DRAFT

FOUNDATION REPORT

Long Valley Creek Main Channel Bridge

Bridge No. 7C-81

Lassen County, California

Prepared by:

Crawford & Associates, Inc.

4220 Rocklin Road, Suite 1

Rocklin, CA 95677

June 2015

Prepared for:

Lassen County Department of Public Works

707 Nevada Street, Suite 4

Susanville, CA 96130

June 11, 2015
CAInc File No. 14-184.4

Dave Ernaga
Associate Engineer
Lassen County Public Works
707 Nevada Street, Suite 4
Susanville, CA 96130

Subject: **DRAFT FOUNDATION REPORT**
Long Valley Creek Main Channel Bridge on Hackstaff Road
Bridge No. 7C-81
Lassen County, California

Dear Mr. Ernaga,

Attached is our Draft Foundation Report for the 7C-81 Long Valley Creek Main Channel Bridge on Hackstaff Road. Crawford & Associates, Inc. (CAInc) completed this report in accordance with our agreement. This report contains the results of our subsurface exploration, conclusions and recommendations for design of new bridge foundations. We will submit the Final Foundation Report after receiving comments from the design team on this draft report.

Please call if you have questions or require additional information.

Sincerely,

Crawford & Associates, Inc.,

Rick D. Sowers, PE, CEG
Principal Engineering Geologist

Benjamin D. Crawford, PE, GE
Principal Geotechnical Engineer

CC: Mr. Bob Morrison, P.E., S.E.

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1 INTRODUCTION

1.1 Purpose

Crawford & Associates, Inc. (CAInc) prepared this Draft Foundation Report for the Long Valley Main Channel Creek Bridge Replacement (Bridge No. 7C-81) project located along Hackstaff Road in Lassen County, California. This report presents the results of our subsurface exploration and testing, and provides our conclusions and recommendations for design of new structure foundations. We will submit a Final Foundation Report including our responses to comments received from this draft.

1.2 Scope of Services

To prepare this report, CAInc:

- Reviewed preliminary bridge design plans and loads provided by Morrison Structures, Inc.
- Visited the site with Mr. Dave Ernaga on November 4, 2014.
- Reviewed geologic and seismic maps pertaining to the site.
- Reviewed previous borings logs by Converse Consultants dated .
- Drilled, logged, and sampled two test borings at the bridge abutments to a maximum depth 75.5 ft below ground surface (bgs) for foundation design.
- Drilled, logged and sampled two test boring along the approach roadway sections to depth 3 ft bgs for pavement design.
- Performed laboratory testing on soil samples recovered from the borings.
- Performed engineering analyses for structure foundations and roadway approaches.

2 PROJECT DESCRIPTION

2.1 Project Location

The project is located on Hackstaff Road, approximately 0.6 miles east of the town of Doyle. Site coordinates are approximately latitude 40.026334 and longitude -120.094791. Figure 1 shows the project location.

2.2 Site Description

The existing bridge is a 6-span, 120-foot long, 13.5-foot wide, structure consisting of a concrete deck on steel stringers supported on timber piles. The existing bridge deck is at approximate elev. 4181 ft and the channel bottom is about elev. 4168 ft (about 12 ft below the deck level). Long Valley Creek flows north at this location. At the time of our investigation (December 2014), creek flow depth was less than one foot depth and bridge approaches appeared to have recently undergone pavement improvements.

2.3 Proposed Project

Bridge 7C-81 will be located unparalleled to the existing bridge with the proposed west and east abutments located approximately 70 and 128 feet north (downstream), respectively, of their existing counterparts. We understand the new bridge will be a 169-foot long two span bridge. Discussion with Bob Morrison (Bridge Designer) indicated that the bridge will be precast I-girders (to avoid falsework within the channel) with cast-in-place deck. Pile cap elevations for Abutment 1, Bent 2, and Abutment 3 will be 4166.7 ft, 4159.2 ft, and 4165.4 ft, respectively.

The new roadway for the realignment will be designed by the county; however, to support project objectives, we collected bulk samples at each bridge approach to perform R-value testing for pavement design.

3 SITE GEOLOGY

The site is located along the edge of the Long Valley River and east of the Port of Sage Mountains. Published geologic mapping[1] shows the site underlain by Quaternary lake deposits and Quaternary Alluvium. The hills to the east and west are mapped as Permian metavolcanic rocks and Tertiary volcanic. We show the site geology on Figure 2.

Web soil survey shows this site surface to be mostly Bobert sandy loam along Long Valley Creek Main Channel and Mottsville gravelly loamy coarse sand to the east and west of the channel.

4 SUBSURFACE CONDITIONS

4.1 Exploration

CAInc retained Geo-Ex Subsurface Exploration (Geo-EX) to drill four test borings on Dec 7-8, 2014 to a maximum depth of 75.5 ft (elevation 4105.5 ft). Per Lassen County request, we located our test borings about 100 ft south of the proposed bridge alignment at the existing bridge to avoid right-of-entry issues. Geo-Ex used a truck mounted CME 55 drill rig equipped with an automatic hammer and auger/rotary wash capabilities. CAInc 's project engineer, Mr. Shawn Leyva, logged the test borings consistent with the Unified Soil Classification System (USCS) and the Caltrans 2010 Logging Manual. CAInc retained samples from the test borings and made ground water observations during drilling operations. The test borings were backfilled in accordance with Lassen County Environmental Health Department.

4.2 Soil Profile

Based on the data obtained from the test borings, we divide the soils into three general units. The uppermost unit, from ground surface to depth 8 ft in B-1 (west abutment, elev. 4173 elev. ft) and 3 ft at B-4 (east abutment, elev. 4178 ft), is primarily dense, silty sand with gravel and stiff, sandy silt.

The middle unit extends to depth 22 ft in B-1 (west abutment, to elev. 4159 ft) and depth 22 ft in B-4 (east abutment, to elev. 4159 ft). These materials are comprised of mostly soft, sandy silt and clayey silt with sand, intermixed with layers of medium dense silty sand.

The lowermost unit extends to the maximum depth explored (75.5 ft, elev. 4105.5 ft) and is comprised of dense to very dense, silty sand and poorly graded sand with silt.

Details of the soil profiles are shown on the Log of Test Borings drawing in Appendix A.

4.3 Groundwater

During our December 7, 2014 field investigation, we encountered groundwater in B-1 at 9.5 ft bgs (elevation 4171.5); which is consistent with the water level in the channel. Groundwater was not measured in Boring B-4 due to the use of rotary wash drilling method. In general, we expect the alluvial soils below groundwater levels to be saturated and yield significant water volume to open excavations.

[1] Strand, Rudolph G., *Geologic Atlas of California Map, Redding Sheet*, California Geological Survey, 1:250,000, 1962.

5 LABORATORY TESTING

CAInc completed the following laboratory tests on representative soil samples obtained from the exploratory borings:

- Moisture Content - Dry Density (ASTM D2216 / D2937)
- Particle Size Analysis (ASTM D422)
- Atterberg Limits (ASTM D4318)
- Triaxial U-U Shear Strength (ASTM D2850)
- Sulfate/Chloride Content (CTM 417/422)
- pH/Minimum Resistivity (CTM 643)
- R-value (CTM 301)

We present the laboratory test results in Appendix B.

6 SCOUR CONSIDERATIONS

We understand hydraulic analysis is still pending on this project, but it is unlikely scour will impact foundation performance since pile caps will be constructed below existing channel elevation and armored with rock slope protection (RSP). If it is determined that scour will impact foundation performance (i.e., design scour elevation is below the pile cap), our firm should be consulted so that we may revise our calculations.

7 CORROSION EVALUATION

Table 1 summarizes the results of soil corrosivity tests on a sample obtained from the borings for this study.

Table 1: Soil Corrosion Test Summary

Boring/Sample Number	Depth (ft)	Elevation (ft)	Minimum Resistivity (Ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
B1/1	15	4166	1210	7.33	31.5	46.4

According to Caltrans corrosion guidelines, a site is considered to be corrosive to foundation elements if one or more of the following conditions exist: Chloride concentration is greater than or equal to 500 ppm, sulfate concentration is greater than or equal to 2000 ppm, minimal resistivity of 1000 ohm-cm or less, or the pH is 5.5 or less. Per Caltrans corrosion guidelines, the site is not corrosive to structural elements.

These tests are only an indicator of soil corrosivity. The designer should consult with a corrosion engineer if these values are considered significant.

8 SEISMIC DATA

8.1 Ground Motion Study

CAInc used the Caltrans ARS Online (web-based) to calculate both deterministic and probabilistic acceleration response spectra for the site based on criteria provided in Appendix B of Caltrans' Seismic Design Criteria.

The deterministic spectrum is determined as the average of median response spectra calculated using ground motion prediction equations developed under the "Next Generation Attenuation" (NGA) project. These equations are applied to all faults considered active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater.

Based on Caltrans ARS Online (V2.3.06), and 2012 Fault Database, the nearest deterministic seismic source is the Honey Lake 2011 CFM.

Table 2: Fault Data

Fault Parameters	Honey Lake 2011 CFM
Fault Identification Number (FID)	50
Maximum Moment Magnitude (M_{max})	6.9
Site-to-Fault (R_{RUP}) Distance (km/mi)	0.492/0.305
Style of Faulting	Strike Slip
Fault Dip (degrees)	90
Dip Direction	Vertical

Based on our test boring data and correlations outlined in the Caltrans "Geotechnical Services Design Manual," we assign the site an average small strain shear wave velocity (V_S30) equal to 282 meters per second (Site Class D) for the upper 100 ft of the soil profile. Since the site is located less than 15.5 miles from the causative fault, we applied an adjustment factor for near-fault effects consistent with Caltrans procedures.

We used the above information to develop deterministic response spectra for the site and compared that to the Caltrans minimum deterministic response spectrum. Using the Caltrans ARS Online tool, we then compared the deterministic results with the probabilistic response spectrum based on data from the 2008 United States Geological Survey (USGS) National Seismic Hazard Map for a 5% in 50 year probability of exceedance (975 year return period).

We recommend a design spectrum based on both the USGS 5% in 50 years hazard (2008) probabilistic response spectra and the Honey Lake 2011 CFM across the period spectrum from 0 to 5 seconds. We assign the site a Maximum Moment Magnitude (M_{max}) of 6.9 with a Peak Ground Acceleration (PGA) of 0.49g. We present limited data points for site spectra in Table 3 and additional data points and the graphed site spectra on Figure 3.

Table 3: Caltrans ARS Online Envelope Spectrum Data

Period	SA	Period	SA	Period	SA
0.01	0.547	0.5	1.063	3	0.294
0.05	0.786	0.6	1.006	4	0.204
0.1	0.920	0.7	0.964	5	0.154
0.15	1.049	0.85	0.914		
0.2	1.152	1	0.867		
0.25	1.154	1.2	0.756		
0.3	1.157	1.5	0.627		
0.4	1.103	2	0.471		

8.2 Fault Rupture

The site does not lie within an Alquist–Priolo Earthquake Fault Zone and no known active faults are mapped within or through the project area. The closest fault considered in the ground motion analysis is the Honey Lake 2011 CFM system (Caltrans Fault Identification No. 50) located approximately 1500 feet northeast of the site. We show nearby faults on Figure 4.

Based on this mapping we consider the potential for fault rupture at the site to be low.

9 LIQUEFACTION POTENTIAL

9.1 Liquefaction

Liquefaction can occur when saturated, loose to medium dense, granular soils (generally within 50 ft of the surface), or specifically defined cohesive soils, are subjected to ground shaking. Based on the soil and ground water conditions encountered during our exploration and current industry accepted liquefaction evaluation methods, the potential for liquefaction exists. We calculate liquefaction induced settlement to be on the order of 1½ inches.

Liquefaction induced settlement can create downdrag (negative skin friction) on deep foundations when non-liquefiable soils exist above liquefied soils. Typically, a minimum of ½ to 1 inch of settlement is required to mobilize the downdrag forces; therefore, because settlement is sufficient to induce downdrag, pile capacities must be reduced to account for the reduced strength of liquefiable soil layers as well as downdrag loads imposed. We considered these conditions when developing theoretical pile capacities and tip elevations.

10 FOUNDATION RECOMMENDATIONS

Structure support can be achieved by either steel pipe piles or steel H-piles. Both options can be readily transported and spliced in the field. Based on discussions with Morrison Structures, Inc. and the County, Class 140 HP (10 x 57) piles are the preferred pile type and are recommended below.

Precast piles are not recommended due to the potentially difficult driving condition through coarse sand. Cast-in-drilled-hole (CIDH) piles are not desirable due to the loose, granular sediments and shallow groundwater that would require special installation measures, including casing, slurry drilling methods and the use of minimum 24-inch diameter piles for tremie concrete placement. Spread footings are not recommended due to the soft/loose near surface soils at the abutments.

10.1 Foundation Data and Loading

To evaluate H-piles foundations, CAInc used the following information provided by Lassen County and Morrison Structures, Inc.:

- Load & Resistance Factor Design (LRFD) Method.
- Class 140 H-Piles (HP 10 X 57) for the abutments and bent.
- Strength Limit State compression loads of 195 kips atAbutment 1, 200 kips at Bent 2 and 175 kips at Abutment 3.
- No tension demand on Abutments 1 and 3 and 46 kips tension demand on Bent 2.
- Pile cut-off at elevation 4166.7 ft at Abutment 1, 4159.2 at Bent 2 and 4165.4 at Abutment 3.
- Pile layouts for Abutments 1 and 3 and Bent 2 as shown on the September 17, 2014 plot (Revised March 19, 2015).
- Permissible settlement of 0.5-inch at Strength Limit State.

Morrison Structures, Inc. provided the foundation design and load information shown in Tables 4 and 5 below.

Table 4: Foundation Design Data

Support No.	Pile Type	Finished Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap Size (ft)		Permissible Settlement under Service Load (in)*	Number of Piles per Support
				B	L		
Abut 1	HP 10x57	4175.7	4166.7	38.2	7.0	0.5	8
Bent 2	HP 10x57	4166.6	4159.2	36.2	7.0	0.5	16
Abut 3	HP 10x57	4174.9	4165.4	38.2	8.0	0.5	9

Table 5: Foundation Factored Design Loads

Support No.	Service-I Limit State (kips)		Strength/Construction Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
			Compression		Tension		Compression		Tension	
	Total Load Per Support	Permanent Loads Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	692	526	1008	195	0	0	562	132	0	0
Bent 2	1611	979	3182	200	0	0	979	181	0	46
Abut 3	726	560	1051	175	0	0	560	123	0	0

10.2 Engineering Parameters

Table 6 and 7 below show the general soil parameters used in our analyses. We base these parameters on our material observations, laboratory testing, and empirical values. For this study we assume liquefiable soils do not contribute to pile capacity.

Table 6: Abutment 1 Soil Parameter Profile

Elevation (NVGD29)	Soil Type	Unit Weight Top/Bottom (psf)	Friction Angle Top/Bottom (degrees)	Cohesion Top/Bottom (psf)	Modulus, K (psf)	E50 Top/Bottom
4166.7' to 4159	Clay	58/62.6	---	500/603	---	0.016
4159' to 4137'	Sand	57.6/72	34/37	---	40	---
4137’ to 4092	Sand	65/70	36/37	---	50	---

Table 7: Bent 2 Soil Parameter Profile

Elevation (NVGD29)	Soil Type	Unit Weight Top/Bottom (psf)	Friction Angle Top/Bottom (degrees)	Cohesion Top/Bottom (psf)	Modulus, K (psf)	E50
4159.2' to 4154'	Liquefiable Sand	55	---	---	---	---
4154' to 4139'	Sand	57.6/72	34/37	---	40	---
4139' to 4084'	Sand	65/70	36/37	---	50	---

Table 8: Abutment 3 Soil Parameter Profile

Elevation (NVGD29)	Soil Type	Unit Weight Top/Bottom (psf)	Friction Angle Top/Bottom (degrees)	Cohesion (psf)	Modulus, K Top/Bottom (psf)	E50 Top/Bottom
4165.4' to 4159	Clay	55.5	---	670	---	0.019
4159' to 4151'	Liquefiable Sand	55	---	---	---	---
4151' to 4149	Sand	63.4	31	---	16	---
4149' to 4115'	Sand	60/65	34/37	---	45/50	---

10.3 Pile Analyses

10.3.1 Compressive Resistance

CAInc determined compressive resistance for the Class 140 steel H-piles using A-Pile computer program developed by Ensoft, Inc. We applied a Strength Limit reduction factor of 0.7 to the soil profile. We then calculated the pile length needed to support the factored compression requirement of each abutment and bent. We include static pile results in Appendix C.

10.4.2 Tension/Uplift Resistance

We analyzed the 10 X 57 H-Pile for tension and uplift. Based on Caltrans procedures and the tension loading provided by Morrison Structures, Inc. we anticipate the piles will provide adequate resistance to accommodate the tension and uplift demands.

10.4.3 Settlement

Settlement was calculated to be within the permissible 0.5-inch settlement specified for the structure foundations driven at or below the specified tip elevations. We do not anticipate significant long-term settlement at this site.

10.4.4 Lateral Load Analysis

We used LPILE Plus Version 2013.7.07 software to evaluate lateral pile capacity. CAInc determined the allowable lateral pile design loads that would produce pile head deflections of approximately 1.53 inch, 1.40 inch, and 1.26 inch pile head deflection at Abutment 1, Bent 2 and Abutment 3, respectively, along with ¼-inch displacement for each abutment and the bent. All lateral displacement was analyzed using a pinned (free-head) condition top-of-pile deflection.

At Abutment 1 and Abutment 3 we used a p-multiplier of 1 in the longitudinal and transverse direction with spacing of 4.8 to 14 times the pile diameter (center-to-center spacing).

At Bent 2 we used a p-multiplier of 0.82 in the longitudinal direction with spacing of 5.7 times the pile diameter and a p-multiplier of 1.0 in the transverse direction with spacing 4.8 times the pile diameter.

For our analysis, we applied a minimum axial compression of 140 kips to the top of the pile. We show our lateral pile analysis results for the strong and weak axes direction in Tables 9 and 10 respectively. Lpile output graphs are presented in Appendix D.

Table 9: Lateral Pile Capacity
(H-Pile Strong Axis)

Support	Top-of-Pile Deflection (inches)	Lateral Resistance (kips)
Abutment 1	0.25	21
	1.53	48
Bent 2	0.25	5
	1.4	18.8
Abutment 3	0.25	34
	1.26	36

Refer to the LPILE output graphs in Appendix D for additional details.

Table 10: Lateral Pile Capacity
(H-Pile Weak Axis)

Support	Top-of-Pile Deflection (inches)	Lateral Resistance (kips)
Abutment 1	0.25	16
	1.53	32
Bent 2	0.25	3
	1.4	11
Abutment 3	0.25	27
	1.26	30

Refer to the LPILE output graphs in Appendix D for additional details.

10.4 Pile Data Table

CAInc evaluated abutment foundations using current Caltrans Bridge Design Specifications for foundations using Load & Resistance Factor Design method. Table 8 presents our pile data table.

Table 8: Pile Data Table

Support No.	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (ft.)[1]	Specified Tip Elevation (ft.)
		Compression	Tension		
Abut 1	Class 140 HP 10 X 57	195	0	(a) 4122 (b) 4131	(a) 4122
Bent 2	Class 140 HP 10 X 57	200	46	(a) 4118 (b) 4129 (c) 4119	(a) 4118
Abut 3	Class 140 HP 10 X 57	175	0	(a) 4126 (b) 4137.4	(a) 4126

[1]Design tip elevations for Abutments are controlled by (a) Compression, (b) Lateral Load (c) Tension Load

11 LATERAL EARTH PRESSURES

We assume that the approach fill material abutment and wing-wall backfill will meet the requirements of Caltrans standard for Structure Backfill. To determine equivalent fluid weights (EFWs), we used Caltrans specified structural backfill with a soil unit weight of approximately 125 pcf, a minimum angle of internal friction equal to 34 degrees, and an assumed drained condition material behind the walls. Table 11 shows the recommended EFWs for design of abutment walls and wing walls.

Table 11: Equivalent Fluid Weights

Condition	Static EFW (pcf)	Seismic EFW (pcf)
Active	36	42
At-Rest	56	66
Passive	211	205

We estimate the EFWs for seismic loading using the Mononabe-Okabe equation for active and passive lateral coefficients Ka and Kp. We estimate the at-rest coefficient, Ko, for the seismic condition using an increase ratio similar to the active condition. We use a horizontal acceleration of 0.24g (approximately 50% of the peak site acceleration of 0.49g) in the Mononabe-Okabe equation.

Apply the resultant of the seismic active and at-rest pressures at a depth 0.5H from the base of the wall, where H equals the wall height. For surcharge loads, apply an additional uniform lateral load behind the wall equivalent to 0.30 times the surcharge pressure. Use a coefficient of friction of 0.48 to resist sliding for concrete placed on compacted fill.

As noted in the Caltrans Seismic Design Criteria (SDC), the maximum passive pressure is 5.0 ksf, which must be used with the proportionality factor presented in Section 7.8.1 of the SDC. Assuming that backfill at the abutments meets Caltrans criteria for structure backfill, SDC Section 7.8 criteria for initial abutment soil stiffness (20 kips/inch/ft) should be applicable.

12 APPROACH ROADWAY SUBGRADE AND EMBANKMENT

We completed two R-value tests (CTM 301) on bulk samples from each bridge approach consisting of silty sand with gravel. Test results indicate R-values of 69 and 70 by stabilometer. Assuming new roadway fill will be local borrow similar to the on-site soils, we consider a basement R-value of 50 to be appropriate for design (consistent with Class-2 aggregate subbase). Using an R-value of 50 and Chapter 600 of the Caltrans Highway Design Manual (CHDM), 5th Edition, we recommend the pavement sections in Table 12 for design of the approach roadway pavement.

Table 12: Preliminary Pavement Sections

Traffic Index	Material Type/Depth Required	
	Hot Mix Asphalt (HMA) (ft)	Aggregate Base (ft)
11.0	0.55	0.75
10.0	0.50	0.65
9.0	0.45	0.55
8.0	0.4	0.45
7.0	0.3	0.45

Appropriate traffic indixes (TI's) should be determined by the Design Engineer.

13 CONSTRUCTION CONSIDERATIONS

13.1 Earthwork

Perform earthwork and grading operations in accordance with Section 19 of Caltrans Standard Specifications.

13.2 H-Piles

Piles shall conform to Section 49-1 of the Caltrans Standard Specifications. Verify pile capacity during final driving using energy equations in accordance with Caltrans Standard Specification 49-1.08 (Modified Gates Formula).

Jetting or vibratory hammers should not be used to obtain the specified pile penetration. H-piles can sometimes "walk" out of plane along their weak axis during difficult driving conditions. The contractor should take care not to overdrive the piles. Although H-piles are not considered "displacement" piles, they will densify adjacent soil structure during driving. Drive piles within the interior footprint of the pile configuration first to reduce the potential for pile refusal during installation of subsequent piles.

13.3 Shoring

The contractor is responsible for design and construction of excavation sloping and shoring in accordance with CalOSHA Standards, and to protect existing structures, utilities and other facilities during construction.

13.4 Excavation Dewatering

Excavations extending below the creek water level will require dewatering and/or diking/diversion methods to construct pile caps in the "dry."

14 RISK MANAGEMENT

Our experience and that of our profession clearly indicates that the risks of costly design, construction, and maintenance problems can be significantly lowered by retaining the geotechnical engineer of record to provide additional services. For this project, CAInc should be retained to:

- Review and provide written comments on the (civil, structural) plans and specifications prior to construction.
- Monitor construction to check and document our report assumptions. At a minimum, CAInc should observe pile installation.
- Update this report if design changes occur, 2 years lapse between this report and construction, or site conditions change.

If CAInc is not retained to perform the above applicable services, we are not responsible for any other parties' interpretation of our report, and subsequent addendums, letters, and discussions.

15 LIMITATIONS

CAInc performed these services in accordance with generally accepted geotechnical engineering principles and practices currently used in this area. This report is based on the current site and project conditions and should be used only for the design and construction of the Long Valley Creek Bridge Replacement on Hackstaff Road over Long Valley Creek Main Channel (Bridge 7C-81) project. We agreed with the County to perform our soil explorations within the current road bridge alignment about 100 ft south of the new bridge alignment. We assume soil and ground water conditions in our borings are representative of the subsurface conditions within the construction area; however, subsurface conditions can vary. Accordingly, we recommend additional exploration during construction if site conditions vary from those described herein.

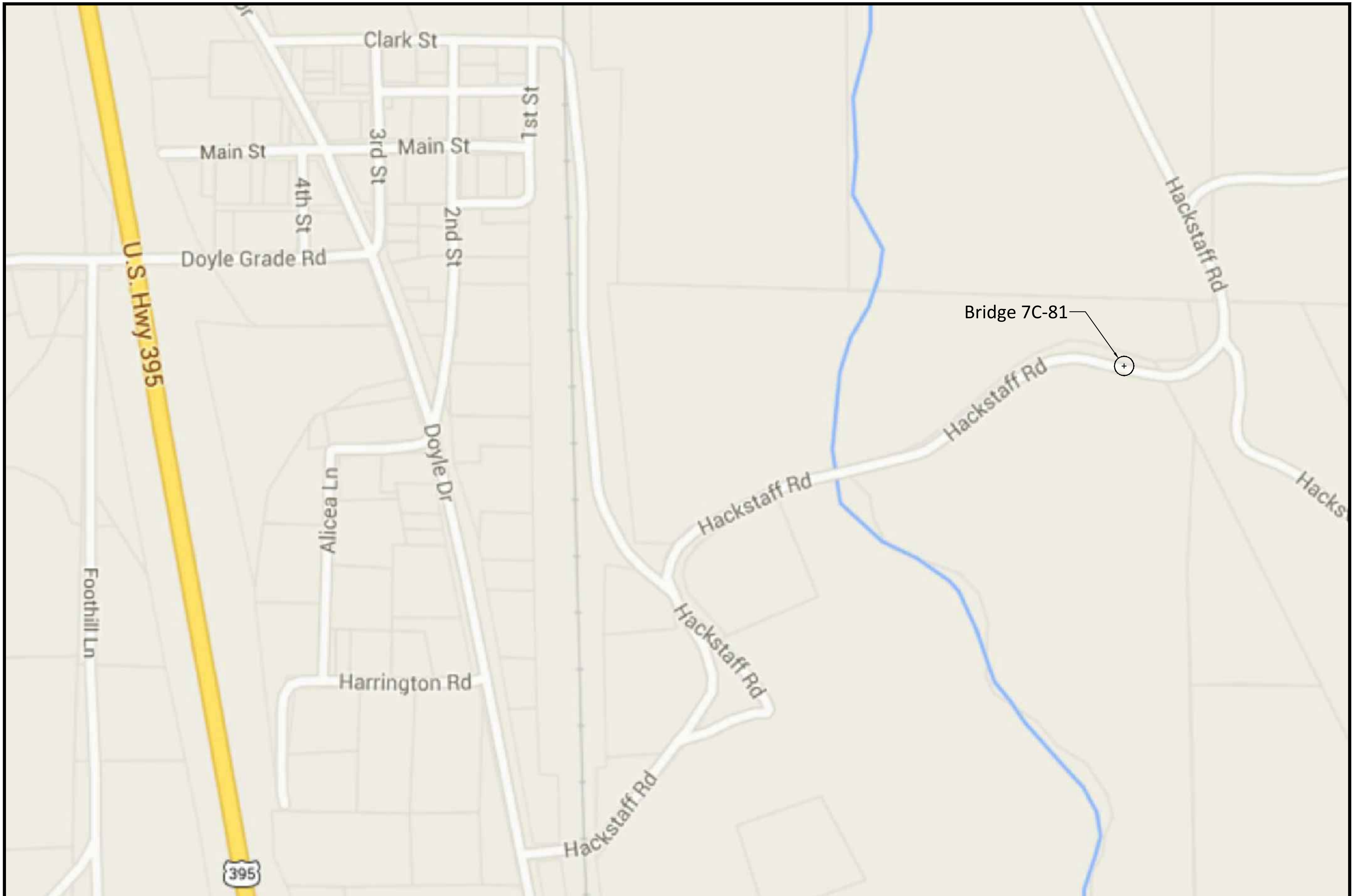
Modern design and construction is complex and it is common to experience changes and delays. The owner should set aside a reasonable contingency fund based on complexities and cost estimates to cover changes and delays.

The interface shown between soil materials on the logs is approximate. The transition between materials may be abrupt or gradual. We base our recommendations on the final logs, which represent our interpretation of the field logs and general knowledge of the site and geological conditions.

DRAFT FOUNDATION REPORT

Long Valley Creek Main Channel Bridge on Hackstaff Road
Bridge No. 7C-81
Lassen County, California

Figures
Figure 1: Vicinity Map
Figure 2: Geologic Map
Figure 3: Design ARS Curve
Figure 4: Fault Map



Project Mgr.	AJK	5/11/15
Project Eng.	SML	5/11/15
Designer		
Checked By		
Drawn By	SJC	5/11/15
	By	Date

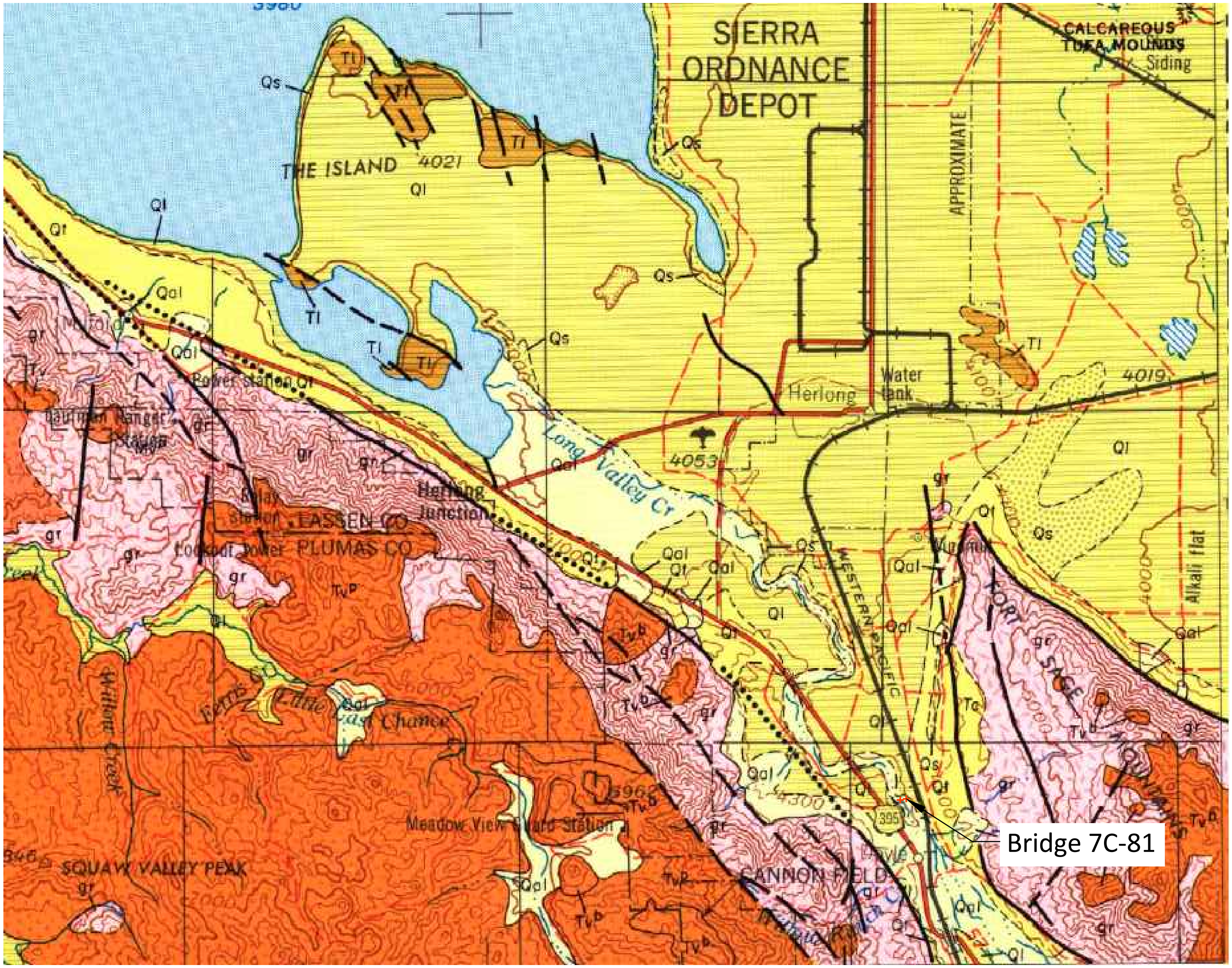
Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Long Valley Creek Main Channel Bridge on Hackstaff Road

Lassen County, CA

Figure 1
Vicinity Map

Project No.	14-184.4
Scale	NTS
Date	5/11/15



LEGEND

Qal	Alluvium	Qt	Quaternary nonmarine terrace deposits	Ql	Quaternary lake deposits

Project Mgr.	AJK	5/11/15
Project Eng.	SML	5/11/15
Designer		
Checked By		
Drawn By	SJC	5/11/15
	By	Date

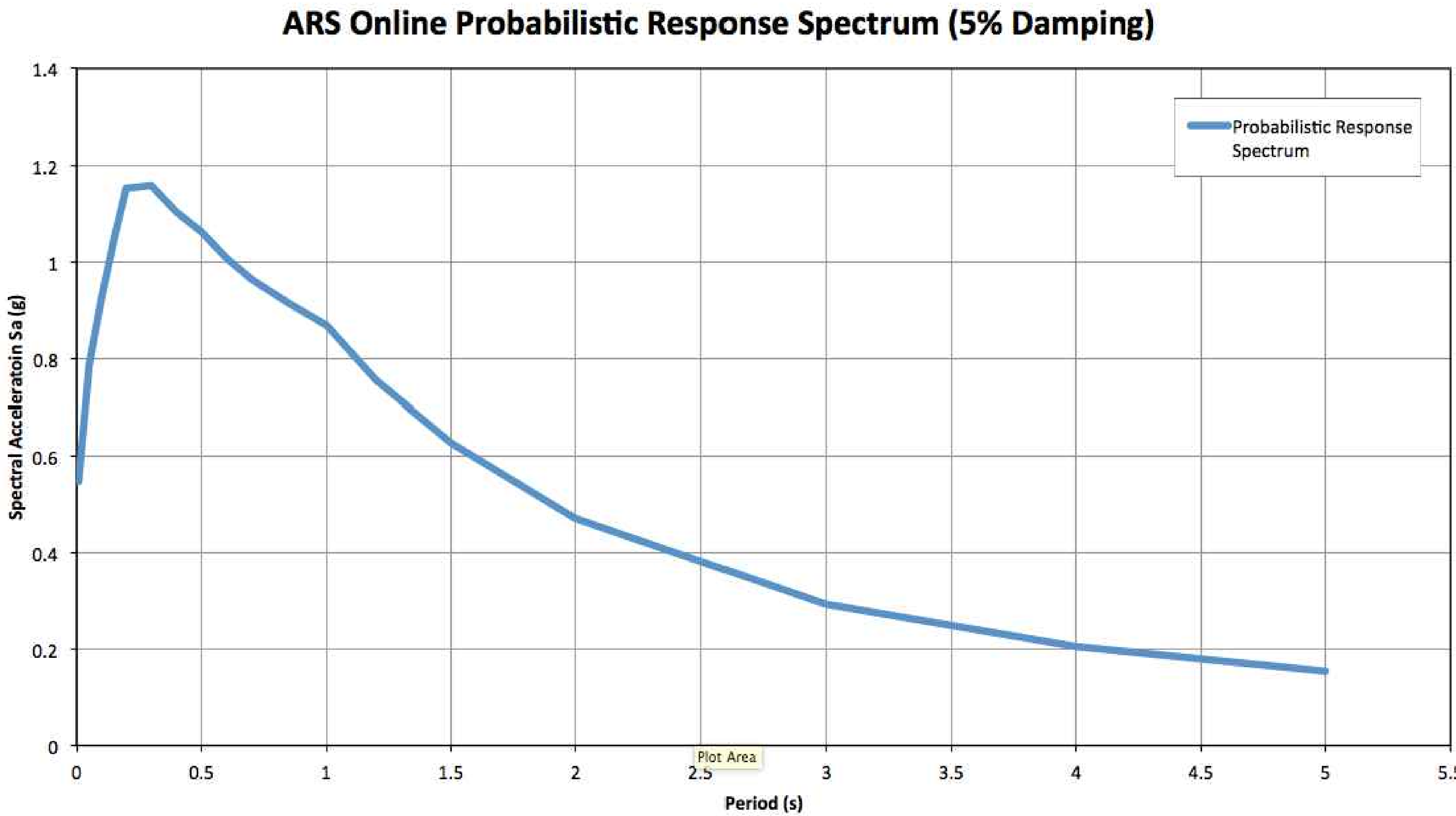
Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Long Valley Creek Main Channel Bridge on Hackstaff Road

Lassen County, CA

Figure 2
Geologic Map

Project No.	14-184.4
Scale	NTS
Date	5/11/15



Project Mgr.	AJK	5/11/15
Project Eng.	SML	5/11/15
Designer		
Checked By		
Drawn By	SJC	5/11/15
	By	Date

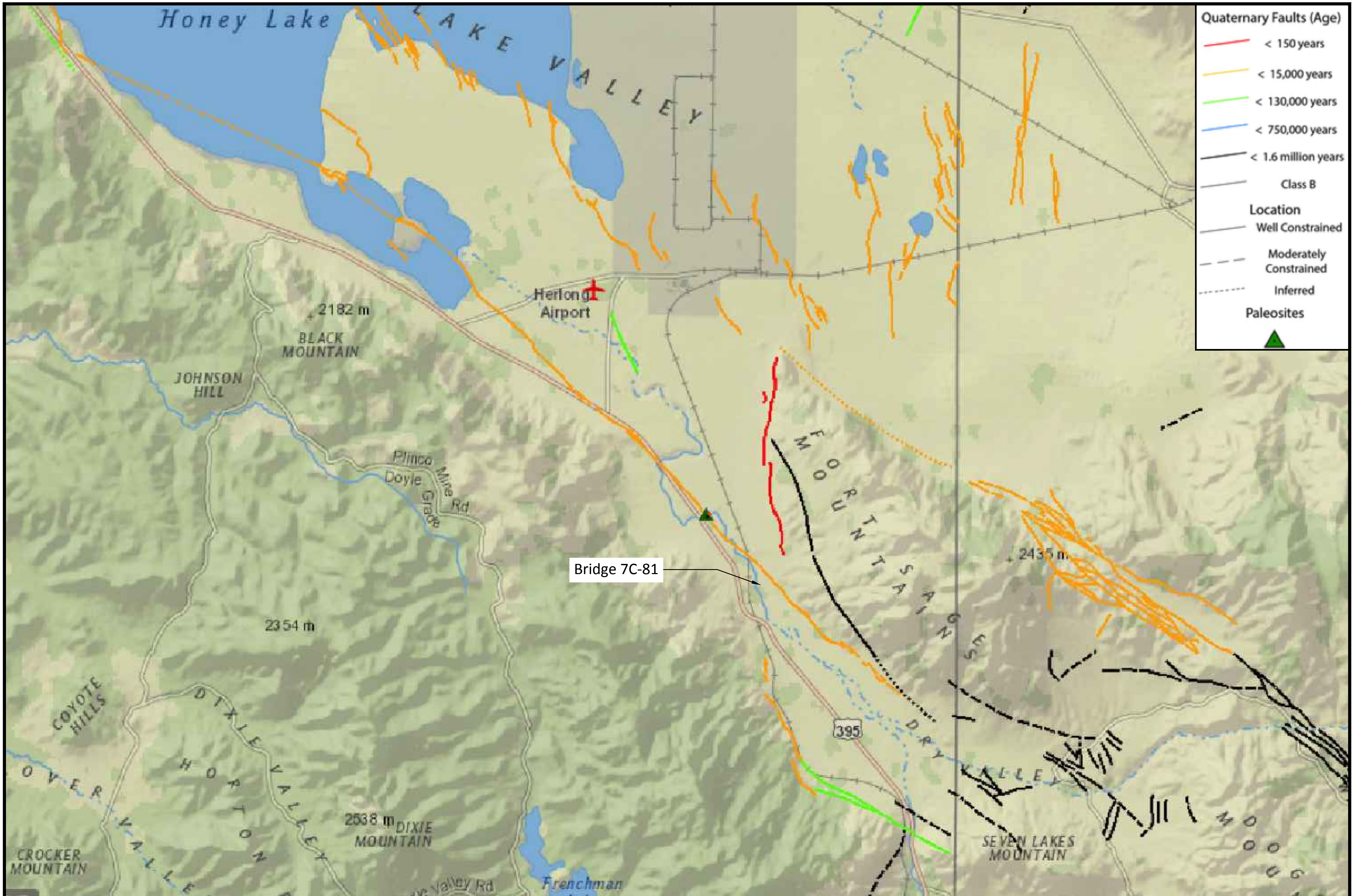
Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Long Valley Creek Main Channel Bridge on Hackstaff Road

Lassen County, CA

Figure 3
Design ARS Curve

Project No.	14-184.4
Scale	NTS
Date	5/11/15



Project Mgr.	AJK	5/11/15
Project Eng.	SML	5/11/15
Designer		
Checked By		
Drawn By	SJC	5/11/15
	By	Date

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Long Valley Creek Main Channel Bridge on Hackstaff Road

Lassen County, CA

Figure 4
Fault Map

Project No.	14-184.4
Scale	NTS
Date	5/11/15

DRAFT FOUNDATION REPORT

Long Valley Creek Main Channel Bridge on Hackstaff Road

Bridge No. 7C-81

Lassen County, California

Appendix A

Log of Test Borings

DIST	COUNTY	ROUTE	TOTAL PROJECT	SHEET NO	TOTAL SHEETS
2	LASSEN				

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER BENJAMIN D. CRAWFORD No. 68457 EXP. 9-30-15 CIVIL STATE OF CALIFORNIA

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CEMENTATION

DESCRIPTION	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.

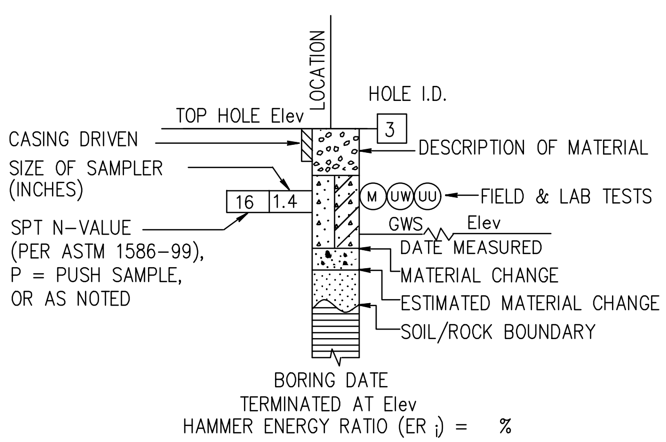
BOREHOLE IDENTIFICATION

SYMBOL	HOLE TYPE	DESCRIPTION
Size	A	AUGER BORING (HOLLOW OR SOLID STEM BUCKET)
Size	R RW RC P	ROTARY DRILLED BORING (CONVENTIONAL) ROTARY DRILLED WITH SELF–CASING WIRE–LINE ROTARY CORE WITH CONTINUOUSLY–SAMPLED, SELF–CASING WIRE–LINE ROTARY PERCUSSION BORING (AIR)
Size	R	ROTARY DRILLED DIAMOND CORE
Size	HD HA	HAND DRIVEN (1–INCH SOIL TUBE) HAND AUGER
●	D	DYNAMIC CONE PENETRATION BORING
▲	CPT	CONE PENETRATION TEST (ASTM D 5778)
□	O	OTHER (NOTE ON LOTB)

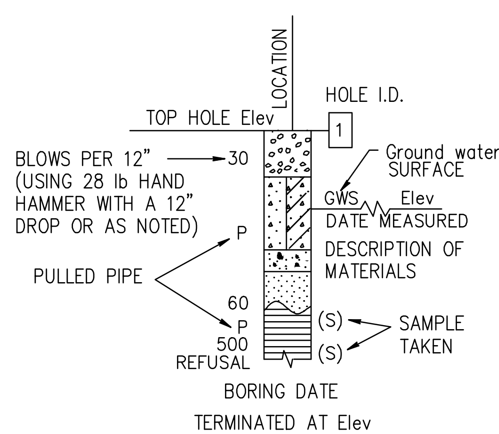
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

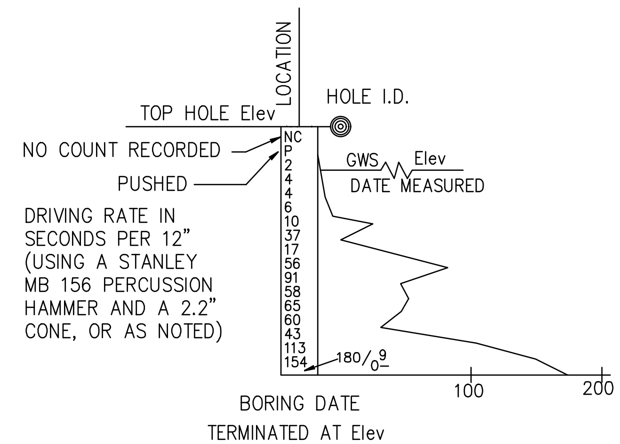
DESCRIPTION	SHEAR STRENGTH (tsf)	POCKET PENETROMETER MEASUREMENT, PP, (tsf)	TORVANE MEASUREMENT, TV, (tsf)	VANE SHEAR MEASUREMENT, VS, (tsf)
VERY SOFT	LESS THAN 0.12	LESS THAN 0.25	LESS THAN 0.12	LESS THAN 0.12
SOFT	0.12 – 0.25	0.25 – 0.5	0.12 – 0.25	0.12 – 0.25
MEDIUM STIFF	0.25 – 0.5	0.5 – 1	0.25 – 0.5	0.25 – 0.5
STIFF	0.5 – 1	1 – 2	0.5 – 1	0.5 – 1
VERY STIFF	1 – 2	2 – 4	1 – 2	1 – 2
HARD	GREATER THAN 2	GREATER THAN 4	GREATER THAN 2	GREATER THAN 2



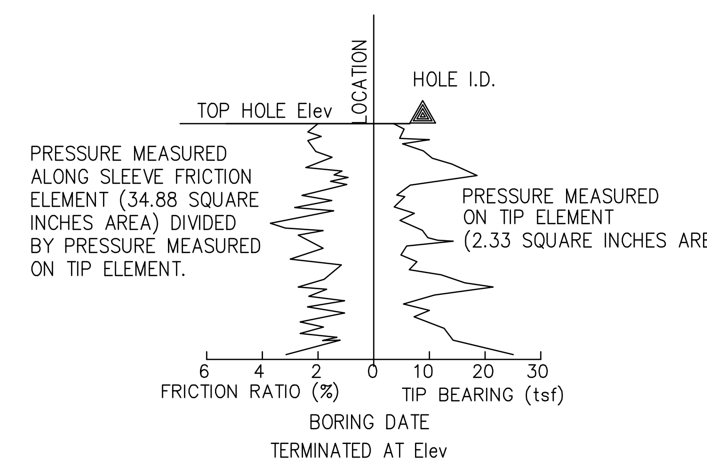
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

LEGEND – SOIL (SHEET 1 OF 2)

NO SCALE

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

ENGINEERING SERVICES		GEOTECHNICAL SERVICES		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH	BRIDGE NO. 7C-81	HACKSTAFF ROAD BRIDGE 7C-81
FUNCTIONAL SUPERVISOR NAME: Benjamin D. Crawford	DRAWN BY: SJC CHECKED BY: AJK	FIELD INVESTIGATION BY: Shawn M. Leyva				POST MILE	DRAFT LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU XXXXX
EA XXXXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

DIST	COUNTY	ROUTE	TOTAL PROJECT	SHEET NO	TOTAL SHEETS
2	LASSEN				

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER
BENJAMIN D. CRAWFORD
No. 68457
EXP. 9-30-15
CIVIL
STATE OF CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

LEGEND – SOIL (SHEET 2 OF 2)

NO SCALE

GROUP SYMBOLS AND NAMES

GRAPHIC/SYMBOL	GROUP NAMES
GW	WELL-GRADED GRAVEL WELL-GRADED GRAVEL WITH SAND
GP	POORLY-GRADED GRAVEL POORLY-GRADED GRAVEL WITH SAND
GW-GM	WELL-GRADED GRAVEL WITH SILT WELL-GRADED GRAVEL WITH SILT AND SAND
GW-GC	WELL-GRADED GRAVEL WITH CLAY (OR SILTY CLAY) WELL-GRADED GRAVEL WITH CLAY AND SAND (OR SILTY CLAY AND SAND)
GP-GM	POORLY-GRADED GRAVEL WITH SILT POORLY-GRADED GRAVEL WITH SILT AND SAND
GP-GC	POORLY-GRADED GRAVEL WITH CLAY (OR SILTY CLAY) POORLY-GRADED GRAVEL WITH CLAY AND SAND (OR SILTY CLAY AND SAND)
GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL WITH SAND
SW	WELL-GRADED SAND WELL-GRADED SAND WITH GRAVEL
SP	POORLY-GRADED SAND POORLY-GRADED SAND WITH GRAVEL
SW-SM	WELL-GRADED SAND WITH SILT WELL-GRADED SAND WITH SILT AND GRAVEL
SW-SC	WELL-GRADED SAND WITH CLAY (OR SILTY CLAY) WELL-GRADED SAND WITH CLAY AND GRAVEL (OR SILTY CLAY AND GRAVEL)
SP-SM	POORLY-GRADED SAND WITH SILT POORLY-GRADED SAND WITH SILT AND GRAVEL
SP-SC	POORLY-GRADED SAND WITH CLAY (OR SILTY CLAY) POORLY-GRADED SAND WITH CLAY AND GRAVEL (OR SILTY CLAY AND GRAVEL)
SM	SILTY SAND SILTY SAND WITH GRAVEL
SC	CLAYEY SAND CLAYEY SAND WITH GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND WITH GRAVEL
PT	PEAT
	COBBLES COBBLES AND BOULDERS BOULDERS

GRAPHIC/SYMBOL	GROUP NAMES
CL	LEAN CLAY LEAN CLAY WITH SAND LEAN CLAY WITH GRAVEL SANDY LEAN CLAY SANDY LEAN CLAY WITH GRAVEL GRAVELLY LEAN CLAY GRAVELLY LEAN CLAY WITH SAND
CL-ML	SILTY CLAY SILTY CLAY WITH SAND SILTY CLAY WITH GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY WITH GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY WITH SAND
ML	SILT SILT WITH SAND SILT WITH GRAVEL SANDY SILT SANDY SILT WITH GRAVEL GRAVELLY SILT GRAVELLY SILT WITH SAND
OL	ORGANIC LEAN CLAY ORGANIC LEAN CLAY WITH SAND ORGANIC LEAN CLAY WITH GRAVEL SANDY ORGANIC LEAN CLAY SANDY ORGANIC LEAN CLAY WITH GRAVEL GRAVELLY ORGANIC LEAN CLAY GRAVELLY ORGANIC LEAN CLAY WITH SAND
OL	ORGANIC SILT ORGANIC SILT WITH SAND ORGANIC SILT WITH GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT WITH GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT WITH SAND
CH	FAT CLAY FAT CLAY WITH SAND FAT CLAY WITH GRAVEL SANDY FAT CLAY SANDY FAT CLAY WITH GRAVEL GRAVELLY FAT CLAY GRAVELLY FAT CLAY WITH SAND
MH	ELASTIC SILT ELASTIC SILT WITH SAND ELASTIC SILT WITH GRAVEL SANDY ELASTIC SILT SANDY ELASTIC SILT WITH GRAVEL GRAVELLY ELASTIC SILT GRAVELLY ELASTIC SILT WITH SAND
OH	ORGANIC FAT CLAY ORGANIC FAT CLAY WITH SAND ORGANIC FAT CLAY WITH GRAVEL SANDY ORGANIC FAT CLAY SANDY ORGANIC FAT CLAY WITH GRAVEL GRAVELLY ORGANIC FAT CLAY GRAVELLY ORGANIC FAT CLAY WITH SAND
OH	ORGANIC ELASTIC SILT ORGANIC ELASTIC SILT WITH SAND ORGANIC ELASTIC SILT WITH GRAVEL SANDY ORGANIC ELASTIC SILT SANDY ORGANIC ELASTIC SILT WITH GRAVEL GRAVELLY ORGANIC ELASTIC SILT GRAVELLY ORGANIC ELASTIC SILT WITH SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL WITH SAND ORGANIC SOIL WITH GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL WITH GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL WITH SAND

FIELD AND LABORATORY TESTING

- (C) CONSOLIDATION (ASTM D 2435)
- (CL) COLLAPSE POTENTIAL (ASTM D 5333)
- (CP) COMPACTION CURVE (CTM 216)
- (CR) CORROSIVITY TESTING (CTM 643, CTM 422, CTM 417)
- (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) PERMEABILITY (CTM 220)
- (PA) PARTICLE SIZE ANALYSIS (ASTM D 422)
- (PI) PLASTICITY INDEX (AASHTO T 90) LIQUID LIMIT (AASHTO T 89)
- (PL) POINT LOAD INDEX (ASTM D 5731)
- (PM) PRESSURE METER
- (R) R-VALUE (CTM 301)
- (SE) SAND EQUIVALENT (CTM 217)
- (SG) SPECIFIC GRAVITY (AASHTO T 100)
- (SL) SHRINKAGE LIMIT (ASTM D 427)
- (SW) SWELL POTENTIAL (ASTM D 4546)
- (UC) UNCONFINED COMPRESSION-SOIL (ASTM D 2166) UNCONFINED COMPRESSION-ROCK (ASTM D 2938)
- (UU) UNCONSOLIDATED UNDRAINED TRIAXIAL (ASTM D 2850)
- (UW) UNIT WEIGHT (ASTM D 4767)

APPARENT DENSITY OF COHESIONLESS SOILS

DESCRIPTION	SPT N_{60} (BLOWS / 12 INCHES)
VERY LOOSE	0 – 5
LOOSE	5 – 10
MEDIUM DENSE	10 – 30
DENSE	30 – 50
VERY DENSE	GREATER THAN 50

MOISTURE

DESCRIPTION	CRITERIA
DRY	NO DISCERNABLE MOISTURE
MOIST	MOISTURE PRESENT, BUT NO FREE WATER
WET	VISIBLE FREE WATER

PERCENT OR PROPORTION OF SOILS

DESCRIPTION	CRITERIA
TRACE	PARTICLES ARE PRESENT BUT ESTIMATED TO BE LESS THAN 5%
FEW	5% – 10%
LITTLE	15% – 25%
SOME	30% – 45%
MOSTLY	50% – 100%

PARTICLE SIZE

DESCRIPTION		SIZE
BOULDER		GREATER THAN 12"
COBBLE		3" – 12"
GRAVEL	COARSE	f" – 3"
	FINE	1/5" – f"
SAND	COARSE	~" – 1/5"
	MEDIUM	" – ~"
	FINE	1/300" – "
SILT AND CLAY		LESS THAN 1/300"

ENGINEERING SERVICES		GEOTECHNICAL SERVICES	
FUNCTIONAL SUPERVISOR	DRAWN BY: SJC	FIELD INVESTIGATION BY: Shawn M. Leyva	
NAME: Benjamin D. Crawford	CHECKED BY: AJK		

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN
DESIGN BRANCH

BRIDGE NO. 7C-81
POST MILE

HACKSTAFF ROAD BRIDGE 7C-81

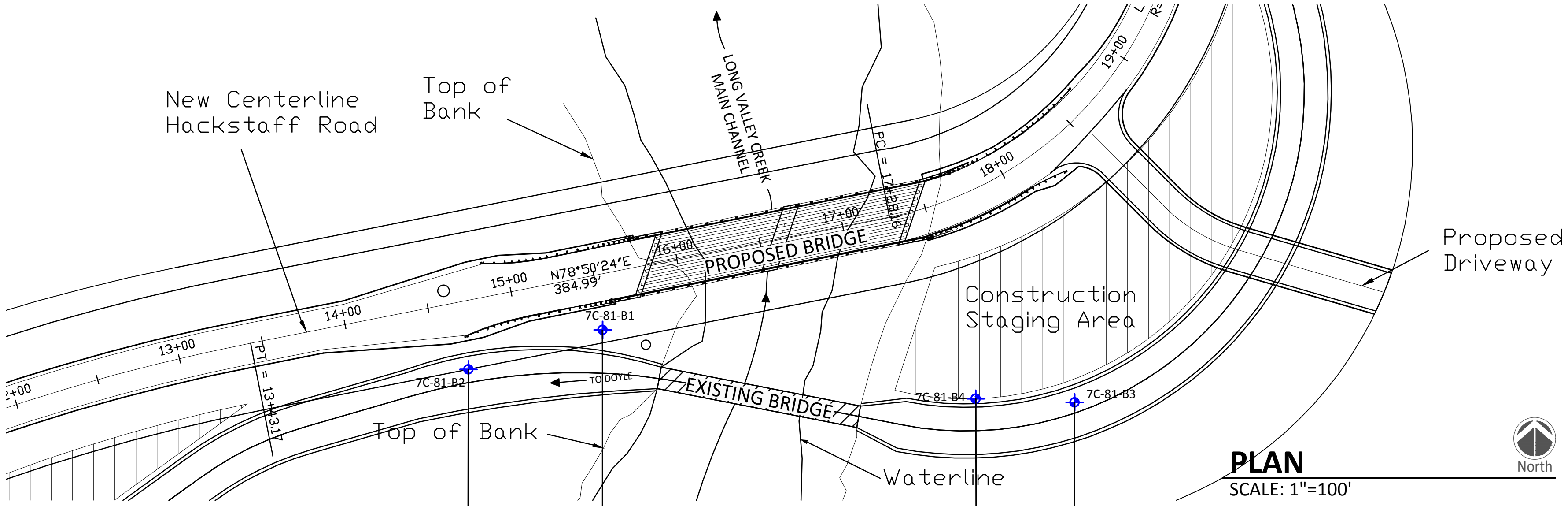
DRAFT LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU XXXXX
EA XXXXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF



PLAN

SCALE: 1"=100'

NOTES:

1. Field classification of soils was in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010). See Log of Test Borings No. 2, "Soil Legend".
2. Standard Penetration tests were performed using in accordance with ASTM D 1586-99 using a hammer operated with an automated drop system. Drill rods were 1 5/8-inch diameter "A"-rods; sampler was driven with brass liners.
3. "2.4 inch sampler": ID=2.4 inch, OD=2.9 inch. "2.0 inch sampler": ID=2.0 inch, OD=2.5 inch. Both driven in same manner as SPT ("1.4 inch") sampler.
4. If laboratory tests are not shown as being performed, the soil descriptions presented in the LOTB are based solely on the visual practices described in this Manual.
5. The length of each sampled interval is shown graphically on the boring log. Whole number blow counts ("N") represent the "standard penetration resistance" interval in accordance with the Caltrans Soil & Logging, Classification, and Presentation Manual (June 2010). Where less than 0.5 feet of penetration is achieved, the blow count shown is for that fraction of the "standard penetration resistance" interval actually penetrated.
6. Consistency of soils shown in ( ) where estimated.
7. Ground water surface (GWS) elevations in the borings indicated on the Log of Test Boring Sheets reflect the fluid level in the borings on the specified date.
8. Ground water surface elevations are subject to seasonal fluctuations and may occur at higher or lower elevations depending on the conditions at any particular time.
9. The "Log of Test Borings" drawing is included with plans in accordance with Section 2-1.03 of Caltrans "Standard Specifications".
10. Groundwater was encountered in boring 7C-81-B4, but elevation was not measured.
11. Test borings were drilled with offset (top of boring may not match profile grade).

DIST	COUNTY	ROUTE	TOTAL PROJECT	SHEET NO	TOTAL SHEETS
2	LASSEN				

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER BENJAMIN D. CRAWFORD No. 68457 EXP. 9-30-15 CIVIL STATE OF CALIFORNIA

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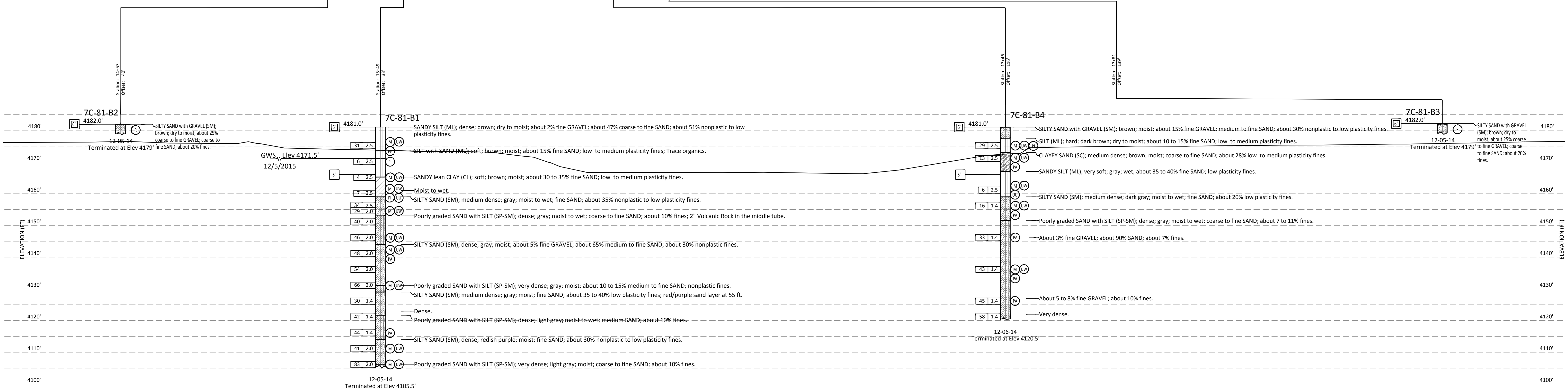


PROFILE

HORIZ: 1"=30'
VERT: 1"=30'

ENGINEERING SERVICES		GEOTECHNICAL SERVICES		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 7C-81	HACKSTAFF ROAD BRIDGE 7C-81
FUNCTIONAL SUPERVISOR	DRAWN BY: SJC	FIELD INVESTIGATION BY: Shawn M. Leyva			DESIGN BRANCH	POST MILE	DRAFT LOG OF TEST BORINGS
NAME: Benjamin D. Crawford	CHECKED BY: AJK						

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU XXXXX
EA XXXXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

DRAFT FOUNDATION REPORT

Long Valley Creek Main Channel Bridge on Hackstaff Road
Bridge No. 7C-81
Lassen County, California

Appendix B
Laboratory Test Results

GEOCON CONSULTANTS

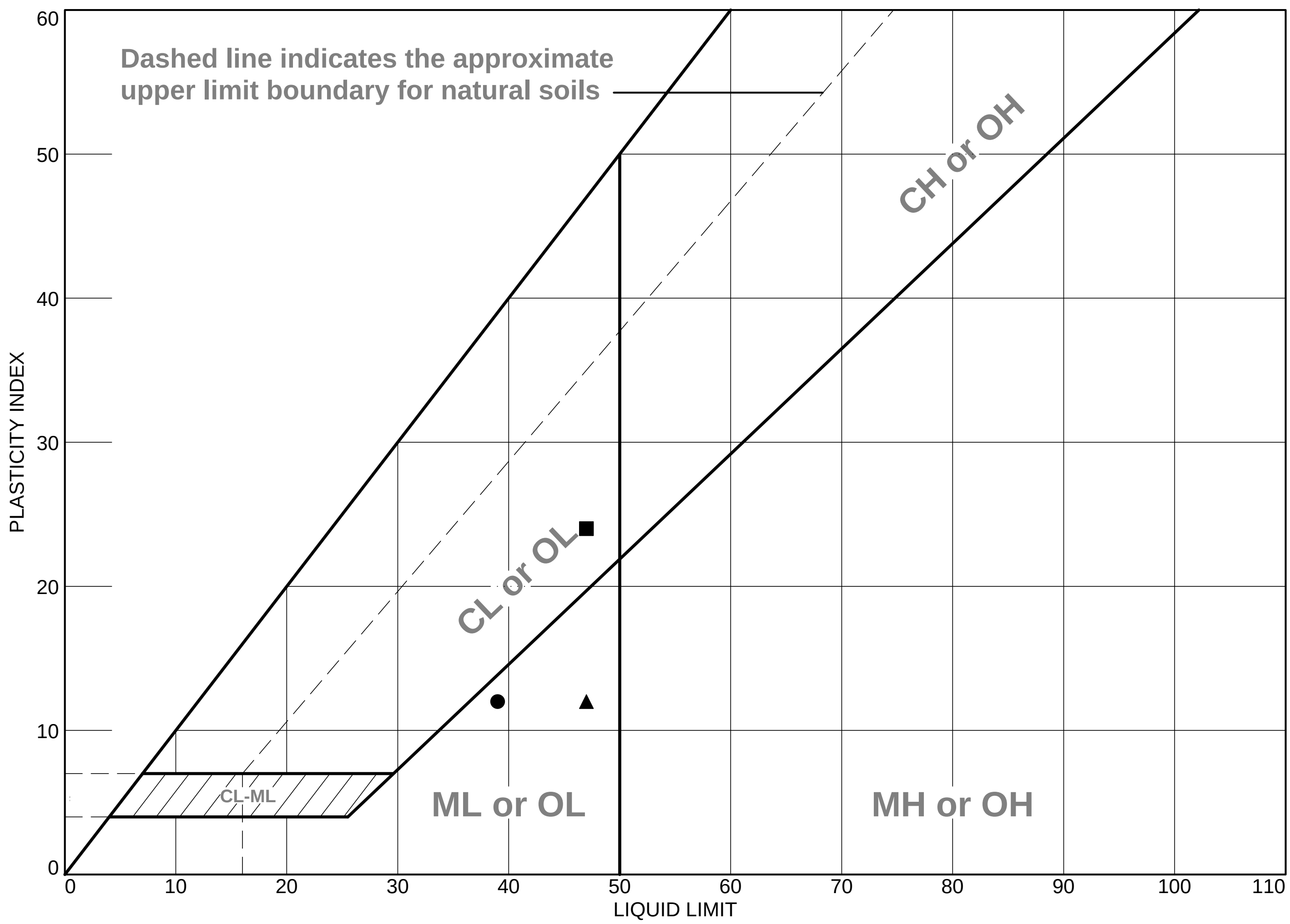
MOISTURE / DENSITY TESTS

PROJECT NAME: Crawford Lab-14-184.4 PROJECT NUMBER: S9763-05-33

DATE: 1/15/2015 TESTED BY: MR/RC LAB NUMBER: 3937 SHEET 1

SAMPLE NO.	B1@5-7C-81	B1@15-7C-81	B1@34-7C-81	B1@39-7C-81	B4@5-7C-81	B4@11-7C-81
DEPTH OF SAMPLE (ft)	6-6.5	16-16.5	35-35.5	39.5-40	6-6.5	11-11.5
SAMPLE DIAMETER (in.)	2.39	2.39	1.91	1.90	2.41	2.40
SAMPLE HEIGHT (cm)	14.86	12.18	15.16	13.84	13.91	14.82
TARE NO.	M-2	G-2	G-1	K2	0-1	BB-1
WET WT.+TARE (gm.)	1006.2	911.3	816	649.5	911.3	1083.8
WET WT.+TARE (gm.) (split)	593.5	400.6	816.00	389.2	660.70	514.7
DRY WT.+TARE (gm.)	533.70	359.70	746.10	340.6	571.5	473.8
TARE WT. (gm.)	206.3	221.00	220.90	134.80	215.4	212.7
WT. OF WATER (gm.)	59.8	40.9	69.9	48.6	89.2	40.9
WT. OF DRY SOIL (gm.)	676.4	533.1	525.2	416.4	556.5	753.1
WT. OF DRY SOIL (gm.) (split)	327.4	138.7	525.2	205.8	356.1	261.1
WATER CONTENT (%)	18.3%	29.5%	13.3%	23.6%	25.0%	15.7%
DRY DENSITY (PCF)	98.2	94.4	117.0	102.7	84.9	108.7

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	SILT	39	27	12			
■	lean CLAY	47	23	24			
▲	sandy silt	47	35	12			

Project No. S9763-05-33 **Client:** Crawford and Associates

Project: Crawford 14-184.4

● **Location:** B1 **Depth:** 11-11.5 **Sample Number:** B1@10-7C-81
■ **Location:** B1 **Depth:** 20 **Sample Number:** B1@20-7C-81-1
▲ **Location:** B4 **Depth:** 6-6.5 **Sample Number:** B4@5-7C-81

Remarks:

GEOCON CONSULTANTS, INC.

Figure

Tested By: LC **Checked By:** MR

GEOCON
CONSULTANTS, INC.
3160 GOLD VALLEY DR – SUITE 800 – RANCHO CORDOVA, CA 95742
PHONE 916.852.9118 – FAX 916.852.9132

GEOCON CONSULTANTS

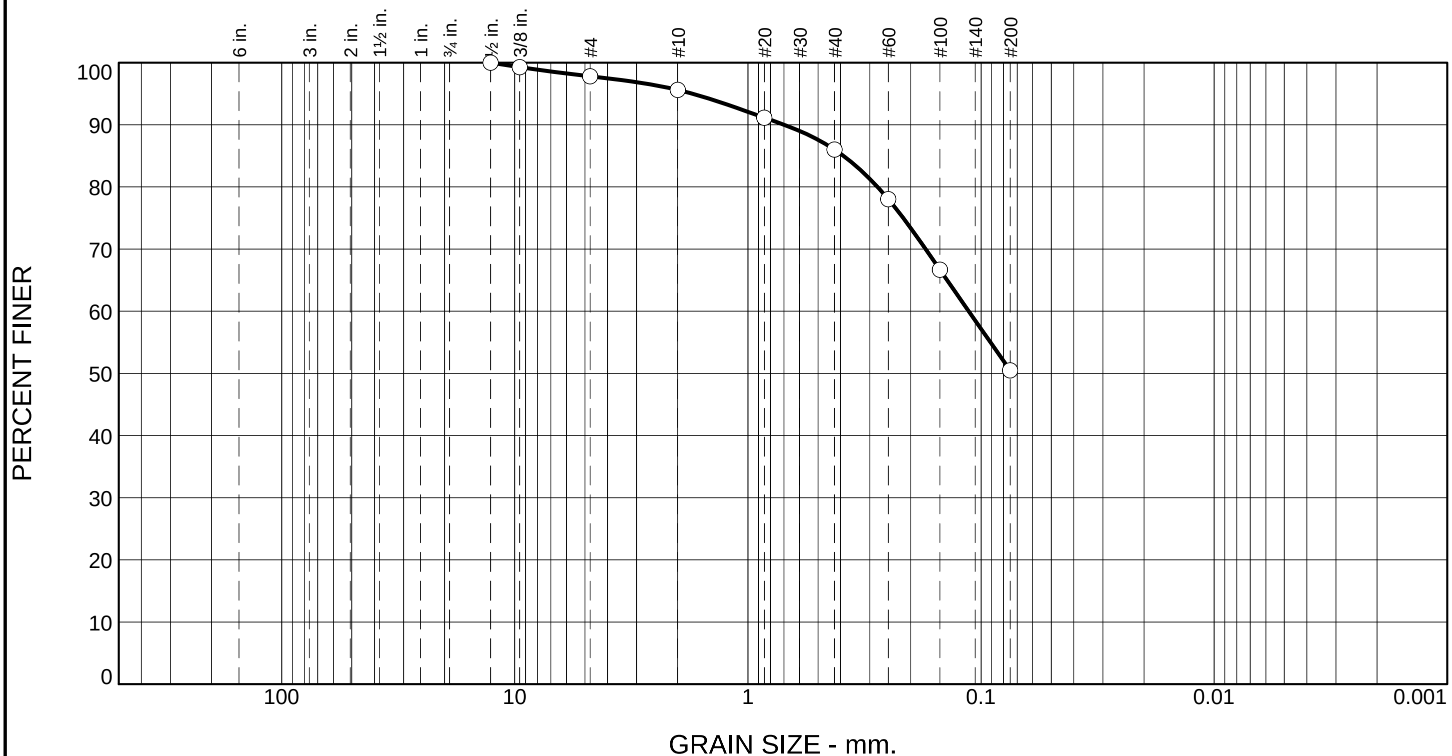
200 Wash (ASTM 1140)

PROJECT NAME: Crawford 14-184.4 PROJECT NUMBER: S9763-05-33

DATE: 1/15/2015 TESTED BY: MR/RC LAB NUMBER: 3937 SHEET 1

BORING NO.	B1@64-7C-81	B4@11-7C-81	B4@24-7C-81	B4@44-7C-81			
DEPTH OF SAMPLE (ft)	64-65.5	11-11.5	24-25.5	44-45.5			
TARE NO.	K-3	BB-1	SR-2	999			
DRY WT. Before Wash + TARE (gm.)	357.9	473.8	362.4	483.3			
DRY WT. After Wash + TARE (gm.)	337.9	400.6	336.2	465			
TARE WT. (gm.)	135.6	212.7	227.9	220.4			
Percent Passing 200 (%)	9.0%	28.0%	19.5%	7.0%			
Sample Description (ASTM D2487/D2488)							

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.2	2.2	9.6	35.5	50.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.5	100.0		
.375	99.3		
#4	97.8		
#10	95.6		
#20	91.1		
#40	86.0		
#60	78.0		
#100	66.7		
#200	50.5		

* (no specification provided)

Material Description

Sandy SILT

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.6995 D_{85}= 0.3892 D_{60}= 0.1128
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 1/15/15

Tested By: RC

Checked By: MR

Title: Lab Manager

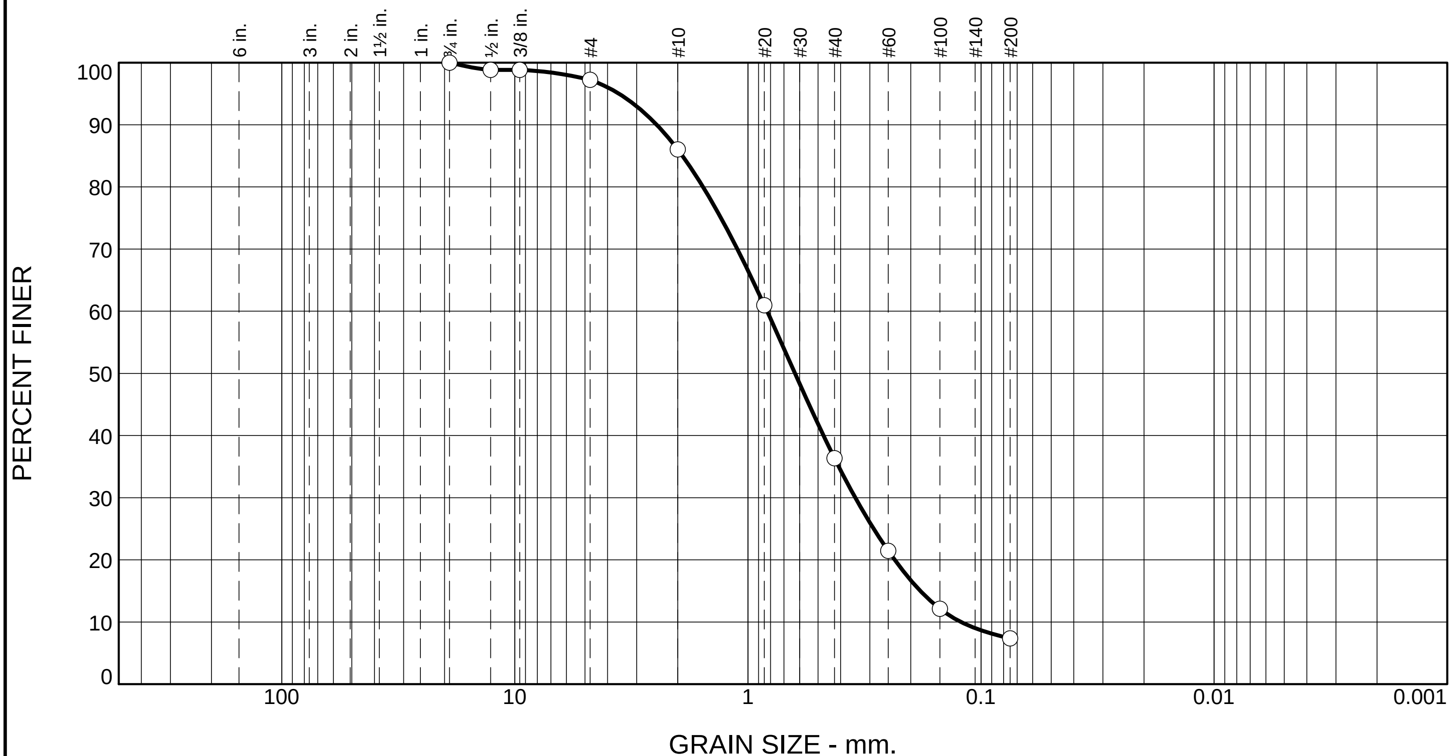
Location: B1
Sample Number: B1@5-7C-B1 **Depth:** 6-6.5 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford 14-184.4

Project No: S9763-05-33 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.8	11.2	49.7	28.9	7.4	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	98.8		
.375	98.8		
#4	97.2		
#10	86.0		
#20	61.0		
#40	36.3		
#60	21.5		
#100	12.1		
#200	7.4		

* (no specification provided)

Material Description

Poorly graded SAND with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 2.4610 D_{85}= 1.9088 D_{60}= 0.8273
D_{50}= 0.6276 D_{30}= 0.3461 D_{15}= 0.1820
D_{10}= 0.1218 C_u= 6.79 C_c= 1.19

Remarks

Date Received: **Date Tested:** 1/15/15

Tested By: RC

Checked By: MR

Title: Lab Manager

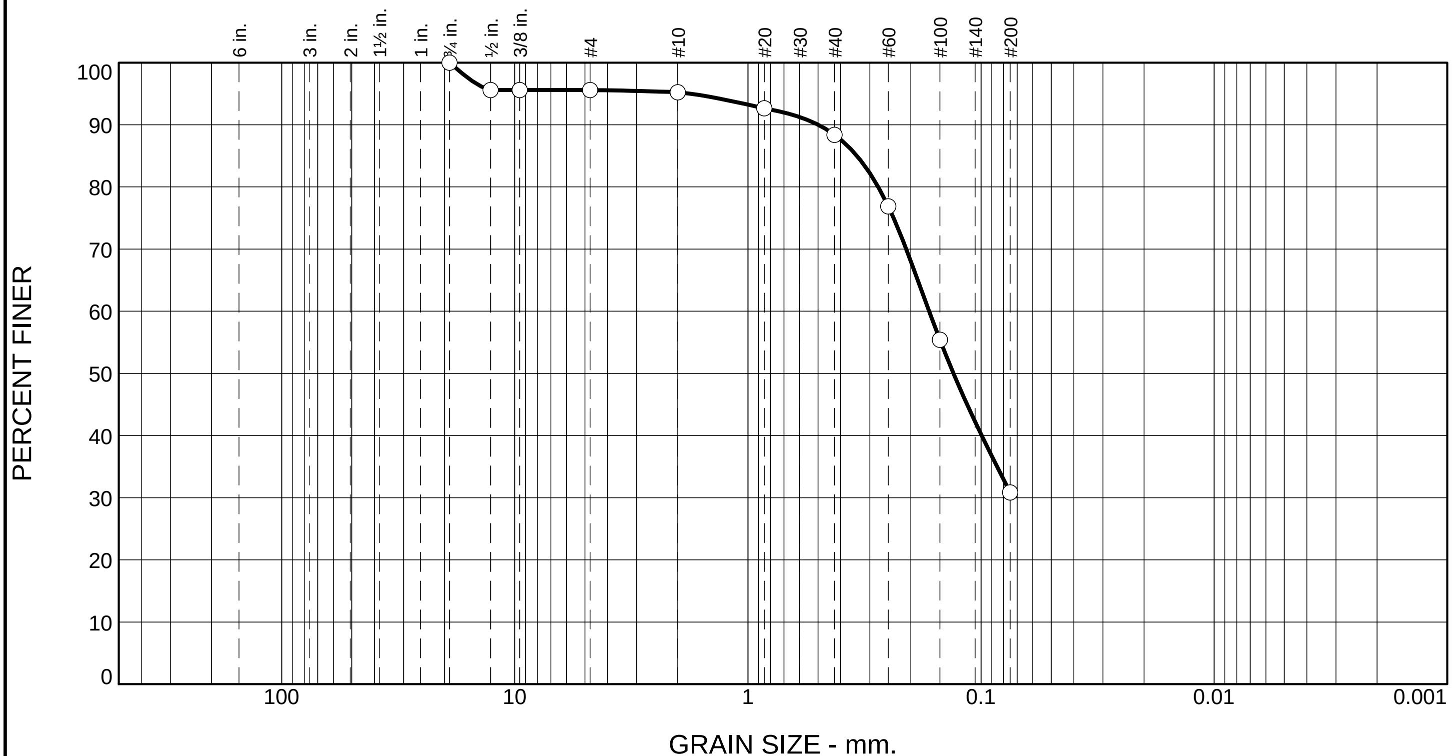
Location: B4
Sample Number: B4@34-7C-81 **Depth:** 34-34.5 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford 14-184.4

Project No: S9763-05-33 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.4	0.4	6.8	57.5	30.9	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	95.6		
.375	95.6		
#4	95.6		
#10	95.2		
#20	92.7		
#40	88.4		
#60	76.9		
#100	55.4		
#200	30.9		

* (no specification provided)

Material Description

Silty SAND

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 0.4989 D_{85}= 0.3406 D_{60}= 0.1668
D_{50}= 0.1312 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 1/15/15

Tested By: RC

Checked By: MR

Title: Lab Manager

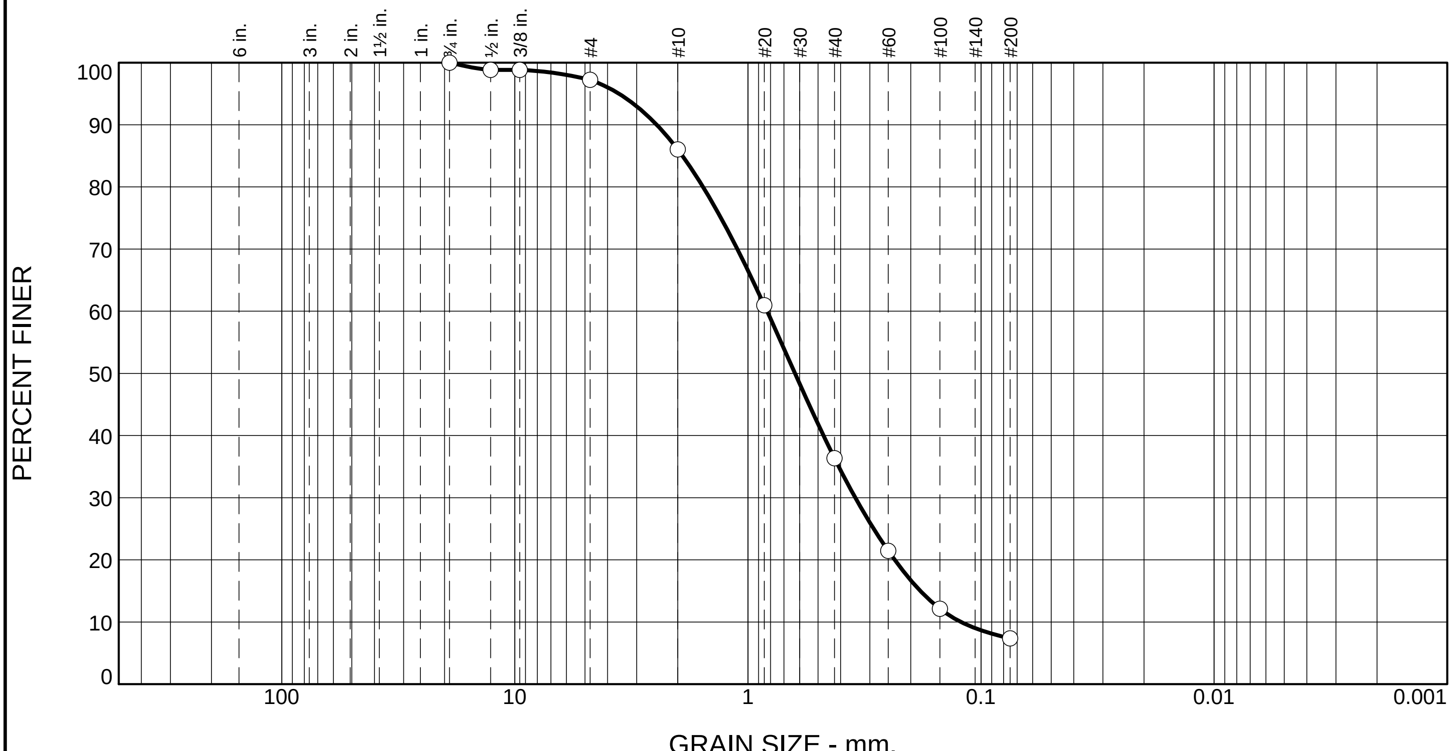
Location: B1
Sample Number: B1@39-7C-81 **Depth:** 39.5-40 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford 14-184.4

Project No: S9763-05-33 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.8	11.2	49.7	28.9	7.4	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	98.8		
.375	98.8		
#4	97.2		
#10	86.0		
#20	61.0		
#40	36.3		
#60	21.5		
#100	12.1		
#200	7.4		

* (no specification provided)

Material Description

Poorly graded SAND with silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 2.4610 D_{85}= 1.9088 D_{60}= 0.8273
D_{50}= 0.6276 D_{30}= 0.3461 D_{15}= 0.1820
D_{10}= 0.1218 C_u= 6.79 C_c= 1.19

Remarks

Date Received: **Date Tested:** 1/15/15

Tested By: RC

Checked By: MR

Title: Lab Manager

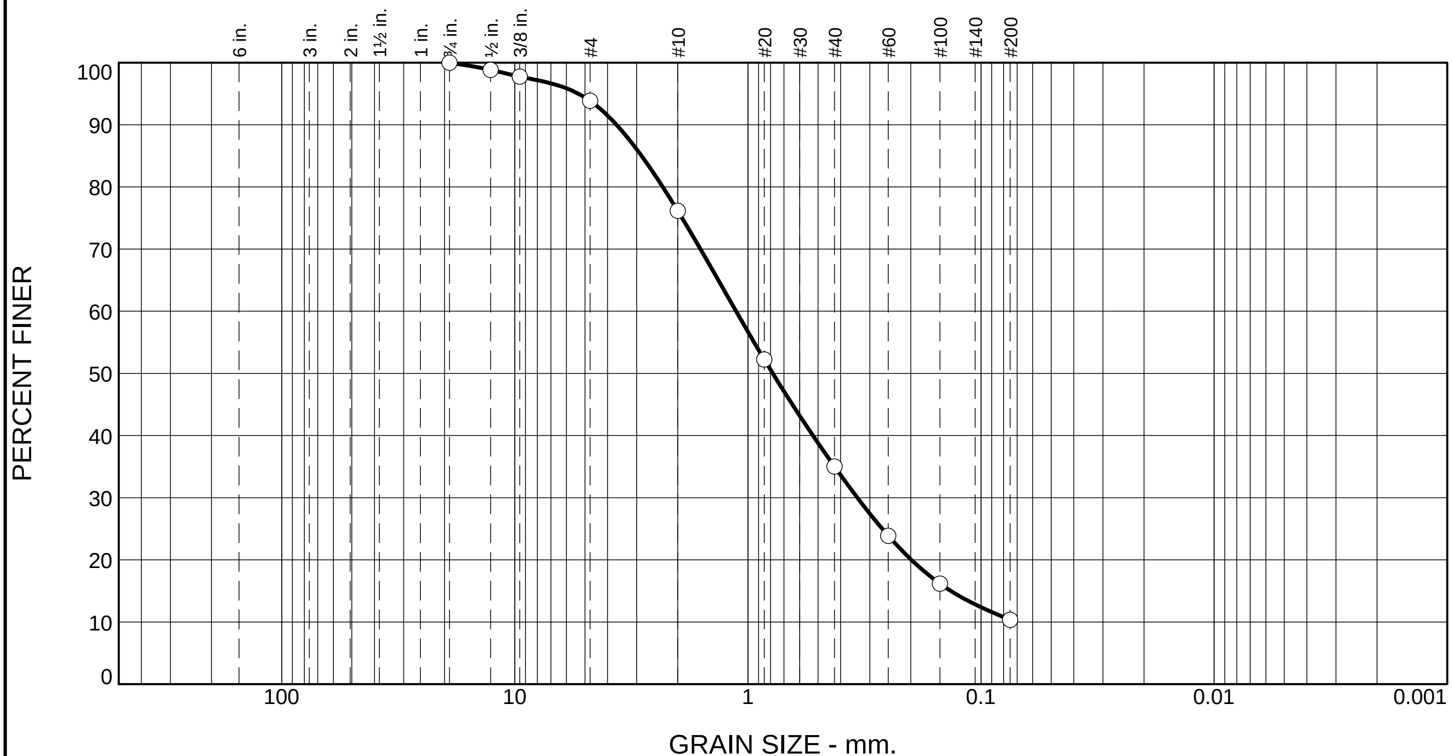
Location: B4
Sample Number: B4@34-7C-81 **Depth:** 34-34.5 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford 14-184.4

Project No: S9763-05-33 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.1	17.8	41.1	24.7	10.3	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	98.8		
.375	97.8		
#4	93.9		
#10	76.1		
#20	52.2		
#40	35.0		
#60	23.9		
#100	16.2		
#200	10.3		

* (no specification provided)

Material Description

Poorly graded SAND with silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 3.6576 D_{85}= 2.8576 D_{60}= 1.1242
D_{50}= 0.7820 D_{30}= 0.3393 D_{15}= 0.1348
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 1/15/15

Tested By: RC

Checked By: MR

Title: Lab Manager

Location: B4

Sample Number: B4@54-7C-81 **Depth:** 54-55.5

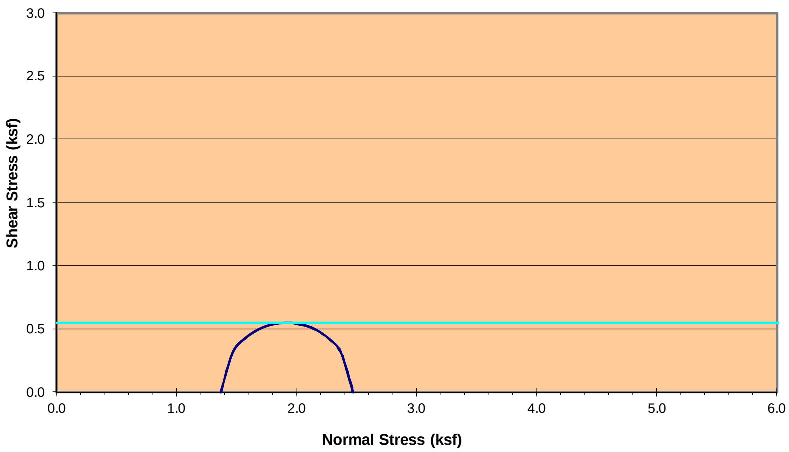
Date Sampled:

GEOCON CONSULTANTS, INC.

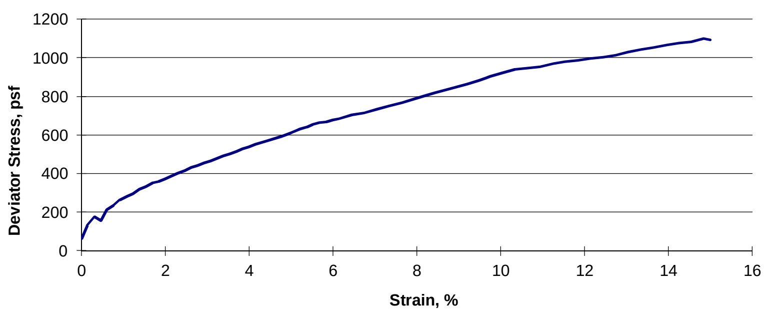
Client: Crawford and Associates

Project: Crawford 14-184.4

Project No: S9763-05-33 **Figure**

MOHR'S CIRCLES	Failure Photo
	

STRESS-STRAIN



Sample Description	
Sample Number	B2@10-7C-12
Sample Depth (feet)	11-11.5
Material Description	Dark Olive Sandy SILT
Initial Conditions at Start of Test	
Height (inch)	4.92
Diameter (inch)	2.41
Moisture Content (%)	36.2
Dry Density (pcf)	82.2
Estimated Specific Gravity	2.7
Saturation (%)	92.9
Shear Test Conditions	
Strain Rate (%/min)	0.9993
Major Principle Stress at Failure (psf)	2470
Minor Principle Stress, Cell Pressure (psf)	1370
Deviator Stress at Fail (psf)	1100
Test Results	
Friction Angle ϕ, (degrees)	0
Cohesion, (psf)	548

Note: Strength attibuted to cohesion with no value of friction assigned

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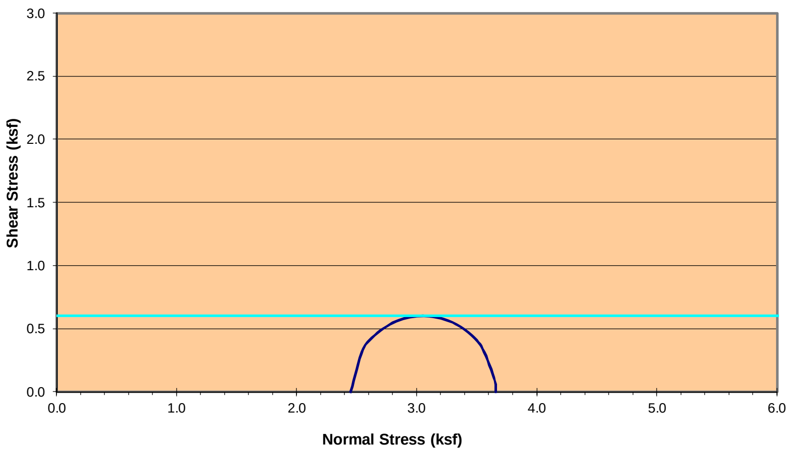
Rancho Cordova, California 95742
Telephone: (916) 852-9118
Fax: (916) 852-9132

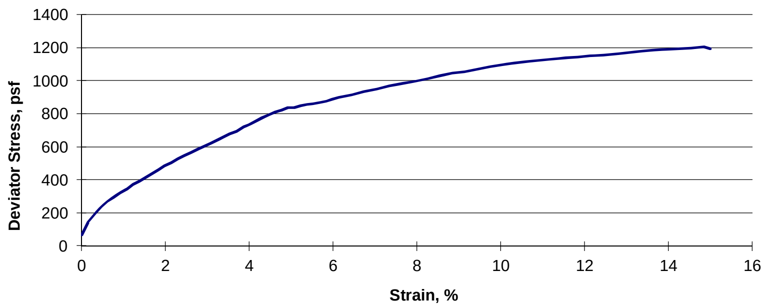
Triaxial Shear Strength - UU Test (single)

Project: Crawford 14-184.4
Location: Lassen County, CA
Number: S9763-05-33
Figure:

MOHR'S CIRCLES



STRESS-STRAIN



Failure Photo

Sample Description	
Sample Number	B1@20-7C-81-1
Sample Depth (feet)	21-21.5
Material Description	Dark brown lean CLAY
Initial Conditions at Start of Test	
Height (inch)	4.92
Diameter (inch)	2.40
Moisture Content (%)	37.2
Dry Density (pcf)	84.8
Estimated Specific Gravity	2.8
Saturation (%)	99.8
Shear Test Conditions	
Strain Rate (%/min)	0.9989
Major Principle Stress at Failure (psf)	3650
Minor Principle Stress, Cell Pressure (psf)	2450
Deviator Stress at Fail (psf)	1210
Test Results	
Friction Angle ϕ, (degrees)	0
Cohesion, (psf)	603

Note: Strength attibuted to cohesion with no value of friction assigned

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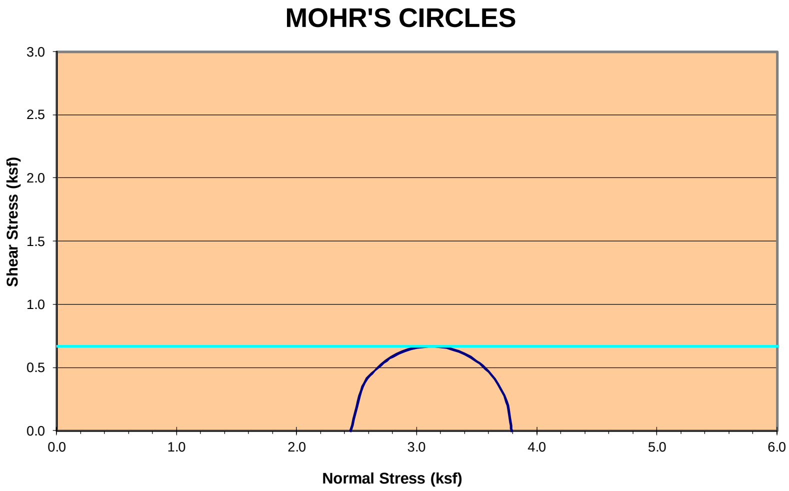
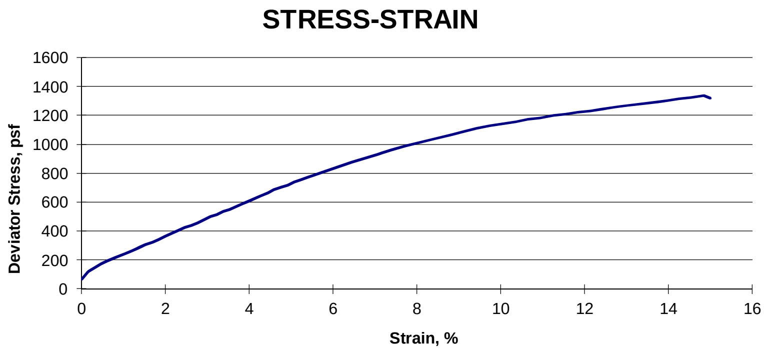
Triaxial Shear Strength - UU Test (single)

Project: Crawford 14-184.4
Location: Lassen County, CA
Number: S9763-05-33
Figure:





Failure Photo

Sample Description	
Sample Number	B4@20-7C-B4-4
Sample Depth (feet)	20-20.5
Material Description	Dark brown lean CLAY
Initial Conditions at Start of Test	
Height (inch)	4.89
Diameter (inch)	2.41
Moisture Content (%)	34.3
Dry Density (pcf)	87.8
Estimated Specific Gravity	2.8
Saturation (%)	98.8
Shear Test Conditions	
Strain Rate (%/min)	0.9984
Major Principle Stress at Failure (psf)	3790
Minor Principle Stress, Cell Pressure (psf)	2450
Deviator Stress at Fail (psf)	1340
Test Results	
Friction Angle ϕ, (degrees)	0
Cohesion, (psf)	670

Note: Strength attibuted to cohesion with no value of friction assigned

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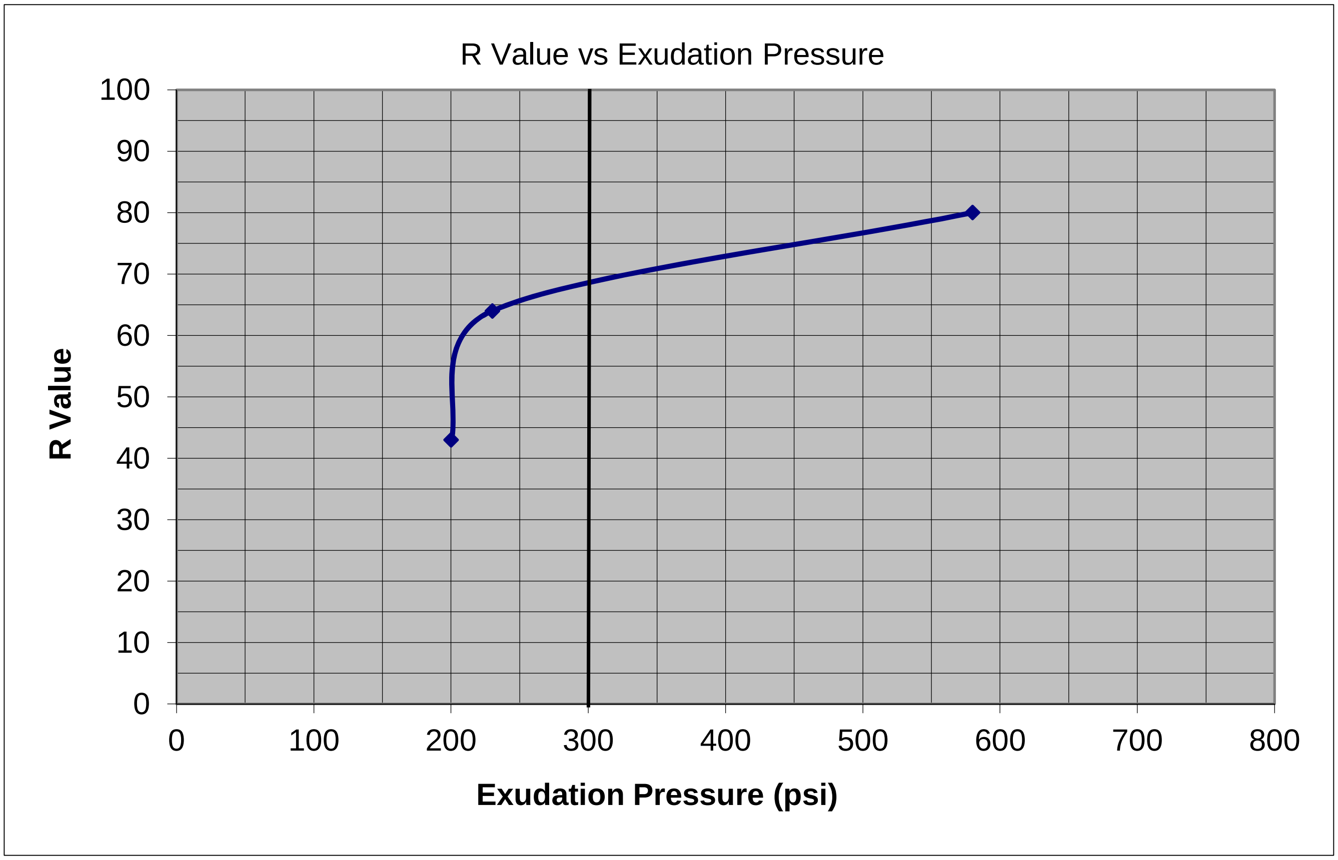
Triaxial Shear Strength - UU Test (single)

Project:	Crawford 14-184.4
Location:	Lassen County, CA
Number:	S9763-05-33
Figure:	



Sample ID & Description

Boring Number	B2
Sample ID	B2@0-3-7C-81-2
Material Description	Grayish Brown Silty SAND with trace clay

Test Data

Specimen	D	E	F
Exudation Pressure (psi)	200	230	580
Expansion Dial (.0001")	0	0	6
Expansion Pressure (psf)	0	0	26
Resistance 'R' Value	43	64	80
Moisture at test (%)	10.2	9.1	8.1
Dry density at test (pcf)	128.2	128.8	129.9

R Value at 300 psi exudation pressure	**69**
R Value by expansion pressure (TI=5.0)	83

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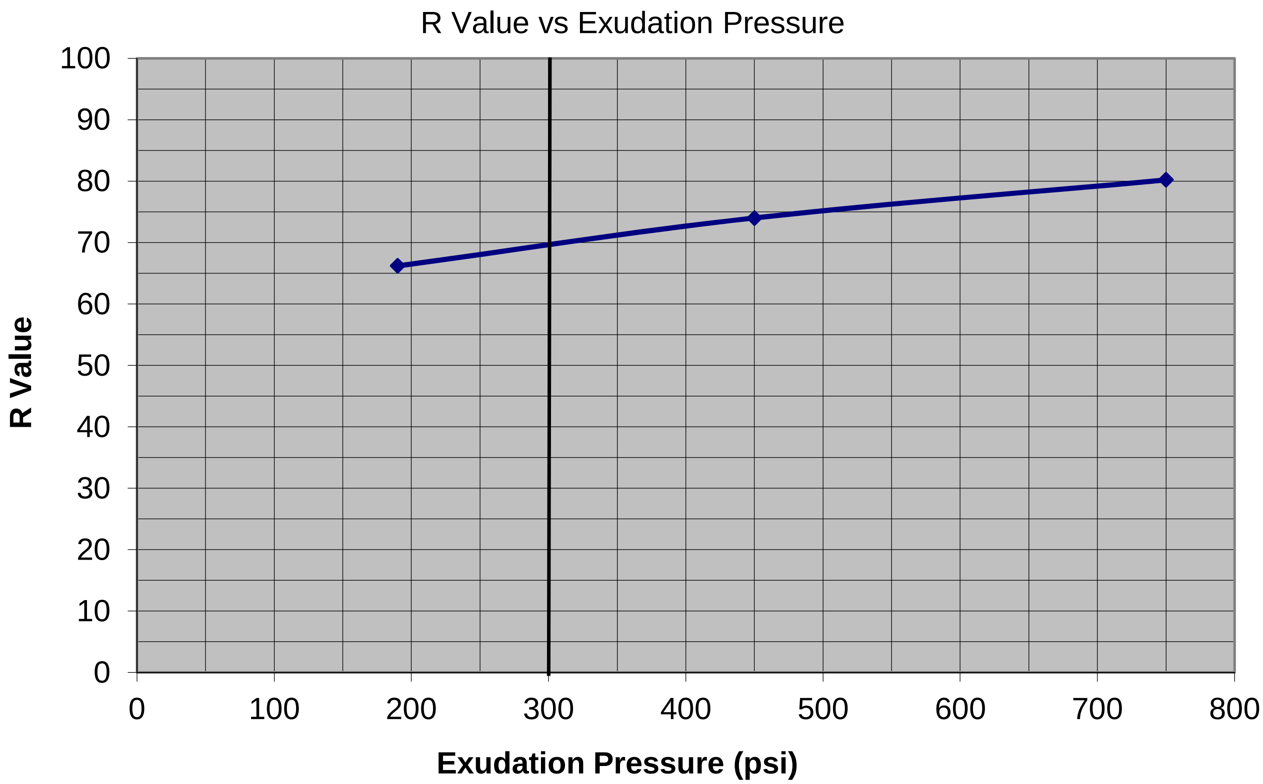
R Value By Exudation

Project: Crawford 14-184.4
Location: Lassen County, CA
Number: S9763-05-33
Figure:



Sample ID & Description	
Boring Number	B3
Sample ID	B3@5-3-7C-B1
Material Description	Grayish Brown Silty SAND with trace clay

Test Data			
Specimen	D	E	F
Exudation Pressure (psi)	190	450	750
Expansion Dial (.0001")	0	0	0
Expansion Pressure (psf)	0	0	0
Resistance 'R' Value	66	74	80
Moisture at test (%)	9.3	8.3	7.8
Dry density at test (pcf)	125.6	127.3	125.6
R Value at 300 psi exudation pressure	**70**		
R Value by expansion pressure (TI=5.0)	--		

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R Value By Exudation

Project: Crawford 14-184.4
Location: Lassen County, CA
Number: S9763-05-33
Figure:

Sunland Analytical
11419 Sunrise Gold Cir.#10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 01/23/15
Date Submitted 01/20/15

To: Mark Repking
Geocon
3160 Gold Valley Dr. #800
Rancho Cordova, CA, 95742

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : S9763-05-33-14-184.4 Site ID: B1@15-7C-B1-1
Thank you for your business.

* For future reference to this analysis please use SUN # 68609 - 142544

EVALUATION FOR SOIL CORROSION

Soil pH	7.33		
Minimum Resistivity	1.21	ohm-cm (x1000)	
Chloride	31.5 ppm	0.0032	%
Sulfate-S	46.4 ppm	0.0046	%

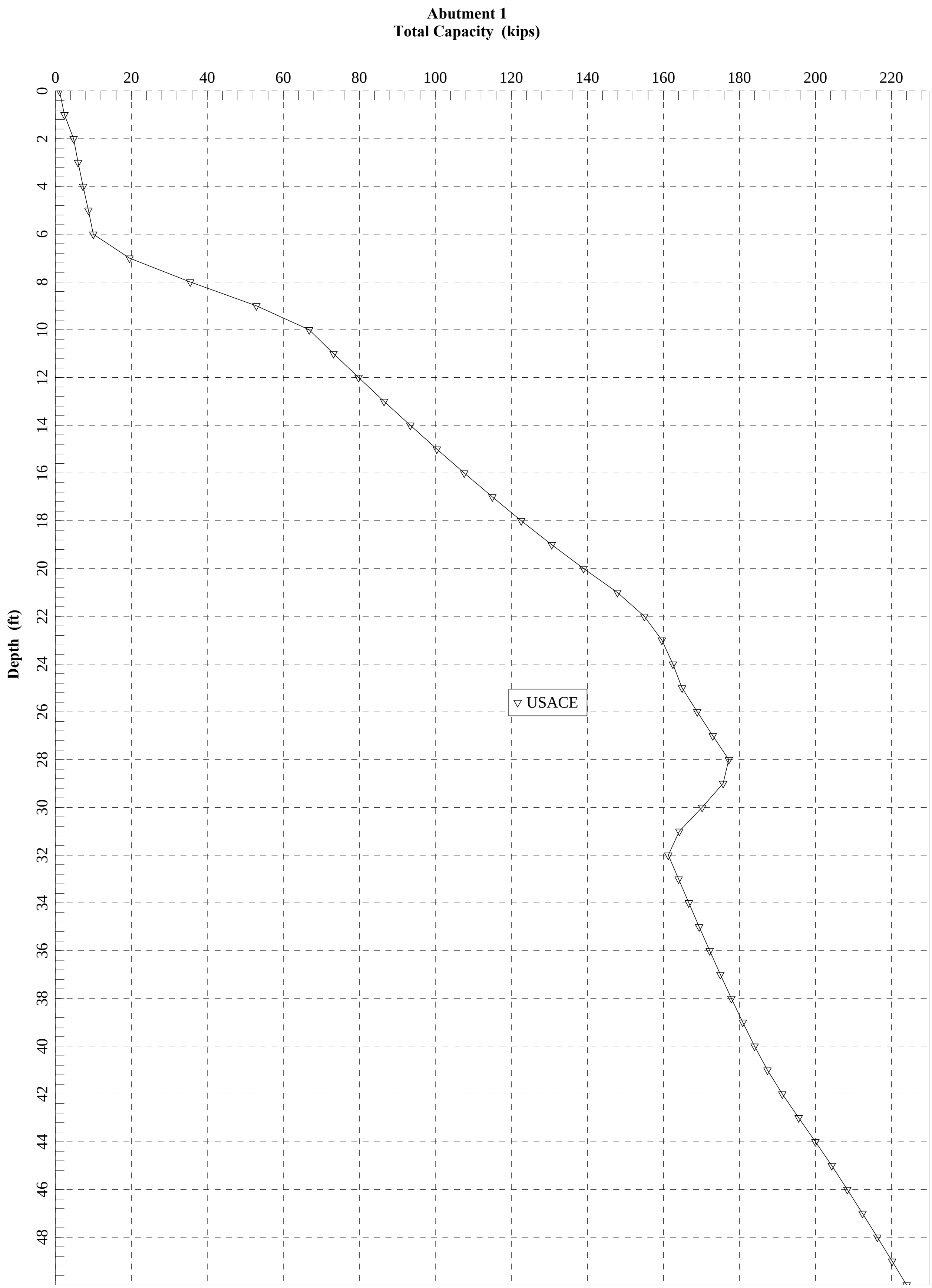
METHODS:
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

DRAFT FOUNDATION REPORT

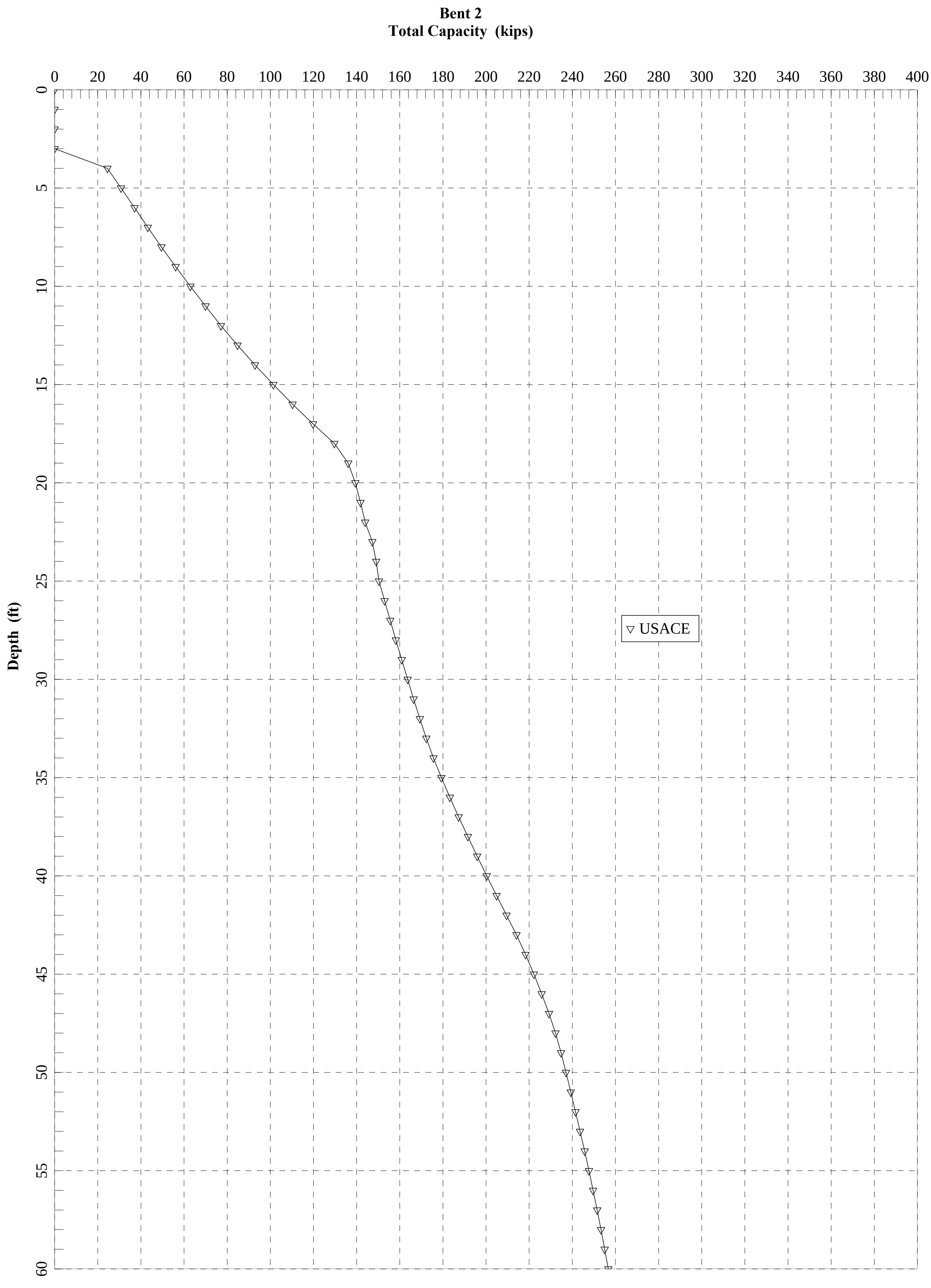
Long Valley Creek Main Channel Bridge on Hackstaff Road
Bridge No. 7C-81
Lassen County, California

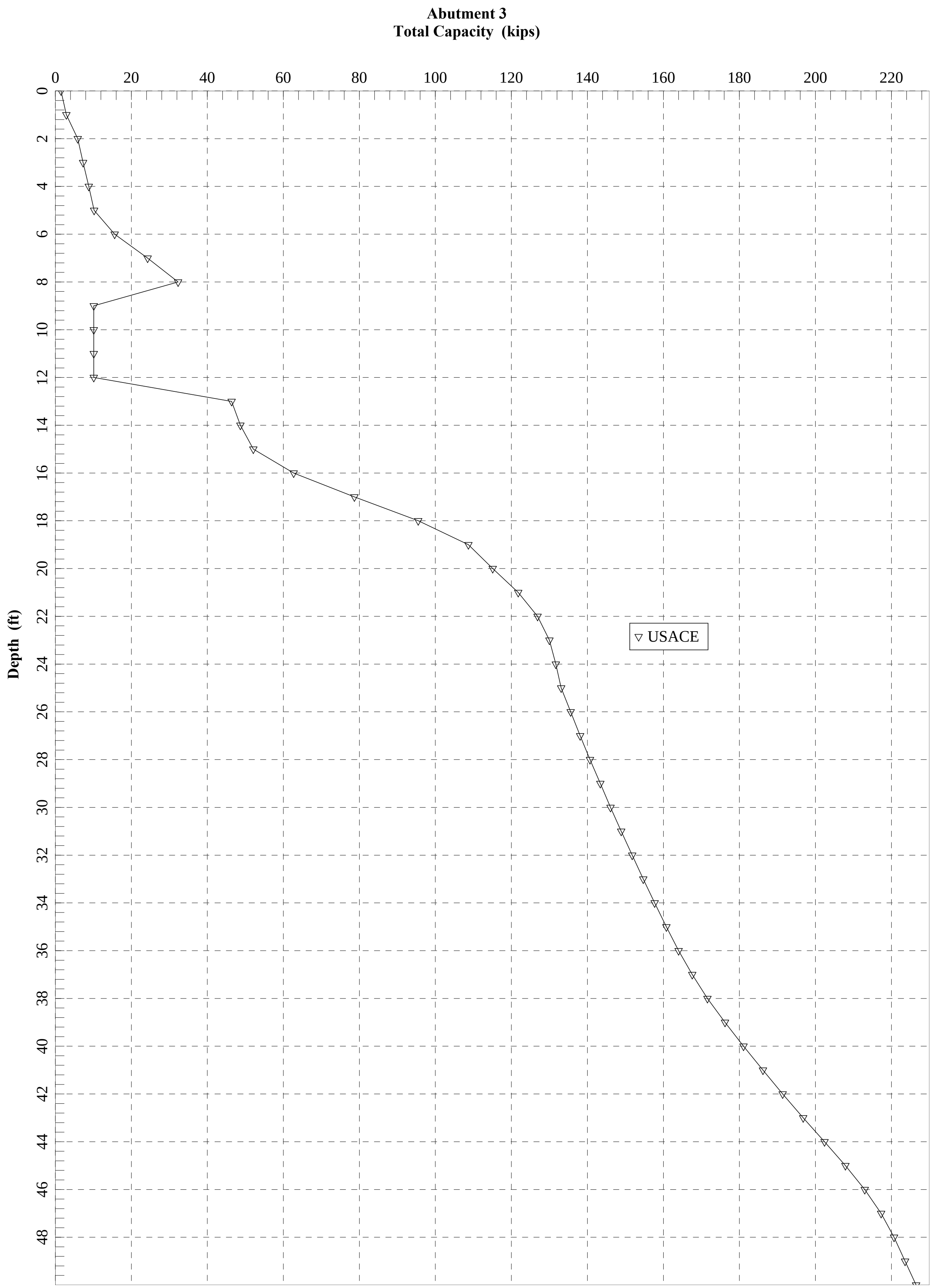
Appendix C

APile Analysis



Abutment 1
Total Capacity (kips)
0 20 40 60 80 100 120 140 160 180 200 220
Depth (ft)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
USACE


Bent 2
Total Capacity (kips)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
USACE



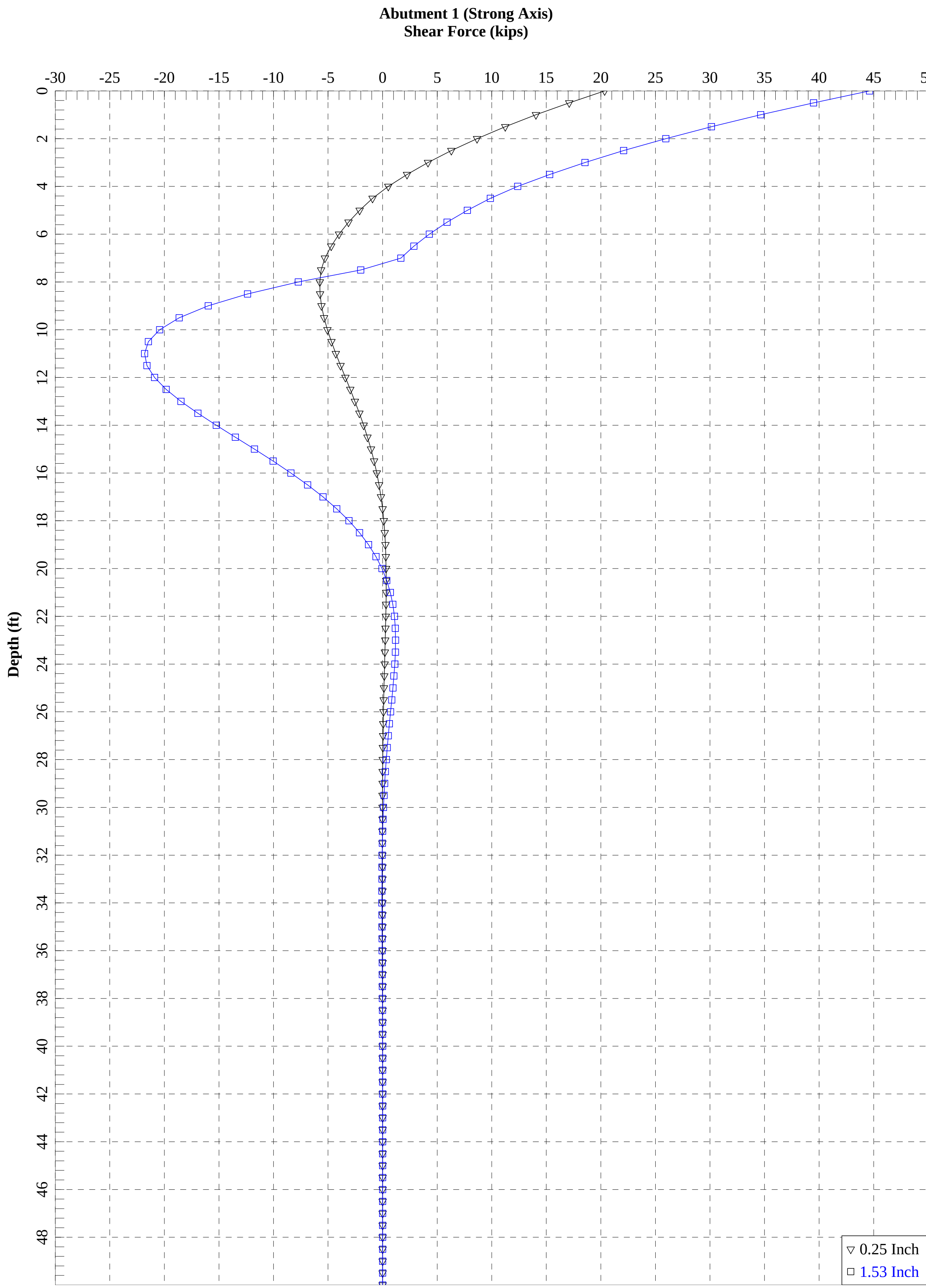
Abutment 3
Total Capacity (kips)
0
20
40
60
80
100
120
140
160
180
200
220
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
USACE

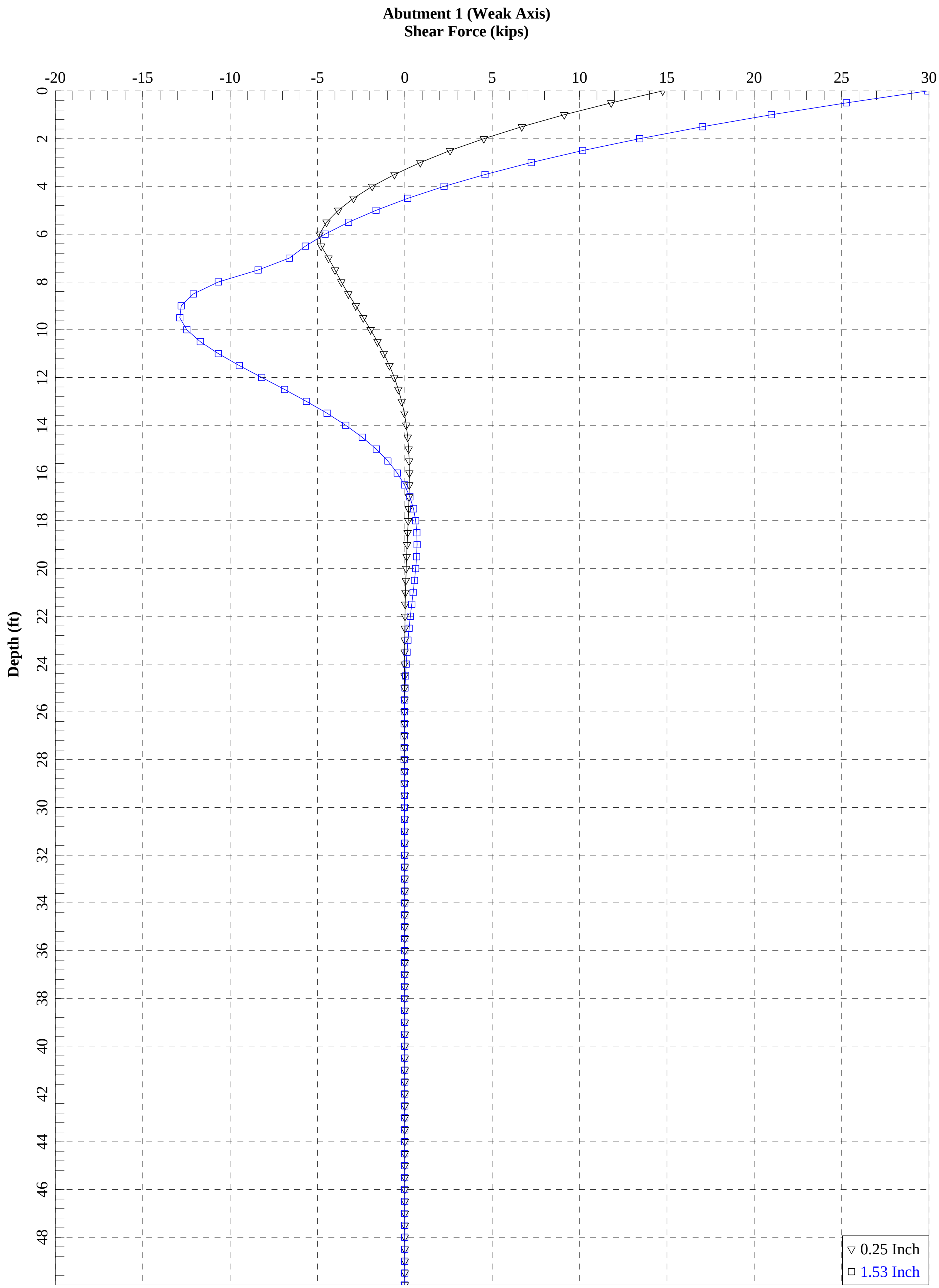
DRAFT FOUNDATION REPORT

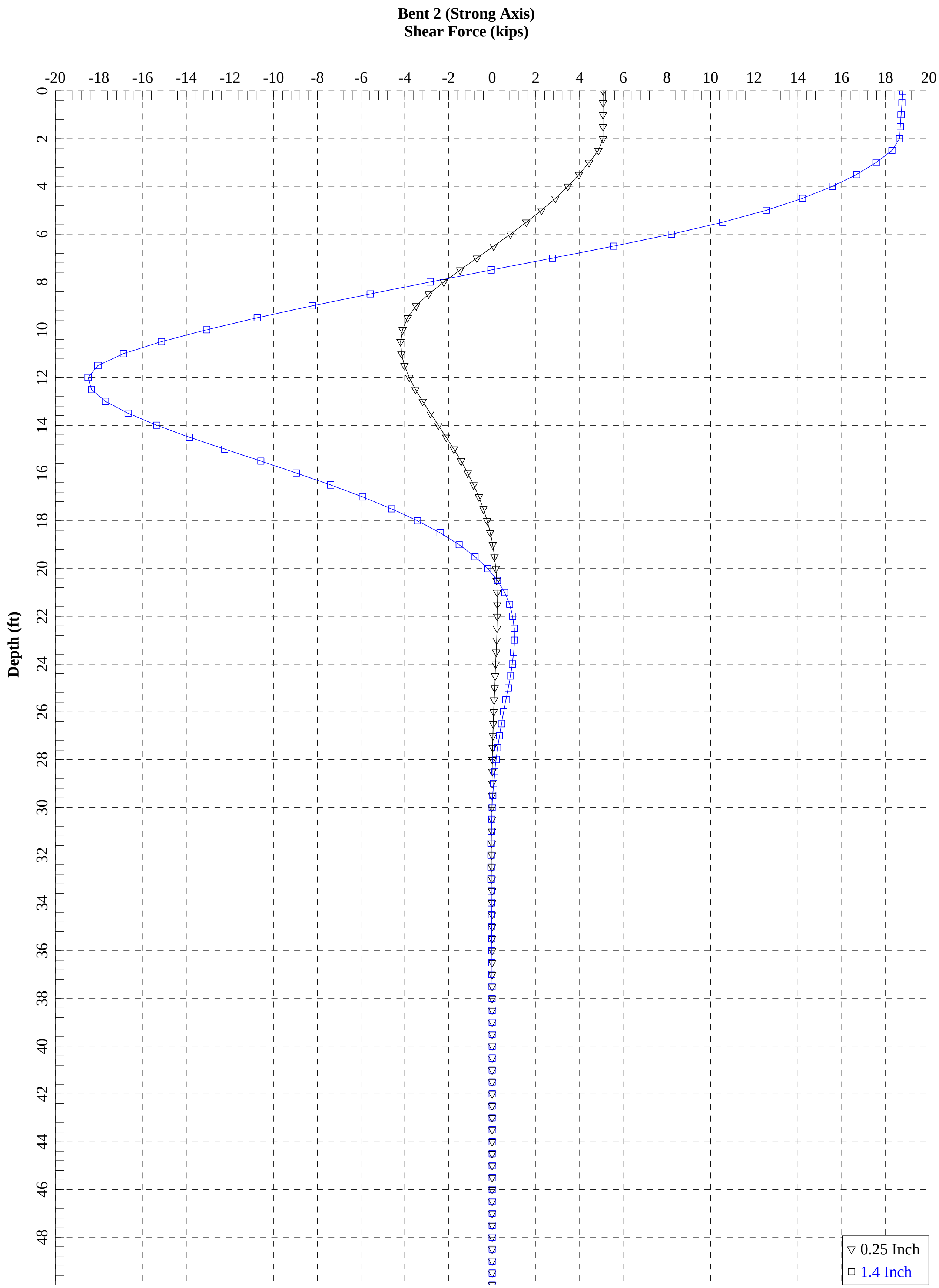
Long Valley Creek Main Channel Bridge on Hackstaff Road
Bridge No. 7C-81
Lassen County, California

Appendix D

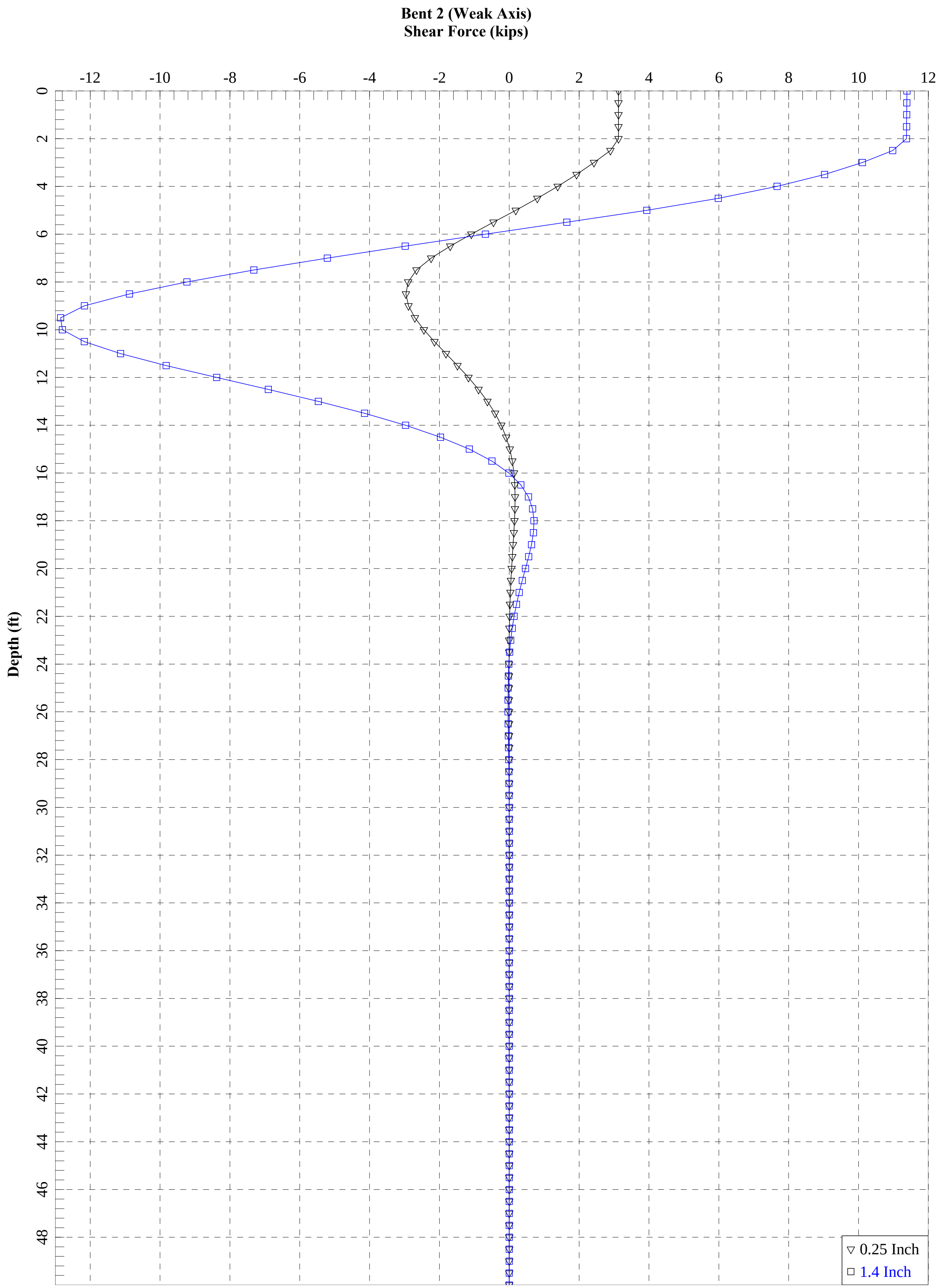
LPile Analysis


Abutment 1 (Strong Axis)
Shear Force (kips)
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
45
50
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
0.25 Inch
1.53 Inch

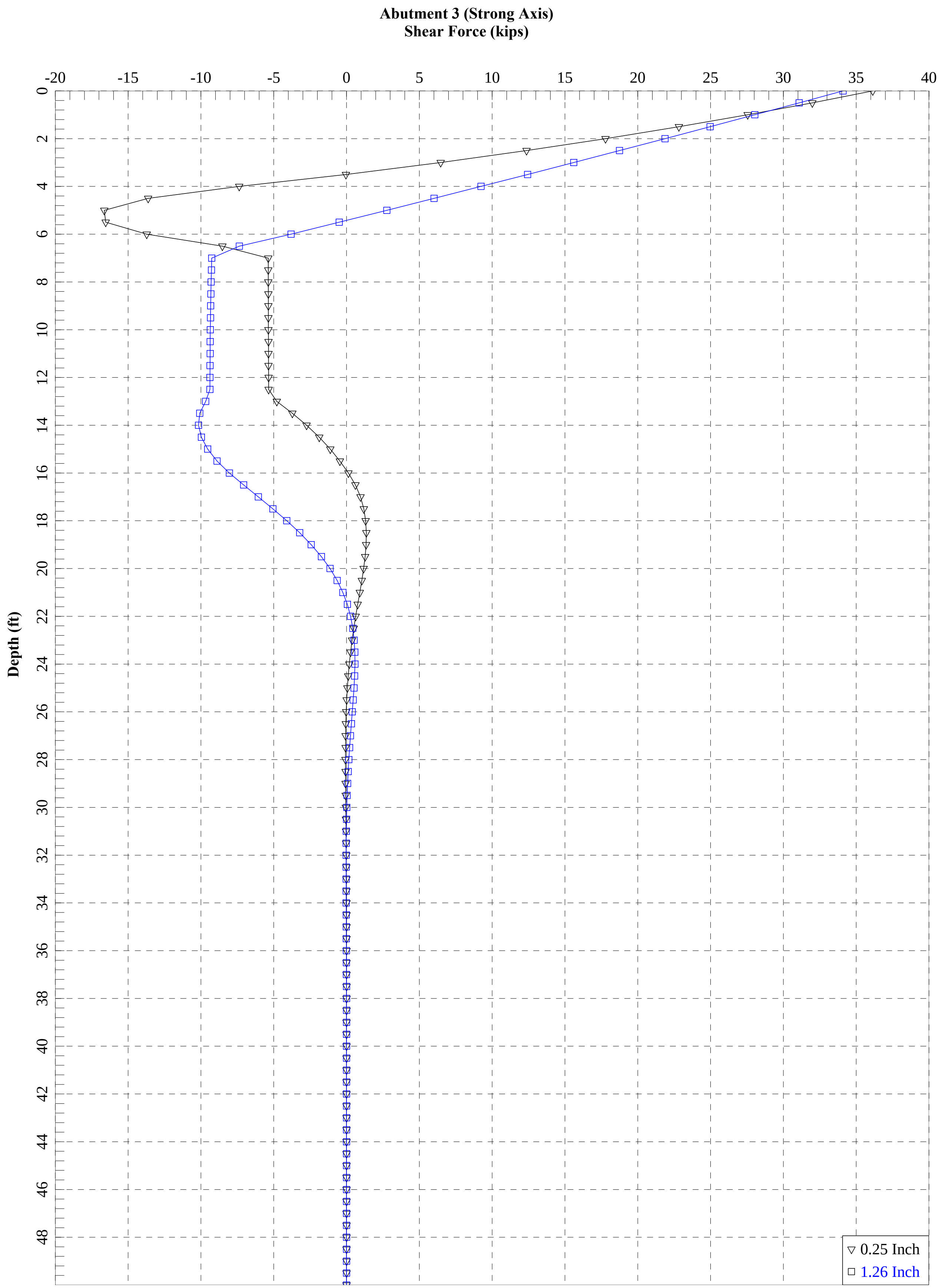

Abutment 1 (Weak Axis)
Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
25
30
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
0.25 Inch
1.53 Inch



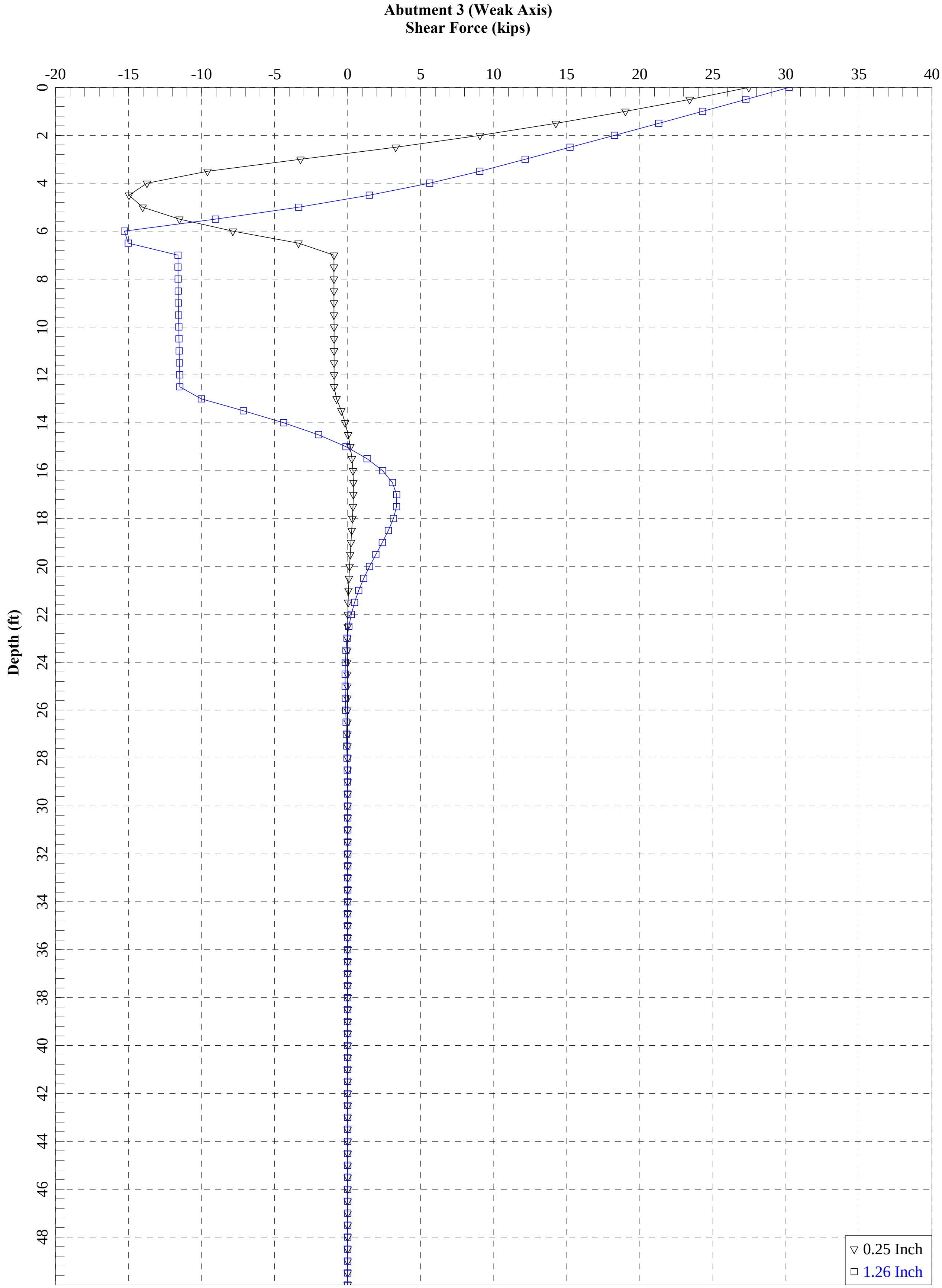
Bent 2 (Strong Axis)
Shear Force (kips)
Depth (ft)
0.25 Inch
1.4 Inch



Bent 2 (Weak Axis)
Shear Force (kips)
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
0.25 Inch
1.4 Inch



Abutment 3 (Strong Axis)
Shear Force (kips)
-20 -15 -10 -5 0 5 10 15 20 25 30 35 40
Depth (ft)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
0.25 Inch
1.26 Inch


Abutment 3 (Weak Axis)
Shear Force (kips)
Depth (ft)
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
0.25 Inch
1.26 Inch