  |                  | 9.4                        |                         |                       |
|                                    |                |  |                       | 39                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
| 30                                 |                | Same as above except with trace silt and very dense.   |                       | 28                    |                  |                  |                            |                         |                       |
|                                    |                |  |                       | 50                    |                  |                  | 8.2                        | 113.7                   |                       |
|                                    |                |  |                       |                       |                  |                  |                            |                         |                       |
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# EXPLORATION LOG

| Project: <b>301 West Palm Avenue</b>      |                |  |                       | Boring No.: <b>B-1</b>   |                                      |                            |                         |                       |
|---|----------------|--|-----------------------|--------------------------|--------------------------------------|----------------------------|-------------------------|-----------------------|
| Location: <b>Redlands</b>                 |                |  |                       | Elevation: <b>±1510'</b> |                                      |                            |                         |                       |
| Job No.: <b>18-430</b>                    |                | Client: <b>Diversified Pacific</b>   |                       | Date: <b>1/21/19</b>     |                                      |                            |                         |                       |
| Drill Method: <b>6" Hollow Stem Auger</b> |                | Driving Weight:  |                       | Logged By: <b>KTM</b>    |                                      |                            |                         |                       |
| Depth<br>(Feet)                           | Lith-<br>ology | Material Description   | W<br>A<br>T<br>E<br>R | Samples                  |                                      | Laboratory Tests           |                         |                       |
|   |                |  |                       | Blows<br>per<br>6 in.    | C<br>o<br>r<br>e<br>B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 35  |                | <u>Silty Sand (SM)</u> : Reddish-brown, moist, dense, fine- to coarse-grained.                     |                       | 15<br>17<br>22           |                                      | 11.6                       | 124.9                   |                       |
| 40  |                | Becomes orangish-brown and very dense.   |                       | 28<br>42<br>50           |                                      | 8.2                        |                         |                       |
| 45  |                | Same as above.   |                       | 19<br>34<br>37           |                                      | 8.3                        |                         |                       |
| 50  |                | <u>Sand (SP)</u> : Olive brown, moist, very dense, fine- to medium-grained, trace quartz crystals. |                       | 24<br>44<br>50           |                                      | 13.1                       |                         |                       |
| 51' 5"                                    |                | Total Depth= 51' 5"<br>No groundwater encountered<br>Boring backfilled with cuttings and tamped.   |                       |                          |                                      |                            |                         |                       |
| 55  |                |  |                       |                          |                                      |                            |                         |                       |
| 60  |                |  |                       |                          |                                      |                            |                         |                       |
| 65  |                |  |                       |                          |                                      |                            |                         |                       |
|   |                |  |                       |                          |                                      |                            |                         |                       |
|   |                |  |                       |                          |                                      |                            |                         |                       |

# EXPLORATION LOG

| Project: 301 West Palm Avenue      |                |  | Boring No.: B-2       |                       |  |                            |                         |                       |
|------------------------------------|----------------|--|-----------------------|-----------------------|--|----------------------------|-------------------------|-----------------------|
| Location: Redlands                 |                |  | Elevation: ±1531'     |                       |  |                            |                         |                       |
| Job No.: 18-430                    |                | Client: Diversified Pacific  |                       | Date: 1/21/19         |  |                            |                         |                       |
| Drill Method: 6" Hollow Stem Auger |                | Driving Weight:  |                       | Logged By: KTM        |  |                            |                         |                       |
| Depth<br>(Feet)                    | Lith-<br>ology | Material Description   | W<br>A<br>T<br>E<br>R | Samples               |  | Laboratory Tests           |                         |                       |
|                                    |                |  |                       | Blows<br>per<br>6 in. | C<br>o<br>r<br>e<br><br>B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 0                                  |                | <b>TOPSOIL</b><br><u>Silty Sand (SM)</u> : Brown, very moist, loose, fine- to medium-grained sand.   |                       |                       |  |                            |                         |                       |
|                                    |                | <b>YOUNG ALLUVIAL FAN DEPOSITS (Qyf)</b><br><u>Silty Sand (SM)</u> : Dark reddish-brown, very moist, medium-dense, fine- to medium-grained sand.<br>Same as above. |                       | 1<br>4<br>6           |  | 13.9                       | 117.0                   |                       |
|                                    |                | Becomes reddish-brown, moist, fine- to coarse-grained, with trace clay.  |                       | 6<br>9<br>12          |  | 13.3                       | 118.0                   |                       |
| 5                                  |                | Same as above.   |                       | 6<br>11<br>11         |  | 12.9                       | 118.5                   |                       |
|                                    |                | <u>Sand (SP)</u> : Reddish-brown, moist, medium-dense, fine- to medium-grained sand, poorly graded.  |                       | 4<br>8<br>11          |  | 9.0                        | 107.9                   |                       |
| 10                                 |                | Becomes fine- to coarse-grained sand.  |                       | 6<br>12<br>16         |  | 6.5                        | 109.6                   |                       |
|                                    |                |  |                       |                       |  |                            |                         |                       |
| 15                                 |                | <b>OLD ALLUVIAL FAN DEPOSITS (Qof)</b><br><u>Silty Sand (SM)</u> : Reddish-brown, moist, dense, fine- to medium-grained sand.                                      |                       | 11<br>23<br>48        |  | 11.7                       | 123.7                   |                       |
|                                    |                |  |                       |                       |  |                            |                         |                       |
| 20                                 |                | Becomes very dense and fine- to coarse grained.  |                       | 23<br>50              |  | 9.8                        | 118.8                   |                       |
|                                    |                |  |                       |                       |  |                            |                         |                       |
| 25                                 |                | Same a above and slightly cemented.  |                       | 16<br>42<br>50        |  | 10.3                       | 116.4                   |                       |
|                                    |                |  |                       |                       |  |                            |                         |                       |
|                                    |                | Total Depth= 26'3"<br>No groundwater encountered<br>Boring backfilled with cuttings and tamped.  |                       |                       |  |                            |                         |                       |
| 30                                 |                |  |                       |                       |  |                            |                         |                       |
|                                    |                |  |                       |                       |  |                            |                         |                       |
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# EXPLORATION LOG

| Project: 301 West Palm Avenue      |                                  |   |                       | Boring No.: B-3       |                  |                  |                            |                         |                       |
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| Location: Redlands                 |                                  |   |                       | Elevation: ±1524'     |                  |                  |                            |                         |                       |
| Job No.: 18-430                    |                                  | Client: Diversified Pacific   |                       | Date: 1/21/19         |                  |                  |                            |                         |                       |
| Drill Method: 6" Hollow Stem Auger |                                  | Driving Weight: 140lbs/30"  |                       | Logged By: KTM        |                  |                  |                            |                         |                       |
| Depth<br>(Feet)                    | Lith-<br>ology                   | Material Description  | W<br>A<br>T<br>E<br>R | Samples               |                  |                  | Laboratory Tests           |                         |                       |
|                                    |                                  |   |                       | Blows<br>per<br>6 in. | C<br>o<br>r<br>e | B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 0                                  |                                  | <b>TOPSOIL</b><br>Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.  |                       |                       |                  |                  | 5.4                        | 109.4                   | pH, RES,<br>S04, CL   |
|                                    |                                  | <b>YOUNG ALLUVIAL FAN DEPOSITS (Qyf)</b><br>Silty Sand (SM): Orangish-brown, moist, very dense, fine- to medium-grained sand, with trace gravel up to 1.5" in diameter.<br>Same as above. |                       | 7<br>20<br>44         |                  |                  |                            |                         |                       |
|                                    |                                  |   |                       | 12<br>15<br>17        |                  |                  |                            |                         |                       |
| 5                                  |                                  | <b>Sand (SP):</b> Reddish-brown, moist, medium-dense, fine- to coarse-grained sand.   |                       | 8<br>14<br>24         |                  |                  |                            |                         |                       |
|                                    |                                  | <b>Silty Sand (SM):</b> Reddish-brown, moist, medium-dense, fine- to medium-grained, with trace coarse-grained sand, trace clay.<br>Same as above.  |                       | 8<br>14<br>14         |                  |                  |                            |                         |                       |
|                                    |                                  | Same as above, dense.   |                       | 7<br>16<br>24         |                  |                  |                            |                         |                       |
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| 15                                 |                                  | <b>OLD ALLUVIAL FAN DEPOSITS (Qof)</b><br><b>Sand (SP):</b> Reddish- brown, moist, very dense, fine- to medium-grained, with trace coarse-grained sand, trace clay, Disturbed.            |                       | 11<br>28<br>50        |                  |                  |                            |                         |                       |
|                                    |                                  |   |                       |                       |                  |                  |                            |                         |                       |
| 20                                 | Becomes fine- to coarse-grained. | 15<br>36<br>50  |                       |                       |                  |                  |                            |                         |                       |
|                                    |                                  |   |                       |                       |                  |                  |                            |                         |                       |
| 25                                 | Same as above.                   | 21<br>38<br>50  |                       |                       |                  |                  |                            |                         |                       |
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# EXPLORATION LOG

| Project: 301 West Palm Avenue      |                |  | Boring No.: B-4                                      |   |                  |                  |                            |                         |                       |  |
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| Location: Redlands                 |                |  | Elevation: ±1503'                                    |   |                  |                  |                            |                         |                       |  |
| Job No.: 18-430                    |                | Client: Diversified Pacific  |  | Date: 1/21/19   |                  |                  |                            |                         |                       |  |
| Drill Method: 6" Hollow Stem Auger |                | Driving Weight: 140lbs/30"   |  | Logged By: KTM  |                  |                  |                            |                         |                       |  |
| Depth<br>(Feet)                    | Lith-<br>ology | Material Description   | W<br>A<br>T<br>E<br>R                                | Samples   |                  |                  | Laboratory Tests           |                         |                       |  |
|                                    |                |  |  | Blows<br>per<br>6 in.   | C<br>o<br>r<br>e | B<br>u<br>l<br>k | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |  |
| 0                                  |                | <b>TOPSOIL</b><br><u>Silty Sand (SM)</u> : Brown, very moist, loose to medium-dense, fine- to medium-grained sand.<br><b>YOUNG ALLUVIAL FAN DEPOSITS (Qyf)</b><br><u>Silty Sand (SM)</u> : Reddish-brown, moist, medium-dense, fine- to medium-grained sand, trace rootlets.<br>Same as above. |  | 7<br>8<br>9   |                  |                  | 7.2                        | 108.5                   | CON                   |  |
| 5                                  |                | <u>Sand (SP)</u> : Reddish-brown, moist, medium-dense, very fine- to medium-grained sand, poorly graded, trace clay.<br><br>Becomes very dense.<br><br>Same as above.  | 13<br>17<br>17                                       |   |                  | 5.9              | 114.5                      |                         |                       |  |
|                                    |                |  | 10<br>24<br>50                                       |   |                  | 8.8              | 120.7                      |                         |                       |  |
|                                    |                |  | 24<br>50   |   |                  | 10.7             | 116.9                      |                         |                       |  |
|                                    |                |  | 22<br>45<br>48                                       |   |                  | 6.8              | 125.3                      |                         |                       |  |
| 15                                 |                | Same as above.   | 14<br>28<br>47                                       |   |                  | 8.2              | 119.2                      |                         |                       |  |
| 20                                 |                |  | Same as above and very fine- to medium-grained sand. | 17<br>37<br>50  |                  |                  | 3.6                        | 114.0                   |                       |  |
|                                    |                |  |  | Total Depth= 21'5"<br>No groundwater encountered<br>Boring backfilled with cuttings and tamped. |                  |                  |                            |                         |                       |  |
| 25                                 |                |  |  |   |                  |                  |                            |                         |                       |  |
| 30                                 |                |  |  |   |                  |                  |                            |                         |                       |  |

# ***APPENDIX B***

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## ***LABORATORY TEST PROCEDURES***

## ***LABORATORY DATA SUMMARY***

## **LABORATORY TEST PROCEDURES**

### **Soil Classification**

Soils encountered within the exploration borings were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D2488). The samples were re-examined in the laboratory and the classifications reviewed and then revised where appropriate.

### **In-Situ Moisture and Density**

Moisture content and unit dry density of in-place soil were determined in representative strata and are depicted on the Exploration Logs, Appendix A.

### **Laboratory Maximum Dry Density**

Maximum dry density and optimum moisture content were determined for selected samples of soil in accordance with ASTM D1557. Pertinent test values are given on Plate B-1.

### **Expansion Index**

An expansion index test was performed on a selected sample of soil in accordance with ASTM D4829. The expansion potential classification was determined from 2010 CBC Section 1802.3.2 on the basis of the expansion index value. The test result and expansion potentials are presented on Plate B-1.

### **Soil Corrosivity**

Chemical analyses were performed on a selected sample of soil to determine concentrations of soluble sulfate and chloride, as well as pH and resistivity. These tests were performed in accordance with California Test Method Nos. 417 (sulfate), 422 (chloride) and 643 (pH and resistivity). Test results are included on Plate B-1.

### **Consolidation**

Volume change (settlement or heave) characteristics of select undisturbed soils were determined by one-dimensional consolidation tests. These tests were performed in general accordance with the current version of the Test Method ASTM D2435. Axial loads were applied in several increments to laterally restrained 1-inch-high samples. The resulting deformations were recorded at selected time intervals. The test samples were inundated at the approximate in-situ and/or anticipated design overburden pressure in order to evaluate the effect of an increase in moisture content, e.g., hydro-consolidation potential or heave. Results of these tests are graphically presented on Plate B-2.

### **Direct Shear**

The Coulomb shear strength parameters, i.e., angle of internal friction and cohesion, were determined for a remolded sample of onsite soil. This test was performed in general accordance with the current version of Test Method ASTM D 3080. Three specimens were prepared for each test. The test specimens were inundated and then sheared under various normal loads at a constant strain rate of 0.005 inch per minute. The results of the direct shear test are graphically presented on Plate B-3.

| LABORATORY DATA SUMMARY* |                   |                  |                                     |                                   |                              |                                       |                               |    |    |                                  |                                      |                 |   |
|--------------------------|-------------------|------------------|-------------------------------------|-----------------------------------|------------------------------|---------------------------------------|-------------------------------|----|----|----------------------------------|--------------------------------------|-----------------|---|
| Boring Number            | Sample Depth (ft) | Soil Description | Max. Dry Density <sup>1</sup> (pcf) | Optimum Moisture <sup>1</sup> (%) | Expansion Index <sup>2</sup> | USCS Soil Classification <sup>3</sup> | Atterberg Limits <sup>4</sup> |    |    | Sulfate Content <sup>5</sup> (%) | Chloride Content <sup>6</sup> (mg/L) | pH <sup>7</sup> | Minimum Resistivity <sup>7</sup> (ohm-cm) |
|                          |                   |                  |                                     |                                   |                              |                                       | LL                            | PL | PI |                                  |                                      |                 |   |
| B-1                      | 0-5               | Silty Sand       | 132.5                               | 8.0                               | 6                            | SM                                    | --                            | -- | -- | --                               | --                                   | --              | --  |
| B-3                      | 0-5               | Silty Sand       | --                                  | --                                | --                           | SM                                    | --                            | -- | -- | 0.0102                           | 420                                  | 7.3             | 4,800                                     |

(--) Tests Not Performed

Test Procedures:

<sup>1</sup> Per ASTM Test Method D 1557

<sup>2</sup> Per ASTM Test Method D 4829

<sup>3</sup> Per ASTM Test Method D 2487

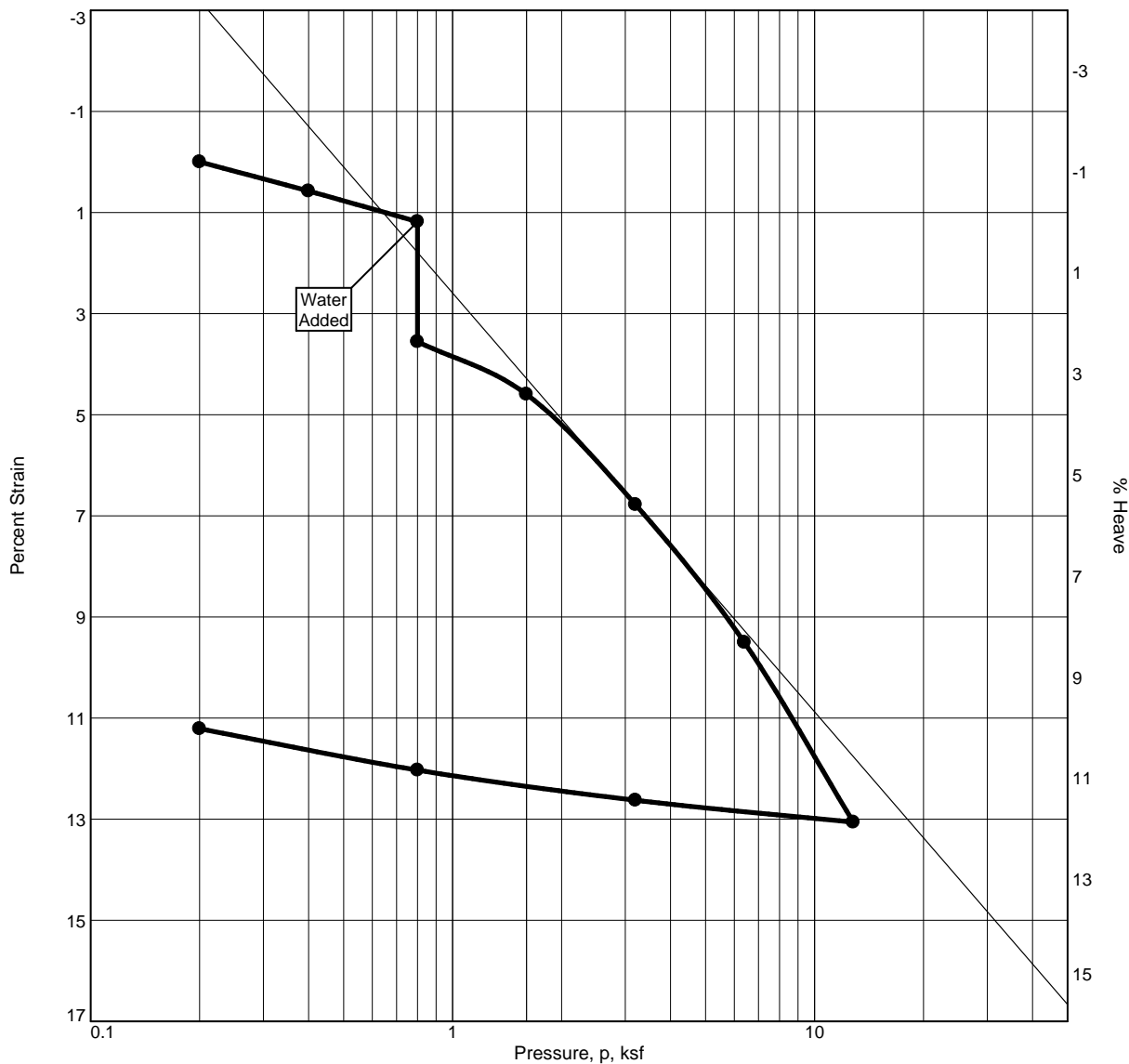
<sup>4</sup> Per ASTM Test Method D 4318

<sup>5</sup> Per Caltrans Test Method 417

<sup>6</sup> Per Caltrans Test Method 422

<sup>7</sup> Per Caltrans Test Method 643

# CONSOLIDATION TEST REPORT



## SUMMARY OF TEST RESULTS

|         | DRY DENSITY<br>(pcf) | MOISTURE<br>CONTENT, (%) | SATURATION<br>(%) | VOID<br>RATIO | SPECIFIC<br>GRAVITY | OVERBURDEN<br>(ksf) | P <sub>C</sub><br>(ksf) | C <sub>C</sub> | SWELL PRESS.<br>(ksf) |
|---------|----------------------|--------------------------|-------------------|---------------|---------------------|---------------------|-------------------------|----------------|-----------------------|
| INITIAL | 97.8                 | 7.2                      | 32.2              | 0.590         | 2.65                | .21                 | 1.8                     | 0.13           |                       |
| FINAL   |                      | 15.8                     | 100.0             | 0.411         |                     |                     |                         |                |                       |

Source of Sample: B-4 Depth: 2  
 Material Description: Dark yellowish brown, Silty fine to coarse Sand  
 Remarks: Oversize found within sample

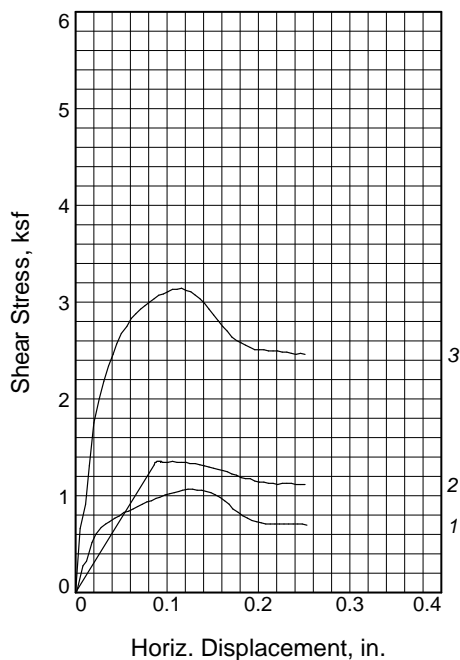
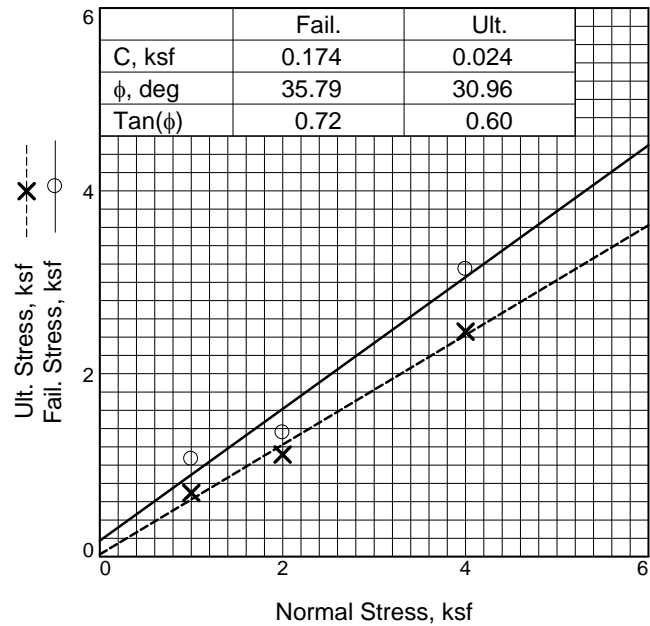
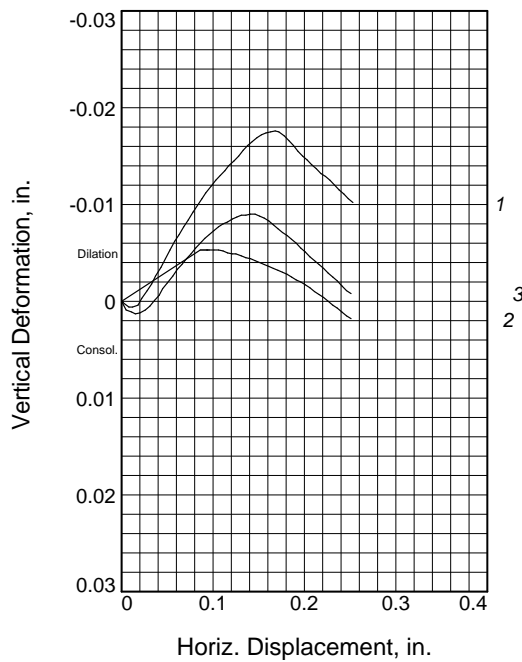
USCS: SM AASHTO:



Client: Diversified Pacific  
 Project: West Palm ave. and Alvarado st.

Project No.: 18-430

PLATE B-2



| Sample No.            | 1      | 2      | 3      |
|-----------------------|--------|--------|--------|
| Initial               |        |        |        |
| Water Content, %      | 8.2    | 8.2    | 8.2    |
| Dry Density, pcf      | 116.7  | 116.7  | 116.7  |
| Saturation, %         | 51.9   | 51.9   | 51.9   |
| Void Ratio            | 0.4179 | 0.4179 | 0.4179 |
| Diameter, in.         | 2.416  | 2.416  | 2.416  |
| Height, in.           | 1.000  | 1.000  | 1.000  |
| At Test               |        |        |        |
| Water Content, %      | 15.9   | 15.7   | 15.6   |
| Dry Density, pcf      | 116.7  | 116.7  | 116.7  |
| Saturation, %         | 100.6  | 99.6   | 99.2   |
| Void Ratio            | 0.4179 | 0.4179 | 0.4179 |
| Diameter, in.         | 2.416  | 2.416  | 2.416  |
| Height, in.           | 1.000  | 1.000  | 1.000  |
| Normal Stress, ksf    | 1.000  | 2.000  | 4.000  |
| Fail. Stress, ksf     | 1.068  | 1.356  | 3.144  |
| Displacement, in.     | 0.128  | 0.089  | 0.116  |
| Ult. Stress, ksf      | 0.696  | 1.116  | 2.460  |
| Displacement, in.     | 0.253  | 0.251  | 0.251  |
| Strain rate, in./min. | 0.005  | 0.005  | 0.005  |

**Sample Type:** Remolded to 90% RC  
**Description:** Reddish brown, Silty fine to coarse Sand  
**Assumed Specific Gravity=** 2.65  
**Remarks:**

**Client:** Diversified Pacific  
**Project:** West Palm ave. and Alvarado st.  
**Source of Sample:** B-1      **Depth:** 0-5  
**Proj. No.:** 18-430      **Date Sampled:** 1-22-19

## ***APPENDIX C***

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### ***PERCOLATION FIELD TEST DATA***

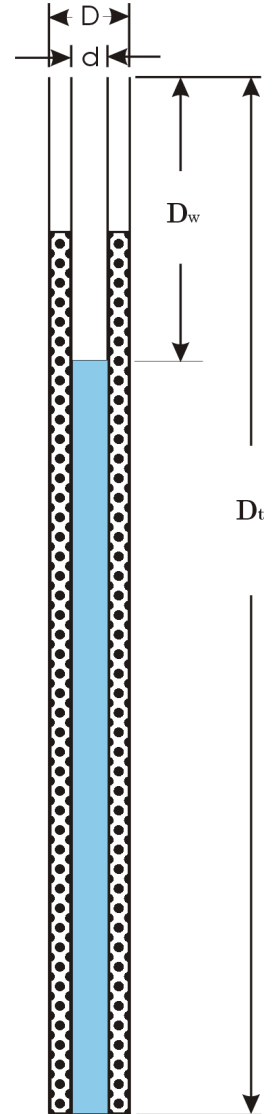
# PERCOLATION TEST SUMMARY

**Test Number: P-1**

Job No. 18-430  
 Project Name: 301 W. Palm Ave. Redlands  
 Client: Diversified Pacific  
 Tested by: Levon Holmes  
 Date: January 21, 2018

Depth to Bottom, ft ( $D_t$ ): 13  
 Diameter of Hole, in (D): 6  
 Diameter of Pipe, in (d): 3  
 Agg. Correction (% Voids): 45  
 Soil Description: fine to medium Silty SAND (SM)

| Time Interval<br>(min) | Depth to Water Surface<br>$D_w$ (ft) |             | Change in<br>Head (in) | Perc Rate<br>gal/day/ft <sup>2</sup> |
|------------------------|--------------------------------------|-------------|------------------------|--------------------------------------|
|                        | 1st Reading                          | 2nd Reading |                        |                                      |
| 30                     | 6.00                                 | 6.50        | 6.0                    | 1.9                                  |
| 30                     | 6.00                                 | 6.25        | 3.0                    | 0.9                                  |
| 30                     | 6.00                                 | 6.27        | 3.2                    | 1.0                                  |
| 30                     | 6.00                                 | 6.22        | 2.6                    | 0.8                                  |
| 30                     | 5.95                                 | 6.22        | 3.2                    | 1.0                                  |
| 30                     | 6.00                                 | 6.21        | 2.5                    | 0.8                                  |
| 30                     | 6.00                                 | 6.25        | 3.0                    | 0.9                                  |
| 30                     | 6.00                                 | 6.23        | 2.8                    | 0.9                                  |
| 30                     | 5.97                                 | 6.20        | 2.8                    | 0.9                                  |
| 30                     | 6.00                                 | 6.20        | 2.4                    | 0.8                                  |
| 30                     | 5.97                                 | 6.18        | 2.5                    | 0.8                                  |
| 30                     | 5.95                                 | 6.16        | 2.5                    | 0.8                                  |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |



Percolation Rate: **0.8 gal/day/ft<sup>2</sup>**  
 Infiltration Rate: **0.05 inches/hour**

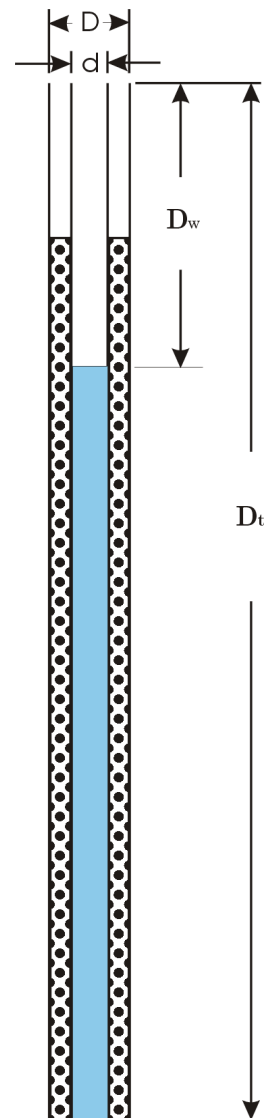
# PERCOLATION TEST SUMMARY

**Test Number: P-2**

Job No. 18-430  
 Project Name: 301 W. Palm Ave. Redlands  
 Client: Diversified Pacific  
 Tested by: Levon Holmes  
 Date: January 21, 2018

Depth to Bottom, ft ( $D_t$ ): 10  
 Diameter of Hole, in (D): 8  
 Diameter of Pipe, in (d): 3  
 Agg. Correction (% Voids): 45  
 Soil Description: fine to medium Silty SAND (SM)

| Time Interval<br>(min) | Depth to Water Surface<br>$D_w$ (ft) |             | Change in<br>Head (in) | Perc Rate<br>gal/day/ft <sup>2</sup> |
|------------------------|--------------------------------------|-------------|------------------------|--------------------------------------|
|                        | 1st Reading                          | 2nd Reading |                        |                                      |
| 30                     | 5.00                                 | 5.65        | 7.8                    | 4.2                                  |
| 30                     | 5.00                                 | 5.53        | 6.4                    | 3.4                                  |
| 10                     | 5.00                                 | 5.20        | 2.4                    | 3.7                                  |
| 10                     | 5.00                                 | 5.15        | 1.8                    | 2.8                                  |
| 10                     | 5.00                                 | 5.15        | 1.8                    | 2.8                                  |
| 10                     | 5.00                                 | 5.12        | 1.4                    | 2.2                                  |
| 10                     | 5.00                                 | 5.12        | 1.4                    | 2.2                                  |
| 10                     | 5.00                                 | 5.12        | 1.4                    | 2.2                                  |
|                        |                                      |             | 0.0                    | #DIV/0!                              |
|                        |                                      |             | 0.0                    | #DIV/0!                              |
|                        |                                      |             | 0.0                    | #DIV/0!                              |
|                        |                                      |             | 0.0                    | #DIV/0!                              |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |
|                        |                                      |             |                        |                                      |



Percolation Rate: **2.2 gal/day/ft<sup>2</sup>**  
 Infiltration Rate: **0.15 inches/hour**