# Appendix C

Geotechnical Investigation

# PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

## DISTRICTWIDE SOLAR PLANNING INITIATIVE PROJECT
## MORENO VALLEY AND NORCO COLLEGE CAMPUSES
Cities of Moreno Valley and Norco, Riverside County, California

*CONVERSE PROJECT NO. 21-81-232-01*

*Prepared For:*

RIVERSIDE COMMUNITY COLLEGE DISTRICT
3801 Market Street, 3rd Floor
Riverside, CA 92501

*Presented By:*


CONVERSE CONSULTANTS
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October 19, 2021

**Converse Consultants**
75 Years of Dedication in Geotechnical Engineering & Consulting, Environmental & Groundwater Science, Materials Testing & Inspection Services

October 19, 2021

Mr. Mehran Mohtasham
Director of Capital Planning, Facilities, Planning and Development
Riverside Community College District (RCCD)
3801 Market Street, 3rd Floor
Riverside, CA 92501

Subject: **PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT**
**Districtwide Solar Planning Initiative Project**
Moreno Valley and Norco College Campuses (RCCD)
Cities of Moreno Valley and Norco, Riverside County, California
Converse Project No. 21-81-232-01

Dear Mr. Mohtasham:

Converse Consultants (Converse) is pleased to submit this preliminary geotechnical investigation report to provide the design/build contractors information on the seismic, subsurface conditions and preliminary recommendations for the Districtwide Solar Planning Initiative project sites (Moreno Valley and Norco College Campuses, RCCD), located in the Cities of Moreno Valley and Norco, Riverside County, California. This report was prepared in accordance with our proposal dated August 11, 2021, and your Purchase Order # P-0082172 dated September 9, 2021.

Based upon our field investigation, laboratory data, and analyses, the proposed project is considered feasible from a geotechnical standpoint. This is a preliminary report; therefore, additional investigation and analysis need to perform for final design and construction.

We appreciate the opportunity to be of service to Riverside Community College District. Should you have any questions, please do not hesitate to contact us at 909-796-0544.

**CONVERSE CONSULTANTS**

Hashmi S. E. Quazi, PhD, PE, GE
Principal Engineer

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# PROFESSIONAL CERTIFICATION

This report has been prepared by the following professionals whose seals and signatures appear herein.

The findings, recommendations, specifications and professional opinions contained in this report were prepared in accordance with the generally accepted professional engineering and engineering geologic principle and practice in this area of Southern California. We make no other warranty, either expressed or implied.

Zahangir Alam, PhD, PE (TX)
Senior Staff Engineer

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Senior Geologist

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Principal Engineer

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## APPENDICES

## 1.0 INTRODUCTION

This report presents the preliminary findings of our geotechnical investigation performed by Converse for the Districtwide Solar Planning Initiative project sites (Moreno Valley and Norco College Campuses, RCCD), located in the Cities of Moreno Valley and Norco, Riverside County, California. The project locations are shown in Figure No. 1a, *Approximate Project Location Map (MVC)* and Figure No. 1b, *Approximate Project Locations Map (NC)*.

The purposes of this investigation were to determine the nature and engineering properties of the subsurface soils, and to provide seismic, subsurface conditions and preliminary design recommendations for the project.

This report is prepared for the project described herein and is intended for use solely by Riverside Community College District (RCCD) and their authorized agents for preliminary information. It should not be used as a bidding document but may be made available to the potential contractors for information on factual data only. For bidding purposes, the contractors should be responsible for making their own interpretation of the data contained in this report.

This is a preliminary report; therefore, please do not rely on this report for final design and construction.

## 2.0 PROJECT DESCRIPTION

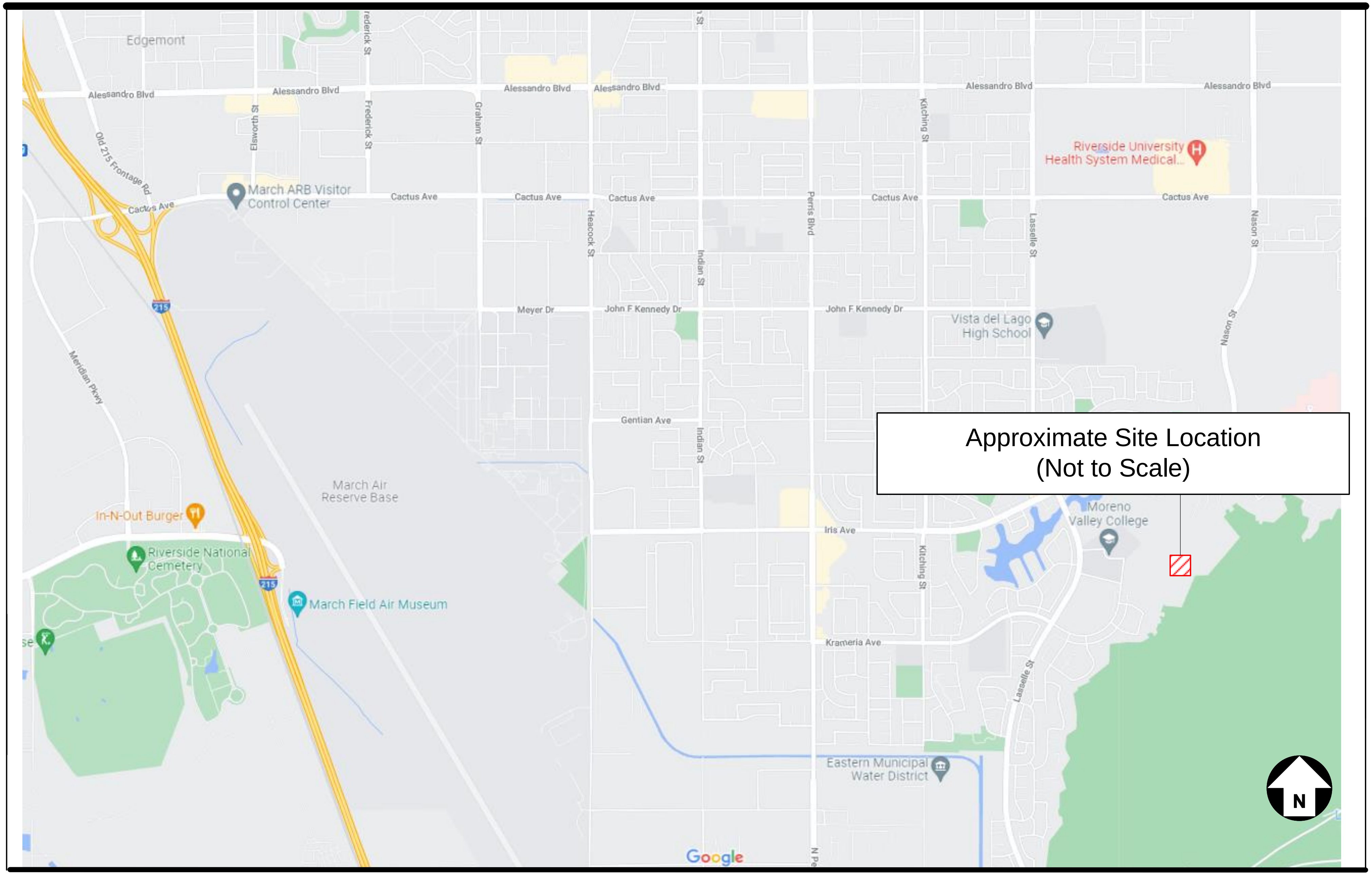
RCCD intends to install ground mounted solar panels at the Norco and Moreno Valley college campuses. This project will be designed and constructed through a design/build procurement process. The following equipment will be required at each college campus.

***Moreno Valley College (MVC) Campus: 1,965 kW Solar and 400kWh BESS***

- New 4 Position Selector Switch
- New 12kV feeder
- New Transformer and Switch Board
- New Bess

***Norco College (NC) Campus: 1,741 kW Solar and 400kWh BESS***

- New 4 Position Selector Switch
- New 12kV feeder
- New Transformer and Switch Board
- New Bess




Project: Districtwide Solar Planning Initiative

Location: Moreno Valley College Campus
City of Moreno Valley, Riverside County, California

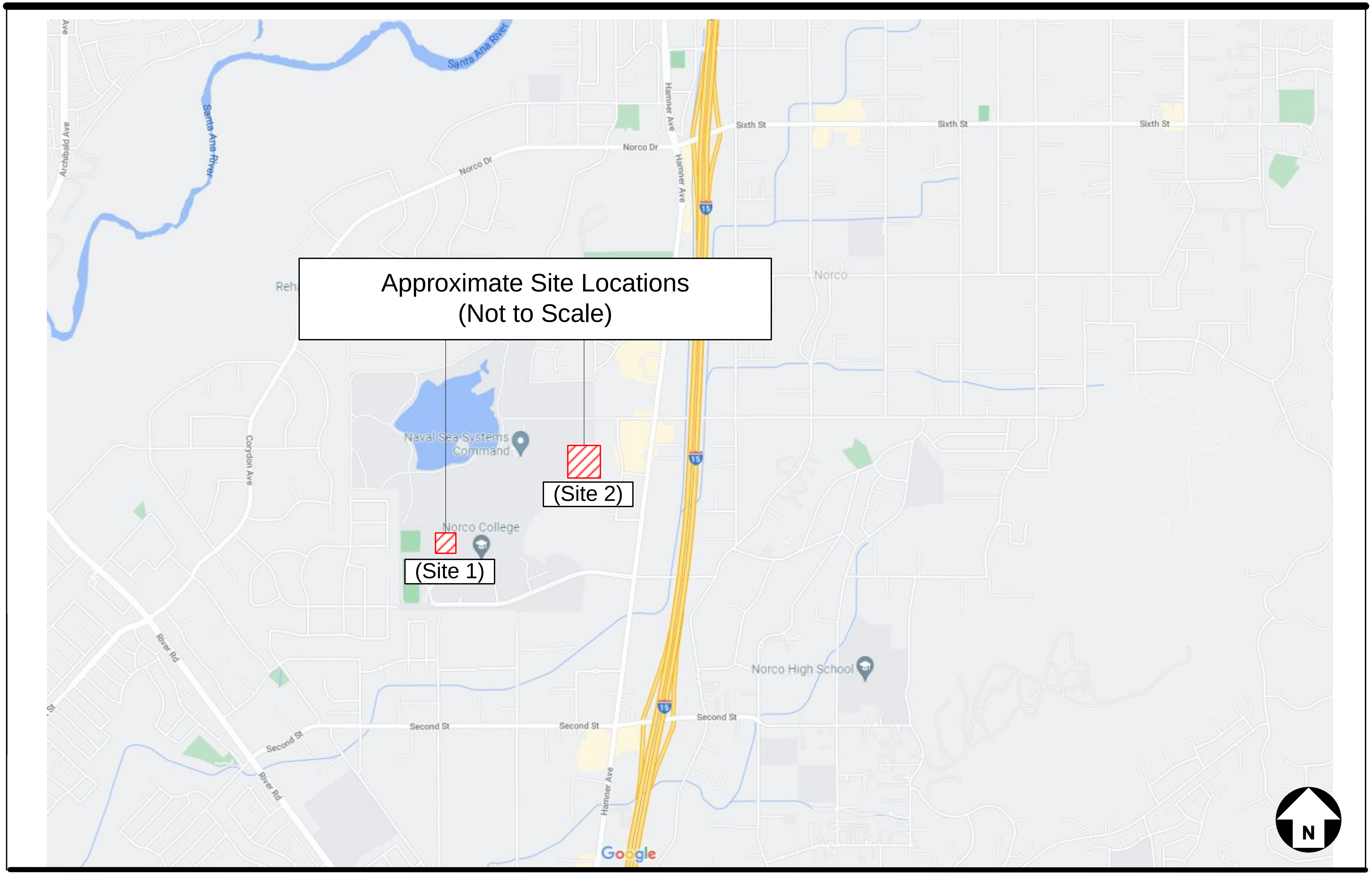
For: Riverside Community College District

# Approximate Site Location Map (MVC)

Project No.
21-81-232-01

**Converse Consultants**

Figure No.
1a




Project: Districtwide Solar Planning Initiative
Location: Norco College Campus
City of Norco, Riverside County, California
For: Riverside Community College District

# Approximate Site Locations Map (NC)

Project No.
21-81-232-01

**Converse Consultants**

Figure No.
1b

# 3.0 SITE DESCRIPTION

General current site conditions at each college campus are presented below.

***Moreno Valley College Campus***

The site is located within Moreno Valley College campus, located at 16130 Lasselle Street, City of Moreno Valley, Riverside County, California. The site is bounded to the north by two Eastern Municipal Water District (EMWD) water reservoirs, to the south and east by vacant land and mountains, to the west by Parkside Drive and Parkside Complex. A slope exists on the west side of the site with an approximate ratio of 5:1. The site is presently vacant and partially covered with minor desert shrubbery. The approximate elevation of the proposed site is 1,660 feet above mean sea level (amsl). Photograph Nos. 1 and 2 depict the present site conditions.

*Photograph No. 1: Present proposed site conditions and existing slope, facing west towards Parkside Dr. and Parkside complex.*

*Photograph No. 2: Present proposed site conditions, facing north towards existing reservoirs.*

***Norco College Campus:***

Two sites (Site 1 and 2) are within Norco College, located at 2001 Third Street City of Norco, Riverside County, California. The first location (Site 1) is located north of the campus buildings in a hilly area. The site is presently vacant and partially covered with minor desert shrubbery, and cobbles and boulders at the surface. The site is bounded to the south by campus buildings, to the north and west by vacant land, and to the east by the Naval Base. The terrain elevation slopes from approximately 715 feet to 680 feet above mean sea level (amsl). Photograph Nos. 3 and 4 depict the present site conditions.

*Photograph No. 3: Present proposed site conditions, facing northeast.*

*Photograph No. 4: Present proposed site conditions, facing south towards facilities buildings.*

The second location (Site 2) is located northeast of the Norco College campus. It is bounded by the Naval Base from the west, Fourth Street from the north, Corona-Norco Unified District and Commercial properties from the east and vacant land from the south. The site is presently vacant and covered with minor desert shrubbery. The approximate elevation of the proposed site is 645 feet above mean sea level (amsl). Photograph Nos. 5 and 6 depict the present site conditions.

*Photograph No. 5: Present proposed site conditions, facing southwest Naval base.*

*Photograph No. 6: Present proposed site conditions, facing north.*

# 4.0 SCOPE OF WORK

The scope of this investigation included project set-up, subsurface exploration, laboratory testing, engineering analysis, and preparation of this report, as described in the following sections.

## *4.1 Document Review*

We reviewed geologic maps, aerial photographs, groundwater data, and other information pertaining to the project area to assist in the evaluation of geologic hazards that may be present. Besides, pertinent information (the documents cited in Section 11, *References*) were used to understand the subsurface conditions and plan the investigation for this project.

## *4.2 Project Set-up*

The project set-up consisted of the following tasks.

- Prepared and submitted boring locations map for your review and approval.
- Coordinated with you and the district for the sites access and temporary parking permit.
- Conducted a field reconnaissance and marked the boring locations.
- Notified Underground Service Alert (USA) at least 48 hours prior to drilling to clear the boring locations of any conflict with existing underground utilities.
- Engaged a California-licensed driller to drill exploratory borings.

### *4.3 Subsurface Exploration*

Subsurface exploration performed at each college campus is presented below.

***Moreno Valley College Campus***
Two exploratory boring (BH-01 and BH-02) were drilled on September 22, 2021, to investigate the subsurface conditions at Moreno Valley College campus. The borings were drilled using an 8-inch dimeter hollow stem auger to the depths of 17.7 feet and 51.5 feet below existing ground surface (bgs).

***Norco College Campus***
Four borings (BH-03 through BH-06) were drilled on September 22 and 23, 2021 to investigate the subsurface conditions at two sites within Norco Community College campus. The borings were drilled using an 8-inch dimeter hollow stem auger to the depths between 7.5 and 50.2 feet below existing ground surface (bgs). Borings (BH-03 and BH-04) were terminated at depths of 7.5 and 10.5 feet bgs due to the obstruction in cobbles/boulders and possible bedrock.

Approximate boring locations are indicated in Figure No. 2a, *Approximate Boring Locations Map (MVC)* and Figure No. 2b*, Approximate Boring Locations Map (NC)*. For a description of the field exploration and sampling program, see Appendix A, *Field Exploration*.

### *4.4 Laboratory Testing*

Representative soil samples of the project sites were tested in the laboratory to aid in the soils classification and to evaluate the relevant engineering properties of the soils. These tests included the following.

- *In*-situ moisture contents and dry densities (ASTM D2216 and ASTM D2937)
- Expansion index (ASTM D4829)
- Collapse potential (ASTM D4546)
- Soil corrosivity (California Tests 643, 422, and 417)
- Grain size distribution (ASTM D6913)
- Maximum dry density and optimum-moisture content (ASTM D1557)
- Direct shear (ASTM D3080)

For *in-situ* moisture and dry density data, see the Logs of Borings in Appendix A, *Field Exploration*. For a description of the laboratory test methods and test results, see Appendix B, *Laboratory Testing Program.*


Project: Districtwide Solar Planning Initiative
Location: Moreno Valley College Campus
City of Moreno Valley, Riverside County, California
For: Riverside Community College District

# Approximate Boring Locations Map (MVC)

Project No.
21-81-232-01

**Converse Consultants**

Figure No.
2a


Project: Districtwide Solar Planning Initiative
Location: Norco College Campus
City of Norco, Riverside County, California
For: Riverside Community College District

# Approximate Boring Locations Map (NC)

Project No.
21-81-232-01

**Converse Consultants**

Figure No.
2b

### *4.5 Analysis and Report Preparation*

Data obtained from the field exploration and laboratory testing program was compiled and evaluated. Geotechnical analyses of the compiled data were performed, and this report was prepared to present our findings, conclusions, and recommendations for the project.

## 5.0 LABORATORY TEST RESULTS

Results of physical and chemical tests performed for this project are presented below.

### *5.1 Physical Testing*

Results of the various laboratory tests are presented in Appendix B, *Laboratory Testing Program*, except for the results of in-situ moisture and dry density tests which are presented on the Logs of Borings in Appendix A, *Field Exploration*. The results are also discussed below.

***Moreno Valley College Campus***

- In-situ Moisture and Dry Density – *In-situ* dry densities and moisture contents of the site soils were determined in accordance with ASTM Standard D2216 and D2937. Dry densities of alluvium soils ranged from 106 to 126 pounds per cubic foot (pcf) with moisture contents of 3 to 8 percent.
- Expansion Index (EI) – One representative sample from the upper 5 feet soils was tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The test result showed an EI of 1, corresponding to very low expansion potential.
- Collapse Potential – The collapse potential of one relatively undisturbed sample was tested under a vertical stress of up to 2.0 kips per square foot (ksf) in accordance with the ASTM Standard D4546 test method. The test result showed collapse of 2.0 percent, corresponding to slight collapse potential.
- Grain Size Analysis –Two representative samples were tested to determine the relative grain size distribution in accordance with the ASTM Standard D6913. The test results are graphically presented in Drawing No. B-1, *Grain Size Distribution Results.*
- Maximum Dry Density and Optimum Moisture Content – Typical moisture-density relationship test was performed on a representative sample in accordance with ASTM D1557. The results are presented in Drawing No. B-2, *Moisture-Density Relationship Results*, in Appendix B, *Laboratory Testing Program*. The laboratory maximum dry density was 132.0 pcf and the optimum moisture content of 6.0 percent.
- Direct Shear – One direct shear test was performed on undisturbed representative ring samples under soaked moisture condition in accordance with ASTM Standard D3080. The results are presented in Drawings No. B-3, *Direct Shear Test Results* in Appendix B, *Laboratory Testing Program*.

***Norco College Campus***

- In-situ Moisture and Dry Density – *In-situ* dry densities and moisture contents of the site soils were determined in accordance with ASTM Standard D2216 and D2937. Dry densities of alluvium soils ranged from 101 (ignoring disturbed) to 128 pounds per cubic foot (pcf) with moisture contents of 2 to 10 percent.
- Expansion Index (EI) – One representative sample from the upper 5 feet soils was tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The test result showed an EI of 9, corresponding to very low expansion potential.
- Collapse Potential – The collapse potential of one relatively undisturbed sample was tested under a vertical stress of up to 2.0 kips per square foot (ksf) in accordance with the ASTM Standard D4546 test method. The test result showed collapse of 1.9 percent, corresponding to slight collapse potential.
- Grain Size Analysis – Two representative samples were tested to determine the relative grain size distribution in accordance with the ASTM Standard D6913. The test results are graphically presented in Drawing No. B-1, *Grain Size Distribution Results.*
- Maximum Dry Density and Optimum Moisture Content – Typical moisture-density relationship test was performed on a representative sample in accordance with ASTM D1557. The results are presented in Drawing No. B-2, *Moisture-Density Relationship Results*, in Appendix B, *Laboratory Testing Program*. The laboratory maximum dry density was 133.5 pcf and the optimum moisture content of 5.5 percent.
- Direct Shear – One direct shear test was performed on undisturbed representative ring samples under soaked moisture condition in accordance with ASTM Standard D3080. The results are presented in Drawings No. B-4, *Direct Shear Test Results* in Appendix B, *Laboratory Testing Program*.

### *5.2 Chemical Testing - Corrosivity Evaluation*

Two representative soil samples (one from each college campus) was tested to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purposes of these tests were to determine the corrosion potential of site soils when placed in contact with common pipe materials. These tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with California Tests 643, 422, and 417. The test results are presented in Appendix B, *Laboratory Testing Program and summarized below.*

***Moreno Valley College Campus***

- The pH measurement of the tested sample was 8.1.
- The sulfate content of the tested sample was 36 ppm (0.0036 percent by weight).
- The chloride concentration of the tested sample was 23 ppm.
- The minimum electrical resistivity when saturated was 6,466 ohm-cm.

***Norco College Campus***

- The pH measurement of the tested sample was 7.4.
- The sulfate content of the tested sample was 23 ppm (0.0023 percent by weight).
- The chloride concentration of the tested sample was 21 ppm.
- The minimum electrical resistivity when saturated was 19,890 ohm-cm.

# 6.0 SUBSURFACE CONDITIONS

A general description of the subsurface conditions, various materials and groundwater conditions encountered at each location during our field exploration is discussed below.

## *6.1 Subsurface Profile*

General subsurface soils description for each college campus is presented below.

***Moreno Valley College Campus***

Based on the exploratory borings and laboratory test results, the subsurface alluvial soils at the site consist primarily of a mixture of sand, silt and gravel. Scattered gravel up to 1 inch in maximum dimension was encountered in the borings. The alluvium is underlain at varying depths (15 feet to 45 feet bgs) by granitic bedrock. Though not encountered, cobbles and boulders will likely be present at the site.

***Norco College Campus***

Based on the exploratory borings and laboratory test results, the subsurface alluvial soils at the site consist primarily of a mixture of sand, silt, gravel, cobbles and boulders. Scattered gravel up to 3 inches and cobbles up to 4 inches were observed in the borings. The alluvium is underlain at varying depths (10 feet to 15 feet bgs) by silty sandstone bedrock. Boulders up to 3 feet is expected to be present at the site.

For a detailed description of the subsurface materials encountered in the exploratory borings, see Drawings No. A-2 through A-7, Logs of Borings, in Appendix A, Field Exploration.

## *6.2 Groundwater*

Groundwater data for each college campus is presented below.

***Moreno Valley College Campus***

Groundwater was not encountered during the investigation at the Moreno Valley College site to the maximum explored depth of 51.5 feet bgs.

For comparison, regional groundwater data from the GeoTracker database (SWRCB, 2021) for locations within a one-mile radius of the project site was reviewed to evaluate the current and historical groundwater levels and no data was available.

Regional groundwater data from the USGS National Water Information System (USGS, 2021) for locations within a one-mile radius of the project site was reviewed to evaluate the current and historical groundwater levels. One site was found with available groundwater data and can be seen below.

- Site No. 335358117114501, located approximately one mile to the northwest of the project site, reported groundwater at a depth of approximately 172 feet below ground surface (bgs) in 2001.

Regional groundwater data from the California Water Data Library (DWR, 2021) for locations within a one-mile radius of the project sites was reviewed to evaluate the current and historical groundwater levels. Two sites were found with available groundwater data and can be seen below.

- Station No. 338982N1171940W001, located approximately one mile to the northwest of the project site, reported groundwater at depths ranging between 38 and 69 feet bgs from 2013 to 2021.
- Station No. 338995N117958W001, located approximately one mile to the northwest of the project site, reported groundwater at depths ranging between 30 and 61 feet bgs from 2011 to 2021.

Based on the absence of groundwater during boring operations at the Moreno Valley College site, as well as current and historical data, groundwater is expected to be deeper than 51.5 feet bgs. It should be noted that the groundwater level could vary depending upon the seasonal precipitation and possible groundwater pumping activity in each site vicinity. Shallow perched groundwater may be present locally, particularly following precipitation or irrigation events.

***Norco College Campus***

Groundwater was not encountered during the investigation in borings BH-03, BH-04, and BH-06; however, groundwater was encountered in BH-05 at 30.7 feet bgs.

For comparison, regional groundwater data from the GeoTracker database (SWRCB, 2021) for locations within a one-mile radius of the project sites was reviewed to evaluate the current and historical groundwater levels. Three sites were found with available groundwater data and can be seen below.

- Thrifty Oil #338 (T0606500206), located approximately 2,100 feet to the southeast of the project site, reported groundwater at depths ranging between 25 and 34 feet bgs from 1991 to 2021.
- Mobil St. Anthony (T0606500393), located approximately 2,300 feet to the northeast of the project site, reported groundwater at depths ranging between 18 and 29 feet bgs from 2001 to 2012.
- Shell Hamner (T0606520856), located approximately 4,200 feet to the southeast of the project site, reported groundwater at depths ranging between 25 and 38 feet bgs from 2003 to 2013.

Regional groundwater data from the USGS National Water Information System (USGS, 2021) for locations within a one-mile radius of the project sites was reviewed to evaluate the current and historical groundwater levels and no data was available.

Regional groundwater data from the California Water Data Library (DWR, 2021) for locations within a one-mile radius of the project sites was reviewed to evaluate the current and historical groundwater levels and no data was available.

Based on the presence of groundwater during boring operations, as well as current and historical data, groundwater is expected to be present around 30 feet bgs. It should be noted that the groundwater level could vary depending upon the seasonal precipitation and possible groundwater pumping activity in each site vicinity. Shallow perched groundwater may be present locally, particularly following precipitation or irrigation events.

### *6.3 Expansive Soils*

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors and may result in unacceptable settlement or heave of structures or concrete slabs supported on grade. Depending on the extent and location below finish subgrade, expansive soils can have a detrimental effect on structures.

Based on the laboratory test results, the expansion indices of the upper 5 feet of both sites soils were 1 and 9, corresponding to very low expansion potentials.

### *6.4 Collapse Potential*

Soil deposits subjected to collapse/hydro-consolidation generally exist in regions of moisture deficiency. Collapsible soils are generally defined as soils that have potential to suddenly decrease in volume upon increase in moisture content even without an increase in external loads. Moreover, some soils may have a different degree of collapse/hydro-consolidation based on the amount of proposed fill or structure loads. Soils susceptible to collapse/ hydro-consolidation include wind-blown silt, weakly cemented sand, and silt where the cementing agent is soluble (e.g. soluble gypsum, halite), alluvial or colluvial deposits within semi-arid to arid climate, and certain weathered bedrock above the groundwater table.

Granular soils may have a potential to collapse upon wetting in arid climate regions. Collapse/hydro-consolidation may occur when the soluble cements (carbonates) in the soil matrix dissolve, causing the soil to densify from its loose/low density configuration from deposition.

The degree of collapse of a soil can be defined by the collapse potential value, which is expressed as a percent of collapse of the total sample using the Collapse Potential Test (ASTM D4546). According to the ASTM guideline, the severity of collapse potential is commonly evaluated by the following Table No. 1, *Collapse Potential Values*.

**Table No. 1, Collapse Potential Values**

| Collapse Potential Value (%) | Severity of Problem |
|---|---|
| 0 | None |
| 0.1 to 2 | Slight |
| 2.1 to 6.0 | Moderate |
| 6.0 to 10.0 | Moderately Severe |
| >10 | Severe |

Based on the laboratory test results (collapse potential of 2.0 percent at a depth of 2.5 feet bgs at MVC and 1.9 percent at NC), a slight problem is anticipated at the sites. Collapse potential distress is typically considered a concern when collapse potential is over 2% (LA County, 2013).

### *6.5 Excavatability*

The surface and subsurface soil materials at the sites are expected to be excavatable by conventional heavy-duty earth moving and trenching equipment. Difficult excavation will be encountered due to the presence of gravel, cobbles, boulders and bedrock.

The phrase "conventional heavy-duty excavation equipment" is intended to include commonly used equipment such as excavators and trenching machines. It does not include hydraulic hammers ("breakers"), jackhammers, blasting, or other specialized equipment and techniques used to excavate hard earth materials. Selection of an appropriate excavation equipment model should be done by an experienced earthwork contractor and may require test excavations in representative areas.

### *6.6 Subsurface Variations*

Based on results of the subsurface exploration and our experience, some variations in the continuity and nature of subsurface conditions within the project sites should be anticipated. Because of the uncertainties involved in the nature and depositional characteristics of the earth material, care should be exercised in interpolating or extrapolating subsurface conditions between or beyond the boring locations.

## 7.0 ENGINEERING GEOLOGY

The regional and local geology within the proposed project area are discussed below.

### *7.1 Regional Geology*

The Norco and Moreno Valley College sites lie in the Chino Basin and Perris Block, respectively, and are centrally located within the Peninsular Ranges Geomorphic Province adjacent to the Transverse Ranges province.

The Peninsular Ranges Geomorphic Province consists of a series of northwest-trending mountain ranges and valleys bounded on the north by the San Bernardino and San Gabriel Mountains, on the west by the Los Angeles Basin, and on the south by the Pacific Ocean.

The province is a seismically active region characterized by a series of northwest-trending strike-slip faults. The most prominent of the nearby fault zones include the San Andreas, Elsinore, and San Jacinto fault zones which have been known to be active during Quaternary time.

Topography within the province is generally characterized by broad alluvial valleys separated by linear mountain ranges. This northwest-trending linear fabric is created by the regional faulting within the granitic basement rock of the Southern California Batholith. Broad, linear, alluvial valleys have been formed by erosion of these principally granitic mountain ranges.

The Chino Basin is a broad alluvial valley bounded by the San Gabriel Mountains on the north, the San Bernardino Mountains on the east and northeast, the Santa Ana Mountains on the southwest, and the Puente Hills on the west. The thickness of the alluvium is more than 800 feet in the central area of the basin with a maximum thickness of 1,300 feet near the Riverside area.

The Perris Block is a relatively stable structural block bounded by the active Elsinore and San Jacinto fault zones to the west and east, and the Chino and Temecula basins to the north and south, respectively. The Perris Block has low relief and is roughly rectangular in shape.

### *7.2 Local Geology*

Local geology for each college campus is presented below.

**Moreno Valley College Campus**

Review of geologic mapping indicates that the Moreno Valley College site is underlain locally by very old (late to middle Pleistocene aged) alluvial-fan deposits. These alluvial-fan deposits primarily consist of moderately to well consolidated silt, sand, gravel, and conglomerate. This site may be underlain at some depth by heterogeneous (Cretaceous aged) granitic rocks derived from the Peninsular Ranges Batholith (Morton and Miller, 2006).

**Norco College Campus**

Review of geologic mapping indicates that the Norco College site is underlain locally by old (late to middle Pleistocene) alluvial-fan deposits. These alluvial-fan deposits primarily consist of moderately to well consolidated silt, sand, and gravel. Portions of the project site are also underlain with various bedrock units including sedimentary rocks of the Norco area (QTn) and Micropegmatite granite (Kmp). The sedimentary rock (QTn) consist of early Pleistocene to late Pliocene aged conglomerate and the micropegmatite granite (Kmp) consists of Cretaceous aged granite with micropegmatitic texture (Morton and Miller, 2006).

## 8.0 FAULTING AND SEISMICITY

The approximate distance and seismic characteristics of nearby faults as well as seismic design coefficients are presented in the following subsections.

### *8.1 Faulting*

The proposed sites are situated in a seismically active region. As is the case for most areas of Southern California, ground-shaking resulting from earthquakes associated with nearby and more distant faults may occur at the project sites. During the life of the project, seismic activity associated with active faults can be expected to generate moderate to strong ground shaking at the sites.

The project sites are not located within a currently mapped State of California Earthquake Fault Zone for surface fault rupture. The sites are also not located within an Alquist-Priolo Earthquake Fault Zone, no faults are located within 1,000 feet from the sites. So, sites are not considered susceptible to surface fault rupture hazards.

### *8.2 CBC Seismic Design Parameters*

Seismic parameters based on the 2019 California Building Code (CBSC, 2019) and ASCE 7-16 are provided in the following table. These parameters were determined using the generalized coordinates and the Seismic Design Maps ATC online tool.

**Table No. 2, CBC Seismic Design Parameters**

| Seismic Parameters | MVC | NC |
|---|---|---|
| Site Coordinates | 33.886083N, 117.197391W | 33.922312N 117.563179W |
| Site Class | D | D |
| Risk Category | II | II |
| Mapped Short period (0.2-sec) Spectral Response Acceleration, $S_S$ | 1.548g | 1.543g |
| Mapped 1-second Spectral Response Acceleration, $S_1$ | 0.6g | 0.6g |
| Site Coefficient (from Table 11.4-1), $F_a$ | 1.0 | 1.0 |
| Site Coefficient (from Table 11.4-2), $F_v$ | 1.7 | 1.7 |
| MCE 0.2-sec period Spectral Response Acceleration, $S_{MS}$ | 1.548g | 1.543g |
| MCE 1-second period Spectral Response Acceleration, $S_{M1}$ | 1.020g | 1.020g |
| Design Spectral Response Acceleration for short period $S_{DS}$ | 1.032g | 1.029g |
| Design Spectral Response Acceleration for 1-second period, $S_{D1}$ | 0.680g | 0.680g |
| Site Modified Maximum Peak Ground Acceleration, $PGA_M$ | 0.723g | 0.719g |

### *8.3 Secondary Effects of Seismic Activity*

In general, secondary effects of seismic activity include surface fault rupture, soil liquefaction, landslides, lateral spreading, and settlement due to seismic shaking, tsunamis, seiches, and earthquake-induced flooding. The site-specific potential for each of these seismic hazards is discussed in the following sections.

***Surface Fault Rupture:*** The project sites are not located within a currently designated State of California or Riverside County Earthquake Fault Zone (CGS, 2007; Riverside County, 2021). There are no known active faults projecting toward or extending across the project sites. The potential for surface rupture resulting from the movement of nearby major faults is not known with certainty but is considered low.

***Liquefaction:*** Liquefaction is defined as the phenomenon in which a cohesionless soil mass within the upper 50 feet of the ground surface suffers a substantial reduction in its shear strength, due the improvement of excess pore pressures. During earthquakes, excess pore pressures in saturated soil deposits may develop as a result of induced cyclic shear stresses, resulting in liquefaction.

Soil liquefaction generally occurs in submerged granular soils and non-plastic silts during or after strong ground shaking. There are several general requirements for liquefaction to occur and they are as follows.

- Soils must be submerged.
- Soils must be loose to medium-dense.
- Ground motion must be intense.
- Duration of shaking must be sufficient for the soils to lose shear resistance.

Based on review of hazard maps, the Moreno Valley and Norco College sites are located within Riverside County liquefaction zones determined to have a liquefaction potential of low and high, respectively. Based on the absence of groundwater at Moreno Valley college site, liquefaction potential is considered to be low.

Groundwater was encountered at Norco College sites at depth of 30.7 feet bgs; however, high blow counts and bedrocks (at depth of around 15 feet bgs) were observed at the site. Therefore, liquefaction potential is considered to be low. This should be verified during final design phase.

***Landslides:*** Seismically induced landslides and slope failures are common occurrences during or soon after large earthquakes. Due to the close proximity of local foothills to the Moreno Valley College site, the potential for seismically induced landslides affecting the proposed site is considered to be low to moderate. Due to the flat nature of the Norco College site, the potential for seismically induced landslides affecting the proposed site is considered to be low.

***Lateral Spreading:*** Seismically induced lateral spreading involves primarily lateral movement of earth materials over underlying materials which are liquefied due to ground shaking. It differs from the slope failure in that complete ground failure involving large movement does not occur due to the relatively smaller gradient of the initial ground surface. Lateral spreading is demonstrated by near-vertical cracks with predominantly horizontal movement of the soil mass involved. Due to the low and high risk of liquefaction for the Moreno Valley and Norco College sites, the risk of lateral spreading is considered low and high, respectively.

***Tsunamis:*** Tsunamis are large waves generated in open bodies of water by fault displacement or major ground movement. Due to the inland location of the sites, tsunamis are not considered to be a risk.

***Seiches:*** Seiches are large waves generated in enclosed bodies of water in response to ground shaking. There are no enclosed bodies of water immediately near the project sites. Seiching is not considered to be a risk during construction.

***Earthquake-Induced Flooding***: Dams or other water-retaining structures may fail as a result of large earthquakes. The project sites are not located within a Riverside County designated dam inundation zone (Riverside County, 2021). The risk for earthquake-induced flooding to affect the project sites is considered low.

## 9.0 PRELIMINARY CONCLUSION AND RECOMMENDATIONS

Preliminary recommendations for the project are presented in the following sections.

### *9.1 General*

These recommendations are based on the results of our field exploration, laboratory tests, our experience with similar projects, and data evaluation as presented in the preceding sections. These recommendations may require modification by the geotechnical consultant based on observation of the actual field conditions during grading.

Prior to the start of construction, all existing underground utilities and appurtenances should be located at the project sites. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications. All excavations should be conducted in such a manner as not to cause loss of bearing and/or lateral support of existing utilities and structure (if any).

All debris, surface vegetation, deleterious material, and surficial soils containing roots and perishable materials should be stripped and removed from the site. Deleterious material, including large particles and debris generated during excavation, should not be placed as fill.

The final bottom surfaces of all excavations should be observed and approved by the project geotechnical consultant prior to placing any fill. Based on these observations, localized areas may require remedial grading deeper than indicated herein. Therefore, some variations in the depth and lateral extent of excavation recommended in this report should be anticipated.

### *9.2 Remedial Grading*

Footings (if used) and concrete pad should be uniformly supported by compacted fill. In order to provide uniform support, structural areas should be overexcavated, scarified, and recompacted as follows.

**Table No. 3, Overexcavation Depths**

| Structure/Pavement | Minimum Excavation Depth |
|---|---|
| Footings/Concrete Pad | 2 feet below footing/pad bottom or 3 feet below existing ground surface, whichever is deeper |

The overexcavation should extend to at least 3 feet beyond the footprint of the footing/concrete pad.

If isolated pockets of very soft, loose, eroded, or pumping soil are encountered, the unstable soil should be excavated as needed to expose undisturbed, firm, and unyielding soils.

The contractor should determine the best manner to conduct the excavations, such that there are no losses of bearing and/or lateral support to the existing structures or utilities (if any).

### *9.3 On-site Soil as Fill Material*

Based on the field investigation and laboratory test results, we anticipate that the on-site alluvial soils may be utilized as engineered fill once debris, vegetation, and large particles (>3 inches) have been segregated, providing that they can be adequately moisture conditioned.

### *9.4 Preliminary Foundation Design Parameters*

Soil types and parameters are almost identical for all sites. Possible foundation types and preliminary design parameters are presented below.

***<u>Shallow Foundation</u>***

The design of the shallow foundations may be based on the parameters presented in the table below.

**Table No. 4, Preliminary Foundation Parameters**

| Parameter | Value |
|---|---|
| Minimum continuous spread footing width | 18 inches |
| Minimum isolated footing width | 18 inches |
| Minimum continuous or isolated footing depth of embedment below lowest adjacent grade | 18 inches |
| Allowable net bearing capacity | 2,000 psf |

The actual footing dimensions and reinforcement should be based on structural design. The allowable bearing capacity can be increased by 500 pounds per square foot (psf) with each foot of additional embedment and 100 psf with each foot of additional width up to a maximum of 3,000 psf.

The net allowable bearing values indicated above are for the dead loads and frequently applied live loads and are obtained by applying a factor of safety of 3.0 to the net ultimate bearing capacity. If normal code requirements are applied for design, the above vertical bearing value may be increased by 33 percent for short duration loadings, which will include loadings induced by wind or seismic forces.

The total settlement of shallow footings designed as recommended above, from static structural loads and short-term settlement of properly compacted fill is anticipated to be 1 inch or less. The static differential settlement can be taken as equal to one-half of the static total settlement.

***Mat Foundation***

The concrete pad may be designed as mat foundation. The modulus of subgrade reaction (k) for design of flexible mat foundation was estimated from the available soil compressibility data and published charts. For design of flexible mat foundation, the following equation may be used.

$$k = k_1[(B+1)/2B]^2$$

Where:
k= vertical modulus of subgrade reaction for mat foundation, kips per cubic feet
$k_1$= 200 kcf, normalized modulus of subgrade reaction for 1-square-foot footing
B= foundation width, feet

Other necessary parameters (modulus of elasticity and Poisson's ratio) for mat foundation design are as follows.

$$E = 33\ W_c^{1.5}\ f_c^{\ 0.5}\ \text{psi}$$

Where, E = Modulus of Elasticity of Concrete (psi)

$W_c$ = weight of concrete (pcf)
$f_c$ = compressive strength of concrete at 28 days (psi)
$\nu$ = 0.35, Poisson's Ratio

An allowable net bearing capacity of 3,000 psf may be used for mat foundations founded on compacted native soil. The mat should be reinforced with top and bottom steel, as appropriate, to provide structural continuity and to permit spanning of local irregularities. The mat foundation dimensions, and reinforcement should be based on structural design. For design purposes, the self-weight of the mat foundation can be negligible.

***Driven Pile Foundation***

Based on the shallow dense to very dense silty sands and presence of gravel, cobbles, boulders and bedrock, driven friction piles may be difficult to install or may encounter refusal during driving. If used, the piles may be designed for compression using an allowable skin friction value of 110 psf per foot for combined dead plus live loads. The piles should have a minimum diameter of at least 18 inches and extend at least 10 feet below the existing ground surface. Piles should have a minimum center-to-center spacing of at least three pier diameters.

This value may be increased by 33 percent for transient wind and seismic forces. For pier design in tension, 50 percent of the recommended allowable skin friction values in compression may be used. For design purpose, the upper at least 2 feet of the soils should be neglected in determining the skin friction. Pile tip resistance will not be considered in the design of friction pile. The equivalent lateral earth pressure equal to 220 pounds per square foot per foot of depth may be used for the design.

Total settlements for properly designed and constructed piles should be less than 0.5 inch.

***Drilled Pier Foundation***

Solar panel can be supported on drilled pier foundations deriving their support primarily through skin friction. The piers may be designed for compression using an allowable skin friction value of 110 psf per foot for combined dead plus live loads. The piers should have a minimum diameter of at least 18 inches and extend at least 10 feet below the existing ground surface. Piers should have a minimum center-to-center spacing of at least three pier diameters.

This value may be increased by 33 percent for transient wind and seismic forces. For pier design in tension, 50 percent of the recommended allowable skin friction values in compression may be used. For design purpose, the upper at least 3 feet of the soils should be neglected in determining the skin friction. Pier tip resistance will not be considered in the design of friction pier. The equivalent lateral earth pressure equal to 220 pounds per square foot per foot of depth may be used for the design.

Total settlements for properly designed and constructed piles should be less than 0.5 inch.

## *9.5 Lateral Earth Pressures and Resistance to Lateral Loads*

In the following subsections, the lateral earth pressures and resistance to lateral loads are estimated by using on-sites native soils strength parameters obtained from laboratory testing.

### 9.5.1 Active Earth Pressures

The active earth pressure behind any buried wall or foundation depends primarily on the allowable wall movement, type of backfill materials, backfill slopes, wall or foundation inclination, surcharges, and any hydrostatic pressures. The lateral earth pressures are presented in the following tables.

**Table No. 5, Active and At-Rest Earth Pressures**

| Loading Conditions | Lateral Earth Pressure (psf) |
|---|---|
| Active earth conditions (wall is free to deflect at least 0.001 radian) | 45 |
| At-rest (wall is restrained) | 65 |

These pressures assume a level ground surface around the structure for a distance greater than the structure height, no surcharge, and no hydrostatic pressure.

If water pressure is allowed to build up behind the walls, the active pressures should be reduced by 50 percent and added to a full hydrostatic pressure to compute the design pressures against the walls.

### 9.5.2 Passive Earth Pressure

Resistance to lateral loads can be assumed to be provided by a combination of friction acting at the base of foundations and by passive earth pressure. A coefficient of friction of 0.35 between formed concrete and soil may be used with the dead load forces. An allowable passive earth pressure of 220 psf per foot of depth may be used for the sides of the footing poured against recompacted native soils. A factor of safety of 1.5 was applied in calculating passive earth pressure. The maximum value of the passive earth pressure should be limited to 2,000 psf.

Vertical and lateral bearing values indicated above are for the total dead loads and frequently applied live loads. If normal code requirements are applied for design, the above vertical bearing and lateral resistance values may be increased by 33 percent for short duration loading, which will include the effect of wind or seismic forces.

Due to the low overburden stress of the soil at shallow depth, the upper 1 foot of passive resistance should be neglected unless the soil is confined by pavement or slab.

### *9.6 Soil Corrosivity*

Two representative soil samples were evaluated for corrosivity with respect to common construction materials such as concrete and steel. The test results are presented in Appendix B, *Laboratory Testing Program* and general recommendations pertaining to soil corrosivity are presented below.

The sulfate contents of the sampled soils correspond to American Concrete Institute (ACI) exposure category S0 for these sulfate concentrations (ACI 318-14, Table 19.3.1.1). No concrete type restrictions are specified for exposure category S0 (ACI 318-14, Table 19.3.2.1). A minimum compressive strength of 2,500 psi is recommended.

We anticipate that concrete structures such as footings, slab, and concrete pad will be exposed to moisture from precipitation and irrigation. Based on the site locations and the results of chloride testing of the sites soils, we do not anticipate that concrete structures will be exposed to external sources of chlorides, such as deicing chemicals, salt, brackish water, or seawater. ACI specifies exposure category C1 where concrete is exposed to moisture, but not to external sources of chlorides (ACI 318-14, Table 19.3.1.1). ACI provides concrete design recommendations in ACI 318-14, Table 19.3.2.1, including a compressive strength of at least 2,500 psi and a maximum chloride content of 0.3 percent.

According to Romanoff, 1957, the following table provides general guideline of soil corrosion based on electrical resistivity.

**Table No. 6, Correlation Between Resistivity and Corrosion**

| Soil Resistivity (ohm-cm) per Caltrans CT 643 | Corrosivity Category |
|---|---|
| Over 10,000 | Mildly corrosive |
| 2,000 – 10,000 | Moderately corrosive |
| 1,000 – 2,000 | corrosive |
| Less than 1,000 | Severe corrosive |

The measured value of the minimum electrical resistivity of the sample when saturated was 6,466 ohm-cm (Moreno Valley College) and 19,890 ohm-cm (Norco College). This indicates that the soils tested are moderately corrosive to mildly corrosive to ferrous metals in contact with the soil. <u>Converse does not practice in the area of corrosion</u>

consulting. If needed, a qualified corrosion consultant should provide appropriate corrosion mitigation measures for any ferrous metals in contact with the site soils.

### *9.7 Preliminary Construction Recommendations*

Since this is preliminary report, no site-specific construction recommendations are presented at this time.

## 10.0 CLOSURE

This report is prepared for the project described herein and is intended for use solely by Riverside Community College District (RCCD) and their authorized agents for preliminary information. Our findings and recommendations were obtained in accordance with generally accepted professional principles practiced in geotechnical engineering. We make no other warranty, either expressed or implied.

Converse Consultants is not responsible or liable for any claims or damages associated with interpretation of available information provided to others. Field exploration identifies actual soil conditions only at those points where samples are taken, when they are taken. Data derived through sampling and laboratory testing is extrapolated by Converse employees who render an opinion about the overall soil conditions. Actual conditions in areas not sampled may differ. In the event that changes to the project occur, or additional, relevant information about the project is brought to our attention, the recommendations contained in this report may not be valid unless these changes and additional relevant information are reviewed and the recommendations of this report are modified or verified in writing. In addition, the recommendations can only be finalized by observing actual subsurface conditions revealed during construction. Converse cannot be held responsible for misinterpretation or changes to our recommendations made by others during construction.

As the project evolves, continued consultation and construction monitoring by a qualified geotechnical consultant should be considered an extension of geotechnical investigation services performed to date. The geotechnical consultant should review plans and specifications to verify that the recommendations presented herein have been appropriately interpreted, and that the design assumptions used in this report are valid. Where significant design changes occur, Converse may be required to augment or modify the recommendations presented herein. Subsurface conditions may differ in some locations from those encountered in the explorations, and may require additional analyses and, possibly, modified recommendations.

Design recommendations given in this report are based on the assumption that it will be used only as primary. Additional consultation may be prudent to interpret Converse's findings for contractors, or to possibly refine these recommendations based upon the review of the actual site conditions encountered during construction. If the scope of the project changes, if project completion is to be delayed, or if the report is to be used for another purpose, this office should be consulted.

## 11.0 REFERENCES

AMERICAN CONCRETE INSTITUTE (ACI), 2014, Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary, October 2014.

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# Appendix A

Field Exploration

# APPENDIX A

## FIELD EXPLORATION

Our field investigation included sites reconnaissance and a subsurface exploration program consisting of drilling soil borings. During the sites reconnaissance, the surface conditions were noted, and the borings were marked at locations approved by Mehran Mohtasham with RCCD. The approximate boring locations were established in the field with reference to existing surroundings, street centerlines and other visible features. The locations should be considered accurate only to the degree implied by the method used.

Two exploratory boring (BH-01 and BH-02) were drilled on September 22, 2021, to investigate the subsurface conditions at Moreno Valley College campus. The borings were drilled to depths between 17.7 feet and 51.5 feet below existing ground surface (bgs).

Four borings (BH-03 through BH-06) were drilled on September 22 and 23, 2021 to investigate the subsurface conditions at two sites within Norco Community College campus. The borings were drilled to depths between 7.5 and 50.2 feet below existing ground surface (bgs). Borings (BH-03 and BH-04) were terminated at depths of 7.5 and 10.5 feet bgs due to obstruction in cobbles/boulders and possible bedrock.

The borings were advanced using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers for soils sampling. Encountered materials were continuously logged by a Converse geologist and classified in the field by visual classification in accordance with the Unified Soil Classification System. Where appropriate, the field descriptions and classifications have been modified to reflect laboratory test results.

Relatively undisturbed samples were obtained using California Modified Samplers (2.4 inches inside diameter and 3.0 inches outside diameter) lined with thin sample rings. The steel ring sampler was driven into the bottom of the borehole with successive drops of a 140-pound driving weight falling 30 inches. Blow counts at each sample interval are presented on the boring logs. Samples were retained in brass rings (2.4 inches inside diameter and 1.0 inch in height) and carefully sealed in waterproof plastic containers for shipment to the Converse laboratory. Bulk samples of typical soil types were also obtained.

Standard Penetration Testing (SPT) was also performed in accordance with the ASTM Standard D1586 test method at 10-foot intervals beginning at 20 feet bgs in borings BH-01 and BH-05 using a standard (1.4 inches inside diameter and 2.0 inches outside diameter) split-barrel sampler. The mechanically driven hammer for the SPT sampler was 140 pounds, falling 30 inches for each blow. The recorded blow counts for every 6 inches for a total of 1.5 feet of sampler penetration are shown on the Logs of Borings.

The exact depths at which material changes occur cannot always be established accurately. Unless a more precise depth can be established by other means, changes in material conditions that occur between drive samples are indicated on the logs at the top of the next drive sample.

Following the completion of logging and sampling, the borings were backfilled with soil cuttings and compacted by pushing down with augers using the drill rig weight. If construction is delayed, the surface may settle over time. We recommend the owner monitor the boring locations and backfill any depressions that might occur or provide protection around the boring locations to prevent trip and fall injuries from occurring near the area of any potential settlement.

For a key to soil symbols and terminology used in the boring logs, refer to Drawing No. A-1a through A-1c, *Unified Soil Classification and Key to Boring Log Symbols*. For logs of borings, see Drawings No. A-2 through A-7, *Logs of Borings*.

# SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | SYMBOLS GRAPH | SYMBOLS LETTER | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS<br>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVEL AND GRAVELLY SOILS<br>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | CLEAN GRAVELS (LITTLE OR NO FINES) | | GW | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | | | GP | POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES) | | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | | | GC | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES |
| | SAND AND SANDY SOILS<br>MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE | CLEAN SANDS (LITTLE OR NO FINES) | | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | | | SP | POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES |
| | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | | | SC | CLAYEY SANDS, SAND - CLAY MIXTURES |
| FINE GRAINED SOILS<br>MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 50 | | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | | | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS | LIQUID LIMIT GREATER THAN 50 | | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS |
| | | | | CH | INORGANIC CLAYS OF HIGH PLASTICITY |
| | | | | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | | | | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

## FIELD AND LABORATORY TESTS

- **C** Consolidation (ASTM D 2435)
- **CL** Collapse Potential (ASTM D 4546)
- **CP** Compaction Curve (ASTM D 1557)
- **CR** Corrosion, Sulfates, Chlorides (CTM 643-99; 417; 422)
- **CU** Consolidated Undrained Triaxial (ASTM D 4767)
- **DS** Direct Shear (ASTM D 3080)
- **EI** Expansion Index (ASTM D 4829)
- **M** Moisture Content (ASTM D 2216)
- **OC** Organic Content (ASTM D 2974)
- **P** Permeablility (ASTM D 2434)
- **PA** Particle Size Analysis (ASTM D 6913 [2002])
- **PI** Liquid Limit, Plastic Limit, Plasticity Index (ASTM D 4318)
- **PL** Point Load Index (ASTM D 5731)
- **PM** Pressure Meter
- **PP** Pocket Penetrometer
- **R** R-Value (CTM 301)
- **SE** Sand Equivalent (ASTM D 2419)
- **SG** Specific Gravity (ASTM D 854)
- **SW** Swell Potential (ASTM D 4546)
- **TV** Pocket Torvane
- **UC** Unconfined Compression - Soil (ASTM D 2166)
  Unconfined Compression - Rock (ASTM D 7012)
- **UU** Unconsolidated Undrained Triaxial (ASTM D 2850)
- **UW** Unit Weight (ASTM D 2937)

## BORING LOG SYMBOLS

### DRILLING METHOD SYMBOLS

Auger Drilling | Mud Rotary Drilling | Dynamic Cone or Hand Driven | Diamond Core

### SAMPLE TYPE

- STANDARD PENETRATION TEST
  Split barrel sampler in accordance with ASTM D-1586-84 Standard Test Method
- DRIVE SAMPLE 2.42" I.D. sampler (CMS).
- DRIVE SAMPLE No recovery
- BULK SAMPLE
- GROUNDWATER WHILE DRILLING
- GROUNDWATER AFTER DRILLING

## UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. 21-81-232-01

Drawing No. A-1a

Project ID: 21-81-232-01.GPJ; Template: KEY

## CONSISTENCY OF COHESIVE SOILS

| Descriptor | Unconfined Compressive Strength (tsf) | SPT Blow Counts | Pocket Penetrometer (tsf) | CA Sampler | Torvane (tsf) | Field Approximation |
|---|---|---|---|---|---|---|
| Very Soft | <0.25 | < 2 | <0.25 | <3 | <0.12 | Easily penetrated several inches by fist |
| Soft | 0.25 - 0.50 | 2 - 4 | 0.25 - 0.50 | 3 - 6 | 0.12 - 0.25 | Easily penetrated several inches by thumb |
| Medium Stiff | 0.50 - 1.0 | 5 - 8 | 0.50 - 1.0 | 7 - 12 | 0.25 - 0.50 | Can be penetrated several inches by thumb with moderate effort |
| Stiff | 1.0 - 2.0 | 9 - 15 | 1.0 - 2.0 | 13 - 25 | 0.50 - 1.0 | Readily indented by thumb but penetrated only with great effort |
| Very Stiff | 2.0 - 4.0 | 16 - 30 | 2.0 - 4.0 | 26 - 50 | 1.0 - 2.0 | Readily indented by thumbnail |
| Hard | >4.0 | >30 | >4.0 | >50 | >2.0 | Indented by thumbnail with difficulty |

## APPARENT DENSITY OF COHESIONLESS SOILS

| Descriptor | SPT $N_{60}$- Value (blows / foot) | CA Sampler |
|---|---|---|
| Very Loose | <4 | <5 |
| Loose | 4- 10 | 5 - 12 |
| Medium Dense | 11 - 30 | 13 - 35 |
| Dense | 31 - 50 | 36 - 60 |
| Very Dense | >50 | >60 |

## MOISTURE

| Descriptor | Criteria |
|---|---|
| Dry | Absence of moisture, dusty, dry to the touch |
| Moist | Damp but no visible water |
| Wet | Visible free water, usually soil is below water table |

## PERCENT OF PROPORTION OF SOILS

| Descriptor | Criteria |
|---|---|
| Trace (fine)/ Scattered (coarse) | Particles are present but estimated to be less than 5% |
| Few | 5 to 10% |
| Little | 15 to 25% |
| Some | 30 to 45% |
| Mostly | 50 to 100% |

## SOIL PARTICLE SIZE

| Descriptor | | Size |
|---|---|---|
| Boulder | | > 12 inches |
| Cobble | | 3 to 12 inches |
| Gravel | Coarse | 3/4 inch to 3 inches |
| | Fine | No. 4 Sieve to 3/4 inch |
| Sand | Coarse | No. 10 Sieve to No. 4 Sieve |
| | Medium | No. 40 Sieve to No. 10 Sieve |
| | Fine | No. 200 Sieve to No. No. 40 Sieve |
| Silt and Clay | | Passing No. 200 Sieve |

## PLASTICITY OF FINE-GRAINED SOILS

| Descriptor | Criteria |
|---|---|
| Nonplastic | A 1/8-inch thread cannot be rolled at any water content. |
| Low | The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit. |
| Medium | The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit. |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit. |

## CEMENTATION/ Induration

| Descriptor | Criteria |
|---|---|
| Weak | Crumbles or breaks with handling or little finger pressure. |
| Moderate | Crumbles or breaks with considerable finger pressure. |
| Strong | Will not crumble or break with finger pressure. |

**NOTE:** This legend sheet provides descriptions and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010), Section 2, for tables of additional soil description components and discussion of soil description and identification.

# UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. **21-81-232-01**

Drawing No. **A-1b**

## LEGEND OF ROCK MATERIALS

- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

## BEDDING SPACING

| Description | Thickness/Spacing |
|---|---|
| Massive | Greater than 10 ft |
| Very Thickly Bedded | 3 ft - 10 ft |
| Thickly Bedded | 1 ft - 3 ft |
| Moderately Bedded | 4 in - 1 ft |
| Thinly Bedded | 1 in - 4 in |
| Very Thinly Bedded | 1/4 in - 1 in |
| Laminated | Less than 1/4 in |

## WEATHERING DESCRIPTORS FOR INTACT ROCK

| | Diagnostic Features | | | | | |
|---|---|---|---|---|---|---|
| | Chemical Weathering-Discoloration-Oxidation | | Mechanical Weathering and Grain Boundary Conditions | Texture and Leaching | | |
| Description | Body of Rock | Fracture Surfaces | | Texture | Leaching | General Characteristics |
| Fresh | No discoloration, not oxidized | No discoloration or oxidation | No separation, intact (tight) | No change | No leaching | Hammer rings when crystalline rocks are struck. |
| Slightly Weathered | Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull | Minor to complete discoloration or oxidation of most surfaces | No visible separation, intact (tight) | Preserved | Minor leaching of some soluble minerals | Hammer rings when crystalline rocks are struck. Body of rock not weakened. |
| Moderately Weathered | Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty"; feldspar crystals are "cloudy" | All fracture surfaces are discolored or oxidized | Partial separation of boundaries visible | Generally preserved | Soluble minerals may be mostly leached | Hammer does not ring when rock is struck. Body of rock is slightly weakened. |
| Intensely Weathered | Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation, grain boundary conditions | All fracture surfaces are discolored or oxidized; surfaces friable | Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated | Texture altered by chemical disintegration (hydration, argillation) | Leaching of soluble minerals may be complete | Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures or veinlets. Rock is significantly weakened. |
| Decomposed | Discolored of oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay | | Complete separation of grain boundaries (disaggregated) | Resembles a soil; partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete | | Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes". |

## PERCENT CORE RECOVERY (REC)

$$\frac{\Sigma \text{ Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100$$

## ROCK QUALITY DESIGNATION (RQD)

$$\frac{\Sigma \text{ Length of intact core pieces} \geq 4 \text{ in.}}{\text{Total length of core run (in.)}} \times 100$$

RQD* indicates soundness criteria not met.

## ROCK HARDNESS

| Description | Criteria |
|---|---|
| Extremely Hard | Cannot be scratched with a pocketknife or sharp pick. Can only be chipped with repeated heavy hammer blows |
| Very Hard | Cannot be scratched with a pocketknife or sharp pick. Breaks with repeated heavy hammer blows. |
| Hard | Can be scratched with a pocketknife or sharp pick with difficulty (heavy pressure). Breaks with heavy hammer blows. |
| Moderately Hard | Can be scratched with a pocketknife or sharp pick with light or moderate pressure. Breaks with moderate hammer blows |
| Moderately Soft | Can be grooved 1/16 in. deep with a pocketknife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure. |
| Soft | Can be grooved or gouged easily with a pocketknife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure. |
| Very Soft | Can be readily indented, grooved or gouged with fingernail, or carved with a pocketknife. Breaks with light manual pressure. |

## Fracturing Spacing

| Description | Observed Fracture Density |
|---|---|
| Unfractured | No fractures |
| Very Slightly Fractured | Core lengths greater than 3 ft. |
| Slightly Fractured | Core lengths mostly from 1 to 3 ft. |
| Moderately Fractured | Core lengths mostly 4 in. to 1 ft. |
| Intensely Fractured | Core lengths mostly from 1 to 4 in. |
| Very Intensely Fractured | Mostly chips and fragments. |

**REFERENCE**: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).

# BEDROCK CLASSIFICATION AND KEY TO BORING LOG AND TEST PIT SYMBOLS

Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. 21-81-232-01

Drawing No. A-1c

# Log of Boring No. BH-01 (MVC)

Dates Drilled: 9/22/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 1656 Depth to Water (ft, bgs): NOT ENCOUNTERED

| Depth (ft) | Graphic Log | SUMMARY OF SUBSURFACE CONDITIONS<br>This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | SAMPLES DRIVE | SAMPLES BULK | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|---|---|
| | | **ALLUVIUM:**<br>**SILTY SAND (SM):** fine to coarse-grained, scattered gravel up to 1" in maximum dimension, indurated, medium dense to dense, moist, brown. | | | | | | CR, CP |
| | | | | | 23/24/26 | 3 | 124 | |
| 5 | | | | | 15/23/35 | 7 | 121 | DS<br>PA |
| | | | | | 10/15/19 | 6 | 120 | |
| 10 | | | | | 8/19/31 | 7 | 123 | |
| 15 | | | | | 6/6/7 | 3 | 113 | |
| 20 | | - loose | | | 1/2/3 | 4 | | |
| 25 | | - medium dense | | | 12/12/23 | 4 | 116 | |
| 30 | | - loose | | | 5/5/6 | 3 | | |

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For: Riverside Community College District

Project No. **21-81-232-01**

Drawing No. **A-2a**

# Log of Boring No. BH-01 (MVC)

Dates Drilled: 9/22/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 1656 Depth to Water (ft, bgs): NOT ENCOUNTERED

| Depth (ft) | Graphic Log | SUMMARY OF SUBSURFACE CONDITIONS<br>This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | SAMPLES: DRIVE | SAMPLES: BULK | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|---|---|
| | | **ALLUVIUM (Qal):**<br>**SILTY SAND (SM):** fine to coarse-grained, medium dense, moist, brown. | ■ | | 12/13/14 | 6 | 118 | |
| 40 | | - loose | ☒ | | 3/4/6 | 7 | | |
| 45 | | **BEDROCK**<br>**GRANITE (Khg):** fine to medium-grained, moderately to intensely weathered, moderately desiccated, hard to very hard<br>**Excavate as: SILTY SAND (SM):** fine to medium-grained, moist, brown. | ■ | | 27/50@6" | 8 | 124 | |
| 50 | | | ☒ | | 14/14/18 | 6 | | |
| | | End of boring at 51.5 feet bgs.<br>No groundwater encountered.<br>Borehole backfilled with soil cuttings and compacted by pushing down with auger using the drill rig weight on 09/22/2021. | | | | | | |

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Project No. **21-81-232-01**

Drawing No. **A-2b**

# Log of Boring No. BH-02 (MVC)

Dates Drilled: 9/22/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 1659 Depth to Water (ft, bgs): NOT ENCOUNTERED

| Depth (ft) | Graphic Log | SUMMARY OF SUBSURFACE CONDITIONS<br>This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | SAMPLES DRIVE | SAMPLES BULK | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|---|---|
| | | **ALLUVIUM:**<br>**SILTY SAND (SM):** fine to coarse-grained, scattered gravel up to 1" in maximum dimension, indurated, very dense, moist, brown. | | | | | | EI, PA |
| | | | | | 39/50@3" | 4 | 116 | CL |
| 5 | | | | | 27/50@6" | 5 | 126 | |
| | | | | | 50@6" | 6 | 112 | |
| 10 | | | | | 14/14/14 | 5 | 126 | |
| 15 | | **BEDROCK**<br>**GRANITE (Khg):** fine to medium-grained, moderately to intensely weathered, moderately desiccated, very hard<br>**Excavate as: SILTY SAND (SM):** fine to medium-grained, moist, brown. | | | 30/42/50@5" | 4 | 106 | |
| | | | | | 38/50@2" | 5 | 116 | |

Boring terminated at 17.7 feet bgs due to obstruction in bedrock.
No groundwater encountered.
Borehole backfilled with soil cuttings and compacted by pushing down with auger using the drill rig weight on 09/22/2021.

# Log of Boring No. BH-03 (NC)

Dates Drilled: 9/22/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 695 Depth to Water (ft, bgs): NOT ENCOUNTERED

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

| Depth (ft) | Summary of Subsurface Conditions | Samples: Drive | Samples: Bulk | Blows | Moisture (%) | Dry Unit Wt. (pcf) | Other |
|---|---|---|---|---|---|---|---|
| 0 | **ALLUVIUM:** **SILTY SAND (SM):** fine to medium-grained, indurated, medium dense, moist, yellowish brown. | | X | | | | |
| ~2.5 | | X | X | 7/19/9 | 2 | 101 | |
| 5 | | X | X | 15/33/31 | 3 | 104 | |
| ~7.5 | - more sand content | X | X | 9/13/14 | 4 | 104 | |
| 10 | **BEDROCK** **Norco Formation (QTn): SILTY SANDSTONE** fine to coarse-grained, moderately to intensely weathered, moderately desiccated, very hard **Excavate as: SILTY SAND (SM):** fine to coarse-grained, moist, brown. | X | | 50@5" | 9 | 94 | dist. |

Boring terminated at 10.5 feet bgs due to obstruction in bedrock.
No groundwater encountered.
Borehole backfilled with soil cuttings and compacted by pushing down with auger using the drill rig weight on 09/22/2021.

# Log of Boring No. BH-04 (NC)

Dates Drilled: 9/22/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 709 Depth to Water (ft, bgs): NOT ENCOUNTERED

| Depth (ft) | Graphic Log | SUMMARY OF SUBSURFACE CONDITIONS<br>This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | SAMPLES DRIVE | SAMPLES BULK | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|---|---|
| | | **ALLUVIUM:**<br>**SILTY SAND (SM):** fine to coarse-grained, scattered gravel up to 3" and cobbles up to 4" in maximum dimension, indurated, very dense, moist, brown. | | | | | | PA |
| | | | | | 50@3" | | | NR |
| 5 | | | | | 50@5" | | | NR |
| | | | | | 50@1" | | | NR |
| | | Boring terminated at 7.5 feet bgs due to presence of cobbles/boulders.<br>No groundwater encountered.<br>Borehole backfilled with soil cuttings and compacted by pushing down with auger using the drill rig weight on 09/22/2021. | | | | | | |

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Districtwide Solar Planning Initiative Project
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For: Riverside Community College District

Project No. **21-81-232-01** Drawing No. **A-5**

# Log of Boring No. BH-05 (NC)

Dates Drilled: 9/23/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 652 Depth to Water (ft, bgs): 30.7

| Depth (ft) | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES (DRIVE / BULK) | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|
| | This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | | | | | |
| | **ALLUVIUM:** **SILTY SAND (SM):** fine to coarse-grained, indurated, very dense, moist, reddish-brown. | | | | | CP, EI |
| | | | 31/50@4" | 6 | 106 | |
| 5 | | | 17/34/40 | 5 | 124 | DS |
| | - few cobbles up to 4" in maximum dimension | | 27/50@5" | 6 | 106 | |
| 10 | - scattered gravel up to 1" in maximum dimension, medium dense | | 13/18/28 | 5 | 103 | |
| | - trace clay | | | | | |
| 15 | **BEDROCK** **Norco Formation (QTn): SILTY SANDSTONE** fine to coarse-grained, moderately weathered, slightly desiccated, very hard **Excavate as: SAND WITH SILT (SP-SM):** fine to coarse-grained, moist, yellowish brown. | | 16/17/50@5" | 9 | 128 | |
| 20 | | | 38/50@2" | 3 | | |
| 25 | | | 50@3" | 4 | 111 | |
| 30 | water was encountered at 30.7 feet bgs, | | 50@2" | 3 | | |

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Project No. **21-81-232-01**

Drawing No. **A-6a**

# Log of Boring No. BH-05 (NC)

Dates Drilled: 9/23/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 652 Depth to Water (ft, bgs): 30.7

| Depth (ft) | Graphic Log | SUMMARY OF SUBSURFACE CONDITIONS<br>This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | SAMPLES DRIVE | SAMPLES BULK | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|---|---|
| | | **BEDROCK**<br>**Norco Formation (QTn): SILTY SANDSTONE** fine to coarse-grained, moderately weathered, slightly desiccated, very hard<br>**Excavate as: SAND WITH SILT (SP-SM):** fine to coarse-grained, moist, yellowish brown. | | | 50@2" | 3 | 106 | |
| 40 | | | | | 50@4" | 7 | | |
| 45 | | | | | 50@2" | 9 | 122 | |
| 50 | | | | | 50@2" | 11 | | |
| | | End of boring at 50.2 feet bgs.<br>Groundwater was encountered at 30.7 bgs.<br>Borehole backfilled with soil cuttings and compacted by pushing down with auger using the drill rig weight on 09/23/2021. | | | | | | |

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Districtwide Solar Planning Initiative Project
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For: Riverside Community College District

Project No. 21-81-232-01

Drawing No. A-6b

# Log of Boring No. BH-06 (NC)

Dates Drilled: 9/23/2021 Logged by: Mahmoud Suliman Checked By: Robert Gregorek

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 648 Depth to Water (ft, bgs): NOT ENCOUNTERED

| Depth (ft) | Graphic Log | SUMMARY OF SUBSURFACE CONDITIONS<br>This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered. | SAMPLES DRIVE | SAMPLES BULK | BLOWS | MOISTURE (%) | DRY UNIT WT. (pcf) | OTHER |
|---|---|---|---|---|---|---|---|---|
| 0 | | **ALLUVIUM (Qal):**<br>**SILTY SAND (SM):** fine to coarse-grained, medium dense, moist, reddish brown. | | X | | | | CR, PA |
| | | | X | X | 9/14/24 | 4 | 120 | CL |
| 5 | | | X | X | 15/30/37 | 7 | 116 | |
| | | - trace clay | X | X | 13/20/28 | 6 | 126 | |
| 10 | | | X | | 15/22/41 | 7 | 124 | |
| 15 | | **BEDROCK**<br>**Norco Formation (QTn): SILTY SANDSTONE**<br>fine to coarse-grained, moderately weathered, slightly desiccated, very hard<br>**Excavate as: SILTY SAND (SM):** fine to coarse-grained, moist, yellowish brown. | X | | 50@6" | 10 | 112 | |
| 20 | | | X | | 50@3" | | | |
| | | End of boring at 20.2 feet bgs.<br>No groundwater encountered.<br>Borehole backfilled with soil cuttings and compacted by pushing down with auger using the drill rig weight on 09/23/2021. | | | | | | |

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Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. **21-81-232-01** Drawing No. **A-7**

# Appendix B

Laboratory Testing Program

# APPENDIX B

## LABORATORY TESTING PROGRAM

Tests were conducted in our laboratory on representative soil samples for the purpose of classification and evaluation of their physical properties and engineering characteristics. The amount and selection of tests were based on the geotechnical parameters required for this project. Test results are presented herein and on the Logs of Borings, in Appendix A, *Field Exploration*. The following is a summary of the various laboratory tests conducted for this project.

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

In-situ dry density and moisture content tests were performed on relatively undisturbed ring samples, in accordance with ASTM Standard D2216 and D2937 to aid soils classification and to provide qualitative information on strength and compressibility characteristics of the site soils. For test results, see the Logs of Borings in Appendix A, *Field Exploration.*

### ***Expansion Index***

Two representative bulk samples were tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The test results are presented in the following table.

**Table No. B-1, Expansion Index Test Results**

| Boring No. | Depth (feet) | Soil Description | Expansion Index | Expansion Potential |
|---|---|---|---|---|
| BH-02/ MVC | 0-5 | Silty Sand (SM) | 1 | Very Low |
| BH-05/ NC | 0-5 | Silty Sand with Gravel (SM) | 9 | Very Low |

**Note:**
- MVC: Moreno Valley College
- NC: Norco College

### ***Soil Corrosivity***

Two representative soil samples were tested to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests was to determine the corrosion potential of sites soils when placed in contact with common construction materials. The tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with Caltrans Test Methods 643, 422 and 417. Test results are presented in the following table.

**Table No. B-2, Summary of Soil Corrosivity Test Results**

| Boring No. | Depth (feet) | pH | Soluble Sulfates (CA 417) (ppm) | Soluble Chlorides (CA 422) (ppm) | Min. Resistivity (CA 643) (Ohm-cm) |
|---|---|---|---|---|---|
| BH-01/ MVC | 0-5 | 8.1 | 36 | 23 | 6,466 |
| BH-06/ NC | 0-5 | 7.4 | 23 | 21 | 19,890 |

***Collapse***

To evaluate the moisture sensitivity (collapse/swell potential) of the encountered soils, two collapse tests were performed in accordance with the ASTM Standard D4546 laboratory procedure. The sample was loaded to approximately 2 kips per square foot (ksf), allowed to stabilize under load, and then submerged. The test results are presented in the following table.

**Table No. B-3, Collapse Test Results**

| Boring No. | Depth (feet) | Soil Classification | Percent Swell (+) Percent Collapse (-) | Collapse Potential |
|---|---|---|---|---|
| BH-02/ MVC | 2.5-4.0 | Silty Sand (SM) | -2.0 | Slight |
| BH-06/ NC | 2.5-4.0 | Silty Sand (SM) | -1.9 | Slight |

***Grain-Size Analyses***

To assist in classification of soils, mechanical grain-size analyses were performed on four select samples in accordance with the ASTM Standard D6913 test method. Grain-size curves are shown in Drawing No. B-1, *Grain Size Distribution Results* and results are presented in the below table.

**Table No. B-4, Grain Size Distribution Test Results**

| Boring No. | Depth (ft) | Soil Classification | % Gravel | % Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|
| BH-01/ MVC | 5-10 | Silty Sand (SM) | 2.0 | 64.9 | 33.1 | |
| BH-02/ MVC | 0-5 | Silty Sand (SM) | 2.0 | 71.7 | 26.3 | |
| BH-04/ NC | 0-5 | Silty Sand (SM) | 5.0 | 80.2 | 14.8 | |
| BH-06/ NC | 0-5 | Silty Sand (SM) | 0.0 | 66.8 | 33.2 | |

***Maximum Density and Optimum Moisture Content***

Laboratory maximum dry density-optimum moisture content relationship tests were performed on two representative bulk samples. The tests were conducted in accordance with the ASTM Standard D1557 test method. The tests results are presented in Drawing No. B-2, *Moisture-Density Relationship Results,* and are summarized in the following table.

**Table No B-5, Summary of Moisture-Density Relationship Results**

| Boring No. | Depth (feet) | Soil Description | Optimum Moisture (%) | Maximum Density (lb/cft) |
|---|---|---|---|---|
| BH-01/ MVC | 0-5 | Silty Sand (SM), Brown | 6.0 | 132.0 |
| BH-05/ NC | 0-5 | Silty Sand (SM), Reddish Brown | 5.5 | 133.0 |

## ***Direct Shear***

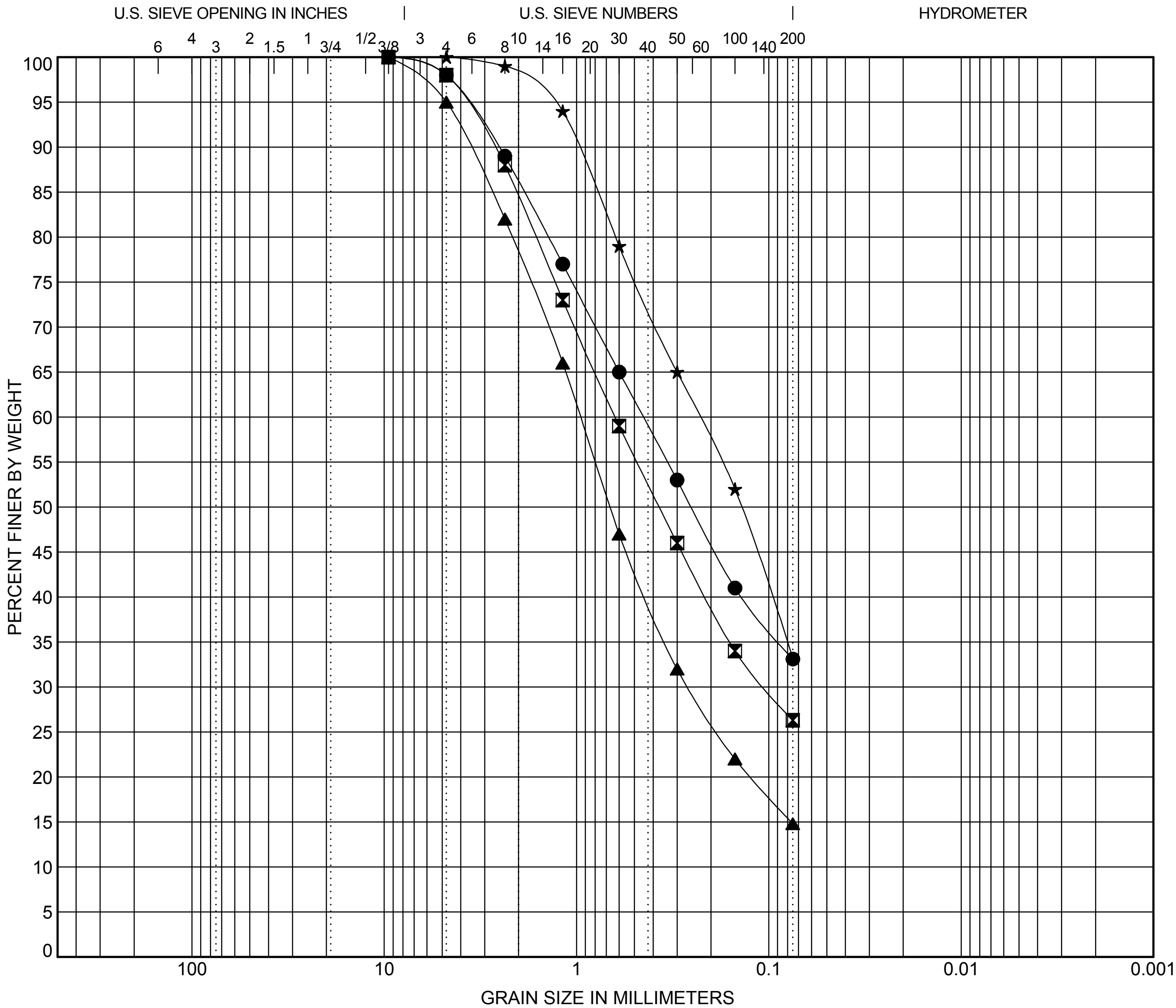
Two direct shear tests were performed on relatively undisturbed representative ring samples under soaked moisture condition in accordance with the ASTM D3080 procedure. For each test, three samples contained in brass sampler rings were placed, one at a time, directly into the test apparatus and subjected to a range of normal loads appropriate for the anticipated conditions. The samples were then sheared at a constant strain rate of 0.02 inch/minute. Shear deformation was recorded until a maximum of about 0.25-inch shear displacement was achieved. Ultimate strength was selected from the shear-stress deformation data and plotted to determine the shear strength parameters. For test data, including sample density and moisture content, see Drawings No. B-3 and B-4*, Direct Shear Test Results,* and the following table.

**Table No. B-6, Summary of Direct Shear Test Results**

| Boring No. | Depth (feet) | Soil Description | Peak Strength Parameters | |
|---|---|---|---|---|
| | | | Friction Angle (degrees) | Cohesion (psf) |
| BH-01/ MVC | 5.0-6.5 | Silty Sand (SM) | 31 | 190 |
| BH-05/ NC | 5.0-6.5 | Silty Sand (SM) | 29 | 70 |

## ***Sample Storage***

Soil samples presently stored in our laboratory will be discarded 30 days after the date of this report, unless this office receives a specific request to retain the samples for a longer period.




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Boring No. | Depth (ft) | Description | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | **BH-01** | **5-10** | **SILTY SAND (SM)** | | | | | |
| ⊠ | **BH-02** | **0-5** | **SILTY SAND (SM)** | | | | | |
| ▲ | **BH-04** | **0-5** | **SILTY SAND (SM)** | | | | | |
| ★ | **BH-06** | **0-5** | **SILTY SAND (SM)** | | | | | |
| | | | | | | | | |

| | Boring No. | Depth (ft) | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **BH-01** | **5-10** | **9.5** | **0.449** | | | **2.0** | **64.9** | **33.1** | |
| ⊠ | **BH-02** | **0-5** | **9.5** | **0.63** | **0.105** | | **2.0** | **71.7** | **26.3** | |
| ▲ | **BH-04** | **0-5** | **9.5** | **0.953** | **0.261** | | **5.0** | **80.2** | **14.8** | |
| ★ | **BH-06** | **0-5** | **9.5** | **0.23** | | | **0.0** | **66.8** | **33.2** | |
| | | | | | | | | | | |

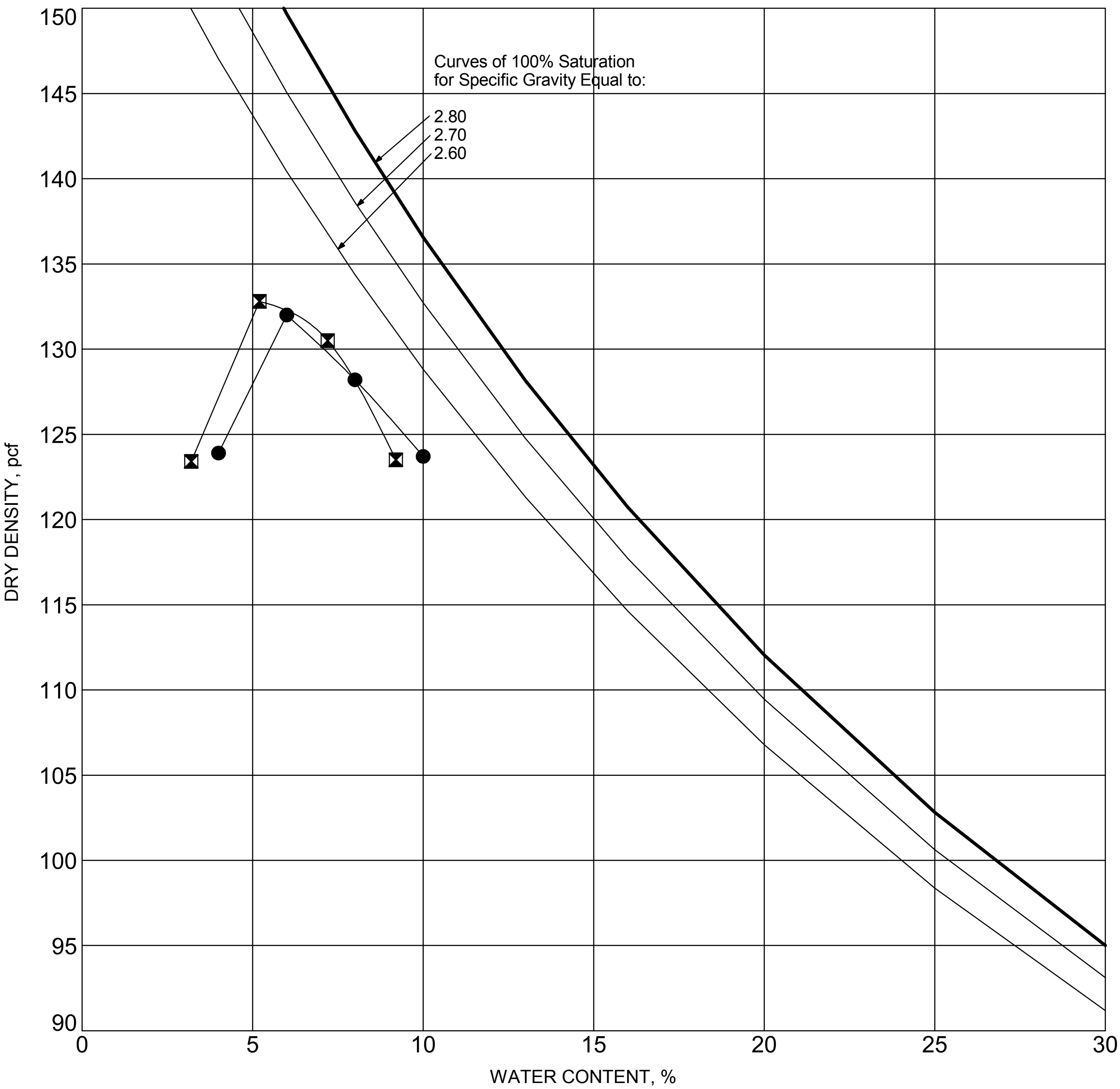
# GRAIN SIZE DISTRIBUTION RESULTS

Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. **21-81-232-01**

Drawing No. **B-1**




| SYMBOL | BORING NO. | DEPTH (ft) | DESCRIPTION | ASTM TEST METHOD | OPTIMUM WATER, % | MAXIMUM DRY DENSITY, pcf |
|---|---|---|---|---|---|---|
| ● | **BH-01** | **0-5** | **SILTY SAND (SM), BROWN** | **D1557- A** | **6.0** | **132.0** |
| ⧗ | **BH-05** | **0-5** | **SILTY SAND (SM), REDDISH BROWM** | **D1557- A** | **5.5** | **133.0** |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# MOISTURE-DENSITY RELATIONSHIP RESULTS

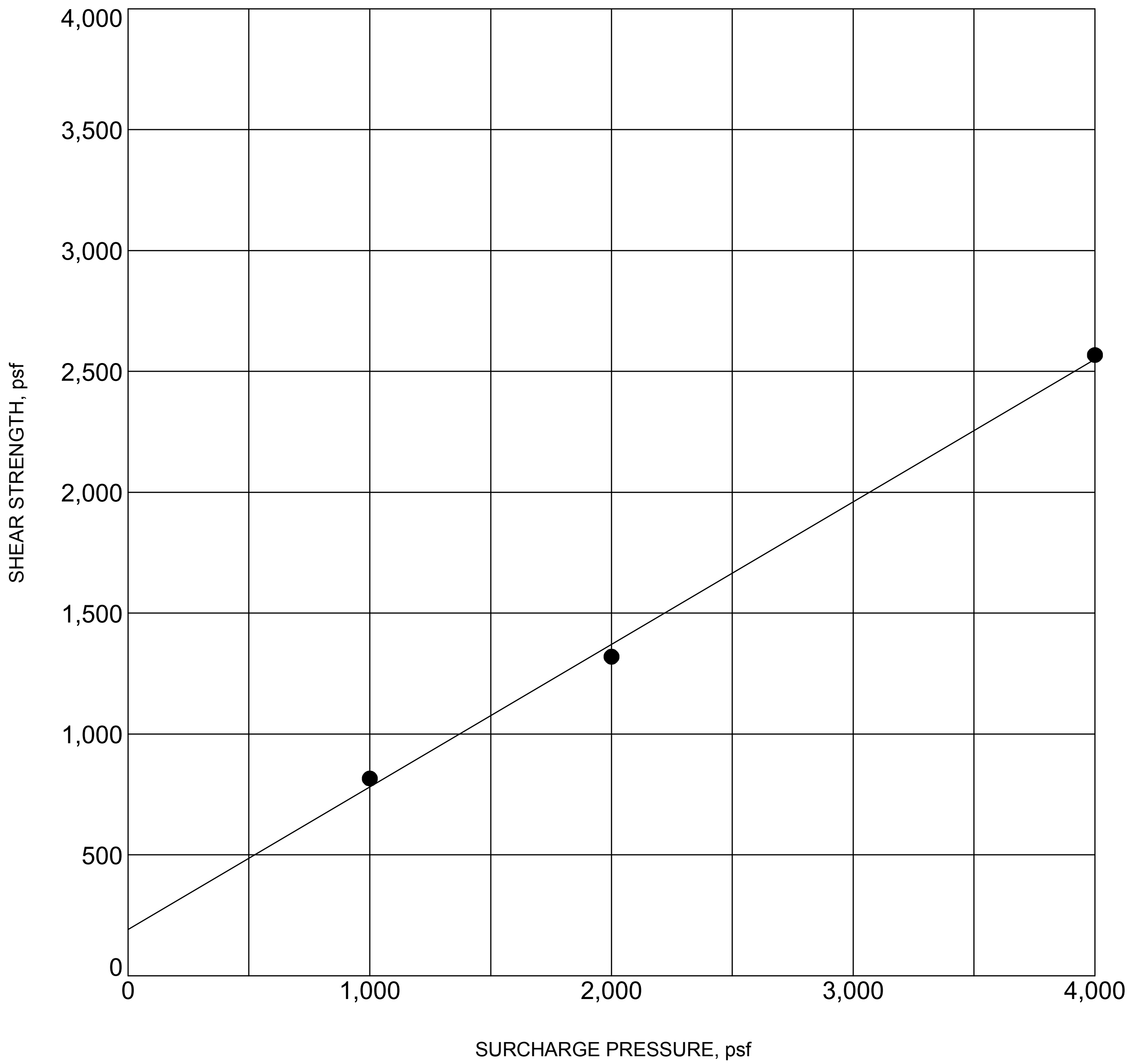
Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No.
**21-81-232-01**

Drawing No.
**B-2**

Project ID: 21-81-232-01.GPJ; Template: COMPACTION




| | | | |
|---|---|---|---|
| BORING NO. : | **BH-01** | DEPTH (ft) : | **5.0-6.5** |
| DESCRIPTION : | **SILTY SAND (SM)** | | |
| COHESION (psf) : | **190** | FRICTION ANGLE (degrees): | **31** |
| MOISTURE CONTENT (%) : | **6.1** | DRY DENSITY (pcf) : | **125.0** |

NOTE: Ultimate Strength.

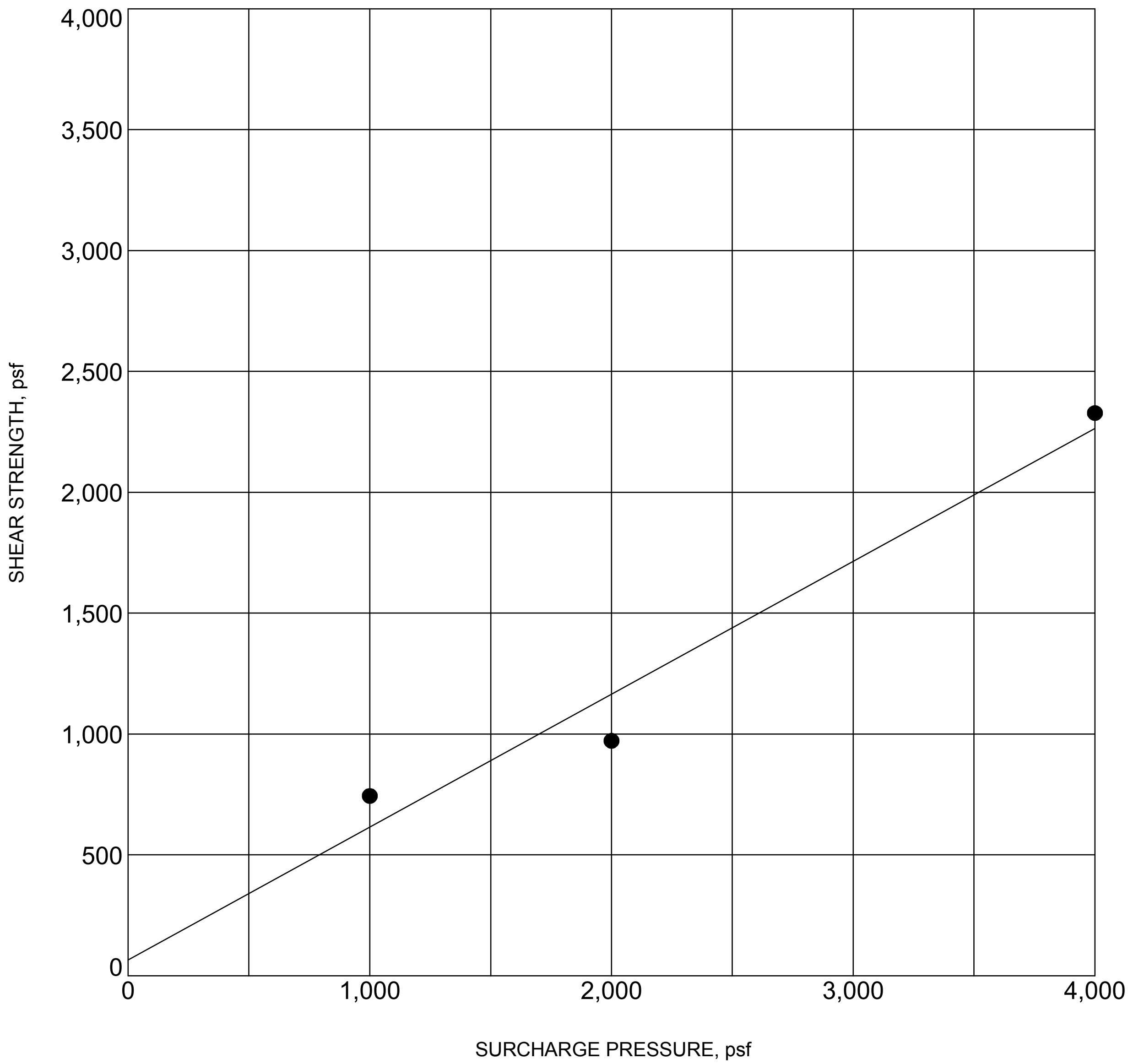
# DIRECT SHEAR TEST RESULTS

Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. **21-81-232-01**

Drawing No. **B-3**




| | | | | | |
|---|---|---|---|---|---|
| BORING NO. | : | **BH-05** | DEPTH (ft) | : | **5.0-6.5** |
| DESCRIPTION | : | **SILTY SAND (SM)** | | | |
| COHESION (psf) | : | **70** | FRICTION ANGLE (degrees): | | **29** |
| MOISTURE CONTENT (%) | : | **4.9** | DRY DENSITY (pcf) | : | **124.2** |

NOTE: Ultimate Strength.

# DIRECT SHEAR TEST RESULTS

Converse Consultants

Districtwide Solar Planning Initiative Project
Moreno Valley and Norco College Campuses
Cities of Moreno Valley and Norco, Riverside County, California
For: Riverside Community College District

Project No. **21-81-232-01**

Drawing No. **B-4**