Draft Geotechnical Data Report
Nacimiento Water Project – Intake and Pump Station

San Luis Obispo County, California

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NOT FOR CONSTRUCTION

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Project No. 10352

Geomatrix

4.0 GEOLOGY

This section summarizes the geologic conditions at the IPS site. The general characteristics of the bedrock and younger surficial deposits that will be encountered when constructing the IPS are described in this section. Section 4.1 presents summary of the regional geologic setting of the project vicinity. Section 4.2 presents a summary of the regional seismic setting and the faults that may impact the IPS. Section 4.3, describes the geology of the IPS site.

4.1 GEOLOGIC SETTING

The NWP is located in the central California Coast Ranges Geomorphic Province, a tectonically active region characterized by relatively rugged and youthful north-northwest trending mountain ranges separated by intervening alluvial valleys. Most active faults and folds within this province also trend north-northwest. This dominant structural trend is generally parallel to the San Andreas fault zone, the active transform fault boundary between the Pacific and North American tectonic plates.

The geology of the Coast Ranges generally consists of Holocene (less than 11,000 years old) to Quaternary (less than 1.8 million years old) alluvium overlying Tertiary (65 to 1.8 million years old) terrestrial sedimentary and volcanic rocks, and marine sedimentary rocks. These units, in turn, overly late Mesozoic (250 to 65 million years old) basement rocks that include either granitic rocks of the Cretaceous (145 to 65 million years old) Salinian Block or the pervasively sheared and faulted deep sea sediments and crustal rocks of the Cretaceous to Jurassic (210 million to 65 million years old) Franciscan Complex. Basement rocks of the Salinian Block are limited to the region bounded by the San Andreas fault on the east and the Nacimiento fault on the west. Basement rocks of the Franciscan Complex occur east of the San Andreas fault, and west of the Nacimiento fault. The proposed IPS site is located about 8 miles northeast of the Nacimiento fault, and therefore likely overlies granitic basement rocks of the Salinian Block.

4.2 SEISMIC SETTING

As mentioned above, the NWP is located within the tectonically and seismically active California Coast Ranges, which are seismically and structurally dominated by the San Andreas fault system. The San Andreas fault system comprises a zone of major, northwest-trending,

active[1] strike-slip and oblique-slip faults that accommodate approximately 1.7 inches per year (42 mm/yr) of right lateral motion between the Pacific and North American plates. At this latitude, the majority of this activity is concentrated on the San Andreas fault itself, although several significant active and potentially active faults closer to the IPS site could accommodate some of this right lateral slip. These faults include the active San Simeon fault, and the potentially active Rinconada, San Marcos, Oceanic and Cambria faults (Jennings, 1994). Athough the Nacimiento fault is not mapped by the State of California as an active or potentially active fault (Jennings, 1994), it is associated with a significant linear trend of accurately located earthquake epicenters (Jennings, 1994).

4.3 GEOLOGIC CONDITIONS

This section provides a description of the major geologic units found at the IPS site. The summary is based on a review of the published mapping and the results of field exploration. The distribution of the major geologic units found at the IPS site is shown on Plate 1.

4.3.1 Setting

The IPS site is located within the in the moderately rugged hills around Lake Nacimiento, on the west side of a large, flat, abandoned parking lot in the upstream left abutment area of Nacimiento Dam. The IPS site is located at an elevation of 830 feet, about 5 feet above the dam crest, and 30 feet higher than the maximum lake level. The parking lot area on which the IPS will be constructed is bounded on the west and south sides by gentle to moderate slopes that descend to the lake, and on the north by a high cutslope that rises up to 55 feet above the parking lot. The cut slope has an inclination of about 3 (horizontal) to 1 (vertical). The parking lot rises very gradually to the east, and is bounded on the east by Lake Nacimiento Drive and an unnamed access road. North of the IPS site, the hillslope climbs to a height of about 1430 feet.

4.3.2 Geologic Conditions

The geology of the IPS site was mapped by Dibblee (1971), Durham (1974), Burch and Durham (1970), and Durham (1968). Plate 1 shows the geology of the IPS site based on the published mapping cited above, and modified based on interpretation of aerial photographs, field mapping and field exploration performed for this project. As shown on Plate 1, the IPS

[1] According to State of California definitions, *active* faults have a documented history of slip within the past 11,000 years of geologic time (the Holocene epoch), and *potentially active* faults have slipped within the past 1.6 million years (the Quaternary period).

site is underlain by early Miocene (about 25 million years to 5 million years old) marine sandstone of the Vaqueros Formation. The east side of the site is underlain by Miocene marine shale of the Monterey Formation. A large part of the parking lot is supported by artificial fill that fills an alluvial valley that passed through the site prior to construction of the parking lot. Each of these units is described below (from youngest to oldest):

Artificial Fill (af): As noted above, part of the flat parking lot at the IPS site is supported by artificial fill that fills a drainage that crosses the east side of the IPS site. The overall composition and consistency of the fill are unknown.

Monterey Formation—Clay Shale (Tmc): The Monterey Formation consists of moderately lithified deep marine rocks of late to middle Miocene age. Consists chiefly of calcareous shale, but also includes porcelaneous rocks, chert, dolomitic carbonate rock, and sandstone.

Vaqueros Formation—Tierra Redonda Member (Tv): The Vaqueros Formation consists dominantly of moderately lithified, light to dark brown or gray, massive, fairly poorly- to well-graded quartz-rich sandstone that is locally pebbly. The Vaqueros Formation ranges from Miocene to Oligocene (37 to 25 million years old) in age. Hall and others (1979) indicate that the quartz content of the Vaqueros Sandstone ranges from 50 percent to more than 90 percent. The Tierra Redonda member locally includes conglomerate and granitic boulders, however mapping by Dibblee (1971) indicates that the Vaqueros Formation at the IPS site is chiefly sandstone.

5.0 LIMITATIONS

In the performance of its professional services, Geomatrix, its employees, and its agents comply with the standards of care and skill ordinarily exercised by members of our profession practicing in the same or similar localities. This report may not provide all of the information needed by a Contractor to construct the project. No warranty, either express or implied, is made or intended in connection with the work performed by us, or by the proposal for consulting or other services, or by the furnishing of oral or written reports or findings. In the event conclusions or recommendations based on these data are made by others, such conclusions and recommendations are not our responsibility unless we have been given an opportunity to review and concur with such conclusions or recommendations in writing.

TABLES

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TABLE 1

SUMMARY OF EXPLORATION METHODS AND PIEZOMETER CONSTRUCTION

Nacimiento Water Project
San Luis Obispo County, California

Exploration No.	Facility	Depth of Exploration (feet)	Exploration Date	Method of Exploration [2,3]	Groundwater Level from Ground Surface at Time of Drilling[1] (feet)	Piezometer (Yes or No)	Depth to Bottom of Well Screen (feet)	Length of Well Screen (feet)	Depth to Top of Sensing Zone (feet)
UA-1R	Intake Structure	207.2	12/5/2005	CME 55	N/A*	Yes	160	120	36
UA-2R	Intake Structure	201.6	8/21/2006	CME 55	N/A*	No	--	--	--
UA-8S	Intake Structure	240 feet long	12/13/2005	SRS	--	--	--	--	--
UA-9S	Intake Structure	240 feet long	12/13/2005	SRS	--	--	--	--	--

1. Asterisk (*) indicates that ground water level was not measured due to mud rotary drilling method.
2. CME 75/CME 55 = Central Mine Equipment drill rig used to advance both rotary wash and hollow-stem auger borings (see text in Appendix A for further explanation)
3. SRS = Seismic Refraction Survey

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TABLE 2

SUMMARY OF GROUNDWATER LEVELS

Nacimiento Water Project
San Luis Obispo County, California

Boring No.	Construction Condition at Location of Boring	Depth of Boring (feet)	Date Drilled	Groundwater Level from Ground Surface at Time of Drilling (feet)	Groundwater Level from Ground Surface (feet), measured 3/17/06	Groundwater Level from Ground Surface (feet), measured 7/19/06	Groundwater Level from Ground Surface (feet), measured 8/21/06
UA-1R	Intake Structure	207.5	12/5/2005	51*	41.0	38	39.5

* Indicates that the ground water level is approximate. This measurement is the level of water in the borehole after it was flushed and left open for 2.5 days.

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TABLE 3

SUMMARY OF PACKER TEST RESULTS

Nacimiento Water Project
San Luis Obispo County, California

Boring	Test Number	Test Depth Top (feet)	Test Depth Bottom (feet)	Flow[1] (gpm)	Gage Pressure[2] (psi)	Hydraulic Conductivity[3] (cm/s)	Average Hydraulic Conductivity[4] (cm/s)	Rock Type	Comments
UA-2R	Test 1	47	67	0	2	~~0.0E+00~~	8.9E-06	Sandstone	No Take
		47	67	0.25	11	9.9E-06			
		47	67	0.25	15	1.1E-05			
		47	67	0.13	9	5.7E-06			
		47	67	0	2	~~0.0E+00~~			No Take
UA-2R	Test 2	67	87	0.05	12	1.9E-06	3.1E-06	Sandstone	
		67	87	0.15	16	5.1E-06			
		67	87	0.15	26	3.9E-06			
		67	87	0.08	17	2.6E-06			
		67	87	0.1	38	2.0E-06			
UA-2R	Test 3	86	106	0.05	8	2.2E-06	2.2E-06	Sandstone	
		86	106	0.07	19	2.2E-06			
		86	106	0.1	30	2.4E-06			
		86	106	0.07	18	2.2E-06			
		86	106	0.05	11	2.0E-06			
		86	106	0.1	42	1.9E-06			
UA-2R	Test 4	107	127	0.05	11	2.0E-06	1.8E-06	Sandstone	
		107	127	0.07	26	1.8E-06			
		107	127	0.12	40	2.4E-06			
		107	127	0.07	29	1.7E-06			
		107	127	0.17	15	7.1E-07			
		107	127	0.12	54	1.9E-06			

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TABLE 3

SUMMARY OF PACKER TEST RESULTS

Nacimiento Water Project
San Luis Obispo County, California

Boring	Test Number	Test Depth Top (feet)	Test Depth Bottom (feet)	Flow[1] (gpm)	Gage Pressure[2] (psi)	Hydraulic Conductivity[3] (cm/s)	Average Hydraulic Conductivity[4] (cm/s)	Rock Type	Comments
UA-2R	Test 5	126	146	0.08	19	2.5E-06	2.5E-06	Sandstone	
		126	146	0.15	34	3.3E-06			
		126	146	0.15	50	2.5E-06			
		126	146	0.1	35	2.1E-06			
		126	146	0.07	21	2.1E-06			
		126	146	0.18	69	2.4E-06			
UA-2R	Test 6	147	167	0.02	26	5.2E-07	2.1E-06	Sandstone	
		147	167	0.12	42	2.3E-06			
		147	167	0.18	60	2.6E-06			
		147	167	0.13	42	2.5E-06			
		147	167	0.08	26	2.1E-06			
		147	167	0.23	79	2.7E-06			
UA-2R	Test 7	167	187	0.13	36	2.7E-06	2.4E-06	Sandstone	
		167	187	0.15	58	2.2E-06			
		167	187	0.23	79	2.7E-06			
		167	187	0.17	61	2.4E-06			
		167	187	0.1	36	2.1E-06			
		167	187	0.85	102	~~8.0E-06~~			Possible Hydrofracturing
UA-2R	Test 8	187	202	0.08	30	2.4E-06	2.0E-06	Sandstone	
		187	202	0.07	55	1.4E-06			
		187	202	0.27	78	4.0E-06			
		187	202	0.08	57	1.5E-06			
		187	202	0.03	31	8.7E-07			

Notes:

1. gpm = gallons per minute
2. Gage pressure indicates the average reading on the pressure gage located at the ground surface during the test, listed in psi (pounds per square inch). Pressure loss to friction within the packer assembly is negligible due to the very low flow rates that occurred during testing.
3. Values that are crossed out are not considered valid.
4. Average hydraulic conductivity is calculated by considering valid tests only.

FIGURES

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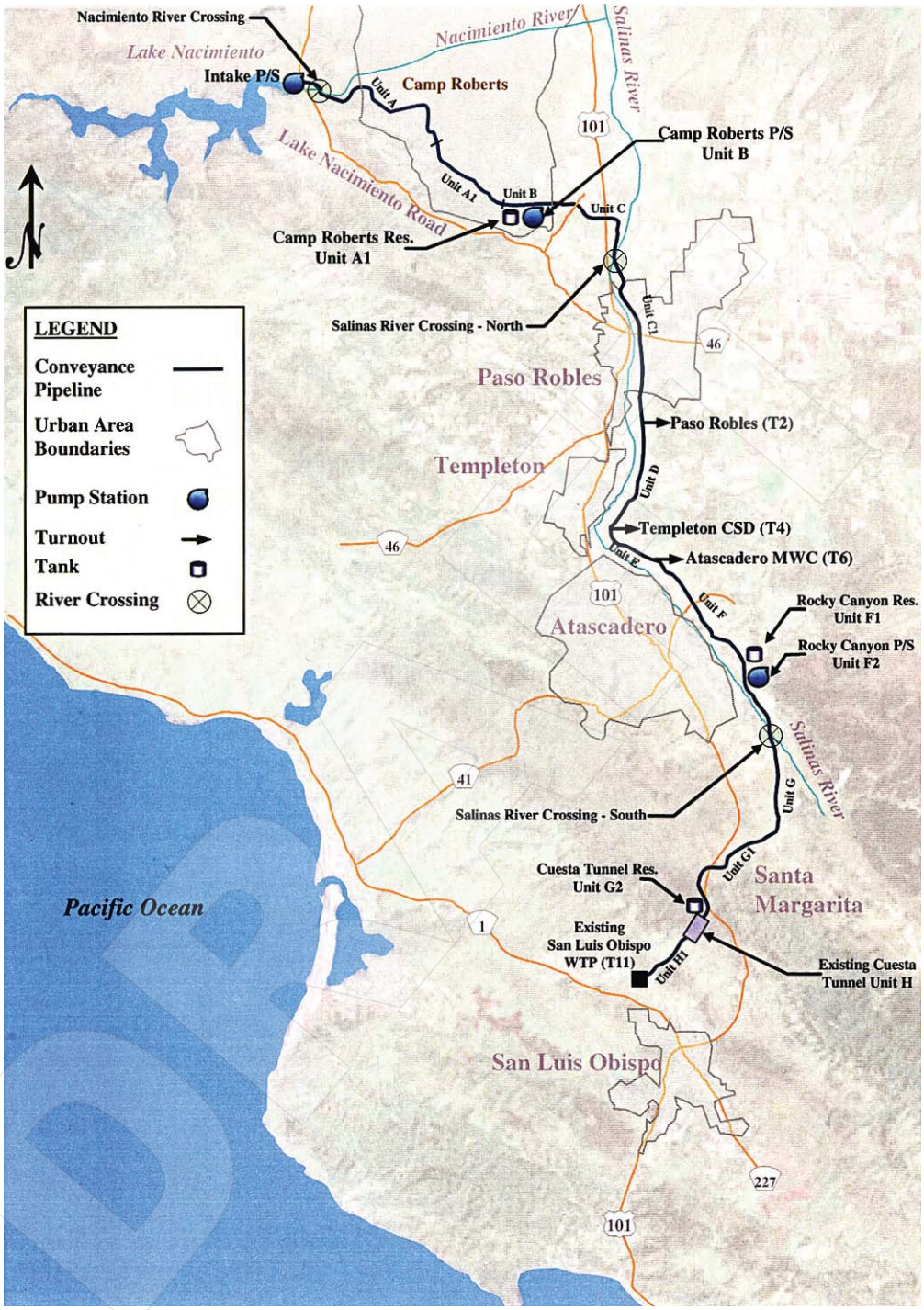

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0 10 miles

NACIMIENTO WATER PROJECT MAP
Nacimiento Water Project
San Luis Obispo County, California

By: __	Date: __	Project No. 10352.000
Geomatrix		Figure 1

S:\10300\10352\10352.000\task_e1\06_0905_gdsfl_fig_01(01).ai

Fault Recency Classification

- Faults with historic surface rupture or creep
- Faults that displace Holocene (~11ka) deposits or geomorphic surfaces
- Faults that displace late Quaternary (~700 ka) deposits or geomorphic surfaces
- Quaternary faults; show evidence for displacement sometime within past 1.6 Million years
- Pre Quaternary-solid

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N

0 8 Kilometers

0 8 Miles

Scale=1:500,000

Fault traces from Jennings (1994). Faults mapped as pre-Quaternary are not shown.

REGIONAL FAULT ACTIVITY MAP
Nacimiento Water Project
San Luis Obispo County, California

By: _____	Date: _____	Project No. 10352.000
Geomatrix		Figure 2

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PLATES

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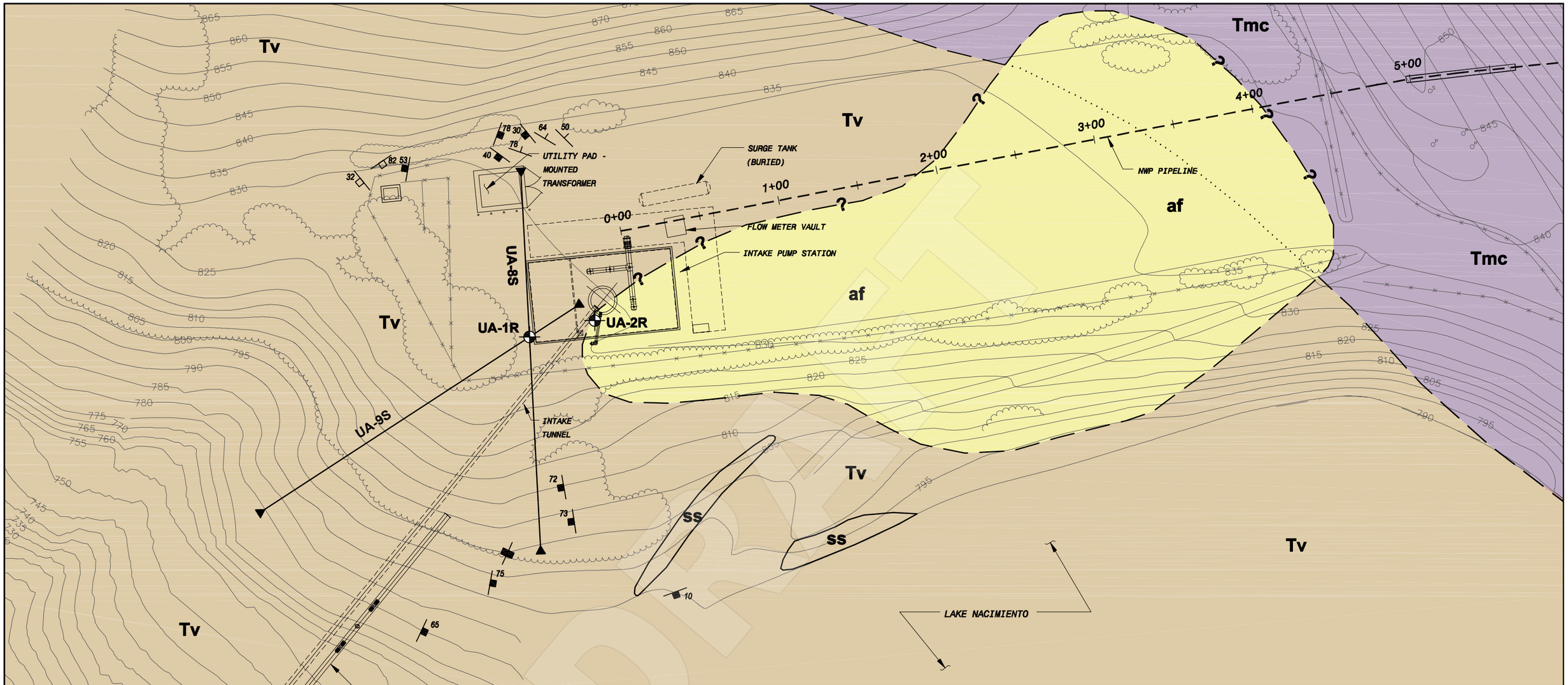

GEOLOGIC EXPLANATION

	af	Artifical fill
Miocene	Tmc	Monterey Formation, clay shale
Oligocene	Tv	Vaqueros Sandstone

LEGEND

Surface elevation contour line	
Geologic unit contact, dashed where approximately located, dotted where hidden, queried where uncertain	
UA-1R	Boring - rotary
UA-8S	Seismic line
ss	Sandstone
35	Strike and dip of bedding
58	Strike and dip of open fracture
70	Strike and dip of filled fracture
	Strike of vertical filled fracture

NOTES

1. Basemap, facility drawing, and grading plan provided by Black & Veatch on August 8, 2006. Contour interval = 1 foot.
2. Geology was modified from Dibblee (1971), Durham (1968), and Burch and Durham (1970) based on review of aerial photography, field mapping, and field exploration.

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0 60'
APPROXIMATE SCALE IN FEET

INTAKE STRUCTURE AND PUMP STATION
Nacimiento Water Project
San Luis Obispo County, California

By: DAS	Date: 09/21/06	Project No. 10352.000
Geomatrix		Plate 1

Plot Date: 09/21/06 - 2:37pm, Plotted by: jgraul
Drawing Path: S:\10300\10352\10352.000\task_e\106_0905_gds\, Drawing Name: _plate_01_intake structure.dwg

Appendix A
Field Exploration

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APPENDIX A
FIELD EXPLORATION
Nacimiento Water Project – Intake and Pump Station
San Luis Obispo County, California

INTRODUCTION

Field exploration at the Intake and Pump Station (IPS) site consisted of:

- Mapping surface geology;
- Drilling, logging, and sampling two borings;
- Performing packer tests in one boring;
- Performing a geophysical survey in one boring;
- Installing a groundwater monitoring well; and,
- Performing two seismic refraction surveys.

The location of each exploration point was selected collaboratively with design engineers from B&V. The exploration points were identified and labeled according to their location relative to the pipeline unit (i.e. Unit A [UA]) and the method of exploration (i.e. rotary wash boring [R] or seismic refraction survey [S]). The exploration points were generally labeled in numerical order within each Unit. For example, Boring UA-1R refers to exploration location number 1 within Unit A, using rotary wash drilling methods. It should be noted that six test pits were originally planned for the IPS site. These tests pits were subsequently omitted from the field exploration program because sufficient bedrock structural data was obtained from nearby bedrock exposures observed during field geologic mapping. The approximate locations of the borings and seismic refraction survey lines used to explore the IPS site are shown on Plate 1.

Before field work began, a site-specific health and safety (H&S) plan was prepared to identify potential health and safety issues for the NWP and to outline procedures to protect Geomatrix personnel. Site personnel, including subcontractors, reviewed the H&S plan.

Geomatrix also coordinated field activities with ESA, the Project Team's environmental consultant. A biologist and/or archeologist from ESA surveyed the NWP alignment, including the IPS site before field activities began. Exploration sites were selected to avoid environmentally- or culturally-sensitive locations.

Geomatrix notified Underground Service Alert (USA) of our intent to conduct subsurface exploration work. Geomatrix also contracted with a private utility locator, C. Cruz Inc., of Hayward, California, to clear the designated exploration locations. A well drilling permit was obtained for the field work from San Luis Obispo County Public Health. Authorization was also obtained from the Monterey County Water Resource Agency (MCWRA) and the owners of Water World to enter the IPS site.

The activities of the field exploration program are described below.

FIELD GEOLOGIC MAPPING

Prior to the field mapping, Geomatrix reviewed stereo aerial photographs of facility sites from 2002 and recent stereo photographs of facility sites taken by the project surveyor in 2005. The purpose of the review was to identify potential geologic hazards (e.g., landslides and erosion) and/or ground conditions (e.g., areas modified by historical land use or grading) that could potentially impact the Project. The information compiled from the aerial photographs is presented on Plate 1.

Field geologic mapping of the IPS site was conducted by Dr. Bob Wright and Dr. Tim Mote, both Senior Geologists with Geomatrix, between July 18 and July 22, 2005. Additional field geologic mapping was performed by Hans AbramsonWard, Project Engineering Geologist on July 13,2006, and by Paisha Jorgensen, Project Geologist with Geomatrix on July 19, 2006 when the piezometer in Boring UA-1R was being developed. The purpose of the field geologic mapping was to review features and conditions that may affect the project's design.

Field mapping was done at a scale of 1:1,200, utilizing aerial photograph base maps provided by San Luis Obispo County. Observed features were approximately located using available reference points shown on the base maps and identified in the field. The mapping focused on documenting the distribution, type (i.e., lithology) and structural characteristics (bedding and joint/fracture orientations) of bedrock materials, and on the distribution and characteristics of slope instabilities at the facility locations. Qualitative estimates of bedrock hardness, strength, and weathering also were sometimes made. Structural data was obtained by examining both man-made (road cuts and cut slopes) and natural exposures that were encountered while walking and/or driving along the alignment. A Brunton compass was used to measure the

orientation (strike and dip) of bedding and bedrock discontinuities observed in the field. The information compiled from the field geologic mapping is presented on Plate 1.

EXPLORATORY BORINGS

One boring was drilled at the IPS site between December 5 and December 8, 2005 to a depth of approximately 207 feet. Because of the generally poor rock conditions encountered in this boring, a second boring was drilled at the IPS site between August 21 and August 24, 2006. The second boring was drilled to a depth of about 202 feet. A summary of this exploration work is presented in Table 1.

Ms. Tami Darden, Staff Geologist with Geomatrix, observed the drilling operations and prepared the field logs for the rotary wash boring UA-1R. The rotary wash boring (including continuous coring) was drilled by Taber Consultants (Taber), of Sacramento, California using a track-mounted CME-55 drill rig. The boring was advanced using either a 4-inch tricone bit or a HQ core barrel for continuous coring.

Mr. Hans AbramsonWard, Project Engineering Geologist with Geomatrix, observed the drilling operations and prepared the field logs for boring UA-2R. This rotary wash boring was drilled by Taber a using a track-mounted CME-55 drill rig. The boring was advanced using a triple HQ core barrel for continuous coring. This boring was cased after it was advanced 40 feet.

Both borings were sampled by continuous coring using a triple barrel HQ wire line coring system, except in the shallowest section of Boring UA-1R. Two soft rock samples from about the upper 6 feet of Boring UA-1R were obtained with a Modified California (2 ½ inch ([I.D.], 3 inch [O.D.]) sampler driven by a 140 pound safety hammer falling 30 inches. Typically, the sampler is driven a total of 18 inches and the number of hammer blows needed to drive the sampler through the final 12 inches of the 18-inch drive was recorded. This number (or blows per foot) is typically given at the corresponding sample location on the boring logs. However, when the sampler was being driven, driving refusal was determined by field personnel and the sampler was not driven the full 18 inches. The number of blows over the distance the sampler was driven (e.g., 50/5”) is given at the corresponding sample location on the boring logs. Samples obtained using the Modified California sampler were capped and sealed to preserve the in situ water content.

Field logging of the boring generally conformed to the draft, Project-specific Geotechnical Field Exploration Plan and Procedural Guidelines for Logging, Sampling, and Classifying Soil and Rock (Exploration Plan) prepared by Geomatrix (2005). The recovered rock core was logged (i.e., recovery, RQD, weathering, fracturing, strength, hardness, lithologic description, and discontinuity description were recorded on field logs) using the descriptive terms presented in Table A-1, photographed, sealed in plastic wrap, and stored in wood boxes. Photographs of the rock cores are presented at the end of this appendix. Colors were described using the Munsell Soil/Rock Color Chart.

The rock quality designation (RQD) of the recovered core is evaluated by determining the percentage of intact, "competent" core pieces within a run that have lengths greater than 4 inches. This determination is somewhat subjective, because the "competency" of the recovered core is often based on experience and judgment. Severely weathered and/or intensely fractured rock is not included in the determination of RQD. In general, rock core that does not easily break apart during handling by the geologist in the field is considered competent.

Rock classifications were verified by further examination in our laboratory and by test results. It should be noted that the boring logs show changes in the subsurface stratigraphy that are based on observations made by our field geologist and drill rig operator during drilling. The contacts/transitions between the various subsurface materials were sometimes based on changes in the drill cuttings and changes in the drilling operations (e.g., loss of drilling fluid, chatter of the drill rig, gauge pressure changes). The final boring logs developed from laboratory test data and conditions recorded on the field logs are presented in this appendix. A boring log explanation sheet is shown on Figure A1-1.

Because fluid is used while using rotary wash drilling methods, groundwater could not be observed during the drilling of the borings. To monitor groundwater, the borings were converted into a open-well piezometer or well after drilling. The details of the piezometer/well construction are shown in Table 1. A typical piezometer construction detail is shown on Figure A1-2. A more detailed description of the piezometer/well installations are described below.

PACKER TESTING

Packer in situ permeability tests were performed to collect data that can be used to estimate the hydraulic conductivity (permeability) of the rock. These tests were originally planned in boring

UA-1R using a double packer system. However, the packer tests attempted in Boring UA-1R failed because the packers could not be seated effectively against the borehole walls. A caliper log made after the completion of the boring indicated that the walls had significantly widened over the majority of this borehole, likely due to collapse and wall erosion caused by the difficulties encountered while advancing this boring (See Appendix E). Packer tests were successfully performed in boring UA-2R with a single packer system as this boring was being advanced. A single packer system was selected to improve the chances of completing successful tests in the generally weak rock that was encountered in boring UA-1R. Performing packer tests with a single packer mitigates concerns that the sidewalls of the hole will degrade as the hole is being advanced or collapse as the tests are being performed.

The packer tests were performed using the procedure outlined in the U.S. Department of the Interior, Bureau of Reclamation Test Designation USBR 7310-89. The test procedure is as follows.

1. The static water level in the boring is measured, and an excess head of water is introduced up to the top of the casing.
2. The packer is seated to isolate the selected test section.
3. Water is pumped into the test section at selected pressures for 3 minutes and the total water flow is measured. The test pressure sequence is ½ P_{max}, ¾ P_{max}, P_{max}, ¾P_{max}, ½ P_{max}, where P_{max} is defined as:

   $$P_{max} = P_t - P_h$$

   where P_t is the maximum allowable excess pressure at the test section, (i.e., 0.5 psi/1 foot for the depth to the center of the test section, or to the top of the test section if the test section is longer than 10 feet), and P_h is the pressure head from the pressure gage at the surface to the groundwater level.

The packer test results and the potential limitations are summarized in Table 3. The permeabilities presented in Table 3 were calculated following procedures outlined in USBR 7310-89. Before performing the tests, boring UA-2R was flushed with clean water until the return flow was clear (as is described in the procedures set forth in USBR 7390-89).

GEOPHYSICAL SURVEY

A geophysical survey of Boring UA-1R was performed on December 9, 2006 by NorCal Geophyical, as a subcontractor to Geomatrix. The geophysical survey of the boring included a

P- and S-wave suspension velocity survey, and optical acoustic televiewer logging. The P- and S-wave suspension velocity survey was performed to aid in the evaluation of the foundation design of the intake structure by evaluating the excavation characteristics pf the bedrock. The optical acoustic televiewer logging was performed to measure the orientation of bedrock discontinuities (i.e. fractures, bedding planes, etc.) as a means of estimating the dominant directional properties of discontinuities in the rock mass in the area of the intake structure.

The P- and S-wave suspension velocity survey was performed by placing a downhole probe with a seismic energy source located at the base of the probe and a pair of geophones located towards the top of the probe down the borehole. Seismic P- and S-waves were generated by the energy source via a metal solenoid striking a plate (anvil) on one side of the interior of the probe housing. The geophones record the arrival of the seismic waves; one geophone contains a horizontal oriented element and the other geophone contains one vertical oriented element.

The optical acoustic televiewer logging survey was perfomed by placing an optical televiewer (OPTV) camera and an acoustic televiewer (BHTV) camera down the borehole. The OPTV and BHTV capture a radial image of the borehole sidewalls and subsequently "unwraps" the image to form a two-dimensional side-view picture of the borehole wall that is referenced to magnetic north.

A report on the geophysical survey, which includes a detailed description of field methods and an interpretation of the results, is included in Appendix E.

PIEZOMETER/WELL INSTALLATION

Boring UA-1R was converted into an open-standpipe groundwater monitoring well (piezometer). The piezometer in boring UA-1R was installed on December 12, 2005 by Taber, as a subcontractor to Geomatrix, under a permit issued by the San Luis Obispo County Department of Public Health.

The piezometer in boring UA-1R was constructed of 2-inch-diameter Schedule 40 flush-threaded PVC well casing and approximately 120 feet of 0.010-inch factory-slotted PVC well screen that extends from depths of 160 feet to 40 feet. Filter pack sand, which consisted of No. 3 sand, was placed from the bottom of the boreholes to approximately 2 feet above the top of the well screens. A 2-foot-thick bentonite seal was placed above the transition sand and hydrated. Type I-II cement grout was pumped into the remaining annular space. The

piezometer and well were capped with locking waterproof expansion caps, and completed at grade level with traffic-rated steel well covers. The well construction details are provided in Table 1 and typical construction details is shown on Figure A1-2 in Appendix A.

It should be noted that boring UA-1R was originally drilled to a depth of approximately 207 feet. Upon completion of drilling, the drill rods were removed and the geophysical surveys of the borehole were performed. After the geophysical surveys, the borehole caved to a depth of approximately 130 feet. The boring was re-drilled to a depth of about 160 feet and the piezometer casing was set at this depth. Groundwater levels in the piezometer installed in boring UA-1R have been measured three times; the measurements are summarized in Table 2.

PIEZOMETER/WELL DEVELOPMENT

The piezometer installed in boring UA-1R was developed on July 13 and July 19, 2006 by Layne Christensen Company, of La Habra, California, as a subcontractor to Geomatrix. Geomatrix field representatives were on-site during the development.

On July 13, 2006, the well was developed by a combination of surging, bailing, and pumping. The well was surged and bailed for approximately 1 hour and 20 minutes until most of the fines were removed from the well. After surging and bailing, the well was purged using a 2-inch grundfos pump. However, a mechanical pump failure occurred while pumping, and the purging of the well could not continue.

On July 19, 2006, Layne Christensen Company remobilized to the site and continued the well development. The well was bailed using airlifting methods for approximately 5 hours until most of the fines, as well as, the sands were removed from the well. After air lifting, the well was purged again using a 2-inch grundfos pump. Generally, purging continued until water quality parameters (temperature, pH, and specific conductance) stabilized. Approximately 87 gallons were removed from Boring UA-1R on this date.

Groundwater purged from the well was placed in 55-gallon drum containers that were labeled and left on-site. The groundwater in these drums was then siphoned into a solid storage bin and removed from site for disposal by Clearwater Environmental Inc.

GROUNDWATER SAMPLING AND TESTING

Geomatrix collected a groundwater sample from Boring UA-1R on July 19, 2006. Prior to sampling, the piezometer was pumped dry twice and groundwater was allowed to recharge. The temperature, pH, and specific conductance of the groundwater were measured periodically during purging.

The groundwater sample was collected using the overflow valve on the pump piping system to fill laboratory-supplied and EPA-approved sample containers. The samples were labeled with the project number, well number, date, time, and laboratory analyses requested, and stored in an ice-cooled chest for transport to the laboratory under Geomatrix chain-of-custody procedures.

Curtis and Tompkins, Ltd., of Berkeley, California, a state-certified analytical laboratory (Certificate No. 1459), analyzed the groundwater sample for the following chemical constituents:

- total dissolved solids (TDS) using United States Environmental Protection Agency (EPA) Method 160.1;
- turbidity (EPA Method 180.1);
- nitrogen nitrate (EPA Method 300.0);
- pH (EPA Method 9040B);
- residual chlorine (EPA Method 330.5); and
- metals, including aluminum, arsenic, cadmium, chromium, copper, lead, nickel, selenium, zinc (EPA Method 6010B); and,
- mercury (EPA Method 7470A).

Analytical data sheets and chain-of-custody records are included in Appendix F.

SEISMIC REFRACTION SURVEYS

Seismic refraction surveys were performed at the IPS site on December 13, 2005 by NorCal Geophyical, as a subcontractor to Geomatrix. Two seismic refraction survey lines were performed, approximately 240 feet in length. The approximate locations of the survey lines are

shown on Plate 1. The seismic refraction surveys were performed to estimate the depth to bedrock and to provide velocity information that can be used to evaluate the excavation characteristics of the bedrock. A report on the seismic refraction surveys, which includes a detailed description of field methods together with the interpreted seismic velocity cross sections, is included in Appendix C.

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TABLE A-1

KEY TO TERMS USED TO DESCRIBE THE PHYSICAL CONDITION OF ROCKS[2]

FRACTURING	SPACING (True spacing)
(VC) Very closely spaced (crushed)	Less than 0.1 ft (< 30 mm)
(Cl) Closely spaced	0.1 ft to 0.3 ft (30 to 100 mm)
(Mo) Moderately spaced	0.3 ft to 1.0 ft (100 to 300 mm)
(Wi) Widely spaced	1.0 ft to 3.0 ft (300 mm to 1 m)
(VW) Very widely spaced	3.0 ft to 10.0 ft (1 to 3 m)
(Ex) Extremely wide	Greater than 10 ft (> 3 m)

BEDDING OR FLOW TEXTURE	THICKNESS/SPACING
(La) Laminated	Less than 0.03 ft (3/8 in) (< 10 mm)
(VTn) Very thinly	0.03 (3/8 in) to 0.1 ft (10 to 30 mm)
(Tn) Thinly	0.1 to 0.3 ft (30 to 100 mm)
(Mo) Moderately	0.3 to 1 ft (100 to 300 mm)
(Tk) Thickly	1.0 to 3.0 ft (300 mm to 1 m)
(VTk) Very thickly	3.0 to 10.0 ft (1 to 3 m)
(Ma) Massive	Greater than 10 ft (> 3 m)

HARDNESS - a measure of the resistance of a rock surface to scratching/abrasion.

(So) Soft – can be grooved or gouged easily with a knife, can be scratched with fingernail
(Lo) Low Hardness - can be grooved 1/16 inch (2 mm) deep with a knife with moderate or heavy pressure
(Mo) Moderately Hard - can be scratched with a knife with light or moderate pressure
(Ha) Hard - can be scratched with a knife with difficulty
(VH) Very Hard - cannot be scratched with a knife

STRENGTH - a measure of crushing resistance of rock.

(Fr) Friable – breaks with light to moderate manual pressure
(We) Weak – core or fragment breaks with light hammer blow or heavy manual pressure
(Mo) Moderately Strong – core or fragment breaks with moderate hammer blow
(St) Strong – heavy hammer blow required to break specimen
(VS) Very Strong – core or fragment breaks only with repeated heavy hammer blows
(Ex) Extremely Strong – core or fragment can only be chipped with repeated heavy hammer blows

WEATHERING - a measure of the physical and chemical alteration of a rock from its original "fresh" condition.

	DECOMPOSITION	DISCOLORATION	FRACTURES
(Fr) Fresh	Unaltered; cleavage surfaces glistening	No discoloration	No stains or coatings
(Sl) Slight	No megascopic alteration of minerals; no grain separations	Slight and localized	Few stains on fracture surfaces
(Mo) Moderate	Slight alternation of minerals; cleavage surfaces lusterless/stained; partial separation of grains visible	Moderate discoloration, usually throughout	Thin coatings or stains
(Se) Severe	Moderate to complete alteration of minerals; feldspars to clay, etc.; rock is friable	Discolored throughout	Extensively coated with oxides, carbonates, or clay

[2] Based on US Bureau of Reclamation, 1998, Engineering Geology Field Manual, Second Edition, Vol.1.

TABLE A-1 (CONT'D)

KEY TO TERMS USED TO DESCRIBE DISCONTINUITES IN ROCK[1]

DISCONTINUITY TYPE (and dip angle)

(Be) Bedding plane
(Fo) Foliation
(Me) Mechanical break (dip angle not recorded)
(Jo) Joint
(Sh) Shear or Fault
(Ve) Vein

APERTURE

(Ti) Tight – No visible separation
(Op) Open – (Note amount of separation; note staining or coatings on fracture surfaces; note fracture surface moisture conditions)
(He) Healed – (Note degree of healing, i.e., partial or complete, thickness and mineralogy/hardness)
(Fi) Filled – (Note degree of filling, i.e., partial or complete, thickness and type of filling)

SURFACE SHAPE

(Ir) Irregular
(Pl) Planar
(Wa) Wavy or undulating

ROUGHNESS (note presence of slickensides or striations)

(St) Stepped – Near normal steps and ridges occur on fracture surface
(Ro) Rough – Large, angular asperities can be seen
(Mo) Moderately rough – Asperities are clearly visible and fracture surface feels abrasive
(Sl) Slightly rough – Small asperities on the fracture surface visible and can be felt
(Sm) Smooth – No asperities, smooth to touch
(Po) Polished – Extremely smooth and shiny

Where appropriate during field mapping, the following discontinuity characteristics also should be noted:

Discontinuity orientations (strike and dip)
Prominent joint sets, cleavages, foliations, etc.
Fracture continuity
Fracture cross-cutting relationships
Moisture/seepage conditions

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BORING LOGS

The boring logs depict subsurface information conditions only at the locations and at the time the borings were performed. Soil, rock, and groundwater conditions at other locations may differ from those observed at these locations. The passage of time may result in changes in soil, rock, and groundwater conditions at these locations.

The boring logs are presented as Figures A1-3 and A1-4; a boring log explanation is presented in Figure A-1. Table A-1 presents the key terms used to describe the rock encountered in the borings at the Intake and Pump Station site. A typical monitoring well/piezometer construction diagram is presented in Figure A1-2.

Photographs of the rock cores obtained from the borings are included at the end of this appendix.

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PROJECT: Nacimiento Water Project
San Luis Obispo County, California

Boring Log Explanation

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Other
				Modified California drive sampler, 3-inch outside diameter, 2 1/2-inch inside diameter (with liners)			
				Bulk sample collected from soil cuttings			
				Standard penetration split-spoon drive sampler, 2-inch outside diameter, 1 3/8-inch inside diameter (without liners)			
			23	Blow count for last 12 inches of sample, or as noted			
			45*/3"	Blow count for entire drive, total drive less than 6 inches			
				HQ core sampler, 4-inch outside diameter, 3-inch inside diameter			
				Distinct contact			
				Gradual or uncertain contact			
				First groundwater encountered during drilling ▽			
				Measured groundwater level prior to backfill or after well completion ▼			
				Grain size distribution			Sieve
				Fine content (percentage of soil passing No. 200 sieve)			<#200=67%
				LL=Liquid limit; PI=Plastic index			LL=27 PI=4
				Unconfined compressive strength in psf			UC=1300
				Unconsolidated-undrained triaxial test, shear strength in psf (confining pressure in psf)			UU=500 (300)
				Resistance value (California Test-301)			R-Value
				Pocket penetration unconfined compressive strength in tsf			PP=1.5
				Moisture-density relationship (compaction curve)			D1557
				Direct shear			DS
				Unconsolidated-drained triaxial test			TXCU

NOTES:

1. The stratification lines shown on the boring logs represent the approximate boundaries between material types. The actual transitions between materials may be gradual.
2. These logs of the test borings and related information depict subsurface conditions only at the specific locations and at the particular time the boring was made.
3. Soil conditions at other locations may differ from conditions occurring at these locations. Also, the passage of time may result in changes in the soil and groundwater conditions at these locations.
4. Soil colors from Munsell Soil Color Charts.

GT-2 (6/98)

EXP-698 EXPLANATION_NWP.GPJ GES32003-7.GDT 9/5/06

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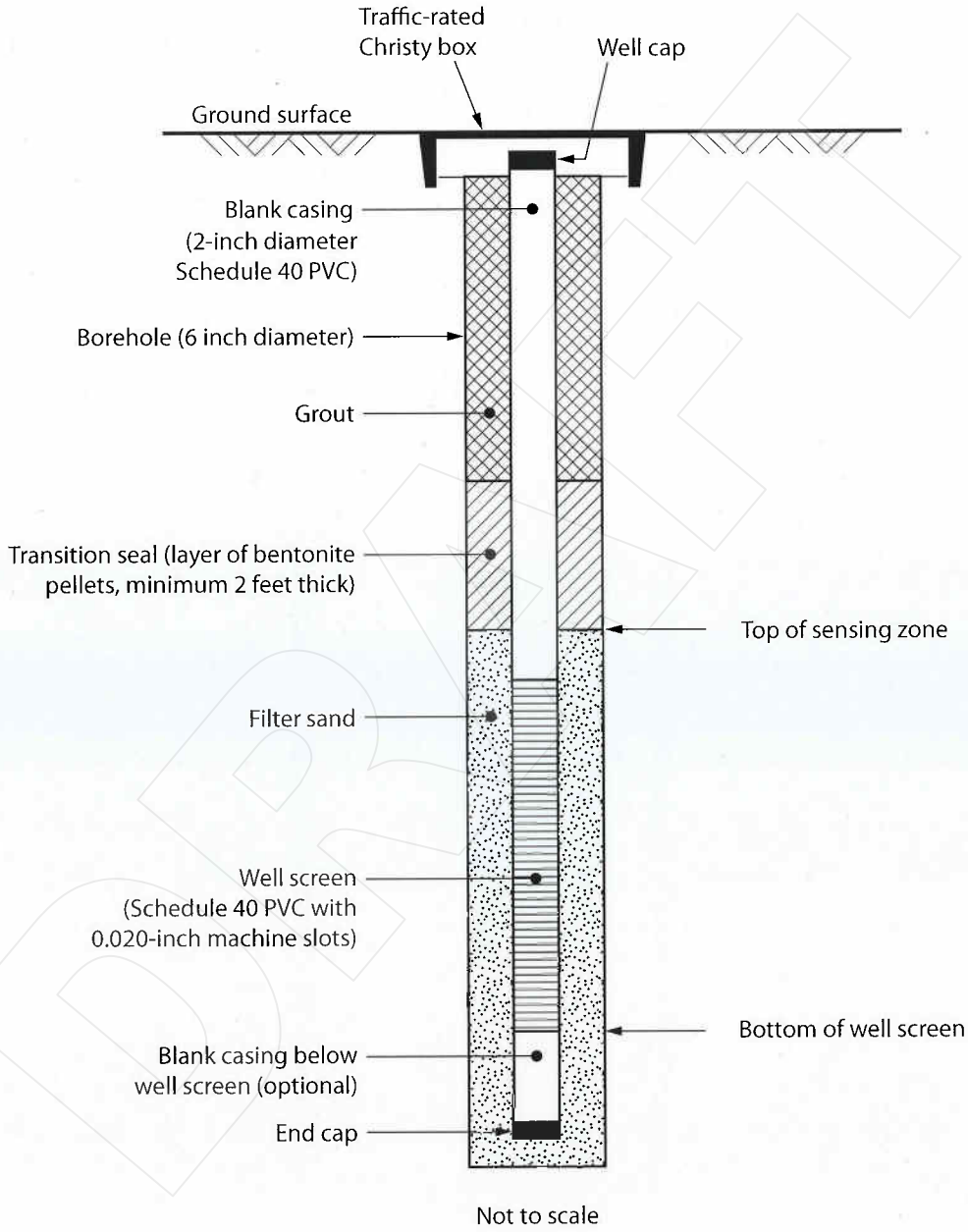

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GEOMATRIX

TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM
Nacimiento Water Project
San Luis Obispo County, California

Project No.
10352.000

Figure
A1-2

PROJECT: Nacimiento Water Project San Luis Obispo County, California		**Log of Boring No. UA-1R**	
BORING LOCATION: Intake Structure		ELEVATION AND DATUM:	
DRILLING CONTRACTOR: Taber Drilling		DATE STARTED: 12/5/2005	DATE FINISHED: 12/8/2005
DRILLING EQUIPMENT: CME-55		TOTAL DEPTH (feet): 207.2	MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash		DEPTH TO FREE WATER FIRST ENCOUNTERED: N/A	
SAMPLING METHOD: See Figure A1-1, Boring Log Explanation		DEPTH TO FREE WATER AT COMPLETION: N/A	
HAMMER WEIGHT: 140 pounds	HAMMER DROP: 30 inches	LOGGED BY: T.Darden	

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Other
1				SANDSTONE Very pale brown (10YR 8/4), fine grained, mixed lithology consisting mostly of quartz and feldspars, soft to low hardness, friable to weak, moderately weathered; [VAQUEROS FORMATION]			
2	1	☒	50*/5"				Drillers using sand catcher Bulk sample of cuttings taken between 0 feet and 5 feet Sieve <200=34% D1557
3							
4							
5	2	☒	53*/5"				
6				continued on rock log			
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							

GT-1 (12/03)

GEES-SOIL 12/03 SOILLOGS_INTAKE_10352.GPJ GES32003-7.GDT 9/15/06

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
1											
2											
3											
4											
5											
6	2	93	93	VW	So-Lo	Fr-We	Mo	continued from soil log SANDSTONE [VAQUEROS FORMATION] Mottled grayish orange (10YR 7/4) with very pale orange (10YR 5/2), medium to fine grained, mixed lithology consisting mostly of quartz and feldspar; consistency alternates between hard and soft rock;	N/R		Run 1 core recovered on Run 2. Drillers are using sand catcher. Run 2: 3 minutes
7											
8										Me	
9											
10	3	100	100	VW	So-Lo	Fr-We	Mo				Run 3: 3 minutes
11										Me	
12										Me	
13	4	100	100	VW	So-Lo	Fr-We	Mo				Run 4: 3 minutes Sieve <200=25%
14										Me Me	
15											
16											
17										Me	
18	5	100	100	VW	Ha So-Lo	St Fr-We	Mo	abrupt change in hardness and strength at 17.2 feet		Be, 0°, He	Run 5: 6 minutes

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

Geomatrix Consultants

GEES-ROCK 3/03 PLUS 10352R~1.GPJ GES32003-7.GDT 8/14/06
RT-1 Plus (3/03)
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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
19–22	5	100	100	VW	Lo / So	Fr-We	Mo / Se	SANDSTONE, as before	Me	
22–27	6	98	92	Wi / Mo / Wi	Lo / Ha / So-Lo	We-Mo / Mo / We	Mo / Sl / Mo	color grades to pale yellowish brown (10YR 6/2)	N/R; Me; Jo, 15°, Op, Wa, Mo; Me; Be, 55°, He; Jo, 25°, Ti, Ir	Run 6: 5 minutes; Moisture=2% Dry Density=147 UC=986110
27–32	7	100	92	Cl / Mo	Mo	Mo	Sl		Jo, 30°, Op, Ir, Ro; Jo, 25°, Op, Ir, Mo; Be? (Gradational from soft to hard); Jo, 40°, Ti, Ir, Mo; Jo, 55°, Op, Wa, Mo	Run 7: 4 minutes
32–37	8	100	73	Wi / Cl-Mo	Lo / Mo / Lo	We / Mo-St / We	Mo		Jo, 0°, Op, Pl, Sl; Jo, 40°, Op, Pl, Sl; Me; Jo, 35°, Op, Wa, Sl; Jo, 50°, Op, Pl, Sl; Be (gradational)	

GRAPHIC LOG

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

Geomatrix Consultants

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								SANDSTONE, as before all soft material (fine to medium grained sand)		Me	Run 9: 5 minutes
38											
39											Sieve <200=23%
	9	100	100	VW	So	Fr-We	Mo			Me	
40										Me	
41											
42										Jo, 30°, Ti, Pl Me	Run 10: 8 minutes
43				N/R	N/R	N/R	N/R		No recovery		
44											
45	10	50	26		Mo	We					
					So	Fr					
46				Cl	Mo	Mo	Mo			Jo, 5°, Op, Ir, Sl Jo, 50°, Op, Pl, Ro Jo, 50°, Op, Pl, Ro	
47								includes white, platy carbonate layers		Jo, 30°, Op, Ir, Ro Me	Run 11: 7 minutes
					Mo	Mo	Mo				
48					So	Fr-We	Se	mottled yellow and gray			
49											
50	11	100	82	VW	Mo	Mo	Mo			Jo, 35°, Ti, Ir	
51										Jo, 20°, Ti, Pl	
52					So	Fr-We	Se	thin veins of iron oxidation pervasive iron oxidation from 52.2 feet to 57.2 feet		Me N/R	Run 12: 6 minutes
53											
54	12	92	88	Wi	So	We	Mo-Se			Me	
55										Me	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

Geomatrix Consultants

RT-2 (3/03)
GES-ROCK 3/03 PLUS 10352R~1.GPJ GES32003-7.GDT 8/14/06

PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
56	12	92	88	Wi	So	We	Mo-Se	SANDSTONE, as before		
57					Lo-Mo			includes semi-healed fractures of various orientations	Me Me	
58	13	100	62	Cl	Mo	Mo	Mo-Se	from 57.2 feet to 62.2 feet, Many discontinuities are infilled with iron oxide or carbonate and have various orientations	Ve, 50°, He, Ir, Sm Jo, 45°, Op, Pl, Sl Jo, 25°, Ti, Pl, Sl Jo, 60°, Ti, Pl, Sl Ve, 35°, He, Pl, Sm	Run 13: 6 minutes
59									Ve, 35°, He, Ir, Sm	
60					So	Fr			Ve, 85°, He, Ir, Sl Jo, 45°, Ti, Pl, Sl	
					Mo	Mo			Jo, 10°, Ti, Ir, Ro	
61					So	Fr			Jo, 25°, Ti, Ir, Sl	
62					Mo	Mo			Me	
	14	96	18	VC-Cl	So-Lo	We	Mo		N/R	Run 14: 6 minutes
63									Me Me	Sieve <200=14% DS
64									Me	
65									Jo, 40°, Ti, Pl, Sl Me	
66					Mo	Mo		significant irregular and rough fracturing occurs where rock grades from soft to hard, sandstone is pebbly	Jo, 30°, Op, Ir, Ro	
67					So-Lo	Fr	Se		Jo, 45°, Op, Ir, Sl Me	Run 15: 6 minutes
68	15	64	24	N/R	N/R	N/R	N/R		N/R	
69					Mo	Mo	Mo		Me Me Be (gradation from hard to soft)	
70										
71					So	Fr	Se			
72										
73	16	0	0	N/R	N/R	N/R	N/R		No Recovery	
74										

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

Geomatrix Consultants

PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
75–77	16	0	0	N/R	N/R	N/R	N/R	SANDSTONE, as before	No recovery		
77–79	17	96	0	N/A	So	Fr	Fr	very soft from 77.2 feet to 79.6 feet			Run 17: 18 minutes Sieve <200=22%
79–80					Mo	We					
80–81	18	84	40	Cl	Mo	Mo	Fr-Mo	fracture planes oxidized; fresh breaks not oxidized	N/R	Me Jo, 50°, Op, Ir, Ro	Run 18: 12 minutes
81–82					So	We		from 81.2 feet to 96.6 feet, rock is very soft, core has consistency of wet sand (i.e. no cementation), contains relatively less fines		Me Me	
82–87	19	76	0	VW	So	Fr	Fr		N/R	Me Me Me	Run 19: 12 minutes Moisture=19% Dry Density=108 UU=2880 (8350)
87–92	20	100	0	N/A	So	Fr	Fr				Run 20: 12 minutes
92	21										Run 21: 12 minutes

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
93								SANDSTONE, as before			Moisture=18% Dry Density=113 UC=900 UU=5990 (9070)
94											
95	21	88	80	VW	So-Lo	Fr-We	Fr				
96										Me Jo, 35°, Op, Pl, Sl	
97					Lo-Mo	Lo-Mo		abrupt change from soft to hard rock; higher fines content near contact	No recovery		Run 22: 15 minutes
98											
99				Cl	Lo-Mo	Lo-Mo				Me Jo, 85°, Op, pl, Sl Me Me	Moisture=17% Dry Density=115 UU=8660 (9500)
100	22	70	38				Fr-Sl				
101				Mo	So	Fr				Jo, 30°, Ti, Pl	
102									No recovery	Me	Run 23: 12 minutes
103				N/R	N/R	N/R	N/R				
104											
105	23	66	30	Cl-Mo	So-Mo	Fr-We	Sl				
106										Jo(?), 35°, Ti, Pl Me	
107											Run 24: 9 minutes
108								from ~107.2 feet to ~154 feet, rock is extremely soft, with occasional zones of low to moderate hardness, slight color change to dark yellowish orange (10YR 6/6); significant iron oxidation throughout soft areas suggests severe weathering, soft areas disintegrate to sand upon extraction from core barrel; healed fractures are infilled with carbonate in harder rock, hard rock is yellowish gray (5Y 7/2) with iron oxidation.			
109	24	100	96	VW	So	Fr-We	Mo				
110											
111											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								SANDSTONE, as before			
112	24	100	96	VW	So	Fr-We	Mo				
113											Run 25: 10 minutes
114											
115	25	100	96	N/A	So	Fr-We	Mo				
116											
117											
118				N/R	N/R	N/R	N/R		No recovery		Run 26: 12 minutes
119											
120	26	70	38	Cl-Mo	So-Lo	Fr-We	Mo-Se				
121											
122					Mo	We-Mo	Mo				
123				N/R	N/R	N/R	N/R		No recovery		
124											
125	27	60	0	N/A	So	Fr	Mo				
126											
127											Run 28: 12 minutes
128	28	24	0	N/R	N/R	N/R	N/R		No recovery		
129											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
130	28	24	0	N/R	N/R	N/R	N/R	SANDSTONE, as before	No recovery		
131				N/A	So	Fr	Mo-Se				
132											Run 29: 12 minutes
133									N/R		
134	29	78	0	N/A	So	Fr	Se				
135								light bluish gray (5B 7/1), medium to coarse grained		Be, 25°, Fi, Pl	
136								grades into oxidized, grayish orange, highly weathered sandstone, meduim to fine grained, relatively high clay content, core breaks down to clayey sand under light manual pressure			
137											
138											Moisture=16% Dry Density=104 Sieve <200=25% UU=1170 (11810)
139											
140	30	100	0	N/A	So	Fr	Se				
141											
142											
143								sand grades to medium to coarse, mixed lithology, grains are subrounded to subangular, contains some silt and clay, possibly carbonate cement			Run 31: 13 minutes
144											
145	31	100	0	N/A	So	Fr	Se				
146											
147											
148	32	100	0	N/A	So	Fr	Se				Run 32: 12 minutes

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
149								SANDSTONE, as before			
150	32	100	0	N/A	So	Fr	Se				Sieve <200=24% TXCU
151											
152								SANDSTONE [VAQUERO FORMATION] Light bluish gray (5B 7/1), medium to coarse grained, top 0.8 feet is weathered and friable, rest of unit is generally moderately hard to hard, moderately strong to strong, and slightly to moderately weathered, includes several veins of carbonate or quartz (up to 1 cm), iron oxidation and carbonate accumulation on fracture planes; locally, joints have slickenlines;	N/R		Run 33: 16 minutes
153	33	55	0	N/A	So-Lo	Fr-We	Sl				
154					Mo	Mo			N/R		Run 34: 15 minutes
155	34	90	0	VC-Cl	Mo-Ha	Mo	Mo			Jo, 65°, Op, Pl, Sm	
156										Jo, 50°, Ti, Ir, Sl Jo, 60°, Ti, Pl, Sl	
157										Jo, 10°, Ti, Ir Me	Run 35: 20 minutes
158				N/R	N/R	N/R	N/R		N/R		
159	35	82	0	VC-Cl	Mo-Ha	Lo-Mo	Mo-Se			Me Me Me Jo, 30°, Op, Ir, Sl	
160								color change to yellowish gray (5Y 7/2)		Me	
161										Me	
162										Ve, 30°, Fi Me	Run 36: 9 minutes
163									N/R		
164	36	81	16	VC-Cl	Ha	St	Mo			Me Jo, 25°, Ti, Pl, Ro Jo, 35°, Ti, IR, Ro	
165					Fr	So			N/R	Me	
166	37	56	0	Cl	Ha	Mo	Fr	SANDSTONE, see next page for description	N/R		Run 37: 5 minutes

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
167	37	56	0	Cl	Ha	Mo	Fr	SANDSTONE [VAQUEROS FORMATION] Light bluish gray (5B 7/1), sand is entirely quartz, medium grained, subangular to subrounded, rock is characterized by alternating layers of hard and moderately strong rock with soft and friable rock;	Jo, 60°, Op, Pl, Sl Me Me Me	Run 38: 8 minutes
168				N/R	N/R	N/R	N/R			
169	38	90	38	Cl	So-Mo	We-Mo	Sl			
170									Me	
171									Me Me Me	
172									Quartz veins	
173	39	67	0	Cl	Ha	St-Ex	Fr	from 172.2 feet to 173.7 feet, requires several heavy hammer blows to chip rock, thick quartz veins, irregular texture on core surface (individual quartz grains plucked out)	Me Jo, 10°, Op, Ir, Sl Me Me	Run 39: 5 minutes
174	40	0	0	N/R	N/R	N/R	N/R			Run 40: 8 minutes
175										
176										
177										
178	41	40	0	VC-Cl	Lo-Mo	We	Sl			
179										
180									Me Jo, 0°, Op, Ir, Ro Jo, 20°, Op, Ir, Ro	
181					So	Fr		grades to soft and friable, core breaks down to gravel at ~182 feet.	Me Me Me	
182										Run 42: 8 minutes
183	42	76	12	N/R	N/R	N/R	N/R			
184				Cl	Lo-Mo	Lo-Mo	Fr	alternating beds of hard and soft rock grades more silty, clayey	Me Me Me	Sieve <200=21% TXCU
185										

GRAPHIC LOG: No recovery; N/R; No recovery; N/R

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
186	42	76	12	Wi	So	Fr	Fr	SANDSTONE, as before		Jo, 10°, Ti, Pl	
187											Run 43: 7 minutes
188									No recovery		
189											
190	43	62	32	Cl-Mo	Lo	We	Fr			Me Me Me	
191											
192										Me Me Me	
193				N/R	N/R	N/R	N/R		No recovery		Run 44: 9 minutes
194											
195	44	62	0	Cl	Lo-Mo	We-Mo	Fr			Me Jo, 70°, Op, Ir, Sl Me	
196					So	Fr				Me Me Jo, 10°, He, Ir	
197											Run 45: 6 minutes
198											
199											
200	45	0	0	N/R	N/R	N/R	N/R		No recovery		
201											
202											
203	46	0	0	N/R	N/R	N/R	N/R				

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-1R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
204								SANDSTONE, as before			
205	46	0	0	N/R	N/R	N/R	N/R		No recovery		
206											
207											
								Bottom of boring at 207.2 feet. Piezometer constructed in boring.			
208											
209											
210											
211											
212											
213											
214											
215											
216											
217											
218											
219											
220											
221											
222											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-3 Cont.

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PROJECT: Nacimiento Water Project County of San Luis Obispo		**Log of Boring No. UA-2R**	
BORING LOCATION: Intake-Center of Shaft		ELEVATION AND DATUM:	
DRILLING CONTRACTOR: Taber Drilling		DATE STARTED: 8/1/2006	DATE FINISHED: 8/24/2006
DRILLING EQUIPMENT: CME-55		TOTAL DEPTH (feet): 201.6	MEASURING POINT: Ground Surface
DRILLING METHOD: 4-inch diameter rotary wash		DEPTH TO FREE WATER FIRST ENCOUNTERED: N/A	
SAMPLING METHOD: See Figure A1-1, Boring Log Explanation		DEPTH TO FREE WATER AT COMPLETION: N/A	
HAMMER WEIGHT: 140 lbs	HAMMER DROP: 30 inches	LOGGED BY: H. Abramsonward	

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								ASPHALT SILTY SAND with GRAVEL (SM) Dense, brownish yellow (10YR 6/6), dry; [FILL]			Auger to 5', drive casing to 3', casing later advanced to 40 ft
1											
								SILTY SANDSTONE [VAQUEROS FORMATION] Brownish yellow (10YR 6/6), interbedded fine and medium grained silty, clayey, and clean sandstone, lithology of grains is mostly quartz and feldspar, rock crumbles when handled, even under very slight pressure, clayey intervals stick to the sides and split down the middle when core barrel is opened			
2											
3											
4									No Recovery		
5											Run 1: 3 minutes
6	1	62	0	Cl	So	Fr	Se			Jo,55°,He,Ir,Ro	
7											Run 2: 5 minutes
8										oxidized around concretion, friable	
9	2	100	0	Mo	So	Fr	Se	9-10.6: grades slightly less friable		Jo,60°,He,Pl Jo,80°,Op,Wa,Ro	
10											
11	3	93	0	Mo	So	Fr	Se			Rock crumbled when core was opened	Run 3: 1 minutes
12											Run 4: 6 minutes
13	4	32	0	Mo	So	Fr	Se		No Recovery		
14											
15											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-4

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RT-1 (3/03)
GEES-ROCK 3/03 10352R-1.GPJ GES32003-7.GDT 9/19/06
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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								SILTY SANDSTONE, as before			
16	4	32	0	Mo	So	Fr	Se			Me Me	
17									N/R		Run 5: 2 minutes
18	5	40	0	Mo	So	Fr	Se		N/R		
19									No Recovery		Run 6: 6 minutes
20	6	29	0	Mo	So	Fr	Se				
21								grades pinkish gray (7.5R 7/1), slightly less friable, local tan oxidation along beds/fractures			
22											Run 7: 4 minutes
23	7	48	0	Cl	So	Fr	Se		N/R	Me Jo,30°,Op,Pl,Mo	
24										Me	
25									N/R		Run 8: 3 minutes
26	8	60	0	Mo	So	Fr	Se	25.6-26.6: medium grained speckled orange (7.5YR 7/8), and pinkish gray (7.5R 7/1)		Me Me Jo,10°,Op,Pl,Sl	
27										Me	Run 9: 3 minutes
28	9	68	0	Mo	So	Fr	Se	28.4-29.1: very friable, very silty	N/R		
29											
30								30.2-31.2: slightly less friable, less silty		Be,40°,Ti,Pl (oxide) Jo,10°,Ti,Pl (oxide)	Run 10: 4 minutes
31	10	100	0	Mo	So	Fr	Se			Be,40°,Ti,Pl (oxide)	
32								32.1-32.8: oxidized orange (7.5YR 7/8)			Run 11: 5 minutes
33	11	100	0	Mo	So	Fr	Se	32.5: 2" bed of clayey fine sand		Be,30°,Pl (oxide)	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-4 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								SILTY SANDSTONE, as before		Be,30°,Pl (oxide)	
34				Mo						Jo,30°	
										Be,30°,Pl (oxide)	
35	11	100	0	Wi	So	Fr	Se	33.4-34.9: core narrower where edge has washed away		Jo,25°	
36										Be,45° No opening	
37											Run 12: 3 minutes
38	12	100	0	Wi	So	Fr	Se / Mo	38.1-39.1: core partially washed away 38.3: sharp color change from mottled orange (7.5YR 7/8), with gray (10YR 5/1), to uniform light gray (7.5YR 7/1)		Me Me Be,35°,Pl	
39											
40									N/R		Run 13: 3 minutes
41	13	48	0	Wi	So	Fr	Mo	41.1-41.8: core partially washed away, very friable 41.8: 2" thick bed, very fine, very silty			Drillers advance casing to 39 ft
42										Me	Run 14: 4 minutes
43	14	48	0	Wi	So	Fr	Mo		N/R		
44								44.4-44.6: 2" interval of less fraible rock, fine grained		Me Me	
45	15	40	0	Mo	So	Fr	Mo		No Recovery		Run 15: 3 minutes
46								46: Some beds are slightly speckled/motlled with light grayish orange (7.5YR 7/3)		Me Me	
47								46.8-47: bed of less friable fine silty sand		Me Me	
48	16	32	0	Mo	So	Fr	Mo		No Recovery		Run 16: 4 minutes
49								49.4-49.6: less friable, fine silty sand		Me	Run 17: 3 minutes
50	17	46	0	Mo	So	Fr	Mo		N/R		
51										Me Me	
52											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

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Figure A1-4 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
								SILTY SANDSTONE, as before 51.9-52.1: less friable, fine silty sand			Run 18: 8 minutes
53				Mo						Jo,20°,Pl,Sl Jo,0°,Fi,Pl	
54								53.6: grades less friable, slightly cemented, generally less soft than upper 50 ft		Jo,0°,Fi,Pl Me Be,40°	
	18	98	0		So	Fr	Mo				
55				Wi				55.4: grades brownish yellow (10YR 6/6) with minor gray (10YR 5/1) speckles, medium grained			
56											
57								from 53.6 to 73.6 core is interbedded with zones (3 to 1') of less friable rock (borderline weak) and zones (3 to 1') of very friable rock (ratio 1:1)			Run 19: 7 minutes
58									N/R		
										Be,15° Zone of stained sand	
59	19	72	20	Mo	So	Fr	Mo			Jo,55°,Ti,Pl,Sm	
60								60.2-61.6: more friable		Me Jo,10°,Pl	
61										Me	
62										Jo,25°,Ti,Pl Jo,5°,Fi,Pl	Run 20: 6 minutes
63										Me	
64	20	98	24	Mo	So	Fr	Mo			Me	
65								64.6-65.4: core is clayey, sticks to barrel		Me Jo,80°,Ti,Pl Jo,0°,Fi	
66										Jo,30°,Ti,Wa	
67									N/R	Jo	Run 21: 7 minutes
68											
	21	86	20	Mo	So	Fr	Mo			Jo,50°,Op,Pl,Sm	
69										Jo,10°,Fi	
70										Me Me	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
71	21	86	20	Mo	So	Fr	Mo	SILTY SANDSTONE, as before	Me Me Jo,5°,Fi Be,35°,Ti,Pl	
72	22	86	36	Wi	So	Fr	Mo			Run 22: 11 minutes
73									Me	
74					Lo			73.6: grades slightly harder, core is soft to low hardness, and is mostly less friable than upper 73 ft	Jo,50°,Ti,Pl	
75										
76					So				Me Me	
77	23	80	60	N/R	N/R	N/R	N/R			Run 23: 9 minutes
78				Wi	So	Fr	Sl	grades uniform light gray (7.5YR 7/1)		This run scores RQD because the core can be picked up in pieces
79										
80										
81									Be,65°,He,Pl Me	
82	24	98	32	Wi	So	Fr	Sl		Me	Run 24: 10 minutes Fluid loss to this point is 5 gallons per run
83										
84								84.2: grades yellowish brown (10YR 5/6), locally mottled with gray (10YR 5/1)	Core partially washed away Me	
85							Mo		Jo,85°,Ti,Pl,Mo Me	
86									Many rough irregular fractures	
87	25	100	66	Mo	So	Fr	Mo	87.1-87.3: bed is moderately hard	Me Me Be,50°,Ti,Pl	Run 25: 13 minutes
88					Lo Mo	Mo		SANDSTONE [VAQUEROS FORMATION] Yellowish brown (10YR 5/6), locally mottled with gray (10YR 5/1), fine to medium grained, clean sandstone interbedded with silty and clayey sandstone	Me Me	

GRAPHIC LOG: N/R (71–73.6); N/R (77–81); N/R (82–84.2); N/R (87–88)

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
90–91	25	100	66	Mo	Mo	Mo	Mo	Continued from above: includes beds of low and moderate hardness and minor soft beds, bedding is 3" to 1 ft thick, locally includes subvertical veins of calcite that crosscut bedding and extend several feet	Me Me Be,45°,Op,Pl Be,45°,He,Pl	
92–96	26	100	62	Mo	So-Lo Mo So-Lo	Fr We Fr	Mo Sl Mo	93.2-94: moderately hard, gray (10YR 5/1) bed with soft rip-ups in it	Me Me Jo,45°,Ti,Pl Be,10°,Ti,Wa Jo,5°,Op,Wa,Ro Be,5°,Ti,Wa Jo,40°,Ti,Wa Jo,35°,Op,Wa Ve,90°,He Me	Run 26: 18 minutes
97–101	27	100	40	Mo-Wi	So-Lo Mo So	Fr Mo Fr	Mo	99.6-103.4: grades to soft and very friable with local less friable interbeds, grain size still fine to medium	Me Me Be,60°,Ti,Pl Jo,50°,Ti,Wa,Mo Be,60°,Ti,Pl Be,60°,Ti,Pl	Run 27: 14 minutes
102–107	28	100	36	Wi	So So-Mo	Fr Fr-Mo	Mo	103.4-104.2: 2-3" thick beds of cemented moderately hard sandstone	Be,60°,Ti,Pl Be,60°,Ti,Pl Be,60°,Ti Me Be,55°,Ti,Pl Jo,50°,Ti,Pl,Mo	Run 28: 13 minutes
107	29	98	28	Wi	So-Lo	Fr-We	Mo			Run 29: 15 minutes

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

Geomatrix Consultants

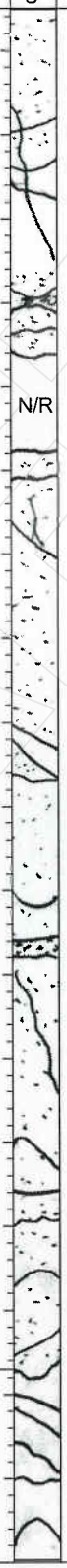
RT-2 (3/03)
GEES-ROCK 3/03 10352R~1.GPJ GES32003-7.GDT 9/19/06

PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
108	29	98	28	Wi	So-Lo	Fr-We	Mo	SANDSTONE, as before 107.5: core partly washed away		
109					Mo	Mo			Jo,25°,Ti,Pl,St Jo,20°,Ti,Ir,St Jo,20°,Ti,Wa,St	
110									Ve,85°,He	
111					So-Lo	Fr-We			Me	
112	30	76	46	N/R	N/R	N/R	N/R		N/R	Run 30: 21 minutes
113				Wi	So	Fr	Mo	generally includes more cemented beds		
114					Mo	Mo				
					Lo	We				
115					So	Fr				
116								116.2: moderately hard bed, 2" thick	Be,55°,Ti,Pl Be,60°,Ti,Pl	
117	31	100	62	Wi	So	Fr	Mo			Run 31: 13 minutes
118					Lo	We			Jo,40°,Ti,Pl,Sl	
119								118.6-118.8: very friable	Me	
120					Mo	Mo			Ve,75°,He,Wa	
121									Jo,65°,Ti,Wa,Sl	
122	32	98	62	Mo	So-Mo	Fr-We	Sl		Me	Run 32: 18 minutes
123									Jo,20°,Ti,Wa,Sl Jo,30°,Fi,Pl,Sl	
124					Mo-Ha	Mo		SANDSTONE [VAQUEROS FORMATION] Gray (10YR 5/1), fine to medium grained, moderately hard to hard, minor brown (10YR 5/3) interbeds of low hardness, fractures are commonly stained with iron oxide	Be,50° Jo,50°,Ti,Pl,Sl Jo,55°,Ti,Pl,Sl Jo,60°,Ti,Wa,Ro	
125									Me	

GRAPHIC LOG



FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

Geomatrix Consultants

RT-2 (3/03)
GEES-ROCK 3/03 10352R~1.GPJ GES32003-7.GDT 9/19/06

PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
	32	98	62	Mo	Mo-Ha	Mo	Sl	SANDSTONE, as before	Jo,55°,Ti,Pl,Mo	
127					Mo-Ha	Mo			Jo Me	Run 33: 17 minutes
128					Mo	Lo			Be,60°,Ti,Pl,Sl Jo,25°,Fi,Ir,Mo	
129	33	100	68	Wi	So	Fr	Sl	128.6-129.3: very friable bed, split apart when core opened	Jo,30°,Ti,Wa,Mo	
130					Mo	Mo			Jo,65°	
131										Run 34: 12 minutes
132								132: friable bed, 3" thick 132.2: grades weaker	Be,50°	
133										
134	34	94	57	Wi	Lo	We	Sl		Jo,50°,Ti,Pl,Sl	
135								135: grades slightly brownish gray (10YR 6/2)		
136									Jo,70°,Ti,Pl,Sl Me	
137				Wi			Sl			Run 35: 12 minutes
138								SANDSTONE [VAQUEROS FORMATION] Strong Brown (7.5YR 4/6), fine grained, quartz and feldspar rich, moderately bedded and fractured, soft, friable, severely weathered	Be,40°,Ti,Pl	
139	35	100	66		So-Lo	Fr-We				
140				Mo			Se		Jo,45° Jo,50° Me	
141									Me	Run 36: 13 minutes
142									Me Me	
143	36	100	54	Wi	Lo	We	Se			
144									Be,45°,He,Pl	

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

Geomatrix Consultants

RT-2 (3/03)
GEES-ROCK 3/03 10352R~1.GPJ GES32003-7.GDT 9/19/06

PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
145	36	100	54	Wi	Lo	We	Se	SANDSTONE, as before		
146					So	Fr		grades soft and friable	Jo,65°,Ti,Ir,St Jo,85°,Ti,Wa,Sl Me	
147	37	38	28	Wi	Lo	We	Se	147.1: healed joint is harder, stronger, than the rock, healed joints appear as lines of grayer or browner rock	Jo,40°,He,Pl Me Me	Run 37: 27 minutes
148					So	Fr			Jo,25°,He,Pl Me	
149				N/R	N/R	N/R	N/R		No Recovery	
150										
151										
152	38	94	68	Wi	So	Fr	Se			Run 38: 21 minutes
153								153.4: becomes gray (10YR 5/1), fine grained sharp contact, 3" bed of low hardness at contact	Be,55°,Pl	
154							Mo			
155									Jo,65°,He,Pl	
156								155.8: gradually grades to brownish gray (10YR 6/2)		
157	39	100	82	Wi	So	Fr	Mo-Se		Be,65°,Ir	Run 39: 10 minutes
158									Be,60°,Pl	
159								159.5-160.5: core stuck to core barrel and split down middle when opened	Be,55°,Pl	
160										
161										
162	40	100	56	Wi	So	Fr	Mo-Se	162: includes interbedded layers of gray (10YR 5/1) and brown fine grained sandstone (10YR 4/3)		Run 40: 14 minutes

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

Geomatrix Consultants

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
								SANDSTONE, as before		
164								brown (10YR 4/3) fine grained sandstone	Jo,65°,He,Pl	
165	40	100	56	Wi	So	Fr	Mo-Se			
166								166: grades predominately brown	Jo,30°,Ti,Pl,Mo Be,70°,He,Pl	
										Run 41: 15 minutes
167									Jo,65°,He,Pl	
168										
169	41	100	70	Wi	So-Lo	Fr	Mo-Se	169-170: edge of core washed away		
170								170.2-170.4: bed of moderately hard gray (10YR 5/1) sandstone, cemented and oxidized directly above contact	FeO2, cemented Be,50°,Pl (oxide)	
171									Jo,75°,Ti,Wa,Mo Me	
										Run 42: 13 minutes
172				Wi			Mo-Se			
173								SANDSTONE [VAQUEROS FORMATION] Bluish Gray (GLEY 2 5/1), fine grained, grading downsection to medium and coarse grained, clasts are subangular to well rounded, quartz, volcanics, chert, and other lithologies, closely fractured, very soft, very friable, slightly to moderately weathered, includes several fractures filled with sandy silt	Be,50°,Pl Be,50°,Pl	
174	42	100	44	Cl	So	Fr	Sl		Fr,Ir,St Fr,Ir,St Fr,Ir,St	
175									Be,50°,Pl Me	Fractures may be mechanical breaks
176									Jo,45°,Ti,Ir,St Jo,45°,Ti,Ir,St Me	
										Run 43: 6 minutes
177								177.4-177.6: bed of friable medium to coarse grained sand	Be Me	
178								178.5-179: low hardness around healed joints	Jo,55°,He,Pl Jo,55°,He,Pl	
179	43	96	59	Mo	So	Fr	Sl		Jo,0°,Fi,Pl Jo,50°,Ti,Pl,Mo	
180									Jo,0°,Fi,Pl	
181									Jo,80°,Ti,Pl,Sl	

GRAPHIC LOG

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

Geomatrix Consultants

PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	DISCONTINUITY DESCRIPTION	REMARKS
								SANDSTONE, as before		Run 44: 6 minutes
182									Clay filled joints, 0°,Pl	
183									Me	
									Many clay filled joints, 0°,Pl	
184	44	90	26	Mo	So	Fr	Sl	184: coarse grained bed, 1" thick, includes scattered coarse grains, mostly medium grained		
185								Includes scattered coarse grains, mostly medium grained	Jo,75°,He,Pl	
186									Me	
				N/R	N/R	N/R	N/R		N/R	
				N/R	N/R	N/R	N/R			
187										Run 45: 6 minutes
188								187.9-189.2: coarse grained bed, clasts include quartz, chert, lithic volcanics, subangular to well rounded	Be	
189	45	92	17	Mo	So	Fr	Sl		Be	
190										
191					Lo	We				
										Run 46: 11 minutes
192									Me	
									Jo,5°,Fi	
					So	We		core washes away on clay-filled joints		
193									Jo,5°,Fi	
194	46	84	28	Wi	So-Mo	Fr-Mo	Sl	193.5: includes alternating beds of friable, weak, and moderately strong, mdeium to coarse sandstone 194.5-195: moderately hard bed	Jo,50°,He,Wa,	
195									Jo,50°,Ti,Wa, Jo,10°,Ti,Wa,	
									Me	
196				N/R	N/R	N/R	N/R		N/R	Rig chattering
										Run 47: 14 minutes
197				N/R	N/R	N/R	N/R			
198	47	82	72	Wi	Lo-Mo	We	Sl		Me	
199									Jo,25°,Ti,Ir,Ro Be,65°,Pl Jo,35°,He,Pl Jo,35°,Ti,Pl,Sm Jo,25°,Ti,Ir,Ro	
				Mo	Mo	Mo	Fr	SANDSTONE, see next page for description		Rig chattering

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

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PROJECT: Nacimiento Water Project
County of San Luis Obispo

Log of Boring No. UA-2R cont.

DEPTH (feet)	RUN NO.	RECOVERY (%)	RQD (%)	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	DISCONTINUITY DESCRIPTION	REMARKS
201	47	82	72	Mo	Mo	Mo	Fr	SANDSTONE [VAQUEROS FORMATION] Whitish gray (10YR 7/1), fine to medium grained, well cemented		Jo,65°,Ti,Pl,Sm Jo,50°,Ti,Pl,Sl	
202								Bottom of boring at 201.6 ft. Backfilled with cement grout.			
203											
204											
205											
206											
207											
208											
209											
210											
211											
212											
213											
214											
215											
216											
217											
218											

FRACTURING: VC-Very Close (<0.01'), Cl-Close (0.1'-0.3'), Mo-Moderate (0.3'-1'), Wi-Wide (1'-3'), and VW-Very Wide (3'-10'). HARDNESS: So-Soft, Lo-Low, Mo-Moderate, Ha-Hard, and VH-Very Hard. STRENGTH: Fr-Friable, We-Weak, Mo-Moderate, St-Strong, and Ex-Extremely Strong. WEATHERING: Fr-Fresh, Sl-Slight, Mo-Moderate, and Se-Severe. DISCONTINUITY: Type (BJ-Bedding Joint, Be-Bedding, Jo-Joint, Fo-Foliation, Sh-Shear, Me-Mechanical Break, and Ve-Vein), Dip Angle, Aperture (Ti-Tight, Op-Open, He-Healed, and Fi-Filled), Surface Shape (Ir-Irregular, Pl-Planar, and Wa-Wavy), Roughness (St-Stepped, Ro-Rough, Mo-Moderately Rough, Sl-Slightly Rough, Sm-Smooth, and Po-Polished).

Project No. 10352.000.0

Figure A1-4 Cont.

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Photographs of Rock Core

DRAFT

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Run 2: 7.2' to 9.7'

Run 3: 9.7' to 12.2'

Run 4: 12.2' to 17.2'

Run 6: 22.2' to 27.2'

Notes:
1. "Up" direction is to the left
2. No photo available for Run 5
3. Photographs by Geomatrix
4. No recovery on Run 1
5. No picture taken on Run 5

DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 7.2 TO 27.2 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalni	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R2-R6**

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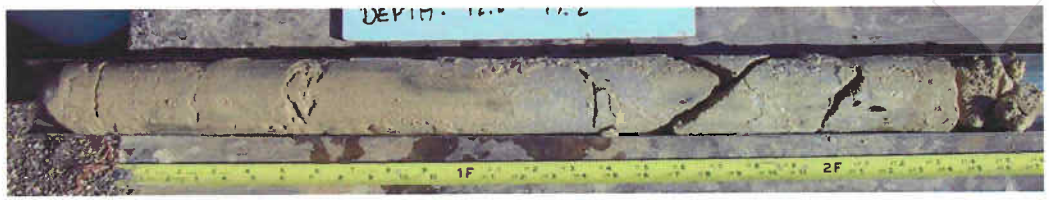
Run 7: 27.2' to 31.2'

Run 8: 31.2' to 36.2'

Run 9: 37.2' to 42.2'

Run 10: 42.2' to 47.2'



Notes: 1. "Up" direction is to the left
2. Photographs by Geomatrix

DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 27.2 TO 47.2 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R7-R10**

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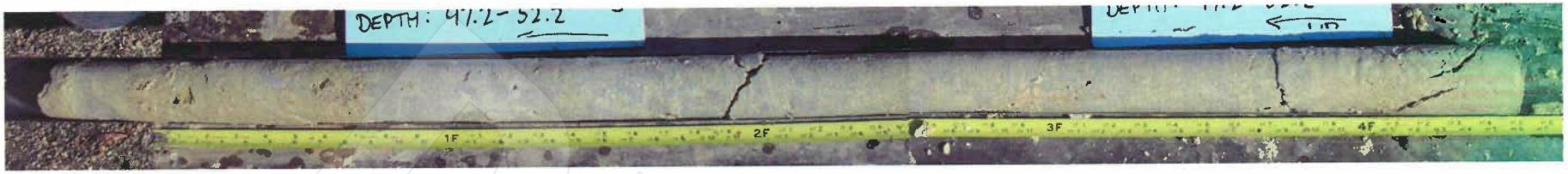
Run 11: 47.2' to 52.2'



Run 13: 57.2' to 62.2'

Run 14: 62.2' to 67.2'

Run 15: 67.2' to 72.2'

Notes: 1. "Up" direction is to the left
2. No photo available for Run 12
3. Photographs by Geomatrix

DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 47.2 TO 72.2 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R11-R15**

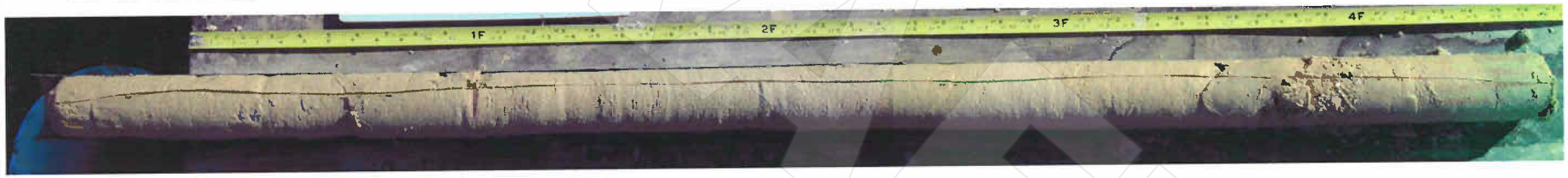
L:\Project\10000s\10352.000\photos\UA-1R\UA-1R_core_rock_figures\04.ai

Run 17: 77.2' to 79.7'

Run 18: 79.7' to 82.2'

Run 19: 82.2' to 87.2'

Run 20: 87.2' to 92.2'



Run 21: 92.2' to 97.2'

Notes: 1. "Up" direction is to the left
2. No photo available for Run 16
3. Photographs by Geomatrix

DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 77.2 TO 97.2 FT
Nacimiento Water Project
San Luis Obispo County, California

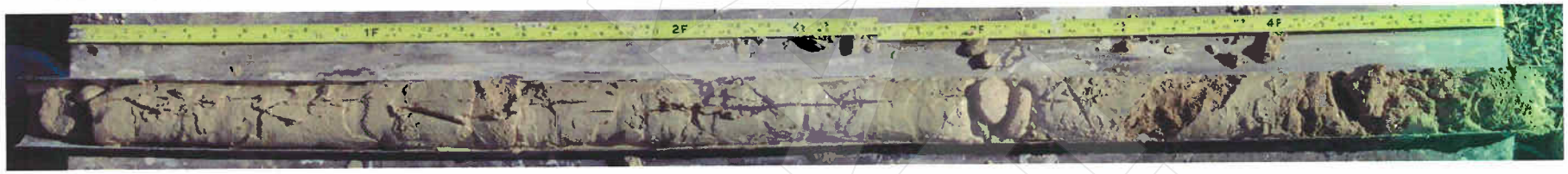
By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R17-R21**

L:\Project\10000s\10352.000\photos\UA-1R\UA-1R_core_rock_figures\05.ai

Run 22: 97.2' to 102.2'

Run 23: 102.2' to 107.2'

Run 24: 107.2' to 112.2'



Run 25: 112.2' to 117.2'

Notes: 1. "Up" direction is to the left
2. Photographs by Geomatrix

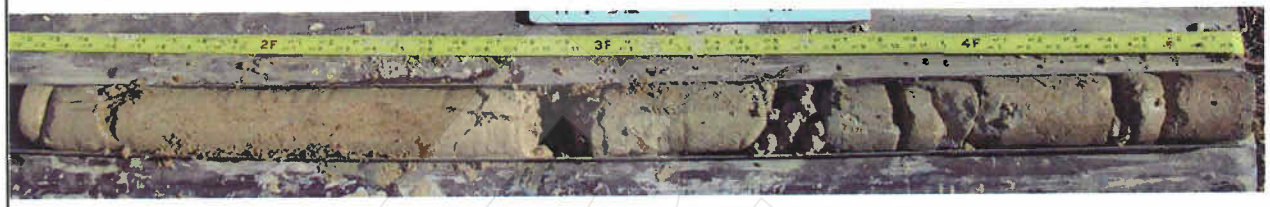
DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 97.2 TO 117.2 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R22-R25**

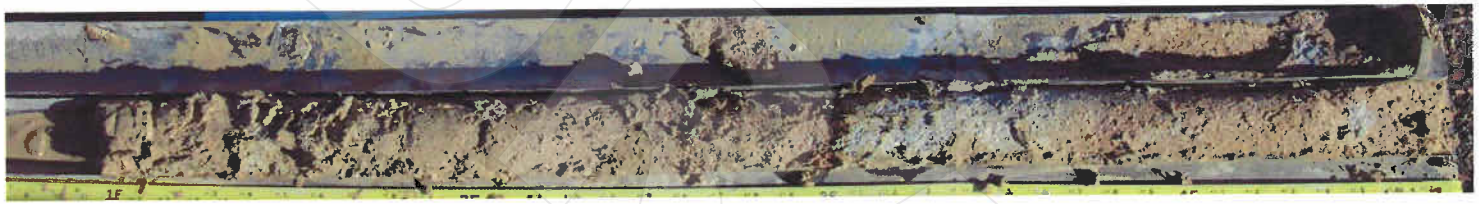
L:\Project\10000s\10352.000\photos\UA-1R\UA-1R_core_rock_figures\06.ai

Run 26: 117.2' to 122.2'



Run 28: 127.2' to 132.2'

Run 29: 132.2' to 137.2'



Run 30: 137.2' to 142.2'

Run 31: 142.2' to 147.2'

Notes: 1. "Up" direction is to the left
2. No photo available for Run 27
3. Photographs by Geomatrix

DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 117.2 TO 147.2 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R26-R31**

L:\Project\10000s\10352.000\photos\UA-1R\UA-1R_core_rock_figures\07.ai

Run 32: 147.2' to 152.2'

Run 33: 152.2' to 154.2'

Run 34: 154.2' to 157.2'

Run 35: 157.2' to 162.2'

Run 36: 162.2' to 164.2'

Run 37: 164.2' to 165.4'

Notes: 1. "Up" direction is to the left
2. Photographs by Geomatrix

DRAFT

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 147.2 TO 165.4 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R32 R37**

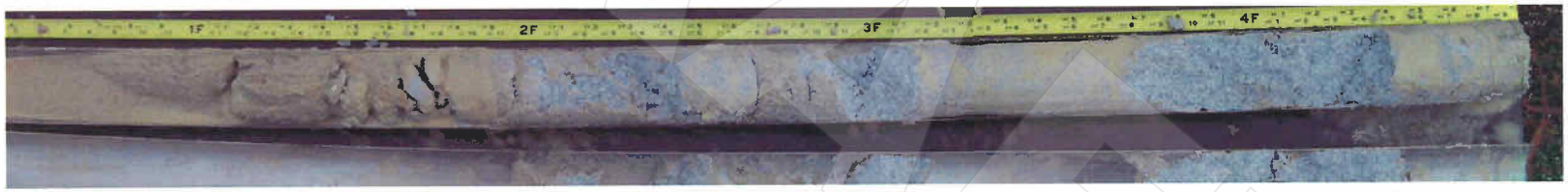
L:\Project\10000s\10352.000\photos\UA-1R\UA-1R_core_rock_figures\08.ai

Run 38: 167.2' to 172.2'

Run 39: 172.2' to 173.7'

Run 41: 177.2' to 182.2'

Run 42: 182.2' to 187.2'



Run 43: 187.2' to 192.2'

Notes: 1. "Up" direction is to the left
2. Photographs by Geomatrix
3. No recovery on Runs 40, 45, and 46

DRAFT

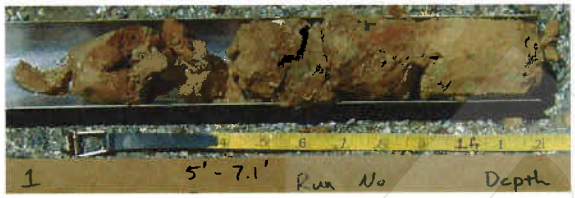
Run 44: 192.2' to 197.2'

BORING UA1 - ROCK CORE PHOTOGRAPHS
DEPTH INTERVAL 167.2 TO 197.2 FT
Nacimiento Water Project
San Luis Obispo County, California

By: J. Chalini	Date: 01-26-06	Project No. 10352
Geomatrix		Figure **UA1: R38 R44**

L:\Project\10000s\10352.000\photos\UA-2R\figures\01_B1_R1-R8.ai

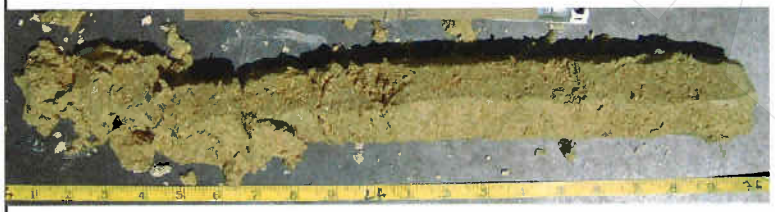
Run 1: 5.0' to 7.1'



DRAFT

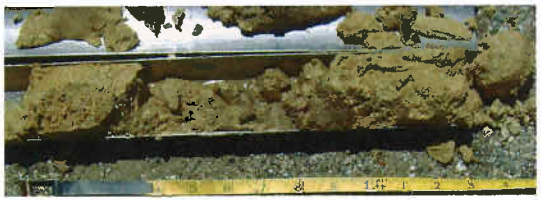
Run 2: 7.1' to 10.7'

Run 3: 10.7' to 12.1'



Run 4: 12.1' to 17.1'

Run 5: 17.1' to 18.6'



Run 6: 18.6' to 22.1'

Run 7: 22.1' to 24.6'

Run 8: 24.6' to 27.1'

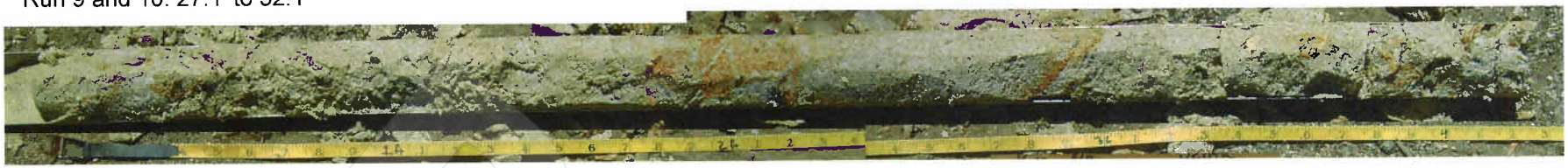
Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 1 THROUGH 8, DEPTH INTERVAL 5.0 - 27.1 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/10/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R1-R8**

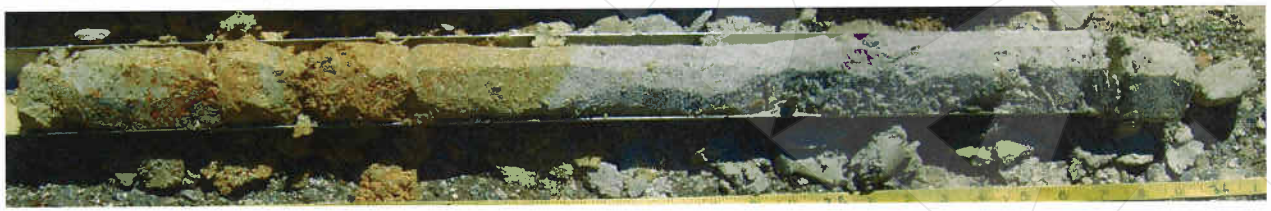
L:\Project\10000s\10352.000\photos\UA-2R\figures\02_R9-R17.ai

Run 9 and 10: 27.1' to 32.1'



Run 11: 32.1' to 37.1'

Run 12: 37.1' to 40.0'



Run 13: 40.0' to 42.1'

Run 14: 42.1' to 44.6'

Run 15: 44.6' to 47.1'

Run 16: 47.1' to 49.6'

Run 17: 49.6' to 52.1'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

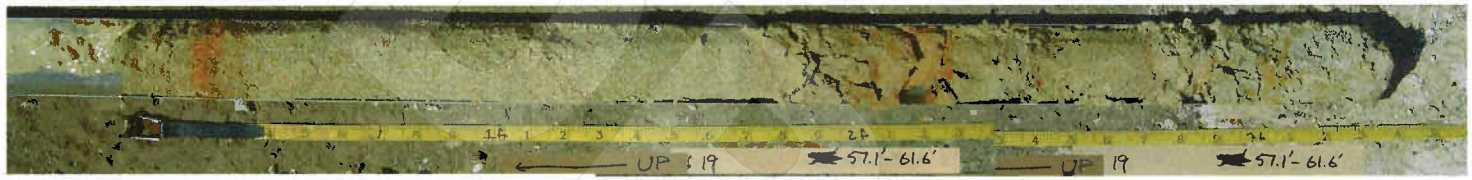
BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 9 THROUGH 17, DEPTH INTERVAL 27.1 - 52.1 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R9-R17**

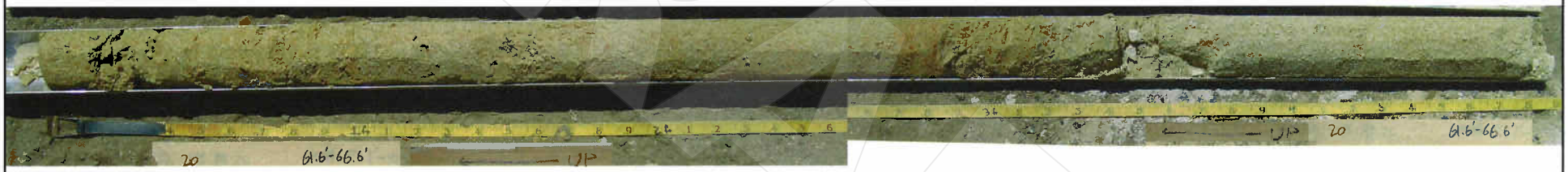
L:\Project\10000s\10352.000\photos\UA-2R\figures\03_R18-R21.ai

Run 18: 52.1' to 57.1'

Run 19: 57.1' to 61.6'



Run 20: 61.6' to 66.6'



Run 21: 66.6' to 71.6'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 18 THROUGH 21, DEPTH INTERVAL 52.1 - 71.6 FT
Nacimiento Water Project
San Luis Obispo County, California

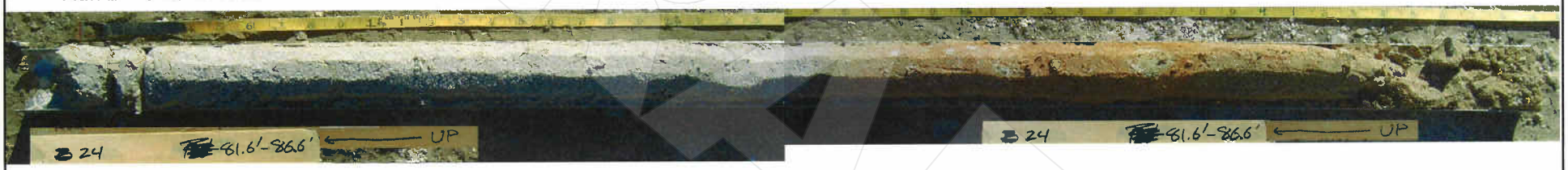
By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R18-R21**

L:\Project\10000s\10352.000\photos\UA-2R\figures\04_R22-R25.ai

Run 22: 71.6' to 76.6'

Run 23: 76.6' to 81.6'

Run 24: 81.6' to 86.6'



Run 25: 86.6' to 91.6'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

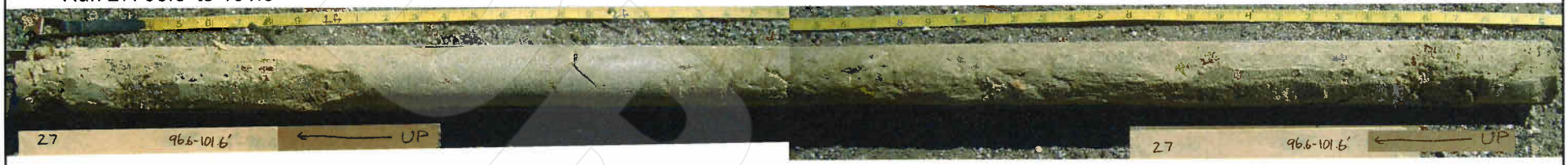
BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 22 THROUGH 25, DEPTH INTERVAL 71.6 - 91.6 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R22-R25**

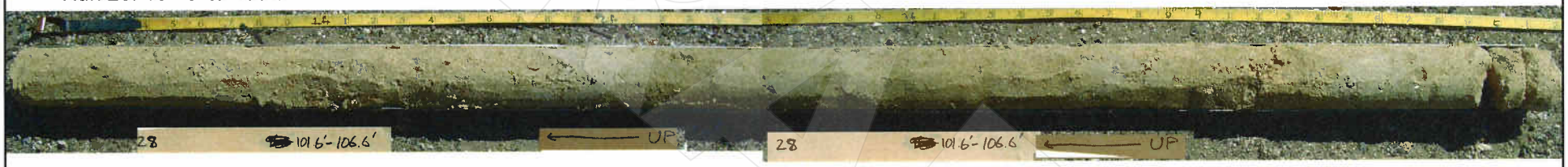
L:\Project\10000s\10352.000\photos\UA-2R\figures\05_R26-R29.ai

Run 26: 91.6' to 96.6'

Run 27: 96.6' to 101.6'



Run 28: 101.6' to 106.6'



Run 29: 106.6' to 111.6'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 26 THROUGH 29, DEPTH INTERVAL 91.6 - 111.6 FT
Nacimiento Water Project
San Luis Obispo County, California

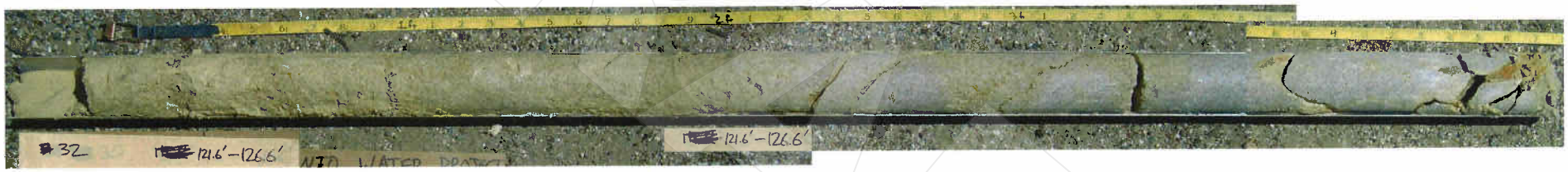
By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R26-R29**

L:\Project\10000s\10352.000\photos\UA-2R\figures\06_R30-R33.ai

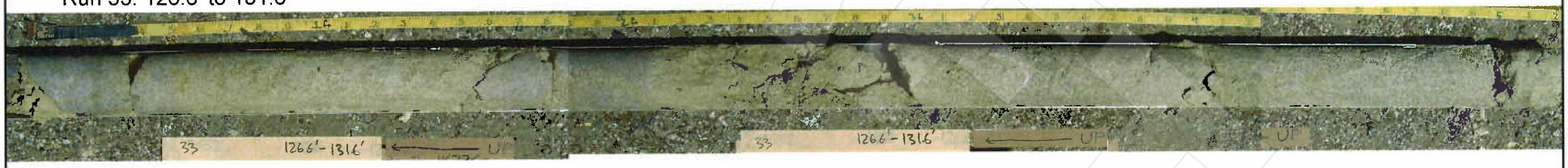
Run 30: 111.6' to 116.6'

Run 31: 116.6' to 121.6'

Run 32: 121.6' to 126.6'



Run 33: 126.6' to 131.6'



DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 30 THROUGH 33, DEPTH INTERVAL 111.6 - 131.6 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R30-R33**

L:\Project\10000s\10352.000\photos\UA-2R\figures\07_R34-R37.ai

Run 34: 131.6' to 136.6'

Run 35: 136.6' to 141.6'

Run 36: 141.6' to 146.6'

Run 37: 146.6' to 151.6'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

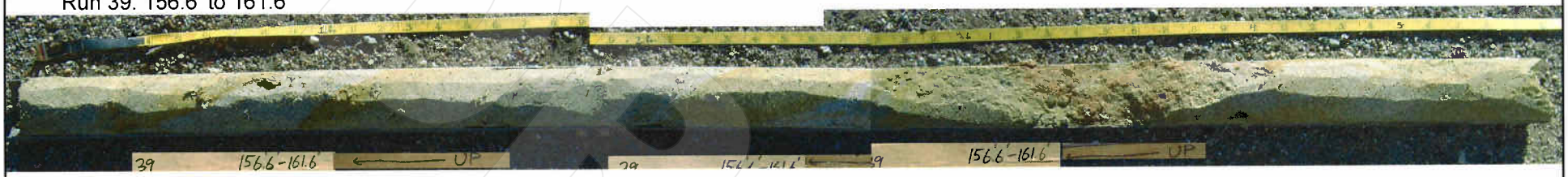
BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 34 THROUGH 37, DEPTH INTERVAL 131.6 - 151.6 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R34-R37**

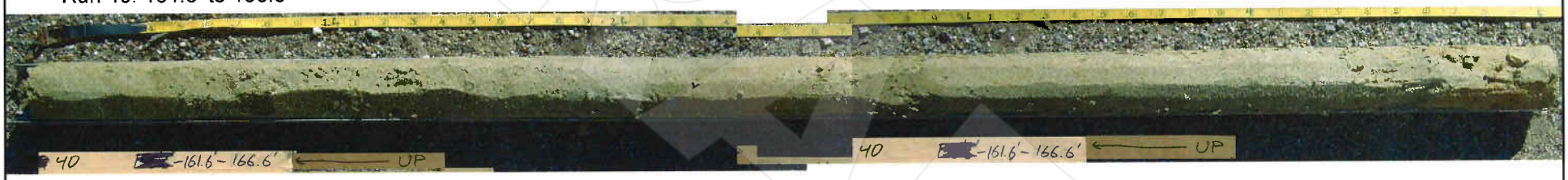
L:\Project\10000s\10352.000\photos\UA-2R\figures\08_R38-R41.ai

Run 38: 151.6' to 156.6'

Run 39: 156.6' to 161.6'



Run 40: 161.6' to 166.6'



Run 41: 166.6' to 171.6'

DRAFT

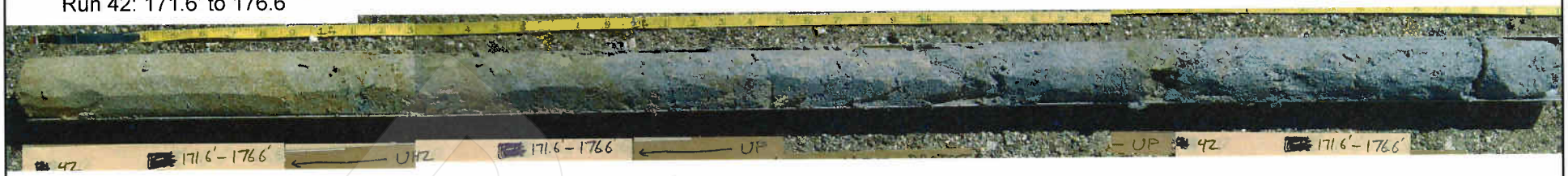
Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 38 THROUGH 41, DEPTH INTERVAL 151.6 - 171.6 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R38-R41**

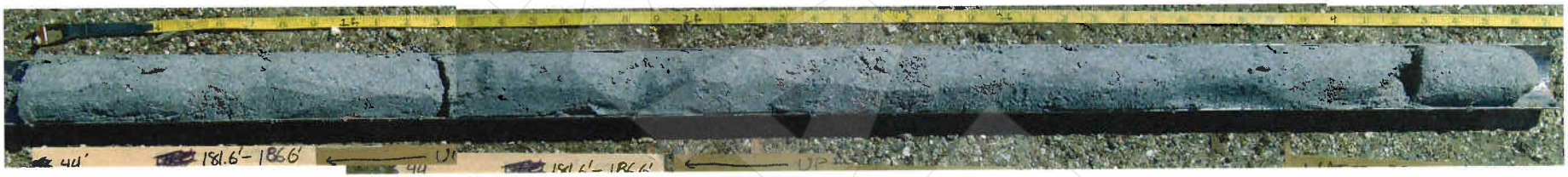
L:\Project\10000s\10352.000\photos\UA-2R\figures\09_R42-R45.ai

Run 42: 171.6' to 176.6'



Run 43: 176.6' to 181.6'

Run 44: 181.6' to 186.6'



Run 45: 186.6' to 191.6'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 42 THROUGH 45, DEPTH INTERVAL 171.6 - 191.6 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R42-R45**

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Run 46: 191.6' to 196.6'

Run 47: 196.6' to 201.6'

DRAFT

Notes:
1. "Up" direction is to the left
2. Photographs by Geomatrix

BORING UA-2R - ROCK CORE PHOTOGRAPHS
RUN 46 THROUGH 47, DEPTH INTERVAL 191.6 - 201.6 FT
Nacimiento Water Project
San Luis Obispo County, California

By: HAW	Date: 09/08/2006	Project No. 10352
Geomatrix		Figure **UA-2R: R46-R47**

Appendix B
Laboratory Testing

DRAFT

INTRODUCTION

Laboratory tests were performed on selected bedrock samples to assess their engineering properties and physical characteristics.

The following tests were performed at the Geomatrix Consultants, Inc. laboratory located in Newport Beach, California.

- moisture content and dry unit weight;
- Atterberg limits (liquid and plastic limits);
- grain-size distribution;
- unconfined compression.

The following tests were performed at the Geomatrix Consultants, Inc. laboratory located in Oakland, California.

- compaction
- point load

The following tests were performed at Cooper Testing Laboratory, located in Palo Alto, California.

- unconsolidated-undrained triaxial strength
- consolidated-undrained triaxial strength

The following test was performed at GeoTest Unlimited of Nevada City, California.

- unconfined compression.
- Cerchar abrasivity index (CAI)

DRAFT

Corrosion testing of selected samples is also being performed by M.J. Schiff & Associates of Claremont, California.

As previously mentioned in Appendix A, a groundwater sample was collected from the boring/well for chemical analyses and the analyses was performed by Curtis &Tompkins, Ltd., of Berkeley, California. The analytical results of these tests are presented in Appendix F.

Test procedures are described herein. Results are summarized on the boring logs in Appendix A or in tables or figures at the end of this appendix. It should be noted that the test result figures contained in this appendix are organized and separated by laboratory test type and do not have assigned figure numbers. Figure numbers will be assigned in the final GDR after the field exploration has been completed.

It should also be noted that additional laboratory testing on samples from Boring UA-2R was underway at the time this report was written. The results of this testing will be included in the final GDR.

MOISTURE CONTENT AND DRY UNIT WEIGHT

Measurements of the moisture content and dry unit weight were performed on select samples recovered from the boring. These tests were conducted in general accordance with ASTM Test Methods D 2216-98 and EM 1110-2-1906. Results of the moisture content and dry unit weight measurements are presented at the corresponding sample locations on the boring log included in Appendix A.

GRAIN-SIZE DISTRIBUTION

Grain-size distribution tests were performed on samples of weathered/soft rock to assist in the classification of the earth materials that exist at the IPS. The grain-size (sieve) analyses were performed in general accordance with ASTM Method D 422 on either the entire sample or the portion of the sample retained on the No. 200 sieve. Results of the sieve analyses are presented on figures in this appendix. The percent (by weight) of the portion of the sample finer than the No. 200 sieve obtained from the sieve analyses is indicated at the corresponding sample location on the boring log included in Appendix A.

UNCONFINED COMPRESSIVE STRENGTH (Soil)

An unconfined compressive strength test was performed on a representative sample of soft/weathered rock in general accordance with ASTM Test Method 2166. The result of this test, along with the water content and dry density, is presented on a figure in this appendix and on the boring log included in Appendix A.

UNCONFINED COMPRESSIVE STRENGTH (Rock)

An unconfined compressive strength test was performed on a core of harder rock in general accordance with ASTM Test Method D3148. The result of this test, along with moisture content and dry density, is presented on a figure in this appendix and on the boring log in Appendix A.

UNCONSOLIDATED – UNDRAINED TRIAXIAL STRENGTHS

An unconsolidated – undrained triaxial test was performed on a "soil-like" sample of weathered rock in accordance with ASTM Test Method D 2850. The result of this test is presented on a figure in this appendix and on the boring log in Appendix A.

CONSOLIDATED-UNDRAINED TRIAXIAL STRENGTH

Consolidated undrained triaxial tests with pore pressure measurements were conducted on representative, relatively undisturbed core samples of weathered/weak rock to evaluate their strength and behavior under static loading conditions. The tests were performed generally following ASTM D 4767, with modification to allow for "staged tests", described below. The general procedure employed in these tests consisted of the following steps:

1. Each specimen was prepared having a length-to-diameter ration of at least 2.0.

2. Strips of filter paper were placed on the ends and exterior of the specimen to facilitate drainage during testing. Then, the specimen was covered with a rubber membrane and placed in the triaxial cell.

3. The triaxial cell was filled with water and pressurized.

4. The specimen was saturated using a back pressure and was isotopically consolidated (i.e., consolidated with a uniform effective confining pressure; K_c = 1.0). To minimize the effects of sample disturbance, the effective confining pressure of the test was made somewhat greater that the in situ vertical effective stress.

5. After consolidation, an axial load was applied at a controlled rate of strain. A strain rate that allowed equalization of the sample pore pressure during testing was used. The specimen was then sheared until a desired maximum strain was reached. The axial load, pore pressure, and deformation of the sample was monitored during the tests.

ASTM D 4767 was modified for staged testing as follows. The first stage was consolidated to an effective confining stress somewhat greater than the in situ vertical effective stress, as mentioned above. In situ vertical stresses were computed using estimates of the moist unit weight of the weak rock above groundwater, the total unit weight of the weak rock below groundwater, and the depth to groundwater at the Boring UA-1R boring location. The depth to groundwater was estimated from groundwater levels measured in the piezometer that was installed during the field program. The second stage was performed after shearing the sample to an axial strain of 5 percent. The axial load was removed and the sample was allowed to drain. The sample was then incrementally consolidated to a second effective confirming stress (or stage). The second stage was consolidated with an effective confining stress between 1½ to 2 times greater than the first consolidation pressure. This was done to yield two strength "points" for each sample tested.

Test results and stress-strain relationships for each test specimen are presented on figures in this appendix.

POINT LOAD

Point load tests were performed on selected intact rock core samples in accordance with ASTM Test Method 5731. The point load test involves placing a piece of rock core between two conical platens, measuring the diameter of the test sample, and applying pressure with a hydraulic jack until the sample fails (i.e., breaks). All tests were diametral, meaning they were done on core samples with a length/diameter ratio greater than one. Tests are considered invalid if the rock failure surfaces only passed through

one of the loading points, as described in ASTM D 5731. The validity of a test (i.e., whether the test is valid or invalid) was noted when the tests were performed. The calculated Point Load Strength Index for each test sample was size-corrected, and the compressive strength was estimated, following the procedures described in ASTM D 5731. The results of the point load tests are presented at the corresponding sample locations on the boring logs in Appendix A and are summarized in Table B-1.

COMPACTION

Compaction tests were performed on bulk samples of soil and soft bedrock collected from the borings used to explore the NWP alignment. The purpose of these tests was to assess the compaction characteristics of the various soils and soft bedrock and the densities at which these materials likely would be placed if used as trench backfill during construction. These tests were performed in accordance with ASTM Method D 1557-02. Before testing, the bedrock sample was "processed" by breaking up the pieces of soft rock using a rubber mallet. Test results are presented on figures in this appendix.

CERCHAR ABRASIVITY INDEX (CAI)

Core samples of harder rock obtained from boring UA-2R were tested in the laboratory to determine CAI values. The tests were being performed at the time this draft report was being prepared.

DRAFT

TABLE B-1

SUMMARY OF POINT LOAD TEST DATA

Nacimiento Water Project
San Luis Obispo County, California

Jack Piston Area = 1.499 in^2

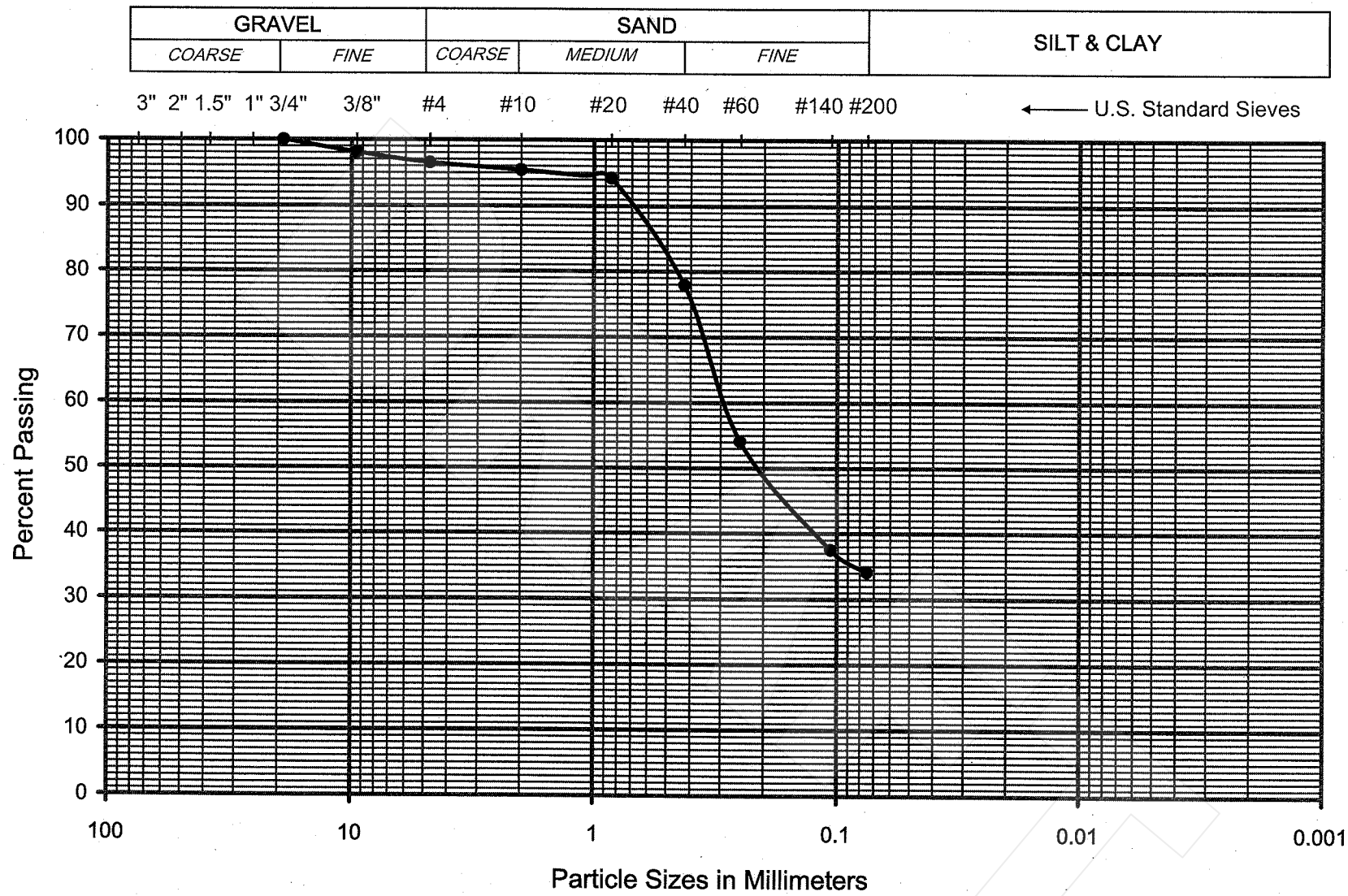
Boring No.	Depth (feet)	Diameter (mm)	Rupture Load (psi)	Rupture Load (kPa)	Rupture Force (N)	Uncorrected PLSI (Is) (MPa)	Corrected PLSI (Is50) (MPa)	Estimated Compressive Strength (MPa)	Estimated Compressive Strength (psi)	Rock Type	Test Validation
UA-1R	97.3	55	793	5,468	5,287	1.75	1.82	43.8	6,351	Sandstone	v
UA-1R	102.4	40	23	159	153	0.10	0.09	1.8	264	Sandstone	v
UA-1R	107.5	50	16	110	107	0.04	0.04	1.0	142	Sandstone	v
UA-1R	196.4	50	42	290	280	0.11	0.11	2.6	374	Sandstone	v

Notes:
* v=valid, nr-not reported, inv=invalid

DRAFT

GRAIN-SIZE DISTRIBUTION TESTS

DRAFT

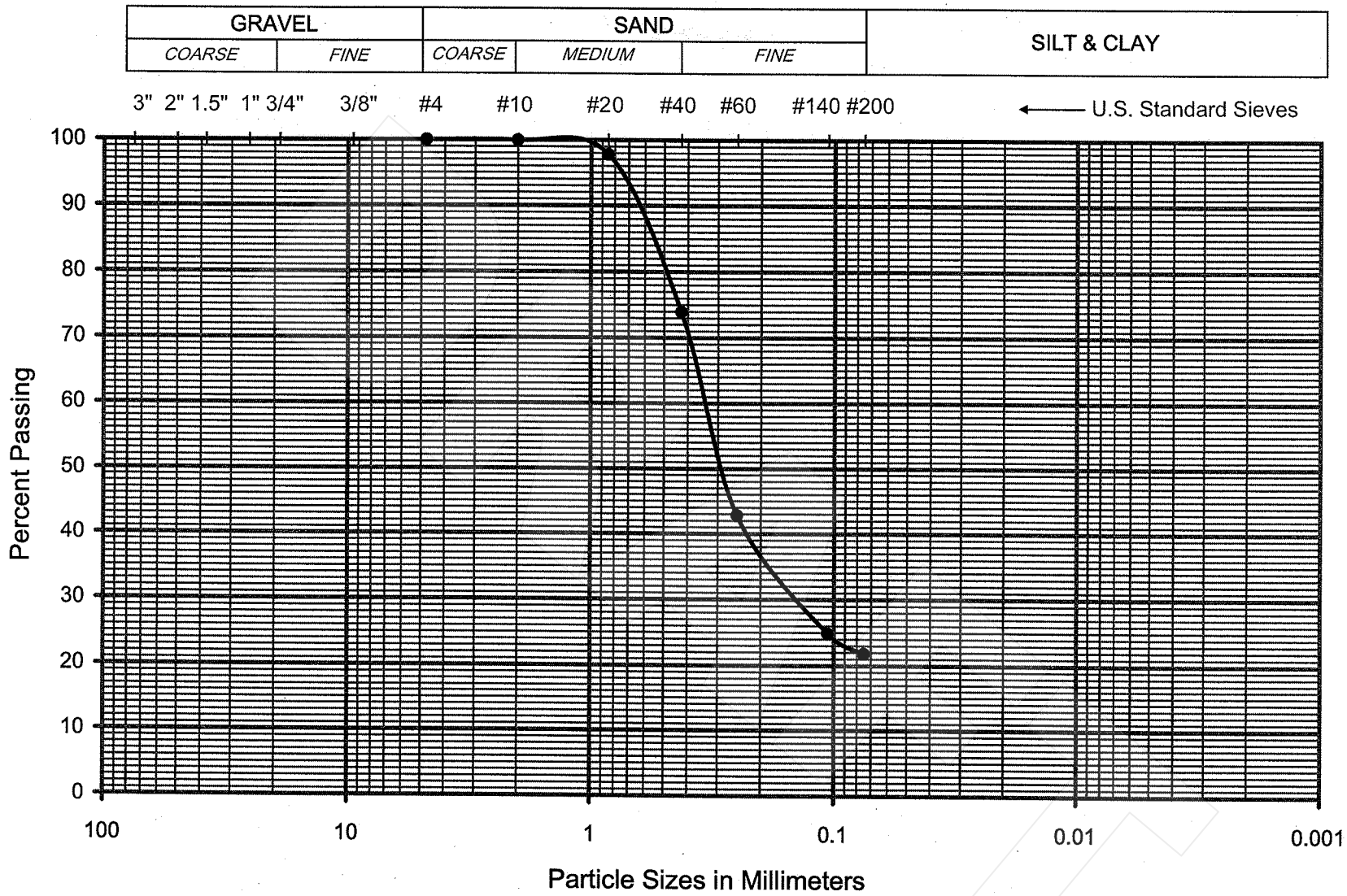


Sample Identification: UA1R @ 0-5 Ft

Soil Classification: Pale Yellow (2.5Y, 7/3) Clayey Sand (SC)

GRAIN SIZE DISTRIBUTION CURVE
NACIMIENTO WATER PROJECT
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

PROJECT No.
10352.000.0

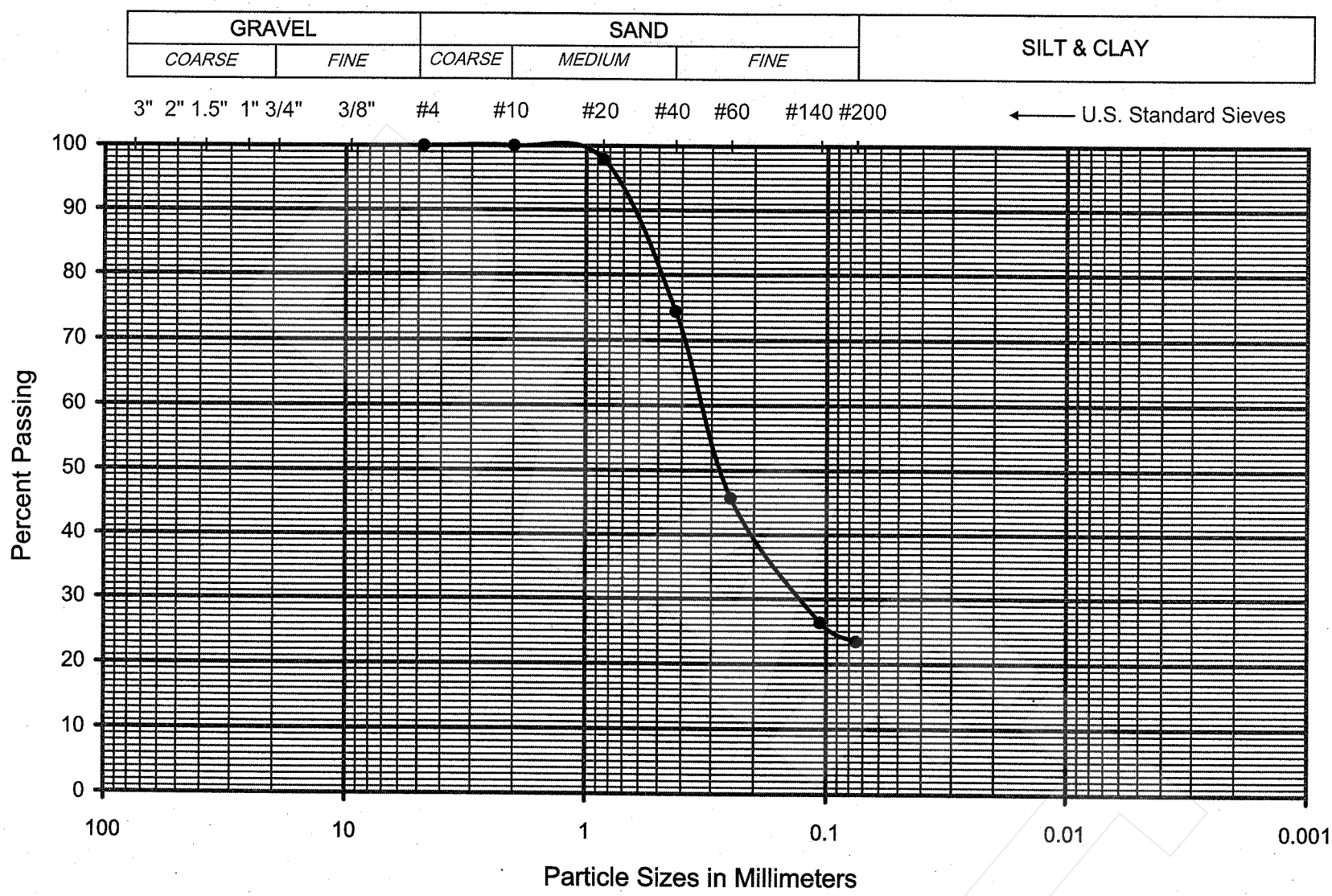


Sample Identification: UA1R-17 @ 78.2-79 Ft

Soil Classification: Pale Yellow (2.5Y; 7/4) Clayey Sand (SC)

GRAIN SIZE DISTRIBUTION CURVE
NACIMIENTO WATER PROJECT
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

PROJECT No.
10352.000.0

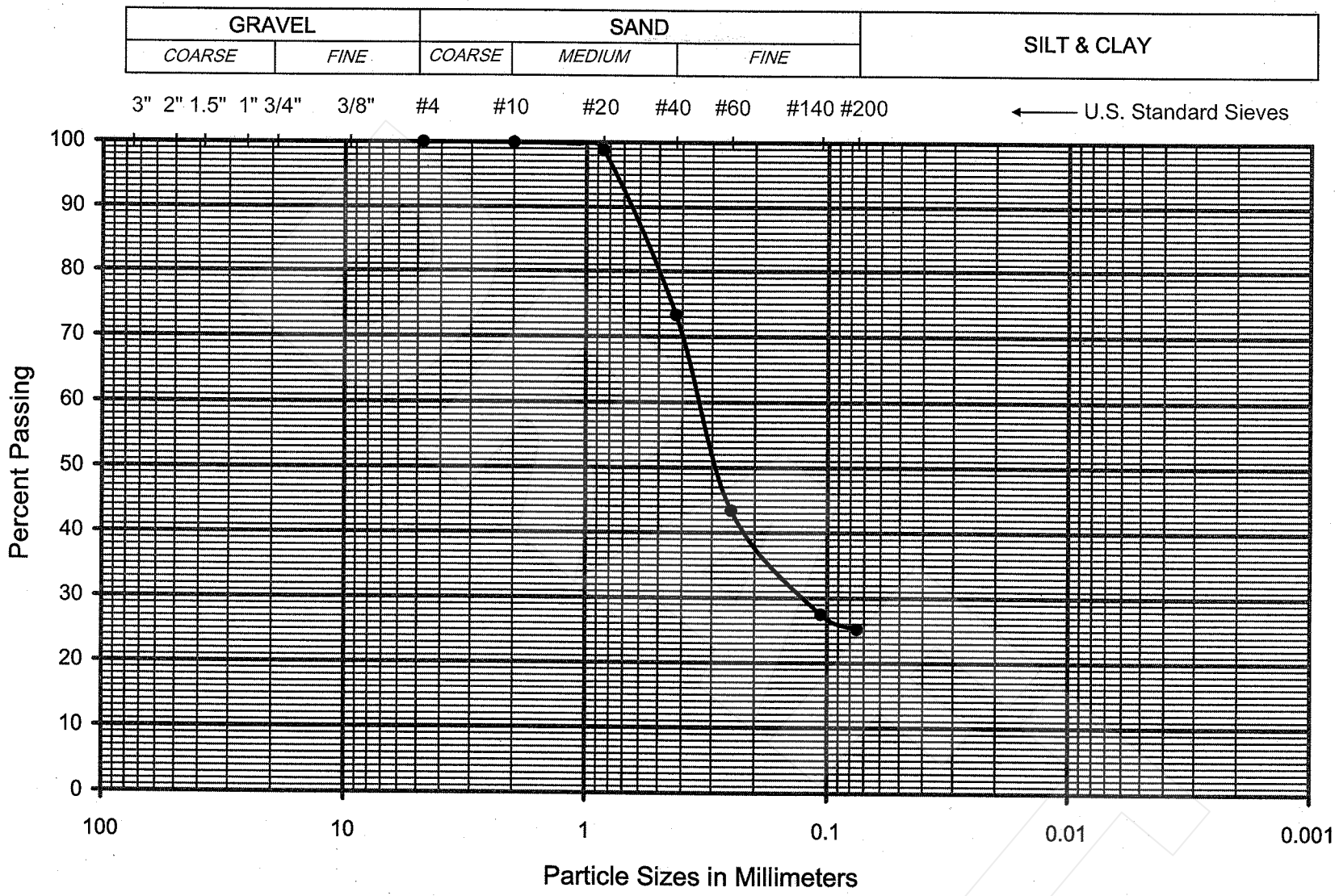


Sample Identification: UA1R-9 @ 39.6-40.3 Ft

Soil Classification: Pale Yellow (2.5Y, 7/4) Clayey Sand (SC)

GRAIN SIZE DISTRIBUTION CURVE
NACIMIENTO WATER PROJECT
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

PROJECT No.
10352.000.0



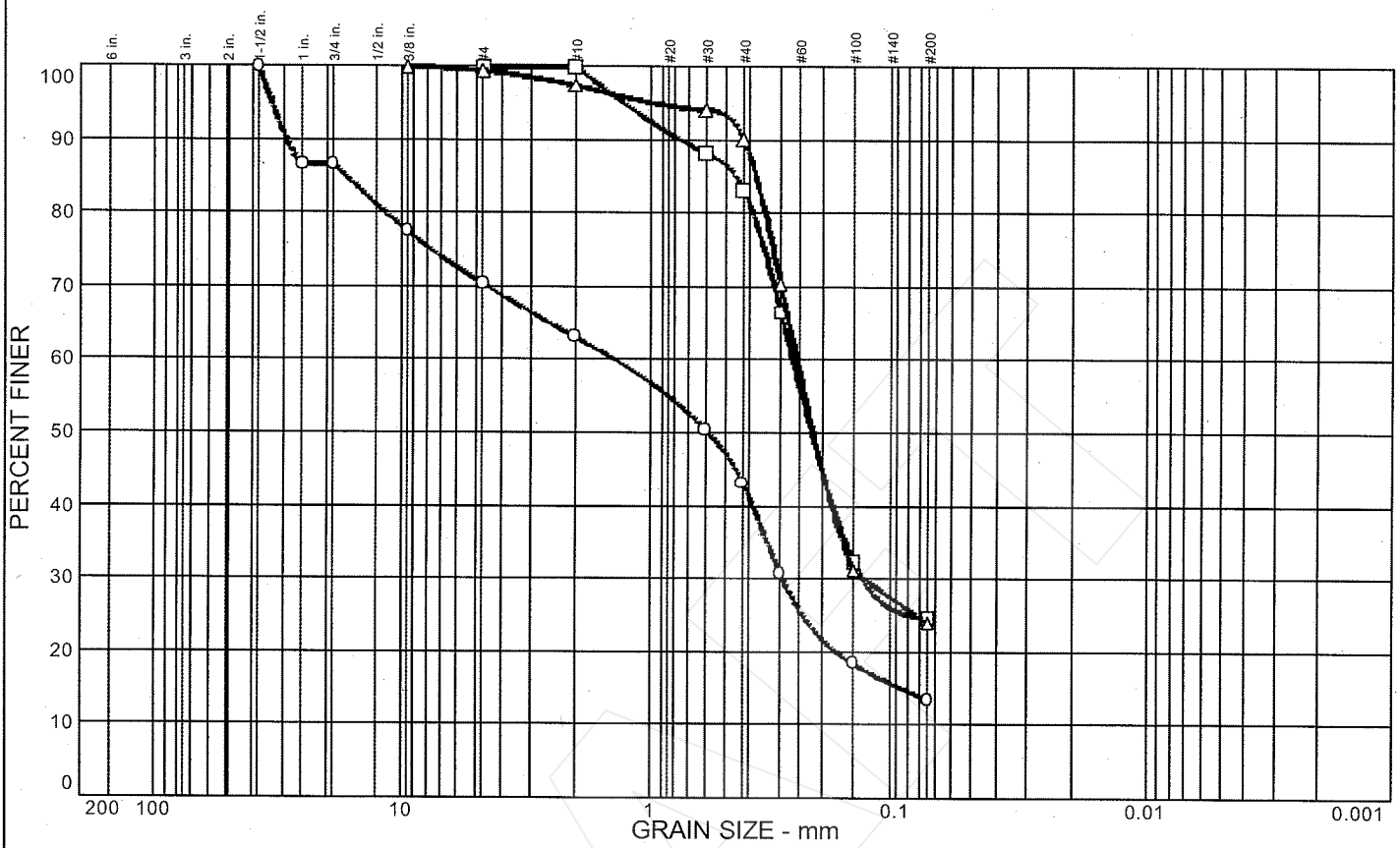
Sample Identification: UA1R-4 @ 12.2-12.5 Ft

Soil Classification: Pale Yellow (2.5Y, 7/4) Clayey Sand (SC)

GRAIN SIZE DISTRIBUTION CURVE
NACIMIENTO WATER PROJECT
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

PROJECT No.
10352.000.0

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		29.6	56.9	13.5					
□			75.4	24.6					
△		0.6	75.5	23.9					

SIEVE inches size	PERCENT FINER ○	□	△
1.5	100.0		
1	86.7		
3/4	86.7		
3/8	77.5		100.0
GRAIN SIZE			
D_{60}	1.38	0.268	0.258
D_{30}	0.293	0.137	0.135
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	70.4	100.0	99.4
#10	63.1	100.0	97.4
#30	50.4	88.2	94.1
#40	43.1	83.2	90.1
#50	30.8	66.5	70.3
#100	18.4	32.4	31.1
#200	13.5	24.6	23.9

SOIL DESCRIPTION

○ Light Yellowish Brown Silty SAND w/ Gravel

□ Yellowish Brown Silty SAND

△ Yellowish Brown Silty SAND

REMARKS:

○

□

△

○ Source: UA-1R	Sample No.: 14	Elev./Depth: 63-63.8'
□ Source: UA-1R	Sample No.: 30	Elev./Depth: 138.5-139.3'
△ Source: UA-1R	Sample No.: 32	Elev./Depth: 150.2-150.7'

COOPER TESTING LABORATORY

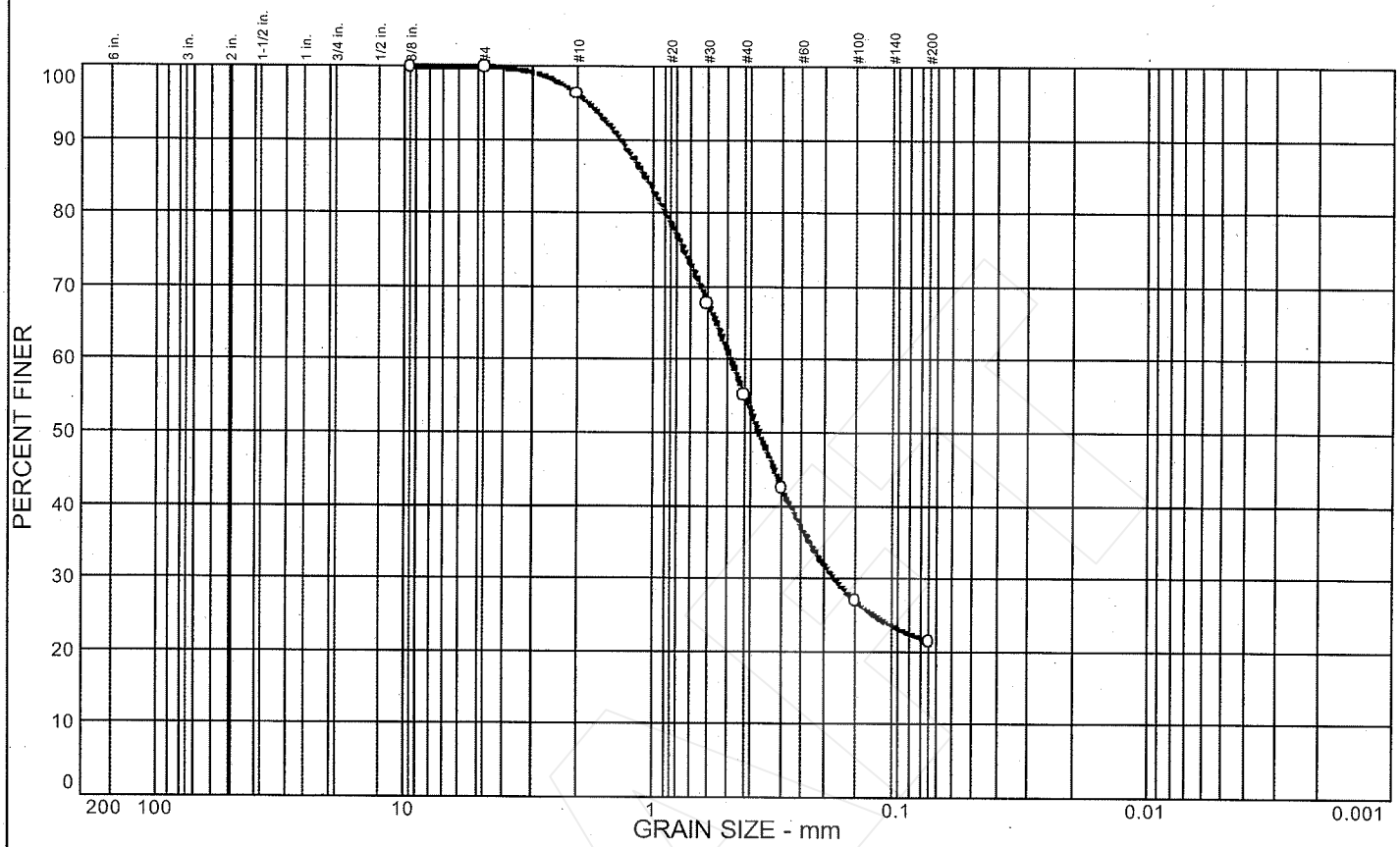
Client: Geomatrix Consultants

Project: Nacimiento Water Project - 10352.000.0

Project No.: 109-479

Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
o		0.1	78.5	21.4					

SIEVE inches size	PERCENT FINER o		
3/8	100.0		
GRAIN SIZE			
D_{60}	0.482		
D_{30}	0.182		
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER o		
#4	99.9		
#10	96.3		
#30	67.8		
#40	55.3		
#50	42.5		
#100	27.0		
#200	21.4		

SOIL DESCRIPTION

o Light Gray Silty SAND

REMARKS:

o

o Source: UA-1R Sample No.: 42 Elev./Depth: 184.2-184.8

COOPER TESTING LABORATORY

Client: Geomatrix Consultants

Project: Nacimiento Water Project - 10352.000.0

Project No.: 109-479

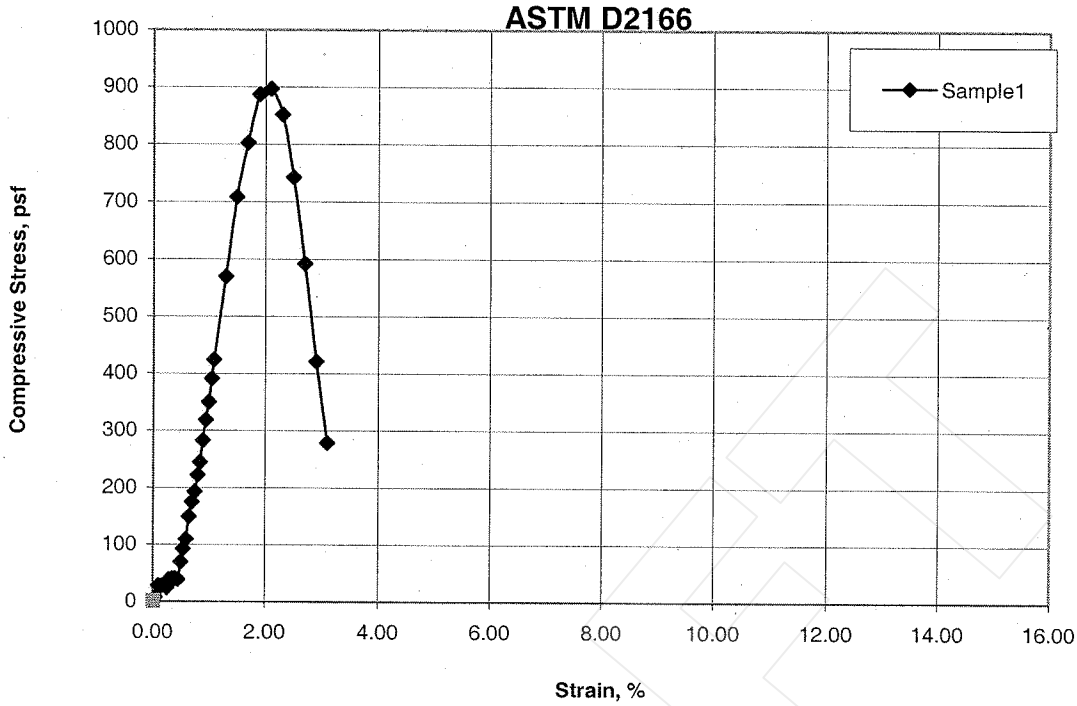
Figure

UNCONFINED COMPRESSIVE (SOIL) STRENGTH TESTS

DRAFT

Unconfined Compressive Strength

ASTM D2166



Sample No.:	1	2	3	4	
Unconfined Compressive Strength, psf	897				
Unconfined Compressive Strength, psi	6.2				
Undrained Shear Strength, psf	448				
Failure Strain, %	2.1				
Strain Rate, % per minute	1.0				
Strain Rate, inches/minute	0.05				
Moisture Content, %	18.2				
Dry Density, pcf	112.7				
Saturation, %	99.3				
Void Ratio	0.495				
Specimen Diameter, inches	2.310				
Specimen Height, inches	5.03				
Height to Diameter Ratio	2.2				
Assumed Specific Gravity	2.70				

Sample Location

	Boring	Sample	Depth, ft.	Soil Description
1	UA-1R	21	93.5-94.7	Yellowish Brown Silty SAND
2				
3				
4				

Job No.:	109-479	**Type of Sample**	Undisturbed
Client:	Geomatrix Consultants		
Project:	Nacimiento Water Project - 10352.000.0	Remarks:	
Date:	3/1/2006 **By:** MD/MJ		

COOPER TESTING LABORATORY

UNCONFINED COMPRESSIVE (ROCK) STRENGTH TESTS

DRAFT

COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D3148)

CTL Job No.:	109-479g	Boring:	UA-1R	Date:	2/27/2006
Client:	Geomatrix Consultants	Sample:	6	By:	PJ
Project Name:	Nacimiento Water Project	Depth,ft.:	24.4-25	Checked:	PJ
Project No.:	10352.000.0				

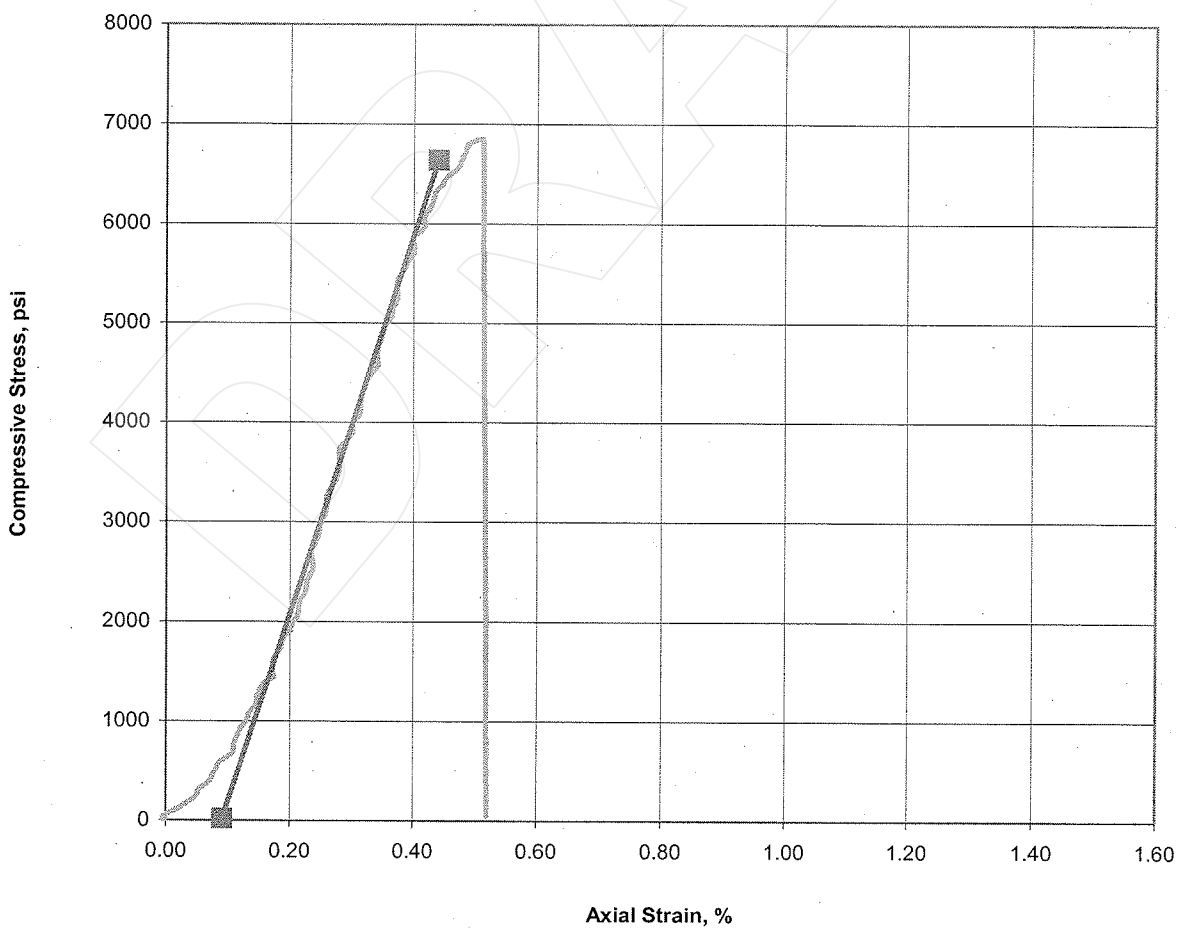
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (°C): Ambient

Remarks: Sample failed explosively.

Sample Height, in.	5.22	**Unconfined Compressive Strength, psi**	**6848**
Sample Diameter, in.	2.41		
Height / Diameter	2.17		
Sample Area, in^2	4.56		
Wet Density, pcf	149.6	**Young's Modulus (E) (psi)**	**1,891,000**
Dry Density, pcf	146.9		
Moisture Content, %	1.8		
Strain Rate, % / min	0.21		

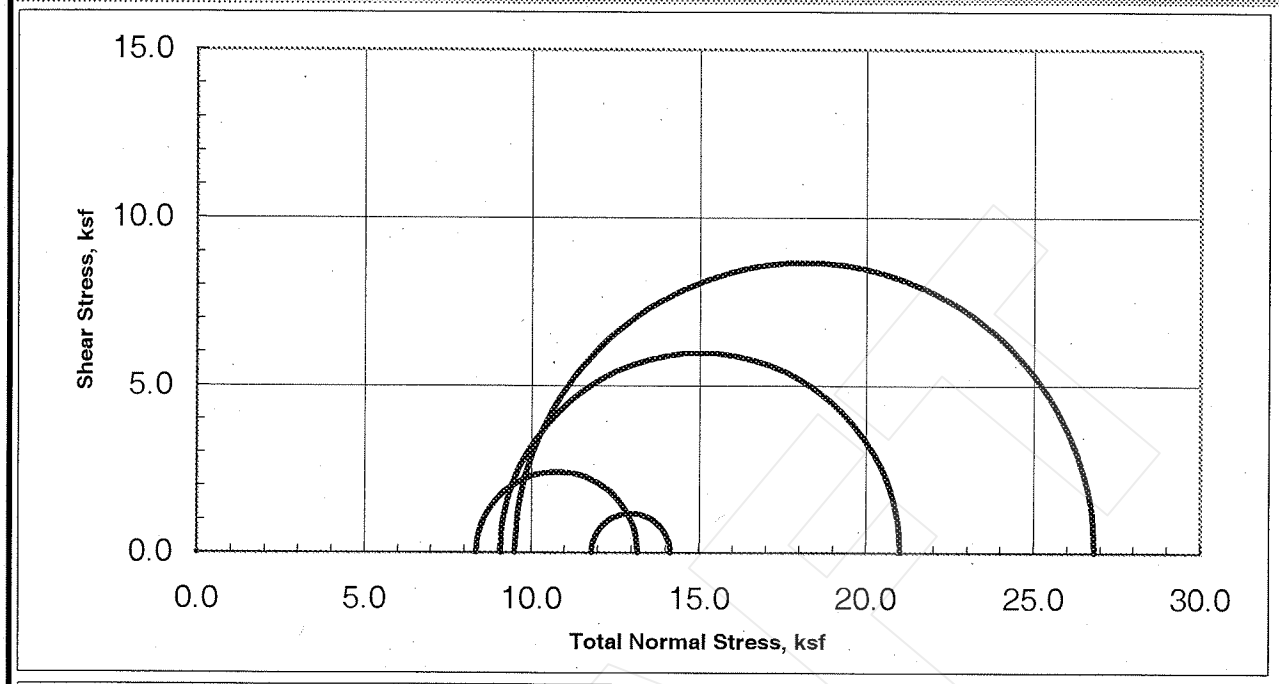


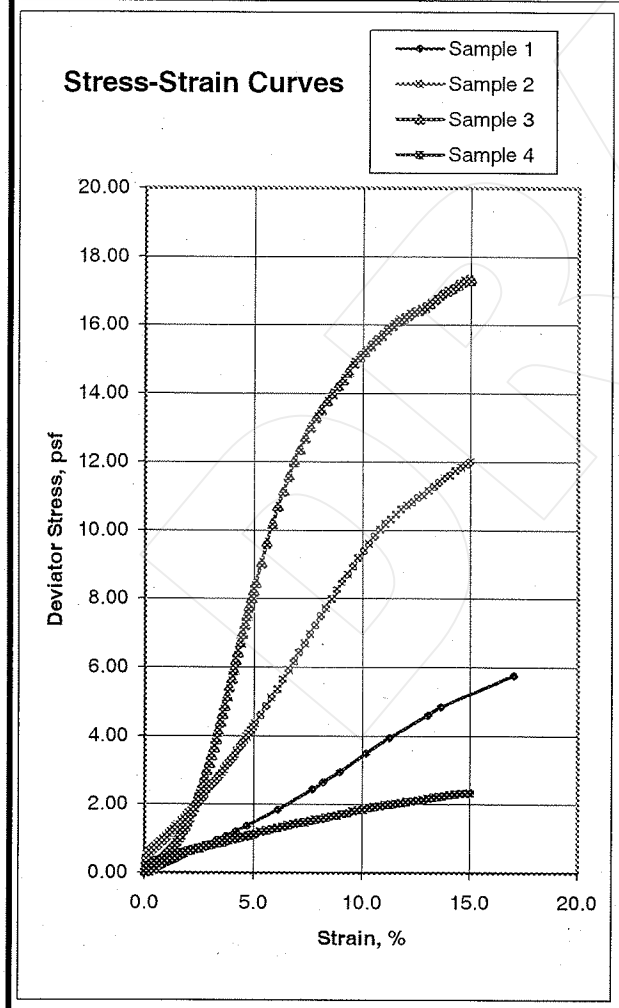
UNCONSOLIDATED-UNDRAINED TRIAXIAL TESTS

DRAFT

Unconsolidated-Undrained Triaxial Test

ASTM D-2850





Sample Data				
	1	2	3	4
Moisture %	19.4	17.7	17.0	15.8
Dry Den,psf	107.6	108.2	115.3	104.3
Void Ratio	0.566	0.558	0.462	0.617
Saturation %	92.7	85.7	99.3	69.3
Height in	5.03	5.00	5.02	5.03
Diameter in	2.27	2.38	2.41	2.30
Cell psi	58.0	63.0	66.0	82.0
Strain %	17.00	15.00	14.90	15.00
Deviator, ksf	5.753	11.978	17.319	2.342
Rate %/min	0.99	1.00	1.00	0.99
in/min	0.050	0.050	0.050	0.050
Job No.:	109-479			
Client:	Geomatrix Consultants			
Project:	Nacimiento Water Project - 10352.000.0			
Boring:	UA-1R	UA-1R	UA-1R	UA-1R
Sample:	19	21	22	30
Depth ft:	83-83.7	93.5-94.7	100-100.5	138.5-139.3

Visual Soil Description	
Sample #	
1	Yellowish Brown Silty SAND
2	Yellowish Brown Silty SAND
3	Yellowish Brown Silty SAND
4	Yellowish Brown Silty SAND

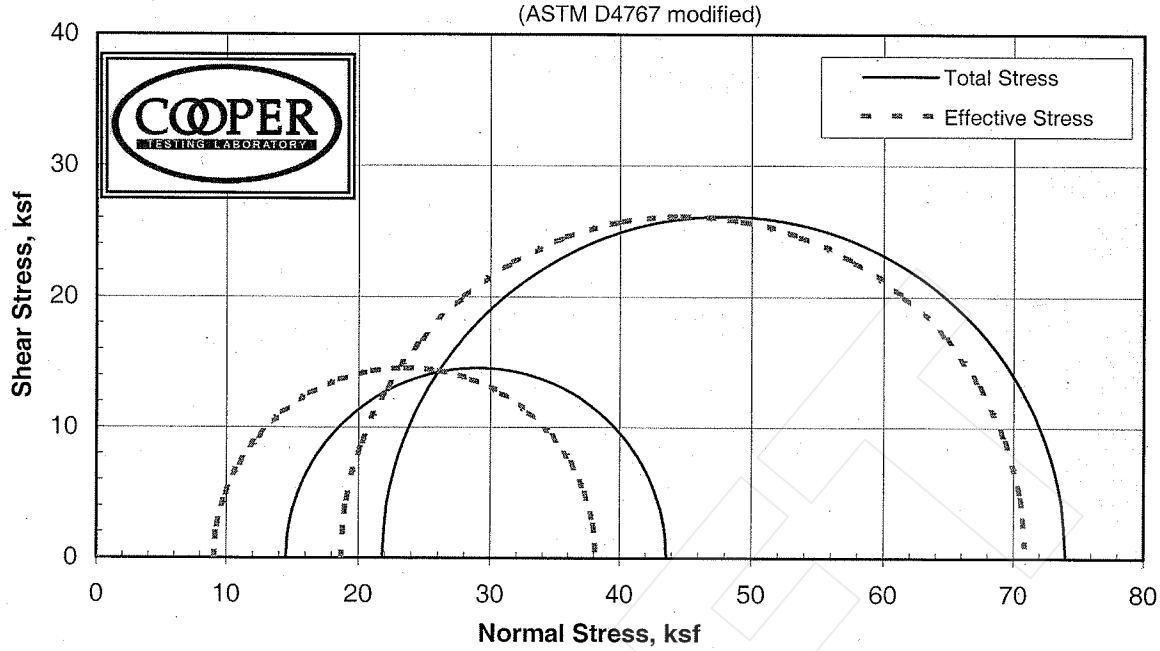
Remarks:

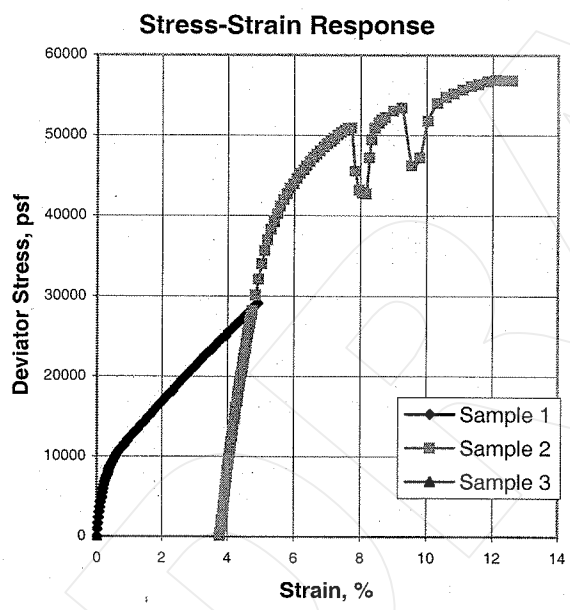
CONSOLIDATED-UNDRAINED TRIAXIAL TESTS

DRAFT

Triaxial Consolidated Undrained

(ASTM D4767 modified)





Sample:	1	2	3
MC, %	15.6	15.6	
Dry Dens., pcf.	117.9	117.9	
Sat. %	98.6	98.6	
Void Ratio	0.428	0.428	
Diameter in	2.40	2.40	
Height, in	5.06	5.06	
	Final		
MC, %	20.5	18.3	
Dry Dens., pcf.	108.5	109.3	
Sat. %	100.0	100.0	
Void Ratio	0.564	0.494	
Diameter, in	2.52	2.54	
Height, in	5.00	4.88	
Cell, psi	162.4	215.7	
BP, psi	61.6	64.4	
	Effective Stresses At:		
Strain, %	5.0	5.0	
Deviator ksf	29.094	52.241	
Excess PP	5.466	3.107	
Sigma 1	38.138	70.927	
Sigma 3	9.043	18.686	
P, ksf	23.590	44.807	
Q, ksf	14.547	26.120	
Stress Ratio	4.217	3.796	
Rate in/min	0.0010	0.0010	

Job No.: 109-479b **Date:** 3/2/2006

Client: Geomatrix Consultants BY:DC

Project: Nacimiento Water Project - 10352.000.0

Sample: UA-1R, 42 @ 184.2-184.8' Light Gray Silty SAND (weathered

Remarks: ** Staged Test ** Strengths at 5% strain.

Staged Test (Two Stage) Staged testing can adversly affect the phi & C. There is a tendancy to force the effective C greater than the total, which is theoretically not possible. The phi will also be lower than separate points may indicate.

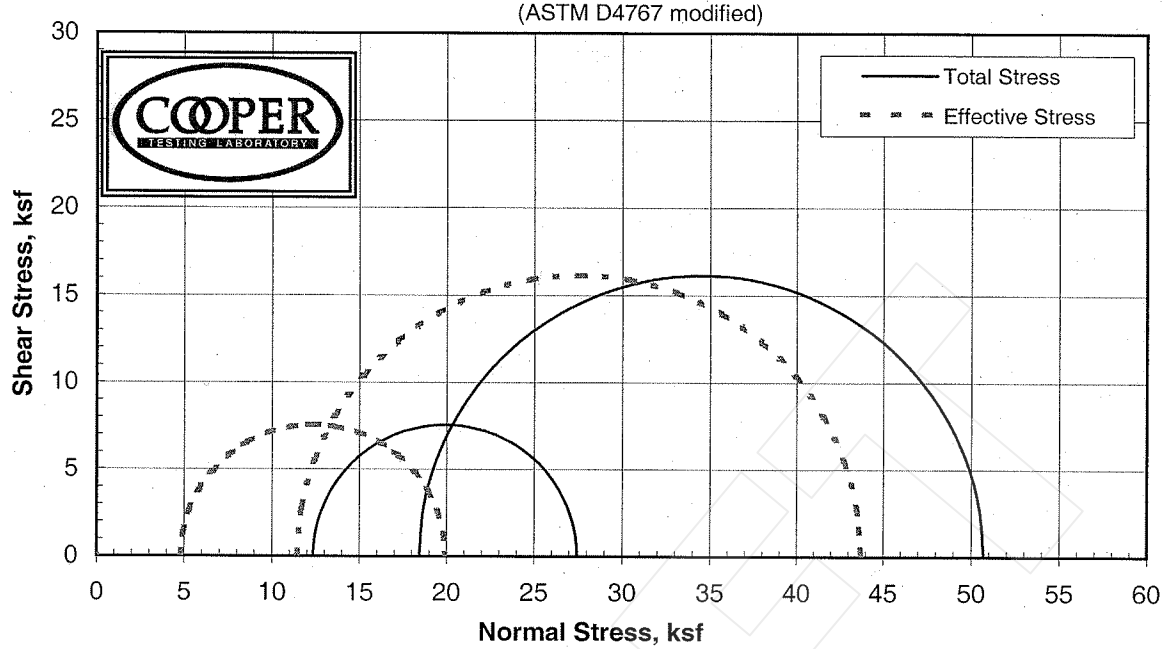
This sample dispayed some odd behavior during the second stage. We believe that this is because some of the more brittle material in the sample failed successively as the sample strained.

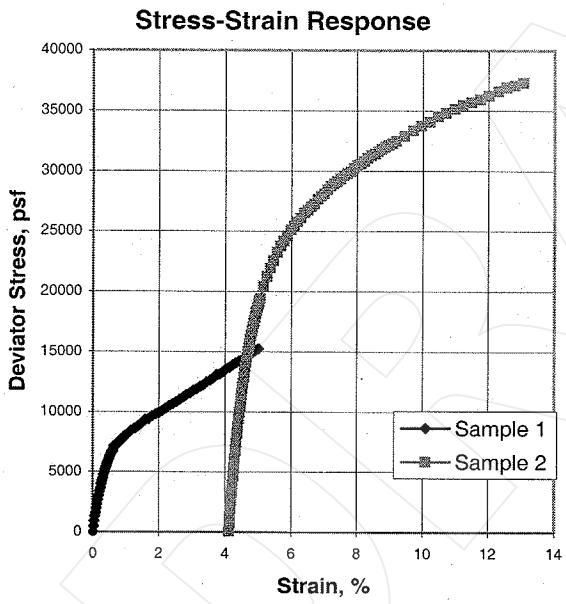
Total C _____ Effective C _____

Total Phi _____ Effective Phi _____

Triaxial Consolidated Undrained

(ASTM D4767 modified)





Sample:	1	2	3
MC, %	20.8	20.8	
Dry Dens., pcf.	104.2	104.2	
Sat. %	91.2	91.2	
Void Ratio	0.617	0.617	
Diameter in	2.36	2.36	
Height, in	4.96	4.96	
	Final		
MC, %	20.2	16.9	
Dry Dens., pcf.	109.1	109.9	
Sat. %	100.0	100.0	
Void Ratio	0.555	0.456	
Diameter, in	2.33	2.34	
Height, in	4.86	4.76	
Cell, psi	146.9	191.0	
BP, psi	61.2	63.1	
	Effective Stresses At:		
Strain, %	5.0	5.0	
Deviator ksf	15.116	32.280	
Excess PP	7.541	6.988	
Sigma 1	19.917	43.715	
Sigma 3	4.801	11.435	
P, ksf	12.359	27.575	
Q, ksf	7.558	16.140	
Stress Ratio	4.149	3.823	
Rate in/min	0.0010	0.0010	

Job No.: 109-479a **Date:** 2/28/2006

Client: Geomatrix Consultants BY:DC

Project: Nacimiento Water Project - 10352.000.0

Sample: UA-1R, 32 @ 150.2-150.7' Yellowish Brown Silty SAND

Remarks: ** Staged Test ** Strengths at 5% strain.
Staged Test (Two Stage) Staged testing can adversly affect the phi & C. There is a tendancy to force the effective C greater than the total, which is theoretically not possible. The phi will also be lower than separate points may indicate.

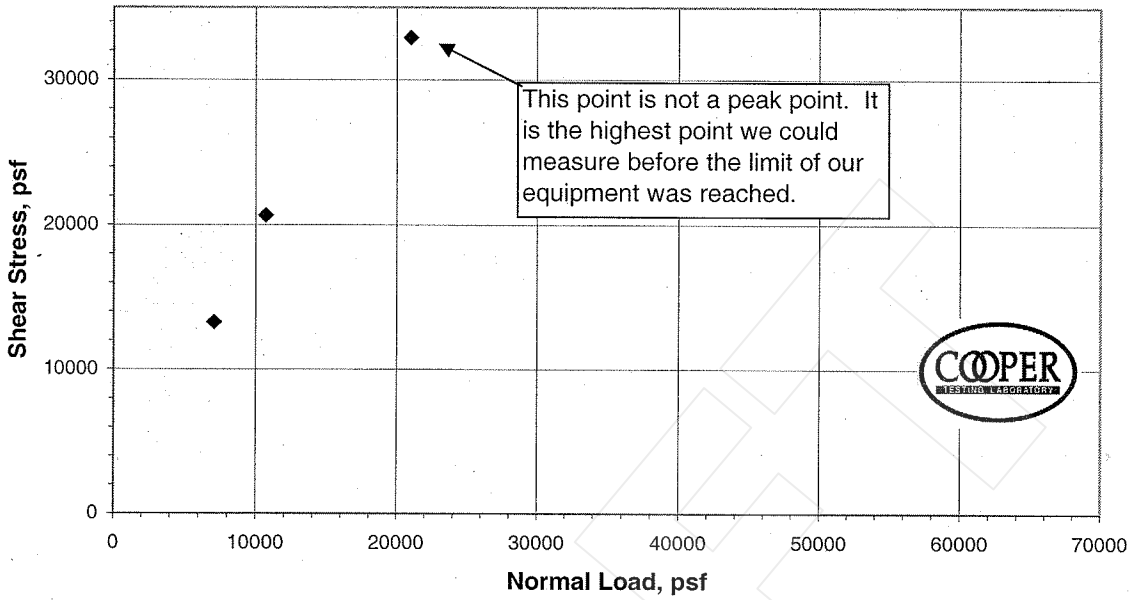
Total C _____ Effective C _____

Total Phi _____ Effective Phi _____

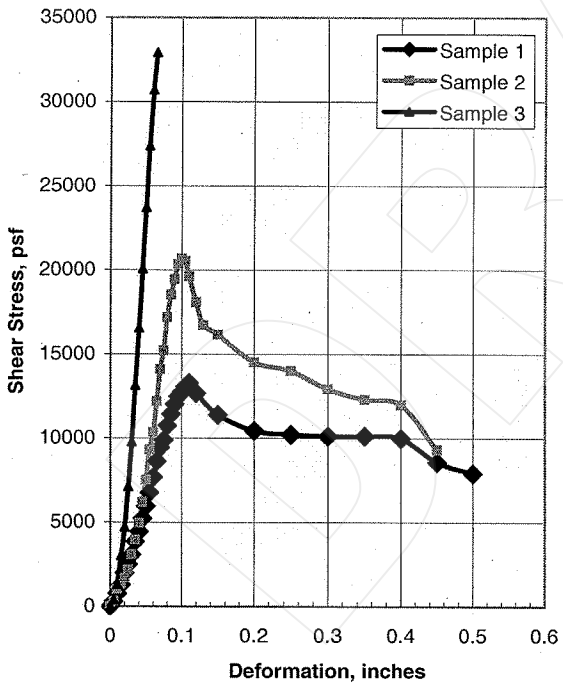
DIRECT SHEAR TESTS

DRAFT

Direct Shear Test



Peak, phi:		Peak, C:		Ultimate, phi:		Ultimate, C:	



	Sample Data: Initial			
	1	2	3	4
Moisture %	10.3	10.2	10.2	
Dry Dens., pcf	119.7	124.0	125.3	
Void Ratio	0.409	0.359	0.345	
Saturation %	67.8	76.5	79.9	
Diameter	2.36	2.36	2.36	
Height	1.00	1.00	1.00	
	Sample Data: At Test			
Moisture %	10.3	10.2	10.2	
Dry Dens., pcf	119.7	124.0	125.3	
Void Ratio	0.409	0.359	0.345	
Saturation %	67.8	76.5	79.9	
Diameter	2.36	2.36	2.36	
Height	1.00	1.00	1.00	
Normal Stress, psf	7100	10700	21000	
Shear Stress, psf	13266	20673	32919	
Strengths picked at	peak	peak	see note	
Ult. Stress, psf				
Rate in/min.	0.020	0.020	0.020	

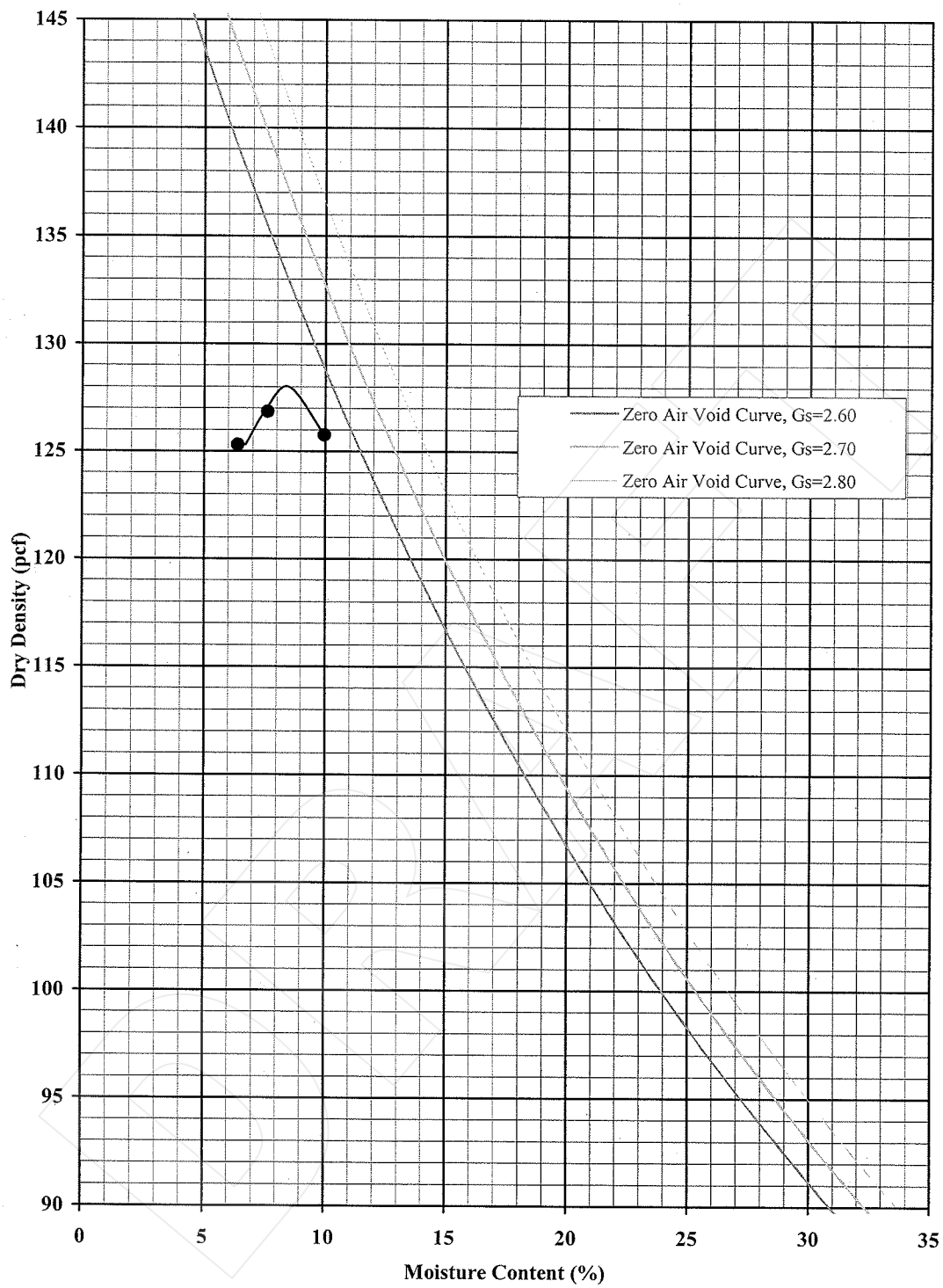
CTL #	109-479
Client:	Geomatrix Consultants
Project	Nacimiento Water Project - 10352.000.0
Tested By:	MD
Reduced By:	RU
Date:	2/28/2006

Specimen #	Boring:	Sample:	Depth, ft:	Visual Soil Classification
1	UA-1R	14	63'	Light Yellowish Brown Silty SAND (Weathered Sandstone)
2	UA-1R	14	63'	Light Yellowish Brown Silty SAND (Weathered Sandstone)
3	UA-1R	14	63'	Light Yellowish Brown Silty SAND (Weathered Sandstone)
4				

Remarks: *DS-UU* Quick shear run at field moisture.

COMPACTION TESTS

DRAFT



Sample Identification	Soil Type	Test Method	Maximum Dry Density (PCF)	Optimum Moisture Content (%)
UA-1R @ 1 - 5 ft.	Sandstone	ASTM-D1557-A	128.0	8.5
After Oversize Correction Per ASTM-D4718 →			N/A	N/A

MAXIMUM DRY DENSITY - OPTIMUM MOISTURE CONTENT CURVE

NACIMIENTO WATER PROJECT

SAN LUIS OBISPO COUNTY, CALIFORNIA

Project No.
10352.000.0

PRELIMINARY REPORT ON ROCK TESTING FROM GEOTEST UNLIMITED

DRAFT

Geo Test Unlimited GTU

Test Equipment Design & Fabrication
Laboratory & Field Testing
Consulting Services

Dr. Anders Bro

September 19, 2006

Nacimiento Water Project
Unconfined Compression and Cerchar Testing

Annmarie Behan
Geomatrix Consultants, Inc.
2101 Webster St., 12th Floor
Oakland, CA 94612-3066

Dear Annmarie,

Thanks for using my lab for these Unconfined Compression and Cerchar tests. This short letter summarizes the test results and includes the raw data sheets, plots, the standard test procedures and a CD containing the data files and digital photos of the samples.

A total of five compression tests were performed, as well as five Cerchar Abrasion tests.

The rock consisted of weakly to moderately cemented sandstone. The moderately cemented sandstone appeared to be quite competent whereas the weakly cemented rock was easy to break apart with gentle finger pressure. As such, the weakly cemented samples were not suitable for Cerchar testing as the application of the pin load resulted in the pin penetrating the sample completely and splitting the sample in half. Photographs of this failure were taken to demonstrate the weakness of these Cerchar samples. In light of these weak rock samples, one of the weakest Cerchar test samples scheduled for testing was exchanged for a sample from 90 feet. As a consequence, only three valid Cerchar abrasivities are reported, two samples being too weak to result in any test result.

In order to prepare the ends of the weak samples, they had to be wrapped with heat shrink-wrap to confine the samples sufficiently to allow the samples to be cut and ground. These weaker samples were typically of slightly lower quality than the strong ones in that the sides of the samples were occasionally gouged, and removal of the caked on drilling mud resulted in removal of some of the weakly cemented rock.

A table of the Cerchar test results follows:

Cerchar Test Results

Sample (Depth)	Description	Cerchar Index
R25 (90.4-91.5')	Cream, medium grained, well cemented sandstone.	2.0
R46B (196.3-196.6')	Light gray, medium grained, weakly cemented sandstone.	1.5
R47B (199.9-200.6')	Light gray, medium grained, well cemented sandstone.	3.2

Two more samples were tested, R46A (191.9-192.2'), and R47A (197.8-198.4') but broke in half when the abrasion pin was loaded and penetrated deeply into the samples.

27069 N. Bloomfield Rd. Nevada City, CA 95959 Tel/Fax (530)470-0583 email: abro@saber.net

Another sample, R36 (144.5-145.3') that was initially slated for testing, was not tested as it was clearly too weak and would have broken in a manner similar to Sample R46A and R47A.

One interesting feature of these abrasion tests was the high degree of variability of the abrasion values. The high variability of Sample R46B (ranging from 0.0 to 4.0) is highly unusual and appears to demonstrate the heterogeneity of the rock. It appeared to contain highly abrasive particles in a weak matrix. When the pin encountered one of the abrasive clasts, a large amount of abrasion occurred, whereas if a pin did not encounter such a particle, the abrasion could be quite low. A more typical test variability of other rock types might be on the order of 1 (e.g. ranging from 2.7-3.7).

The unconfined compressive strengths were generally quite low, with the strongest sample having a strength of 2110 psi, and the weakest samples had a strength of 94 psi. These test results follow:

Unconfined Test Results

Sample (Depth)	Description	ρ (pcf)	UCS (psi)
R25 (90.4-91.5')	Cream, medium grained, well cemented sandstone with numerous calcite and mineral healed joints.	150.1	2110
R33 (129.6-130.2')	Light creamy gray medium grained, weakly cemented sandstone with a few calcite (?) healed joints.	142.4	295
R36 (144.5-145.3')	Tan, medium grained, weakly cemented sandstone.	134.3	114
R41 (168.3-169.0')	Light grayish tan, medium grained, weakly cemented sandstone, with a short vertical open fracture.	132.1	94
R47B (199.9-200.6')	Light gray, medium grained, well cemented sandstone with several clay and calcite filled joints.	153.5	1802

The low strength of Sample 47B can be attributed to the large number of filled fractures within the sample. This sample clearly failed along two such planar surfaces, weakening the otherwise moderately competent rock.

If you have any questions regarding these test results or the test procedures, please feel free to contact me.

for GeoTest Unlimited

_____

Dr. Anders Bro

Appendix C
Seismic Refraction Survey

DRAFT

NORCAL GEOPHYSICAL CONSULTANTS, INC.

January 8, 2006

Mr. Hans Ward
Geomatrix Consultants, Inc.
2101 Webster Street, 12th Floor
Oakland, CA 94612

Subject: Seismic Refraction Survey
Nacimiento Water Project, San Luis Obispo County, California
NORCAL Job Number 05-325.23B

Dear Mr. Ward:

This report presents the findings of a seismic refraction (SR) survey performed by NORCAL Geophysical Consultants, Inc. at various locations between Lake Nacimiento and the City of San Luis Obispo in San Luis Obispo County, California. The survey was performed on December 12 - 13, 2005 by NORCAL geophysicist Donald J. Kirker and geophysical technician Chris Blom. Background information and logistical support was provided by Annmarie Behan of Geomatrix Consultants, Inc (Geomatrix).

PURPOSE

Lake Nacimiento is located near the west boundary of Camp Roberts approximately 45 miles northwest of San Luis Obispo, CA. It was created in the late 1950's to provide water for multiple uses including flood control, irrigation, and water supply. Currently, Geomatrix and others are designing a water supply system (pipes, tanks, etc.) that will deliver water from the reservoir to various users in San Luis Obispo County.

The purpose of the SR survey was to obtain seismic refraction data to aid in evaluating the thickness of overburden and the depth and excavation characteristics (rippability) of the bedrock at predetermined locations along the proposed pipeline as determined by Geomatrix. We understand that this information will be used in conjunction with other geotechnical investigations to provide subsurface information to aid in the design and construction of the pipeline.

SITE DESCRIPTION

The SR survey was conducted along eight lines, as determined by Geomatrix. They are referred to as UA8S, UA9S, UA16S, UA17S, UF17S, UF18S, UG34S, and UG35S, and are located at four separate areas along the proposed pipe alignment. The location of each seismic refraction line, and the site topography, are shown on Plates 1 through 4. Lines UA8S and UA9S are located along the north shore of Lake Nacimiento near the spillway. UA16S and UA17S parallel the Nacimiento River within Camp Roberts. UF17S and UF18S are positioned on a hillside along Rock Canyon Road near the town of Atascadero. Lines UG34S and UG35S are located on a hillside near the Cuesta grade along highway 101. The terrain at each site is characterized by rolling hills covered with grass, shrubs, and deciduous trees. Surface elevations range from a low of approximately 600 feet above mean sea level at Camp Roberts to over 1,440 feet above mean sea level along the Cuesta grade. Each site is accessed by either asphalt or soil covered roadways.

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Geologic data, obtained from core borings installed in each area by Geomatrix, indicates that the subsurface conditions generally consist of residual topsoil, interbedded sand, gravel, and clay, and sandstone and claystone bedrock. Visual evidence of highly bedded sandstone was noted along some of the seismic refraction lines. Specifically, steeply dipping sandstone outcrops were evident along the southern ends of Lines UA8S and UA9S, and along the canyon walls above Lines UA16S and UA17S.

METHODOLOGY

The SR method is used to determine the compressional velocity of subsurface materials. The seismic velocity of fill, sediments, and rock are dependent on physical properties such as compaction, density, hardness, and induration. However, other factors such as bedding, fracturing, and saturation also effect seismic velocity. Typically, low velocities are indicative of loose soil, poorly compacted fill material, poorly to semi-consolidated sediments, and deeply weathered and highly fractured rock. Moderate velocities are usually indicative of dense and highly compacted sediments and fill, and/or moderately weathered and moderately fractured rock. High velocities are indicative of slightly weathered to unweathered rock with little fracturing. A more detailed description of the SR methodology is provided in Appendix A.

FIELD INVESTIGATIONS

We obtained seismic refraction data along eight lines (Plates 1 through 4). Each line measured 240 feet and consisted of 24 geophones and three shot points distributed in a collinear array. The geophones were coupled to the ground surface at 10 foot intervals. Two of the shot points were located 5 feet beyond the geophones at both ends of each spread. The third shot point was positioned in the center of the spread.

We produced seismic energy at each shot point by striking an aluminum plate with a 16-pound sledge hammer. An accelerometer attached to the hammer transmitted a triggering pulse to the seismograph each time the plate was struck. The resulting travel time data were recorded on a seismograph and processed to generate seismic velocity cross-sections. A more detailed description of data acquisition and analysis procedures are also provided in Appendix A.

RESULTS

The results of the SR survey are represented by the eight seismic velocity cross-sections shown on Plates 5 through 8. Our interpretation of the seismic refraction data resolves the subsurface into two or three seismic layers with velocities ranging from 1,100 to 9,200 feet per second (ft/sec). These layers are labeled V1 through V3 in order of increasing velocity and depth. The velocity, thickness, and depth range to the top of the seismic velocity layers are presented in Table A, below.

Table A: Seismic Layer Velocities, Thicknesses, and Depths

SEISMIC LINE	DIRECTION	SEISMIC LAYER	VELOCITY (ft/sec)	THICKNESS (ft)	DEPTH* (ft)
UA8S (Plate 5)	S -N	V1 V2 V3	2,500 3,000 5,900	6 - 26 0 - 53 undefined	0 6 - 20 20 - 62
UA9S (Plate 5)	SW - NE	V1 V2 V3	1,500 3,400 not detected	8 - 15 undefined -------	0 8 - 15 --------
UA16S (Plate 6)	S - N	V1 V2 V3	1,600 not detected 7,000	5 - 12 ------- undefined	0 ------- 5 - 12
UA17S (Plate 6)	S - N	V1 V2 V3	1,000 6,400 9,200	3 - 6 2 - 43 undefined	0 3 - 6 7 - 46
UF17S (Plate 7)	W -E	V1 V2 V3	1,300 2,500 7,300	3 - 10 44 - 57 undefined	0 3 - 10 51 - 63
UF18S (Plate 7)	SW -NE	V1 V2 V3	1,300 2,800 not detected	1 - 17 undefined -------	0 1 - 17 -------
UG34S (Plate 8)	W - E	V1 V2 V3	1,600 not detected 8,500	7 - 22 ------- undefined	0 ------- 7 - 22
UG35S (Plate 8)	NW - SE	V1 V2 V3	1,200 3,000 6,700	4 - 10 7 - 26 undefined	0 4 - 10 31 - 15

* to top of layer

DISCUSSION

Lines UA8S & UA9S, Lake Nacimiento (Plate 5)

As shown on Plate 5, Lines UA8S and UA9S cross at boring UA-1R. Along Line UA8S, the seismic refraction profile shows V1 and V2 velocities of 2,500 to 3,000 ft/s overlying a V3 velocity layer of 5,900 ft/s. Along UA9S, V1 and V2 velocities range from 1,500 to 3,400 ft/s. A V3 velocity layer was not defined.

Based on boring UA-1R, all velocity layers (V1 through V3) represent sandstone of the Vaquero Formation. This wide range of velocities suggests that the sandstone has a wide range in weathering characteristics. The low velocities of V1 and V2 is consistent with highly fractured and/or weathered sandstone. The higher V3 velocity is consistent with rock that is moderately

fractured and/or weathered. Since the southern end of both lines are located on steeply dipping sandstone outcrops, it should be noted that apparent velocities can be affected by the orientation of bedding planes with respect to the direction of the seismic profile. Therefore, apparent velocities of rock are typically slower when measured along lines oriented perpendicular to bedding planes of steeply dipping rock, than those measured along lines oriented parallel. Additionally, lack of V3 along line UA9S suggests that degree of weathering increases with depth to the west.

Lines UA16S & UA17S, Camp Roberts (Plate 6)

Along Line UA16S, the seismic refraction profile shows a V1 velocity of 1,600 ft/s and a V3 velocity of 7,000 ft/s. A V2 velocity layer was not defined. Based on nearby boring UA-14R (not shown on Plate 6), the low velocity layer V1 represents interbedded sand and gravel. The high velocity V3 material represents bedded sandstone that exhibits varying degrees of fracturing.

Along Line UA17S, the seismic refraction profile shows a low V1 velocity of 1,000 ft/s overlying a moderately high V2 velocity of 6,400 ft/s and a high V3 velocity layer of 9,200 ft/s. The V1 and V2 velocity layers represent sand, clay, and gravel, as indicated by boring UA-15R. However, the higher velocity of V2 suggests that the interbedded sediments may be more consolidated at a depth of three to six feet. The V3 material (9,200 ft/s) represents bedded sandstone. This high velocity is consistent with rock that is moderately to little fractured and/or weathered.

Lines UF17S & UF18S, Rock Canyon Road (Plate 7)

Along Line UF17S, the seismic refraction profile shows relatively low V1 and V2 velocities of 1,300 to 2,500 ft/s overlying a moderately high V3 velocity layer of 7,300 ft/s. The V1 and V2 velocity layers represent clay and claystone, as indicated by Boring UF-12A. The low velocity of the claystone suggests that it is highly weathered and/or fractured. The high velocity V3 material was not encountered by the boring. However, the velocity of this material is consistent with moderately fractured and/or weathered bedrock.

Along Line UF18S, the profile indicates low V1 and V2 velocities of 1,300 to 2,800 ft/s. A V3 velocity layer was not defined. Based on boring UF-11A, the velocity layer of V1 represents interbedded sand and clay, and V2 represents interbedded sand and silt.

Lines UG34S & UG35S, Cuesta grade (Plate 8)

Along Line UG34S, the seismic refraction profile shows a V1 velocity of 1,600 ft/s and a V3 velocity of 8,500 ft/s. A V2 velocity layer was not defined. Based on boring UG-31A, the low velocity layer (V1) represents interbedded sand, clay, and gravel. The high velocity V3 material represents shale. The velocity of the V3 material is consistent with moderately fractured and/or weathered bedrock.

Along Line UG35S, the profile indicates low V1 and V2 velocities of 1,200 to 3,000 ft/s overlying a moderately high V3 velocity layer of 6,700 ft/s. The low velocity layers represent interbedded sand, clay, and gravel, as indicated by boring UG-26R. The V3 material (6,700 ft/s) represents shale. The velocity of this layer is consistent with rock that is moderately fractured and/or weathered. It should be noted, that the velocity of this material is relatively low compared to the higher V3 velocity defined along nearby Line UG34S. The difference in these velocities suggests that the bedrock may be variable.

EXCAVATION CHARACTERISTICS (Rippability)

The V3 velocities (5,900-9,200 ft/s) defined at this site are highly variable and are consistent with rock that is rippable to non-rippable. Seismic velocity charts relating seismic velocity and excavation characteristics have been developed from field tests by others. These charts list the seismic velocity of various types of rock and their relative ease of excavation using different types of rippers. Caterpillar Tractor Company publishes a performance manual that lists ripper performance charts for the D8L, D9L, and D11L tractors. The following information in Table B was obtained from a performance chart for a D9L Ripper:

Table B: D9L Ripper Performance Chart

PERFORMANCE	ROCK TYPE	VELOCITY RANGE (ft/s)
Rippable	Sedimentary	< 6,400 to 7,800
	Igneous	< 6,700 to 7,600
	Metamorphic	< 7,200 to 7,300
Marginally Rippable	Sedimentary	6,400 to 9,700
	Igneous	6,700 to 8,600
	Metamorphic	7,200 to 9,200
Non-rippable	Sedimentary	> 8,600 to 9,700
	Igneous	> 8,000 to 8,700
	Metamorphic	> 9,000 to 9,200

This information should only be used as a general guide, however, as many other factors should also be considered. These factors include rock jointing and fracture patterns, the experience of the equipment operator, and the equipment and excavation methods selected. Also, the computed velocities measured along each profile are an average for each layer. Therefore, there may be localized zones within each layer where the velocities may be higher or lower than indicated. Since

the accuracy of our findings is subject to these limitations, it should be noted that subsurface conditions may vary slightly from those depicted in the final results. A more detailed discussion of the limitations with regard to the seismic refraction method is presented in Appendix A.

STANDARD OF CARE

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the standard of care ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

We appreciate having the opportunity to provide you with this information.

Respectfully,

NORCAL Geophysical Consultants, Inc.

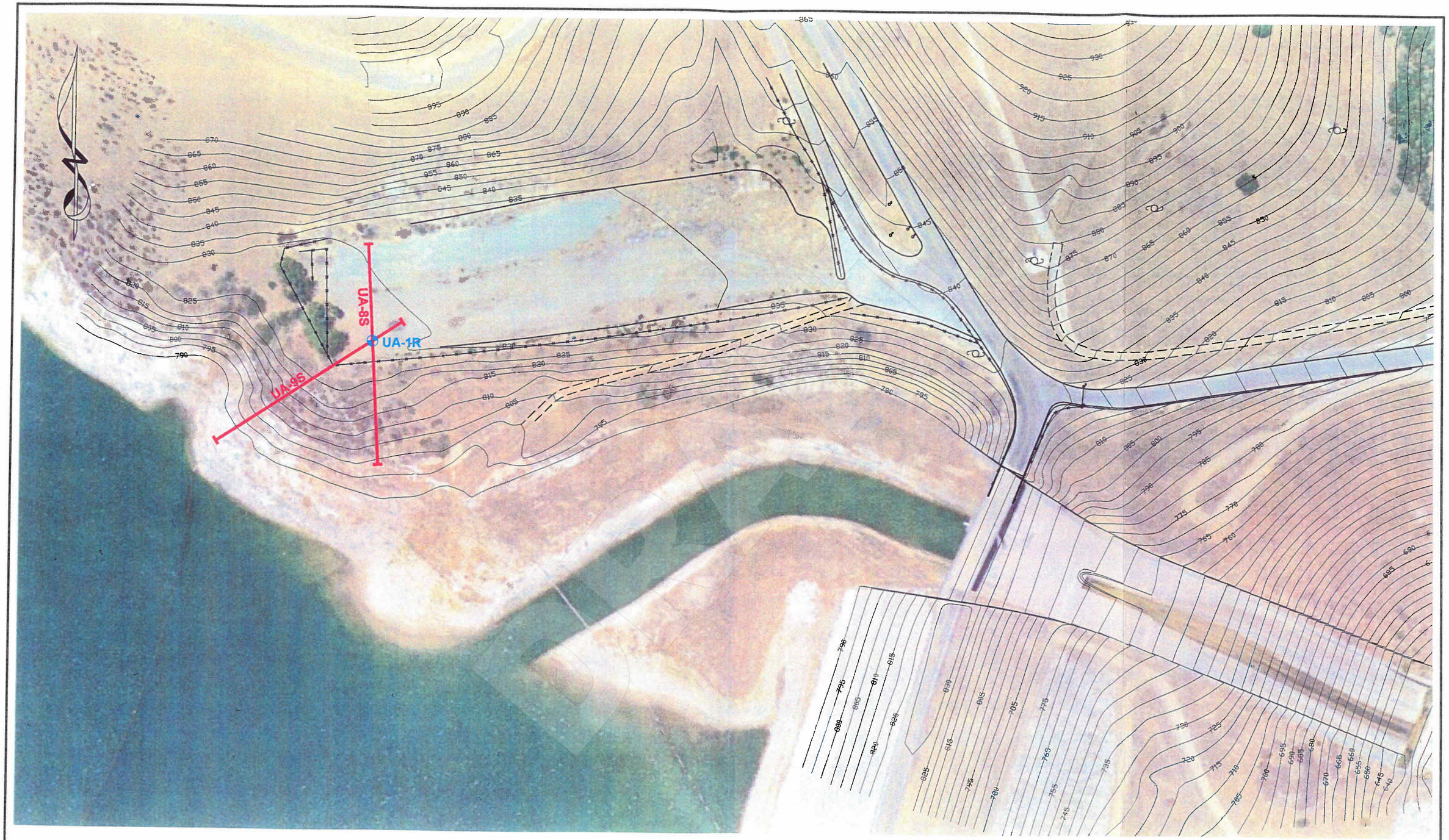
Donald J. Kirker

Donald J. Kirker
Geophysicist, GP-997

DJK/tt

Enclosures: Plates 1 through 8
Appendix A Seismic Refraction Survey

DRAFT



LEGEND	
	SEISMIC REFRACTION PROFILE LOCATION
	BORING

SCALE

0 50 100 200

(1 inch = 100 feet)

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SITE LOCATION MAP
LAKE NACIMIENTO
SEISMIC REFRACTION SURVEY

LOCATION: PASO ROBLES, CALIFORNIA

CLIENT: GEOMATRIX

NORCAL GEOPHYSICAL CONSULTANTS INC.

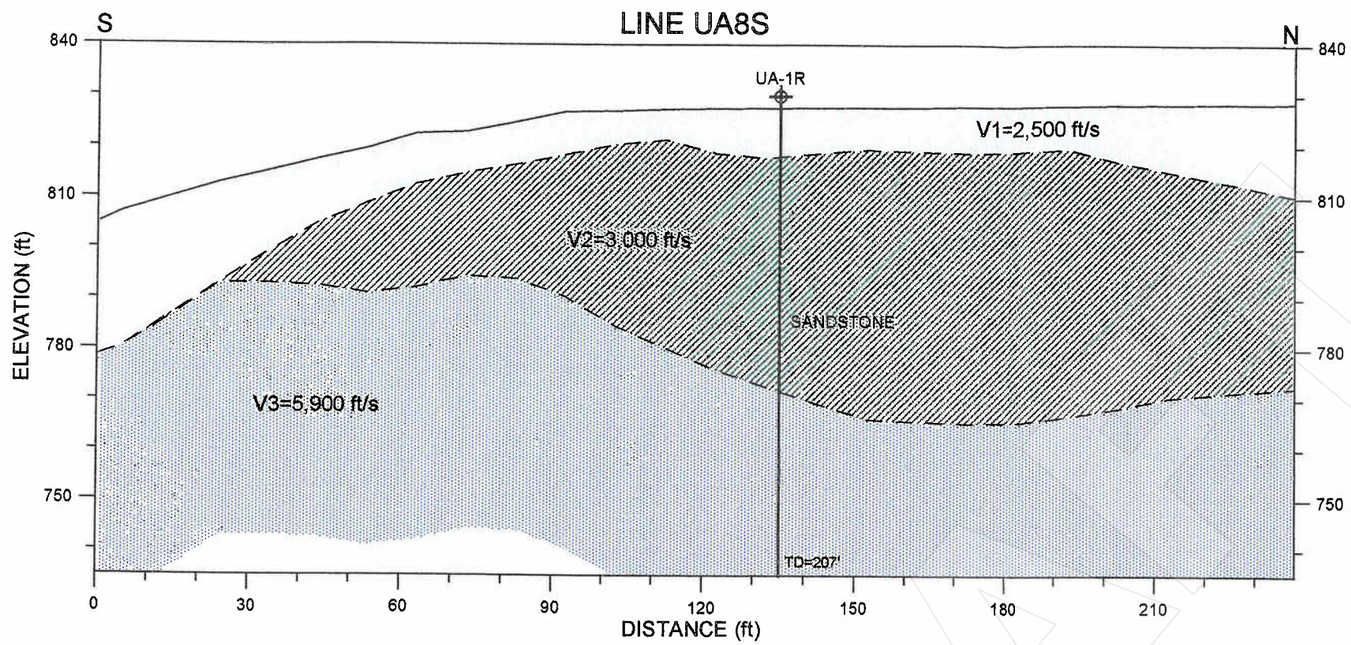
JOB #: 05-325.23B

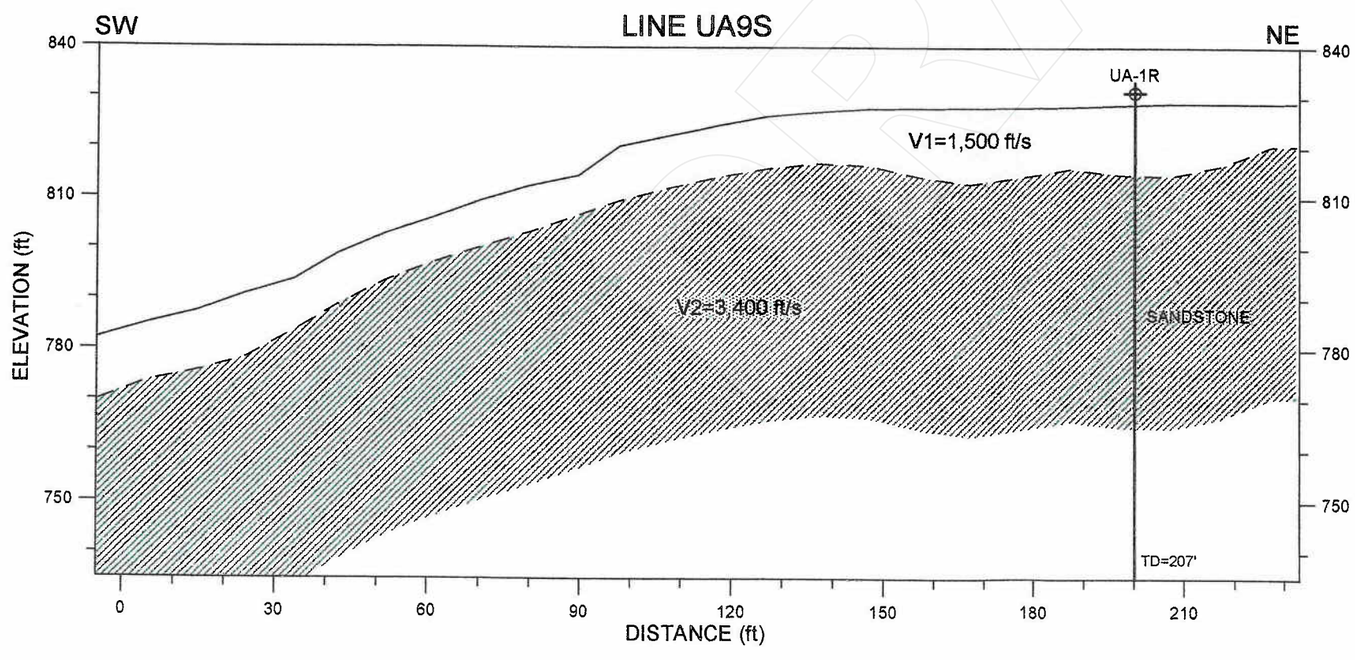
DATE: JAN. 2006

DRAWN BY: G.RANDALL

APPROVED BY: DJK

PLATE 1





LEGEND	
V1=1,000 ft/s	VELOCITY OF LAYER IN FEET PER SECOND
— — —	VELOCITY INTERFACE
UA-1 ⌖	BORING LOCATION

SCALE: 1 INCH = 30 FEET

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SEISMIC REFRACTION PROFILES
LINES UA8S & UA9S
LAKE NACIMIENTO

LOCATION: PASO ROBLES, CALIFORNIA
CLIENT: GEOMATRIX
JOB #: 05-325.23B
NORCAL GEOPHYSICAL CONSULTANTS INC.
DATE: DEC. 2005
DRAWN BY: G. RANDALL
APPROVED BY: DJK

PLATE 5

NORCAL

Appendix A

SEISMIC REFRACTION SURVEY

DRAFT

Appendix A

SEISMIC REFRACTION (SR)

Methodology

The seismic refraction method provides information regarding the seismic velocity structure of the subsurface. An impulsive (mechanical or explosive) source is used to produce compressional (P) wave seismic energy. The P-waves propagate into the earth and are refracted along interfaces caused by an increase in velocity. A portion of the P-wave energy is refracted back to the surface where it is detected by sensors (geophones) that are coupled to the ground surface in a collinear array (spread). The detected signals are recorded on a multi-channel seismograph and are analyzed to determine the shot point-to-geophone travel times. These data can be used along with the corresponding shot point-to-geophone distances to determine the depth, thickness, and velocity of subsurface seismic layers.

The seismic refraction technique is based on several assumptions. Paramount among these are:

1) that seismic velocity increases with depth, and,
2) that the velocity of each seismic layer is uniform over the length of the given spread.

In cases where these assumptions do not hold, the accuracy of the technique decreases. For example, if a low velocity layer occurs between two layers of higher velocity, the low velocity layer will not be detected and the depth to the underlying high velocity layer will be erroneously large. Also, if the velocity of a seismic layer varies laterally within a spread, those variations will be interpreted as fluctuations in the elevation of the underlying seismic layer.

Instrumentation

Data acquisition is initiated along each SR line by producing seismic energy using a mechanical source. Mechanical sources produce energy by impacting a metal strike plate on the ground surface with either a 12-16 pound sledge hammer or an elastic-band driven weight drop. The resulting seismic wave forms are recorded using a Geometrics 24-channel engineering seismograph and Mark Products geophones with a natural frequency of 10 Hz. The data are recorded on hard copy records (seismograms) as well as on computer disks for future processing. The seismograms display the amount of time it takes for a compression (P) wave to travel from a given shot point to each geophone in a spread.

Data Analysis

The seismic data are downloaded to a computer and processed using the program SIPIK by Rimrock Geophysics to determine the shot point to geophone travel times. These values versus the shot point to geophone distances are then plotted to form time versus distance graphs. By fitting straight lines to the data points, the number of seismic velocity layers and the travel times associated with each layer are determined. These values, the travel times, and the location of each

shot point and geophone are then entered into the computer program SIPT2 (also by Rimrock Geophysics). When applicable, the elevation of each shot point and geophone is also entered into this program. Specific elevations (above mean sea level) are determined by topography maps that are typically provided by the client. However, if a topography map is not available, the relative elevation of each shot point and geophone is determined by hand-level techniques and/or a global positioning system (GPS).

SIPT2 uses a variation of the time-delay method to compute a preliminary model listing the depth to each seismic layer beneath each shot point and geophone. The program then uses a ray tracing routine to check the validity of this model and adjust it as necessary to fit the observed data. The final output consists of a cross-section showing the surface topography, the elevation and configuration of the seismic layers, the velocity of each layer, and the locations of the shot points.

Limitations

In general, there are limitations unique to the SR method. These limitations are primarily based on assumptions that are made by the data analysis routine. First, the data analysis routine assumes that the velocities along the length of each spread are uniform. If there are localized zones within each layer where the velocities are higher or lower than indicated, the analysis routine will interpret these zones as changes in the surface topography of the underlying layer. A zone of higher velocity material would be interpreted as a low in the surface of the underlying layer. Zones of lower velocity material would be interpreted as a high in the underlying layer.

Second, the data analysis routine assumes that the velocity of subsurface materials increase with depth. Therefore, if a layer exhibits velocities that are slower than those of the material above it, the slower layer will not be resolved. Also, a velocity layer may simply be too thin to be detected. Due to these and other limitations inherent to the SR method, the results of the SR survey should be considered only as approximations of the subsurface conditions. The actual conditions may vary locally.