**APPENDIX C**

**FOUNDATION REPORT**

# FOUNDATION REPORT

## Replacement of County Road 200 Bridge over Salt Creek, Caltrans Bridge No. 11C-0132 Glenn County, California

| Dist | Co | Rte | PM | EA |
|---|---|---|---|---|
| 03 | Glenn | 200 | N/A | N/A |

Report Prepared By:

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Project No. 106454-4000
October 8, 2019

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October 8, 2019

Mr. Gary Gordon
Willdan Engineering
2400 Washington Avenue, Suite 101
Redding, CA 96001

Subject: Foundation Report
Replacement of County Road 200 Bridge over Salt Creek, Caltrans Bridge No. 11C-0132, Glenn County, California
Willdan Geotechnical Project No. 106454-4000

Dear Mr. Gordon,

Willdan Engineering Geotechnical Group (Willdan Geotechnical) is pleased to submit this Foundation Report (FR) for the proposed replacement of County Road 200 Bridge over Salt Creek (Caltrans Bridge No. 11C-0132) in Glenn County, California. This report has been written to meet the requirements for a FR per "Caltrans Foundation Report Preparation for Bridges", February 2017 Edition.

Should you have any questions regarding the contents of this report, or should you require additional information, please contact us.

Respectfully Submitted,
**WILLDAN ENGINEERING**
**GEOTECHNICAL GROUP**

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**APPENDICES**

## 1. SCOPE OF WORK

This Foundation Report (FR) is presented to assist in the structure type selection for the proposed replacement of the County Road 200 Bridge over Salt Creek (Caltrans Bridge No. 11C-0132) in Glenn County, California.

This FR documents existing foundation conditions, provides preliminary structure-specific seismic recommendations, and makes preliminary foundation recommendations. The site geology and subsurface conditions discussed in this FR are based on review of available published data and the findings from the field exploration.

We have performed the following tasks as the scope of work for this FR:

- Provide site geology and subsurface conditions based on review of published data and the findings from the field exploration;
- Provide preliminary seismic recommendations, including addressing seismic hazards such as liquefaction potential, surface fault rupture potential, seismically induced settlement, and seismic slope instability, as applicable;
- Provide preliminary design recommendations for foundation, retaining walls, earthwork, and construction considerations.

An evaluation of the erodibility and scour potential are not included in the project scope. Scour evaluation for the subject site will be done as part of the hydraulics report prepared by others. Soil and rock resistance evaluation within the subject project site will be discussed in Section 6. Scour Evaluation.

## 2. PROJECT DESCRIPTION AND SITE LOCATION

The existing bridge crosses Salt Creek on County Road 200 approximately 0.8 miles west of the intersection of County Roads 200 and 306. The latitude and longitude at the approximate center of the proposed new bridge are 39.7935° N and 122.5336° W, respectively. The location of the project site is shown on Figure 1, Site Location Map.

The existing bridge is a continuous three-span reinforced concrete T-beam superstructure on reinforced concrete abutments and pier walls on assumed spread footings. According to the Caltrans Bridge Inspection Report dated 9/11/2012, the bridge was built in 1925. The project entails replacement of the existing bridge with a new bridge on the same alignment.

## 3. FIELD INVESTIGATION AND TESTING PROGRAM

Willdan Geotechnical drilled and sampled two (2) soil borings. Borings A-18-001 and A-18-002 were drilled along the approach roadways and advanced to the maximum depth of 25 feet below ground surface (bgs). Underground Service Alert of Northern California and Nevada (USA North) was notified for clearance of underground utilities in the vicinity of the borings. Approximate borings locations are shown on Figure 2, Boring Location Plan.

Borings were advanced within the soil to the top of the solid bedrock using a truck-mounted rig equipped with an 8-inch diameter solid flight auger/mud rotary, and then the corings were advanced within bedrock to the maximum depth using a rock coring device. Disturbed and relatively undisturbed drive samples were collected at select depth intervals from each soil boring. Bulk samples were collected from auger cuttings obtained from within the near-surface soils. Relatively undisturbed samples were collected by driving a three-inch outside diameter Modified California Sampler lined with brass rings/steel tubes, and disturbed samples were collected by driving a 1⅜-inch inside diameter Standard Penetration split-spoon sampler. The samplers were driven into the underlying soil for 18-inch intervals with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler was recorded for each 6-inch penetration interval. The blow count for the final 12 inches, or for a lesser distance if the sampler could not be driven 12 inches, is shown on the Log of Test Borings in Appendix A. The number of blows required to drive the sampler the last 12 inches was used to estimate the in-situ relative density of granular soils. A pocket penetrometer was also used to evaluate consistency of cohesive soils. All soil and rock samples were retained for laboratory testing. Upon completion of the borings, the boreholes were backfilled with soil cuttings.

Classification of the soils encountered in the exploratory borings was made in general accordance with the Unified Soil Classification System (USCS), using visual-manual procedure (ASTM D2488) and/or based on laboratory testing (ASTM D2487). A Log of Test Borings (LOTB) is included as Appendix A. The soil and rock descriptions in the LOTB are per Appendix A of Caltrans "Soil and Rock Logging, Classification, and Presentation Manual, 2010 Edition".


# FIGURE 1. SITE LOCATION MAP

**REPLACEMENT OF COUNTY ROAD 200 BRIDGE OVER SALT CREEK**
**GLENN COUNTY, CALIFORNIA**

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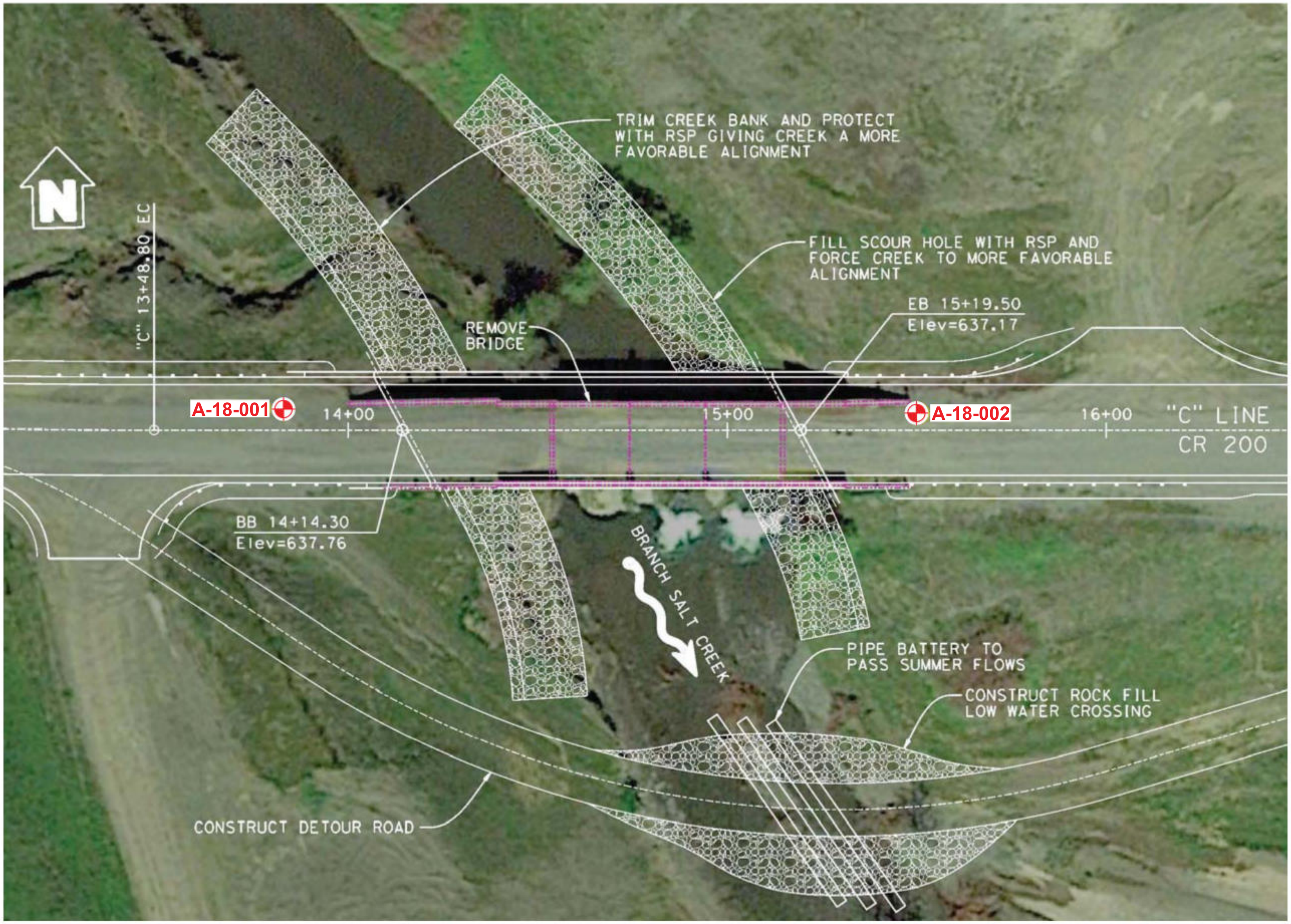
| | |
|---|---|
| Drawn By: MR | Date: 07-20-2018 |
| Approved By: MR | Project No.: 106454-4000 |




Approximate Boring Location
A-18-002

# FIGURE 2. BORING LOCATION PLAN

**REPLACEMENT OF COUNTY ROAD 200 BRIDGE OVER SALT CREEK**
**GLENN COUNTY, CALIFORNIA**

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| | |
|---|---|
| Drawn By: MR | Date: 07-20-2018 |
| Approved By: MR | Project No.: 106454-4000 |

## 4. LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected soil and rock samples to evaluate their physical characteristics and engineering properties. Laboratory testing included determination of in-situ moisture and density, sieve analysis, Atterberg limits, R-value and corrosion potential for soil samples, as well as unconfined compressive strength for rock cores. Laboratory tests were conducted in general accordance with American Society for Testing of Materials (ASTM) Standards or California Test Methods. The in-situ dry density and moisture content test results are shown on the LOTB. The remaining laboratory test results are presented in Appendix B, Laboratory Test Results.

Groundwater observations were made in the borings during drilling operations. Upon completion of the borings, the boreholes were backfilled with soil cuttings and pavement was patched with cold asphalt. Soil and rock samples were delivered to Willdan's laboratory for testing.

## 5. SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 5.1. REGIONAL GEOLOGY

The project site lies on the west side of the northern portion of the Great Valley geomorphic province near the border of the Coast Range geomorphic province. The Great Valley is a large northwestward trending, asymmetric structural trough comprised of the Sacramento and San Joaquin Valleys and has been filled with as much as six vertical miles of sediment. The Great Valley is bordered by the Coast Range Mountains on the west, the Cascade Range on the northeast, the Klamath Mountains on the north and the Sierra Nevada Mountain Range on the east and southeast. The localized drainage in the project vicinity is generally trending south, downhill, eventually terminating at the San Francisco Bay.

According to a geologic map of the area, the site is underlain by Quaternary non-marine terrace deposits (USGS, 2015). Geology in the vicinity of the site is dominated by sedimentary features associated with the Stony Creek fan alluvium which extends from around the Glenn Tehama County line southward about 15 miles from Orland Buttes eastward to the Sacramento River. Stony Creek fan alluvium have also been mapped as Riverbank formation on various regional geologic maps. These deposits are composed of sand gravel with clay and silt. The alluvial fan deposits in the vicinity of the project site are underlain by the Tehama formation. The Tehama formation consists of semi-consolidated and erosion-resistant fluvial deposits derived from the Coast Range. These deposits were laid down by the ancestral Sacramento River and its tributaries. The Tehama Formation consists of predominantly silt and clay deposits, with discontinuous layers of sand and gravel.

Borings drilled within the limits of the project site during our investigation on April 24, 2018 encountered alluvium consisting of clayey sand/sandy clay, clayey sand with gravel, underlain by Tehama Formation sedimentary rocks.

### 5.2. GROUNDWATER

The approximate elevation at the subject site is 625 feet based on NAVD88. There is currently no map or data published by the Department of Conservation or the United States Geological Survey (USGS) to provide historical groundwater information at the site vicinity. Groundwater was not encountered in our exploratory borings. Due to the type of the proposed bridge and expected depth of grading/excavation, as well as the location of the site within a creek, it is likely that groundwater would be encountered during the course of construction for the proposed bridge.

### 5.3. SUBSURFACE INFORMATION

The subsurface soils encountered in the borings to depths between 13 and 14 feet bgs consisted of layers of clayey sand, sandy clay and clayey sand with gravel. The sandy layers were found in loose to medium dense condition, and the clayey layers were found in soft condition. Following these layers and to the maximum depth drilled, moderately hard bedrock was encountered which was found in intensely to moderately weathered condition. Table 1 summarizes the estimated soil strength properties for the generalized subsurface strata profile for the subject project site.

**Table 1. Idealized Soils Properties**

| Material | Depth bgs (ft) | Unit Weight (pcf) | UC Strength $q_u$ (psi) | $N_{SPT}$ |
|---|---|---|---|---|
| Clayey SAND (SC) | 0.0 – 14.0 | 110 | N/A | 14 |
| SILTSTONE/CLAYSTONE | 14.0 + | 150 | 1590 | N/A |

## 6. SCOUR EVALUATION

Evaluation of the scour and erodibility potential are not included in the project scope. Scour evaluation will be done as part of the hydraulics report prepared by others. However, based on the data obtained from our field exploration, the bedrock underlying the bridge foundations is moderately fractured sedimentary bedrock with rock quality designation (RQD) ranging from 50% to 82% corresponding to poor to fair rock mass conditions.

## 7. CORROSION EVALUATION

The available test results for pH, minimum resistivity, soluble chloride content and soluble sulfate content on samples for the bridge site vicinity shows pH value of 8.35, minimum resistivity of 2031 ohm-cm, soluble chloride content of 90 parts per million (ppm), and soluble sulfate content of 60 ppm.

The Caltrans Corrosion Guidelines (Caltrans, 2012) classifies soil as corrosive if the soluble chloride content is 500 ppm or greater, if the soluble sulfate content is 2,000 ppm or greater, or if the pH is 5.5 or less. Based on the above test results and the Caltrans criteria, the on-site soils are not considered to be corrosive to bare metals and concrete. Further interpretation of the corrosivity test results and providing corrosion design and construction recommendations are referred to corrosion specialists.

## 8. SEISMIC CONSIDERATIONS

### 8.1. SEISMIC GROUND MOTION INFORMATION

According to current data from Caltrans, the controlling fault for a deterministic scenario is the Great Valley 01 fault, located approximately 19.2 km east of the site. Table 2 summarizes the fault parameters.

**Table 2. Controlling Fault for Deterministic Seismic Scenario**

| Name | Type | Dip | PGA | Maximum Moment Magnitude |
|---|---|---|---|---|
| Great Valley 01 Fault | Reverse | 15° | 0.223 g | 6.70 |

There is currently no map or data published by the USGS to provide information with respect to the special studies zones at the site vicinity, however the site lies in a seismically active zone and will be subject to strong ground shaking.

### 8.2. DESIGN RESPONSE SPECTRUM

Figure 3, Design Acceleration Response Spectra, shows a plot of the acceleration response spectrum (ARS) curve considering near-fault effects. The corrections for near-fault effects were done as per recommendations contained in Appendix B of the Caltrans Seismic Design Criteria.

The design spectral acceleration values are the envelope of the probabilistic and deterministic spectra and are controlled by probabilistic criteria. The deterministic and probabilistic spectra have been determined using version 2.3.09 of the Caltrans ARS Online tool. Also, the probabilistic spectrum has been determined using edition v3.3.1 of the United State Geological Survey (USGS) Unified Hazard Tool website. We estimated a deaggregated moment magnitude of 7.10 for a return period of 975 years (5% probability of exceedance in 50 years) using edition v3.3.1 of the USGS Unified Hazard Tool website. Based on the soils encountered during current subsurface investigations by Willdan within the project site and consideration of the geologic units mapped in the area, it is our opinion that the site soil profile corresponds to Soil Profile C in accordance with Figure B.12 in Appendix B of Caltrans Seismic Design Criteria (SDC 2017). The shear wave velocity at a depth of 30 meters ($V_{S,30}$) used for the analyses is 560 m/s, estimated based on the NEHRP classification (FEMA, 1994 & 1997) and the data collected during current subsurface investigations by Willdan within the project site.

### 8.3. LIQUEFACTION

Liquefaction is the loss of strength that can occur in saturated coarse-grained soils during earthquake seismic shaking. The susceptibility of a granular soil to liquefaction is a function of the gradation, relative density, and fines content of the soil. Susceptibility to liquefaction generally decreases with increasing mean grain size, relative density, fines content and clay-size fraction of the fines, and the age of the deposit.

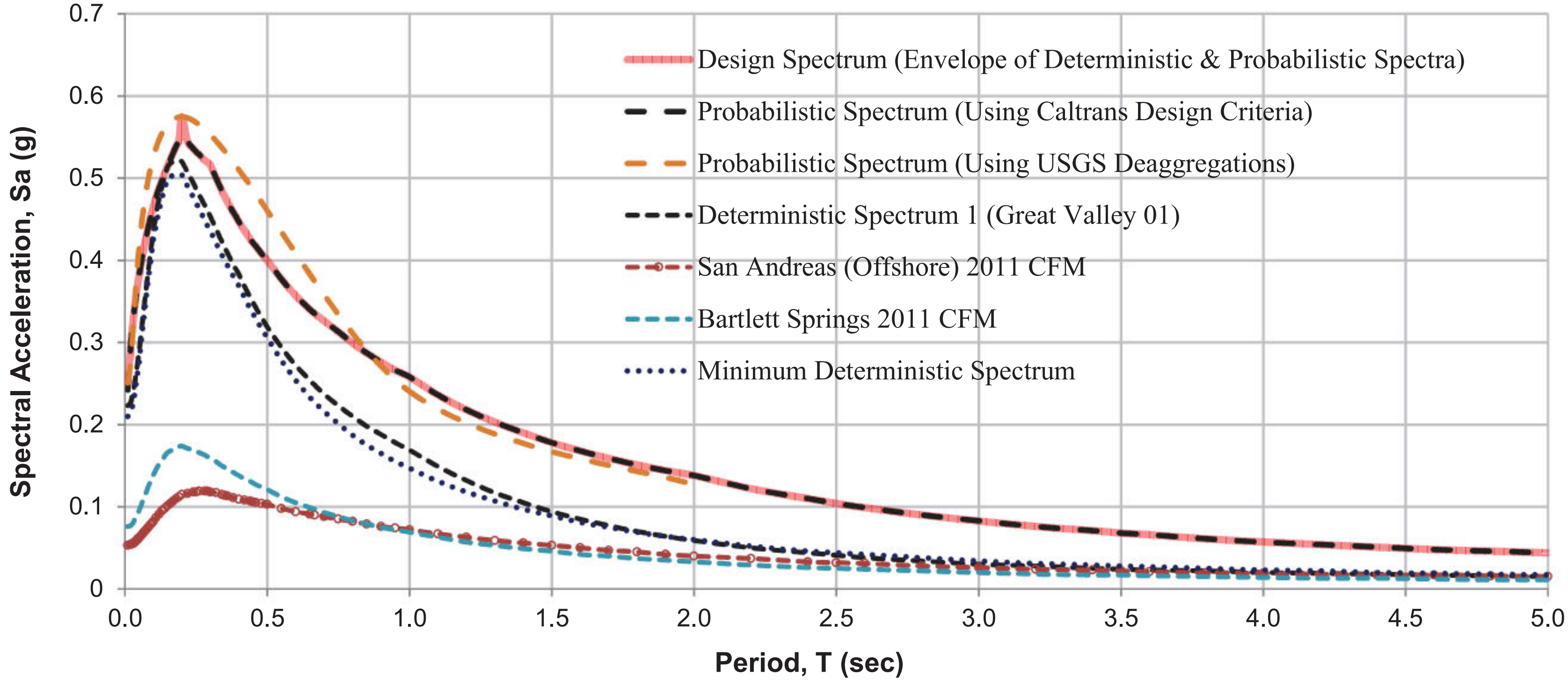
The subsurface soils at the bridge site to a depth corresponding to the approximate elevation of 625 feet predominantly consist of loose to medium dense clayey sand underlain by siltstone/claystone bedrock. As we understand from the preliminary plans, the bridge is proposed to be supported on abutments that in turn will be supported on spread footings supported on bedrock, or piles penetrating into the bedrock. As such, it is our opinion that liquefaction, if any, does not have any effect on the bridge structure and is not a potential hazard for the project.

### 8.4. SURFACE FAULT RUPTURE POTENTIAL

No known faults project through the site. As such, it is our professional opinion that surface fault rupture is not likely to occur at the project site during the design seismic scenario.

## 9. SLOPE STABILITY

The embankment slopes at a slope ratio of 2H:1V or flatter are expected to be stable under both static and design seismic loads.




| Design Curve | Design Criteria | Probability of Exceedence | Return Period | Moment Magnitude | PGA (g) |
|---|---|---|---|---|---|
| | Envelope of Deterministic & Probabilistic Spectra with Near-Fault Effect Included [1, 2] | 5 percent in 50 years | 975 years | 7.10 | 0.251 |

**Notes:**
1 - Based on Caltrans Seismic Design Criteria, Version 2.3.09, April 26, 2017
2 - Design spectrum is controlled by probabilistic criteria. Probabilistic spectral accelerations for small periods are also obtained using the United State Geological Survey (USGS) Unified Hazard Tool website at https://earthquake.usgs.gov/hazards/interactive/, Edition Conterminous U.S. 2008 (v3.3.1)

**FIGURE 3. DESIGN ACCELERATION RESPONSE SPECTRUM**

**Replacement of County Road 200 Bridge over Salt Creek**
**Caltrans Bridge No. 11C-0132, Glenn County, California**

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| | | |
|---|---|---|
| Drawn By: | AM | Date: 20-Jul-18 |
| Approved By: | MR | Project No.: 106454-4000 |

## 10. FOUNDATION RECOMMENDATIONS

It is our opinion that the proposed new bridge may be supported on conventional spread/strip footings or cast-in-drilled-hole (CIDH) concrete piles. The following sections of this report contain our geotechnical recommendations for design and construction of two different types of foundation system. For the purposes of this report we have assumed that the column loads and continuous loads will be less than 90 kilo pounds (kips) and 10 kips per foot, respectively.

### 10.1. ALTERNATIVE A: SPREAD/STRIP FOOTINGS

**Bearing Capacity:** The footings shall have a minimum width of 24 inches and be embedded at least 12 inches in competent bedrock at approximate elevation of 611 feet. The bottom of footing excavation shall be observed and confirmed by the project geotechnical engineer to be in competent bearing material. The footings may be designed using a maximum allowable bearing value of 2,500 pounds per square foot (psf) or a maximum ultimate bearing value of 7,500 psf. A one-third increase in the bearing value may be used when considering wind or seismic loads.

**Lateral Resistance:** Lateral soil resistance will be provided by a combination of frictional resistance between the bottom of the footings and the underlying soils, and by passive soil resistance acting against side of the footing. For frictional resistance between concrete and soil, a frictional coefficient of 0.35 may be used. For passive resistance, an allowable pressure developed by a fluid with density of 350 pound per cubic foot (pcf), to a maximum pressure of 3500 psf, may be used for a level ground surface condition in front of the footing. To consider the scour effect, the soil overlying the bedrock within the ground surface and approximate elevation of 612 feet should be neglected in passive resistance calculation. When combining both frictional and passive resistance, the passive resistance should be reduced by one-third.

**Settlement:** Our preliminary computations indicate that the total settlement of the footings due to the anticipated loads, for footings designed as recommended herein, will be less than 0.5 inch, and the differential settlements are expected to be less than 0.25 inch over a 50-foot span.

### 10.2. ALTERNATIVE B: CDIH PILES

**Axial Capacity:** Ultimate downward and uplift capacities for piles with different diameters were evaluated using SHAFT 2017 program and are presented in Appendix C. The presented graphs are provided for 12, 18, and 24-inch diameter piles that are entirely embedded in the bedrock. Similar graphs for different diameters other than above will be provided upon request. The capacities are based on frictional resistance of the piles. For frictional pile design using the attached graphs, the weight of the shaft can be assumed to be taken by end-bearing resistance of the pile and it is not necessary to add the weight of the shaft to the structural loads. Uplift capacity of the pile may be assumed as half of the downward capacity of the pile. It is recommended that the piles have a minimum diameter of 12 inches and minimum embedment length of 5 feet in the bedrock. The actual length of the drilled piles shall be calculated by the structural engineer for the project, considering recommendations provided herein. The provided capacities are based on the strength of the soils, not the pile section, which should be designed and checked by the project structural engineer.

**Lateral Capacity:** Lateral loads can be resisted by passive pressure developed against the vertical shafts. The lateral capacity of the pile depends on the permissible deflection and the degree of fixity at the top of the pile. For this project, lateral resistance of a free-head and a fixed-head single pile were evaluated using LPILE 2016 program.

A lateral deflection of 0.25 inch has been applied to the top of the pile, and the lateral capacity graphs of lateral deflection, bending moment and shear force vs. depth, for 10 feet long, and 12, 18 and 24 inches diameter piles, with 90 kips axial load are presented within Appendix C. The provided capacities are based on the strength of the soils, not the pile section, which should be designed and checked by the project structural engineer.

**Settlements:** The pile settlement vs. axial load were evaluated using SHAFT 2017 program and the graphs are presented in Appendix C.

## 11. ABUTMENT, WING AND RETAINING WALLS

### 11.1. ABUTMENT WALLS

The lateral earth pressure behind the abutment walls, which are restrained at the top, may be estimated using the recommendations of Section 5.5.5.11 of the Caltrans Bridge Design Specifications (2004). The walls may be designed using the pressure that is developed by an equivalent fluid with density of 65 pounds per cubic foot (pcf) and 45 pcf for at-rest and active pressure, respectively.

The abutment walls shall also be designed in accordance to the recommendations of Section 7.8 of the Caltrans Seismic Design Criteria (Caltrans SDC 1.7, 2013). The walls may be designed for a passive resistance force calculated using Equation 7.8.1-3 from the SDC to resist movement at the abutment walls.

### 11.2. WING AND RETAINING WALLS LATERAL EARTH PRESSURES

Lateral earth pressures for the design of wing walls and retaining walls may be assumed to be equal to the pressure developed by an equivalent fluid with density presented in Table 3.

**Table 3. Summary of Lateral Earth Pressures**

| Lateral Earth Pressure Condition | Equivalent Fluid Density |
|---|---|
| Active Pressure | 45 pcf |
| At-Rest Pressure | 65 pcf |
| Passive Pressure | 320 pcf |

In addition to the above active earth pressure, walls more than 12 feet high, should be designed to support a seismic active pressure. The seismic active lateral earth pressure may be assumed to be an inverted triangular pressure distribution equal to 24H psf at the top of the retaining wall and decreasing linearly to zero at the bottom of retaining wall, where H is the height of retaining wall in feet.

### 11.3. WALL FOUNDATIONS

The walls may be supported on shallow or deep foundations designed in accordance with the recommendations provided in Section 10 of this report.

### 11.4. SUBDRAIN INSTALLATION

Subdrain systems shall be installed to prevent hydrostatic pressure build-up acting as an additional lateral load. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. Retaining wall backfill and typical subdrain details for conditions of native soil, imported sand, or crushed rock are provided in Appendix D.

## 12. PAVEMENT DESIGN

Laboratory testing of a bulk sample from the shallow subsurface soil of the approach roadway of the subject bridge indicates a minimum R-value of 14. A flexible section consisting of asphalt concrete (AC) over aggregate base (AB), or a full-depth AC section may be used. The pavement sections listed in Table 4 have been developed in accordance with the procedure presented in the Caltrans Highway Design Manual for a range of traffic index (TI) values.

**Table 4. Flexible Pavement Design**

| TI | AC/AB (in/in) | Full Depth AC (in) |
|---|---|---|
| 6 | 3.5/11.0 | 8.5 |
| 8 | 5.0/15.0 | 11.5 |
| 10 | 6.5/20.0 | 14.5 |

The pavement section shall be supported on the subgrade prepared per recommendations of Section 13.0 of this report. The base material shall consist of AB-Class 2 as specified in the Caltrans Standard Specifications (2015) and compacted to a minimum of 95% of maximum dry density.

## 13. EARTHWORK RECOMMENDATIONS

All earthwork and grading should be performed in accordance with the recommendations of this report and requirements of Section 19 of the Caltrans Standard Specifications (2015). Within the approach roads, any existing fills or soils disturbed during construction and associated site clearing operations should be removed down to a minimum of 24 inches and replaced with engineered fill.

The exposed subgrade to receive fill or pavement section should be scarified to a minimum of 8 inches and compacted to minimum of 90% relative compaction. The fill materials under the roadways and behind the retaining walls shall be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned and compacted to minimum 90% of relative compaction. The onsite soil free of debris and deleterious material or import granular material may be used as backfill material.

## 14. CONSTRUCTION CONSIDERATIONS

### 14.1. TEMPORARY EXCAVATION

Temporary excavations shall be properly sloped or shored. Based on the earth materials encountered in our borings, excavation of 5 feet or less in depth may be performed with vertical sidewalls. Deeper excavation up to a depth of 15 feet can be accomplished in accordance with the Occupational Safety and Health Administration (OSHA) requirements for Type B soils. The contractor is responsible for maintaining the stability of the cuts and personnel safety in the field during construction. All excavations shall be performed in accordance with applicable requirements established by the State, County, or local government. The regulatory requirement may supersede the recommendations presented in this section. A representative of the geotechnical engineer of record should be present during all excavations.

### 14.2. CIDH PILE INSTALLATION

Although during the course of field investigation, no caving was noticed in the borings, caving should be anticipated when the layers are sandy, gravelly or less cohesive, and when drilling below the groundwater table. Precautions should be taken during the drilling operation to minimize caving of the drilled holes. To minimize caving potential, it is recommended to keep pile diameter as small as possible. Other means and methods such as using casing or drilling mud may be employed by contractor when necessary. Experienced contractors shall be retained to install drilled pile foundations. It is necessary to perform continuous observation during pile construction by a project geotechnical engineer's representative.

Piles closer than three pile diameters on center to each other shall be drilled and filled with concrete alternately and concrete shall be permitted to set at least 8 hours before drilling an adjacent pile. The drilled hole shall be inspected and filled with concrete as soon as possible. The holes should not be left open overnight. The concrete shall be poured using tremie method.

## 15. LIMITATIONS

This report is based on the available information for the project and obtained from the current subsurface investigations. The materials data available from the current investigation are believed to be representative of the subject project site, and the conclusions and recommendations contained in this report are presented on that basis. However, soil materials can vary in characteristics between points of exploration, both laterally and vertically, and those variations could affect the conclusions and recommendations contained herein. Any changes noted during construction should be brought to the attention of the Geotechnical Engineer so that any changes to these recommendations can be made as appropriate.

This Foundation Report has been prepared consistent with the level of care being provided by other professionals providing similar services at the same locale and time period. The contents of this report are professional opinions and as such, are not to be considered a guarantee or warranty.

The information contained herein 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.

## 16. REFERENCES


- Caltrans, 2010a. Soil and Rock Logging, Classification, and Presentation Manual, 2010 Edition.
- Caltrans, 2004. Bridge Design Specifications, Section 5 - Retaining Walls, August 2004.
- Caltrans, 2015. Standard Specifications, 2015.
- Caltrans, 2015c. Standard Plans, 2015 Edition.
- Caltrans, 2017. Foundation Report Preparation for Bridges, February 2017.
- Caltrans, 2013. Seismic Design Criteria, Version 1.7, April 2013.
- Caltrans, 2013. ARS Online Tool, version 2.3.09, at http://dap3.dot.ca.gov/ARS_Online/index.php
- Caltrans, 2008a. Memo to Designers 4-1, April 2008.
- Caltrans, 2012. Highway Design Manual, May 2012.
- Caltrans, 2003. Bridge Design Specifications, Section 4 – Foundations, November 2003.
- Caltrans, 2012. Corrosion Guidelines, Version 2.0, November 2012.
- United States Geological Survey (USGS) Unified Hazard Tool, at https://earthquake.usgs.gov/hazards/interactive
- USGS (2015), Geology of California, Ukiah Sheet, available at https://ngmdb.usgs.gov/Prodesc/proddesc_336.htm

# APPENDIX A: LOGS OF TEST BORINGS

| Dist | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No. | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | Gle | CR 200 | NA | X | X |

GEOTECHNICAL PROFESSIONAL XX/XX/XX DATE

MM/DD/YYYY
PLANS APPROVAL DATE

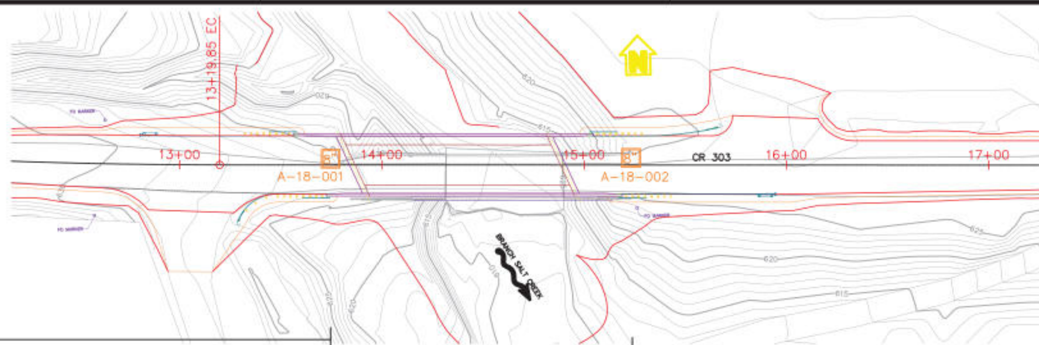
REGISTERED PROFESSIONAL ENGINEER
Mohsen Rahimian
No. GE3059
Exp. 12/31/18
GEOTECHNICAL
STATE OF CALIFORNIA

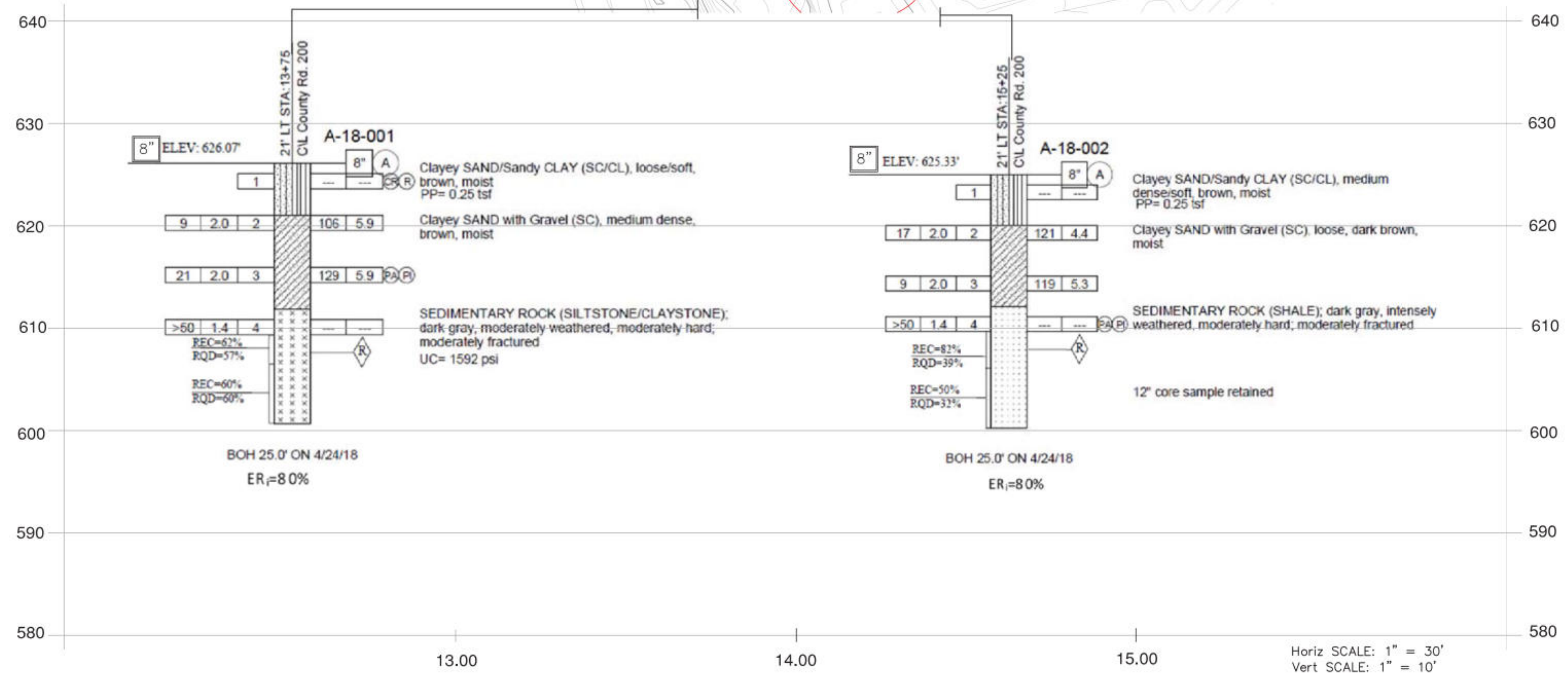
Prepared by:
WILLDAN ENGINEERING
1515 SOUTH SUNKIST STREET, SUITE E
ANAHEIM, CALIFORNIA 92806

## BENCH MARK

Horizontal Datum is NAD83 (2011) epoch 2010.0000. Coordinates are California State Plane Coordinate System, Zone 2 Scaled to Ground about Control Point #101. To Obtain Grid Distances Scale Coordinates 0.99996563 about Control Point #100.

Vertical Datum is NAVD88 based on NGS OPUS Solution FOR THE Project Taken from Control Point #100, Elevation=626.959'




Horiz SCALE: 1" = 30'
Vert SCALE: 1" = 10'

| | | |
|---|---|---|
| DRAWN | BY | AM |
| CHECKED | BY | MR |

M.T.Hall and Associates
FIELD INVESTIGATOR
04/23/2018
DATE

PREPARED FOR
COUNTY OF GLENN
PUBLIC WORKS AGENCY

G. GORDON
PROJECT ENGINEER

BRIDGE No. 11C0132
POST MILE NA

BRANCH SALT CREEK BRIDGE (REPLACE)
LOG OF TEST BORINGS

DATE PLOTTED => $DATE
FILE => $REQUEST
TIME PLOTTED => $TIME
USERNAME => $USER
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES
SHEET X OF X

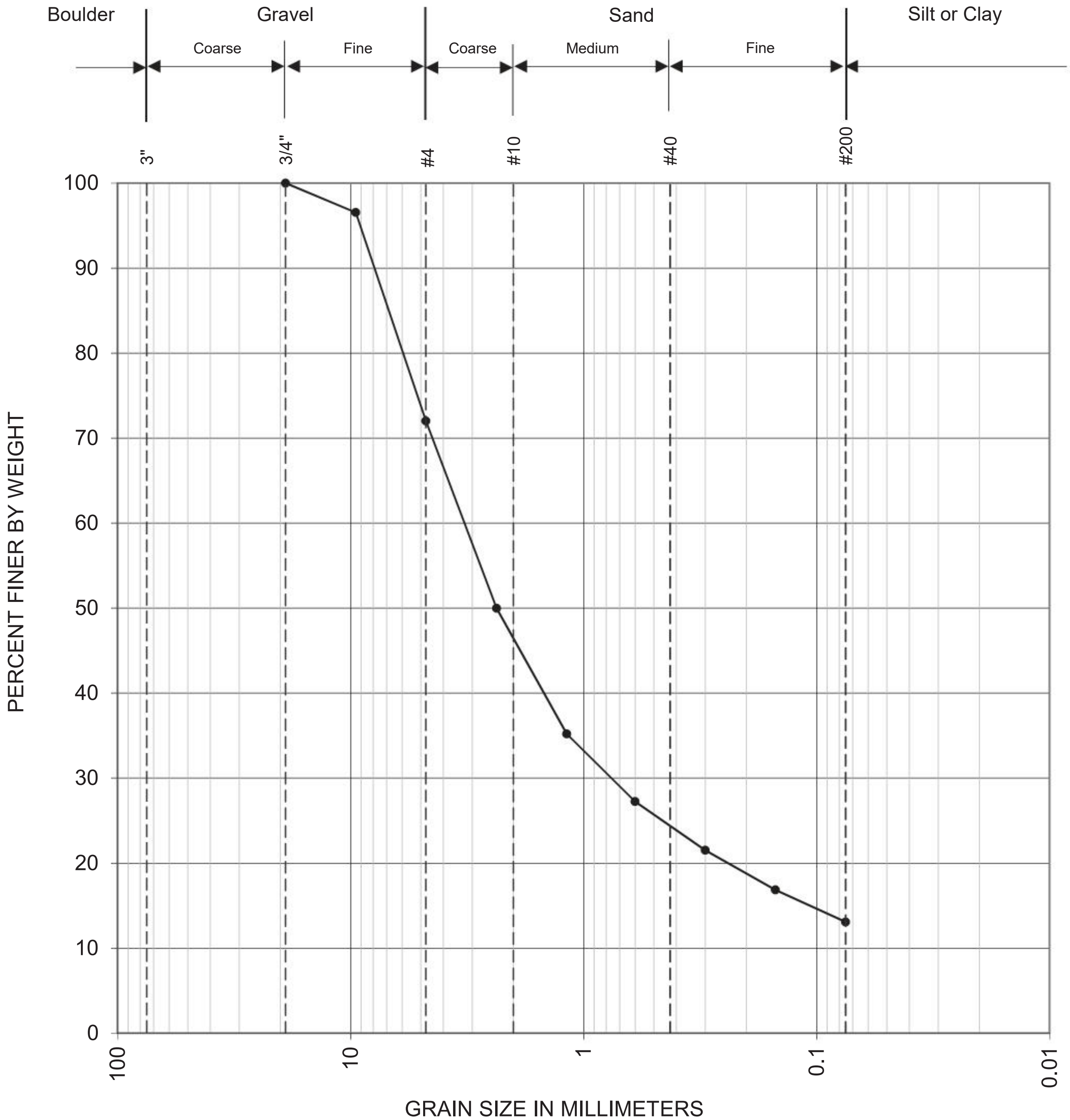
# APPENDIX B: LABORATORY TEST RESULTS

## TABLE B-1. SUMMARY OF LABORATORY TEST RESULTS

**REPLACEMENT OF COUNTY ROAD 200 BRIDGE OVER SALT CREEK, GLENN COUNTY, CALIFORNIA**

**WILLDAN GEOTECHNICAL PROJECT NO. 106454-4000**

| Sample | | USCS Soil Description | Gradation (ASTM D422) | Atterberg Limits (ASTM D4318) | | R-Value (CTM 301) | Unconfined Compressive Strength (ASTM D7012) | Corrosivity (CTM 422, 417, 643) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring No. | Depth (ft) | | (% G : S : F) | Liquid Limit | Plasticity Index | | $q_u$ (psi) | pH | Soluble Sulfate (ppm) | Soluble Chloride (ppm) | Minimum Resistivity (ohm-cm) |
| A-18-001 | 0 to 5 | Clayey SAND/Sandy CLAY (SC/CL) | | | | 14 | | 8.35 | 60 | 90 | 2031 |
| | 10.0 | Clayey SAND with Gravel (SC) | 28 : 59 : 13 | 24 | 10 | | | | | | |
| | 14.0 | Sedimentary Rock (SILTSTONE/CLAYSTONE) | | | | | 1592 | | | | |
| A-18-002 | 15.0 | Clayey SAND with Gravel (SC) | 31 : 39 : 30 | 31 | 13 | | | | | | |




| Boring No. | Sample No. | Depth | USCS Symbol | Classification | Natural W % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|
| A-18-001 | - | 10.0' | SC | Clayey SAND with Gravel | | | | |

| % +3" | % Gravel | % Sand | % Fines |
|---|---|---|---|
| 0 | 28 | 59 | 13 |

| $C_u$ | $C_c$ |
|---|---|
| | |

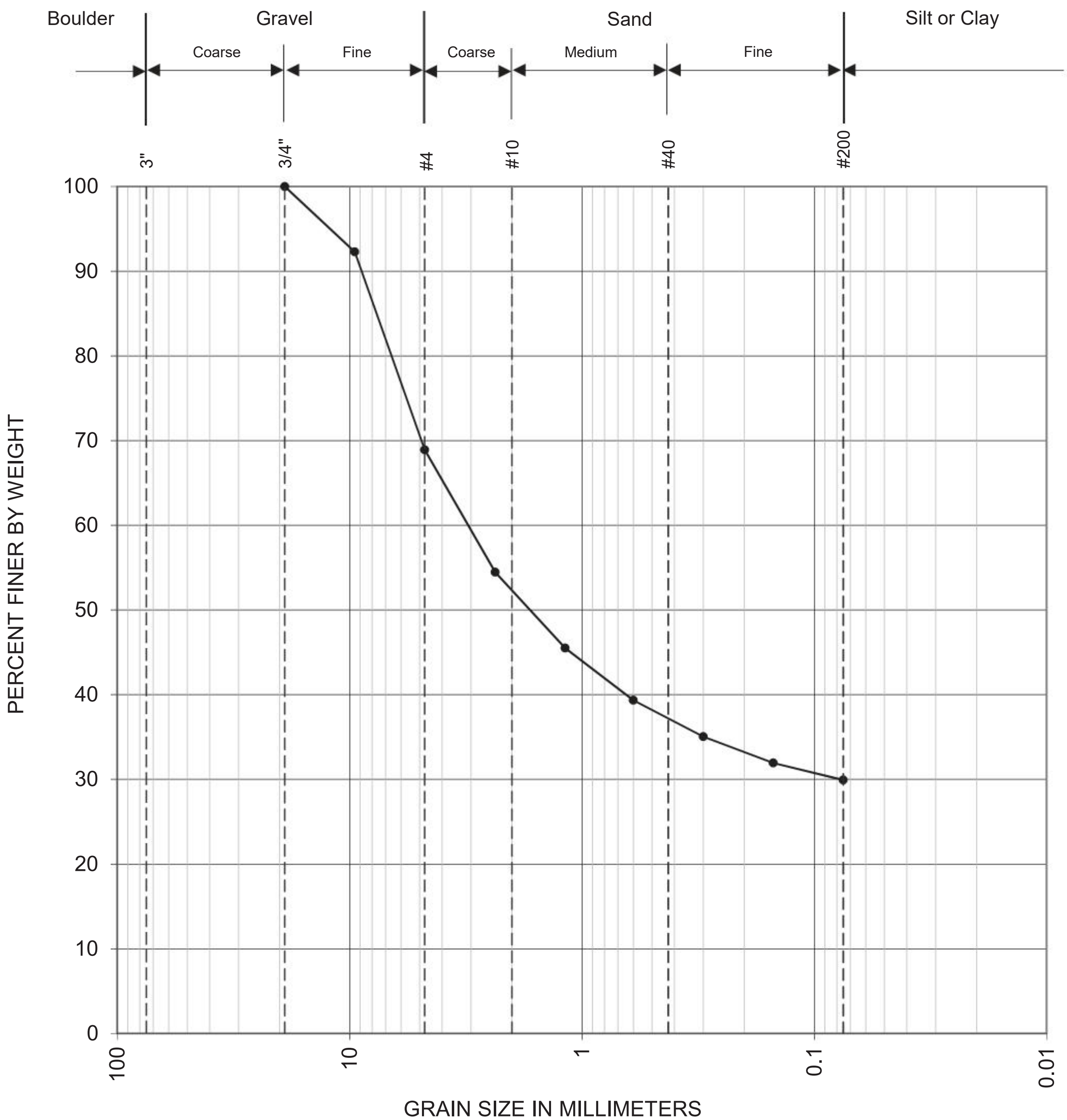
Project Name: County Rd. 200 Bridge over Salt Creek

Project No.: 106454-4000

# PARTICLE SIZE CURVE

(ASTM D422)

WILLDAN Geotechnical | extending your reach




| Boring No. | Sample No. | Depth | USCS Symbol | Classification | Natural W % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|
| A-18-002 | - | 15' | SC | Clayey SAND with Gravel | | | | |

| % +3" | % Gravel | % Sand | % Fines |
|---|---|---|---|
| 0 | 31 | 39 | 30 |

| $C_u$ | $C_c$ |
|---|---|
| | |

Project Name: County Rd. 200 Bridge over Salt Creek

Project No.: 106454-4000

# PARTICLE SIZE CURVE

(ASTM D6913)

WILLDAN Geotechnical | extending your reach

| | | | | | |
|---|---|---|---|---|---|
| Project Name : | County Rd. 200 Bridge over Salt Creek | Project No.: | 106454-4000 | | |
| Sample Location / Source : | | Tested by : | RMC | Date: | 6/7/2018 |
| Sample Depth / No. : | A-18-001 @ 10' | Sampled by: | | Date: | |
| Sample Description / Classification : | Lean CLAY (CL) | | | | |

**PLASTIC LIMIT**

| DETERMINATION NO. | | 1 | |
|---|---|---|---|
| DISH NO. | | 11 | |
| MASS, DISH + WET SOIL | (g) | 39.04 | |
| MASS, DISH + DRY SOIL | (g) | 37.55 | |
| MASS OF WATER | (g) | 1.49 | |
| MASS OF DISH | (g) | 26.71 | |
| MASS OF DRY SOIL | (g) | 10.84 | |
| MOISTURE CONTENT | (%) | 13.7 | |

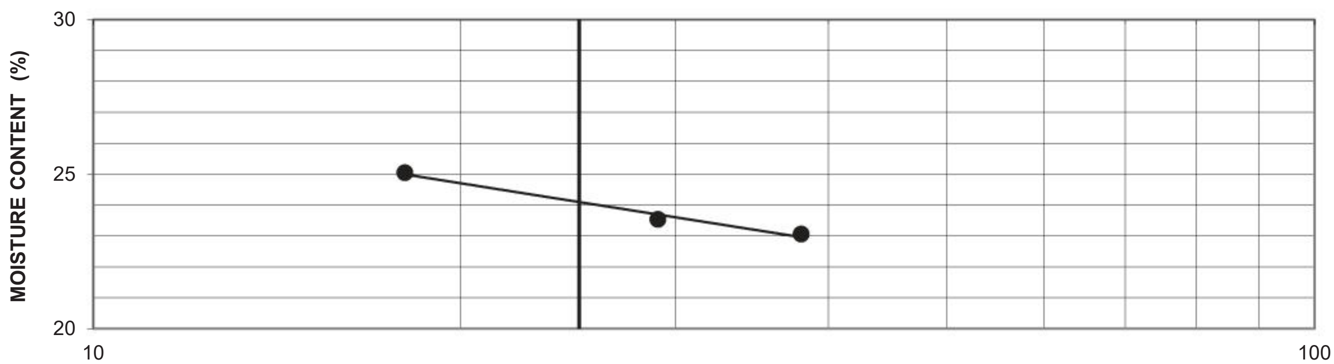
**LIQUID LIMIT**

| DETERMINATION NO. | | 1 | 2 | 3 |
|---|---|---|---|---|
| DISH NO. | | 5 | 3 | 13 |
| MASS, DISH + WET SOIL | (g) | 30.97 | 33.27 | 36.03 |
| MASS, DISH + DRY SOIL | (g) | 29.59 | 30.66 | 33.92 |
| MASS OF WATER | (g) | 1.38 | 2.61 | 2.11 |
| MASS OF DISH | (g) | 24.08 | 19.57 | 24.77 |
| MOISTURE CONTENT | (%) | 25.0 | 23.5 | 23.1 |
| NUMBER OF BLOWS | | 18 | 29 | 38 |

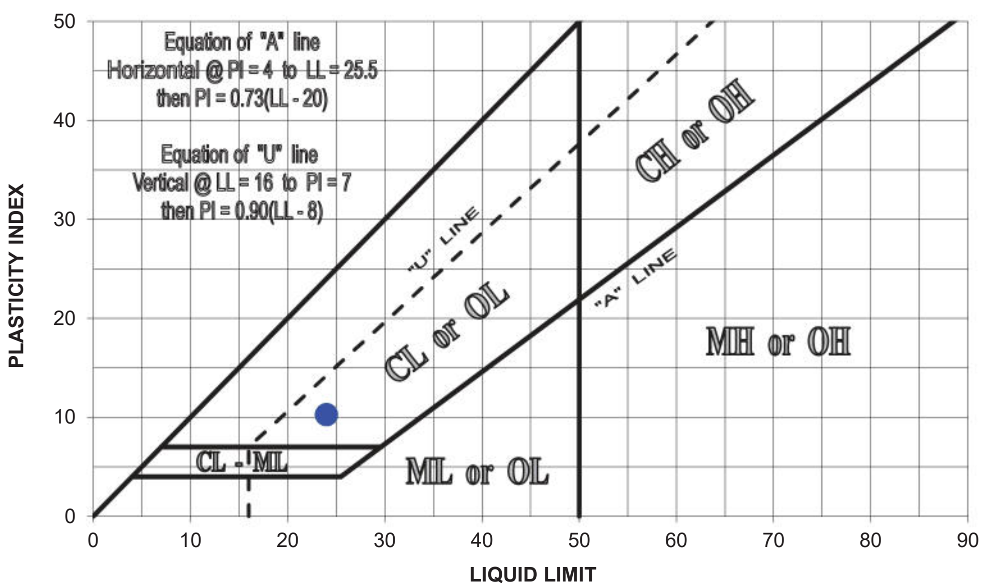
**NATURAL MOISTURE CONTENT,%**

| |
|---|
| |
| |
| |
| |
| |

## FLOW CURVE




## PLASTICITY CHART




## RESULT SUMMARY

| | |
|---|---|
| NATURAL MOISTURE CONTENT, (%) | |
| LIQUID LIMIT (LL) | 24 |
| PLASTIC LIMIT (PL) | 14 |
| PLASTICITY INDEX (PI) | 10 |
| SYMBOL FROM PLASTICITY CHART | CL |

| METHOD OF PREPARATION | | METHOD OF LL DETERMINATION | |
|---|---|---|---|
| DRY | X | MULTIPOINT | X |
| WET | | ONE-POINT | |

REMARKS :

# ATTERBERG LIMITS

( ASTM D4318 )

WILLDAN Geotechnical | extending your reach

| | | | | | |
|---|---|---|---|---|---|
| Project Name : | County Rd. 200 Bridge over Salt Creek | Project No.: | 106454-4000 | | |
| Sample Location / Source : | | Tested by : | RMC | Date: | 6/7/2018 |
| Sample Depth / No. : | A-18-002 @ 15' | Sampled by: | | Date: | |
| Sample Description / Classification : | Lean CLAY (CL) | | | | |

**PLASTIC LIMIT**

| DETERMINATION NO. | | 1 | |
|---|---|---|---|
| DISH NO. | | 7 | |
| MASS, DISH + WET SOIL | (g) | 40.80 | |
| MASS, DISH + DRY SOIL | (g) | 38.62 | |
| MASS OF WATER | (g) | 2.18 | |
| MASS OF DISH | (g) | 26.32 | |
| MASS OF DRY SOIL | (g) | 12.3 | |
| MOISTURE CONTENT | (%) | 17.7 | |

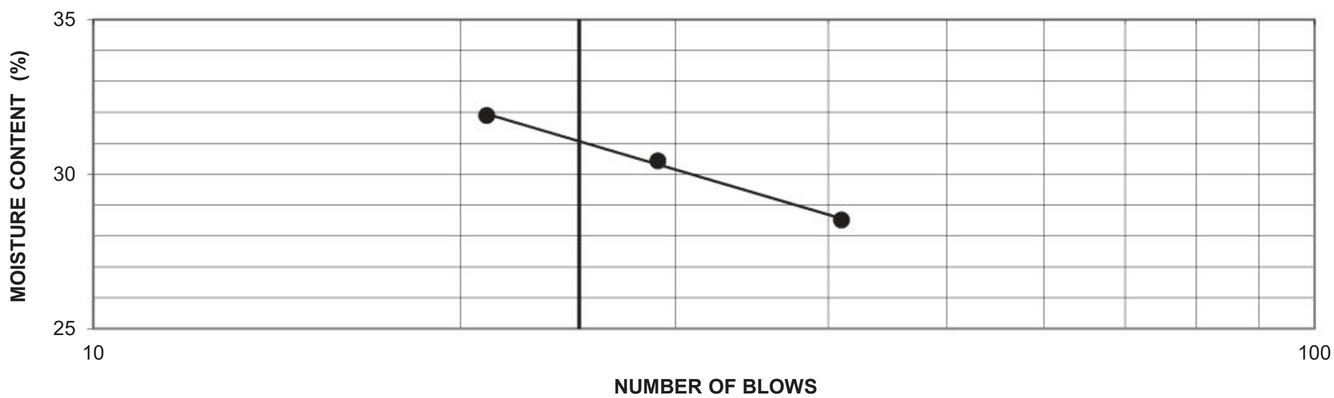
**LIQUID LIMIT**

| DETERMINATION NO. | | 1 | 2 | 3 |
|---|---|---|---|---|
| DISH NO. | | 5 | 18 | 22 |
| MASS, DISH + WET SOIL | (g) | 34.27 | 35.00 | 38.46 |
| MASS, DISH + DRY SOIL | (g) | 31.99 | 32.63 | 35.17 |
| MASS OF WATER | (g) | 2.28 | 2.37 | 3.29 |
| MASS OF DISH | (g) | 24.84 | 24.84 | 23.63 |
| MOISTURE CONTENT | (%) | 31.9 | 30.4 | 28.5 |
| NUMBER OF BLOWS | | 21 | 29 | 41 |

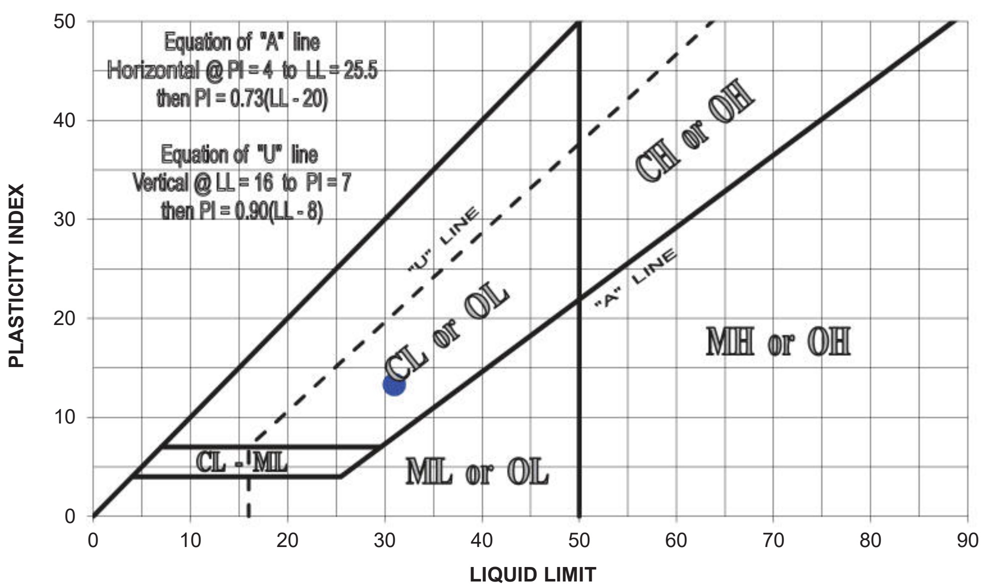
**NATURAL MOISTURE CONTENT,%**

| |
|---|
| |
| |
| |
| |
| |

## FLOW CURVE




## PLASTICITY CHART




## RESULT SUMMARY

| | |
|---|---|
| NATURAL MOISTURE CONTENT, (%) | |
| LIQUID LIMIT (LL) | 31 |
| PLASTIC LIMIT (PL) | 18 |
| PLASTICITY INDEX (PI) | 13 |
| SYMBOL FROM PLASTICITY CHART | CL |

| METHOD OF PREPARATION | | METHOD OF LL DETERMINATION | |
|---|---|---|---|
| DRY | X | MULTIPOINT | X |
| WET | | ONE-POINT | |

REMARKS :

# ATTERBERG LIMITS

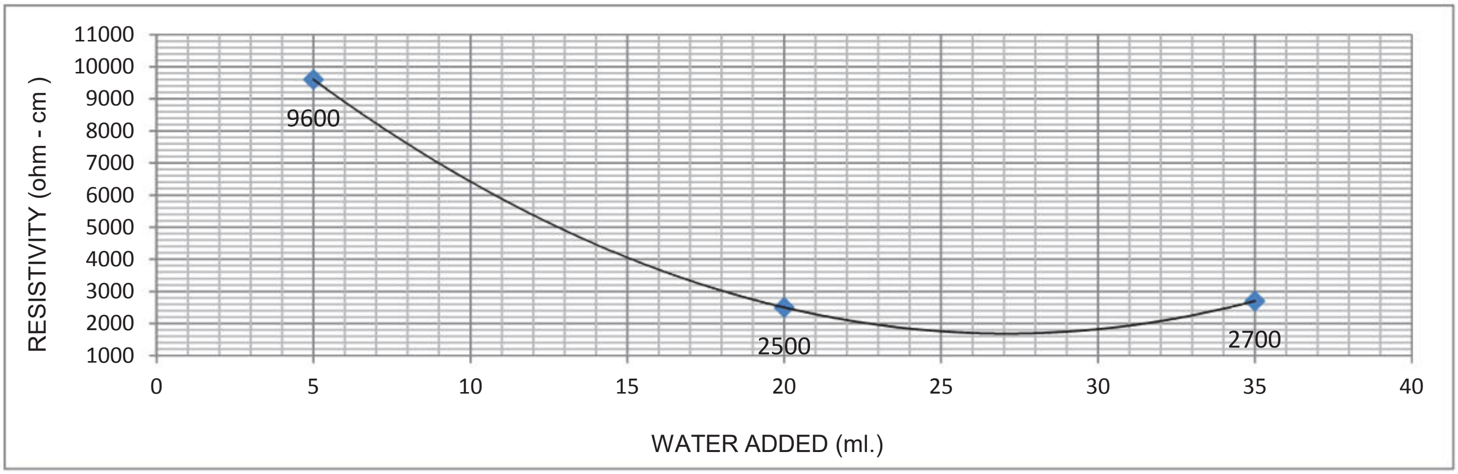
( ASTM D4318 )

WILLDAN Geotechnical | extending your reach

| | | | | | |
|---|---|---|---|---|---|
| Project Name : | County Rd.200 Bridge over Salt Creek | Project No.: | 106454-4000 | | |
| Sample Location / Source : | A-18-001 | Tested by : | RMC | Date: | 6/7/2018 |
| Sample Depth / No. : | 0.0' - 5.0' | Sampled by: | | Date: | |
| Sample Description / Classification : | Clayey SAND / Sandy CLAY (SC/CL) | | | | |

## A. MINIMUM RESISTIVITY (CTM 643)

| | | | | |
|---|---|---|---|---|
| WATER ADDED, (ml) | 5 | 20 | 35 | |
| RESISTIVITY MEASURED, (ohm-cm) | 9600 | 2500 | 2700 | |
| TEMPERATURE MEASURED, ($^{0}$C) | 23.9 | | | |
| MINIMUM RESISTIVITY (ohm-cm) | 1700 | | | |
| MIN. RESISTIVITY CORRECTED , $R_{min\ -15.5}$ (ohm-cm) | 2031 | | | |




## B. SULFATE CONTENT OF SOILS (CTM 417)

| | |
|---|---|
| SOIL - WATER RATIO | 100 : 300 |
| $SO_4$ DILUTION (ALIQUOT : DISTILLED $H_2O$) | 5 : 20 |
| FACTOR | 15 |
| SULFATE READING (ppm) | 4 |
| WATER SOLUBLE SULFATES, (ppm) | 60 |

## C. CHLORIDE CONTENT OF SOILS (CTM 422, SILVER NITRATE METHOD)

| | |
|---|---|
| CHLORIDE DILUTION (ALIQUOT:DISTILLED $H_2O$) | 50 : 50 |
| NUMBER OF DIGITS REQUIRED | 30 |
| WATER SOLUBLE CHLORIDES, (ppm) | 90 |

## D. pH OF SOILS (CTM 643)

| | |
|---|---|
| pH VALUE | 8.35 |

REMARKS :

CORROSION TESTS

(CTM 417, 422, 643)

WILLDAN Geotechnical extending your reach

Project Name: County Rd. 200 Bridge over Salt Creek    Willdan Project No.: 106454-4000

US STD. SIEVE OPENING IN INCHES    US STD. SIEVE NUMBERS    HYDROMETER

COBBLES    G R A V E L    S A N D    SILT OR CLAY

COARSE    FINE    COARSE    MEDIUM    FINE

# 'R' VALUE CA 301

3"    1-1/2"    3/4"    3/8"    #4    #10    #40    #200

Client: Willdan Geotechnical    Date: 6/7/18    By: LD

Client's Job No.: 106454-4000    Sample No.: A-18-001 @ 0 - 5'

GLA Reference: 2005-224    Soil Type: Clayey SAND/Sandy CLAY (SC/CL)

| TEST SPECIMEN | | A | B | C | D |
|---|---|---|---|---|---|
| Compactor Air Pressure | psi | **80** | **50** | **60** | |
| Initial Moisture Content | % | **6.0** | **6.0** | **6.0** | |
| Water Added | ml | **80** | **108** | **94** | |
| Moisture at Compaction | % | 13.1 | 15.6 | 14.3 | |
| Sample & Mold Weight | gms | **3246** | **3182** | **3215** | |
| Mold Weight | gms | **2105** | **2092** | **2104** | |
| Net Sample Weight | gms | 1141 | 1090 | 1111 | |
| Sample Height | in. | **2.489** | **2.495** | **2.471** | |
| Dry Density | pcf | 122.8 | 114.5 | 119.2 | |
| Pressure | lbs | **5390** | **2330** | **3980** | |
| Exudation Pressure | psi | 429 | 186 | 317 | |
| Expansion Dial | x 0.0001 | **76** | **0** | **33** | |
| Expansion Pressure | psf | 329 | 0 | 143 | |
| Ph at 1000lbs | psi | **40** | **78** | **58** | |
| Ph at 2000lbs | psi | **103** | **143** | **121** | |
| Displacement | turns | **3.4** | **5.04** | **4.22** | |
| R' Value | | 29 | 6 | 16 | |
| Corrected 'R' Value | | **29** | **6** | **16** | |

| FINAL 'R' VALUE | |
|---|---|
| By Exudation Pressure (@ 300 psi): | **14** |
| By Expansion Pressure : | **15** |
| TI = 5 | |

PERCENT FINER BY WEIGHT: 100.0, 90.0, 80.0, 70.0, 60.0, 50.0, 40.0, 30.0, 20.0, 10.0, 0.0

100.00    10.00    1.00    0.10    0.01

GRAIN SIZE IN MILLIMETERS

Project No. : 102357-2000    Project Name : MORENO VALLEY

| Boring No. | Sample No. | Depth | Symbol | Classification | Nat.W % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|
| B-1 | S-2 | 5' - 6' | SM | Weathered GRANITE/ Silty SAND | | - | - | - |

Geo-Logic ASSOCIATES

R VALUE TEST (CTM 301)

GRAIN SIZE CURVE

WILLDAN Geotechnical | extending your reach

Project Name: County Rd. 200 Bridge over Salt Creek Willdan Project No.: 106454-4000

US STD. SIEVE OPENING IN INCHES US STD. SIEVE NUMBERS HYDROMETER

COBBLES GRAVEL SAND SILT OR CLAY

COARSE FINE COARSE MEDIUM FINE

3" 1-1/2" 3/4" 3/8" #4 #10 #40 #200

**AP Engineering and Testing, Inc.**
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0

PERCENT FINER BY WEIGHT

## UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN (ASTM D7012 Method C)

| | | | | | |
|---|---|---|---|---|---|
| Project Name: | County Rd.200 Bridge | Prepared | LS | Date | 06/07/18 |
| Project No. | 106454-4000 | Tested by | L S | Date | 06/07/18 |
| Boring No | A-18-001 | Calculated by | JP | Date | 06/08/18 |
| Sample No | - | Checked by | AP | Date | 06/08/18 |
| Depth: | 14 | | | | |

Lithologic Description of the Rock: SILTSTONE/CLAYSTONE

### INITIAL CONDITION OF SPECIMEN

| | | |
|---|---|---|
| Diameter | 2.390 | in |
| Height | 5.010 | in |
| Weight Before | 894.19 | g |
| Area | 4.49 | $in^2$ |
| Volume | 22.5 | $in^3$ |
| Unit Weight | 151.5 | pcf |
| h/d Ratio | 2.1 | |

**Moisture After Test**

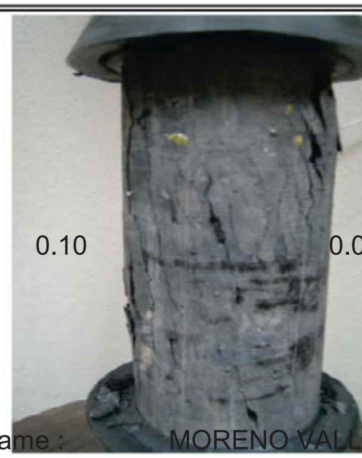
| | |
|---|---|
| Container No. | |
| Wt. Wet Soil+Container (g) | 760.29 |
| Wt. Dry Soil+Container (g) | 738.24 |
| Wt. Container (g) | 142.79 |
| Moisture, (%) | 3.70 |

### SHEARING DATA

| Strain Rate (in/min) | Strain Rate (%/min) | Temperature ( $^oF$ ) | Axial Load (lbs) | Compressive Strength (psi) |
|---|---|---|---|---|
| 0.05 | 0.01 | 75.0 | 7140 | 1592 |
| | | | | |
| | | | | |

| *Failure Types | | | |
|---|---|---|---|
| | | 1 | Cone |
| | | 2 | Cone and Split |
| | X | 3 | Columnar Vertical Cracking |
| | | 4 | Shear |
| | | 5 | Side Fracture (Top or Bottom) |
| | | 6 | Side Fracture (Pointed) |
| | | 7 | Other |

Specimen Pictures After Test



100.00 10.00 1.00 0.10 0.01

GRAIN SIZE IN MILLIMETERS

Project No. : 102357-2000 Project Name : MORENO VALLEY

Remarks:

| Boring No. | Sample No. | Depth | Symbol | Classification | Nat.W % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|
| B-1 | S-2 | 5' - 6' | SM | Weathered GRANITE/ Silty SAND | | - | - | - |

UNCONFINED COMPRESSIVE STRENGTH TEST (ASTM D7012)

GRAIN SIZE CURVE

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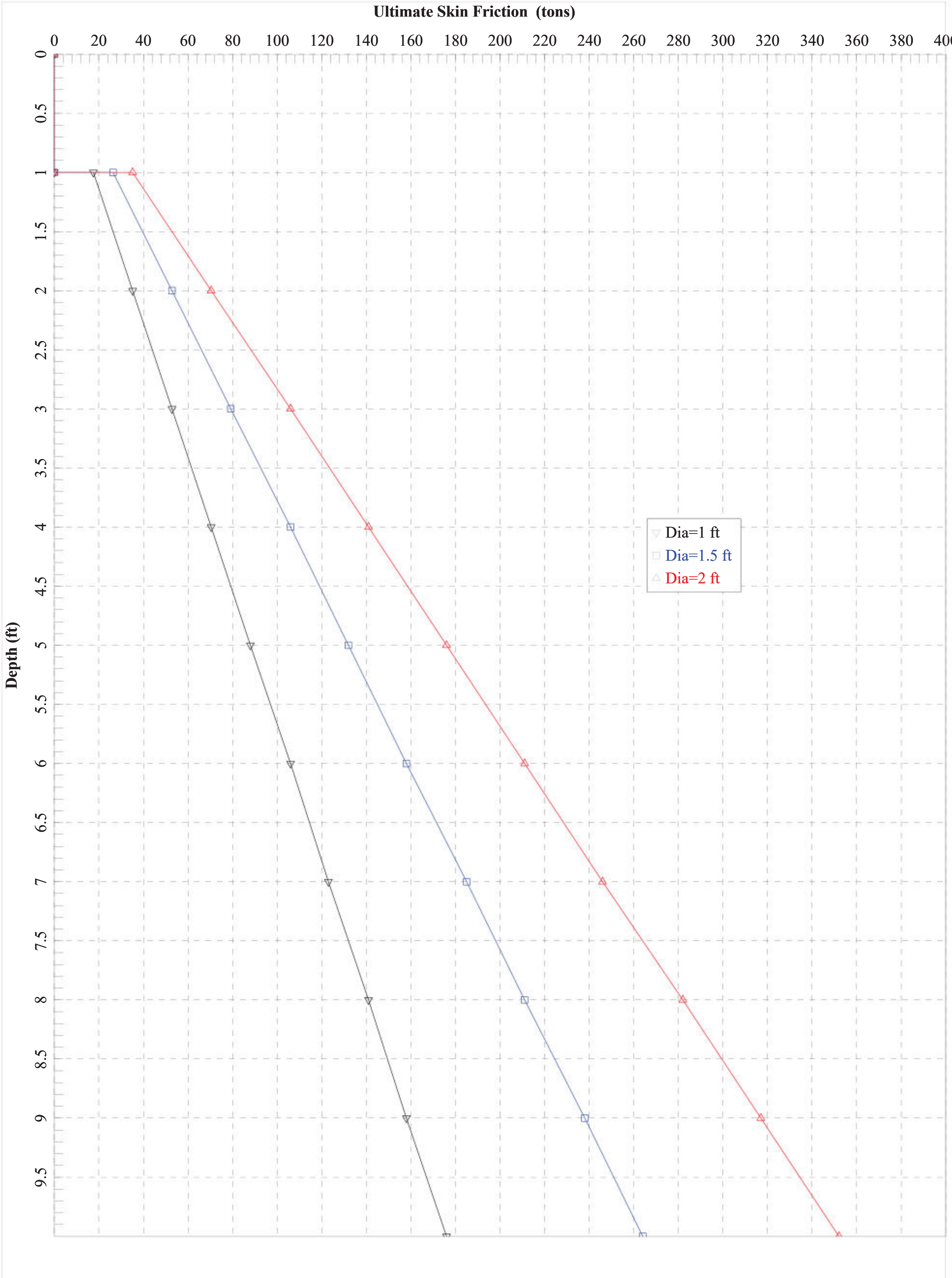
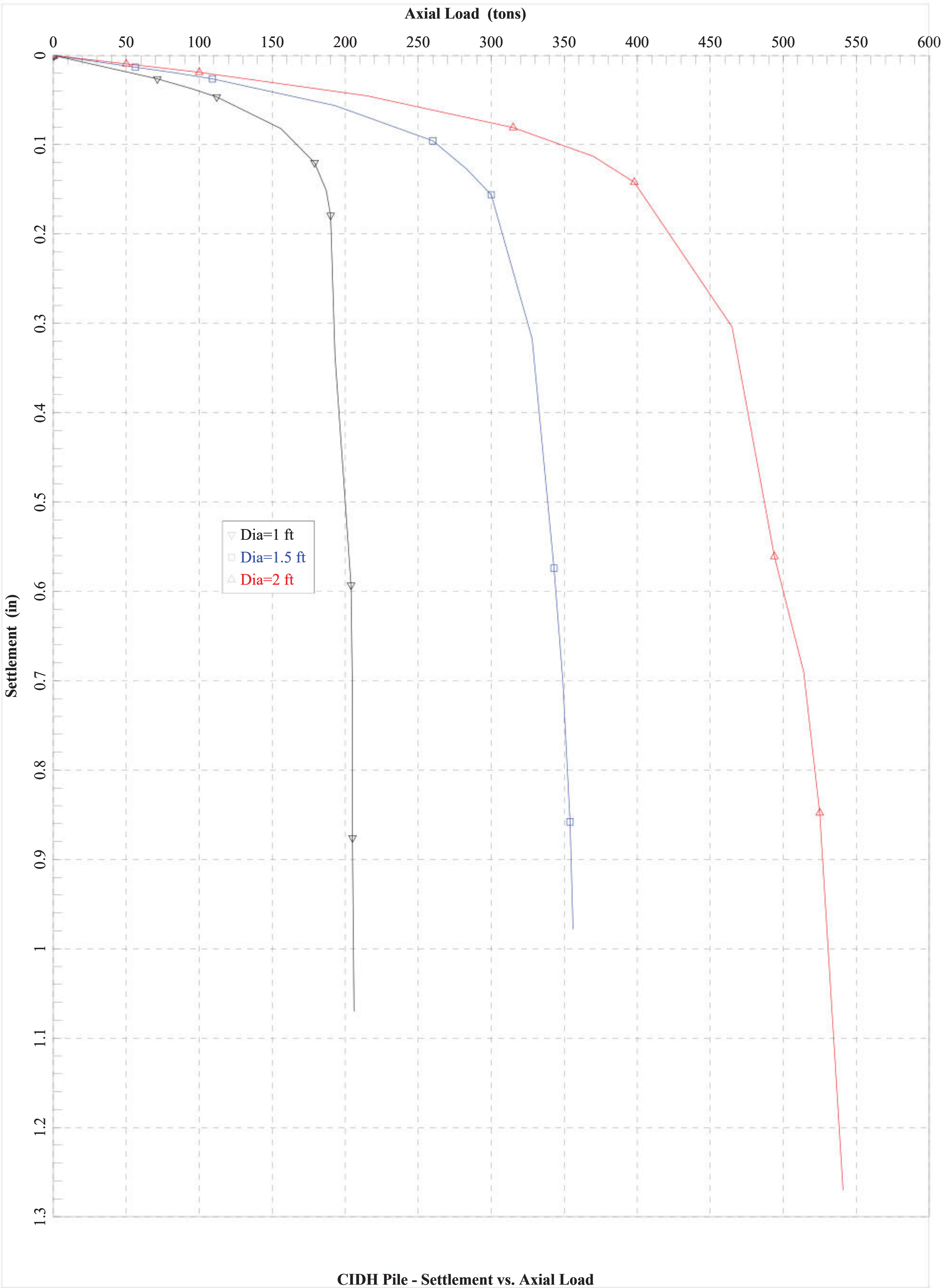
# APPENDIX C: PILE CAPACITY GRAPHS



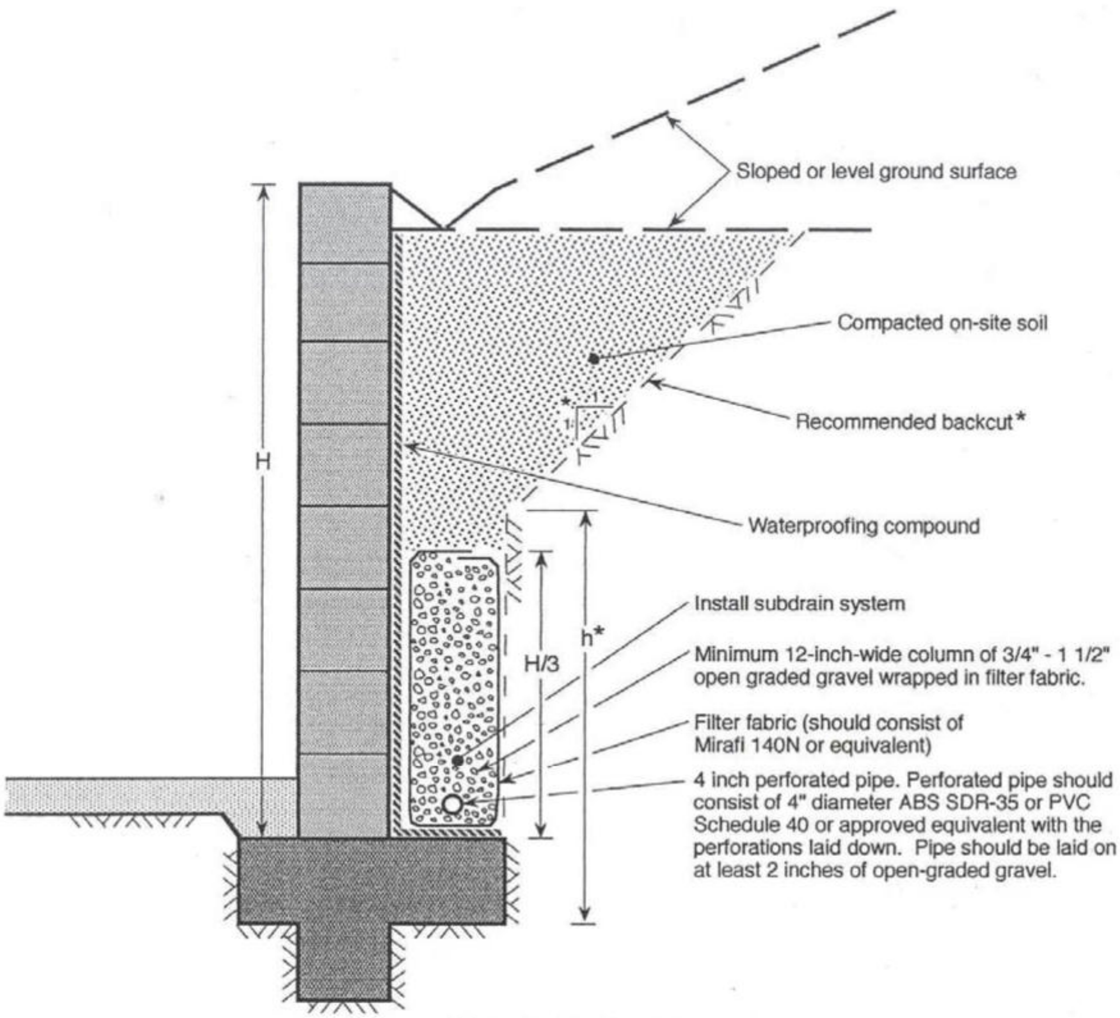
CIDH Pile - Ultimate Axial Compression Capacity




CIDH Pile - Settlement vs. Axial Load

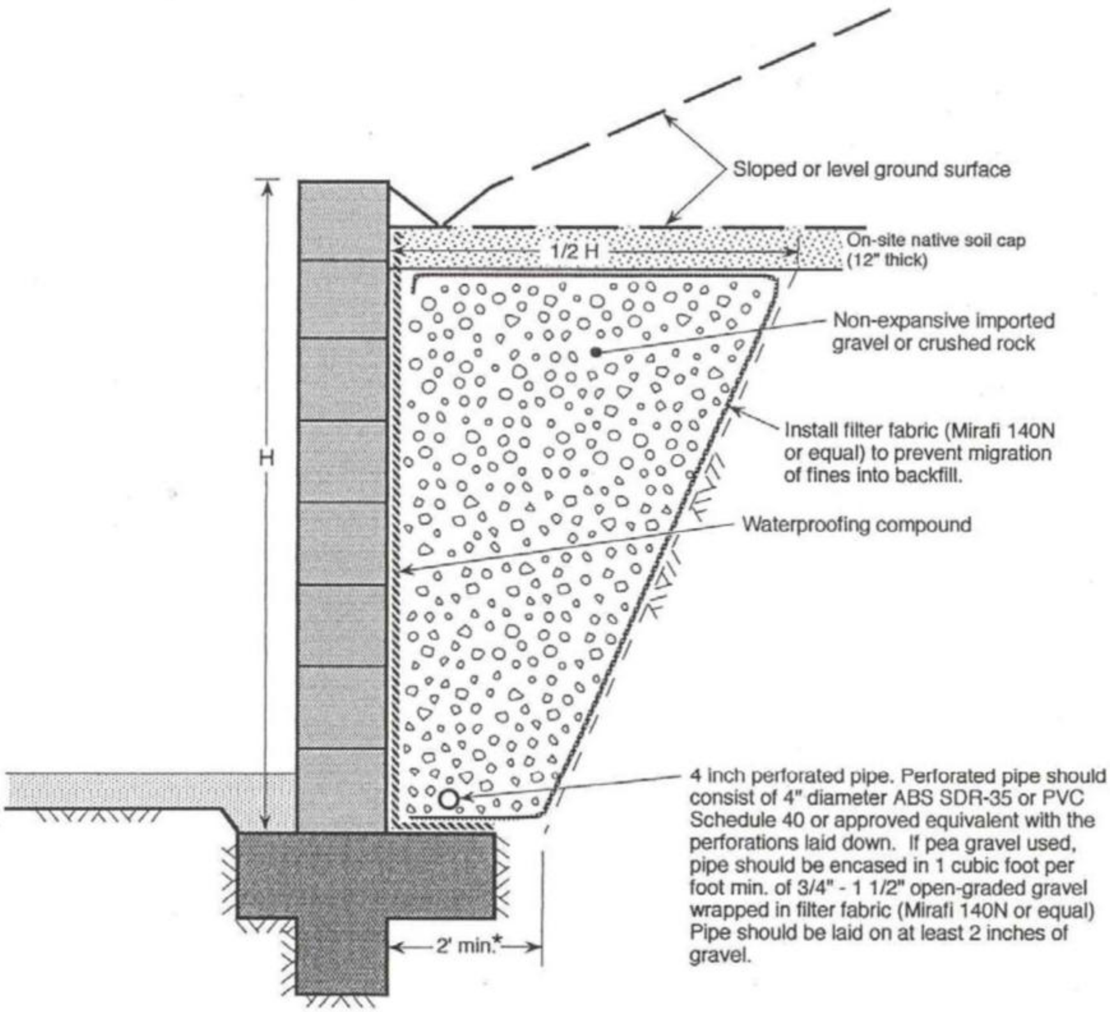
# APPENDIX D: TYPICAL RETAINING WALL BACKFILL DETAILS

## NATIVE SOIL BACKFILL



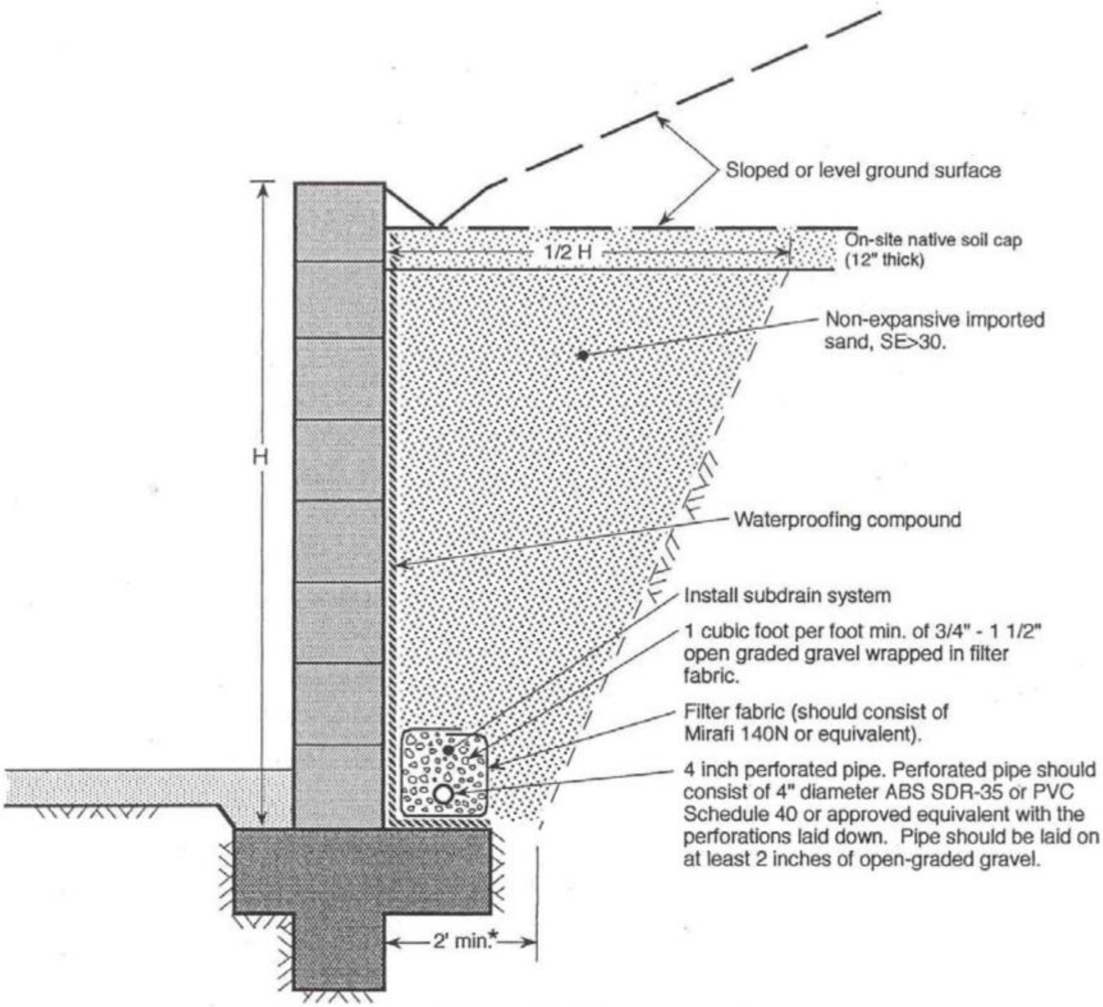

* Vertical height (h) and slope angle of backcut per soils report. Based on geologic conditions, configuration of backcut may require revisions (i.e. reduced vertical height, revised slope angle, etc.)

# IMPORTED GRAVEL OR CRUSHED ROCK BACKFILL




* At base of wall, the non-expansive backfill materials should extend to a min. distance of 2' or to a horizontal distance equal to the heel width of the footing, whichever is greater.

## IMPORTED SAND BACKFILL




* At base of wall, the non-expansive backfill materials should extend to a min. distance of 2' or to a horizontal distance equal to the heel width of the footing, whichever is greater.