



**GEOTECHNICAL DATA REPORT
LAGUNITAS ROAD BRIDGE
PROJECT
ROSS, CALIFORNIA**

**Job No. 43-00067008.00
January 30, 2002**

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Sverdrup/Gerwick JV
20 California Street, Suite 400
San Francisco, CA 94111

Attention: Mr. Robert J. Filgas, PE
Project Manager

Dear Mr. Filgas:

Final Geotechnical Data Report
San Francisco District COE
IDC DACW07-00-D-0003
Lagunitas Road Bridge Project
Ross, California

We are pleased to submit five (5) copies of our final geotechnical data report for the investigation of the Lagunitas Road Bridge. Our geotechnical investigation and preparation of this data report completes the scope of services proposed on September 17, 2001 and authorized by the San Francisco District COE.

Our geotechnical investigation consisted of drilling 25 sounding holes, excavating a shallow test pit, drilling and sampling two geotechnical boreholes, and performing selected laboratory tests. The field and laboratory data is summarized in this geotechnical data report. The data report includes a subsurface profile.

We appreciated the opportunity to provide the geotechnical investigation services to assess the subsurface conditions and bridge foundation as-builts. If you have any questions regarding this data report, please contact Francis R. Greguras at (415) 243-3808.

Very truly yours,

URS CORPORATION

Francis R. Greguras, PE, GE
Project Manager

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION.....	1
2.0 PROJECT DESCRIPTION.....	2
3.0 FIELD EXPLORATION SERVICES.....	2
3.1 PERMITTING AND COORDINATION	2
3.2 EXPLORATION STREAMBED AREA.....	3
3.3 EXPLORATION WEST ABUTMENT.....	4
3.4 DRILLING EQUIPMENT AND METHOD.....	4
3.5 SAMPLING EQUIPMENT AND TOOLS.....	5
3.6 ABANDONMENT OF BOREHOLES AND CUTTINGS DISPOSAL	6
4.0 LABORATORY TEST PROGRAM	7
4.1 INDEX TESTS.....	7
4.2 SHEAR STRENGTH TESTS.....	7
4.3 CONSOLIDATION TESTS	8
5.0 GEOLOGIC SETTING.....	8
6.0 SITE CONDITIONS.....	9
6.1 SURFACE CONDITIONS	9
6.2 BRIDGE FOUNDATION TYPES AND CONFIGURATIONS.....	9
6.3 SURFACE CONDITIONS	11
7.0 REFERENCES.....	12

TABLES

Table 1	Index Test Results Summary
Table 2	Shear Strength Test Summary
Table 3	Consolidation Test Results Summary
Table 4	Sounding Hole Summary

FIGURES

Figure 1	Site Vicinity Map
Figure 2	Boring and Sounding Location Plan
Figure 3	Site Photos (Photographs 1 and 2)
Figure 4	Site Photos (Photographs 3 and 4)
Figure 5	Site Photos (Photographs 5 and 6)
Figure 6	Site Photos (Photographs 7 and 8)
Figure 7	Subsurface Profile

- Figure 8 Borehole B-2 Standard Penetration Test N-Value and Undrained Shear Strength Plot
- Figure 9 Borehole B-1 Standard Penetration Test N-Value Plot

APPENDICES

- Appendix A Logs of Borings and Legend Key
- Appendix B Signet Testing Labs Data Reports

GEOTECHNICAL DATA REPORT LAGUNITAS ROAD BRIDGE PROJECT ROSS, CALIFORNIA

1.0 INTRODUCTION

The Lagunitas Road Bridge Project background, site, and geotechnical investigations were performed for the San Francisco District, U.S. Army Corps of Engineers (COE) under Indefinite Delivery Contract (IDC) DACW07-00-D-0003. The notice-to-proceed was issued on September 18, 2001.

The project team for the background, site, and geotechnical investigations consisted of Sverdrup/Gerwick JV (prime consultant) and URS Corporation, Inc. (geotechnical subconsultant). URS Corporation, Inc. will be referred to as "USR" in this report.

The purpose of the Geotechnical Data Report for the Lagunitas Road Bridge Project is to achieve the following objectives:

- Determine pier foundation types, configurations, and as-built dimensions using auger and core drilling methods;
- Determine the west headwall foundation type, configuration, and as-built dimensions using auger and core drilling methods;
- Develop a soil profile for the west abutment and the two pier locations of the bridge;
- Perform a laboratory test program to determine index properties, and soil compressibility and shear strength characteristics; and
- Prepare a Geotechnical Data Report that includes a soil profile.

This report is organized into sections that describe the project, field exploration services performed, the laboratory test program, geologic setting, and site conditions. Figures are used to illustrate features of the existing bridge structure, show exploration locations, equipment used, show foundation concrete and rock core conditions, and present a soil/foundation profile. Tables are used to summarize the data from the 25 sounding holes drilled and the laboratory test program. The logs of the two geotechnical borings and a key to the soil classifications and test

data on the logs are presented in Appendix A. The laboratory test reports prepared by Signet Testing Labs are presented in Appendix B.

2.0 PROJECT DESCRIPTION

The Lagunitas Road Bridge is located about 200 feet west of Sir Francis Drake Boulevard in the Town of Ross, California as shown in Figure 1, Site Vicinity Map. The project site is in Marin County. Data research performed by Sverdrup/Gerwick JV has been unable to find any as-built documents/drawings for the Lagunitas Road Bridge. Information provided by the COE in their Request for Proposal (RFP) dated August 29, 2001 indicates that the bridge was constructed in 1908 by the Town of Ross and is identified as an architecturally significant structure.

The Lagunitas Road Bridge consists of concrete girder type construction that is supported on two piers. The bridge is skewed to the Corte Madera Creek channel as shown on Figure 2. The bridge is about 26 feet wide and about 87 feet long. The concrete box girders are haunched at the pier locations as shown on the elevation view (Photograph 1), Figure 3. The architectural features of the Lagunitas Road Bridge at the roadway level are illustrated in Photograph 2, Figure 3.

The project purpose for the COE is to provide flood protection for residential, commercial, and public property along Corte Madera Creek. The alternatives proposed in the vicinity of the Lagunitas Road Bridge are for the completion of the Corte Madera Creek Flood Control Project that started many years ago. The alternatives include using a combination of a sediment basin, channel excavation, raising of existing flood walls, replacement of an existing fish ladder, and adding a bypass culvert. The background, site, and geotechnical data from the project investigation team will be used under a structural analysis phase to determine the impact, if any, that the COE flood control project will have on the Lagunitas Road Bridge.

3.0 FIELD EXPLORATION SERVICES

This section will present the permitting and coordination activities performed to implement the exploration services, describe the exploration program, and type of drilling equipment and sampling tools used.

3.1 PERMITTING AND COORDINATION

As part of the URS permitting scope of service approved and requested by the COE, pursuance of a Streambed Alteration Agreement from the California State Department of Fish and Game (Fish and Game) was undertaken. On October 2, 2001, the project team received an e-mail from

Christina Broscius of the COE clarifying the requirements for a permit from Fish and Game. As stated in the e-mail, federal agencies are not regulated by states; therefore, a permit from Fish and Game will not be required. Also, the U.S. Fish and Wildlife Service does not have jurisdiction for the exploration work (Broscius e-mail); however, the National Marine Fisheries Service does have jurisdiction, if exploration work is performed after October 31.

Boring permits were required and applied for through the County of Marin, Environmental Health Services for the geotechnical and sounding boreholes. Exploration boreholes in the west abutment required an Encroachment Permit from the Town of Ross. The Encroachment Permit required URS to provide full traffic control during the drilling work and to coordinate with the Ross Public Safety Department for traffic control. Other coordinating services were required for the USA contact, an underground locator service, drilling subcontractors, a crane service, and a traffic control contractor.

3.2 EXPLORATION STREAMBED AREA

Along the east side of the west bridge pier seven sounding holes were drilled. The staked locations (i.e., after drilling) of the seven sounding holes are shown on Photograph 3, Figure 4. In addition, three soundings were drilled north of the west pier and two soundings were drilled south of the west pier. Specific locations of the twelve soundings drilled adjacent to the west pier are presented in Figure 2, Boring and Sounding Location Plan. At sounding location S-14, the pier foundation concrete was cored (C-14) to evaluate the condition of the concrete and to determine the foundation thickness.

At the north end of the west abutment headwall and the south end of the retaining wall containing the drain flap gate, three sounding holes were drilled (S-8, S-9, and S-10) and a shallow test pit was excavated with shovels. The locations of these soundings and the test pit are shown on Figure 2.

Along the western and southern end of the east bridge pier, four sounding holes were drilled (S-16 through S-19). The locations are shown on Figure 2.

A geotechnical borehole (B-1) was drilled at approximately mid-channel in the streambed about 25 feet south of the south side of the Lagunitas Road Bridge (refer to Figure 2 for the specific location).

3.3 EXPLORATION WEST ABUTMENT

Exploration work in the west abutment consisted of drilling three sounding holes adjacent to the west headwall, three sounding holes along the south line of the bridge, and one geotechnical borehole. Figure 2 shows the specific locations of the sounding holes (S-20 through S-25) and the geotechnical borehole (B-2). Photograph 6 in Figure 5 shows the locations of S-20, S-21, and S-22 in the eastbound traffic lane and the drilling of S-25.

3.4 DRILLING EQUIPMENT AND METHOD

The streambed soundings were advanced using a skid-mounted Diedrich D-25 rig with 6-inch-diameter solid shaft continuous flight augers. The surrounding holes were advanced until foundation concrete (refusal) was encountered or to a maximum depth of 19.4 feet. The drilling contractor for this work was HEW Drilling Company, Inc. (HEW). The rig and drilling method are shown in Photograph 5, Figure 5. The Diedrich D-25 rig was lowered into the creek with a 30-ton crane and was moved with a Bobcat loader.

For drilling the foundation core boring (S-14/C-14), the skid-mounted Diedrich D-25 rig was used. Hollow stem continuous augers were used to case through the overburden soils above the west pier foundation. After setting the hollow stem augers on the foundation, the drilling method was converted to a rotary/diamond coring procedure.

The streambed geotechnical borehole (B-1) was advanced using a track-mounted Failing 750 rotary-type drill rig from Pitcher Drilling Company, Inc. The track-mounted rig used a Town of Ross creek bank ramp for access to the creek channel. The geotechnical borehole B-1 was advanced to about 31 feet below the streambed elevation that existed on October 18, 2001. Borehole B-1 was sampled at 5 foot intervals or less using the sampling equipment and tools described in Section 3.5. A cathead, rope, and 140-pound safety hammer was used for driving the driven-type samplers.

The west abutment sounding holes were drilled by HEW with a CME 75 rig using 8-inch-outside-diameter hollow stem augers for S-20 and 6-inch-diameter solid shaft augers for S-21 through S-25. The rig and drilling method are shown in Photograph 2, Figure 3 and Photograph 6, Figure 5. Sounding S-20 was drilled to 35 feet at which depth a standard penetration test was performed. Sounding S-21 was advanced to only about 8 inches due to encountering the west headwall. Sounding S-22 was moved about three inches to the west of S-21 and was drilled to 30.5 feet below the top of the asphalt pavement. The edge of the solid shaft auger was in contact with the west side of the headwall. Soundings S-23 through S-25 were drilled to 10.5 feet.

The west abutment geotechnical borehole (B-2) was drilled with a CME 75 using 8-inch-diameter hollow stem auger to about 41 feet. Disturbed and undisturbed samples were obtained at 5 foot intervals or less. A 140-pound CME auto-hammer was used for driving the driven-type samplers. After 41 feet, the drilling method was converted to rotary/diamond coring. The rock encountered in borehole B-2 was cored from 41 to 43.7 feet.

3.5 SAMPLING EQUIPMENT AND TOOLS

The following is a brief description of the sampling and coring equipment used to collect soil samples, and to obtain concrete and rock cores.

Dames & Moore U-Sampler

The U-sampler was used to obtain relatively undisturbed samples for laboratory testing. The U-sampler is a ring-lined, split-barrel sampler with a nominal 2½-inch inner diameter and 3¼-inch outer diameter, in substantial compliance with ASTM D 3550. The U-sampler was driven with either a 140-pound safety hammer or a 140-pound CME auto-hammer falling 30 inches.

Standard Penetration Sampler

The standard penetration sampler was used in conjunction with the Standard Penetration Test (SPT), ASTM D 1586, to obtain disturbed samples for soil identification and to obtain penetration resistance data for correlation with engineering properties. The standard penetration sampler consists of a head, split-barrel, and drive shoe. The nominal outer diameter is 2 inches. The inner diameter of the drive shoe is 1⅜ inches and the inner diameter of the split-barrel section is 1.5 inches. The standard penetration sampler was driven with either a 140-pound safety hammer or a 140-pound CME auto-hammer falling 30 inches as specified in ASTM D 1586.

Pitcher Sampler

The Pitcher sampler is a double-tube core barrel in which the inner barrel is spring loaded so as to provide for the automatic adjustment of the distance by which the cutting edge of the inner barrel leads the coring bit. The Pitcher sampler used on this project was equipped with a 2⅞-inch inner diameter thin-walled sampling tube. This sampler is effective in obtaining relatively undisturbed samples of stiff to hard cohesive soils.

Shelby Tube Sampler

This sampler is commonly used to obtain undisturbed samples. The sampler consists of a thin-wall metal tube connected to a sampler head with a ball-check valve. The tube is drawn in at the lower end and is reamed to form the cutting edge. The Shelby tubes were 3 feet long with an outer diameter of 3 inches and an inner diameter of $2\frac{7}{8}$ inches. The Shelby tubes were pushed with a continuous, smooth hydraulic stroke.

Double-Tube Core Barrel

The double-tube core barrel with a 5-foot-long split inner barrel and a diamond bit was used to core the foundation concrete (S-14/C-14) and the rock (B-2). A “NV” size core (1.99-inch diameter) was recovered.

3.6 ABANDONMENT OF BOREHOLES AND CUTTINGS DISPOSAL

Sounding holes S-1 through S-19 were abandoned by allowing the auger cuttings to fall back into the bored hole. No auger cutting spoils were generated from these sounding holes.

Auger cutting spoils were generated from sounding holes S-20 through S-25 in the west abutment. These spoils were placed in 55-gallon drums for chemical profiling and disposal. Sounding holes S-23 through S-25 were backfilled with cement grout that was placed into an open hole because no groundwater was encountered. Soundings S-20 and S-22 were backfilled with cement grout that was placed by a tremie method. Auger cuttings were backfilled into sounding S-21 to within seven inches of the top of the asphalt pavement. The top seven inches of sounding holes S-20 through S-22 were patched with compacted cold-mix asphalt.

The geotechnical boring in the streambed (B-1) was abandoned by backfilling the borehole with a cement-bentonite grout to within 5 feet of the current streambed surface. The grout was placed by a tremie method. The upper 5 feet of the borehole was allowed to cave and form a natural, gravelly backfill over the cement-bentonite grout.

The geotechnical boring in the west abutment (B-2) was abandoned by backfilling the borehole, with a cement-bentonite grout that was tremied. The grout was placed to within seven inches of the top of the asphalt pavement. The top seven inches of borehole B-2 was patched with compacted cold-mix asphalt.

Drill spoils were generated from the two geotechnical boreholes. These spoils were contained in 55-gallon drums.

Eight drums of drill spoils were profiled and transported to the Altamont Landfill for disposal by Foss Environmental and Infrastructure.

4.0 LABORATORY TEST PROGRAM

A geotechnical testing program was performed in the laboratory to measure the index and engineering properties of the major subsurface strata encountered at the site. The geotechnical testing program included conventional tests to confirm the existing information on the engineering characteristics of the major strata and to refine some of the engineering parameters where it was deemed appropriate. The tests were performed by Signet Testing Labs, Inc. This section briefly describes the testing program and procedures for the different types of tests and presents the test results.

4.1 INDEX TESTS

The index tests included moisture contents, density determinations, Atterberg limits, and grain-size analyses using mechanical sieve in accordance with the applicable ASTM standards. The ASTM standards consisted of:

- ASTM D 2216 for moisture content tests;
- ASTM D 2937 for total and dry density tests;
- ASTM 422 for grain size analyses; and
- ASTM D 4318 for Atterberg Limits.

Results of the moisture content, total density, grain size analyses and Atterberg limits are presented on the Log of Boring adjacent to the appropriate sample depth and are summarized in Table 1. The laboratory data reports from Signet Testing Labs are presented in Appendix B.

4.2 SHEAR STRENGTH TESTS

Unconsolidated, Undrained Triaxial Compression Tests (TXUU) were performed on selected samples of the soil. The tests were performed consistent with the procedures in ASTM D 2850. The samples were tested at a confining pressure of approximately equal to the total overburden pressure, except for the shale sample from borehole B-1. Results of TXUU tests are presented adjacent to the appropriate sample depth on the Log of Boring and in Table 2. Deviator stress versus axial strain for each of the tests are presented in the Signet Testing Labs, Inc. data reports (Appendix B).

A Consolidated, Drained Direct Shear Test (DSCD) was performed on Sample 2 from borehole B-1. The test was performed consistent with the procedures in ASTM D 3080. The results of the DSCU test are reported in Table 2 and in Appendix B.

4.3 CONSOLIDATION TESTS

Two consolidation tests (consol) were performed on selected samples to evaluate compressibility characteristics. The tests were performed substantially in accordance with the ASTM D 2435. Small consolidation stress increments were applied until the specimen was compressed into the virgin compression zone. The purpose of this procedure was to refine the estimates of the maximum past pressure. An unload cycle was performed to evaluate the recompression characteristics of the soils.

Table 3 presents the results of the consolidation tests. The compressibility parameters, Compression Index (C_c), Recompression Index (C_r), and coefficient of consolidation (c_v) for the in-situ effective stress level of the sample are summarized on the table. The maximum past pressure was estimated using the Casagrande construction and the end-of-primary consolidation compression curve. The overconsolidation ratio (OCR) can be computed from the maximum past pressure divided by the in-situ vertical effective pressure at the depth from which the sample was taken.

The compression curves (vertical strain at the end of the load increment versus the log of the effective stress), coefficient of vertical consolidation versus the log of the effective stress curves, and the time-rate curves are included in the Signet Testing Labs, Inc. data reports (Appendix B).

5.0 GEOLOGIC SETTING

The bridge crosses Corte Madera Creek in the central Ross Valley near the Town Hall of Ross. Holocene alluvium, consisting predominantly of gravels, sands, and silts, with some clay, underlies the valley, which at this point is about 1,500 to 2,000 feet wide. The hills to the east of Sir Francis Drake Boulevard are composed of interbedded sandstones and shales of the Franciscan assemblage that trends NW-SE. Where observed, bedding also strikes NW-SE and dips steeply easterly. The hills west of Sir Francis Drake Boulevard are underlain by Franciscan melange, a tectonic mixture of sheared shale and sandstone with hard inclusions of chert, greenstone, sandstone, and some serpentinite (Blake et al., 1974).

The bridge is located about 7.5 miles northeast of the active San Andreas Fault and 11 miles southwest of the active Hayward Fault (Walter et al., 1998). Therefore, the bridge will be exposed to strong shaking during future earthquakes.

6.0 SITE CONDITIONS

This section describes surface conditions at the time of our exploration work, bridge foundation types and configurations, and the subsurface conditions encountered in the streambed and west abutment.

6.1 SURFACE CONDITIONS

The roadway and bridge deck are paved with an asphalt concrete (AC). In the west abutment the AC ranges from 7 to 8 inches in thickness. The top of the pavement is about elevation 25 feet National Geodetic Vertical Datum of 1929 (NGVD), based on the vertical control survey performed by Carruthers Land Surveying for Sverdrup/Gerwick JV. The reference monument was located at the corner of Lagunitas Road and Sir Francis Drake Boulevard and is stamped County of Marin RC-1. The monument has an elevation of 26.601 feet NGVD.

The streambed elevation at the time of our explorations ranged from 10 to 11 feet NGVD in the vicinity of the bridge. About one week prior to our streambed exploration work, the Town of Ross dredged two to three feet of sediments from the creek channel in the vicinity of the bridge. The Town of Ross performs this dredging operation annually under a permit from Fish and Game.

The retaining walls located north and south of the west headwall are separate structures that appeared to be constructed sometime after the original bridge and headwall were constructed. The retaining wall north of the west headwall has separated from direct contact with the headwall and the top of the retaining wall appears to be tilting towards the creek.

The surface soils between the two bridge piers consist of predominantly fine to coarse gravels. The surface soils between the headwalls and bridge piers grades finer to silts and clays with sand and gravel.

6.2 BRIDGE FOUNDATION TYPES AND CONFIGURATIONS

Based on the results of our explorations and information provided by Sverdrup/Gerwick JV, data and findings are presented in this section that describe foundation types, depths, and configurations.

West Bridge Pier

Sounding holes S-1, S-3, S-6, S-11, S-12, and S-14 encountered very hard drilling and/or auger refusal at about 9.2 to 9.8 feet below the streambed level at the time of our exploration. The soil conditions and description of drilling conditions for 12 sounding holes advanced adjacent to the west bridge pier are presented in Table 4. The very hard drilling and/or auger refusal encountered in six sounding holes is related to the west pier foundation. This conclusion was confirmed with the recovery of the 27 inch concrete core from S-14/C-14, and the visual inspection conducted by Sverdrup/Gerwick JV in the test pit dug to expose the foundation along the west side of the west bridge pier (oral communication with Robert Filgas, November 5, 2001). Based on the Sverdrup/Gerwick JV inspection, the west bridge pier is supported on a spread footing foundation. The estimated dimensions of the west pier foundation are 5.7 feet wide, 32.5 feet long, and 2.3 feet (27 inches) deep. Based on the concrete core, the lower 10 inches of the 27-inch core indicates that the concrete was placed under water because of secretion evidence (i.e., cement paste washed out) as shown in Photograph 7, Figure 6. The west pier foundation elevation is shown in Figure 7. The top of the footing foundation is at elevation 1.5 feet (NGVD) and the bottom is at elevation -0.75 feet (NGVD).

East Bridge Pier

Based on sounding S-18 (Table 4), the top of the pier foundation may be at 10.7 feet below the streambed level at the time of our exploration. The four sounding holes would indicate that the width of the foundation is 5 feet and that it extends less than 1.5 feet on the southern side of the east pier. Based on the data collected at the southern end of the east pier, the estimated dimensions of the foundation are 5 feet wide and 30 feet long. Since the west bridge pier is supported on a spread footing foundation, it is assumed that the east bridge pier is also supported on the same type of foundation. A precise foundation elevation was not determined for the east bridge pier. Estimated foundation elevations are presented in Figure 7. The top of the footing foundation may be at elevation 1.5 feet (NGVD), based on the data from the west pier location or at elevation 0.25 feet (NGVD), based on the results of S-18.

Retaining Wall North of West Headwall

Based on soundings S-9 and S-10 (Table 4) and the excavated test pit (location shown on Figure 2), the retaining wall is supported on a spread footing foundation that extends 33 inches east from the wall face. The top of the foundation is 1.1 feet below the streambed level (at the time of exploration) and the bottom is 2.1 feet below the streambed level. Based on the elevation at the time of our exploration, the top of the foundation is 10.5 feet NGVD.

West Abutment Headwall

Sounding S-8 (Figure 2) indicates any foundation extending beyond the east face of the west headwall is less than 18 inches. No foundation was encountered in S-8 within the 14.4 foot depth investigated (Table 4). Soundings S-20 and S-22 did not encounter a foundation within the depths investigated (S-20, 36.5 feet and S-22, 30.5 feet). Sounding holes S-23 through S-25 did not encounter any wing wall coming off the west headwall. The bottom elevation of the west abutment headwall cannot be determined from this exploration since no foundation was encountered in soundings S-8 and S-22.

6.3 SURFACE CONDITIONS

The surface conditions described are based on visual classification of the auger cuttings from the sounding and geotechnical boreholes, conversion of the various driven sampler resistances to SPT N-values (i.e., blows per foot), and laboratory classification test results.

West Abutment

Below the 7 to 8 inches of AC, about 21 inches of aggregate base material exists. The subsoil below the aggregate base and behind the west headwall consists of sandy lean clay (CL) with a stiff to very stiff consistency to about 15 feet below the top of the pavement (elevation 10 feet NGVD). From about 15 feet (10 feet NGVD) to about 25 feet (0 feet NGVD), the sandy lean clay exhibits a slight increase in plasticity and the consistency decreases from stiff to medium stiff. From about 25 feet (0 feet NGVD) to about 29.5 feet (-4.5 feet NGVD), clayey sand (SC) with gravel is interbedded with sandy clay. From about 29.5 feet (-4.5 feet NGVD) to about 35 feet (-10 feet NGVD), sandy clay (CL) of medium stiff to stiff consistency was encountered. Below the sandy clay, a medium dense, poorly-graded sandy gravel with silt (GP-GM) existed to about 38.5 feet (-13.5 feet NGVD). Below the poorly-graded sandy gravel, bedrock consisting of shale and sandstone (graywacke) was encountered. The elevation of the top of the bedrock is -13.5 feet NGVD. The subsoil profile described is also presented in Figure 7.

The driven sampler resistance that has been converted to an equivalent SPT N-value using a procedure reported in Fang (1991) and shear strength data are plotted in Figure 8.

Groundwater was not measured at the time of drilling. It is estimated that the groundwater in the west abutment is about elevation 5.0 feet NGVD due to free water observed on the sample tube.

Streambed

The streambed subsoils between the two bridge piers consist of sorted clayey sand (SC), well-graded sandy gravel (GW), well-graded gravelly sand with silt (SW-SM), well-graded sandy gravel with a trace of silt (GW-GM), and poorly-graded sandy gravel with silt (GP-GM). The stratification of these granular-type deposits is shown in Figure 7. About elevation -14.0 feet NGVD, shale bedrock is encountered. Sandstone was not encountered in the streambed boring B-1 within elevation -21 feet NGVD.

The driven sampler resistance that has been converted to an equivalent SPT N-value is plotted in Figure 9. A consolidated, drained direct shear test performed on well-graded gravelly sand with silt measured a shear strength of cohesion (c) equal to 1,250 psf and phi equal to 37 degrees.

The upper subsoils between the piers and headwalls generally grades finer. This is limited to the upper 10 to 15 feet of streambed soils.

Groundwater was encountered at the surface in the streambed during our exploration (about elevation 10.5 feet NGVD).

7.0 REFERENCES

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**TABLE 1
INDEX TEST RESULTS SUMMARY**

Boring and Sample No.	Sample Depth (feet)	Laboratory Soil Classification	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Other Tests
B-1, 1	4-5.5	GW				71.8	26.0	2.2				
B-1, 2	9-10.5	SW-SM	16.4 20.4 17.3	140.6 136.8 144.4	120.8 113.6 123.1	39.6	51.0	9.4				DSCD
B-1, 3	12-13.5	GW-GM				63.4	30.7	5.9				
B-1, 4	14-15.5											
B-1, 5	20-21.5											
B-1, 6	25-25.5											
B-1, 7	30-31	CL	10.5	142.3	128.9				31	19	12	TXUU
B-2, 1	4.5-6											
B-2, 2A	9.5-10.5	CL	15.1	123.3	107.1	0	33.7	66.3	32	22	10	TXUU
B-2, 3	14.5-17	CL	24.3 23.8	128.8 123.8	103.7 100.2				36	22	14	TXUU Consol
B-2, 4	19.5-22	CL	22.3 26.2	128.8 124.2	105.2 98.4	0	36.6	63.4	43	23	20	TXUU Consol
B-2, 5	24.5-26.5	SC				22.4	62.8	14.8	26	18	8	
B-2, 6	29.5-31	(Visual) CL				18.3	29.9	51.8				
B-2, 7	34.5-36	GP-GM				45.1	43.3	11.6				
B-2, 8	39.5-40.1											

**TABLE 2
SHEAR STRENGTH TEST SUMMARY**

Boring and Sample No.	Sample Depth (feet)	Type of Test	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Confining Stress (psf)	Undrained Shear Strength (psf)	Normal Stress (psf)	Peak Shear Stress (psf)	Displacement (inches)	Consolidated, Drained Strength
B-1, 2, 1 B-1, 2, 2 B-1, 2, 3	9-10.5	DSCD	16.4 20.4 17.3	140.6 136.8 144.4	120.8 113.6 123.1	— — —	— — —	1,200 4,000 7,200	2,150 3,770 6,677	0.144 0.129 0.162	c = 1,250 psf phi = 37 degrees
B-1, 7	30-31	TXUU	10.5	142.3	128.9	10,000	240	—	—	—	—
B-2, 2	9.5-10.5	TXUU	15.1	123.3	107.1	1,150	3,986	—	—	—	—
B-2, 3	14.5-17	TXUU	24.3	128.8	103.7	1,650	1,514	—	—	—	—
B-2, 4	19.5-22	TXUU	22.3	128.8	105.2	2,500	728	—	—	—	—

**TABLE 3
CONSOLIDATION TEST RESULTS SUMMARY**

Boring and Sample No.	Sample Depth (feet)	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	In-Situ Vertical Effective Stress (pcf)	Maximum Past Pressure (pcf)	Compression Index (C_c)	Recompression Index (C_r)	Coefficient of Consolidation at In-Situ Stress (c_v, ft²/day)
B-2, 3	14.5-17	23.8	123.8	100.2	1,950	6,200	0.240	0.035	0.66
B-2, 4	19.5-22	26.2	124.2	98.4	2,570	5,800	0.274	0.055	0.32

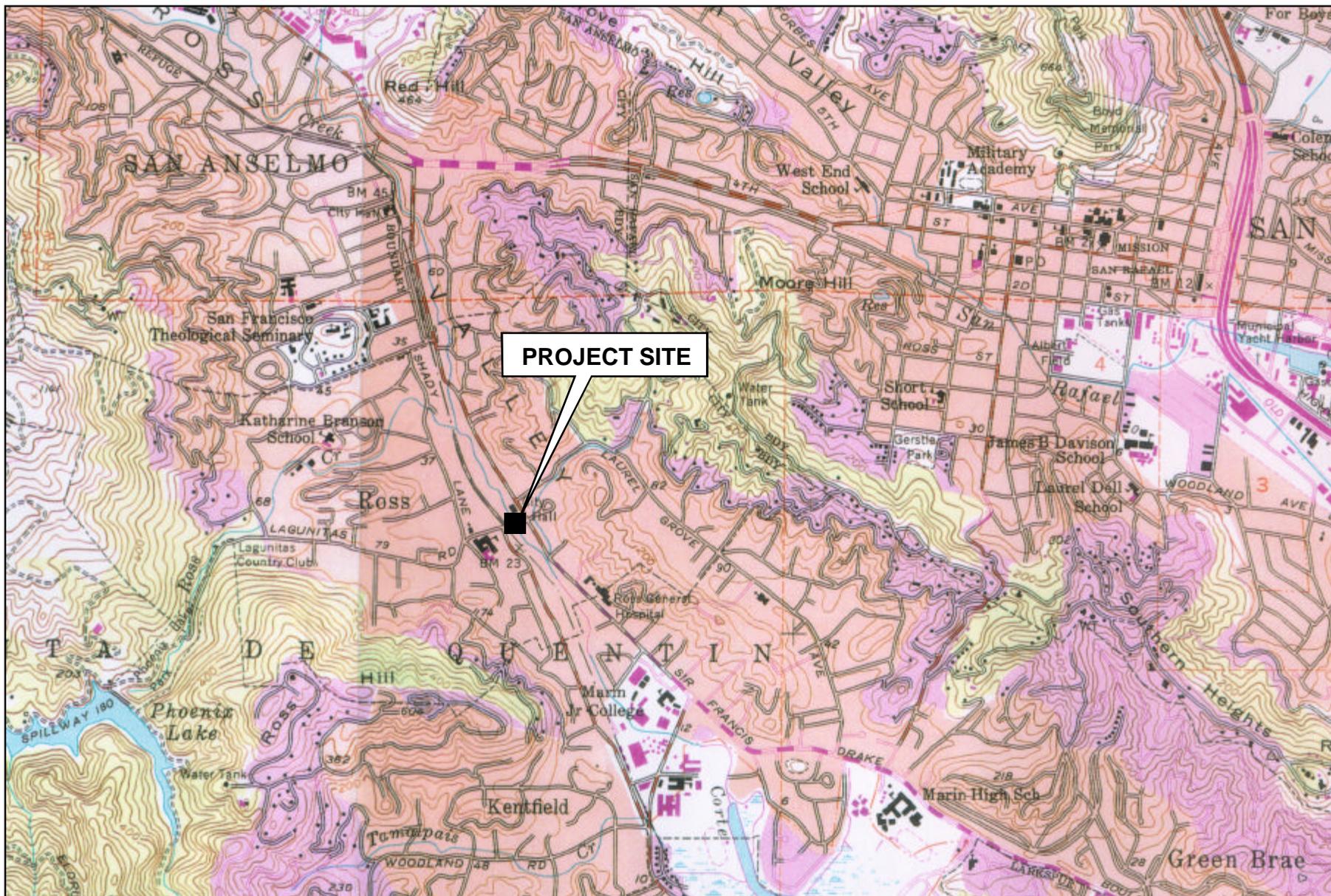
**TABLE 4
SOUNDING HOLE SUMMARY**

Sounding Hole No.	Date Drilled	Depth (feet)	Soil Description	Description of Drilling Conditions	Remarks
S-1	10/15/01	9.3	Grayish to Brownish Gravels, rounded to subrounded, relatively loose.	Very hard drilling between 9.2 and 9.3 feet. Timber pieces on auger bit.	Center of hole about 24 inches from east side of west pier. Possible interface between foundation concrete and wood lagging encountered at 9.2 feet.
S-2	10/15/01	14.1	0-12.5' Gravels, rounded to subrounded. 12.5'-14.1' Brownish Clayey Sand with silt.	No hard drilling.	Center of hole about 37 inches from east side of west pier. No concrete or timber encountered.
S-3	10/15/01	9.3	Gravels, rounded to subrounded.	Very hard drilling at 9.3 feet. Rig lifted. A few small pieces of timber augered up.	Center of hole about 19 inches from east side of west pier. Possible foundation concrete at 9.3 feet.
S-4	10/15/01	14.2	0-12' Gravels, rounded to subrounded. 12'-14.2' Clayey Sand.	Drilling resistance between 9.2 and 10 feet timber pieces.	Center of hole about 33 inches from east side of west pier. No concrete encountered.
S-5	10/15/01	14.3	0-12' Gravels, rounded to subrounded. 12'-14.2' Clayey Sand.	No hard drilling.	Center of hole about 47 inches from east side of west pier. No concrete encountered.
S-6	10/15/01	9.4	Gravels, rounded to subrounded.	Very hard drilling at 9.4 feet. Pieces of steel on auger bit.	Center of hole about 21 inches from east side of west pier. Possible foundation concrete at 9.4 feet.
S-7	10/15/01	14.4	0-11' Gravels, rounded to subrounded. 11'-14.4' Clayey Sand.	Brick pieces augered up at 9.5 to 10 feet. No hard drilling.	Center of hole about 38 inches from east side of west pier. No concrete encountered.
S-8	10/15/01	14.4	Brownish fine Sandy Clay with Silt grades to Clayey Sand.	No hard drilling.	Center of hole about 21 inches east of the west headwall. No concrete encountered.

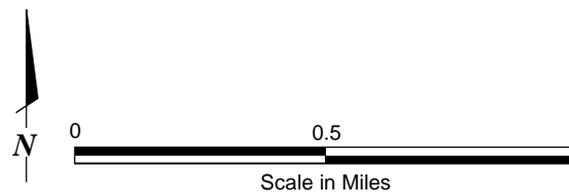
Sounding Hole No.	Date Drilled	Depth (feet)	Soil Description	Description of Drilling Conditions	Remarks
S-9	10/16/01	1.1	0-1.1' Gravel with Clayey Sand. 1.1' Concrete.	Refusal at 1.1 feet.	Center of hole about 19 inches east of retaining wall. Concrete footing at 1.1 feet.
S-10	10/16/01	2.0	0-1' Gravel and Clayey Sand. 1-2' Timber and Concrete pieces.	Refusal at 2.0 feet.	Center of hole about 34 inches east of retaining wall. Edge of concrete footing.
S-11	10/16/01	9.2	0-8' Gravels, rounded to subrounded. 8'-9.2' Gravels with Clayey Sand.	Very hard drilling at 9.2 feet. Rig lifted.	Center of hole about 20 inches north of the west pier. Possible foundation concrete at 9.2 feet.
S-12	10/16/01	9.2	0-8' Gravels, rounded to subrounded. 8'-9.2' Gravels with Clayey Sand.	Very hard drilling at 9.2 feet. Rig lifted.	Center of hole about 30 inches north of the west pier. Possible foundation concrete at 9.2 feet.
S-13	10/16/01	14.4	0-9.5' Gravels , rounded to subrounded. 9.5'-14.4' Brownish Silt with fine Sand and Clay.	No hard drilling.	Center of hole about 43 inches north of the west pier. No concrete encountered.
S-14	10/16/01	9.8	0-4' Gravels, rounded to subrounded. 4'-9.8' Grayish Clayey Sand with Gravel.	Very hard drilling at 9.8 feet. Rig lifted.	Center of hole about 25 inches south of the west pier. Possible foundation concrete at 9.8 feet. This location selected for core boring (C-14).
S-15	10/16/01	14.4	0-4' Gravels, rounded to subrounded. 4'-14.4' Grayish Clayey Sand with Gravel.	No hard drilling.	Center of hole about 49 inches south of the west pier. No concrete encountered.
S-16	10/16/01	14.4	Grayish Clayey Sand with Gravel.	No hard drilling.	Center of hole about 27 inches west of the west side of the east pier. No concrete encountered.
S-17	10/17/01	19.4	Grayish Clayey Sand with Gravel.	No hard drilling.	Center of hole about 18 inches south of the east pier. No concrete encountered.

Sounding Hole No.	Date Drilled	Depth (feet)	Soil Description	Description of Drilling Conditions	Remarks
S-18	10/17/01	10.7	0-10.3' Grayish Clayey Sand with Gravel. 10.3'-10.7' Light gray Clay with Gravel and some timber pieces.	Auger refusal at 10.7 feet. Standard penetration test conducted at 10.7 feet. Fifty blows for first inch of penetration. No concrete in tip of sampler.	Center of hole about 18 inches southwest of the south end of the east pier. Possible foundation at 10.7 feet.
S-19	10/17/01	19.4	Grayish Clayey Sand with Gravel.	No hard drilling.	Center of hole about 23 inches southwest of sounding S-18. No concrete encountered.
S-20	10/19/01	36.5	0-7" Asphalt. 7"-21" Aggregate Base. 21"-13' Reddish Brown Lean Clay with Sand. 13'-22' Reddish Brown Silty Clay with Sand. 22'-35' Gray Brown, Sandy Clay grading to Clayey Sand with Gravel. 35'-36.5' Sandy Gravel with standard penetration test N-value of 19 blows per foot.	No concrete encountered.	Hole about 2 feet west of the west headwall. No foundation encountered within 36.5 feet.
S-21	10/19/01	0.7	0-8" Asphalt. 8" Concrete of Headwall in east half of boring. 8"-16" Void under Asphalt in west half of boring.	Refusal hit top of west headwall.	Hole over west headwall.
S-22	10/19/01	30.5	Soil profile same as S-20	Timber pieces noted in auger cuttings from about 8 feet. No concrete encountered.	Hole is about 6 inches from west headwall. No foundation or concrete encountered within 30.5 feet.
S-23	10/19/01	10.5	Reddish Brown Lean Clay with Sand.	No hard drilling.	Hole is about 30 inches west of the south concrete light pole stand in the west abutment. No foundation encountered.

Sounding Hole No.	Date Drilled	Depth (feet)	Soil Description	Description of Drilling Conditions	Remarks
S-24	10/19/01	10.5	Reddish Brown Lean Clay with Sand.	No hard drilling.	About 2 feet east of sounding S-23. No foundation encountered.
S-24	10/19/01	10.5	Reddish Brown Lean Clay with Sand.	No hard drilling.	About 1.5 feet east and 0.5 feet north of sounding S-23. No foundation encountered.



Source:
 USGS 7.5 Min. Series, San Rafael, California
 Quadrangle, photorevised 1980.



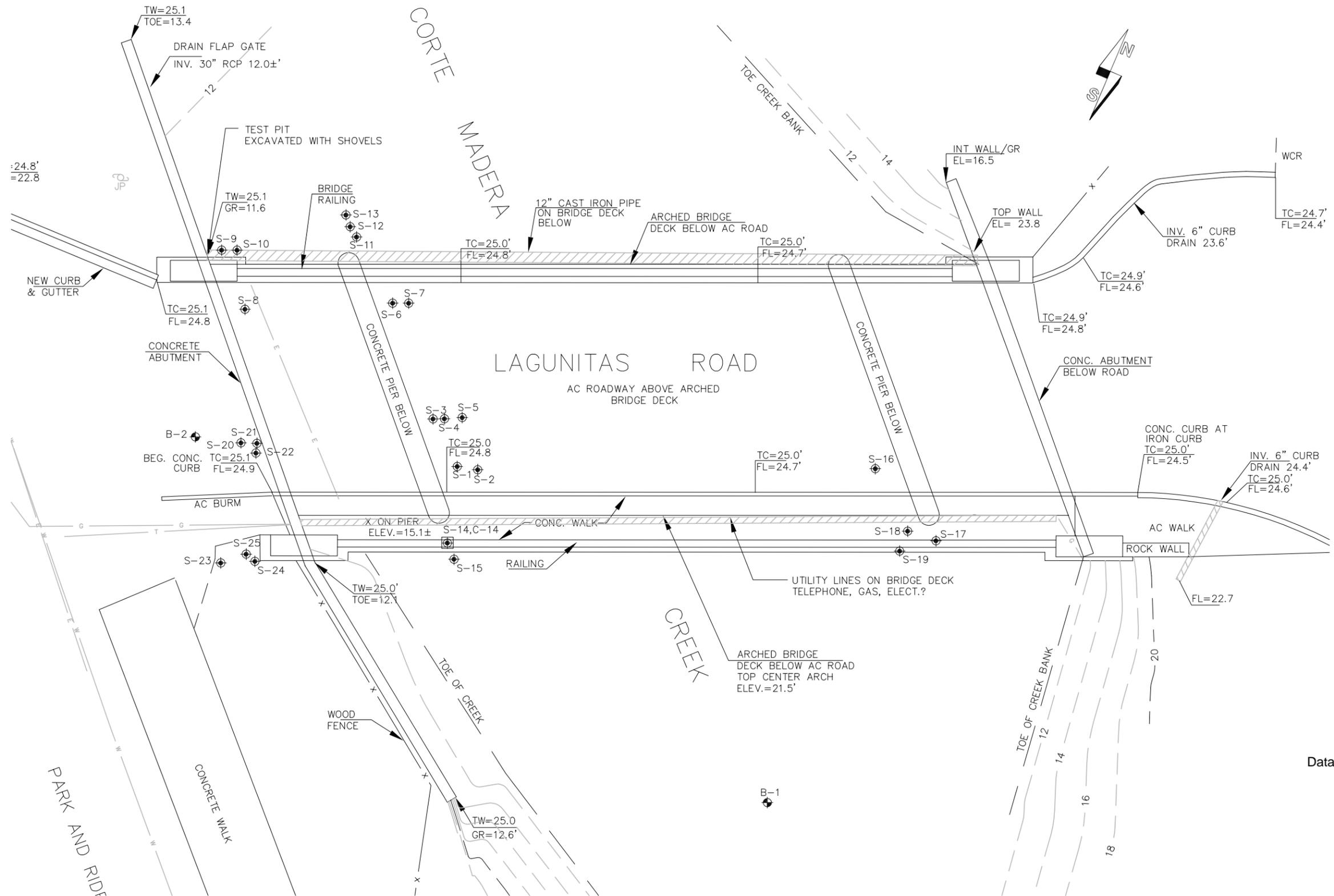
SITE VICINITY MAP

Lagunitas Road Bridge Project
 Geotechnical Data Report
 Ross, California

January 2002
 43-00067008.00



FIGURE 1



LEGEND:

- ⊕ Auger Soundings
- ⊕ Auger Sounding and Foundation Core Hole
- ⊕ Geotechnical Boreholes



Data Reference: Topographic Survey Prepared By Carruthers Land Surveying for Sverdrup/Gerwick JV, November 2001

BORING AND SOUNDING LOCATION PLAN

January 2002
43-00067008.01

Lagunitas Road Bridge Project
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Ross, California



FIGURE 2



Photograph 1: Elevation View of Lagunitas Road Bridge - looking to south from the middle of the streambed.



Photograph 2: Roadway View of Lagunitas Road Bridge - looking towards east (Sir Francis Drake Blvd.). Also, shows CME 75 rig drilling a sounding hole in the west abutment.

SITE PHOTOS

Lagunitas Road Bridge Project
Geotechnical Data Report
Ross, California

January 2002
43-00067008.00



FIGURE 3



Photograph 3: View of west bridge pier - looking to north. Shows staked locations of 10 sounding holes drilled along east and north sides of the west pier.



Photograph 4: View of east bridge pier - looking to north. Shows staked locations of 4 sounding holes drilled west and south of the east pier.

SITE PHOTOS

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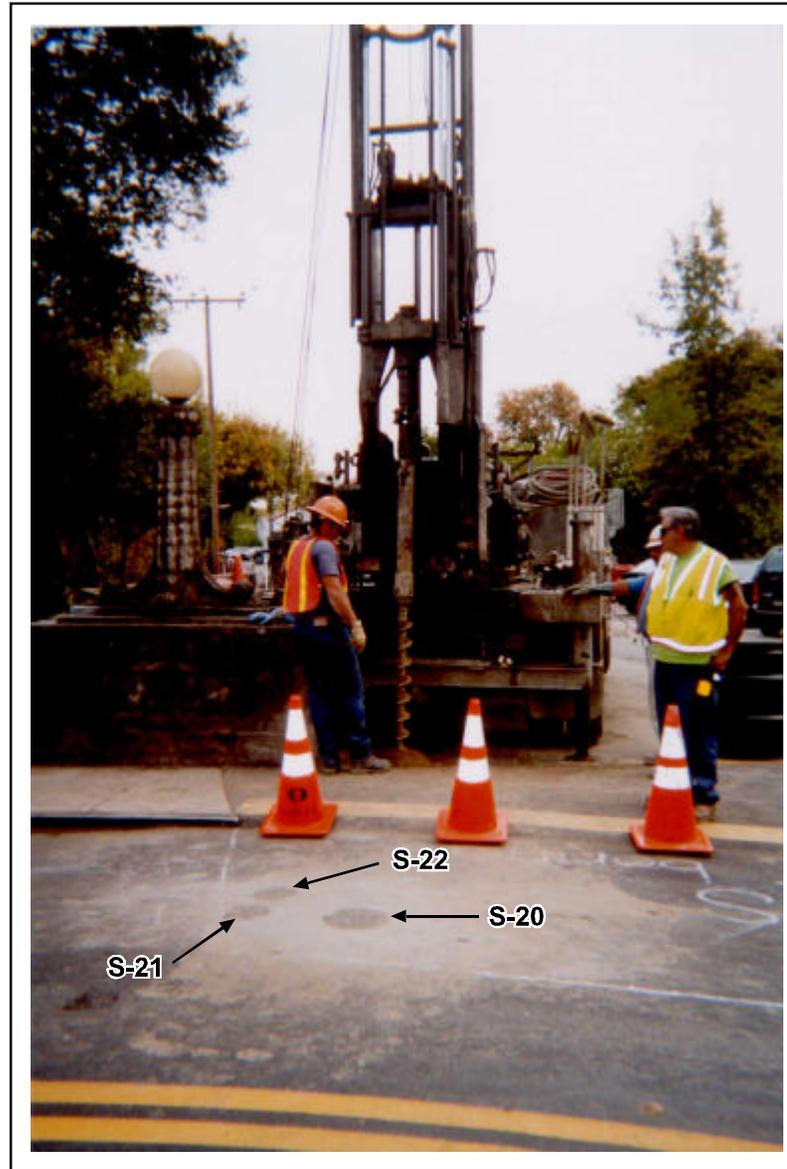
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FIGURE 4



Photograph 5: Shows skid-mounted Diedrich D-25 rig drilling sounding hole S-17 south of the east bridge pier.



Photograph 6: Shows truck-mounted CME 75 rig drilling sounding hole S-25 and the locations of sounding holes S-20, S-21, and S-22 in the west abutment.

SITE PHOTOS

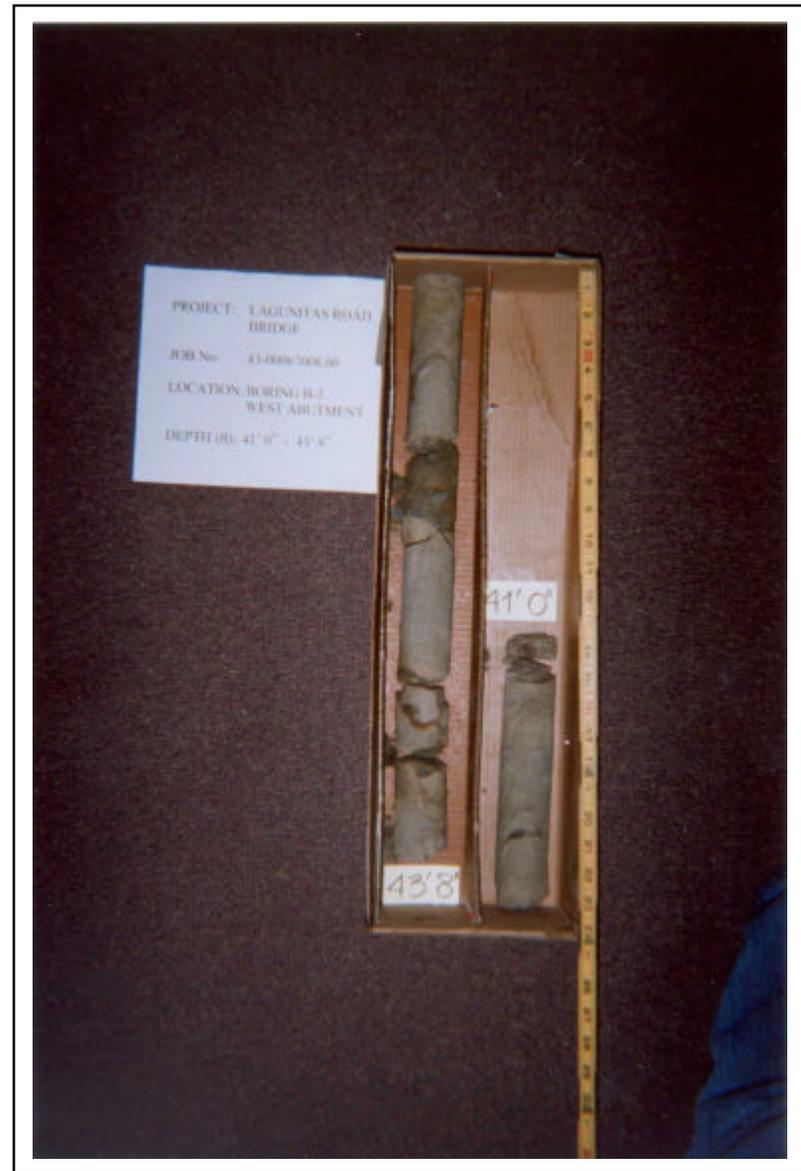
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FIGURE 5



Photograph 7: Shows core of foundation concrete sounding S-14, C-14 recovered from the south end of the west bridge pier. Total length of the concrete core is 27 inches.



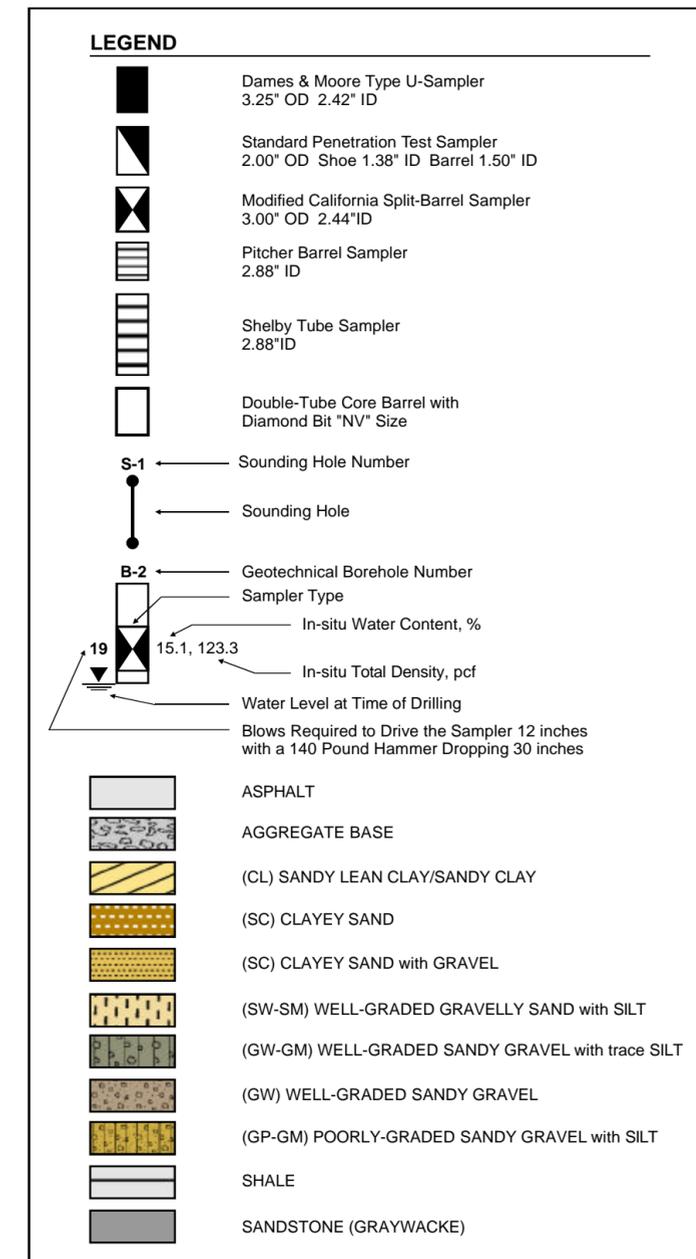
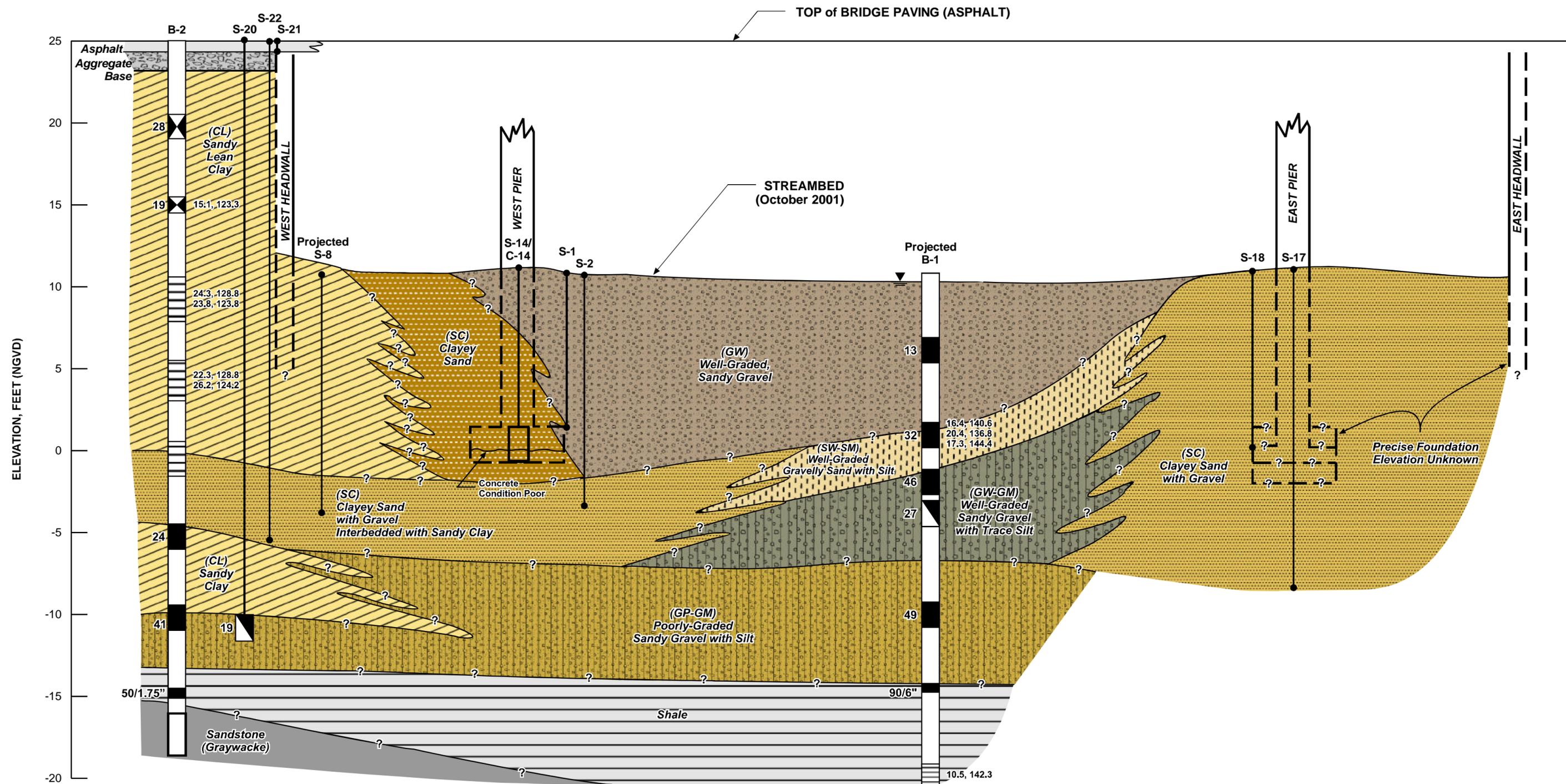
Photograph 8: Shows rock core recovered from geotechnical borehole B-2 (west abutment). Rock is graywacke sandstone.

SITE PHOTOS

Lagunitas Road Bridge Project
 January 2002
 43-00067008.00
 Geotechnical Data Report
 Ross, California

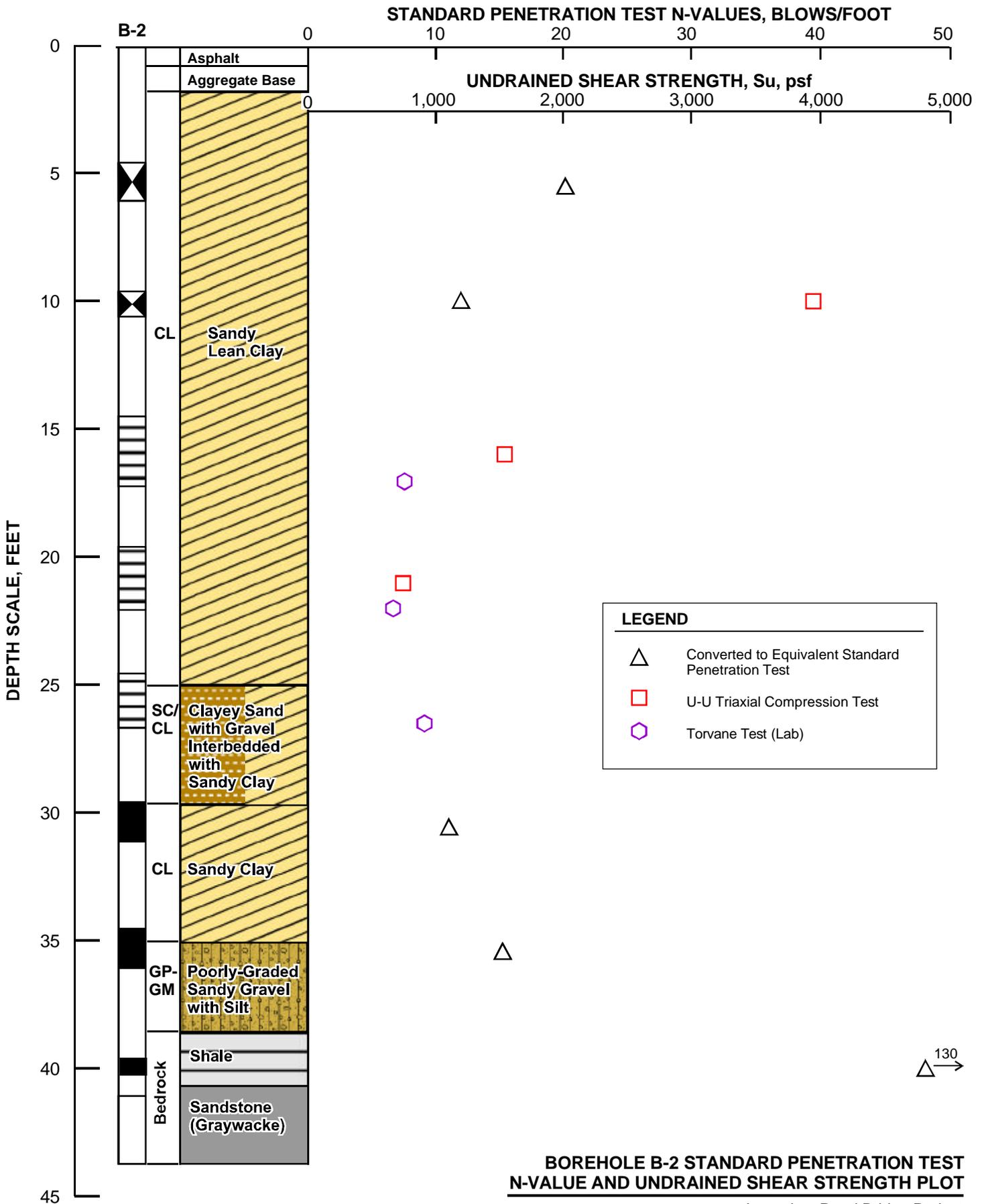


FIGURE 6



SUBSURFACE PROFILE
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 Ross, California

1/28/02 sv...43-00067008.00/profile.cdr
 1/30/02 vsa



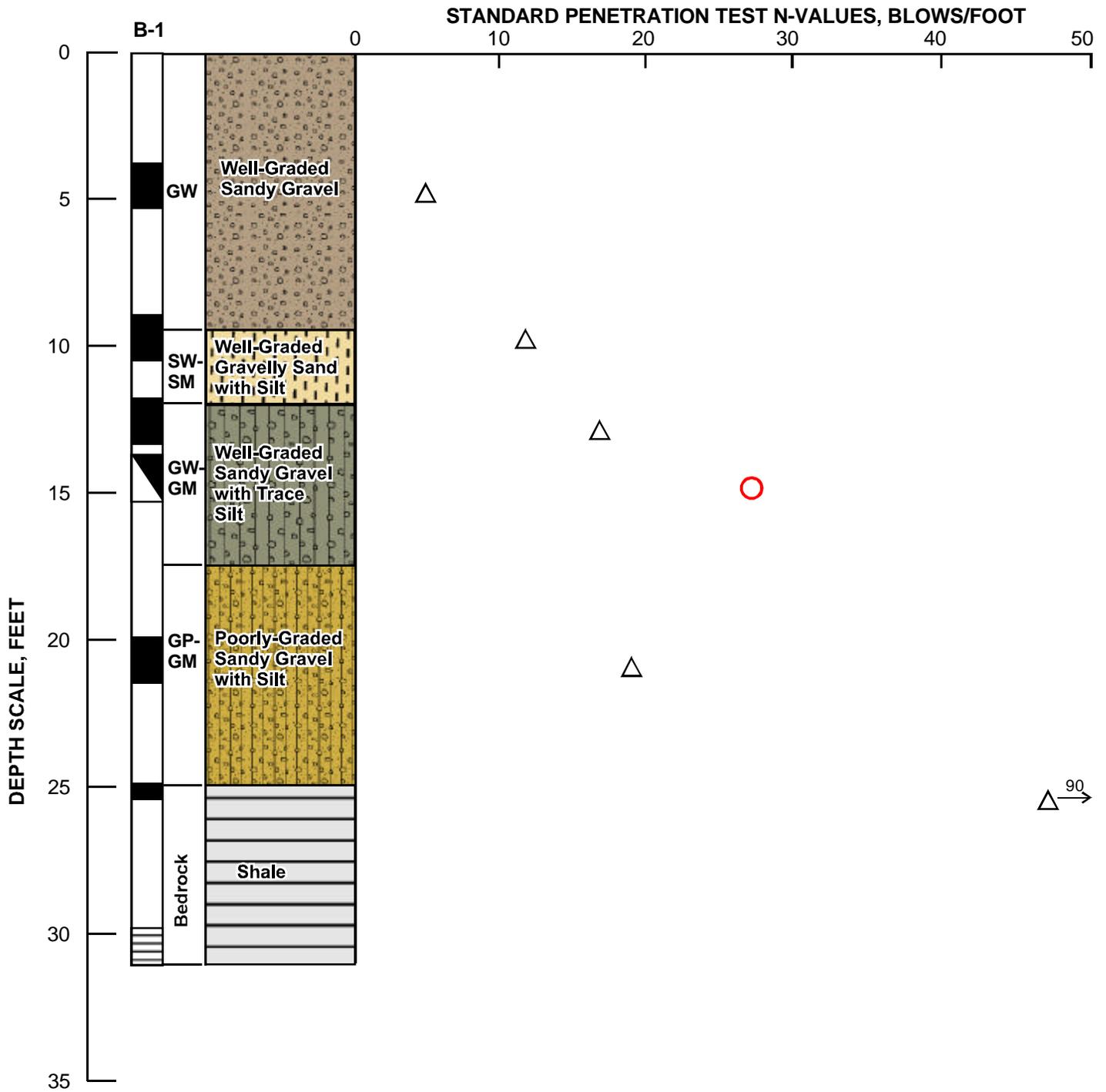
BOREHOLE B-2 STANDARD PENETRATION TEST N-VALUE AND UNDRAINED SHEAR STRENGTH PLOT

January 2002
43-00067008.00

Lagunitas Road Bridge Project
Geotechnical Data Report
Ross, California



FIGURE 8



LEGEND

- Standard Penetration Test (SPT)
- △ Converted to Equivalent SPT

BOREHOLE B-1 STANDARD PENETRATION TEST N-VALUE PLOT

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 43-00067008.00

Lagunitas Road Bridge Project
 Geotechnical Data Report
 Ross, California



FIGURE 9

BORING B-1

DEPTH IN FEET	LABORATORY TEST DATA								SAMPLING	
	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS		STRENGTH DATA			TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	
		LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)				MOISTURE CONTENT (%)
0										
5	SA							U	13	
10	SA					16.4	1406	U	32	
	DSCD					20.4	1368			
						17.3	1444			
15	SA							U	46	
								SPT	27	
20								U	49	
25								U	906"	
30	31	12	TXUU	10000	240	10.5	1423	PT		
35										

SAMPLES

SYMBOL	DESCRIPTION
GW	DARK BROWN WELL-GRADED FINE TO COARSE GRAVEL WITH FINE TO COARSE SAND, with occasional cobbles, trace silt. Gravel is subangular to rounded, up to 1.5" in diameter. Wet. Loose. Groundwater at ground surface
	Grades with more gravel and less sand.
	Grades more silt.
SW SM	BROWN WELL-GRADED MEDIUM TO COARSE SAND WITH FINE GRAVEL, trace fine sand, silt. Gravel is subangular to rounded. Wet. Medium dense.
GW GM	BROWN WELL-GRADED FINE TO COARSE GRAVEL with SAND, trace of silt. Medium dense.
	Zero sample recovered.
GP	BROWN POORLY-GRADED FINE TO COARSE GRAVEL, trace sand, silt, with occasional cobbles. Wet. Medium dense.
	DARK GRAY SHALE, highly to completely weathered, moderately weak to weak, fractures extremely close and occasionally coated with yellowish brown iron oxide staining.
	Grades with no iron oxide staining.

Notes:

- Boring drilled with track-mounted Falling 750 rig using rotary wash method with 4 7/8" O.D. tri-cone bit.

Continued Next Page

Job No: 43-00067008.00 Pt. ID: BRIDGE.GPJ / B-1	URS Dewberry & Moore	Log of Boring
Date Completed: 10/18/01 Boring Depth: 31.0 ft.	Surface Elev: 10.8 feet NRVF based on Marin County Publick Works Monument. Coordinates:	Location: Lagunitas Road Bridge, Ross, CA

BORING B-1

DEPTH IN FEET	LABORATORY TEST DATA							SAMPLING		
	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS		STRENGTH DATA			MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE
		LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)				
35										
40										
45										
50										
55										
60										
65										
70										

SAMPLES

SYMBOL

DESCRIPTION

2. Boring completed to a depth of 31.0 feet on October 18, 2001, and was backfilled with cement grout.
3. Sampling resistance for the "SPT" and "U" samplers is measured in blows required to drive the sampler 12 inches with a 140-lb safety hammer dropping 30 inches after the sampler has been seated 6 inches into the bottom of the borehole. Rope and cathead used to lift/drop hammer.
4. Groundwater level was at the surface during the operation of drilling.
5. Boring log indicates interpreted soil and groundwater conditions representative only of the time and location of drilling.
6. See Figure A-3 for general log notes and explanations of symbols.

BORING B-2

DEPTH IN FEET	LABORATORY TEST DATA								SAMPLING		SAMPLES	SYMBOL	DESCRIPTION
	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS		STRENGTH DATA			TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE				
		LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)				MOISTURE CONTENT (%)			
0												Asphalt pavement - 7 inches	
												GP Crushed rock aggregate base - 14 inches	
												CL DARK REDDISH BROWN LEAN CLAY, trace fine gravel, sand. Dry to moist. Stiff to very stiff.	
5									MC	28		PP Su > 4,500 psf (field)	
												Grades dark brown, more sand, no gravel.	
10	SA	32	10	TXUU	1150	3986	15.1	123.3	MC	19		PP Su > 4,500 psf (field).	
												Grades mottled brown and gray, moist, medium stiff to stiff with no fine gravel.	
15	Consol	36	14	TXUU	1650	1514	24.3	128.8	ST	300-400 psi		TV Su = 520 psf, PP Su = 700-750 psf (field) TV Su = 750 psf, PP Su = 500-1,000 psf (lab)	
20	Consol	43	20	TXUU	2500	728	22.3	128.8	ST	400 psi		CL MOTTLED GRAY BROWN FINE SANDY LEAN CLAY. Moist to very moist. Medium stiff. TV Su = 780 psf, PP Su = 1,000-1,250 psf (field) TV Su = 650 psf, PP Su = 1,500-1,750 psf (lab)	
25	SA	26	8						ST	400 psi		SC MOTTLED GRAY BROWN CLAYEY SAND with fine gravel. Interbedded with SANDY LEAN CLAY. Gravel is rounded to subrounded. PP Su = 800-1,000 psf. (field) TV Su = 900 psf, PP Su = 500 psf (lab)	
30	SA								U	24		CL BROWN FINE SANDY LEAN CLAY with gravel, very moist. Medium stiff to stiff. Grades less sand, medium stiff to stiff	
35													

Continued Next Page

Job No: 43-00067008.00	URS Design & More	Log of Boring
Pt. ID: BRIDGE.GPJ / B-2		
Date Completed: 10/20/01	Surface Elev: 24.9 feet NFVD based on Marin County Public Works Monument.	Location: Lagunitas Road Bridge, Ross, CA
Boring Depth: 43.8 ft.	Coordinates:	

BORING B-2

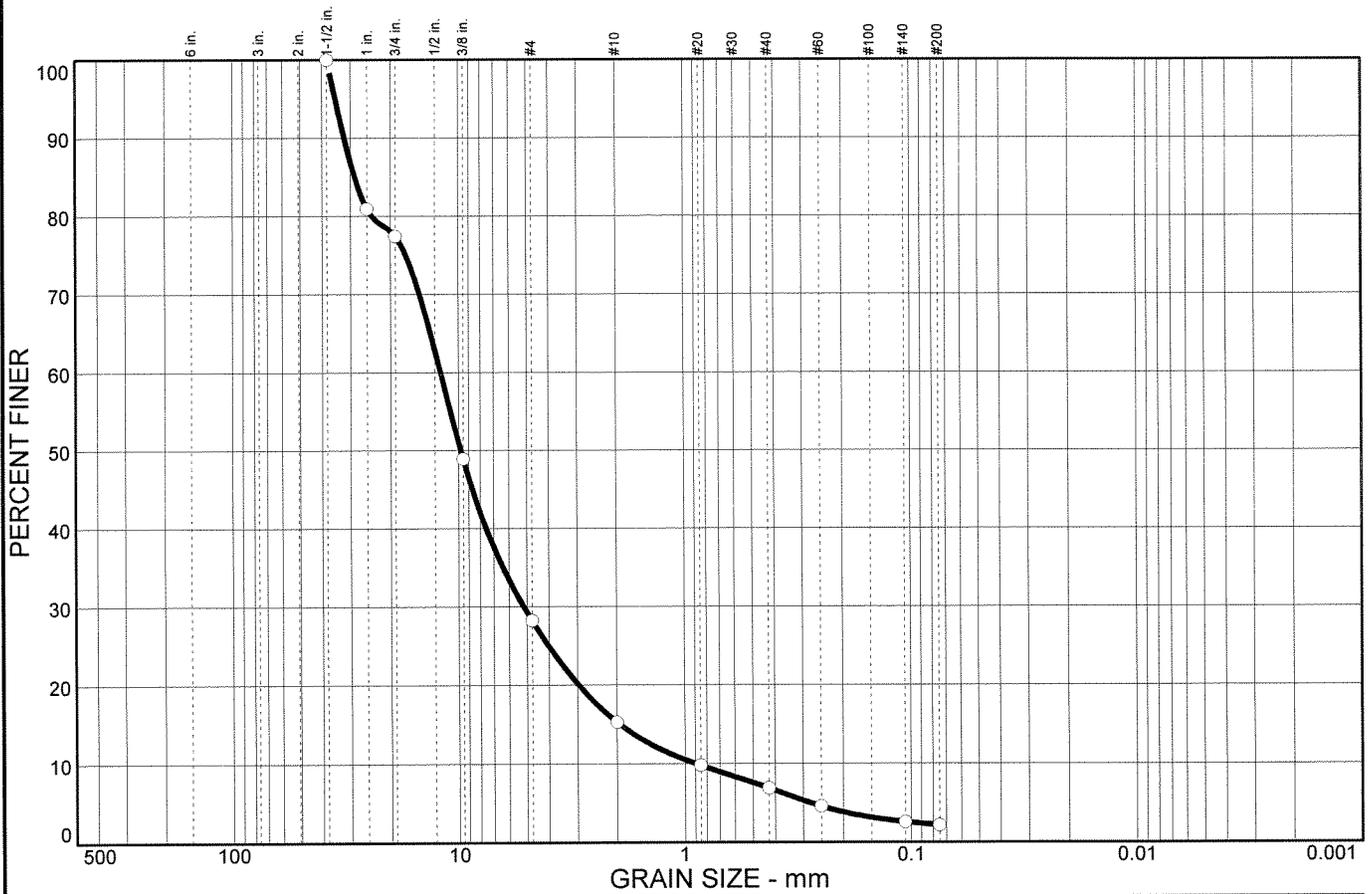
DEPTH IN FEET	LABORATORY TEST DATA								SAMPLING	
	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS		STRENGTH DATA			TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	
		LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)				
35	SA							U	41	
40								U	501.75'	
45								NV		
50										
55										
60										
65										
70										

SAMPLES	SYMBOL	DESCRIPTION
	GP GM	BROWN POORLY GRADED FINE TO COARSE GRAVEL WITH MEDIUM TO COARSE SAND, some fine sand, silt. Wet. Medium dense. Harder drilling after 38.5 feet.
		DARK GRAY SHALE, highly to completely weathered, weak, joints extremely close.
		DARK GRAY SANDSTONE (GRAYWACKE), moderately hard to moderately soft, intensely to moderately fractured, 30 degrees to 45 degrees, occasionally slickensided, occasionally clay-coated, about 1/2 inch thick clay, gouge at 41.3', slightly rough joints (core recovery=95%, RQD=36%).

Notes:

- Boring drilled with truck-mounted CME 75 rig using 8" O.D. hollow-stem augers. Hollow-stem auger method used to 40.5 feet drilling method then switched to rotary and a NX double-tube core barrel with a diamond bit.
- Boring completed to a depth of 43.67 feet on October 20, 2001 and was backfilled with cement grout.
- Sampling resistance for the "MC" and "U" samplers is measured in blows required to drive the sampler 12 inches with a 140-lb automatic CME hammer assembly dropping 30 inches after the sampler has been seated 6 inches into the bottom of the borehole.
- Groundwater level was not measured during the drilling operation.
- Boring log indicates interpreted soil and groundwater conditions representative only of the time and location of drilling.
- See Figure A-3 for general log notes and explanations of symbols.

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	22.6	49.2	12.9	8.4	4.7	2.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	80.9		
3/4 in.	77.4		
3/8 in.	48.9		
#4	28.2		
#10	15.3		
#20	9.8		
#40	6.9		
#60	4.6		
#140	2.6		
#200	2.2		

Soil Description

Dark brown Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D₈₅= 28.8 D₆₀= 12.0 D₅₀= 9.76
D₃₀= 5.18 D₁₅= 1.94 D₁₀= 0.889
C_u= 13.50 C_c= 2.51

Classification

USCS= GW AASHTO=

Remarks

* (no specification provided)

Sample No.: 1
Location:

Source of Sample: B-1

Date:
Elev./Depth: 4.8

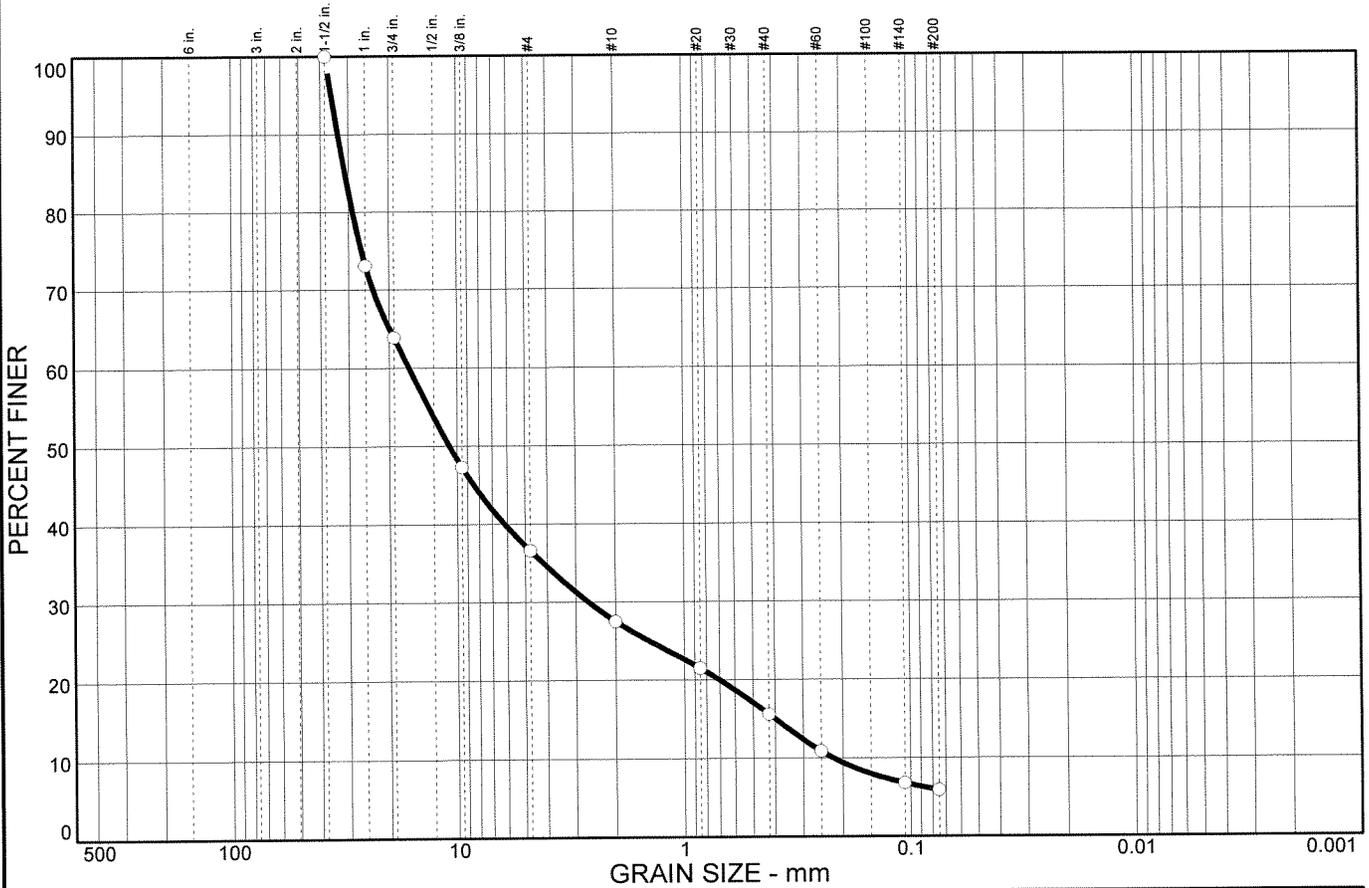
SIGNET TESTING LABS, INC.

Client: URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
Ross, California

Project No: 43-00067008.00

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	36.1	27.3	9.1	11.9	9.7	5.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	73.1		
3/4 in.	63.9		
3/8 in.	47.3		
#4	36.6		
#10	27.5		
#20	21.5		
#40	15.6		
#60	10.9		
#140	6.8		
#200	5.9		

Soil Description

Dark brown Well-graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D₈₅= 31.1 D₆₀= 16.3 D₅₀= 10.8
D₃₀= 2.64 D₁₅= 0.399 D₁₀= 0.220
C_u= 74.31 C_c= 1.94

Classification

USCS= GW-GM AASHTO=

Remarks

* (no specification provided)

Sample No.: 3
Location:

Source of Sample: B-1

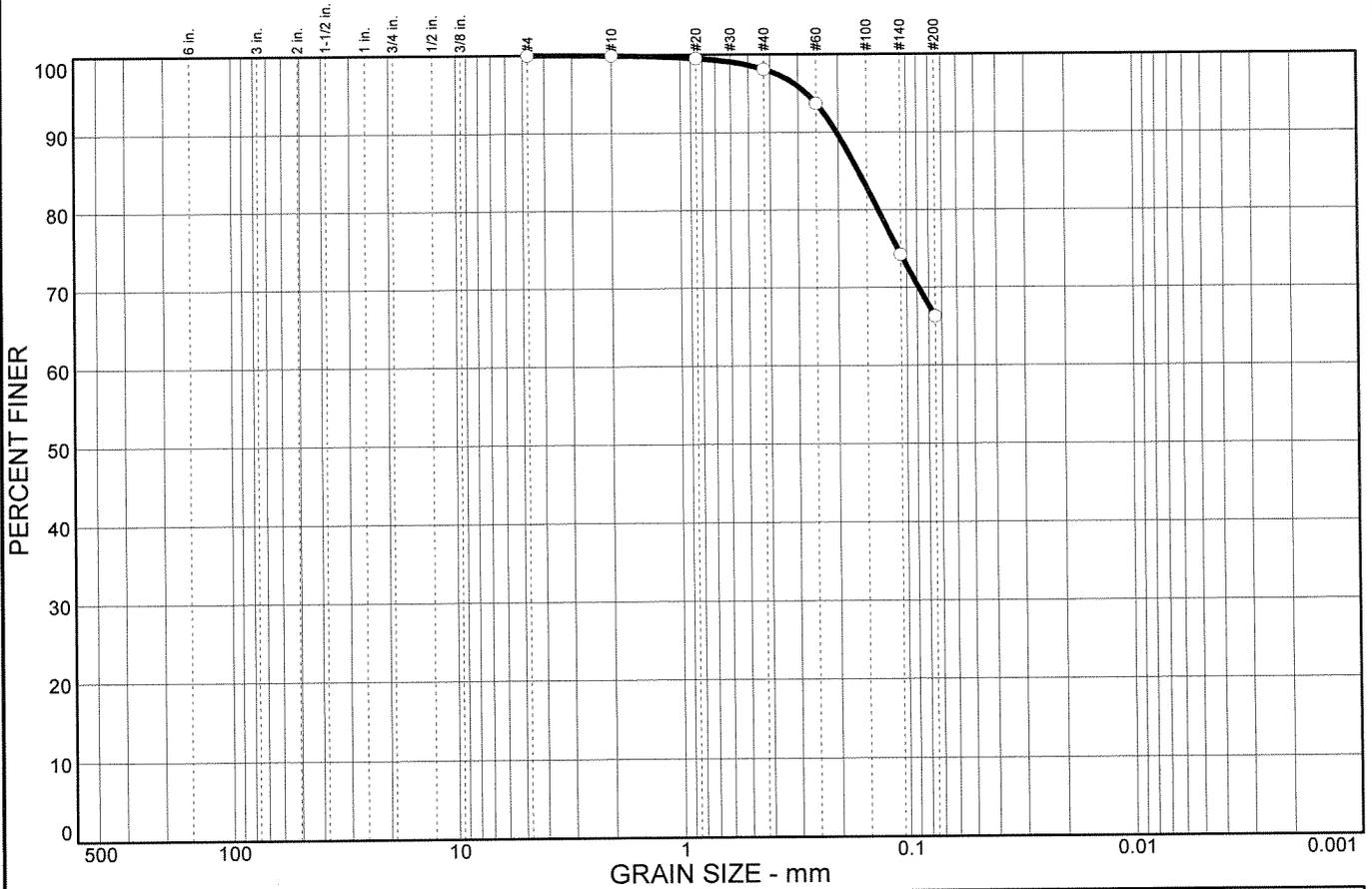
Date:
Elev./Depth: 12.5

SIGNET TESTING LABS, INC.

Client: URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
Ross, California
Project No: 43-00067008.00

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.8	31.8	66.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.5		
#40	98.1		
#60	93.7		
#140	74.2		
#200	66.3		

Soil Description

Brown Sandy lean clay

Atterberg Limits

PL= 22 LL= 32 PI= 10

Coefficients

D₈₅= 0.163 D₆₀= D₅₀=
D₃₀= D₁₅= D₁₀=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

* (no specification provided)

Sample No.: 2A
Location:

Source of Sample: B-2

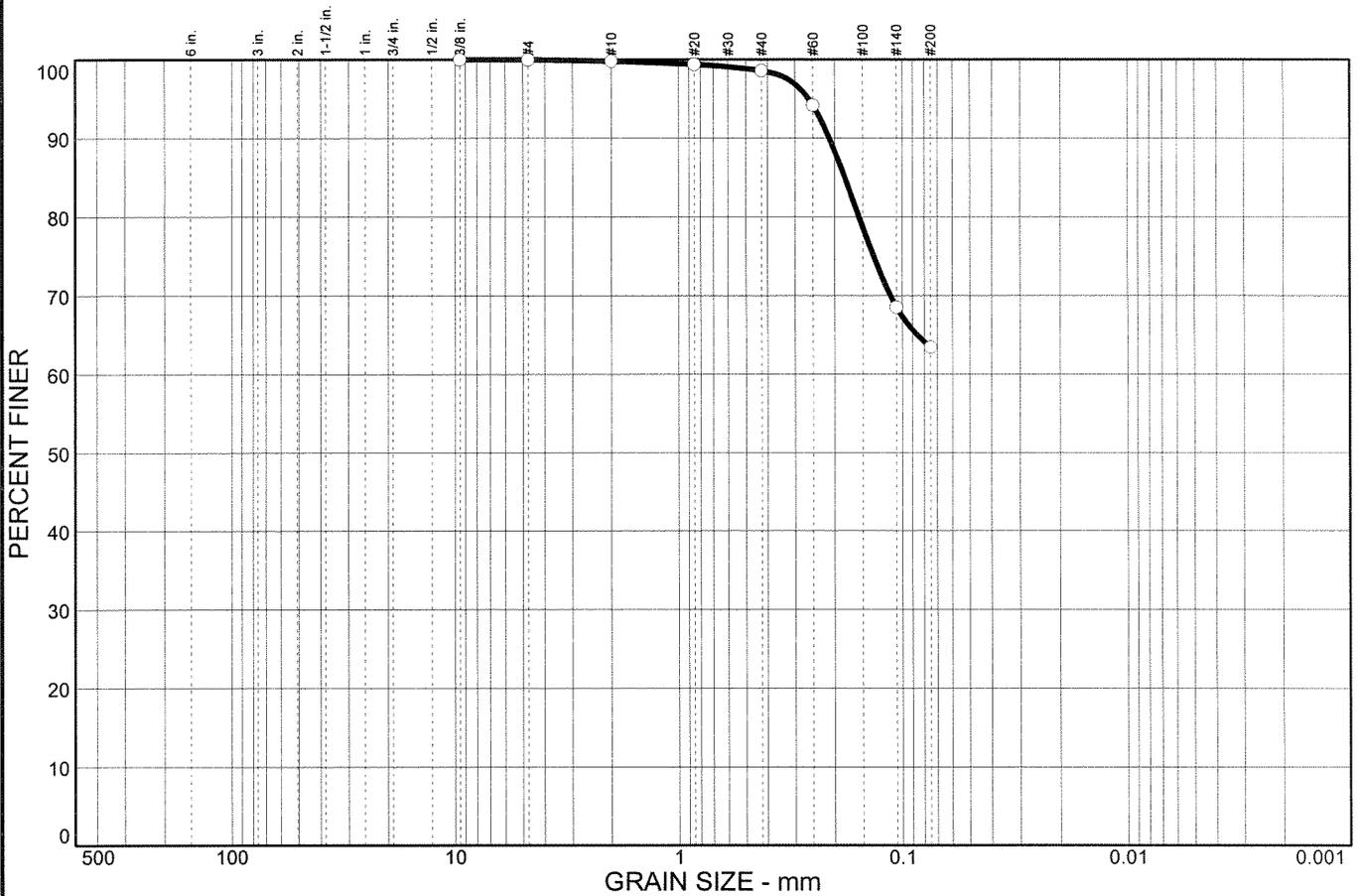
Date:
Elev./Depth: 10-10.5

SIGNET TESTING LABS, INC.

Client: URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
Ross, California
Project No: 43-00067008.00

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	1.2	35.2	63.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	100.0		
#10	99.8		
#20	99.4		
#40	98.6		
#60	94.2		
#140	68.5		
#200	63.4		

Soil Description

Dark Brown Sandy lean clay

Atterberg Limits

PL= 23 LL= 43 PI= 20

Coefficients

D₈₅= 0.180 D₆₀= D₅₀=
D₃₀= D₁₅= D₁₀=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

* (no specification provided)

Sample No.: 4
Location:

Source of Sample: B-2

Date:
Elev./Depth: 19.5-21

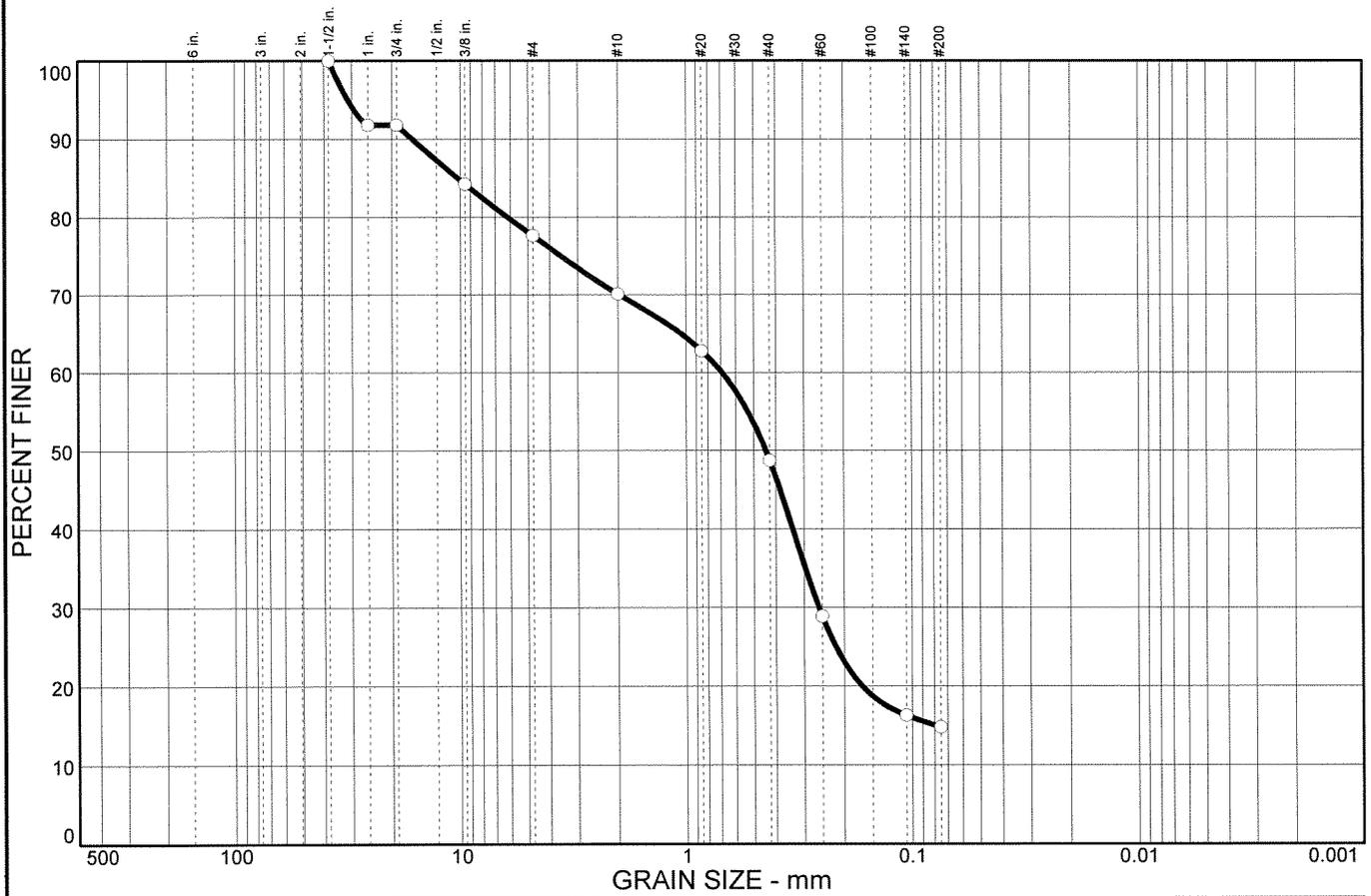


Client: URS
Project: Lagunitas Bridge Road Phase I Ross, California

Project No: 43-00067008.00

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	8.2	14.2	7.5	21.4	33.9	14.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	91.8		
3/4 in.	91.8		
3/8 in.	84.2		
#4	77.6		
#10	70.1		
#20	62.8		
#40	48.7		
#60	28.9		
#140	16.3		
#200	14.8		

Soil Description

Gray Clayey sand with gravel

Atterberg Limits

PL= 18 LL= 26 PI= 8

Coefficients

D₈₅= 10.3 D₆₀= 0.689 D₅₀= 0.442
D₃₀= 0.259 D₁₅= 0.0788 D₁₀=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

* (no specification provided)

Sample No.: 5
Location:

Source of Sample: B-2

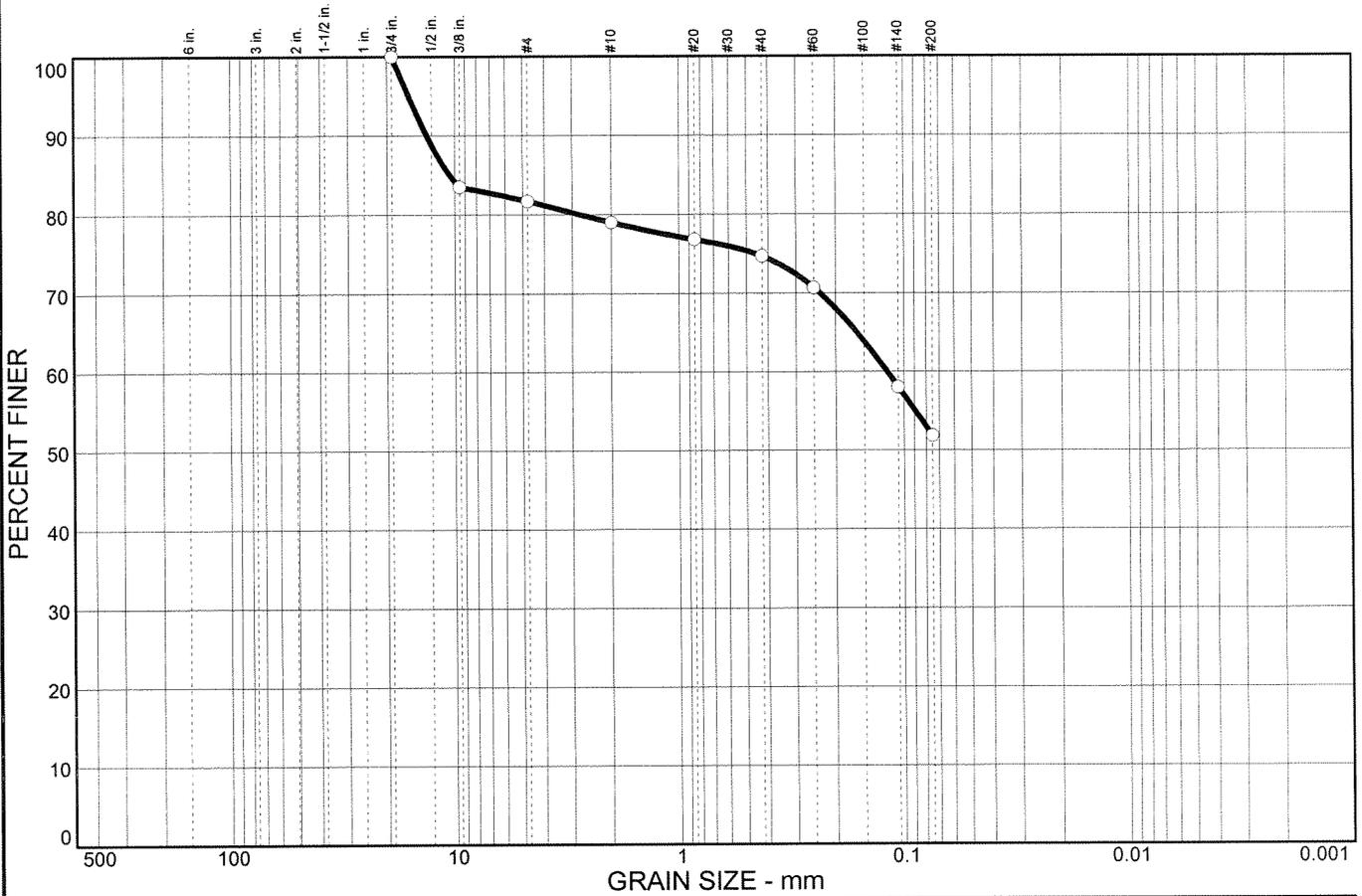
Date:
Elev./Depth: 24.5-26.5

SIGNET TESTING LABS, INC.

Client: URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
Ross, California
Project No: 43-00067008.00

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	18.3	2.7	4.3	22.9	51.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	83.5		
#4	81.7		
#10	79.0		
#20	76.8		
#40	74.7		
#60	70.7		
#140	58.0		
#200	51.8		

Soil Description

Dark brown sandy silt with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D₈₅= 10.5 D₆₀= 0.119 D₅₀=

D₃₀= D₁₅= D₁₀=

C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

* (no specification provided)

Sample No.: 6
Location:

Source of Sample: B-2

Date: 1-22-02
Elev./Depth: 29.5-31

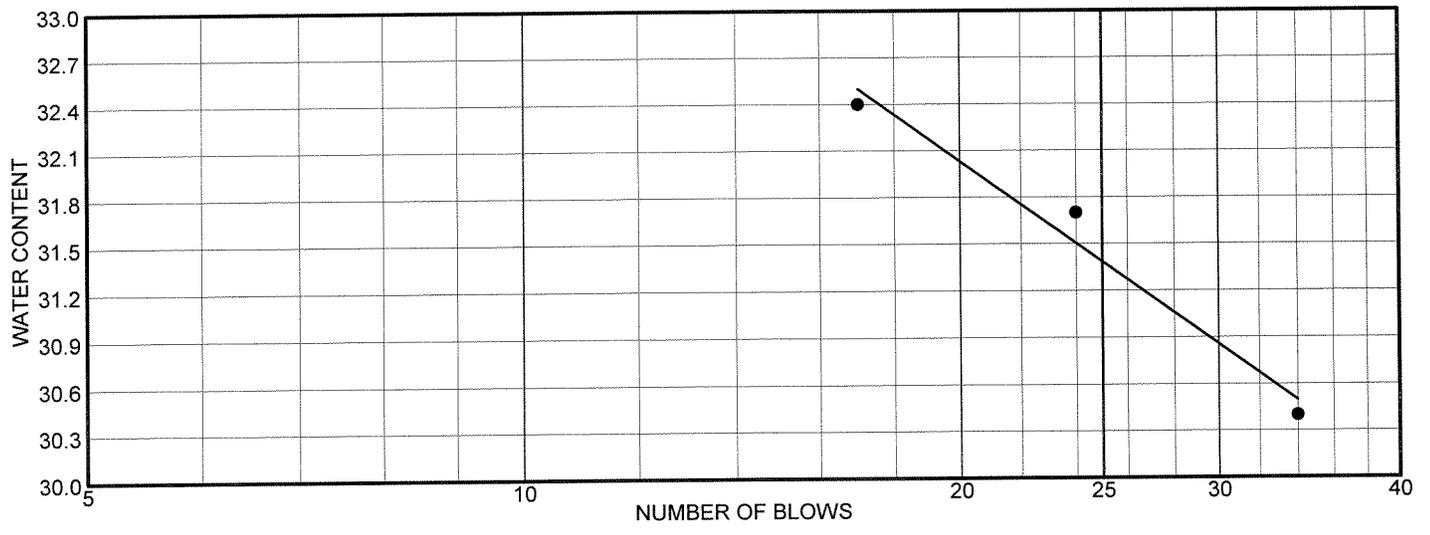
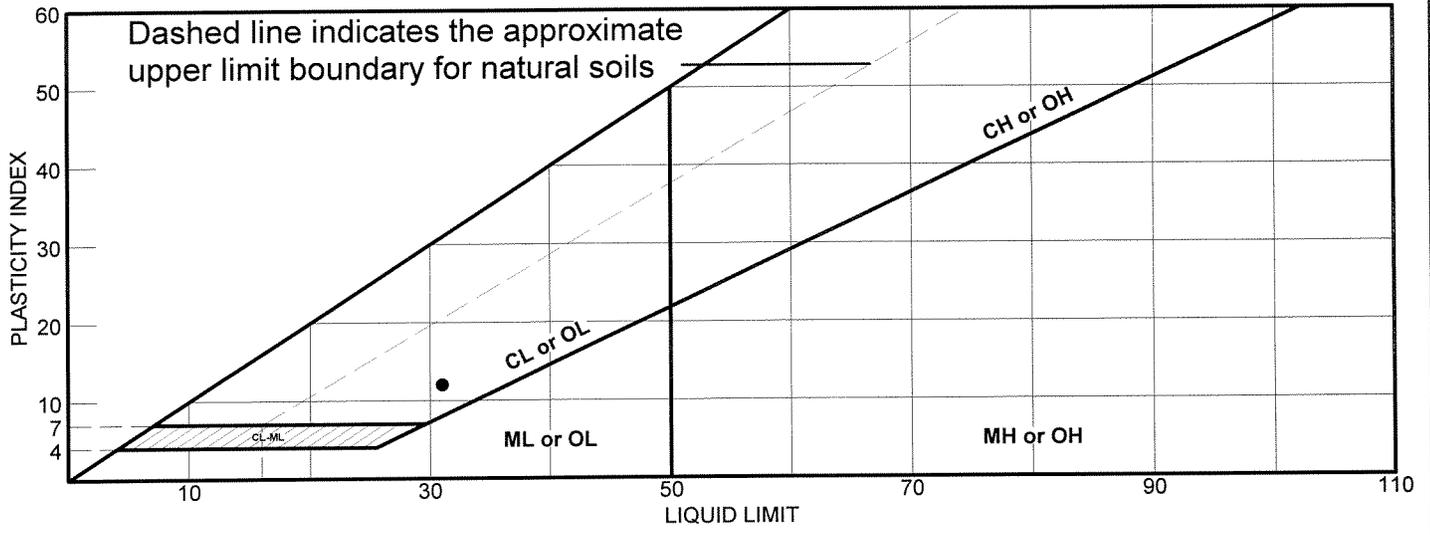


Client: URS
Project: Lagunitas Bridge Road Phase I Ross, California

Project No: 43-00067008.00

Plate

LIQUID AND PLASTIC LIMITS TEST REPORT

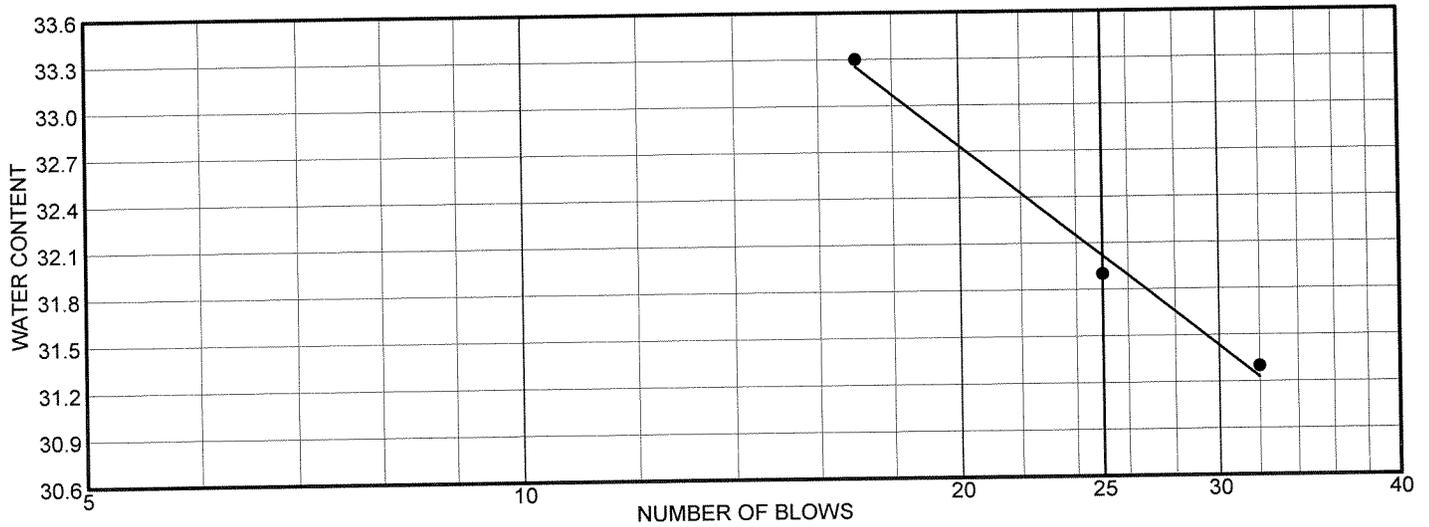
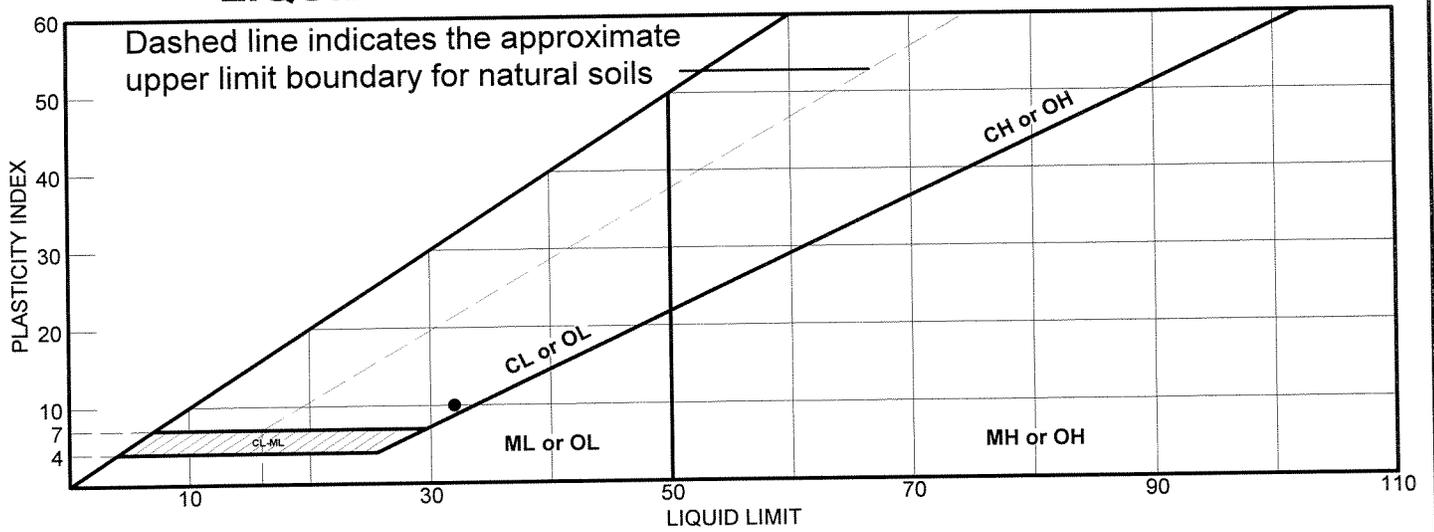


●	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark gray silty clay	31	19	12			

Project No. 43- **Client:** URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
 Ross, California
● Source: B-1 **Sample No.:** 7 **Elev./Depth:** 30

Remarks:
 ●

LIQUID AND PLASTIC LIMITS TEST REPORT

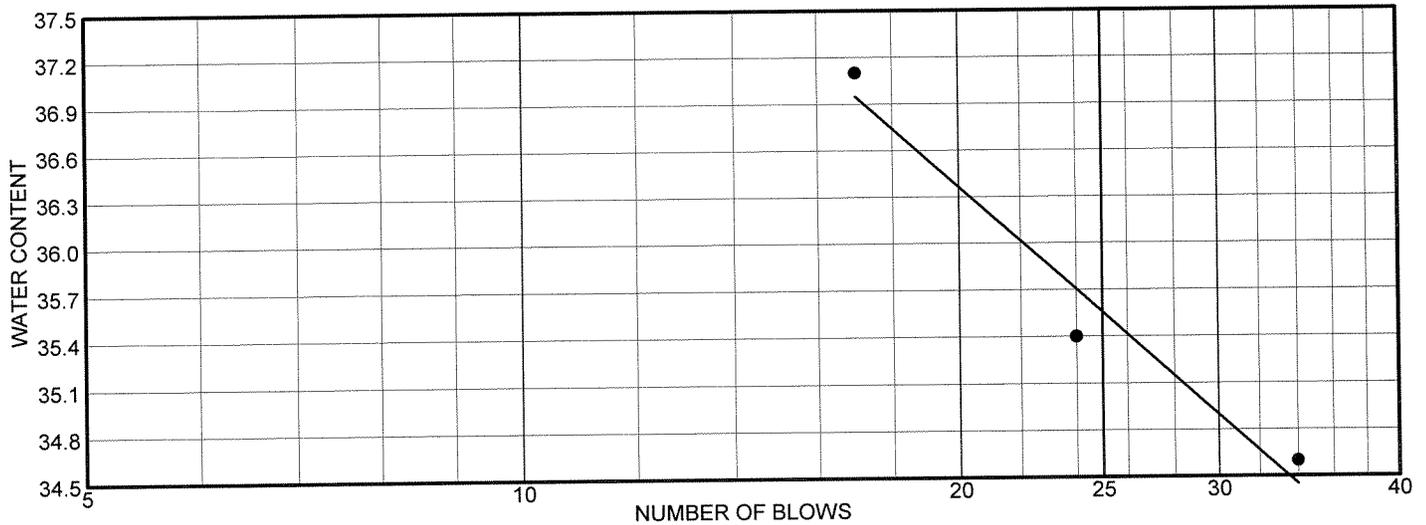
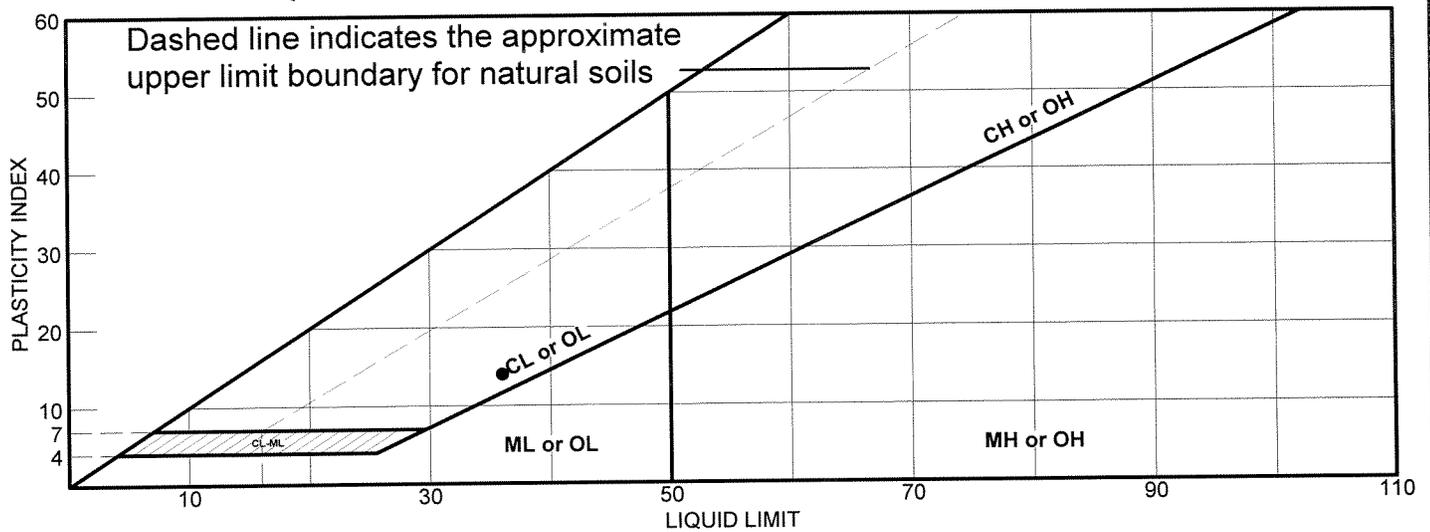


MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
• Brown Sandy lean clay	32	22	10	98.1	66.3	CL

Project No. 43- **Client:** URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
 Ross, California
 • **Source:** B-2 **Sample No.:** 2A **Elev./Depth:** 10-10.5

Remarks:
 •

LIQUID AND PLASTIC LIMITS TEST REPORT



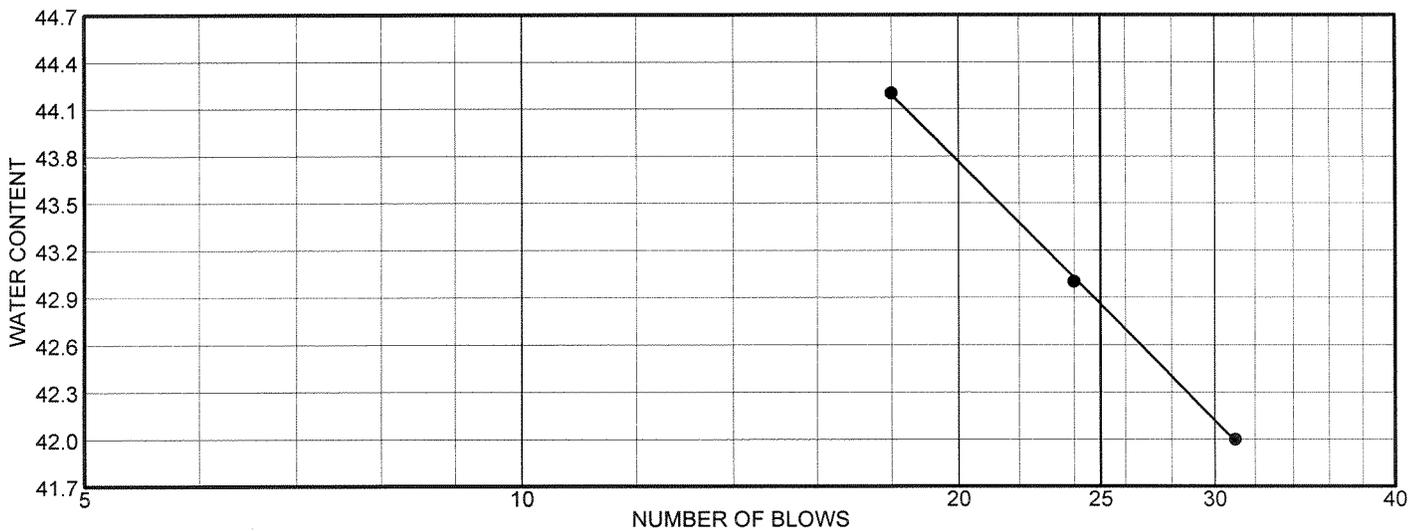
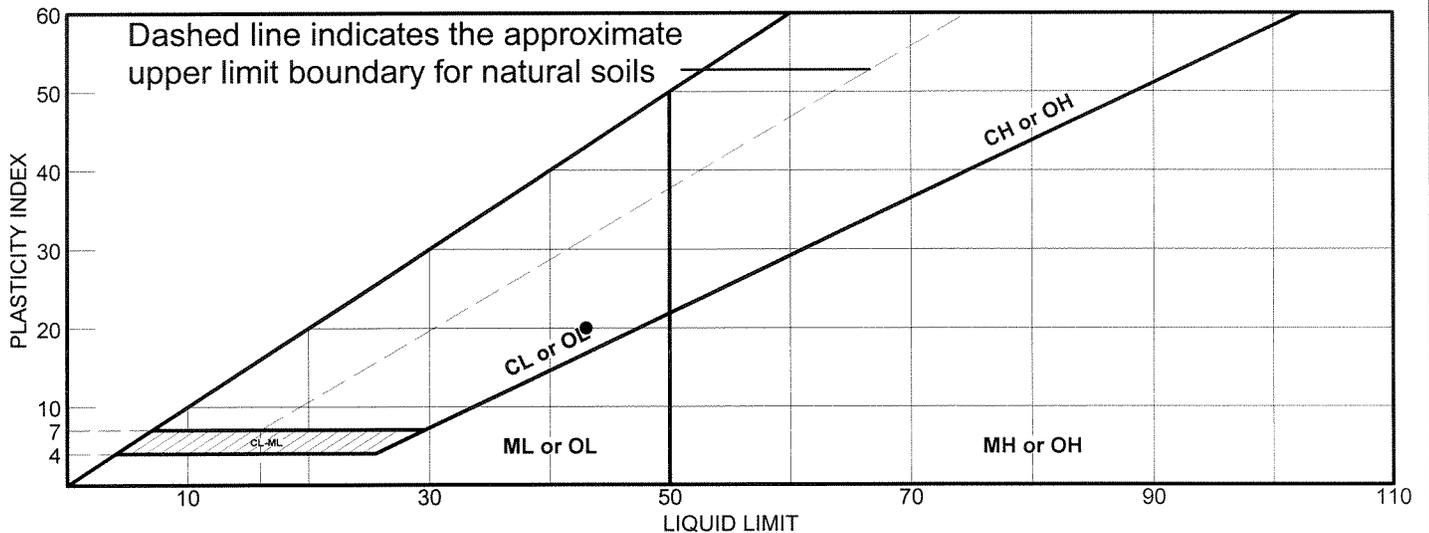
●	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown clay w/silt	36	22	14			

Project No. 43- **Client:** URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
 Ross, California
● Source: B-2 **Sample No.:** 3 **Elev./Depth:** 14.5-16.9

Remarks:

●

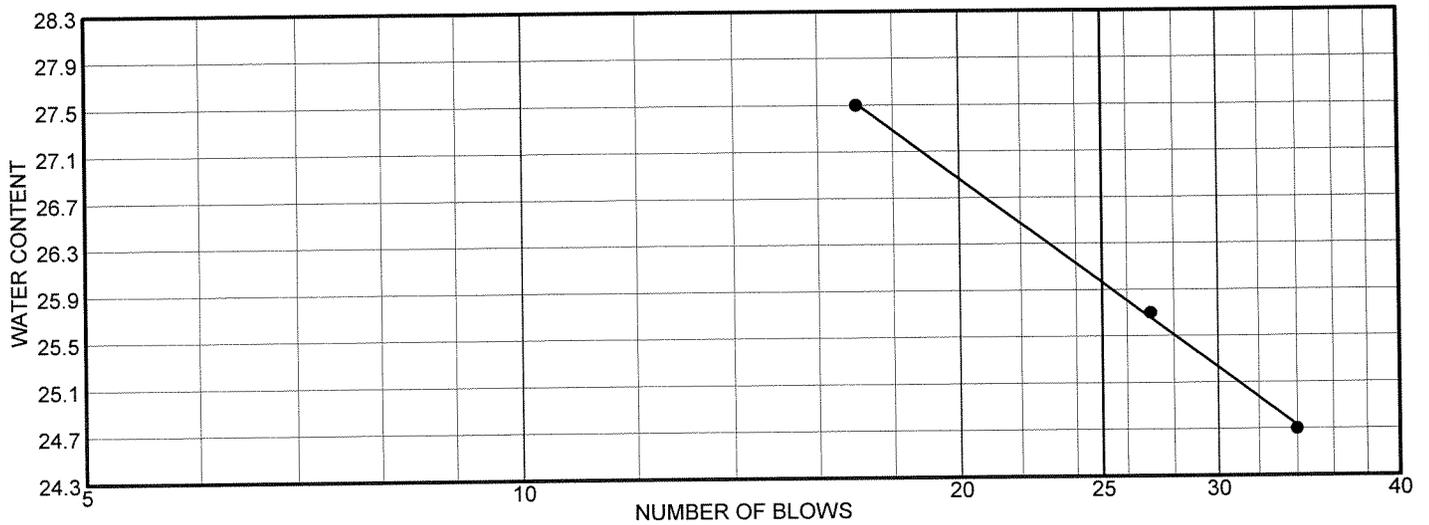
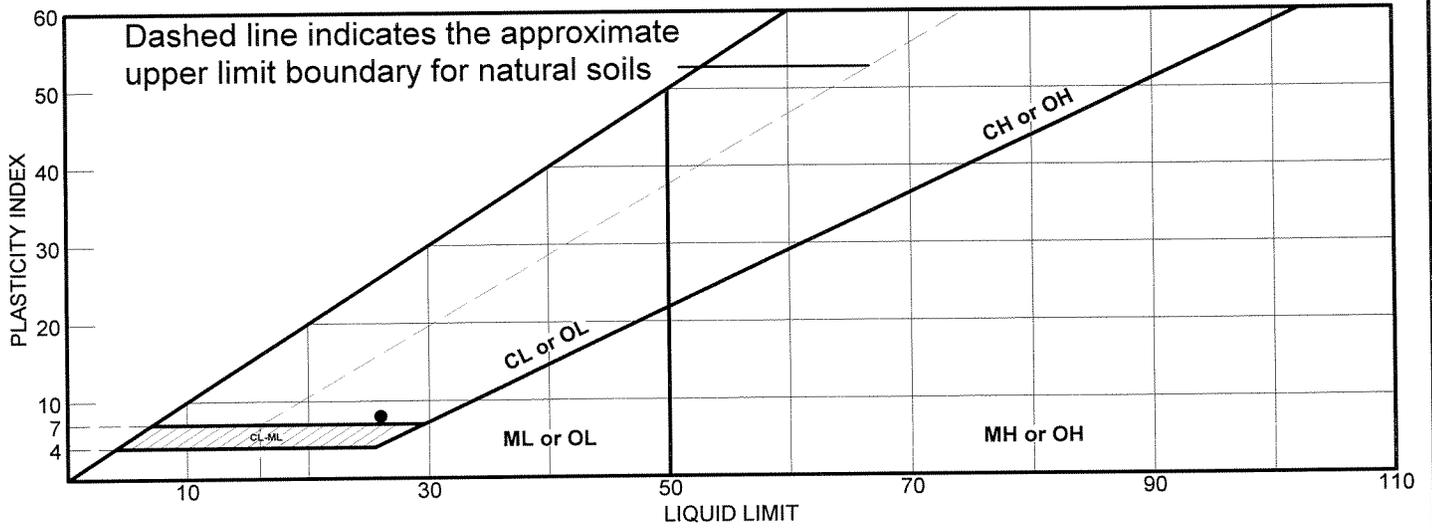
LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Brown Sandy lean clay	43	23	20	98.6	63.4	CL

<p>Project No. 43- Client: URS</p> <p>Project: Lagunitas Bridge Road Phase I Ross, California</p> <p>● Source: B-2 Sample No.: 4 Elev./Depth: 19.5-21</p>	<p>Remarks:</p> <p>●</p>
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LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Gray Clayey sand with gravel	26	18	8	48.7	14.8	SC

Project No. 43- **Client:** URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1
 Ross, California
 ● **Source:** B-2 **Sample No.:** 5 **Elev./Depth:** 24.5-26.5

Remarks:

●

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS/Dames & Moore
 Project : Lagunitas Bridge Road, Phase I Ross, California
 Job # : 43-00067008.00
 Boring # B-1
 Sample # : 7
 Depth (ft) : 30
 Date tested : 12/20/01
 Soil : Dark Gray Silty Clay

Data Reduction:

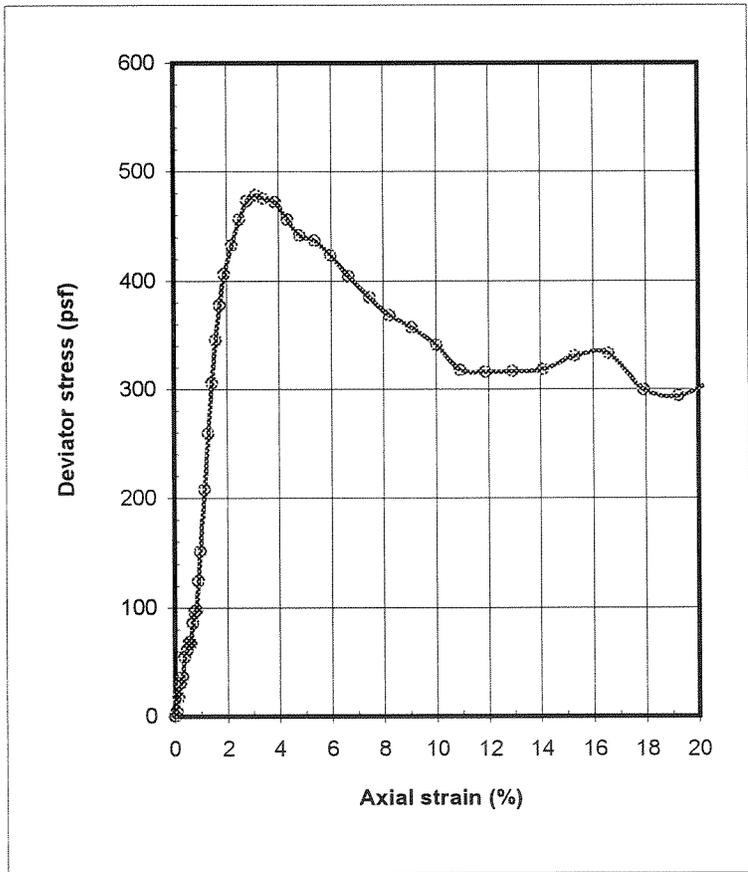
Dial factor = 1.0 in/unit
 Load factor = 1.0 lb/unit

Specimen: Total wt. = 1463.3 gms
 Ht. = 6.000 in
 Ave dia. = 2.882 in
 Area = 6.525 sq.in
 Volume = 641.5 c.c.
 Shearing rate = 0.04 inch/min
 Shearing rate = 0.67 %/min
 Gs (assumed) = 2.70

Test Report:

Void ratio = 0.308
 Ht/Dia ratio = 2.08
 Moisture = 10.5 %
 Total density = 142.3 pcf
 Dry density = 128.9 pcf
 Saturation = 91.9 %
 Chamber pressure = 10000 psf
 Max. deviator stress = 479 psf
 Strain @ failure = 3.10 %

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
0.002	0.0	0.00	0.0
0.006	0.2	0.07	4.6
0.011	0.8	0.15	17.5
0.015	1.4	0.22	30.4
0.020	1.7	0.30	36.7
0.025	2.5	0.38	54.4
0.029	2.8	0.45	60.8
0.034	3.1	0.53	68.1
0.038	3.0	0.61	66.7
0.043	3.9	0.68	85.7
0.048	4.4	0.76	95.4
0.052	4.5	0.84	97.7
0.057	5.7	0.91	124.6
0.061	6.9	0.99	151.6
0.070	9.5	1.14	208.0
0.079	11.9	1.29	259.0
0.089	14.1	1.44	305.8
0.098	15.9	1.59	345.2
0.107	17.4	1.75	377.7
0.116	18.8	1.90	406.3
0.134	20.1	2.20	432.9
0.152	21.2	2.50	456.0
0.170	22.1	2.80	473.4
0.188	22.4	3.10	478.6
0.207	22.3	3.41	475.3
0.234	22.2	3.87	471.8
0.262	21.6	4.33	456.5
0.290	21.0	4.81	441.3
0.324	20.9	5.36	436.8
0.361	20.4	5.99	423.2
0.402	19.6	6.66	403.9
0.451	18.9	7.48	384.8
0.497	18.2	8.24	368.0
0.546	17.8	9.07	356.7
0.604	17.1	10.03	340.4
0.657	16.2	10.93	317.8
0.716	16.3	11.90	315.9
0.779	16.5	12.95	316.7
0.848	16.8	14.10	318.3
0.921	17.7	15.31	330.8
0.997	18.1	16.58	333.1
1.077	16.5	17.92	299.2
1.156	16.5	19.24	293.4
1.227	17.4	20.42	305.5
1.271	17.7	21.14	308.7
1.272	17.8	21.16	309.4
1.287	15.9	21.41	275.5
1.287	15.1	21.41	261.3
1.287	14.9	21.41	257.5



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

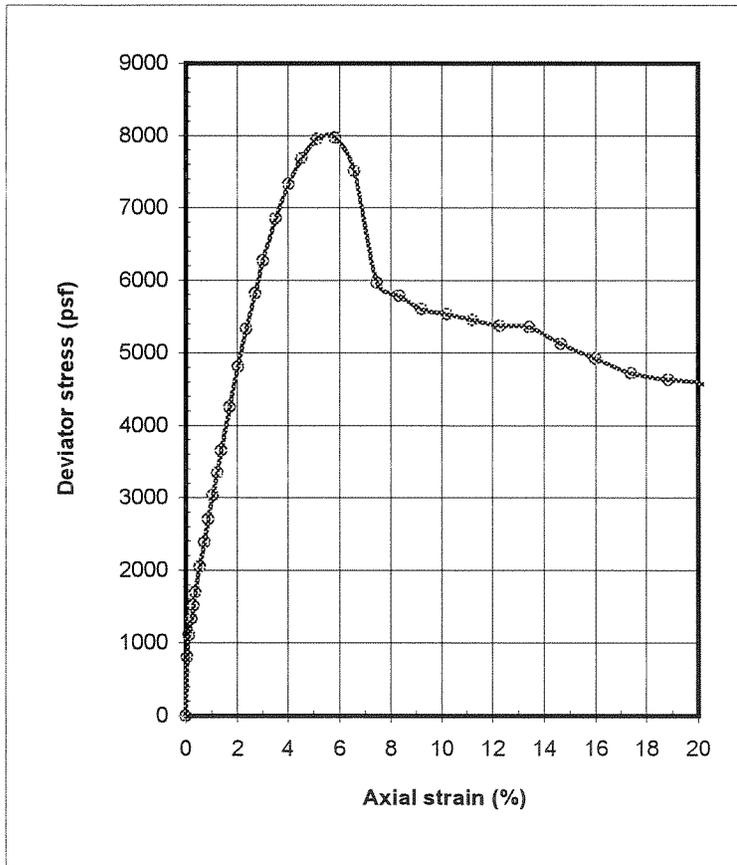
Client : URS/Dames & Moore
 Project : Lagunitas Bridge Road, Phase I Ross, California
 Job # : 43-00067008.00
 Boring # B-2
 Sample # : 2A
 Depth (ft) : 10-10.5
 Date tested : 12/20/01
 Soil : Brown Sandy Lean Clay

Data Reduction:

Dial factor = 1.0 in/unit
 Load factor = 1.0 lb/unit

Specimen:	Total wt. =	797.0	gms	Dial	Load	Axial	Deviator
	Ht. =	5.500	in	Read.	Read.	Strain	Stress
	Ave dia. =	2.387	in			(%)	(psf)
	Area =	4.476	sq.in	0.000	-0.8	0.00	0.0
	Volume =	403.4	c.c.	0.003	24.3	0.06	806.2
	Shearing rate =	0.04	inch/min	0.008	33.8	0.13	1113.5
	Shearing rate =	0.73	%/min	0.012	40.7	0.22	1333.7
	Gs (assumed) =	2.70		0.017	46.5	0.30	1517.6
				0.021	52.1	0.39	1697.1
				0.030	63.2	0.55	2048.9
				0.040	73.8	0.72	2384.6
				0.049	84.1	0.89	2706.4
				0.058	94.3	1.06	3027.9
				0.067	104.5	1.22	3347.9
				0.076	114.4	1.39	3655.0
				0.094	133.6	1.71	4251.4
				0.112	151.8	2.04	4809.2
				0.130	168.7	2.37	5326.5
				0.149	185.3	2.71	5825.0
				0.166	200.1	3.02	6268.9
				0.194	220.0	3.52	6855.3
				0.221	236.5	4.02	7328.5
				0.249	249.2	4.53	7680.6
				0.282	259.6	5.13	7948.2
				0.320	262.3	5.82	7971.7
				0.362	248.9	6.57	7506.4
				0.410	199.7	7.46	5970.0
				0.458	195.2	8.32	5782.0
				0.506	190.9	9.20	5599.9
				0.562	190.7	10.22	5532.4
				0.617	190.0	11.21	5451.6
				0.676	189.6	12.28	5374.9
				0.739	191.5	13.43	5357.6
				0.807	185.9	14.66	5125.8
				0.879	181.2	15.98	4919.4
				0.956	176.8	17.38	4721.6
				1.037	176.5	18.86	4628.6
				1.113	177.2	20.23	4568.3
				1.182	170.6	21.50	4330.8

Test Report: Void ratio = 0.573
 Ht/Dia ratio = 2.30
 Moisture = 15.1 %
 Total density = 123.3 pcf
 Dry density = 107.1 pcf
 Saturation = 71.3 %
 Chamber pressure = 1150 psf
 Max. deviator stress = 7972 psf
 Strain @ failure = 5.82 %



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

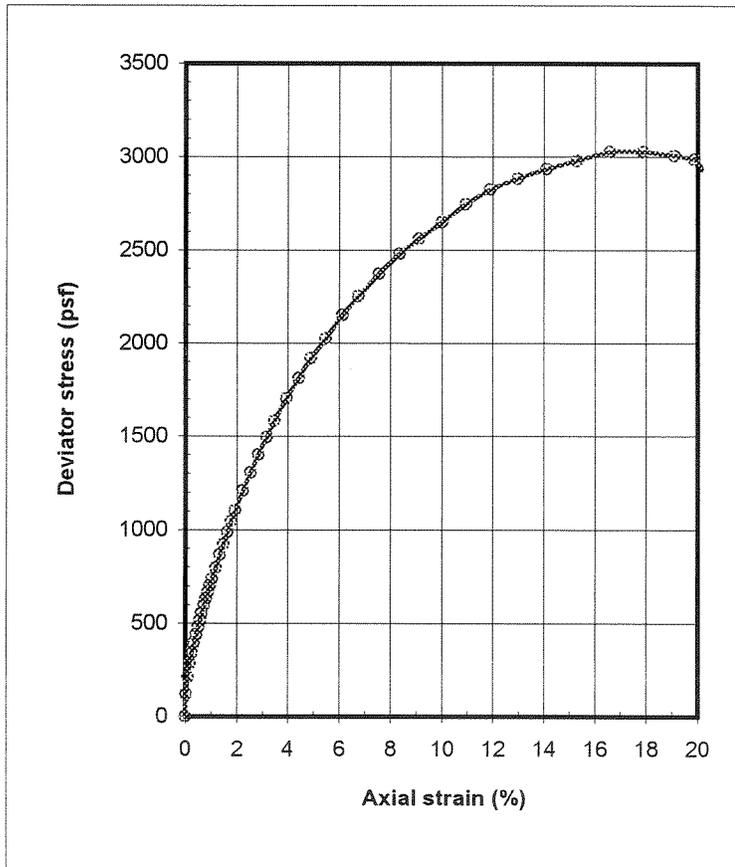
Client : URS/Dames & Moore
 Project : Lagunitas Bridge Road, Phase I Ross, California
 Job # : 43-00067008.00
 Boring # B-2
 Sample # : 3
 Depth (ft) : 14.5-16.9
 Date tested : 12/20/01
 Soil : Brown Silty Clay

Data Reduction:

Dial factor = 1.0 in/unit
 Load factor = 1.0 lb/unit

Specimen:	Total wt. =	1286.6	gms	Dial	Load	Axial	Deviator
	Ht. =	6.000	in	Read.	Read.	Strain	Stress
	Ave dia. =	2.840	in			(%)	(psf)
	Area =	6.337	sq.in	0.000	0.2	0.00	0.0
	Volume =	623.1	c.c.	0.002	5.5	0.03	121.2
	Shearing rate =	0.04	inch/min	0.007	9.6	0.11	213.6
	Shearing rate =	0.67	%/min	0.011	12.7	0.18	284.8
	Gs (assumed) =	2.70		0.016	15.3	0.26	342.6
				0.020	17.6	0.34	394.9
				0.025	19.6	0.41	439.4
				0.030	21.3	0.49	478.0
				0.034	23.1	0.57	518.8
				0.038	24.8	0.64	554.9
				0.043	26.7	0.72	599.3
				0.048	28.3	0.80	633.4
				0.052	29.8	0.87	667.9
				0.057	31.4	0.95	701.9
				0.062	33.0	1.03	737.9
				0.070	35.8	1.17	798.9
				0.080	38.8	1.33	866.1
				0.089	41.5	1.48	925.8
				0.098	44.3	1.63	987.2
				0.107	47.2	1.78	1049.5
				0.116	49.6	1.94	1101.5
				0.134	54.7	2.23	1210.4
				0.153	59.2	2.54	1306.3
				0.171	63.7	2.85	1401.8
				0.189	68.0	3.16	1491.9
				0.208	72.2	3.47	1580.7
				0.236	78.2	3.94	1703.2
				0.265	83.6	4.41	1811.8
				0.293	89.0	4.89	1918.8
				0.329	94.5	5.48	2025.3
				0.368	100.9	6.14	2149.3
				0.405	106.5	6.75	2253.9
				0.454	113.2	7.56	2374.3
				0.502	119.2	8.36	2479.1
				0.547	124.2	9.12	2561.8
				0.602	129.9	10.02	2652.0
				0.656	135.8	10.93	2745.5
				0.714	141.3	11.91	2824.2
				0.778	145.9	12.96	2882.6
				0.846	150.5	14.10	2934.1
				0.918	154.9	15.30	2978.1
				0.995	159.9	16.59	3027.1
				1.073	162.4	17.88	3027.3
				1.145	163.8	19.09	3008.1
				1.192	164.2	19.87	2986.0
				1.209	162.0	20.15	2936.7
				1.210	161.8	20.16	2931.8

Test Report: Void ratio = 0.625
 Ht/Dia ratio = 2.11
 Moisture = 24.3 %
 Total density = 128.8 pcf
 Dry density = 103.7 pcf
 Saturation = 104.8 %
 Chamber pressure = 1650 psf
 Max. deviator stress = 3027 psf
 Strain @ failure = 17.88 %



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
 Project : Lagunitas Bridge Road Phase I Ross CA
 Job # : 43-00067008.00
 Boring # B-2
 Sample # : 4
 Depth (ft) : 19.5-21
 Date tested : 01/18/02
 Soil : Dark brown sandy lean clay

Data Reduction:

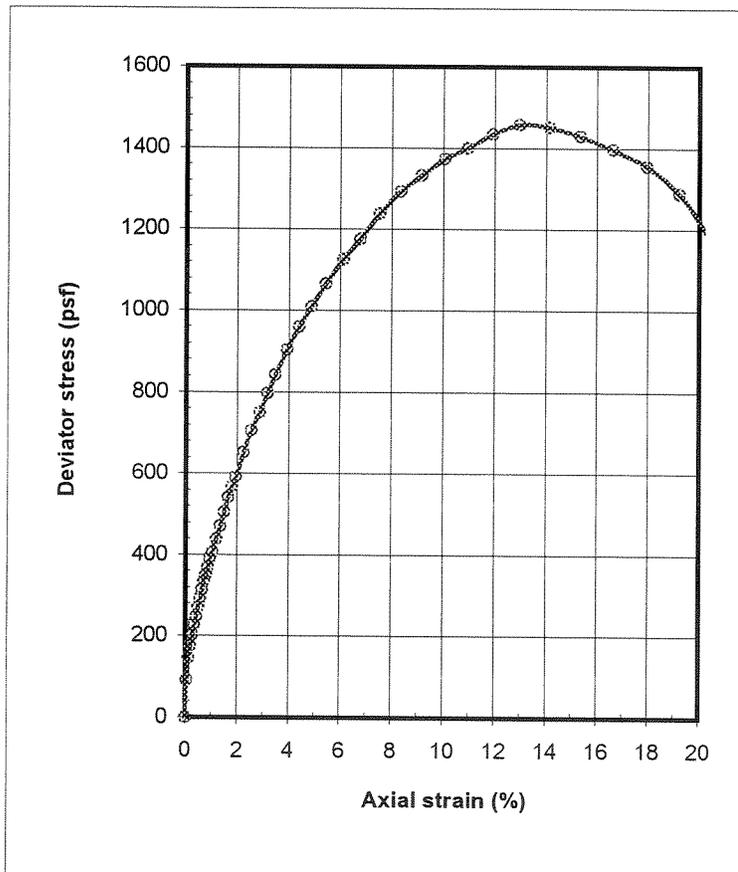
Dial factor = 1.0 in/unit
 Load factor = 1.0 lb/unit

Specimen: Total wt. = 1220.2 gms
 Ht. = 6.000 in
 Ave dia. = 2.767 in
 Area = 6.014 sq.in
 Volume = 591.3 c.c.
 Shearing rate = 0.04 inch/min
 Shearing rate = 0.67 %/min
 Gs (assumed) = 2.70

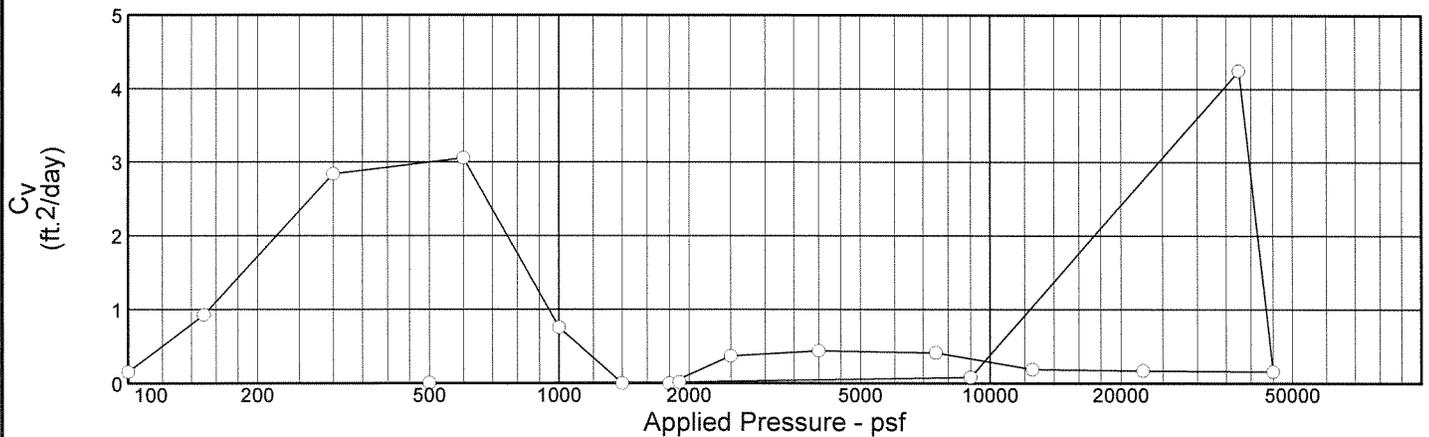
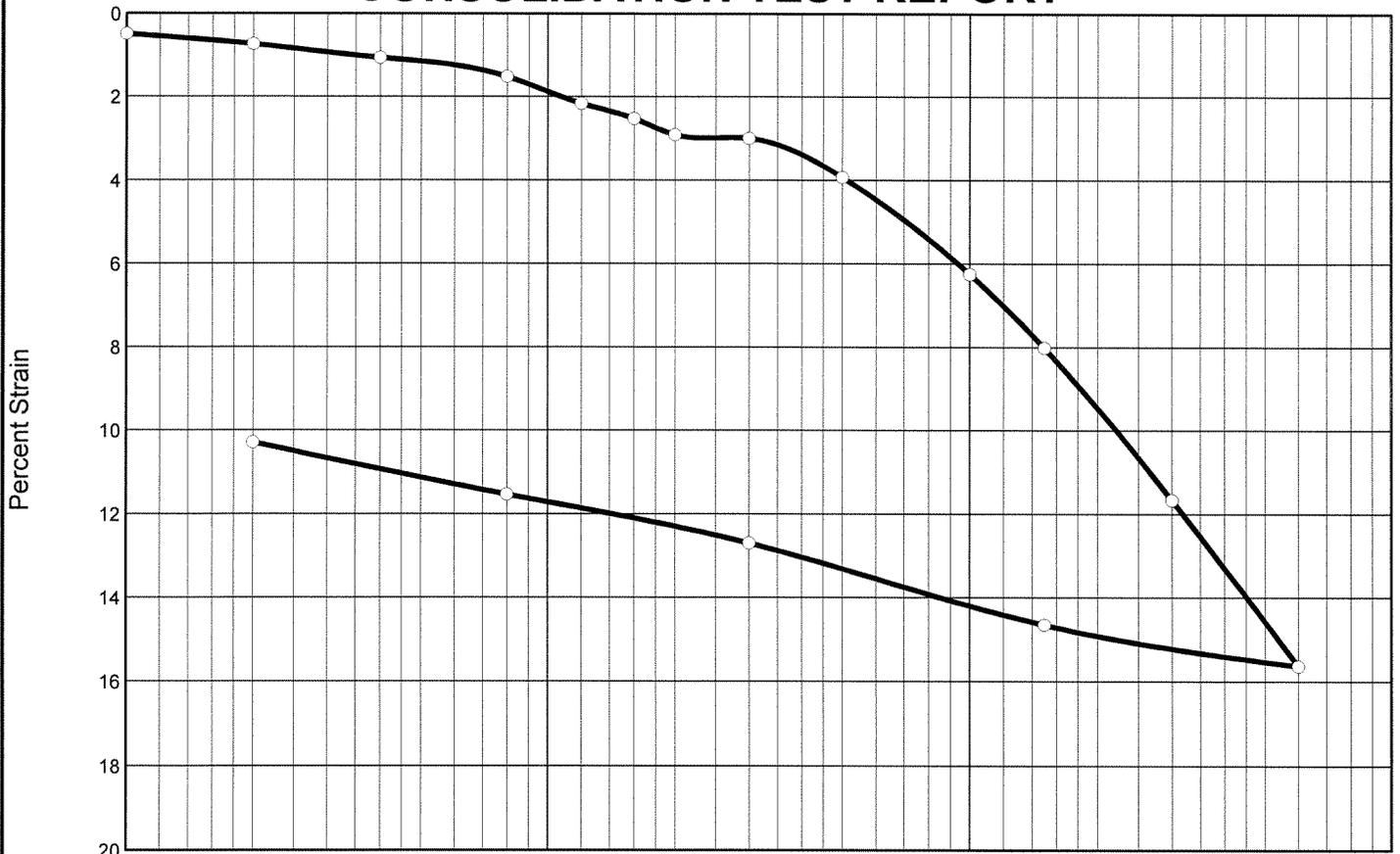
Test Report:

Void ratio = 0.601
 Ht/Dia ratio = 2.17
 Moisture = 22.3 %
 Total density = 128.8 pcf
 Dry density = 105.2 pcf
 Saturation = 100.4 %
 Chamber pressure = 2500 psf
 Max. deviator stress = 1457 psf
 Strain @ failure = 12.99 %

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
0.000	0.1	0.00	0.0
0.003	3.9	0.05	91.3
0.007	6.2	0.12	145.6
0.012	7.4	0.20	175.7
0.016	8.6	0.27	202.8
0.021	9.6	0.35	226.7
0.025	10.4	0.42	246.7
0.030	11.5	0.50	271.3
0.035	12.3	0.58	291.0
0.039	13.2	0.65	312.7
0.044	14.2	0.73	335.2
0.048	14.9	0.81	351.7
0.053	15.7	0.88	369.8
0.058	16.5	0.96	390.6
0.062	17.2	1.04	405.6
0.072	18.6	1.20	439.2
0.081	20.0	1.35	469.9
0.090	21.5	1.50	504.8
0.099	23.0	1.66	541.0
0.109	24.2	1.81	567.7
0.117	25.2	1.96	590.7
0.136	27.9	2.26	651.9
0.154	30.3	2.56	704.5
0.172	32.3	2.87	748.4
0.190	34.4	3.17	796.2
0.209	36.5	3.48	841.4
0.237	39.3	3.95	902.0
0.265	42.0	4.41	959.5
0.293	44.4	4.88	1008.6
0.326	47.1	5.43	1065.8
0.367	50.1	6.11	1124.4
0.406	52.7	6.77	1175.6
0.451	56.0	7.52	1237.8
0.500	59.0	8.34	1293.3
0.549	61.3	9.15	1331.4
0.603	63.8	10.05	1373.0
0.658	65.7	10.96	1399.7
0.716	68.1	11.94	1434.3
0.779	70.0	12.99	1457.4
0.848	70.7	14.13	1451.4
0.920	70.6	15.33	1429.0
0.997	70.0	16.61	1396.5
1.076	69.0	17.94	1355.1
1.154	66.7	19.23	1287.6
1.216	62.5	20.27	1192.3
1.243	58.5	20.71	1109.1
1.244	58.3	20.73	1105.6
1.255	47.7	20.91	901.1



CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
94.3 %	23.8 %	100.2	36	14	2.7			0.682

MATERIAL DESCRIPTION

Dark brown clay w/silt

Project No. 43-	Client: URS/Dames & Moore
Project: Lagunitas Bridge Road Phase 1 Ross, California	
Source: B-2	Sample No.: 3 Elev./Depth: 14.5-16.9

Remarks:

Plate

CONSOLIDATION TEST REPORT

SIGNET TESTING LABS, INC.

Dial Reading vs. Time

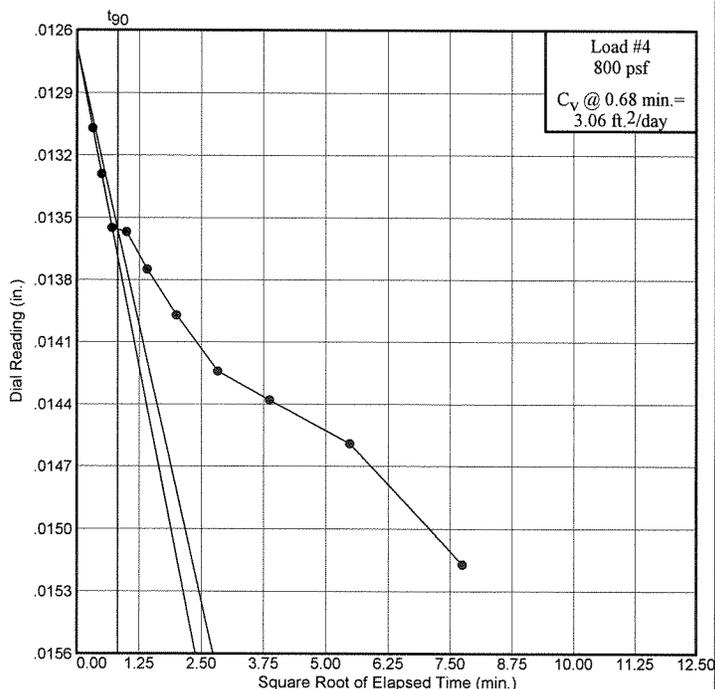
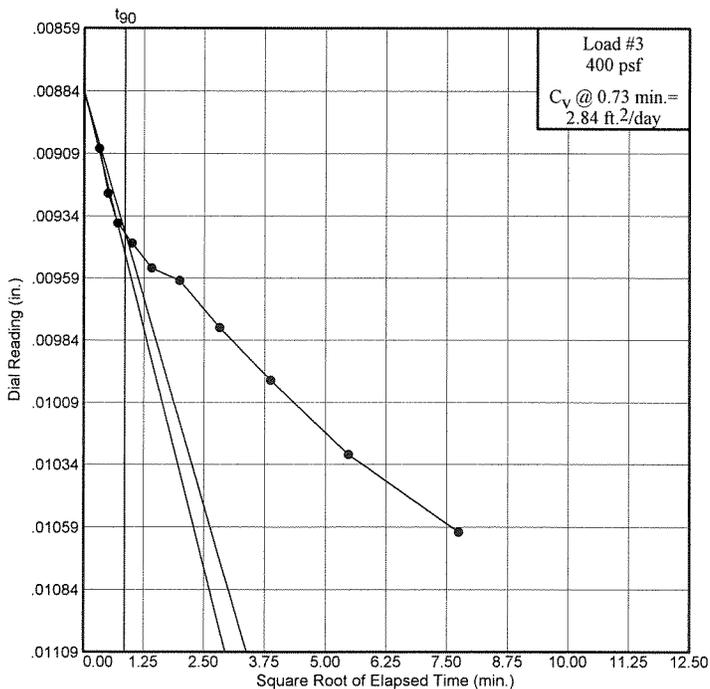
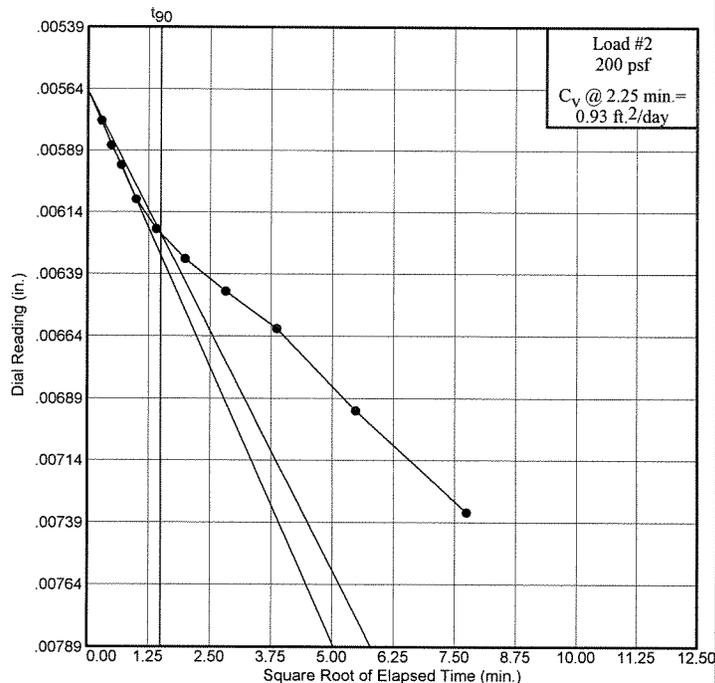
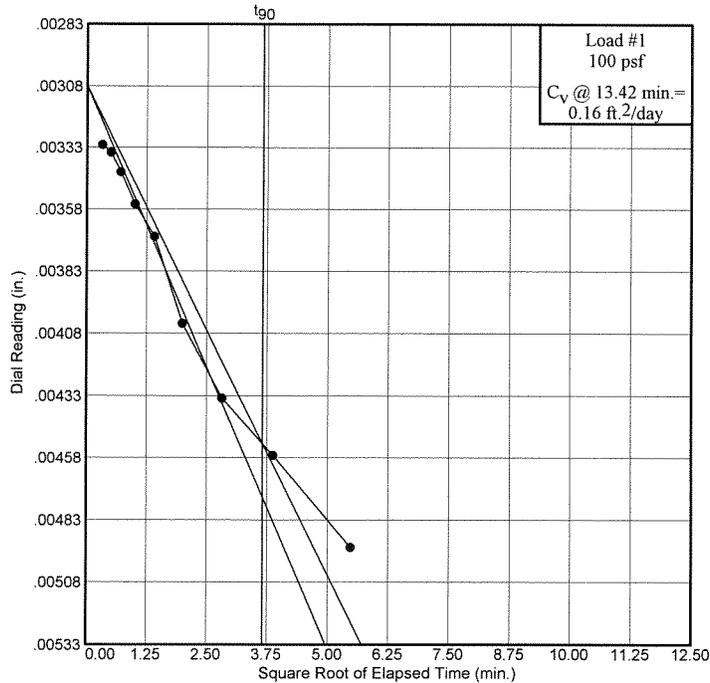
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase 1
Ross, California

Source: B-2

Sample No.: 3

Elev./Depth: 14.5-16.9



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

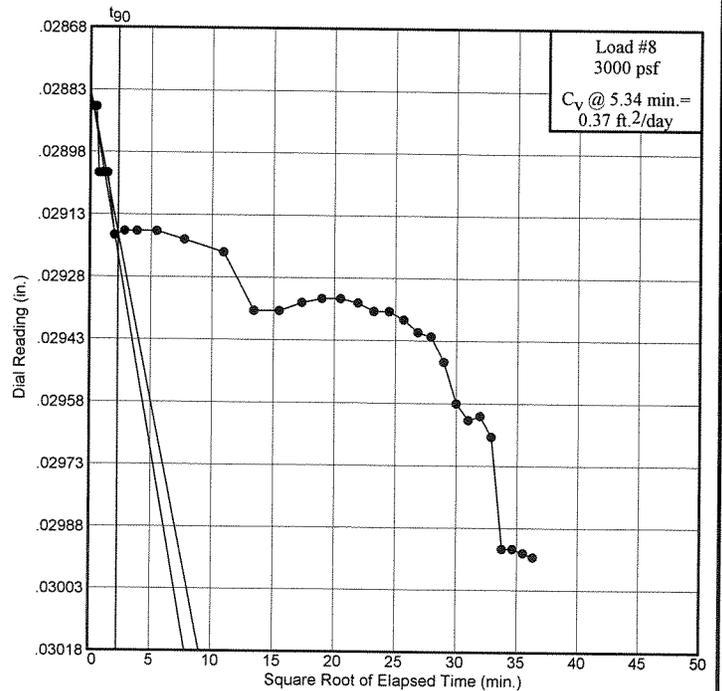
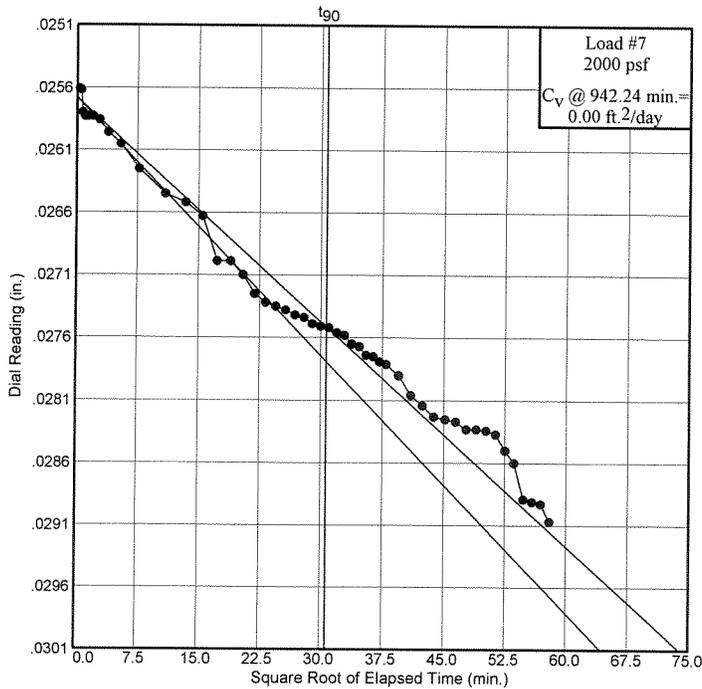
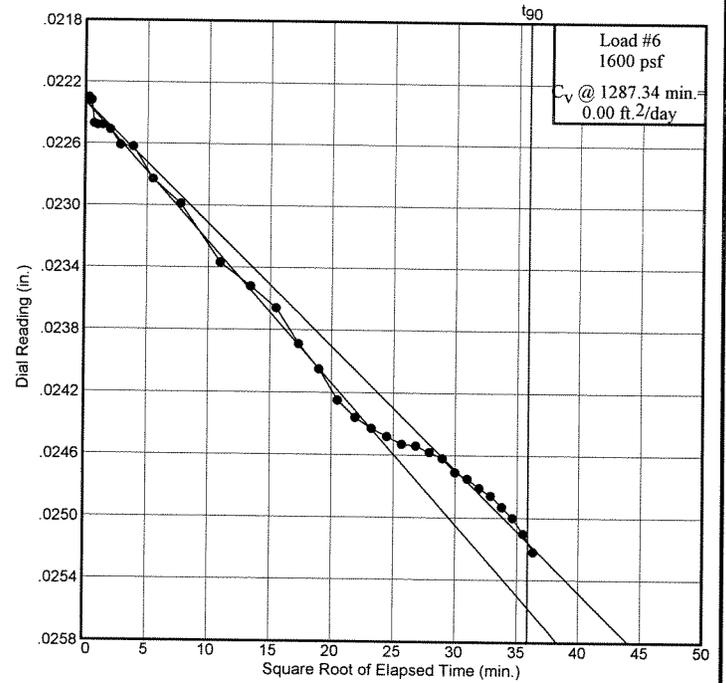
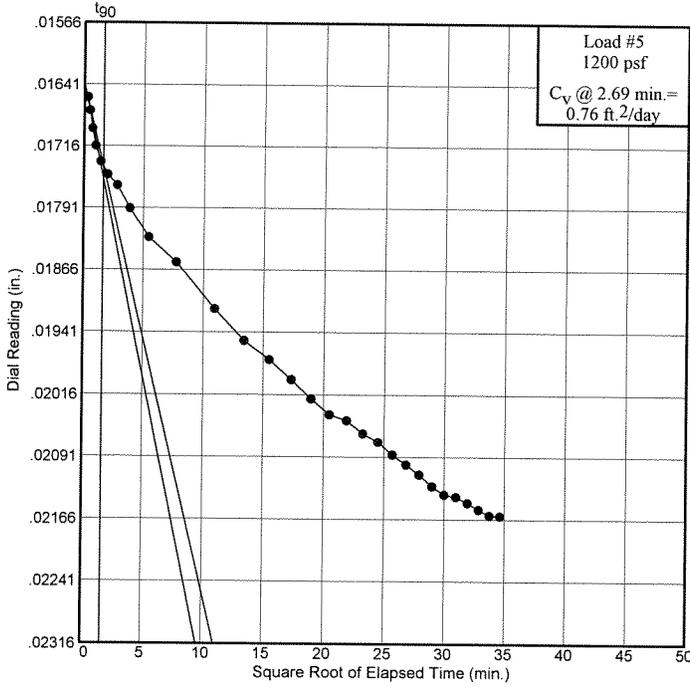
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase 1
Ross, California

Source: B-2

Sample No.: 3

Elev./Depth: 14.5-16.9



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

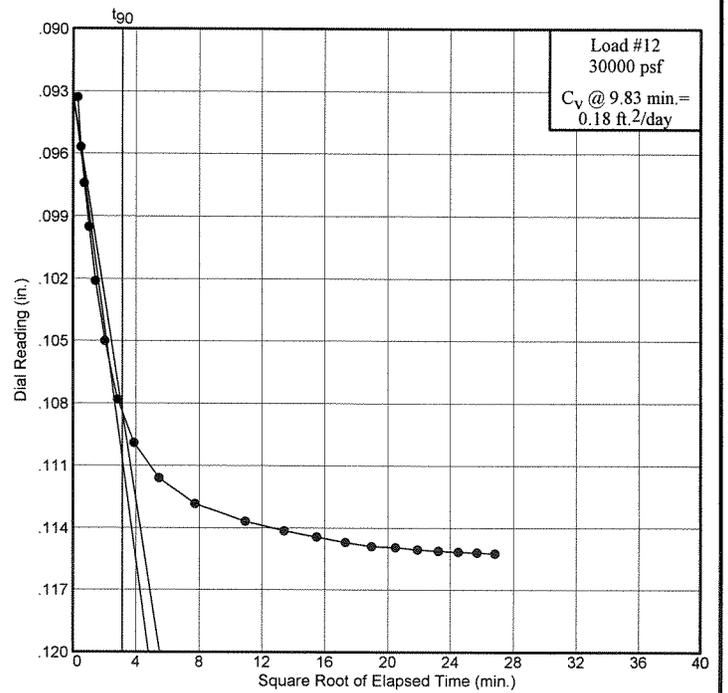
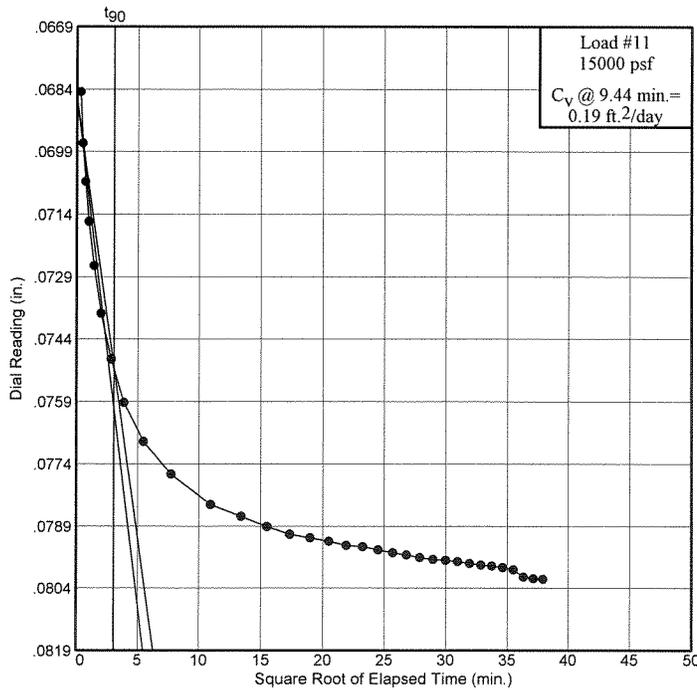
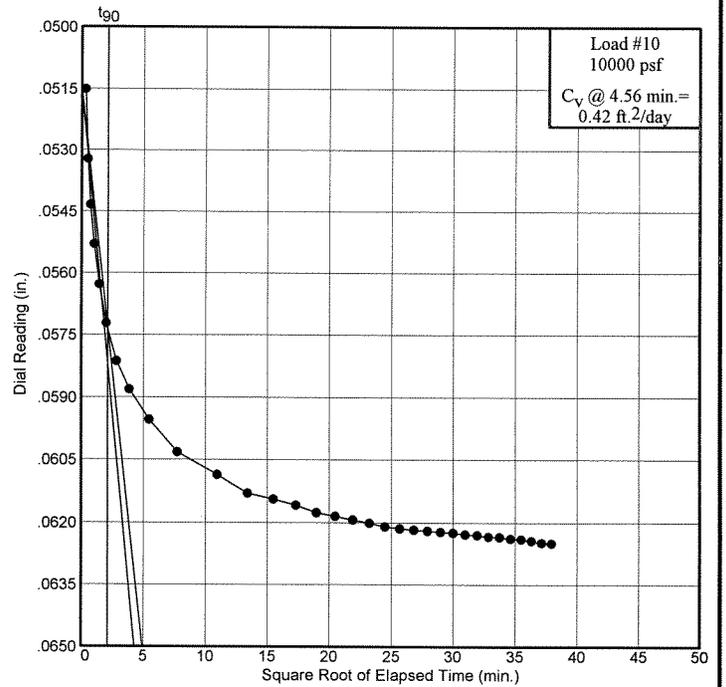
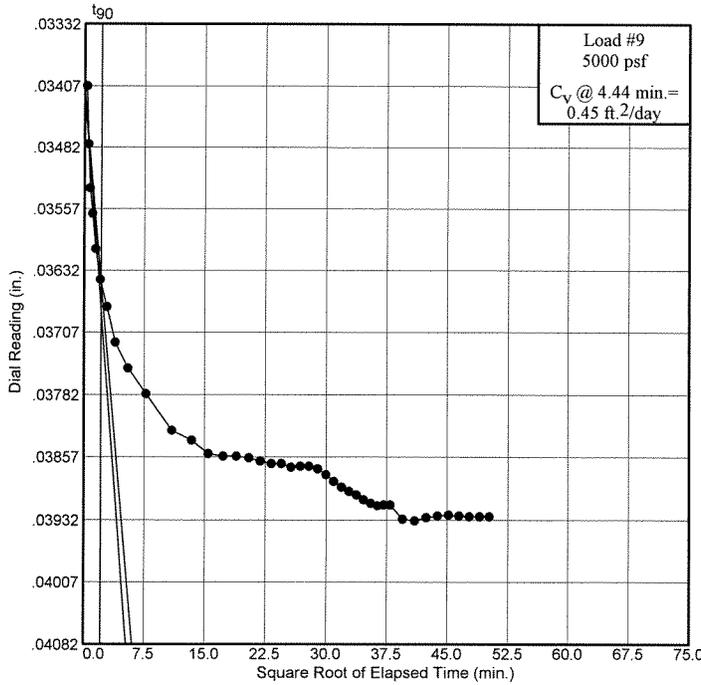
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase 1
Ross, California

Source: B-2

Sample No.: 3

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Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

Project No.: 43-00067008.00

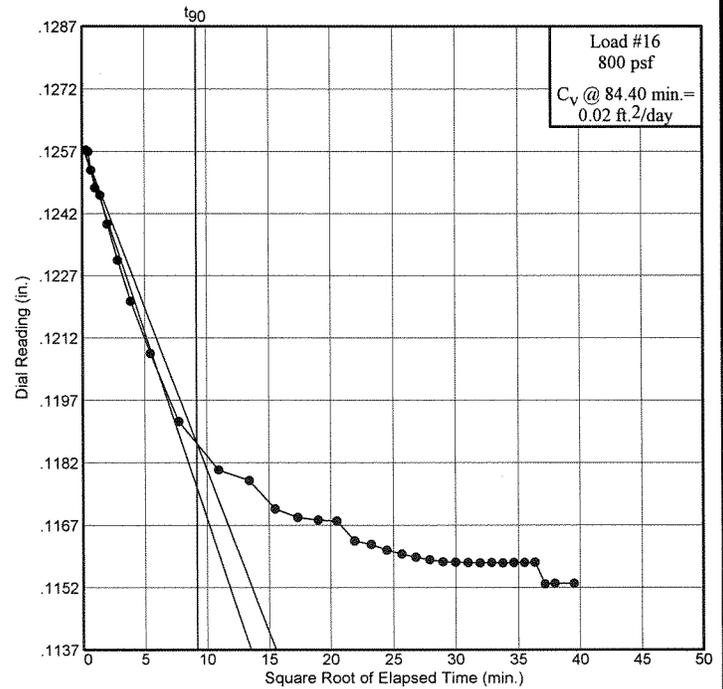
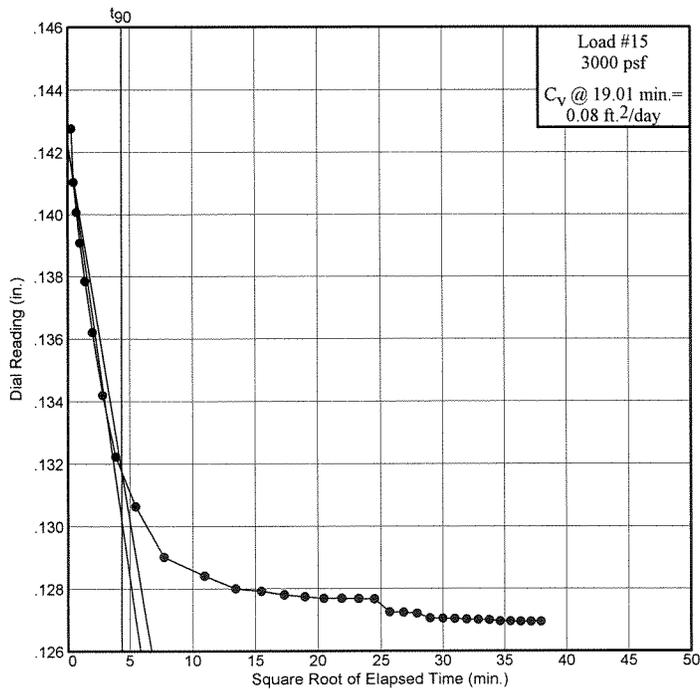
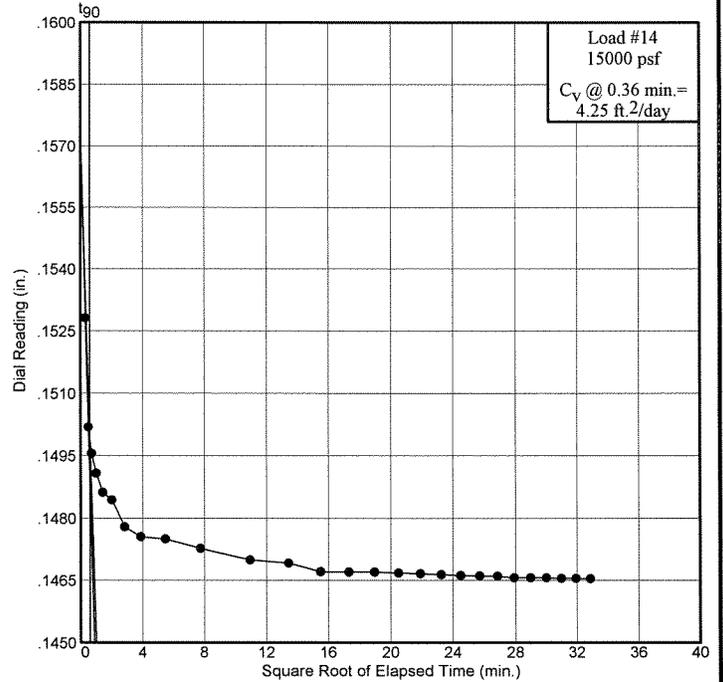
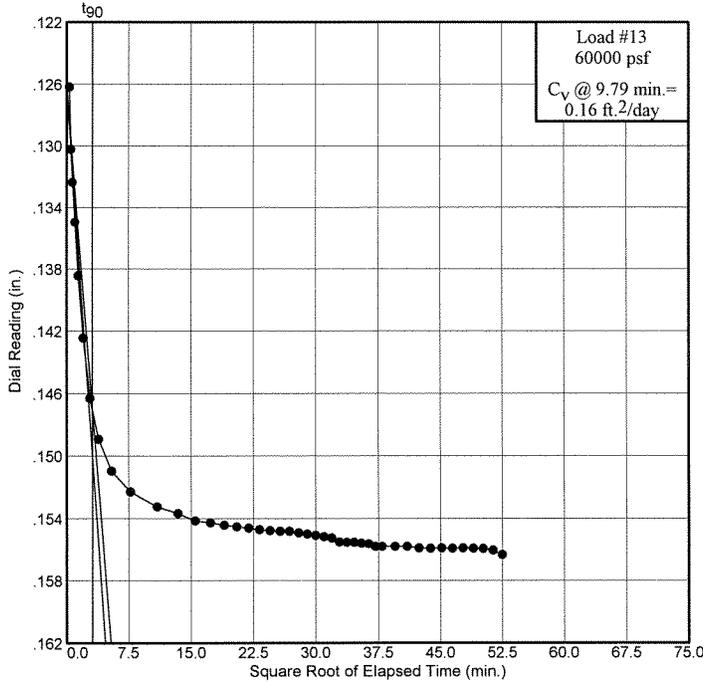
Project: Lagunitas Bridge Road Phase 1

Ross, California

Source: B-2

Sample No.: 3

Elev./Depth: 14.5-16.9



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

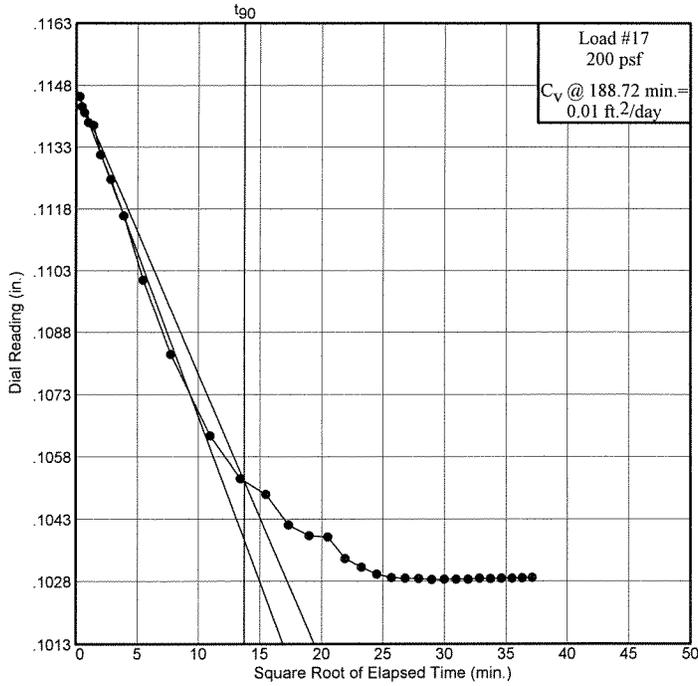
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Project: Lagunitas Bridge Road Phase 1
Ross, California

Source: B-2

Sample No.: 3

Elev./Depth: 14.5-16.9

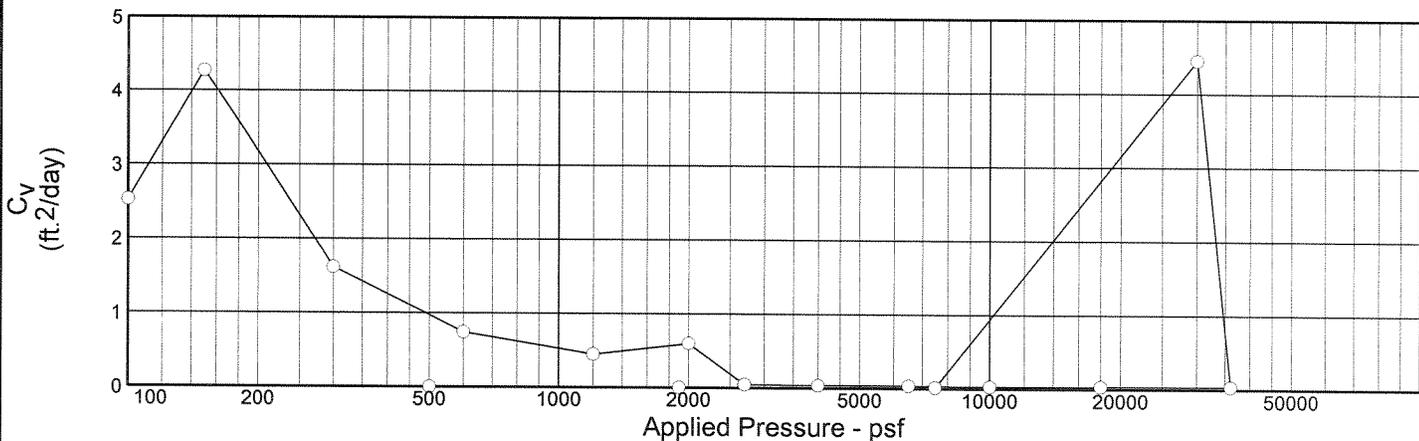
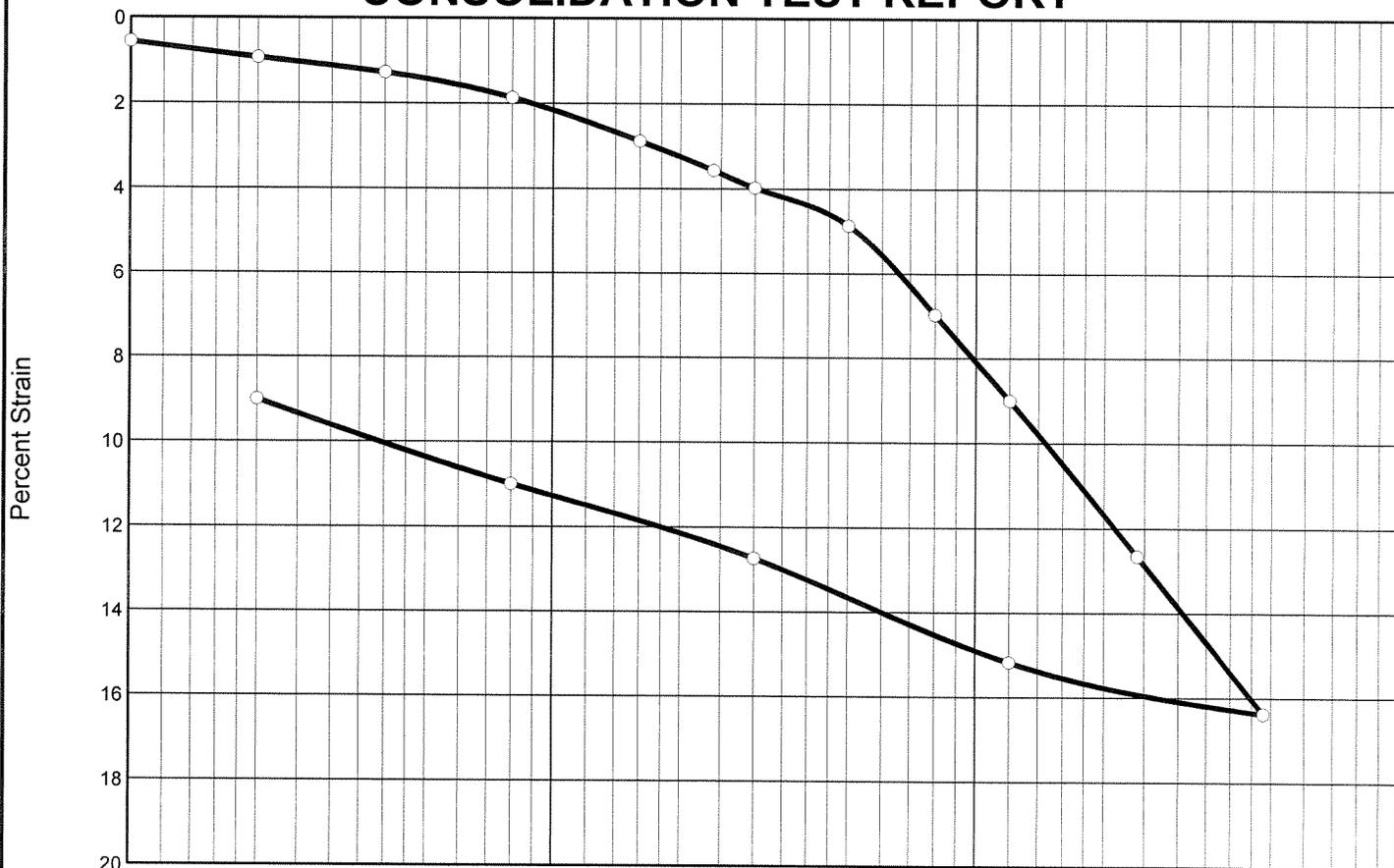


Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
99.1 %	26.2 %	98.4	43	20	2.7	CL		0.712

MATERIAL DESCRIPTION

Dark Brown Sandy lean clay

Project No. 43- **Client:** URS
Project: Lagunitas Bridge Road Phase I Ross, California
Source: B-2 **Sample No.:** 4 **Elev./Depth:** 19.5-21

Remarks:

Plate

CONSOLIDATION TEST REPORT

SIGNET TESTING LABS, INC.

Dial Reading vs. Time

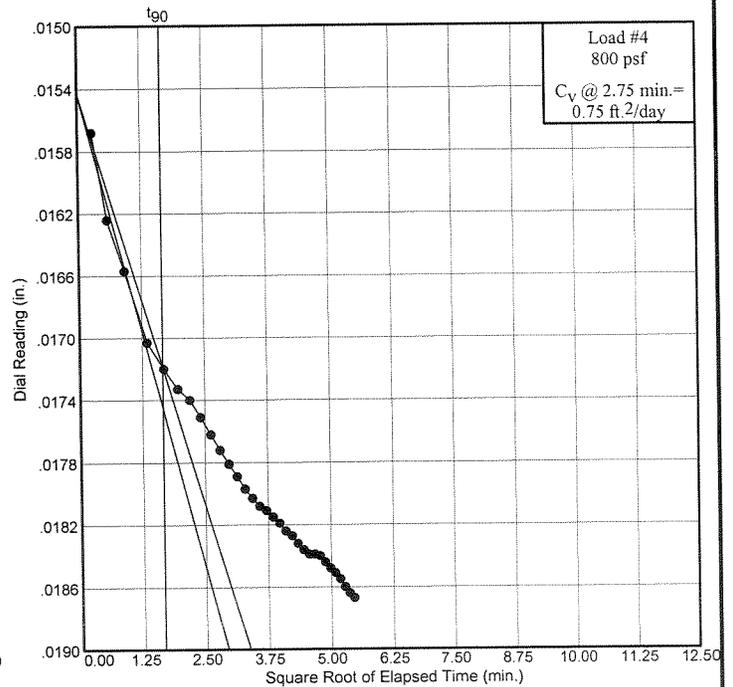
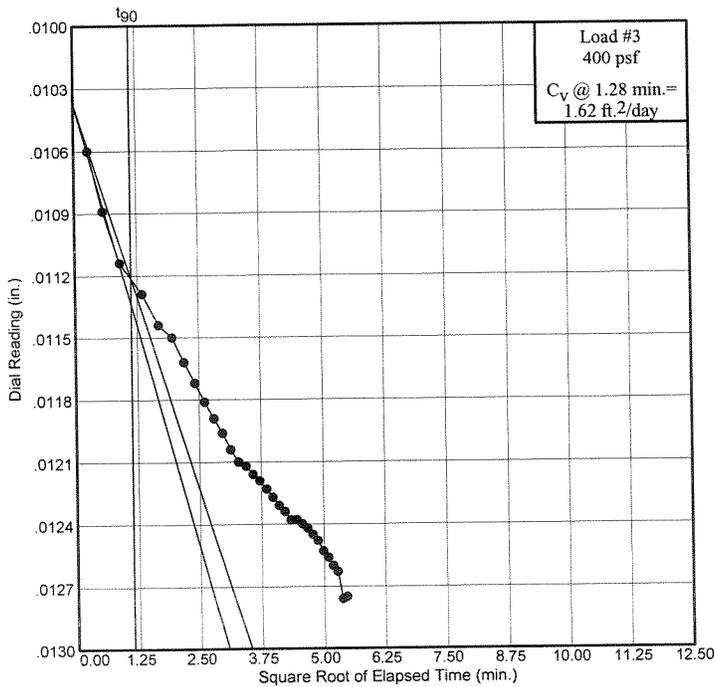
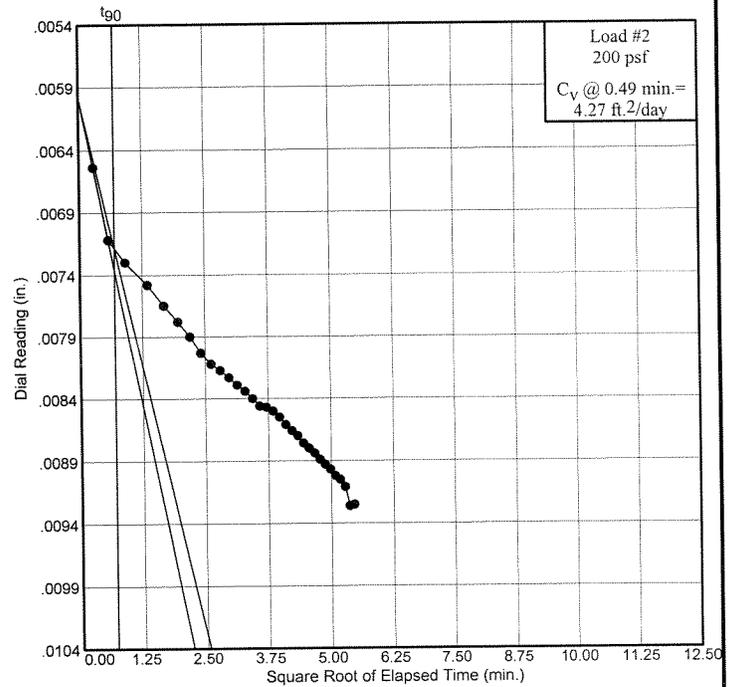
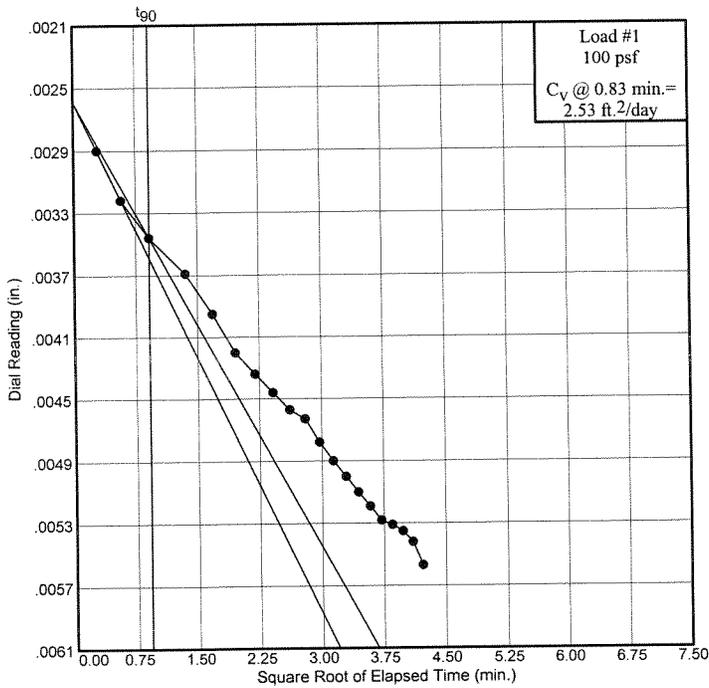
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase I Ross, California

Source: B-2

Sample No.: 4

Elev./Depth: 19.5-21



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

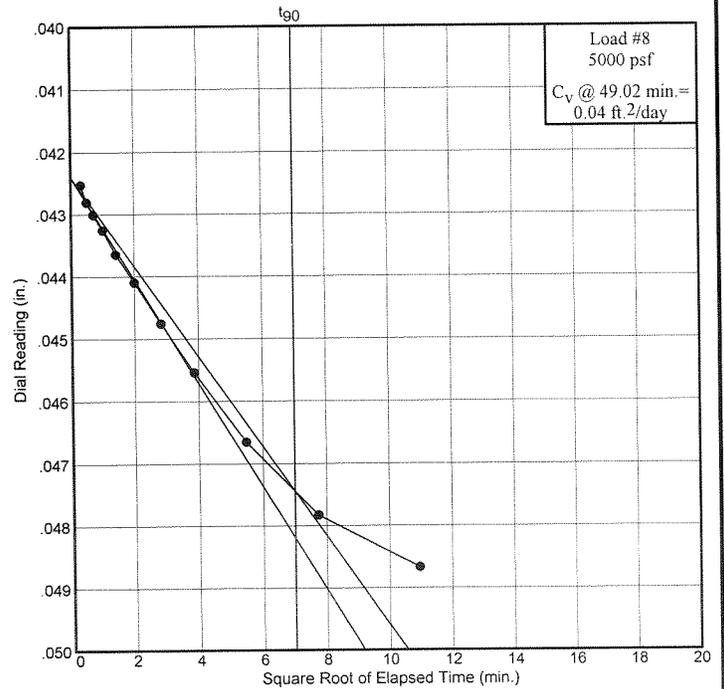
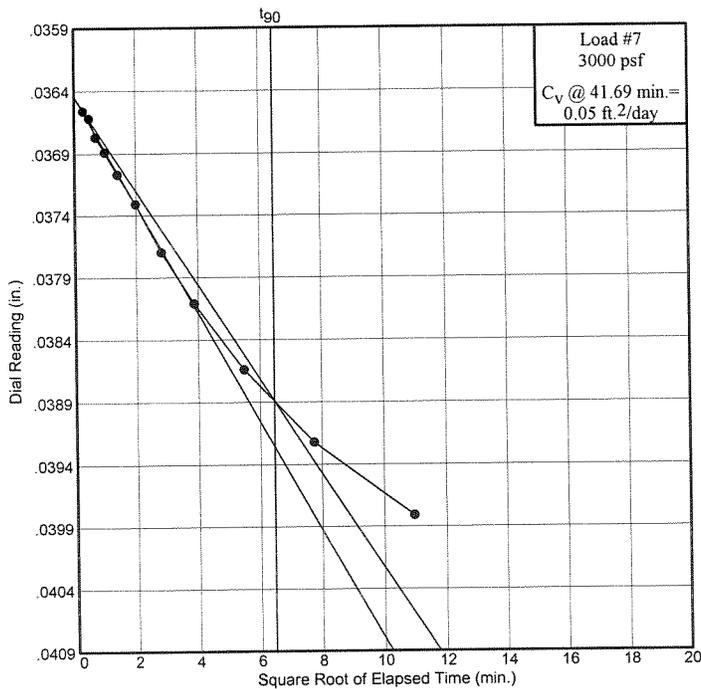
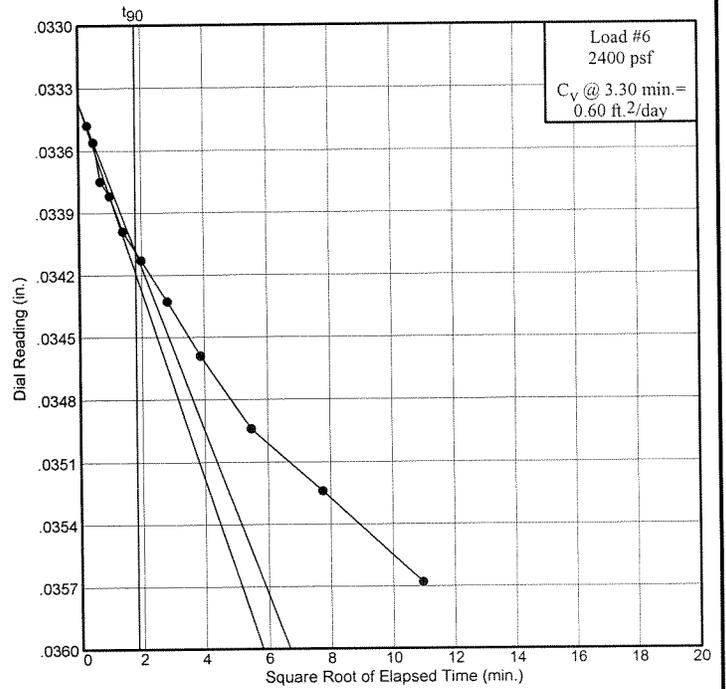
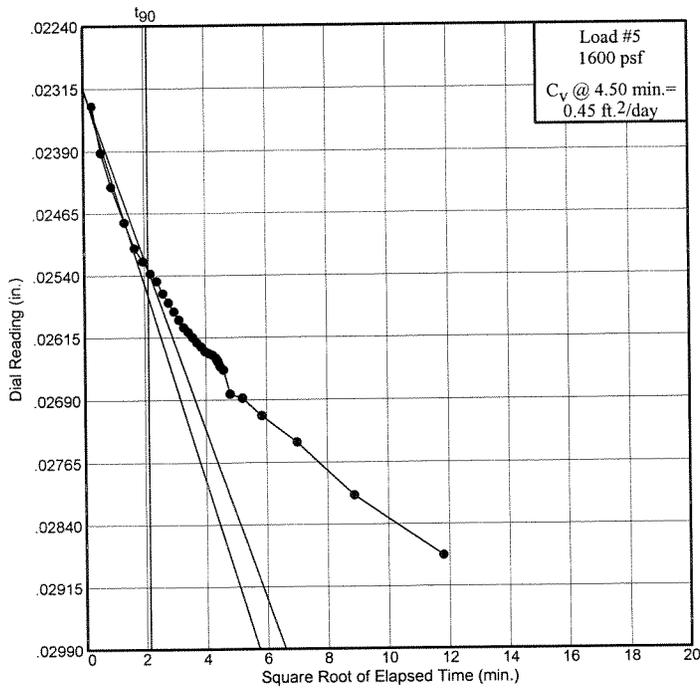
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase I Ross, California

Source: B-2

Sample No.: 4

Elev./Depth: 19.5-21



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

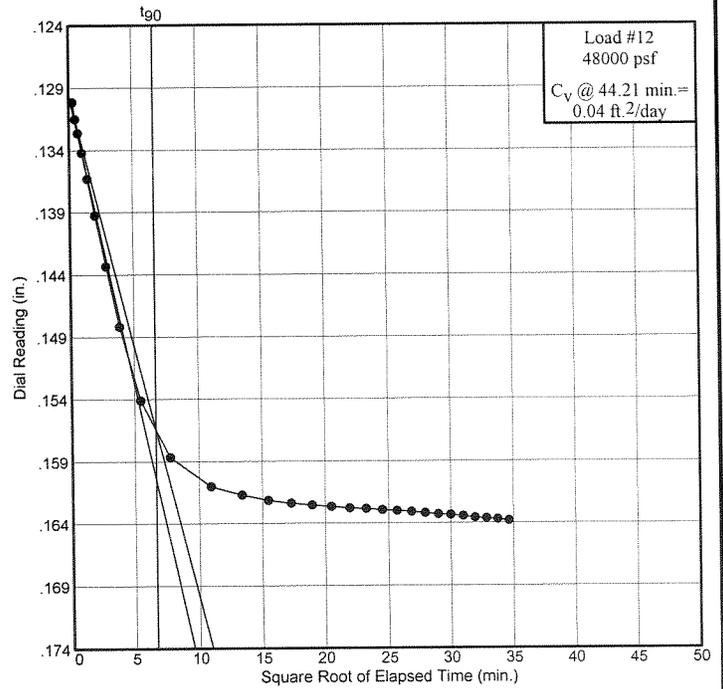
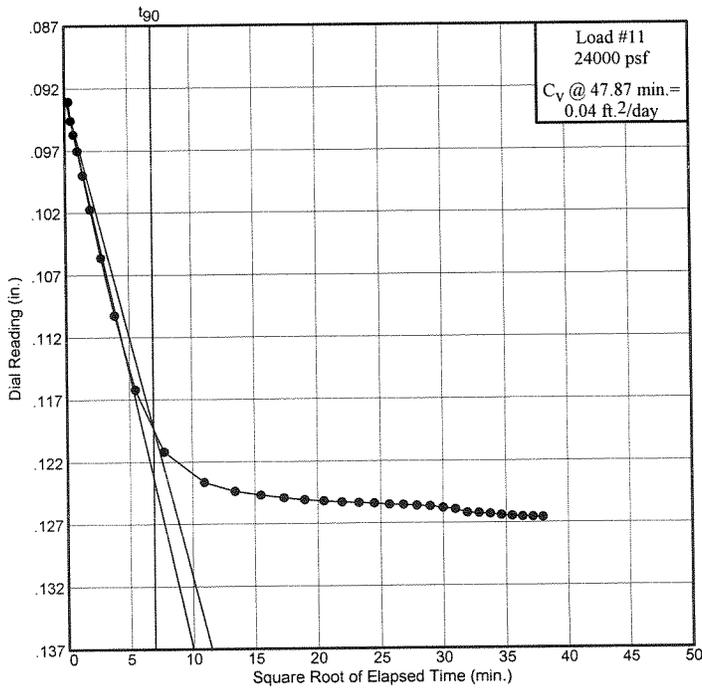
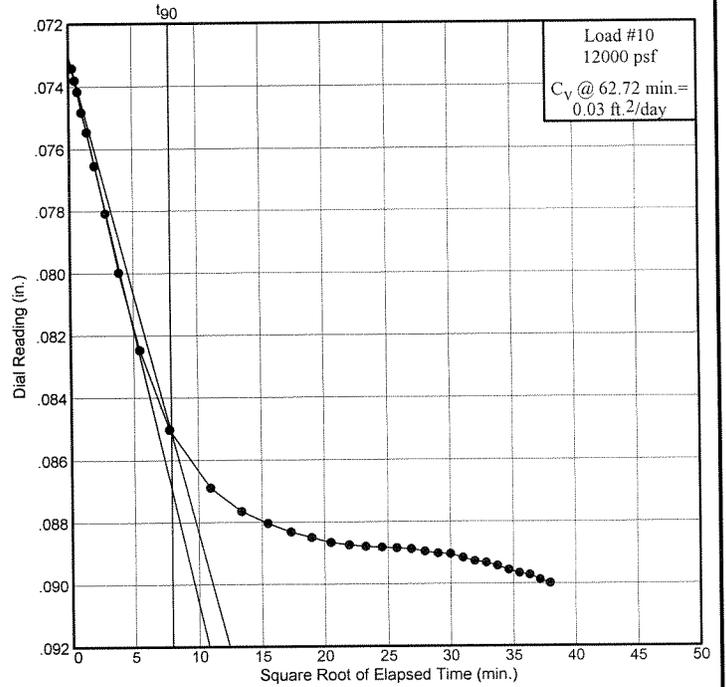
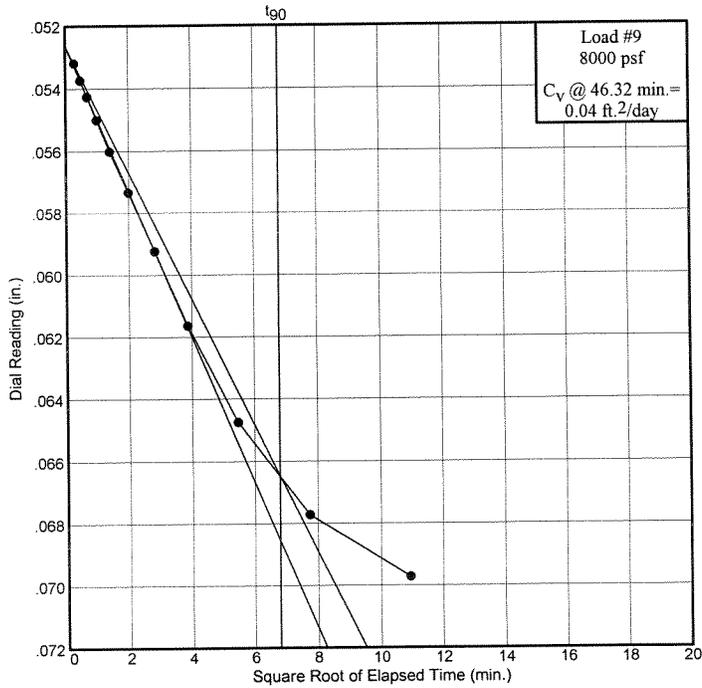
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase I Ross, California

Source: B-2

Sample No.: 4

Elev./Depth: 19.5-21



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate

Dial Reading vs. Time

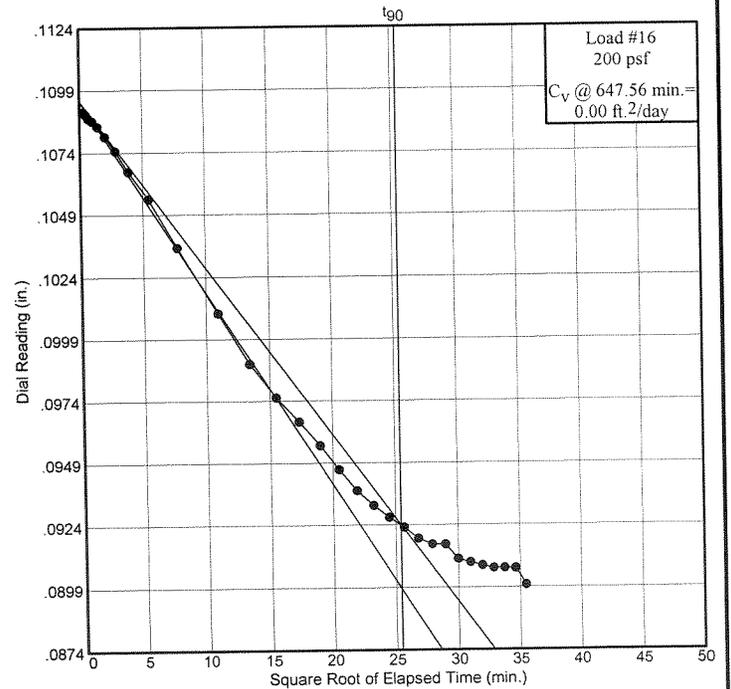
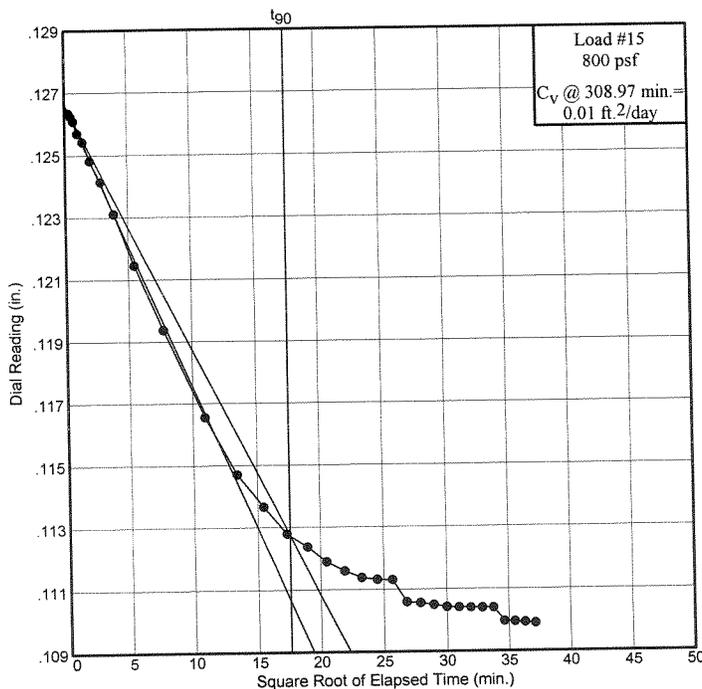
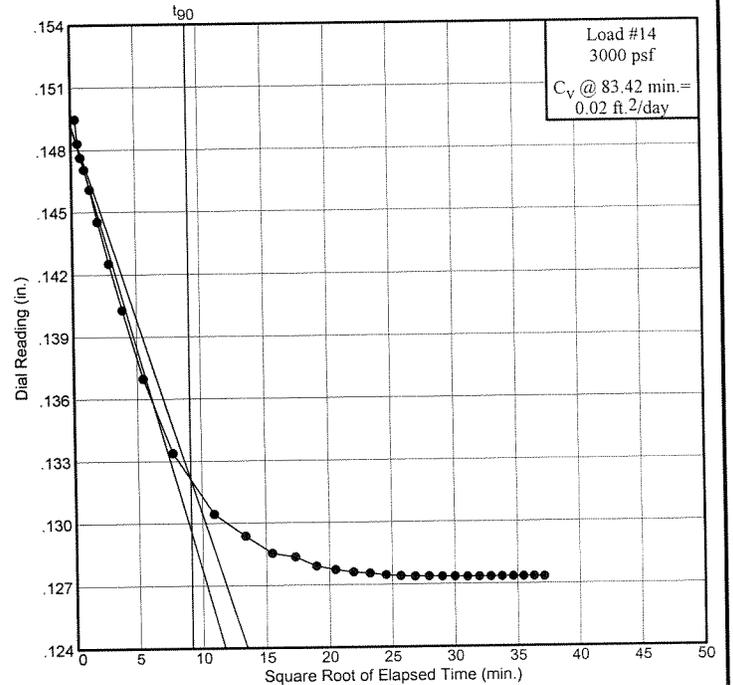
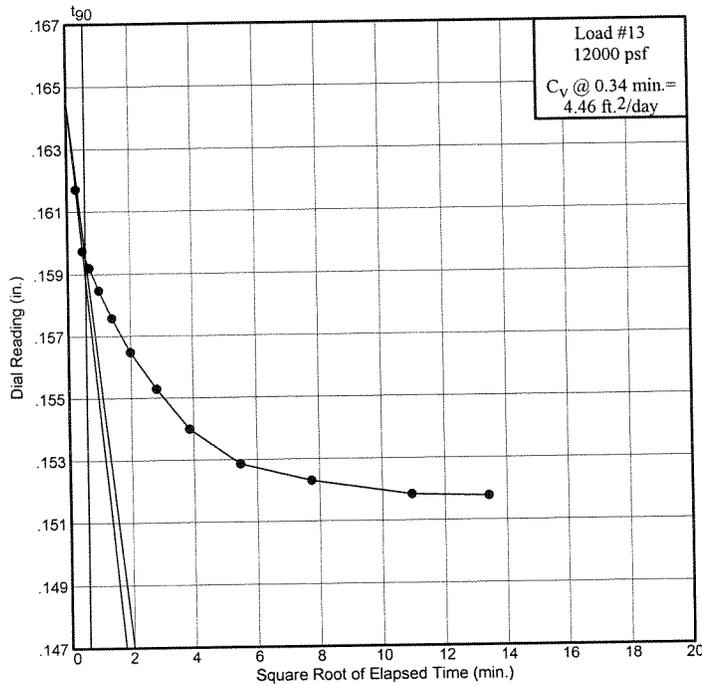
Project No.: 43-00067008.00

Project: Lagunitas Bridge Road Phase I Ross, California

Source: B-2

Sample No.: 4

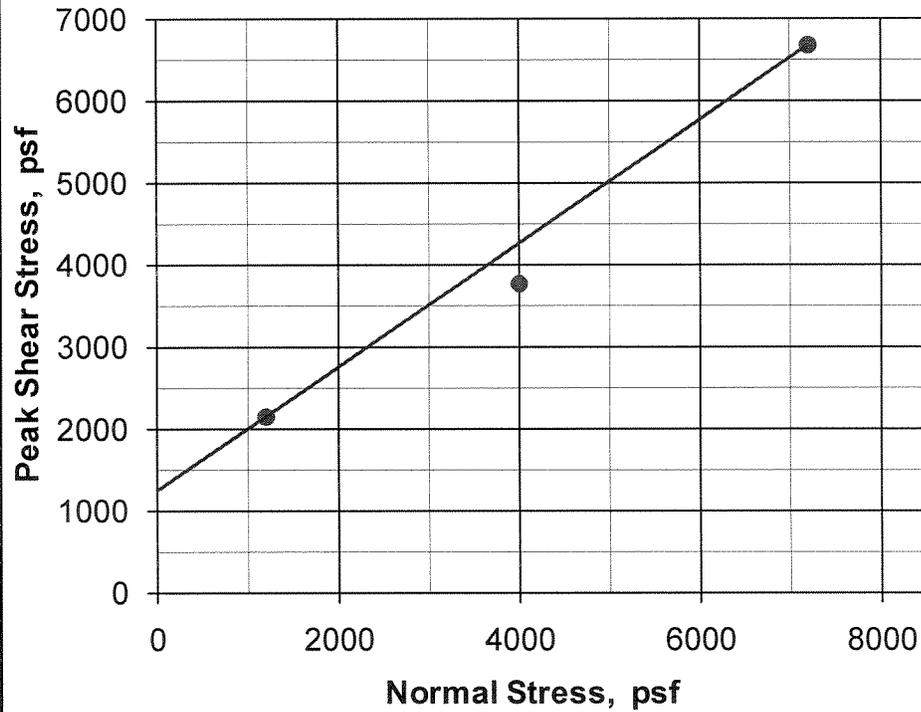
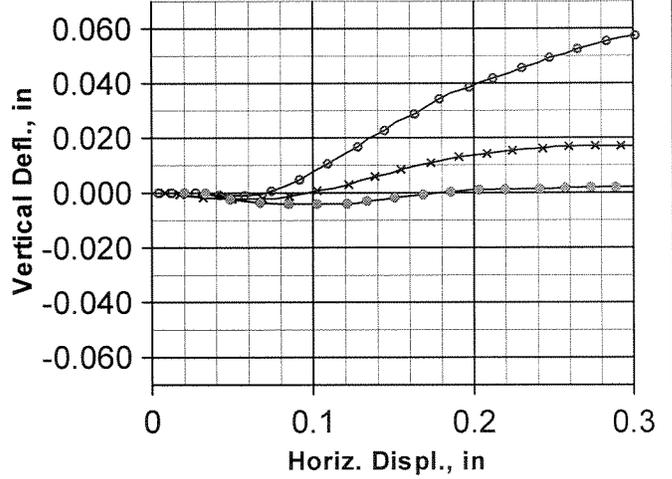
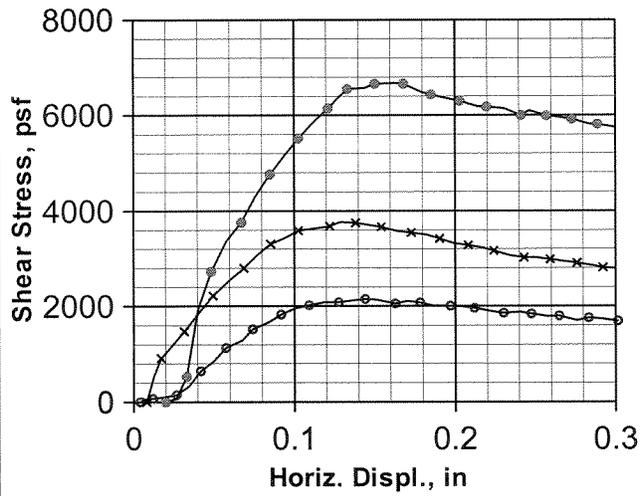
Elev./Depth: 19.5-21



Dial Reading vs. Time

SIGNET TESTING LABS, INC.

Plate



Legend	
○	Test no.1
×	Test no.2
◇	Test no.3

Results

C = 1250 psf
 phi = 37 deg.

Gs = 2.70
 Type = undisturbed

Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1200	2150	0.144	0.18	16.4	120.8	112	0.396	1.00	2.416	16.9	115.2	99	0.463	1.048
2	4000	3770	0.129	0.18	20.4	113.6	114	0.483	1.00	2.416	18.3	115.2	107	0.464	0.987
3	7200	6677	0.162	0.18	17.3	123.1	126	0.370	1.00	2.416	15.0	128.3	128	0.314	0.959

Client: URS/D&M	Boring #: B-1	Sample #: 2
Project: Lagunitas Bridge Road Phase I Ross CA	Depth (ft): 10	
Project #: 43-00067008.00	Soil: Dark brown gravelly sand	

TEST REPORT: Direct shear - inundated, consolidated, & drained test