State of California The Resources Agency Department of Water Resources DIVISION OF ENGINEERING

North of the Delta Offstream Storage Investigations

SITES RESERVOIR FEASIBILITY STUDY

Materials Investigation, Testing, and Evaluation Program

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#### STATE OF CALIFORNIA Gray Davis, Governor

#### THE RESOURCES AGENCY Mary D. Nichols, Secretary for Resources

#### DEPARTMENT OF WATER RESOURCES Thomas M. Hannigan, Director

Leslie F. Harder, Jr. Acting Deputy Director Steve Macaulay Chief Deputy Director Jonas Minton Deputy Director

L. Lucinda Chipponeri Assistant Director for Legislation Peggy Bernardy Chief Counsel

#### SITES RESERVOIR FEASIBILITY STUDY MATERIALS INVESTIGATION, TESTING, AND EVALUATION PROGRAM

Division of Engineering Leslie F. Harder, Jr. Chief

#### This report was prepared under the direction of

Jeff Patterson	
Ron Lee	Chief, Civil Engineering Branch
Jeanne Schallberger	Acting Chief, Dams and Canals Section

by

Ted CraddockSenior	r Engineer,	W.R.
Matt Parker	. Engineer,	W.R.

#### with assistance by

Annie Whitlatch Bill Forsythe	<b>č</b>
Bill Verigin	
Doug Najima	Water Resources Engineering Associate
Roland Johnson	Water Resources Engineering Associate
Dave Tully	Water Resources Engineering Associate
Koll Buer	
Bruce Ross	Associate Engineering Geologist
Dave Forwalter	

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#### ENGINEERING CERTIFICATION

This report has been prepared under my direction as the professional engineer in direct responsible charge of the work, in accordance with the provisions of the Professional Engineers' Act of the State of California.



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# **1.0 EXECUTIVE SUMMARY**

### 1.1 Objectives

The objectives of the construction materials investigation program were to identify the types of available on-site materials, examine their potential uses, and perform limited testing and evaluation to determine their suitability for use in the dams and appurtenant structures for the Sites Reservoir project. It should be pointed out that the objectives of the materials investigation program were developed using the design principal that available on-site materials dictate the design and selection of the dam sections.

The construction materials investigation program identified the following material types within or near the proposed Sites Reservoir project area:

- Impervious Materials (terrace deposits and recent alluvium)
- Venado Sandstone (fresh and weathered from the Cortina Formation)
- Mudstone (Boxer Formation)

These material types were further investigated, tested, and evaluated to explore their suitability for use as the following types of construction materials:

- Impervious Materials
- Rockfill and Riprap Materials
- Random Materials
- Filter, Drain, and Transition Materials
- Concrete Aggregate

### **1.2 Impervious Material**

A surplus of impervious material exists within or near the Sites Reservoir project. Previous studies by USBR identified four main areas of deposits encompassing roughly 36 million cubic yards of material. Additional impervious materials are located within required excavation areas for the appurtenant structures and Funks Reservoir enlargement.

The proposed impervious materials are classified as low to medium plasticity clays  $(CL)^1$ , with lesser amounts of high plasticity clays (CH) and clayey sands (SC). Dry, moist, and saturated densities were found to be 109 pcf, 127 pcf, and 131 pcf, respectively. Permeability tests indicate the material is very impervious with results on the order of 10<sup>-8</sup> to 10<sup>-9</sup> cm/s. From CUE triaxial testing, total friction angle ( $\phi$ ) was

<sup>&</sup>lt;sup>1</sup> Uniform Soil Classification designation

found to be 14° with a total cohesion (C) of 650 psf. Effective friction angle ( $\phi$ ') was found to be 21.5° with an effective cohesion (C') of 600 psf.

Although only limited testing was performed as part of the feasibility level investigation, testing and evaluation indicate the impervious materials are suitable for use in the proposed embankment dams.

#### 1.3 Rockfill and Riprap Material

The best available source of clean rockfill material within the project area is the fresh Venado sandstone, distinguishable from the weathered Venado sandstone. Four prospective sandstone quarry areas have been identified near the dam sites. Sufficient quantities of Venado sandstone are available in the proposed quarry areas for construction of the embankment sections currently under consideration.

Petrographic examination characterizes the Venado sandstone as an arkosic graywacke with fine to medium grained structure, and comprised mostly of quartz and feldspar. Test results indicate the specific gravity to be approximately 2.5, while absorption results ranged from roughly 3% to 5%. Unconfined compressive strength testing on the fresh Venado sandstone indicates strengths of about 9,600 psi for the dry material and about 7,000 psi for the saturated material. Shear strength estimations indicate a friction angle ( $\phi$ ') of 42°. Dry, moist, and saturated densities were found to be 116 pcf, 122 pcf, and 136 pcf, respectively.

Material testing and evaluation indicate the fresh Venado sandstone to be of sufficient quality for use as clean rockfill and riprap materials. In addition to the testing and evaluation performed as part of this investigation, the suitability of the Venado sandstone is evidenced by its performance at Funks Reservoir's dam. The upstream slope protection on this embankment dam is comprised of the Venado sandstone and has been performing satisfactorily since the mid 1970s. Another indicator of the suitability of the Venado sandstone is a review and comparison of particle breakage of the Venado sandstone and Pyramid Dam argillite during large-scale triaxial testing performed by UC Berkeley in the 1970s. The particle breakage of the sandstone was comparable to the argillite, which has performed satisfactorily as rockfill material in Pyramid Dam, both as riprap and shell material.

### 1.4 Random Material

Random embankment material will be comprised of materials unsuitable for use as clean rockfill. It will consist of weathered sandstone, mudstone, slopewash, etc from excavations for the dam foundations, appurtenant structures, and the rockfill quarries. Abundant quantities of random material are available for construction of Golden Gate, Sites, and the saddle dams. It is anticipated that two general types of random materials will be generated during construction depending upon the source of the material. One type of random material will be comprised of predominantly weathered sandstone from the Cortina Formation, while the other type will be predominantly mudstone from the Boxer Formation. It should be pointed out that the mudstone from excavation of the Boxer Formation will tend to be "soil like", because of its propensity to break down when exposed to air and water, and excavation and compaction operations. The weathered Cortina formation will tend to be a dirty rockfill.

Compressive strength testing indicates the mudstone and weathered sandstone have compressive strengths of approximately 3,500 psi and 5,000 psi, respectively. Warranting special note, the average compressive strength of the mudstone only included one near surface sample, while the majority of the samples were obtained at depth. That near surface sample demonstrated a compressive strength of 1,200 psi, which indicates that the material comprised of mudstone from excavation will be of low strength.

Shear strength estimations indicate an effective friction angle ( $\phi'$ ) of 40° for the material comprised of predominantly weathered sandstone. The material comprised predominantly of mudstone was estimated to have an effective friction angle ( $\phi'$ ) of 35°, a total friction angle ( $\phi$ ) of 15°, and a total cohesion of 600 psf. In-place densities for the random material as a whole were assumed to be equivalent to the rockfill densities. Dry, moist, and saturated densities were estimated to be 116 pcf, 122 pcf, and 136 pcf, respectively.

Since random materials are generally used in portions of the dam embankment where hydraulic conductivity and erosion resistant properties are not a consideration, a comprehensive evaluation of the random material's engineering properties is generally not required. As such, the limited testing and evaluation indicate the random materials are suitable for use in the proposed embankment dams.

### 1.5 Filter, Drain, and Transition Material

Since sufficient deposits of sand and gravel are not available in the project area, crushed Venado sandstone was evaluated for use as filter, drain, and transition materials. Although laboratory testing indicates crushed, fresh Venado sandstone may be suitable as filter, drain, and transition materials, it was not extensively tested as part of the feasibility level investigation since an extensive particle breakage and other evaluation would have been necessary. This particle breakage evaluation would have required test quarries and fills and was considered beyond the scope of this feasibility level investigation. Since the suitability of the Venado sandstone cannot be confirmed at this level of investigation, it is assumed that filter, drain, and transition materials for the embankment dams will be imported from the closest off-site sand and gravel

deposit. This off-site deposit was identified as an old abandoned channel on Stony Creek, between Orland and Willows. It is approximately 35 road miles from the project, and has an estimated material availability of 160 million cubic yards that far exceeds the construction requirement.

Both shear strength and density were estimated from published data. The filter, drain, and transition materials are estimated to have a friction angle ( $\phi$ ') of 42°. Dry, moist, and saturated densities were also estimated at 115 pcf, 121 pcf, and 135 pcf, respectively.

### 1.6 Concrete Aggregate

As discussed in Section 1.5, sufficient deposits of sand and gravel are not available within the project area. Therefore, crushed Venado sandstone was also evaluated for use as concrete aggregate. Sources of sandstone are identical to those identified for use in the rockfill and riprap materials. Also, off-site sand and gravel deposits were identified as alternative material sources as part of the geologic exploration program.

Quality testing was the focus of the concrete aggregate evaluation. Specific gravity was found to be roughly 2.6, while absorption ranged from approximately 2% to 6%. Los Angeles Abrasion losses were about 11% at 100 revolutions and about 47% at 500 revolutions. Clay lumps and friable particles ranged from 1% to 5%. Organic impurities had standard colors of mostly "clear". Bulk density was estimated at roughly 88 pcf.

Since the test results indicate the crushed Venado sandstone only marginally meets the adopted concrete aggregate criteria, the suitability of the sandstone can not be confirmed without additional testing and evaluation considered beyond the scope of the feasibility level investigation. Therefore, it is assumed that concrete aggregate will be imported from the off-site sand and gravel deposit on Stony Creek presented in Section 1.5. As discussed previously, an abundance of material is available from this borrow source.

### 1.7 Summary of Engineering Properties for Stability Analysis

Table A presents a summary of the engineering properties recommended for use in the feasibility level embankment stability analysis.

	Shear Strength Parameters			Density (nof)		f)	
Material	Effe	Effective		Total Density (pc)		Density (pcf)	
	φ' (deg)	C' (psf)	φ (deg)	C (psf)	Dry	Moist	Saturated
Impervious Material	21.5	600	14	650	109	127	131
Random, Predominately Weathered Sandstone	40	0	-	-	116	122	136
Random, Predominately Mudstone	35	0	15	600	116	122	136
Rockfill	42	0	-	-	116	122	136
Filter, Drain, & Transition	42	0	-	-	115	121	135

### Table A - Engineering Properties Recommended for Feasibility Level Embankment Stability Analysis

# 2.0 INTRODUCTION

### 2.1 Sites Reservoir Project

Sites Reservoir is one of several alternative reservoir sites being proposed for offstream storage as part of the North of the Delta Offstream Storage Investigation. The reservoir would be located in Antelope Valley, about ten miles west of Maxwell. Most of the project would lie within northern Colusa County, with portions of the reservoir extending into southern Glenn County.

The reservoir currently under investigation has a storage capacity of 1.9 MAF that would be impounded by a system of embankment dams including two major dams, named Sites and Golden Gate, and nine smaller saddle dams. The dams range in height from 15 to 310 feet. The maximum operating water surface elevation of the reservoir would be 520 feet, which would inundate 14,700 acres. The Sites Reservoir project would also include appurtenant structures such as a: spillway, pumping/generating plant, inlet/outlet works, etc..

### 2.2 Construction Materials

The objectives of this feasibility level investigation, testing, and evaluation program were to identify the availability of soil and rock materials within the project area and assess the suitability of these materials for use in construction of the dams and appurtenant structures. Specifically, the use and engineering properties of the soil and rock materials were sought for the purpose of preparing preliminary dam sections for development of cost estimates.

Objectives of this program were accomplished by investigating, testing, and evaluating the properties of the following material types available within the project area:

- Impervious Materials (terrace deposits and recent alluvium)
- Venado Sandstone (fresh and weathered from the Cortina Formation)
- Mudstone (Boxer Formation)

This report presents a summary and discussion of the materials investigation and laboratory testing performed on embankment materials for the Sites Reservoir project. Engineering properties presented in this report were determined directly from laboratory testing, estimated by empirical relationships, or estimated by reviewing published data. Laboratory testing performed for this investigation included: classification, compaction, in-place density, permeability, CUE triaxial compression, and quality and physical properties testing. Testing by DWR was performed at the Bryte Laboratory in Sacramento.

# 3.0 PREVIOUS STUDIES

Construction materials, for use in embankment dams and levee protection, have been investigated in the Sites and Antelope Valley area since the 1960s. As such, published data and reports were available for research. Previous materials investigations by USBR and USACE were used extensively for comparative purposes in this report. Figure 1 identifies USBR and USACE material investigation areas. Warranting special note are two reports by USBR dated August 1969 and March 1980. These reports summarized reconnaissance investigations of construction materials for the Sites Reservoir project and comprised the majority of comparisons.

A UC Berkeley report published by Becker et. al. (1972) proved to be an invaluable resource for the evaluation of engineering properties and suitability of the Venado sandstone. This report includes extensive shear strength testing of the Venado sandstone along with comparisons to other rockfill materials. Test results from this study were frequently used to assist the current evaluation.

### 4.0 CONSTRUCTION MATERIAL SOURCES

The Sites Reservoir area is on the west side of the Sacramento Valley in the foothills of the Coast Ranges. The area is underlain by Lower and Upper Cretaceous sedimentary rocks of the Great Valley Sequence. The major structural features in the region include the Sites anticline, the Fruto syncline, and the Salt Lake fault. A detailed summary of the site geology and material deposits may be found in Division of Planning and Local Assistance (DPLA) reports, included as references. DPLA figures of site geology are included as Figures 2 through 4, which also identify proposed borrow areas and sample locations for DWR and USBR.

Impervious materials for the embankment dams will be excavated from plentiful borrow deposits located within the proposed reservoir area. This impervious material is comprised of Quaternary terrace deposits and recent alluvium. Previous studies by USBR revealed four major borrow areas upstream of Golden Gate and Sites dam sites. The four areas, designated as Area 1 through Area 4 in Figure 1, were adopted by DWR who then performed similar testing within their boundaries. DWR and USBR sample locations are depicted in Figures 3 and 4. Impervious materials are also located within required excavation areas for the appurtenant structures and Funks Reservoir enlargement.

The highest quality rock available in the project area is the Venado sandstone. The sandstone is a Cretaceous marine sedimentary rock of the Cortina Formation. It is fine to medium-grained and well cemented with a variable color indicative of the state of weathering. Fresh material has a light blue gray appearance, while the weathered material has a brownish color. Collectively, DWR, USBR, and USACE identified six potential Venado sandstone quarry areas (identified in Figure 1). Sufficient quantities of sandstone exist to accommodate project requirements. Incidentally, an operational quarry is located one-quarter mile downstream of the Sites Dam site.

Mudstone, of the Boxer Formation, is a weaker, lower quality rock as compared to the Venado sandstone. Additionally, the mudstone tends to break down when exposed to air and moisture limiting its use within the dam embankments to materials that do not require "free-draining" properties (such as: random materials, semiimpervious materials, etc.). Since numerous borrow areas are available in the reservoir area and significant quantities of mudstone will be generated from required excavation for the dam foundations, its borrow locations were not specifically identified or quantified.

Since sufficient quantities of sand and gravel do not exist in near vicinity of the reservoir area, off-site sources were investigated as an alternative to processing these materials from Venado sandstone. The nearest sand and gravel borrow area was identified as an old abandoned channel on Stony Creek, about 35 road miles from the

project site, between Orland and Willows. Available deposits were estimated at 160 million cubic yards, an abundance of material is available to meet the anticipated construction requirements.

### 5.0 IMPERVIOUS MATERIAL

### 5.1 Introduction

The proposed source of impervious materials for construction of the dam embankments are Quaternary terrace deposits and recent alluvium located within the project area. These materials are characterized as predominantly low to medium plasticity clays (CL), with some high plasticity clays (CH) and clayey sands (SC).

Exploration by USBR was performed in the valleys upstream of the two main dam sites in four areas, labeled as Areas 1, 2, 3, and 4 (Figure 1). These four areas contain an estimated 36 million cubic yards of impervious material with 4 million cubic yards and 3 million cubic yards of material located within 1 mile of the Golden Gate and Sites Dam sites, respectively. In addition to the four borrow areas within the reservoir, impervious materials are also located within required excavation areas for the appurtenant structures and Funks Reservoir enlargement. These required excavation areas would be utilized until exhausted.

Exploration and sampling was performed by DWR and USBR at test pits and auger holes located throughout the four areas to determine the extent and suitability of the proposed impervious materials (Figure 3 and Figure 4). Additional exploration and sampling was performed by DWR at sites located upstream of Funks Reservoir within the proposed excavation area for enlarging the reservoir. DWR sample locations are denoted by FR, GG and SC, while USBR used AP and TP to designate their sample locations. Table 1 describes the various sample locations.

Sample	Sampling	Description	Sample
Designation	Agency		Туре
FR-Aug 7 through FR-Aug 9	DWR	FR = Funks Reservoir	Auger Hole
GG-1 through GG-8	DWR	GG = Golden Gate Dam site	Test Pit
SC -1 through SC-10	DWR	SC = Sites/Colusa Dam site	Test Pit
AP	USBR	AP = auger hole	Auger Hole
TP-1 and TP-2	USBR	TP = test pit	Test Pit

Table 1 – Impervious Material Sample Locations

DWR sample locations were selected to characterize the impervious materials available within the project area. The sample locations within the reservoir were selected to compliment and confirm the exploration and testing performed previously by USBR. DWR bag samples were obtained at various depths within the test pits corresponding to visual identification of different material types. Classification testing was performed on all DWR bag samples. In addition, composite samples were prepared from the bag samples in order to perform density, permeability, and shear strength testing on samples representative of the materials within the proposed borrow areas upstream of Golden Gate and Sites Dam. The composite samples were composed of equal portions of material from test pits GG-1 through GG-8 and SC-4 through SC-10, excluding the approximate 10% finest and 10% coarsest samples. The composition of the composite samples is included in Appendix A.

### 5.2 Classification

The following test procedures were used by DWR to classify the proposed impervious material:

- Particle-Size Analysis of Soils (ASTM D 422)
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D 4318)
- Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D 2487)

In addition to classification testing, the following test procedures were used by DWR to provide additional characterization of the proposed impervious materials:

- Specific Gravity of Soil Solids by Water Pycnometer (ASTM D 854)
- Moisture, Ash, and Organic Matter of Peat and Other Organic Soils (ASTM D 2974)

Test procedures used by USBR were not indicated. However, test results are presented on USBR standard forms, and test procedures were probably performed in accordance with USBR standard test designations.

Classification testing was performed on all DWR samples. Table 2 presents the classification summary, and the detailed test results are included in Appendix B. Collectively, testing performed by DWR indicate that the proposed impervious materials are predominantly low to medium plasticity clays (CL), with some high plasticity clays (CH) and clayey sands (SC). More precisely, the low to medium plasticity clays were comprised of lean clay, lean clay with sand, and sandy lean clay. Fat clay and fat clay with sand made up the high plasticity clays.

Golden Gate Sample Locations					
Group	Group Number of Percentage				
Symbol	Name	Samples	of Total		
CL	Lean Clay	6	32		
CL	Lean Clay with Sand	8	42		
CL	Sandy Lean Clay	2	11		
СН	Fat Clay	2	11		
CH	Fat Clay with Sand	1	5		
	Total	19	100		
	Sites Sample Locatio				
Group	Group	Number of	Percentage		
Symbol	Name	Samples	of Total		
CL	Lean Clay	5	21		
CL	Lean Clay with Sand	5	21		
CL	Sandy Lean Clay	4	17		
CH	Fat Clay	6	25		
CH	Fat Clay with Sand	2	8		
SC	Clayey Sand	1	4		
SC	Clayey Sand with Gravel	1	4		
	Total	24	100		
	Funks Reservoir Sample Lo				
Group	Group	Number of	Percentage		
Symbol	Name	Samples	of Total		
CL	Lean Clay	1	17		
CL	Lean Clay with Sand	3	50		
CL	Sandy Lean Clay	1	17		
SC	Clayey Sand	1	17		
	Total	6	100		

### Table 2 – Classification Summary for Impervious Material

Testing performed by USBR indicate comparable material classifications. For reference, USBR test results are also summarized in Table 3, and detailed test results are included in Appendix C.

USBR Samples Collected Near DWR Sites Sample Locations					
Group	Group	Number of	Percentage		
Symbol	Name	Samples	of Total		
CL	Lean Clay with Sand	3	60		
CL	Sandy Lean Clay	1	20		
SC	Clayey Sand with Gravel	1	20		
	Total	5	100		
USBR	Samples Collected Near DWR	Golden Gate Samp	le Locations		
Group	Group	Number of	Percentage		
Symbol	Name	Samples	of Total		
CL	Lean Clay	2	18		
CL	Lean Clay with Sand	6	55		
CL-ML	Sandy Silty Clay	2	18		
CL-ML SM	Sandy Silty Clay Silty Sand with Gravel	2	18 9		

#### Table 3 – Classification Summary of USBR Samples

Figure 5 presents gradation curves for the DWR samples obtained upstream of the Golden Gate Dam site. As shown, the samples are similarly graded with the exception of samples obtained from test pits GG-3 and GG-5 at depths of 10 and 15 feet, respectively. Sandy lean clay was encountered within both test pits which may be the result of their close proximity to Funks Creek. With the exception of the coarser samples obtained from test pits GG-3 and GG-5, the percent passing the No. 4 and No. 200 sieves varied from 98 to 100 percent and 77 to 91 percent, respectively. Testing performed by USBR indicates comparable material gradations and is presented in Appendix C for reference.

Figure 6 presents gradation curves for the DWR samples obtained upstream of the Sites Dam site. Again, the samples are similarly graded with the exception of a few test pits. Test pits SC-2.1, SC-6.3, SC-8.2, SC-8.3 and SC-10.3 all encountered sandy coarser materials probably resulting from their close proximity to neighboring creeks. With the exception of the coarser samples obtained from the previously mentioned test pits, the percent passing the No. 4 and No. 200 sieves varied from 98 to 100 percent and 70 to 97 percent, respectively. Testing performed by USBR indicates comparable material gradations and is presented in Appendix C for reference.

Figure 7 presents gradation curves for the DWR samples obtained upstream of Funks Reservoir. Test pit FR-Aug-7.2 is the only outlier curve, encountering clayey sand at a depth range of 15 to 25 feet. With the exception of the coarser sample obtained from test pit FR-Aug-7.2, the percent passing the No.4 and No. 200 sieves varied from 97 to 99 percent and 68 to 86 percent, respectively. USBR did not perform sampling upstream of Funks Reservoir.

Figure 8 presents a plot of the Atterberg Limits for the samples collected upstream of the Golden Gate Dam site. The Plasticity Index of the samples ranged from a low of 12 to a high of 42. The Liquid Limit of the samples ranged from a low of 30 to a high of 59. The average Liquid Limit and Plasticity Index of the samples was 39 and 22, respectively. For comparison purposes, neighboring USBR samples had an average Liquid Limit and Plasticity Index of 34 and 15, respectively.

Figure 9 presents a plot of the Atterberg Limits for the samples collected upstream of the Sites Dam site. The Plasticity Index of the samples ranged from a low of 17 to a high of 51. The Liquid Limit of the samples ranged from a low of 34 to a high of 72. The average Liquid Limit and Plasticity Index of the samples was 46 and 30, respectively. For comparison purposes, neighboring USBR samples had an average Liquid Limit and Plasticity Index of 36 and 17, respectively.

Figure 10 presents a plot of the Atterberg Limits for the samples collected upstream of Funks Reservoir. The Plasticity Index of the samples ranged from a low of 13 to a high of 25. The Liquid Limit of the samples ranged from a low of 29 to a high of 41. The average Liquid Limit and Plasticity Index of the samples was 38 and 21, respectively. Comparisons to USBR Atterberg Limits were not made because USBR did not sample upstream of Funks Reservoir.

Specific gravity testing was performed on a limited number of DWR samples, including the composite samples. Table 4 presents a summary of the DWR specific gravity test results. USBR test results are not presented in Table 4 since specific gravity testing was performed on numerous samples. However, detailed test results for both DWR and USBR specific gravity tests are included in Appendix B and Appendix C, respectively. Specific gravity values for DWR and USBR samples ranged from 2.74 to 2.80 and 2.59 to 2.74, respectively.

Sample Location	Specific Gravity	
SC-1.1	2.78	
SC-1.2	2.79	
GG-1.1	2.78	
GG-1.2	2.80	
GG-Composite	2.74	
SC-Composite	2.74	

Table 4 – Impervious Material Specific Gravity Summary

Organic content testing was also performed on a limited number of DWR samples, including the composite samples. The organic content of the samples ranged from 3.6 to 7.2 percent. Table 5 presents a summary of the DWR organic content test results.

Lab No.	Sample Location	Sample Depth (ft)	Group Symbol	Organic Content (%)
-		,	2	. ,
98-167	GG-1.1	5	CL	4.0
98-168	GG-1.2	10	CL	5.1
98-169	GG-1.3	15	CL	5.0
98-170	GG-2.1	4	CL	3.8
98-171	GG-2.2	10	CL	4.0
98-172	GG-2.3	14	СН	7.2
98-173	GG-2.4	*	CL	6.1
98-157	SC-1.1	**	CL	4.7
98-158	SC-1.2	**	CL	3.6
98-159	SC-2.1	**	CL	3.7
98-160	SC-2.2	**	CL	4.4
98-161	SC-3.1	**	СН	4.9
98-162	SC-3.2	**	СН	5.0
99-1419	GG-Composite	N/A	CL	3.9
99-1420	SC-Composite	N/A	CL	4.2

#### Table 5 – Impervious Material Organic Content

Notes:

\* Depth of sample GG-2.4 is unknown.

\*\* Depths of SC samples are unknown. Samples taken from stream banks.

### 5.3 Density

Compaction testing was performed by DWR on the two composite samples to characterize the moisture-density relationship of the impervious materials. The test procedure used was ASTM D 1557, Laboratory Compaction Characteristics of Soil (modified to a compactive effort of 20,000 ft-lbs./ft<sup>3</sup>). Compaction curves for the two composite samples can be found in Figures 11 and 12. Table 6 summarizes the compaction test results. As shown, the maximum dry density and optimum water content of the composite samples ranged from 110.0 to 111.8 pcf and 17.0 to 17.4%, respectively.

Table 6 –	Comp	paction	Test	Results
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Sample Classification - Location Group Symbol		Plasticity	Maximum Dry	Optimum Water Content (%)	
		Index	Density (pcf)		
GG-Composite	CL	22	111.8	17.4	
SC-Composite	CL	30	110.0	17.0	

Based upon the compaction testing performed on the composite samples, the following densities are recommended for use in feasibility level stability analysis: Dry Density = 109 pcf; Moist Density = 127 pcf; and Saturated Density = 131 pcf. The recommended values represent an estimation of anticipated in-place densities for

compacted impervious materials using an average of the composite sample compaction test results and assuming 98% compaction at or near the optimum water content.

Compaction testing was also performed by USBR and the detailed test data sheets are included in Appendix C for reference. A summary of the USBR test results is not included for comparison, since the USBR data sheets do not indicate the compactive effort used during testing. However, the average maximum dry density and optimum water content of the USBR samples is comparable to the DWR test results indicating that a modified compactive effort of 20,000 ft-lbs./ft<sup>3</sup> may have been used during USBR testing. The average maximum dry density and optimum water content of the USBR maximum dry density and optimum water content of the USBR testing. The average maximum dry density and optimum water content of the USBR testing.

### 5.4 Permeability

Permeability testing was also performed on the composite samples. Testing was performed in accordance with ASTM D 5084, Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter, Falling Head Test. The permeability tests were performed on the composite samples prepared for CUE triaxial testing. These samples were compacted to approximately 98% of the maximum dry density at or near the optimum water content. Table 7 summarizes the test results, and detailed test results can be found in Appendix D.

Sample Description	Average Permeability (cm/s)	
GG-Composite	1.0 x 10 <sup>-8</sup>	
SC-Composite	2.7 x 10 <sup>-9</sup>	

USBR's Earth Manual lists a range of permeability for this type of material as 10<sup>-5</sup> to 10<sup>-8</sup> cm/s. This indicates the tested samples are on the lower end of the permeability range, indicating the soil is very impervious. It should be noted, however, that lab technicians encountered some difficulty performing tests due to the low permeability of the impervious material.

# 5.5 Shear Strength

Consolidated undrained (CUE) triaxial testing was performed on the composite samples to determine and evaluate the shear strength and stress-strain characteristics of the proposed impervious material. The CUE testing was performed in accordance with ASTM D 4767, Standard Test Method for Consolidated Undrained Triaxial Compression Test on Cohesive Soils. Initial effective confining stresses, sample

densities, and moisture contents were selected to approximate expected field conditions. Initial effective confining stresses were selected to range between 0.4 tsf and 12 tsf with the samples compacted to approximately 98% of the maximum dry density at or near the optimum water content.

Figures 13 through 18 present plots of deviator stress, effective stress ratio, and pore pressure versus strain. These plots were used to develop the failure envelopes (Figures 19 and 20). In addition, the detailed CUE test results are included in Appendix E. The failure criterion used to develop the total and effective stress envelopes are listed below:

•	Total Stress Failure Criteria	<ul> <li>Failure assumed to occur at either the maximum deviator stress or 10 percent strain, whichever occurred first.</li> </ul>
•	Effective Stress Failure Criteria	<ul> <li>Failure assumed to occur at either the maximum effective stress ratio or 5 percent strain, whichever occurred first.</li> </ul>

Table 8 illustrates the shear strength parameters estimated from the CUE testing.

Sample Location	φ	С	φ'	C'
GG-Composite	14.5°	800 psf	23°	700 psf
SC-Composite	13.5°	500 psf	20°	500 psf

Table 8 – Estimated Shear Strength Parameters

Results of the CUE testing for the two composite materials were averaged to provide an estimate of the shear strength parameters for use in the feasibility level stability analysis. Recommended shear strength parameters are: Total Friction Angle ( $\phi$ ) = 14°; Total Cohesion (C) = 650 psf; Effective Friction Angle ( $\phi$ ') = 21.5°; and Effective Cohesion (C') = 600 psf.

By comparison, USBR's Earth Manual lists an average effective friction angle and effective cohesion of 28° and 300 psf, respectively for this type of material. These published average values differ from the shear strength parameters estimated from the testing performed on the composite samples. The limited triaxial testing performed on the impervious materials and difference from average published values indicates the need for additional shear strength testing and evaluation of the impervious materials as part of future design studies.

Another emphasis of the CUE triaxial testing was to evaluate the material's stress-strain behavior. As shown in Figure 13 through Figure 18, plots of the deviator

stress, effective stress ratio, and pore pressure versus strain generally do not exhibit any substantial loss of strength after reaching peak values. The only exception to this is for the effective stress ratio plots for the samples tested at the lowest confining stresses of 1.1 tsf (Figure 14) and 0.4 tsf (Figure 17). These curves may indicate possible testing errors related to the use of relatively low confining stresses on the low permeability material. Excluding these exceptions, the plotted stress-strain curves are similar at different confining pressures and show a generally smooth, plateauing behavior indicating ductile, non-brittle behavior of the impervious material.

### 5.6 Conclusions and Recommendations

Materials testing and evaluation indicate the impervious materials available within the project area are suitable for use in embankment dams. Sufficient quantities of impervious material exist upstream of the dam sites. Approximately 36 million cubic yards of material are available from the deposits within the reservoir area. This is roughly four times the volume required for construction of Golden Gate Dam, Sites Dam, and the nine saddle dams. Additional impervious materials are also available within the required excavation areas for the appurtenant structures and Funks Reservoir enlargement.

Preliminary and final design programs should include further exploration, testing, and evaluation of the impervious materials. This additional investigation should focus on:

- Identification of specific borrow areas within near vicinity of dams in conjunction with constructability review of the project. The selection of impervious borrow areas should be located to minimize the amount of high plasticity lean clays and fat clays utilized within the dam embankments. Additional sampling and testing should be performed to define the limits of the borrow areas to minimize use of these materials.
- Quantification of available materials within these borrow areas to assist development of the optimum dam section. This should include additional exploration to determine the anticipated in-place density and moisture conditions of impervious material within the borrow areas to assist development of borrow quantity estimates.
- Perform additional exploration, sampling, testing, and evaluation of the impervious materials within the specific borrow areas. Additional testing should include expanded evaluation of the moisture-density relationship, permeability, consolidation, and shear strength properties of the impervious materials due to the limited testing performed as part of this feasibility level investigation. Specifically, the moisture-density relationship of the impervious materials should be examined further to ensure that specified moisture and compaction requirements produce a material with desirable placement,

moisture, and compaction characteristics. Shear strength and permeability testing should be performed concurrently with the moisture-density evaluation to ensure selection of engineering properties corresponding to anticipated inplace density and moisture conditions within the dam embankment. Consolidation testing should be performed to estimate the amount of consolidation or settlement expected to occur during construction. In addition, the significance of organic content and plasticity of the impervious materials should be evaluated further to assist development of specification limits.

# 6.0 ROCKFILL AND RIPRAP MATERIAL

### 6.1 Introduction

The best available source of clean rockfill and riprap material within the project area is the fresh Venado sandstone (Figure 21). The sandstone is a Cretaceous marine sedimentary rock, fine-to medium-grained, and well cemented with a variable color that is indicative of the state of weathering. The fresh material has a light blue gray appearance, and the weathered material has a brownish color. The Venado sandstone was the only rock type considered for clean rockfill and riprap. Sandstone-withinterbedded-mudstone and mudstone were not considered for rockfill and riprap since the mudstone breaks down when exposed to air and moisture and would not meet "freedraining" requirements for upstream shell material.

There are four proposed sources of the Venado sandstone for construction of the main dam embankments: two located near the Golden Gate Dam site, one near the Sites Dam site, and one near the Saddle Dam sites (Figure 22). A ridge north of the proposed Golden Gate Dam alignment constitutes the Golden Gate Dam rockfill source. The Sites Dam rockfill source is located just north of the existing Sites quarry, outside the proposed reservoir area. The proposed rockfill source for construction of the saddle dams is outside the proposed reservoir area on Logan Ridge centrally located near the saddle dam sites. The proposed quarry areas contain more than enough sandstone to satisfy the required rockfill quantities for the embankment dams.

Based upon field inspections, the proposed Golden Gate Dam rockfill source within the reservoir area is likely to produce more waste material and require more processing than adjacent quarry locations outside of the reservoir area. Therefore, future design investigations should include an evaluation of quarry locations outside of the reservoir area to identify the quarry that will produce the highest quality and yield of rockfill materials.

DWR samples of the Venado sandstone were obtained from the Sites Quarry and exploration holes. Fresh and moderately weathered samples were collected to characterize properties of sandstone with different degrees of weathering. The following types of samples were obtained for laboratory testing:

- 2.5-inch x 5-inch x 5-inch cubes from Sites Quarry
- 3-inch cube samples from Sites Quarry
- 6-inch diameter x 12-inch long cores from Sites Quarry
- 1<sup>1</sup>/<sub>2</sub>-inch minus crushed sandstone from Sites Quarry
- crushed sandstone from drill cores
- 2.5-inch diameter drill core samples from geologic exploration

USACE also performed limited testing on the sandstone sampled from the active Sites Quarry and the abandoned Sites Quarry south of the active quarry to determine the adequacy of the sandstone for use as riverbank slope protection. In USACE documents the active quarry is referred to as the: Old Sites Quarry, Sites Quarry (Cron), and Sites Quarry North; whereas the abandoned quarry is referred to as the Sites Quarry South and Sites Quarry (Welch). In this report, the active and abandoned quarries will be referred to as the Sites Quarry and Sites Quarry (south), respectively.

### 6.2 Petrography

Petrographic examinations of weathered and fresh samples of Venado sandstone were performed in 1962 and 1972 by USACE. The examinations did not reveal any significant defects and generally characterized the sandstone as an argillaceous, arkosic graywacke with fine to medium grained structure, few fractures, and comprised primarily of quartz and feldspar with a lesser percentage of biotite, chlorite, and clay. The Venado sandstone has a variable color indicative of the state of weathering. The fresh material has a light blue gray appearance, and the weathered material has a brownish color. The USACE petrographic examination reports are included for reference in Appendix G.

### 6.3 Quality

Laboratory testing was performed on a variety of samples obtained by DWR to provide a quantitative characterization of the quality of Venado sandstone for use as rockfill and riprap. This section summarizes the testing performed by DWR, provides a comparison to testing performed by USACE, and presents an evaluation of the Venado sandstone quality based upon a review of the test results and a comparison to published acceptable limits criteria. The following test procedures were used to characterize the Venado sandstone quality:

- Specific Gravity and Absorption of Coarse Aggregate (ASTM C 127)
- Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine (ASTM C 131)
- Evaluation of Durability of Rock for Erosion Control under Wetting and Drying Conditions (ASTM D 5313)

### 3-inch Cube Samples

Specific gravity and absorption testing were performed on the 3-inch cube samples of fresh sandstone from Sites Quarry. A summary of the test results is presented in Table 9. As shown, the average specific gravity and absorption are 2.48 and 2.6, respectively. Specific gravity values ranged from a low of 2.45 to a high of 2.52. Similarly, absorption percentages ranged from 2.3% to 3.0%. Detailed test results are included in Appendix F.

Lab No.	Slab No.	Specimen	Specific Gravity	Percent Absorption
98-174	SSQ-1	A	2.50	2.6
"	"	В	2.48	2.6
"	"	С	2.48	2.8
98-175	SSQ-2	A	2.50	2.5
"	"	В	2.50	2.5
"	"	С	2.49	2.6
98-176	SSQ-3	A	*	*
"	"	В	*	*
"	"	С	*	*
98-177	SSQ-4	A	2.50	2.4
"	"	В	2.50	2.5
"	"	С	**	**
98-178	SSQ-5	A	2.46	3.0
"	"	В	2.45	2.8
"	"	С	2.45	2.8
98-179	SSQ-6	A	2.45	2.8
"	"	В	2.45	2.9
"	"	С	2.45	2.9
98-180	SSQ-7	A	2.52	2.5
"	"	В	2.51	2.3
"	"	С	2.50	2.7
98-181	SSQ-8	A	2.48	2.3
"	"	В	2.49	2.5
"	"	С	2.49	2.4
98-182	SSQ-9	А	2.49	2.8
"	"	В	2.49	2.6
"	"	С	2.48	2.6
98-183	SSQ-10	A	2.45	2.8
"	"	В	2.46	2.7
"	"	С	2.46	2.7
		Average	2.48	2.6

### Table 9 – Specific Gravity and Absorption Test Results for 3-inch Cubes

Notes:

\* Unable to obtain cube samples. Slab was fractured and uneven.

\*\* Only able to secure two cube specimens from slab.

#### Crushed Sandstone from Drill Cores

Specific gravity, absorption, and Los Angeles abrasion testing was performed on a sample of crushed fresh sandstone from exploration drill cores. Testing indicated a specific gravity of 2.48, absorption of 4.2%, and Los Angeles abrasion losses of 11.4% and 43.4% after 100 revolutions and 500 revolutions, respectively. Detailed test results are included in Appendix F.

### 11/2-Minus Crushed Sandstone from Sites Quarry

The 1½-inch minus samples were prepared with random sandstone waste cobbles from the Sites Quarry operator's debris piles. Samples were segregated into fresh and moderately weathered sandstone lots, and transported for crushing to Valley Rock Products in Orland. A rock crusher processed the samples until material passed a 1-inch screen. Approximately two cubic yards of each the fresh and moderately weathered material passing the 1-inch screen, including fines, were transported to the DWR Bryte Lab in Sacramento for testing.

Specific gravity, absorption, and Los Angeles abrasion testing were performed on the 1½-inch minus samples of crushed fresh and moderately weathered sandstone from Sites Quarry. A summary of the test results is presented in Table 10. As shown, the average specific gravity values vary little between the fresh and moderately weathered samples at 2.48 and 2.46, respectively. However, there is a slight difference between the fresh and moderately weathered absorption values of 5.1% and 6.1%, respectively. Similar differences are noted when comparing the Los Angeles Abrasion values for the fresh and moderately weathered sandstone at 100 and 500 revolutions. The fresh sandstone had average losses of 10.1% and 45.7% for the 100 revolutions and 500 revolutions, respectively, while the moderately weathered sandstone had corresponding average losses of 11.8% and 51.3%. Detailed test results are included in Appendix F.

Table 10 – Specific Gravity, Absorption, and Los Angeles Abrasion Test Results for
1 <sup>1</sup> / <sub>2</sub> -Inch Minus Crushed Sandstone from Sites Quarry

				Los Angele	s Abrasion		
				100 Rev.	500 Rev.		
Lab No.	Specimen	Specific Gravity	Percent Absorption	(% loss)	(% loss)		
		F	resh				
99C-113	А	2.48	4.9	11.4	50.8		
99C-113	В	2.49	5.0	7.3	36.9		
99C-113	С	2.48	5.4	11.5	49.5		
	Average	2.48	5.1	10.1	45.7		
		Moderate	y Weathered				
000 444	•			40.7	50		
99C-114	A	2.45	6.2	13.7	56		
99C-114	В	2.46	6.0	9.2	43.5		
99C-114	С	2.46	6.0	12.5	54.5		
	Average	2.46	6.1	11.8	51.3		

### 2.5-Inch x 5-Inch x 5-Inch Cubes

Fresh and moderately weathered 2.5-inch x 5-inch x 5-inch cubes from Sites Quarry were tested for specific gravity, absorption, and percent loss due to 45 wetting-

drying cycles. The results are presented in Table 11. Slight differences are noticed between the fresh and moderately weathered average values. The fresh sandstone had an average specific gravity of 2.49, while the moderately weathered value was 2.43. Average percent absorption for the fresh and moderately weathered materials were 3.3% and 4.7%, respectively. Wetting-drying test results were similar for both the fresh and the moderately weathered sandstone at 0.5% loss and 0.6% loss, respectively. It should be noted that neither the fresh nor the moderately weathered samples exhibited scaling, flaking, cracking, or slabbing during any part of the wetting-drying testing. Detailed test results are included in Appendix F.

			Γ	Wetting-Drying					
Lab No.	Specimen	Specific Gravity	Percent Absorption	(% loss)					
Fresh									
99C-80	А	2.50	3.2	0.5					
99C-80	В	2.49	3.3	0.5					
99C-80	С	2.49	3.3	0.5					
	Average	2.49	3.3	0.5					
		Moderately	Weathered						
99C- 79	A	2.43	4.7	0.6					
99C- 79	В	2.42	4.7	0.6					
99C-79	С	2.43	4.7	0.5					
	Average	2.43	4.7	0.6					

#### Table 11 – Specific Gravity, Absorption, and Wetting-Drying Test Results for 2.5-Inch x 5-Inch x 5-Inch Cubes

### 2.5-Inch Diameter Drill Cores from Geologic Exploration

Fresh and weathered 2.5-inch diameter drill cores from geologic exploration were tested for specific gravity and absorption. The results are presented in Table 12. As shown, the specific gravity and absorption for the fresh sandstone had an average of 2.50 and 2.9%, respectively, while the weathered sandstone had average values of 2.52 and 3.6%. Specific gravity values ranged from a low of 2.33 to a high of 2.66. Similarly, absorption percentages ranged from 0.5% to 5.4%. Detailed test results are included in Appendix F.

Lab No.	Drill Hole	Start Depth (ft)	End Depth (ft)	Condition	Specific Gravity	Absorption (%)
2001-28A	GGC-LA1	75.8	77.3	Fresh	2.56	2.9
2001-28B	GGC-LA1	75.8	77.3	Fresh	2.56	2.9
2001-28C	GGC-LA1	75.8	77.3	Fresh	2.57	2.8
2001-30A	GGC-RC1	56.0	57.0	Fresh	2.49	2.9
2001-30B	GGC-RC1	56.0	57.0	Fresh	2.50	2.8
2001-33A	GGC-RC2	70.8	71.9	Fresh	2.53	2.8
2001-33B	GGC-RC2	70.8	71.9	Fresh	2.52	3.1
2001-33C	GGC-RC2	70.8	71.9	Fresh	2.55	3.0
2001-34A	GGC-RA1	59.9	61.0	Fresh	2.53	2.6
2001-34B	GGC-RA1	59.9	61.0	Fresh	2.55	2.6
2001-34C	GGC-RA1	59.9	61.0	Fresh	2.56	2.6
2001-34D	GGC-RA1	59.9	61.0	Fresh	2.56	2.8
2001-36A	GO-DHS-3	45.0	46.0	Fresh	2.48	2.3
2001-36B	GO-DHS-3	45.0	46.0	Fresh	2.48	2.2
2001-41A	GO-DHT3	71.0	72.2	Fresh	2.48	4.2
2001-41B	GO-DHT3	71.0	72.2	Fresh	2.43	3.3
2001-41C	GO-DHT3	71.0	72.2	Fresh	2.42	3.3
2001-43A	GO-DHT3	272.0	273.0	Fresh	2.45	3.7
2001-43B	GO-DHT3	272.0	273.0	Fresh	2.44	3.9
2001-43C	GO-DHT3	272.0	273.0	Fresh	2.44	3.5
2001-43D	GO-DHT3	272.0	273.0	Fresh	2.43	3.9
2001-52C	GGO-DHS4	56.0	57.0	Fresh	2.66	0.8
2001-56B	GGO-DHT1	176.0	177.2	Fresh	2.66	0.5
2001-57A	GGO-DHT3	316.3	317.7	Fresh	2.33	4.4
2001-57B	GGO-DHT3	316.3	317.7	Fresh	2.42	3.4
2001-57C	GGO-DHT3	316.3	317.7	Fresh	2.43	3.4
2001-57D	GGO-DHT3	316.3	317.7	Fresh	2.44	3.6
2001-57E	GGO-DHT3	316.3	317.7	Fresh	2.46	3.7
2001-58A	GGO-DHT3	327.7	329.0	Fresh	2.49	2.0
2001-60A	GGO-DHT4	124.5	125.5	Fresh	2.50	2.7
2001-60B	GGO-DHT4	124.5	125.5	Fresh	2.59	1.5
2001-61A	GGO-DHT5	430.5	432.0	Fresh	2.49	3.3
2001-61B	GGO-DHT5	430.5	432.0	Fresh	2.53	2.5
2001-61C	GGO-DHT5	430.5	432.0	Fresh	2.54	2.9
2001-61D	GGO-DHT5	430.5	432.0	Fresh	2.52	2.1
1999C-84A	GGLA-1	27.8	28.4	Weathered	2.52	3.7
1999C-84B	GGLA-1	27.8	28.4	Weathered	2.50	3.8
1999C-88	GGLC-1	35.6	36.3	Weathered	2.66	1.5
1999C-90	GGRA-1	16.2	17.2	Weathered	2.41	5.4
1999C-91	GGRA-1	51.0	52.3	Fresh	2.47	3.7
1999C-92A	GGRA-1	53.4	54.2	Fresh	2.50	3.5
1999C-92B	GGRA-1	53.4	54.2	Fresh	2.50	3.4
			-	sh Sandstone =		2.9
		Average	e for Weathere	ed Sandstone =	2.52	3.6

Table 12 – Specific Gravity and Absorption Test Results for 2.5-Inch Diameter Drill Cores from Geologic Exploration

### **USACE Quality Testing**

USACE performed similar quality testing on the Venado sandstone from Sites Quarry and Sites Quarry (south) in the early 1960s and 1970s. For comparison purposes, Table 13 through Table 16 present the USACE test results.

#### Sites Quarry (USACE, 1962)

Specific gravity, absorption, Los Angeles abrasion, and wetting-drying tests were performed by USACE on samples of fresh and weathered Venado sandstone obtained from Sites Quarry in 1962. As shown in Table 13, average specific gravity values for the fresh and weathered sandstone were 2.54 and 2.44, respectively. The fresh and the weathered sandstone had the same average absorption of 3.4%. Los Angeles abrasion testing indicated percent losses for the fresh and weathered sandstone at 36.6% and 45.0%, respectively. Detailed test results can be found in Appendix G.

Sample No.	Condition	Specific Gravity	Percent Absorption	Los Angeles Abrasion (% loss)	Wetting-Drying
*1	Weathered	2.44	3.4	** 45.0	а
*2	Fresh	2.58	3.3	** 39.1	b
*3	Fresh	2.50	3.5	** 34.1	С
Avg.	for Fresh Sandstone =	2.54	3.4	** 36.6	
Avg. for Weathered Sandstone = 2.44			3.4	** 45.0	

Notes:

\* sample No. 1 consisted of 100 lbs. of cobble sized particles, but sample types for samples No. 2 and No. 3 are unknown.

\*\* number of revolutions not specified, although values are comparable to 500 revolutions

a = after 15 cycles in fresh and salt water a noticeable softening and loosening of surface grains was evident

*b* = slight surface sloughing

c = not reported

### Sites Quarry (South) (USACE, April 1972)

Specific gravity, absorption, Los Angeles abrasion and wetting-drying tests were performed by USACE on samples of slightly weathered Venado sandstone obtained from Sites Quarry (south) in April of 1972. As shown in Table 14, the average specific gravity and percent absorption for the slightly weathered sandstone were 2.46 and 2.2%, respectively. Percent loss during the Los Angeles Abrasion test was 27%. Detailed test results can be found in Appendix G.

*Sample No.	Condition	Specific Gravity	Percent Absorption	Los Angeles Abrasion (% loss)	Wetting-Drying			
1	Slightly Weathered	2.47	2.3	**27				
2	Slightly Weathered	2.46	2.1	-	2			
3	Slightly Weathered	2.45	1.9	-	а			
4	Slightly Weathered	2.45	2.4	-				
Av	Avg. for Slightly Weathered Sandstone = 2.46 2.2							

# Table 14 – Rock Quality Test Results from Sites Quarry (South) (USACE, April 1972)

Note:

\* sample types are unknown

\*\* number of revolutions not specified

a = Freshwater slab broke into three large fragments during the fifth to seventh cycles, additional flaking occurred for the duration of the test. The other specimens showed only minor flaking during the test.

#### Sites Quarry (South) (USACE, July 1972)

Specific gravity, absorption, Los Angeles abrasion, and wetting-drying tests were performed by USACE on samples of fresh, moderately weathered, and weathered Venado sandstone obtained from Sites Quarry (south) in July of 1972. As shown in Table 15, average specific gravity values for the fresh, moderately weathered, and weathered sandstone were 2.46, 2.43, and 2.40, respectively. Average percent absorption values were 3.4%, 4.6%, and 6.5%, respectively for the fresh, moderately weathered, and weathered sandstone. Los Angeles abrasion testing was only performed on the fresh and moderately weathered samples. As expected, the moderately weathered sandstone exhibited a greater loss than the fresh sandstone. Percent losses for the Los Angeles abrasion testing were 26% and 39% for the fresh and moderately weathered sandstone parted along joints during the twelfth cycle, and minor flaking occurred throughout the test. The moderately weathered sandstone flaked throughout the entire test. Detailed test results are included in Appendix G.

Sample No.	*Specimen	Condition	Specific Gravity	Percent Absorption	Los Angeles Abrasion (% loss)	Wetting- Drying		
А	1	Fresh	2.43	4.1				
"	2	Fresh	2.50	2.9	** 26	а		
"	3	Fresh	2.45	3.1				
В	1	Mod. Weathered	2.44	4.8				
"	2	Mod. Weathered	2.44	4.8	** 39	b		
"	3	Mod. Weathered	2.41	4.1	1			
С	1	1 Weathered		6.1				
"	2 Weathered		2.37	7.0	-	-		
-	3	Weathered	2.41	6.3				
	•	Fresh Sandstone =	2.46	3.4				
•		hered Sandstone =		4.6				
A	Avg. for Weathered Sandstone =2.406.5							

Notes:

- \* sample types are unknown
- \*\* Los Angeles Abrasion testing performed on specimen 1 of each rock type. Number of revolutions not specified.
- a = Rock specimens parted along joints during the 12th cycle. Minor flaking occurred throughout the test.
- b = Specimens flaked during the test.

#### Sites Quarry and Sites Quarry (South) (USACE, 1974)

Specific gravity, absorption, and Los Angeles abrasion testing were performed on grab samples of fresh Venado sandstone obtained from Sites Quarry and Sites Quarry (south) in 1974. As shown in Table 16, the average specific gravity values for the gradations at Sites Quarry (south) and Sites Quarry are nearly identical at 2.46 and 2.47 respectively. Average percent absorption values for the sandstone at both quarries were identical at 5.3%. Los Angeles abrasion testing, at 100 revolutions, yielded results of 18.9% for Sites Quarry (south) and 12.8% at Sites Quarry. Corresponding values, at 500 revolutions, were 52.6% and 50.2%. Detailed test results are included in Appendix G.

				Los Angele	s Abrasion	
Quarry	Gradation	Specific Gravity	Absorption (%)	100 Rev. (% loss)	500 Rev. (% loss)	
Sites Quarry (south)	1½" - ¾"	2.47	4.4			
Sites Quarry (south)	$\frac{3}{4}" - \frac{3}{8}"$	2.47	5.1	18.9	52.6	
Sites Quarry (south)	<sup>3</sup> / <sub>8</sub> " - #4	2.45	6.4			
Sites Quarry	1½" - ¾"	2.48	4.4			
Sites Quarry	2.47	5.1	12.8	50.2		
Sites Quarry	<sup>3</sup> / <sub>8</sub> " - #4	2.46	6.5			
•	tes Quarry (south) = erage Sites Quarry =	2.46 2.47	5.3 5.3			

# Table 16 – Rock Quality Test Results from Sites Quarry and Sites Quarry (South) (USACE, 1974, Tested by USBR)

#### Quality Evaluation

For ease of comparison and discussion of the Venado sandstone quality evaluation, Table 17 presents a summary of the average rock quality test results performed by DWR. This table also includes acceptable limits criteria, adopted from USBR's Design Standards No. 13, Embankment Dams, Chapter 7, Riprap Slope Protection, 1992 and USACE's Engineer Manual No. 1110-2-2302, Construction with Large Stone, 1990. These criteria indicate specific gravity values should be greater than 2.6, while absorption should be less than 2%. Furthermore, Los Angeles abrasion test results should be less than 10% and 40% for 100 revolutions and 500 revolutions, respectively.

# Table 17 - Average Rock Quality Test Results for the Venado Sandstone

				AST	TM Test Proced	ures	
Sample Type	Weathering Characteristics	Number of Tests	Specific Gravity	Absorption C 127	Los Angele C	Wet-Dry with 45 Cycles	
	onaracteristics	10313	C 127	(%)	100 Rev. (% loss)	500 Rev. (% loss)	D 5313 (% loss)
3-Inch Cubes from Sites Quarry	Fresh	26	2.48	2.6	-	-	-
Crushed Sandstone from Drill Cores (1 <sup>1</sup> / <sub>2</sub> -Inch Minus)	Fresh	1	2.48	4.2	11.4	43.4	-
Crushed Sandstone from	Fresh	3	2.48	5.1	10.1	45.7	-
Sites Quarry (1 <sup>1</sup> ⁄ <sub>2</sub> -Inch Minus)	Moderately Weathered	3	2.46	6.1	11.8	51.3	-
2 <sup>1</sup> / <sub>2</sub> -Inch x 5-Inch x 5-Inch	Fresh	3	2.49	3.3	-	-	0.5*
Cubes from Sites Quarry	Moderately Weathered	3	2.43	4.7	-	-	0.6*
Drill Cores from Geologic	Fresh	37	2.50	2.9	-	-	-
Exploration	Moderately Weathered	5	2.51	3.6	-	-	-
Acceptable Limits**			Should be >2.6	Should be <2.0%	Should be <10%	Should be <40%	***

\* Rock samples did not exhibit scaling, flaking, cracking, or slabbing during or at end of test.

\*\* Acceptable limits criteria adopted from USBR's Design Standards No. 13, Embankment Dams, Chapter 7, Riprap Slope Protection, 1992 and USACE's Engineer Manual No. 1110-2-2302, Construction with Large Stone, 1990.

\*\*\* Rock should not exhibit progressive cracking during or at end of test.

Although a comparison of the test results to the acceptable limits indicate the quality of the Venado sandstone to be slightly unacceptable, the fresh sandstone is of sufficient quality for use as clean rockfill and riprap, provided that considerations regarding its quality are incorporated into design. The acceptable limits are generally applicable for concrete aggregates and should not be used as the only indicator of rock quality. A recent site inspection of Funks Reservoir Dam, where Venado sandstone was used for upstream slope protection, yielded perhaps the most definitive statement about the rock's quality. The dam was constructed in the mid-1970s, and the sandstone is still performing adequately today, exhibiting no significant signs of deterioration or detrimental performance. The quality testing also confirms that the fresh Venado sandstone.

Based upon the test results, the following considerations should be included into the design of the rockfill material:

- Specific gravity values of less than 2.6 may indicate rock with higher potential for displacement by wave action. Larger rock sizes could be used to compensate for lower values of specific gravity.
- Absorption values greater than 2% may indicate the rock will be susceptible to deterioration from wave action or freeze thaw. Rock deterioration by wave action may necessitate the periodic maintenance of the upstream slope. Freeze-thaw damage is not a significant concern in the project area.
- Los Angeles Abrasion test results exceeding 10% for 100 revolutions and 40% for 500 revolutions may indicate the rock will be less resistant to degradation by surface abrasion and impact. Development of test quarries and fills should be performed as part of future design studies to ensure specification requirements produce clean rockfill and riprap materials with desired in-place gradations, while compensating for particle breakage during quarry, placement, and compaction operations.

# 6.4 Physical Properties and Rock Strength

Laboratory testing was performed on fresh and moderately weathered samples to characterize and evaluate the physical properties and strength of the Venado sandstone. The following test procedures were performed on 6-inch diameter by 12-inch long core samples from Sites Quarry and 2.5-inch diameter drill cores from geologic exploration:

- Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression (ASTM D 3148)
  - Unconfined Compressive Strength

- Young's Modulus
- Poisson's Ratio
- Splitting Tensile Strength of Intact Rock Core Specimens (ASTM D 3967)

# 6-Inch Diameter x 12-Inch Long Core Samples

Table 18 presents the physical properties and strength test results of the 6-inch diameter by 12-inch long rock cores from Sites Quarry. As shown, the average unconfined compressive strength for the fresh sandstone was 9,568 psi and 6,983 psi, respectively for the dry and wet samples, while the moderately weathered sandstone had corresponding values of 4,998 psi and 3,589 psi. The average Young's Modulus for the fresh sandstone was  $1.258 \times 10^6$  psi and  $1.180 \times 10^6$  psi, respectively for the dry and wet samples, while the moderately weathered sandstone had corresponding values of 0.916 x 10<sup>6</sup> psi and 0.735 x 10<sup>6</sup> psi. The average Poisson's Ratio for the fresh sandstone was 0.170 and 0.164, respectively for the dry and wet samples, while the moderately weathered sandstone had corresponding values of 0.107 and 0.120. The average Brazilian Tensile Strength for the fresh sandstone was 661 psi and 444 psi, respectively for the dry and wet samples, while the moderately weathered sandstone had corresponding values of 358 psi and 226 psi. Test results indicate that the unconfined compressive strength and Brazilian tensile strength of the fresh sandstone is approximately twice the strength of the moderately weathered sandstone. Detailed test results can be found in Appendix H.

#### Table 18 - Physical Properties of 6-Inch Diameter Sandstone Rock Cores from Sites Quarry

Lab No.	Weathering	Unconfined	Compressive	Young's		Poisso	n's Ratio	Braziliar	Tensile	
		Streng	th (psi)	(x10 <sup>6</sup>	<sup>6</sup> psi)			Streng		Orientation to Bedding
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	
99C-62	Mod. Weathered	5,511		0.945		0.06				
99C-55	Mod. Weathered	4,842		0.896		0.16				
99C-59	Mod. Weathered	4,640		0.906		0.10				
99C-53	Mod. Weathered		3,790		0.663		0.10			
99C-59	Mod. Weathered		3,516		0.730		0.11			
99C-61	Mod. Weathered		3,461		0.813		0.15			
99C-66	Fresh	8,994		1.303		0.22				
99C-69	Fresh	9,983		1.262		0.15				
99C-73	Fresh	9,727		1.209		0.14				
99C-70	Fresh		6,904		1.157		0.22			
99C-72	Fresh		6,818		1.188		0.14			
99C-74	Fresh		7,227		1.196		0.13			
99C-54-3A	Mod. Weathered								182	parallel
99C-54-3B	Mod. Weathered								272	perpendicular
99C-54-3C	Mod. Weathered							247		parallel
99C-54-3D	Mod. Weathered							450		perpendicular
99C-56-5A	Mod. Weathered								172	parallel
99C-56-5B	Mod. Weathered								278	perpendicular
99C-56-5C	Mod. Weathered							235		parallel
99C-56-5D	Mod. Weathered							415		perpendicular
99C-58-7A	Mod. Weathered								174	parallel
99C-58-7B	Mod. Weathered								282	perpendicular
99C-58-7C	Mod. Weathered							279		parallel
99C-58-7D	Mod. Weathered							461		perpendicular
99C-60-9A	Mod. Weathered								145	parallel
99C-60-9B	Mod. Weathered								301	perpendicular
99C-60-9C	Mod. Weathered							304		parallel
99C-60-9D	Mod. Weathered							470		perpendicular
99C-67-2A	Fresh								394	parallel
99C-67-2B	Fresh								577	perpendicular
99C-67-2C	Fresh							617		parallel
99C-67-2D	Fresh							763		perpendicular
99C-71-6A	Fresh								433	parallel
99C-71-6B	Fresh								612	perpendicular
99C-71-6C	Fresh							561		parallel
99C-71-6D	Fresh							798		perpendicular
99C-75-10A	Fresh								342	parallel
99C-75-10B	Fresh								367	perpendicular
99C-75-10C	Fresh							626		parallel
99C-75-10D	Fresh							629		perpendicular
99C-78-13A	Fresh								318	parallel
99C-78-13B	Fresh								508	perpendicular
99C-78-13C	Fresh							539		parallel
99C-78-13D	Fresh		l	1		II	1	754		perpendicular
	Average for Fresh =	9,568	6,983	1.258	1.180	0.170	0.164	661	444	
Ave	erage for Mod. Weathered =	4,998	3,589	0.916	0.735	0.107	0.120	358	226	

#### 2.5-Inch Diameter Drill Cores

Table 19 presents Brazilian tensile strength and compressive strength test results for the 2.5-inch diameter drill cores from geologic exploration. As shown, the average Brazilian tensile strength for the wet and dry, fresh samples of Venado sandstone were 524 psi and 840 psi, respectively. The average compressive strengths for the fresh samples were 6,836 psi and 10,808 psi for the wet and dry samples, respectively. The fresh, wet samples ranged from a low of 4,548 psi to a high of 17,910 psi, while the fresh, dry samples ranged from a low of 4,600 psi to a high of 16,850 psi. The weathered, dry sample had a compressive strength of 7,290 psi. Unconfined compressive strength test results on the drill cores from geologic exploration are comparable to the strength values determined for the 6-inch diameter drill cores from Sites Quarry. Detailed test results can be found in Appendix H.

Table 19 – Brazilian Tensile Strength and Compressive Strength Test Results for	
2.5-Inch Diameter Drill Cores from Geologic Exploration	

Lab Code	Drill Hole	Start Depth (ft)	End Depth (ft)	Weathering Condition	Moisture Condition	Compressive Strength (psi)	Brazilian Tensile Strength (psi)		
	Brazilian Tensile Strength								
2001-57D	GGO-DHT3	316.3	317.7		Wet	-	467		
2001-61A	GGO-DHT5	430.5	432	Fresh	Wet	-	541		
2001-41A	GO-DHT3	71	72.2		Wet	-	565		
2001-52B	GGO-DHS4	56	57		Dry	_	789		
2001-57E	GGO-DHT3	316.3	317.7	Fresh	Dry	-	890		
			1		<u> </u>				
				Average for	Wet Samples	=	524		
				Average for	r Dry Samples	=	840		
			Compr	essive Strengt	th .				
10000 844		27.0		essive Strengt		4 705			
1999C-84A	GGLA-1	27.8	28.4		Wet	4,725	-		
1999C-92A	GGRA-1	53.4	54.2		Wet	7,230	-		
1999C-110	LC-2	51.3	52		Wet	17,910	-		
2001-58A	GGO-DHT3	327.7	329		Wet	4,548	-		
2001-30A	GGC-RC1	56	57	Encl	Wet	4,693	-		
2001-34B	GGC-RA1	59.9	61	Fresh	Wet	4,810	-		
2001-41B	GO-DHT3	71	72.2		Wet	5,226	-		
2001-28B	GGC-LA1	75.8	77.3		Wet	5,703	-		
2001-61B	GGO-DHT5	430.5	432		Wet	5,745	-		
2001-52C	GGO-DHS4	56	57		Wet	6,861	-		
2001-60B	GGO-DHT4	124.5	125.5		Wet	7,740	-		
1999C-91	GGRA-1	51	52.3		Dry	13,080			
1999C-92B	GGRA-1	53.4	54.2		Dry	13,120			
2001-58B	GGO-DHT3	327.7	329		Dry	4,600	-		
2001-61C	GGO-DHT5	430.5	432		Dry	8,803	-		
2001-60A	GGO-DHT4	124.5	125.5		Dry	9,264	-		
2001-30B	GGC-RC1	56	57	Fresh	Dry	9,791	-		
2001-34C	GGC-RA1	59.9	61		Dry	9,997	-		
2001-28C	GGC-LA1	75.8	77.3		Dry	10,125	-		
2001-56B	GGO-DHT1	176	177.2		Dry	11,988	-		
1999C-84B	GGLA-1	27.8	28.4		Dry	11,270	-		
1999C-88	GGLC-1	35.6	36.3		Dry	16,850	-		
1999C-90	GGRA-1	16.2	17.2	Weathered	Dry	7,290	-		
		Averes	o for Frach	, Wet Samples	_	6 926			
		•		, wet Samples i, Dry Samples	=	6,836 10,808			
		Avera		i, Diy Samples	-	10,000			
		Average for	Weathered	l, Dry Samples	=	7,290			

Average physical properties and strength values for the Venado sandstone presented in subsequent sections of this report will be based upon testing performed on the 6-inch diameter cores from Sites Quarry. These samples are considered to provide a better representation of the sandstone that would be obtained from quarry development for the Sites Reservoir project, since these samples were obtained from an active quarry near the surface and not at depth as in the cores obtained from exploration holes.

#### Comparison to Other Rockfill Materials

Table 20 presents a comparison of the average physical properties of the Venado sandstone to other rockfill materials for which physical properties, strength, and shear strength data are available. Of particular interest is a comparison to the Venado sandstone that was extensively tested as part of the UC Berkeley Report by Becker et. al. (1972). The Venado sandstone tested by DWR and UC Berkeley were obtained from the same quarry (Sites Quarry) and have similar unconfined compressive strengths of 9,568 psi and 8,845 psi, respectively. The average compressive strength of the fresh sandstone tested by DWR is higher than the sandstone tested by UC Berkeley, indicating that the use of UC Berkeley's testing for evaluation of the sandstone as part of this study is appropriate. Additionally, compressive and shear strength data for the other rockfill materials presented in Table 20 will be used to develop relationships to estimate shear strengths of the Venado sandstone for use in the feasibility level stability analysis.

Source	Rock Type		Compressive th (psi)	•	Modulus <sup>3</sup> psi)	Poissor	n's Ratio		n Tensile th (psi)	Reference
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	
Sites Quarry	Sandstone (F)	9,568	6,983	1.258	1.180	0.170	0.164	661	444	1
Sites Quarry	Sandstone (MW)	4,998	3,589	0.916	0.735	0.107	0.120	358	226	1
Sites Quarry	Sandstone (A)	8,845	4,797	1.93	1.45	0.220		1,133		2
Newville	Sandstone	22,160	12,160	3.210	2.610	0.13	0.29	1,898	1120	3
Newville	Conglomerate	16,800	5,750	4.260	2.780	0.15	0.47	1,522	844	3
Oroville	Amphibolite	45,500	28,000	6.200	6.200			1,870		2
Oroville	Quartz Schist	48,400	29,500	10.200	6.800	0.30		2,590		2
Oroville	Granulite	17,000		2.850						2
Pyramid	Argillite	15,000		4.200				1,896		2

## Table 20 - Average Physical Properties of Rock Cores

F-Fresh, MW-Moderately Weathered, A-Average

- 1. DWR's current testing and evaluation program.
- 2. Becker, Chan, and Seed, UC Berkeley Report No. TE 72-3 "Strength and Deformation Characteristics of Rockfill Materials in Plane Strain and Triaxial Compression Tests"
- 3. DWR "SWP Future Supply Program Glenn Reservoir Complex, Investigation of Rockfill Materials for Newville Dam," December 1980

#### Rock Strength Classification

Figure 23 presents a graphical comparison of the average compressive strength of the Venado sandstone to other rockfill materials. This figure also includes rock strength classification scales proposed by Leps and Deere. According to these scales, the sandstone would be classified as follows:

- Fresh Sandstone, Dry
  - Leps Scale = Average Strength
  - Deere Scale = Average Strength
- Fresh Sandstone, Saturated
  - Leps Scale = Average Strength
  - Deere Scale = Low Strength
- Moderately Weathered Sandstone, Dry
  - Leps Scale = Average Strength
  - Deere Scale = Low Strength
- Moderately Weather Sandstone, Saturated
  - Leps Scale = Average Strength
  - Deere Scale = Very Low Strength

These strength classifications confirm that the fresh Venado sandstone is a better quality rock than the moderately weathered sandstone.

Figure 24 presents a graphical comparison of the fresh Venado sandstone to other rockfill materials using the Deere engineering classification chart. As shown in this figure, the saturated Venado sandstone is classified as a low strength, low modulus ratio material, while the dry Venado sandstone is classified as a medium strength, low modulus ratio material.

#### 6.5 Shear Strength

Shear strength parameters were estimated by determining the physical properties of the Venado sandstone, identifying rockfill materials with similar properties, and selecting shear strength parameters from published data for those similar rockfill materials.

Table 21 presents published data for the shear strength properties of the Venado sandstone and other rockfill materials. As shown, data was collected from 2.8-inch, 12-inch, and 36-inch triaxial tests as well as plane strain tests. Photographs of the large-scale triaxial and plane strain testing apparatus used at UC Berkeley on Oroville amphibolite, Pyramid argillite, and Venado sandstone are included for reference as

Figure 25 and Figure 26, respectively. Of particular interest is the Venado sandstone test data presented in the 1972 UC Berkeley Report by Becker et. al. The Venado sandstone examined in this report was quarried within the vicinity of the expected borrow locations for the Sites Reservoir project. As such, it is appropriate to make estimations from the published Venado sandstone data regarding the anticipated shear strength of the rockfill material for the Sites Reservoir Project. Shear strength information for the published data is included for reference in Appendix J.

Figure 27 is a comparison of confining stress to friction angle for the rockfill materials presented in Table 21. The figure was modeled after the shearing strength plot first proposed by Leps, 1970 (Appendix J) and includes Leps' rockfill strength scales for comparison. This figure also includes trendlines of confining stress versus friction angle for the 36-inch triaxial tests and plane strain tests performed on the Venado sandstone. These trendlines will be used to estimate shear strength properties of the Venado sandstone.

# Table 21 - Shear Strength Properties of Rockfill Materials

Orivite         Ampinibilite (UReger 1 allings)         36         6         420         39.5         1969           Newville         Sandstone         2.8         0.5         30         44.5         0.5         39.5         0.7	Project	Rock Type	Triaxial Test Size (inches)	Maximum Particle Size (inches)	Confining Pressure (psi)	Friction Angle (degrees)	Reference	
Indraratna et al. 1993         Greywacke (1.5 inch)         Information not available.         1.5         70         37         Indraratna et al.           0         1.5         120         34.5         34.5         34.5         34.5           0         1.5         145         32.5         34.5         34.5         34.5           0         Amphibolite (Dredger Tailling)         36         6         340.0         47.2         38.5         3				1.5	23	45		
Indraratina et al. 1993         Greywacke (1.5 inch)         available.         1.5         90         36         Indraratina et al.           0roville         Amphibolite (Dredger Tailings)         36         6         30         47           0roville         Amphibolite (Dredger Tailings)         36         6         440         43.5           1.5         1.45         30.5         30.5         30.5         1969           0roville         Amphibolite (Dredger Tailings)         36         6         600         38.5           Newville         Sandstone         2.8         0.5         30         43.5           2.8         0.5         300         37.5         30.6         44.5           2.8         0.5         30.0         37.5         30.7         44.5           2.8         0.5         30.0         37.5         30.7         44.5           2.8         0.5         30.0         36.5         41.0         39.5         30.7           2.8         0.5         30.0         35.5         30.7         44.7         42.6         30.5         30.7         44.7         45.7         46.6         30.7         46.7         46.7         46.6         30.7<				1.5	50	39.5		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Indrarated at al. 1002	Crowwooko (1 E inch)	Information not	1.5	70	37	Indrorotop at al. 1002	
$ \begin{array}{ c c c c c c } \hline \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	indialatila et al. 1995	Greywacke (1.5 litch)	available.	1.5	90	36		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				1.5	120	34.5		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				1.5	145	32.5		
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Newville         Conglomerate         2.8         0.5         30         44           2.8         0.5         85         41         DWR, 1980           Eastside         Quartzite BA-2         Not applicable. Eastside friction angles are design values.         30         48         Domenigoni Vc Reservoir Project           Pyramid         Argilite         36         6         30         47           Besk Watts, 1980         Sandstone         10         44         Reservoir Project           Charles & Watts, 1980         Sandstone         11         7         59           UC Berkeley         Venado Sandstone         12         Information not 36         6         30         41           UC Berkeley         Venado Sandstone         12         Information not 36         6         420         36         1969           UC Berkeley         Venado Sandstone         12         Information not 36         6         30         41         96         197           UC Berkeley         Venado Sandstone         12         Information not 36         6         420         36         1972         197           UC Berkeley         Venado Sandstone         NA         4         30         44         30			2.8	0.5	300	37		
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$ \begin{array}{ c c c c c c } \hline & 2.8 & 0.5 & 300 & 35 \\ \hline & 2.8 & 0.5 & 300 & 35 \\ \hline & 0 t applicable. Eastiside friction angles are design values. & 100 & 44 \\ \hline & 30 & 47 & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 44 & \\ \hline & 8eservoir Project & \\ \hline & 100 & 39.5 & \\ \hline & 36 & 6 & \\ \hline & 30 & 47 & \\ \hline & 36 & 6 & \\ \hline & 30 & 47 & \\ \hline & 36 & 6 & \\ \hline & 30 & 47 & \\ \hline & 36 & 6 & \\ \hline & 69 & 39.5 & \\ \hline & & 22 & 51 & \\ \hline & 69 & 39 & \\ \hline & & 150 & 35 & \\ \hline & & 150 & 35 & \\ \hline & & & 150 & 35 & \\ \hline & & & & 150 & \\ \hline & & & & & 150 & \\ \hline & & & & & & \\ \hline & & & & & & \\ \hline & & & &$	Newville		2.8	0.5	140	39		
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UC Berkeley         Venado Sandstone         36         6         140         36.5         Becker et al, UC B         1972           UC Berkeley         Venado Sandstone (under plane strain conditions)         NA         4         30         44         1972 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>								
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UC Berkeley         Venado Sandstone (under plane strain conditions)         NA         4         30         44           NA         4         30         44	UC Berkeley	Venado Sandstone		-				
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Table 22 summarizes the estimated range of friction angles for the Venado Sandstone obtained from Figure 27 at confining stresses equivalent to the average stress and maximum stress levels estimated to occur on deep sliding surfaces within the proposed Golden Gate and Sites dam embankments. The average and maximum confining stresses are estimated to be approximately 40 psi and 100 psi, respectively. As shown in Table 22, the average and maximum confining stresses correspond to triaxial friction angels of 40.5° and 39.0° and plane strain friction angles of 43.5° and 41.5°. According to the reference scale proposed by Leps, 1970, these ranges of friction angles roughly correspond to rockfill shear strength classifications of "Low" and "Average" for triaxial and plane strain conditions, respectively.

Confining Pressure (psi)	Triaxial Friction Angle (degrees)	Plane Strain Friction Angle (degrees)
40	40.5	43.5
100	39.0	41.5

It is customary to estimate shear strengths in terms of triaxial friction angles, but plane strain friction angles are also presented because Marachi et. al. (1969) suggested that long rockfill dams experience deformation conditions generally similar to those of plane strain. It should also be pointed out that the triaxial and plane strain data for the Venado sandstone, corresponding to a 6-inch and 4-inch maximum particle size, respectively, were intentionally chosen for their large particle size. According to the study performed by Becker et al (1972) (Appendix J), there is very little change in shear strength between the 2-inch maximum particle size triaxial tests and the 6-inch maximum particle size triaxial tests, when similar gradations are used. Furthermore, a plot in the same study suggests that little difference would be seen (in terms of shear strength) if the data were extrapolated to include the 30-inch maximum particle size expected for use in rockfill materials for Sites reservoir. In summary, it is therefore appropriate to use the shear strengths estimated from Figure 27 and presented in Table 22.

Since a lower level of evaluation is required for the feasibility level stability analysis, the shear strength for the rockfill material was estimated by adopting a friction angle corresponding to the average confining stress (40 psi) estimated to occur on deep sliding surfaces, and neglecting the effects of varying shear strength with confining stress by using the average value. Specifically, the recommended shear strength for the rockfill material was estimated by adopting the plane strain friction angle for the average confining stress, but reducing the value slightly as a conservative measure. The recommended shear strength for use in the feasibility level stability analysis is: Friction Angle ( $\phi'$ ) = 42°. Since shear strength varies with confining stress, future testing and evaluation of the rockfill materials should account for this effect when recommending shear strengths for use in preliminary and final design of the dam embankments.

Subsequent tables and figures are presented as a supplemental comparison for the selection of appropriate shear strengths for the Venado sandstone.

Table 23 presents published compressive and shear strength properties of selected rockfill materials under triaxial and plane strain conditions at confining pressures of 40 psi and 100 psi. Published data was obtained from UC Berkeley and DWR reports.

#### Table 23 – Published Compressive and Shear Strength Properties of Selected Rockfill Materials

Project	Rock Type	Dry Unconfined Compressive Strength (psi)	Triaxial Friction Angle at 40 psi (degrees)	Triaxial Friction Angle at 100 psi (degrees)	Reference
Oroville	Amphibolite (Dredger Tailings)	45,500	46.5	44.5	1
Newville	Sandstone	22,160	43.0	39.0	2
Newville	Conglomerate	16,800	43.5	40.5	2
Pyramid	Argillite	15,500	46.5	42.0	1
Venado	Sandstone	8,845	40.5	38.0	3
Oroville	Amphibolite (Dredger Tailings)	45,500	*52.0	*49.5	3
Pyramid	Argillite	15,500	*48.5	*45.0	2,3
Venado	Sandstone	8,845	*43.5	*41.5	3

Notes: \* = friction angle under plane strain conditions

1 = Marachi, Becker, et al (1969, 1972)

2 = DWR, 1980

3 = Becker et al, 1972

Figure 28 and Figure 29 present comparisons of dry unconfined compressive strength to friction angle, under triaxial and plane strain conditions, for the rockfill materials presented in Table 23. Figure 28 presents friction angles corresponding to a confining stress of 40 psi, while Figure 29 presents friction angles corresponding to a confining stress of 100 psi. A trendline was developed through the triaxial and plane strain rockfill data to facilitate estimation of the shear strength for the Venado sandstone. As shown in Figure 28, the average dry unconfined compressive strength of 9,568 psi indicates friction angles of approximately 42.0° and 44.5° for the triaxial and plane strain conditions, respectively at a confining stress of 40 psi. As shown in Figure 29, a dry unconfined compressive strength of 9,568 psi indicates friction angles of approximately 38.5° and 42.0° for the triaxial and plane strain conditions, respectively at a confining stress of 100 psi.

Figure 30 is another comparison between compressive strength and friction angle for rockfill materials used in embankment dams. Data was obtained from ICOLD Bulletin 92, and probably reflects design values instead of actual test results. Again, a trendline through the rockfill data, coupled with Venado sandstone's compressive strength of 9,568 psi, indicates a friction angle of approximately 39.5°. Figures 28 through 30 are supplemental comparisons for the selection of appropriate shear strengths for the Venado sandstone for use as rockfill material in the proposed dams. These figures indicate comparable shear strengths for the Venado sandstone and confirm the selection of the shear strengths recommended previously in this section.

## 6.6 Density

Compacted in-place densities of the Venado sandstone to be used as rockfill and riprap materials were estimated from data published by Becker et. al. (1972) (Appendix K). In-place densities were calculated assuming a water content of 5% and a relative density of 90% for the compacted rockfill materials. The published data along with the previous assumptions indicate estimated dry, moist, and saturated densities of 116 pcf, 122 pcf, and 136 pcf, respectively.

## 6.7 Particle Breakage

Particle breakage refers to the phenomenon by which individual rock particles fracture and crush due to external stress concentrations. Because particle breakage can adversely affect a soil's shear strength, it warrants consideration during design. Relevant to this report, particle breakage occurs within embankment dams and can be modeled and simulated in the laboratory by compression tests such as triaxial and plane strain testing.

As discussed in UC Berkeley reports by Marachi, Becker, et. al. (1969, 1972), Marsal (1965) quantified the amount of a soil's particle breakage by devising the particle breakage factor "B". The breakage factor B is calculated by comparing the percent material retained on each sieve before and after shear strength testing, and summing the same sign differences for each sieve. For clarification, a sample calculation of the particle breakage factor B is included below.

	% Retained								
Sieve	Before Testing	After Testing	Δ (%)						
3-inch	6	6	0						
1½-inch	20.5	20.2	0.3						
¾-inch	24.5	24.7	-0.2						
<sup>3</sup> / <sub>8</sub> -inch	17.5	19.1	-1.6						
#4	11.5	9.9	1.6						
Pan	Pan 20 20.1								
Particle Breakage Factor B = 1.9 %									

#### Sample Calculation of Particle Breakage Factor B

A comparison of observed particle breakage of the Venado sandstone during shear strength testing to rockfill materials (argillite) used at Pyramid Dam was performed as a supplemental method for evaluating the suitability of the sandstone for rockfill and riprap materials. This comparison involved review of the large-scale triaxial and plane strain testing documented in UC Berkeley reports published by Marachi, Becker, et. al. (1969, 1972). It should be pointed out that both rockfill materials were composed of angular particles, and both materials had the same initial gradation for each test and/or figure discussed in the following paragraphs.

Figures 31 and 32 present particle breakage as a function of confining pressure, observed from triaxial testing, for the Venado sandstone and Pyramid Dam argillite, respectively. When directly comparing the two curves for the 6-inch maximum particle size (36-inch diameter specimen), it can be seen that the two rockfill materials exhibit comparable particle breakage. In fact, at confining pressures of 30 psi, 420 psi, and 650 psi, the Venado sandstone demonstrated less particle breakage than the Pyramid Dam argillite. Table 24 compares the Venado sandstone and Pyramid argillite particle breakage results as presented in Figures 31 and 32.

Table 24 – Summary of Particle Breakage Results for 6-Inch Maximum Particle	
Size Triaxial Tests for Venado Sandstone and Pyramid Argillite	

	Particle Breakage (%) at Confining Pressures of:							
Rock Type	30 psi	140 psi	420 psi	650 psi				
Venado Sandstone	12.5	22.5	31.5	33.5				
Pyramid Argillite	13.5	21.5	35	43				

Figure 33 is a comparison of particle breakage of the Venado sandstone to the Pyramid Dam argillite for plane strain testing. Particle breakage is plotted against minor principal stress. Of particular interest is the 4-inch maximum particle size curves for the two materials. Similar to the previous two figures, the Venado sandstone and Pyramid Dam argillite exhibit comparable particle breakage. Again, at certain minor principal stresses, the Venado sandstone shows slightly more resistance to particle breakage than the Pyramid Dam argillite. Table 25 compares the Venado sandstone and Pyramid argillite particle breakage results as presented in Figure 33.

Table 25 – Summary of Particle Breakage Results for 4-Inch Maximum Particle SizePlane Strain Tests for Venado Sandstone and Pyramid Argillite

	Particle Breakage (%) at Minor Principal Stresses of:							
Rock Type	30 psi	140 psi	420 psi	650 psi				
Venado Sandstone	8	17	25	26.5				
Pyramid Argillite	8.5	17	27.5	32.5				

Figure 34 presents gradation curves for the Venado sandstone and the Pyramid Dam argillite before and after the plane strain testing at a minor principal stress of 650 psi. This figure confirms the earlier suggestion that the Venado sandstone exhibited slightly more resistance to particle breakage than the Pyramid Dam argillite. As seen in this figure, the Pyramid Dam argillite has a slightly finer gradation after testing than the Venado sandstone, indicating the Venado sandstone to be slightly more resistant to particle breakage.

Figure 31 through Figure 34 indicate the particle breakage of the Venado sandstone is comparable to the Pyramid Dam argillite. In some cases, the Venado sandstone exhibited slightly more resistance to particle breakage than the Pyramid Dam argillite. Considering that the Pyramid Dam argillite is an adequate and successfully performing rockfill material, the Venado sandstone is judged to have sufficient strength and resistance to breakage for use as clean rockfill and riprap material.

# 6.8 Observed Performance

Probably the greatest indicator of the quality, durability, and suitability of the Venado sandstone for use as rockfill and riprap is to evaluate its long-term performance under similar environmental and operating conditions. Venado sandstone was used as upstream slope protection on USBR's Funks Reservoir Dam, constructed during the mid 1970s. Inspection of the slope protection on Funks Reservoir Dam indicates that the Venado sandstone has not exhibited significant deterioration, has performed adequately over the last 25 years, and is of sufficient quality for use as clean rockfill and riprap materials. Figure 35 is a photograph of the upstream slope protection on Funks Reservoir Dam.

## 6.9 Processability

As discussed and evaluated earlier in the report, the fresh sandstone was found to be of better quality, and thus more desirable, than the moderately weathered sandstone. As such, obtaining fresh Venado sandstone for use as riprap and rockfill material is essential to the successful construction and operation of the proposed embankment dams. Past correspondence between the USACE and Teichert Construction (regarding the Venado sandstone quarrying operations at Sites Quarry (south)) indicates that separating the desired fresh Venado sandstone from the lesser quality, weathered sandstone and interbedded mudstone may be a significant task. Teichert's quarry operations at Sites Quarry (south) were producing riprap for Sacramento River bank protection projects. Consequently, further studies should include an assessment of the excavation and processing requirements to produce the desired materials. USACE inspection reports of Teichert's quarry operation are included for reference in Appendix L.

As previously mentioned, USBR's Funks Reservoir Dam also utilized Venado sandstone for use as upstream slope protection. Although USBR and USACE used the Venado sandstone for somewhat different purposes, it should be pointed out that USBR inspector, Paul Freeman, reported no difficulties in processing the sandstone for use as upstream slope protection during a phone conversation in September, 2001

Inspection of Sites Quarry indicates that obtaining the desired stone sizes for rockfill and riprap material may require additional processing. Drilling and blasting will likely produce over-sized and/or under-sized rock fragments depending upon the bedding thickness. Over-sized stones will require further processing (crushing), while under-sized stones will have to be segregated and removed from the prospective rockfill and riprap material to be used as random or possibly transition material. Quality control over the quarrying operations will be necessary to ensure specification requirements are met.

#### 6.10 Conclusions and Recommendations

Material testing and evaluation indicate the fresh Venado sandstone is of sufficient quality for use as clean rockfill and riprap materials. Sufficient quantities of Venado sandstone can be obtained from quarries developed in near vicinity of the dam sites for the embankment dams under consideration. Although beyond the scope of this study, future design investigations should include test quarries and fills to develop the specification requirements. This will ensure that the Venado sandstone will meet design requirements for clean rockfill material, particularly related to limiting the fines content of in-place material. Future design investigations should also include additional testing and evaluation of the Venado sandstone to further define the engineering properties of the clean rockfill material such as: shear strength, hydraulic conductivity, density, etc..

Although use of the highest quality rock meeting laboratory test requirements for concrete aggregates is desirable, use of "softer" rock types (such as the Venado sandstone) is an acceptable practice if the rock is the best quality available within the project area. "Softer" or "weaker" rock types have been used successfully in many existing dams provided that conservative estimates of engineering properties are selected for design. It should be noted that the available types of material should dictate the selected dam section. Design requirements should not dictate material criteria for major embankment zones, only for zones with specific design requirements (such as filters and drains).

Physical properties, strength, and quality testing confirm the observation that the moderately weathered sandstone is a lower quality rock than the fresh sandstone. Dam design criteria generally dictate use of the best quality rock available on site for rockfill and riprap materials. To meet this requirement, it is assumed that only fresh sandstone will be used for riprap and clean rockfill materials, and weathered sandstone will be used for random rockfill material in preparing the feasibility level embankment design and cost estimates. Moderately weathered sandstone may, in fact, be suitable for clean rockfill materials. Use of weathered sandstone for rockfill materials should be investigated further in future design studies.

Although not discussed in the report, drill cores from the geologic exploration program found a north trending unit of conglomerate within the Sites Reservoir area near the proposed saddle dam sites. Preliminary review of the drill cores indicates the conglomerate may be suitable as rockfill for the saddle dams. Compressive strength tests performed towards the end of this investigation on samples from Hole No. SSD 6-1 indicate average dry and saturated compressive strengths of 5,761 psi and 3,058 psi respectively. Detailed test results are included in Appendix P. Future design investigations should include a comprehensive study of the conglomerate to determine its suitability as a rockfill source.

# 7.0 RANDOM MATERIALS

### 7.1 Introduction

Random embankment materials will be comprised of materials unsuitable for use as clean rockfill and generally do not meet the hydraulic conductivity and erosion resistant properties required for rockfill materials. These random materials would consist of weathered sandstone, sandstone with interbedded mudstone, mudstone, slopewash, colluvium, etc. from excavations for the dam foundations, appurtenant structures, and the rockfill quarries. Available quantities of random material in the project area exceed estimated quantities of 1 million cubic yards and 3 million cubic yards for Sites and Golden Gate dams, respectively. In addition, sufficient quantities of random type materials are available for construction of the saddle dams.

It is anticipated that two general types of random materials will be generated during construction depending upon the source of the material. One type of random material will be comprised of predominately weathered sandstone from the Cortina Formation. This material will be comprised of weathered sandstone, sandstone interbedded with mudstone, and fines generated during quarry excavation and processing operation for clean rockfill and riprap materials. This type of random material will also incorporate material generated during dam foundation and structure excavations in the Cortina Formation. It is anticipated that this material will be characterized as semi-pervious and generally be classified as a gravel with sand and cobbles.

The other type of random material will be comprised of predominantly mudstone generated during dam foundation and structure excavation, and from borrow excavation in the Boxer Formation. Since the mudstone is a low strength rock and tends to fall apart when exposed to air and water, this material will likely break down into a "soil like" material during excavation and compaction operations. In comparison to the random material generated from the Cortina Formation, this random material will generally have a higher fines content, smaller maximum particle size, and a lower shear strength. It is anticipated that this material will be characterized as semi-impervious to impervious and generally be classified as a silty or clayey sand with gravel. This estimation was confirmed by after compaction classification gradation tests performed on mudstone obtained from Drill Cores SSD 5-3, SSD 8-1, and SSD 8-3 (Appendix Q).

Since random materials are generally not used in areas of dam embankments that would require engineering properties such as hydraulic conductivity, erosion resistance, etc., the emphasis of this investigation is to provide an estimate of the shear strength and compacted densities for use in the feasibility level stability analysis. The engineering properties of the random materials were estimated by performing limited laboratory testing combined with a review and comparison to published data.

## 7.2 Compressive Strength

Compressive strength testing was performed on samples of moderately weathered sandstone and mudstone to provide an estimate of the strength of the random materials. Compressive strength testing was performed on:

- 6-inch diameter x 12-inch long core samples of weathered sandstone from Sites Quarry
- 2.5-inch diameter drill cores of mudstone from geologic exploration

Testing was performed in accordance with Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression (ASTM D 3148). Test results for the mudstone samples are presented in Table 26, and test results for the moderately weathered sandstone samples were presented in the rockfill section.

As shown in Table 26, the mudstone had an average compressive strength of 3,477 psi. The compressive strengths ranged from a low of 1,180 psi to a high of 5,390 psi. It should be pointed out that the compressive strength testing was primarily performed on samples obtained at depth, since near surface samples tended to expand and break apart and were not suitable for testing. Furthermore, mudstone samples were also tested dry since saturated samples fell apart and could not be tested. The compressive strength of 1,180 psi corresponds to the only sample tested near the surface and is an indicator that materials comprised of mudstone from dam foundation and structure excavation will be low strength. Additionally, the propensity of the mudstone to fall apart when exposed to air and water indicates that it will likely breakdown into a soil like material during excavation and compaction operations. Detailed test results are included for reference in Appendix M.

Bryte Lab Code	Drill Hole	Start Depth (ft)	End Depth (ft)	Compressive Strength (psi)
1999C-87	GGLC-1	23.2	23.8	1,180
2001-32A	GGC-RC2	140.1	141.3	3,980
2001-35A	GGC-RA1	146.3	147.5	2,184
2001-40C	SSD9-1	120.4	121.4	5,238
2001-55A	GGO-DHT1	155.7	156.7	3,170
2001-59D	GGO-DHT4	115.5	116.7	2,816
2001-63A	GGO-DHT6	556.3	557.3	3,856
1999C-89	GGLC-1	199.5	200.3	5,390
			Average =	3,477

Table 26 – Compressive Strength Test Results for Dry Mudstone (2.5-Inch Diameter Drill Cores from Geologic Exploration)

For comparison purposes, Table 27 presents the average compressive strengths for the mudstone samples obtained from geologic exploration and the weathered sandstone samples obtained from Sites Quarry.

Table 27 – Average Compressive Strengths for Mudstone and Weathered Sandstone

Material	Source	Moisture Condition	Compressive Strength (psi)	
Mudstone	udstone 2.5-Inch Diameter Drill Cores from Geologic Exploration		3,477	
Weathered Sandstone	6-Inch Diameter x 12-Inch Long Cores from Sites Quarry	Dry	4,998	

# 7.3 Rock Strength Classification

Based upon the average compressive strength results for the dry materials, the mudstone and moderately weathered sandstone would be classified as follows, according to the Leps and Deere scales previously presented in Figure 23:

- Mudstone
  - Leps = Average Strength
  - Deere = Very Low Strength
- Weathered Sandstone
  - Leps = Average Strength
  - Deere = Low Strength

# 7.4 Shear Strength

#### Material Comprised of Predominantly Weathered Sandstone (Cortina Formation)

Shear strength parameters for the random material comprised of predominately weathered sandstone were estimated using an approach similar to that detailed in Section 6.5. Figure 36 repeats the comparison of dry unconfined compressive strength to friction angles for the rockfill materials presented in Table 23 at a confining stress equivalent to the average stress level estimated to occur on deep sliding surfaces within the proposed dam embankments (40 psi). As shown in Figure 36, the average dry unconfined compressive strength of the weathered Venado sandstone of 4,998 psi indicates friction angles of 40.0° and 41.5° for the triaxial and plane strain conditions, respectively.

Similar to the approach discussed in Section 6.5, the recommended shear strength of the random material comprised predominantly of weathered sandstone was estimated by adopting the friction angle corresponding to plane strain conditions and reducing this value slightly as a conservative measure. Using this approach, the recommended shear strength for use in the feasibility level stability analysis is: Friction Angle ( $\phi'$ ) = 40°.

Figure 37 repeats the supplemental comparison between compressive strength and friction angle for rockfill materials used in embankment dams for data presented in ICOLD Bulletin 92. As shown, the trendline through the rockfill data, coupled with the average compressive strength of the moderately weathered sandstone of 4,998 psi, indicates a friction angle of 38.5°. This figure indicates a comparable shear strength for the weathered sandstone and confirms that the recommended shear strength is an appropriate selection. Another confirmation that the recommended shear strength is an appropriate selection is a direct comparison to Leps' "Rockfill Shearing Strength" chart included in Appendix J. According to Leps' chart, a rockfill material with low density, poorly graded, weak particles would have a friction angle of approximately 39° for the confining stress level under consideration.

#### Material Comprised of Predominantly Mudstone (Boxer Formation)

Since it is anticipated that random material comprised of predominately mudstone will be characterized as a "soil like" material after excavation and compaction operations, estimation of the shear strength using a comparison to published data for rockfill materials is not appropriate. Therefore, shear strength parameters for this type of random material were estimated from published soil data corresponding to the anticipated classification of the in-place material after excavation and compaction operations. As discussed previously, it is anticipated that this material will generally be classified as a silty or clayey sand with gravel. Based upon a review of published data for this type of material, the recommended shear strength parameters for use in the feasibility level stability analysis are: Total Friction Angle ( $\phi$ ) = 15°; Total Cohesion (C) = 0 psf.

These recommended shear strength parameters represent adoption of the average shear strength parameters for SC and SM materials presented in a DWR shear strength study (1976). Published data from this study is included for reference in Appendix N.

#### 7.5 Density

Since test results indicate the mudstone and Venado sandstone have similar specific gravities, in-place densities of the random materials are assumed to be equivalent to the rockfill densities, previously estimated in section 6.6. Recommended

dry, moist, and saturated densities for the random materials are 116 pcf, 122 pcf, and 136 pcf, respectively.

#### 7.6 Conclusions and Recommendations

Random embankment materials will be comprised of materials that are essentially unsuitable for use as clean rockfill. The random materials will include weathered sandstone, mudstone, slopewash, colluvium, and other materials from excavations for the dam foundations, appurtenant structures, and the rockfill quarries and designated borrow areas for construction of the saddle dams. Since random materials are generally used in portions of the dam embankment where hydraulic conductivity and erosion resistant properties are not a consideration, random materials do not require a comprehensive evaluation of engineering properties. As such, only shear strength and density were investigated as part of this feasibility investigation.

Sufficient quantities of random material are available within or near the proposed Sites Reservoir project area. These materials will be generated from required excavation and designated borrow-areas for construction of the saddle dams. Future design investigations should include a thorough evaluation, as part of the constructability review, to identify and quantify the type of random materials generated from required excavation. The dam embankment section should be developed to incorporate these random materials to the maximum extent possible to minimize generation of waste material.

Further studies, including the preliminary design program, should include additional testing and evaluation of the random materials. Specifically, these investigations should include a comprehensive evaluation of the composition (percent weathered sandstone, mudstone, etc.) and gradation of the random materials that are likely to be generated from required excavation at each of the dam sites. This evaluation should include construction of test fills to assist development of the specification requirements. In addition, compaction, hydraulic conductivity (if necessary), shrink/swell, and triaxial testing of the anticipated random materials should be performed to further refine the engineering properties for use in design of the dam embankments.

With specific regard to the Boxer Formation, excavated random material should be explored and laboratory tested to determine engineering properties, especially for the Sites Dam and saddle dams. In further studies, this material should be tested as a soil type material.

# 8.0 FILTER, DRAIN, AND TRANSITION MATERIAL

## 8.1 Introduction

The fresh Venado sandstone may be suitable for use as filter, drain, and transition materials. Visual observation of crushed samples for concrete aggregate testing and the aggregate quality test results indicate that the Venado sandstone may have sufficient strength and durability for use as filter, drain, and transition materials. Use of the Venado sandstone for these materials will require extensive evaluation of particle breakage characteristics during quarry, transport, placement, and compaction operations to ensure the materials meet design hydraulic conductivity and in-place gradation requirements. This particle breakage evaluation will require test quarries and fills and is considered beyond the scope of this feasibility level investigation.

Since the suitability of the sandstone for use as filter, drain, and transition materials can not be confirmed at this level of investigation, the feasibility level cost estimates should include the conservative assumption that these materials will be imported from the closest sand and gravel source identified in the geologic exploration program. This sand and gravel source was identified as an old abandoned channel on Stony Creek located approximately 35 road miles away, between Orland and Willows (Figure 38). An estimated 160 million cubic yards of material exist, which far exceed the construction requirements for the proposed structures.

#### 8.2 Shear Strength

Shear strength parameters for the filter, drain, and transition material were estimated from published data. Specifically, the friction angle was derived from a plot of relative density verses friction angle found in USBR's Earth Manual. This plot is included as Figure 39. In this figure, the trendline corresponding to the No. 3 material (35% gravel,  $\frac{3}{4}$ -inch maximum size) was selected as representative of the proposed filter, drain, and transition materials. This material was selected because it is considered to be representative of an average gradation for the filter, drain, and transition materials. Figure 39 indicates a friction angle for the No. 3 material of approximately 42°. Accordingly, the recommended shear strength for use in the feasibility level stability analysis is: Friction Angle ( $\phi$ ') = 42°.

#### 8.3 Density

In-place compacted densities for the filter, drain, and transition materials were estimated in much the same way as the rockfill material. Assuming a water content of 5%, a relative density of 90% for in-place materials, and using the data published by Becker et al (1972), dry, moist, and saturated densities were estimated at 115 pcf, 121

pcf, and 135 pcf, respectively. The aforementioned published data is included in Appendix K as previously noted in the rockfill section.

#### 8.4 Conclusions and Recommendations

Testing and evaluation of the fresh Venado sandstone presented in the rockfill and concrete aggregate sections indicate that it may be of sufficient quality for filter, drain, and transition materials. Since the quality of the sandstone for use as these materials cannot be confirmed without an extensive testing and evaluation program, feasibility level cost estimates should include the conservative assumption that material will be imported from the closest sand and gravel source identified in the geologic exploration program. This source was identified as an abandoned channel on Stony Creek, approximately 35 road miles from the project site, with an estimated sand and gravel quantity of roughly 160 million cubic yards. Additional testing and evaluation performed as part of future design studies should also include an economic comparison between importing and producing filter, drain, and transition materials to ensure selection of the most economical material source. This comparison should include a detailed examination of the costs required to produce clean filter, drain, and transition materials from the Venado sandstone, particularly related to separating the interbedded mudstone and weathered sandstone during excavation and processing operations.

Preliminary and final design programs should include placement and compaction of test fills constructed of quarried and processed sandstone materials, with gradations approximating anticipated ranges for filter, drain, and transition materials. This would allow the evaluation of whether the sandstone has sufficient strength and durability characteristics for use as filter, drain, and transition material. The evaluation should focus on the propensity of particle breakdown, which would adversely affect the hydraulic conductivity of the material.

# 9.0 CONCRETE AGGREGATE

### 9.1 Introduction

Sufficient deposits of sands and gravels for construction of the proposed project facilities are not available within the project area. Therefore, the emphasis of this program was to evaluate the suitability of crushed Venado sandstone for use as concrete aggregate.

Alternative sand and gravel sources were also identified as part of the geologic exploration program. The closest imported source is located about 35 road miles from the project site, between Orland and Willows, on an old abandoned channel of Stony Creek (Figure 38). This borrow source contains an estimated 160 million cubic yards of material, which is considerably greater than quantities required for construction of the proposed project structures.

# 9.2 Sampling and Testing

Samples for concrete aggregate testing were prepared from 2.5-inch diameter drill cores from geologic exploration and waste cobbles from Sites Quarry. Samples from the latter were segregated into fresh and weathered sandstone lots and then transported to a rock crushing facility. The sandstone was processed until all material passed a 1-inch screen. As a result, two cubic yards each of crushed fresh and weathered Venado sandstone were delivered to Bryte Lab for testing.

The following test procedures were used to evaluate the quality of the sandstone for use as concrete aggregate:

- Specific Gravity and Absorption of Coarse and Fine Aggregates (ASTM C 127 & 128)
- Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine (ASTM C 131).
- Clay Lumps and Friable Particles in Aggregate (ASTM C 142)
- Organic Impurities in Fine Aggregate (ASTM C 40)
- Bulk Density and Voids in Aggregate (ASTM C 29)

Figures 40 and 41 present gradation curves for the fresh and weathered crushed sandstone samples, respectively. The figures include an average gradation curve for each material along with the Caltrans concrete aggregate gradation envelope. As shown, the average fresh and weathered material gradations deviate only slightly from the Caltrans envelope.

# 9.3 Quality

Tables 28 and 29 present concrete aggregate quality test results for crushed Venado sandstone from the drill cores and Sites Quarry, respectively. Detailed test results are included for reference in Appendix O.

As shown in Table 28, the specific gravity and absorption for the fresh sandstone were 2.48 and 4.2%, respectively for the drill core sample. Additionally, Los Angeles abrasion losses were 11.4% and 43.4% for 100 revolutions and 500 revolutions, respectively.

Table 28 – Concrete Aggregate Quality Test Results for Crushed Venado Sandstone from Drill Cores

Sample Type	Degree of Weathering	Specific	Absorption	Los Angeles Abrasion (% loss)		
	weathening	Gravity	(%)	100 Rev.	500 Rev.	
Crushed Sandstone from Drill Cores (1 <sup>1</sup> / <sub>2</sub> "-Minus)	Fresh	2.48	4.2	11.4	43.4	

As shown in Table 29, the average specific gravity for the fine and coarse fresh samples were 2.58 and 2.48, respectively, while corresponding weathered samples were 2.57 and 2.46. Average absorption for the fine and coarse fresh samples were 2.4% and 5.7%, respectively, while corresponding weathered samples were 2.7% and 6.3%. Los Angeles Abrasion losses for the fresh samples were 10.1% and 45.7% for 100 revolutions and 500 revolutions, respectively, while corresponding losses for the weathered samples were 11.8% and 51.3%.

Average percentage of clay lumps and friable particles for the fine and coarse fresh samples were 3.2% and 0.6%, respectively, while corresponding averages for the weathered samples were 5.1% and 1.2%. The average standard colors for the organic impurities for the "as received" and "washed – fines removed" fresh samples were both "clear." Corresponding averages for the weathered samples were 3 and "clear." The average bulk densities for the fresh and weathered samples were 88.5 pcf and 86.7 pcf, respectively.

# Table 29 – Concrete Aggregate Quality Test Results for Crushed Venado Sandstone from Sites Quarry

Table 29A

Sample No.	Degree of	Specific	Gravity	Absorpt	tion (%)	Los Angeles Abrasion (% loss)		
	Weathering	Fine	Coarse	Fine	Coarse	100 Rev.	500 Rev.	
99C-113-A		2.57	2.48	2.4	5.6	11.4	50.8	
99C-113-B	Fresh	2.58	2.49	2.3	5.7	7.3	36.9	
99C-113-C		2.58	2.48	2.5	5.8	11.5	49.5	
99C-114-A		2.56	2.46	2.7	6.4	13.7	56.0	
99C-114-B	Weathered	2.57	2.47	2.7	6.3	9.2	43.5	
99C-114-C		2.57	2.46	2.7	6.3	12.5	54.5	
Average for Average for Weat	2.58 2.57	2.48 2.46	2.4 2.7	5.7 6.3	10.1 11.8	45.7 51.3		

Table 29B

Sample No.	Degree of		mps and irticles (%)	Organic I (standar	mpurities d color)	Bulk Density and Voids	
	Weathering	Fine	Coarse	As Rec'd	Washed	(pcf)	
99C-113-A		6.5	1.55	clear	clear	88.3	
99C-113-B	Fresh	1.7 0.15		clear clear		88.7	
99C-113-C		1.3	0.15	clear	clear	88.6	
99C-114-A		8.6	2.50	2	clear	86.2	
99C-114-B	Weathered	3.0	0.30	3	clear	86.4	
99C-114-C		3.7	0.65	3	clear	87.5	
Average for I Average for Weatl	Fresh Samples = hered Samples =		0.6 1.2	clear 3	clear clear	88.5 86.7	

Table 30 presents the average results from the concrete aggregate quality testing performed on the crushed Venado sandstone from the drill cores and Sites Quarry. This table also includes acceptable limits criteria adopted from USBR's Concrete Manual and ASTM's Test Designation C33, Standard Specification for Concrete Aggregates, for comparison and discussion purposes. As shown, average test results for both the fresh and moderately weathered samples of Venado sandstone were slightly out of the acceptable limits criteria used by USBR and ASTM. However, these test results also indicate that the crushed sandstone is generally within the range of typical values presented in ACI's Manual of Concrete Practice.

# Table 30 - Average Concrete Aggregate Quality Test Results for the Venado Sandstone

				ASTM Test Procedures									
Sample Type	5		Specific Gravity C 127		Absorption C 127 (%)		Los Angeles Abrasion C 131		Rev. (%)		luce a subtice of		Bulk Density and Voids C 29 (pcf)
							100 Rev. 500 Rev.						
			Fine	Coarse	Fine	Coarse	(% loss)	(% loss)	Fine	Coarse	As Rec.	Wash	
Crushed Sandstone from Drill Cores (1 <sup>1</sup> / <sub>2</sub> -Inch Minus)	Fresh	1	-	2.5	-	4.2	11.4	43.4	-	-	-	-	-
Crushed Sandstone from	Fresh	3	2.6	2.5	2.4	5.7	10.1	45.7	3.2	0.6	Clear	Clear	89
Sites Quarry (1½-Inch Minus)	Moderately Weathered	3	2.6	2.5	2.7	6.3	11.8	51.3	5.1	1.2	3	Clear	87
Acceptable Limits*			ıld be 2.6		ot cified	Should be <10%	Should be <40 to 50%		ild be 5%		ot cified	Not Specified	
ACI Range of Typical Values for Aggregates**		1.6 t	o 3.2	0.2 to	4.0%	Not Specified	15 to 50%	0.5 t	o 2%		r 3 or ss	75 to 110 pcf	

\* Acceptable limits criteria adopted from USBR, Concrete Manual, Eighth Edition, 1988; ASTM, Designation C 33, Standard Specification for Concrete Aggregates, 2001; and Waddle, Concrete Construction Handbook, Third Edition, 1993.

\*\* From Guide for Use of Normal Weight Aggregates in Concrete, American Concrete Institute.

#### 9.4 Conclusions and Recommendations

Based upon the test results, the crushed sandstone is considered to marginally meet the criteria for concrete aggregate. However, since the current testing program indicates the sandstone quality is marginal, its suitability for concrete aggregate will require additional testing and evaluation (such as test batches), which is considered beyond the scope of this feasibility investigation.

Since the suitability of the sandstone for use as concrete aggregate can not be confirmed at this level of investigation, the feasibility level cost estimates should include the conservative assumption that aggregates will be imported from the closest sand and gravel source identified in the geologic exploration program. This source was identified as an abandoned channel on Stony Creek, approximately 35 road miles from the project site, with an estimated sand and gravel quantity of roughly 160 million cubic yards. Additional testing and evaluation performed as part of future design studies should also include an economic comparison between importing and producing on-site aggregates to ensure selection of the most economical material source. This comparison should include a detailed examination of the costs required to produce clean concrete aggregate from the Venado sandstone, particularly related to separating the interbedded mudstone and weathered sandstone during excavation and processing operations.

# **10.0** FINAL CONCLUSIONS AND RECOMMENDATIONS

# **10.1 Conclusions**

The construction materials investigation program identified the types of available on-site materials, examined their potential uses, and performed limited testing and evaluation of those materials to determine their suitability for use in the dams and appurtenant structures for the proposed Sites Reservoir project. This investigation was guided by the design principle that available on-site materials should dictate the design and selection of the dam sections.

The construction materials investigation program identified the following material types within or near the proposed Sites Reservoir project area:

- Impervious Materials (terrace deposits and recent alluvium)
- Venado Sandstone (fresh and weathered from the Cortina Formation)
- Mudstone (Boxer Formation)

These material types were further investigated, tested, and evaluated to explore their suitability for use as the following types of construction materials:

- Impervious Materials
- Rockfill and Riprap Materials
- Random Materials
- Filter, Drain, and Transition Materials
- Concrete Aggregate

Materials testing and evaluation indicate the impervious materials available within the project area are suitable as core material for use in embankment dams. Sufficient quantities of impervious material exist upstream of the dam sites. Approximately 36 million cubic yards of material are available from the deposits within the reservoir area. This is roughly four times the volume required for construction of Golden Gate Dam, Sites Dam, and the nine saddle dams. Additional impervious materials are also available within the required excavation areas for the appurtenant structures and Funks Reservoir enlargement.

Material testing and evaluation indicate the fresh sandstone is of sufficient quality for use as clean rockfill and riprap materials. Sufficient quantities of Venado sandstone can be obtained from quarries developed near the dam sites.

Although use of the highest quality rock meeting laboratory test requirements for concrete aggregates is desirable, use of "softer" rock types (such as the Venado sandstone) is an acceptable practice if the rock is the best quality available within the project area. "Softer" or "weaker" rock types have been used successfully in many existing dams provided that conservative estimates of engineering properties are

selected for design. It should be noted that the available types of material should dictate the selected dam section. Design requirements should not dictate material criteria for major embankment zones, only for zones with specific design requirements (such as filters and drains).

Physical properties, strength, and durability testing confirm the observation that the moderately weathered sandstone is a lower quality rock than the fresh sandstone. Dam design criteria generally dictate use of the best quality rock available on site for rockfill and riprap materials. To meet this requirement, it is assumed that only fresh sandstone will be used for riprap and clean rockfill materials, and weathered sandstone will be used for random rockfill material in preparing the feasibility level embankment design and cost estimates. Moderately weathered sandstone may, in fact, be suitable for clean rockfill materials.

Random embankment materials will be comprised of materials that are essentially unsuitable for use as rockfill. The random materials will, therefore, include weathered sandstone, mudstone, slopewash, colluvium, and the like. Unlike rockfill, random materials do not require a strict engineering evaluation of properties. As such, only shear strength and density were investigated as part of this feasibility level investigation. A surplus of random material exists within or near the proposed Sites Reservoir project area. Random material will be generated from required excavation and designated borrow areas for construction of the saddle dams.

Fresh Venado sandstone may be suitable for filter, drain, and transition material as well as concrete aggregate, but feasibility level cost estimates should include the conservative assumption that material will be imported from the closest sand and gravel source identified in the geologic exploration program. This source was identified as an abandoned channel on Stony Creek, approximately 35 road miles from the project site, with an estimated sand and gravel quantity of roughly 160 million cubic yards.

#### **10.2 Recommendations**

#### **Impervious Materials**

Preliminary and final design programs should include further exploration, testing, and evaluation of the impervious materials. Additional testing should include an expanded evaluation of the in-place density, moisture-density relationship, permeability, and shear strength properties due to the limited testing performed as part of this feasibility level investigation. Impervious borrow areas should be selected to minimize the amount of high plasticity lean clays and fat clays. Also, specific borrow areas should be identified and quantified within near vicinity of the dams in conjunction with a constructability review of the project.

#### Rockfill and Riprap Materials

Future design investigations for the Venado sandstone should include test quarries and fills to develop specification requirements. This will ensure that the Venado sandstone will meet design requirements for clean rockfill material, particularly related to limiting the fines content of in-place material. Future design investigations should also include additional testing and evaluation of the Venado sandstone to further define the engineering properties of the clean rockfill material such as: shear strength, hydraulic conductivity, density, etc.. The suitability of weathered sandstone for use as clean rockfill material should also be investigated in future design studies.

Although not discussed in the report, drill cores from the geologic exploration program found a north trending unit of conglomerate within the proposed Sites Reservoir area near the proposed saddle dam sites. Preliminary review of the drill cores indicates the conglomerate may be suitable as rockfill for the saddle dams. Future design investigations should include a comprehensive study of the conglomerate to determine its suitability as a rockfill source.

#### Random Materials

Future design investigations should include a thorough evaluation, as part of the constructability review, to identify and quantify the type of random materials generated from required excavation. The dam embankment section should be developed to incorporate these random materials to the maximum extent possible to minimize generation of waste material.

Further studies, including the preliminary design program, should include additional testing and evaluation of the random materials. Specifically, these investigations should include a comprehensive evaluation of the composition (percent weathered sandstone, mudstone, etc.) and gradation of the random materials that are likely to be generated from required excavation at each of the dam sites. This evaluation should include construction of test fills to assist development of the specification requirements. In addition, compaction, hydraulic conductivity (if necessary), shrink/swell, and triaxial testing of the anticipated random materials should be performed to further refine the engineering properties for use in design of the dam embankments.

With specific regard to the Boxer Formation, excavated random material should be explored and laboratory tested to determine engineering properties, especially for the Sites Dam and saddle dams. In further studies, this material should be tested as a soil type material.

#### Filter, Drain, and Transition Materials

Additional testing and evaluation performed as part of future design studies should also include an economic comparison between importing and producing filter, drain, and transition materials to ensure selection of the most economical material source. This comparison should include a detailed examination of the costs required to produce clean filter, drain, and transition materials from the Venado sandstone, particularly related to separating the interbedded mudstone and weathered sandstone during excavation and processing operations.

Preliminary and final design programs should include placement and compaction of test fills constructed of quarried and processed sandstone materials, with gradations approximating anticipated ranges for filter, drain, and transition materials. This would allow the evaluation of whether the sandstone has sufficient strength and durability characteristics for use as filter, drain, and transition material. The evaluation should focus on the propensity of particle breakdown, which would adversely affect the hydraulic conductivity of the material.

### Concrete Aggregate

Since the current testing program indicates the sandstone quality is marginal, its suitability for concrete aggregate will require additional testing and evaluation (such as test batches). Additional testing and evaluation performed as part of future design studies should also include an economic comparison between importing and producing on-site aggregates to ensure selection of the most economical material source. This comparison should include a detailed examination of the costs required to produce clean concrete aggregate from the Venado sandstone, particularly related to separating the interbedded mudstone and weathered sandstone during excavation and processing operations.

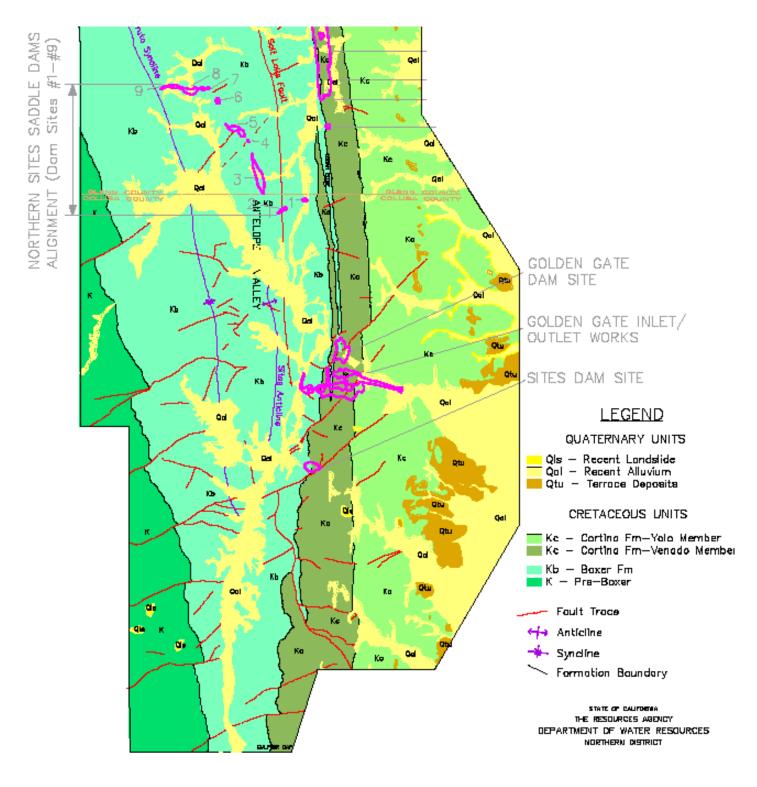
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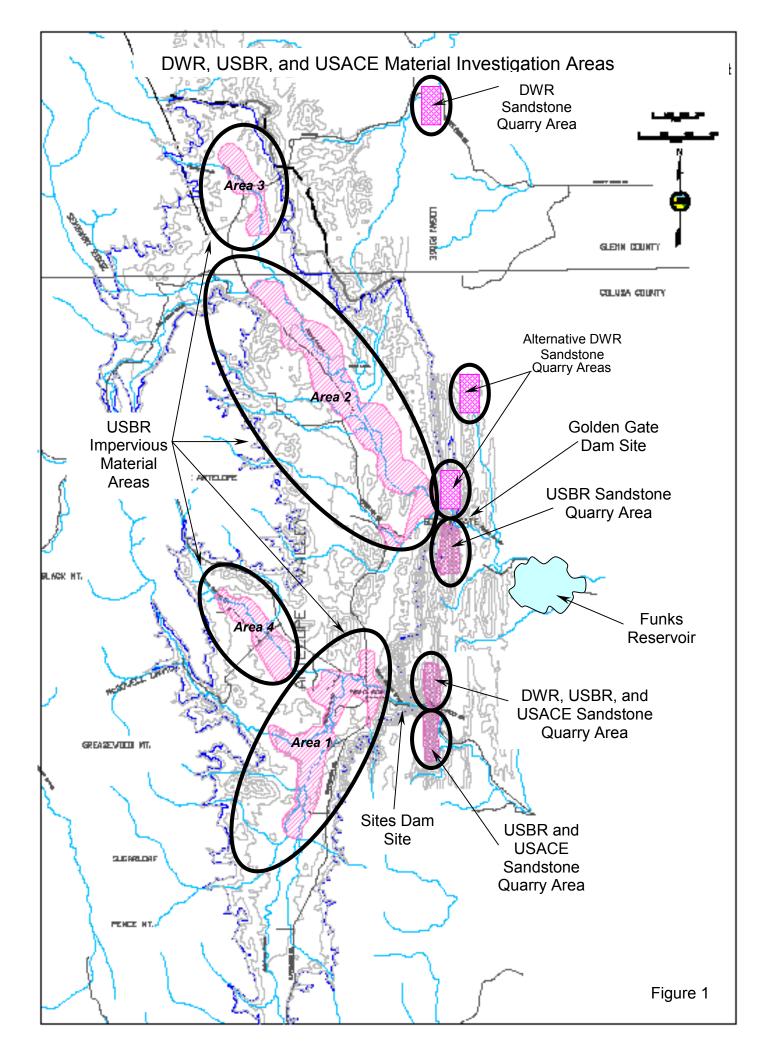
## REFERENCES

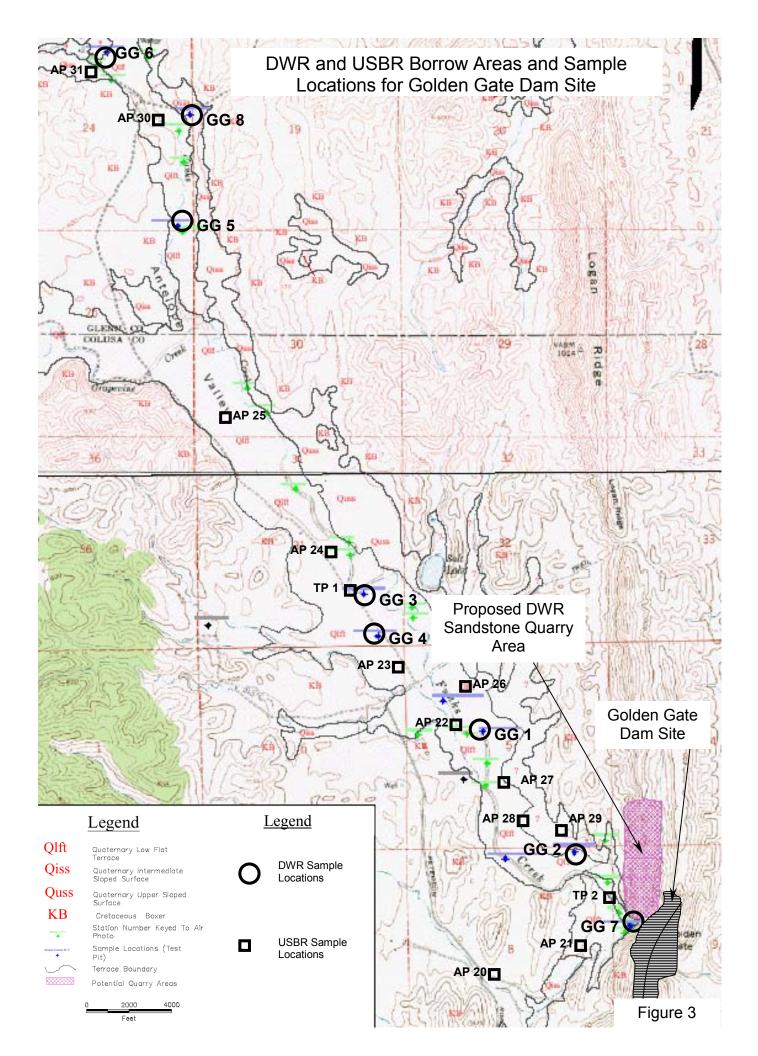
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# Location and Geologic Map of the Sites Reservoir Project

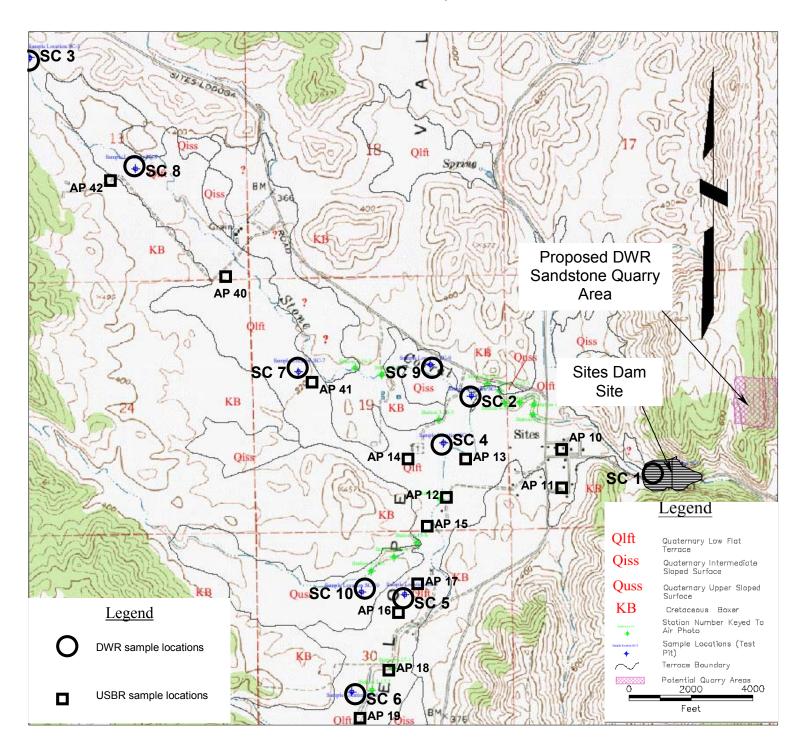


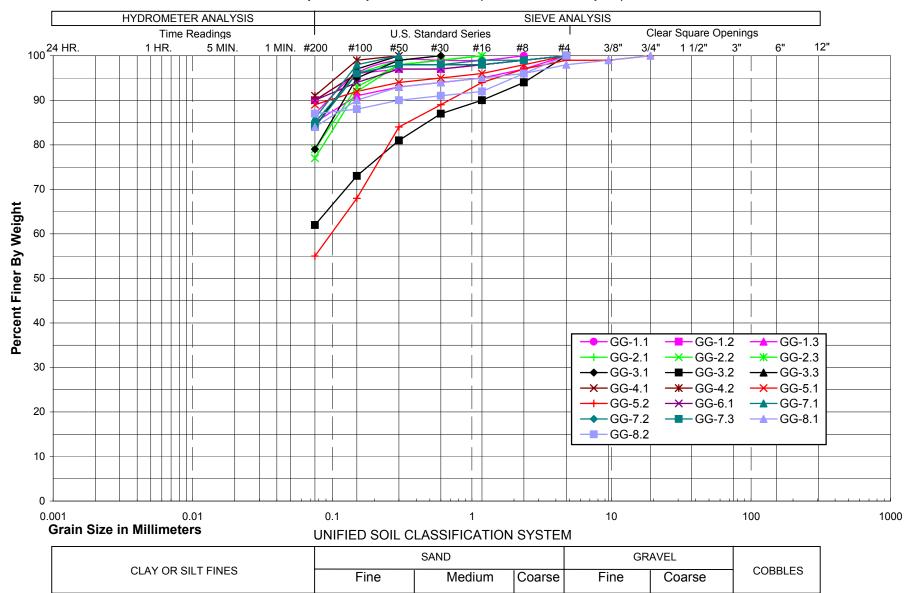
NOTES: Sources of geological data include geologic map interpretation, Brown and Rich (1961), U.S. Geological Survey (1972) and USBR (1983),



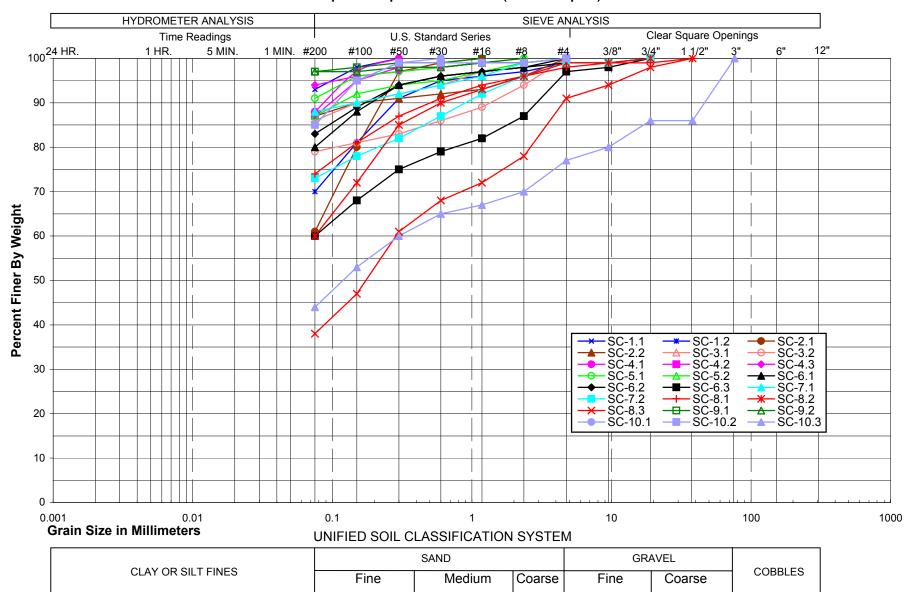


# DWR and USBR Borrow Areas and Sample Locations for Sites Dam Site

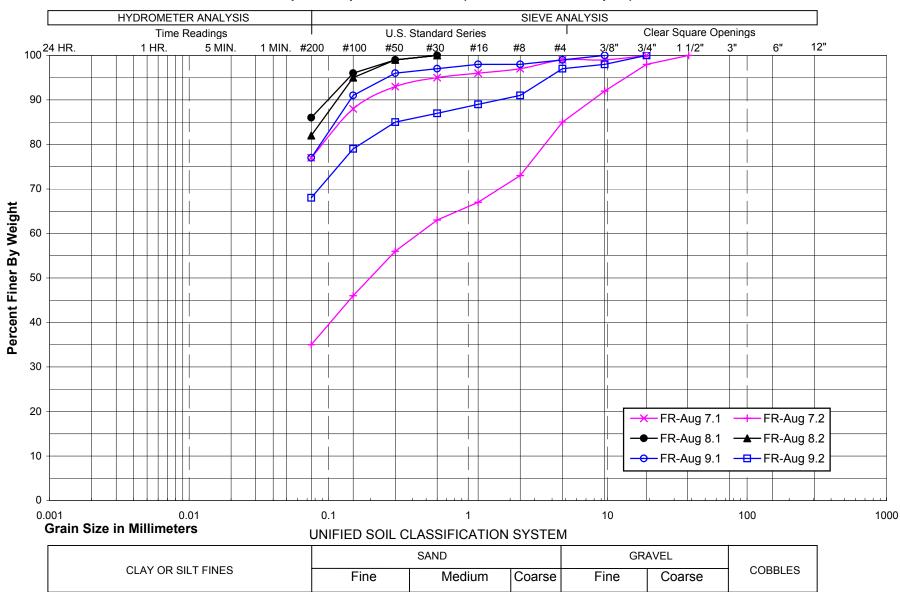




#### Proposed Impervious Material (Golden Gate Samples)

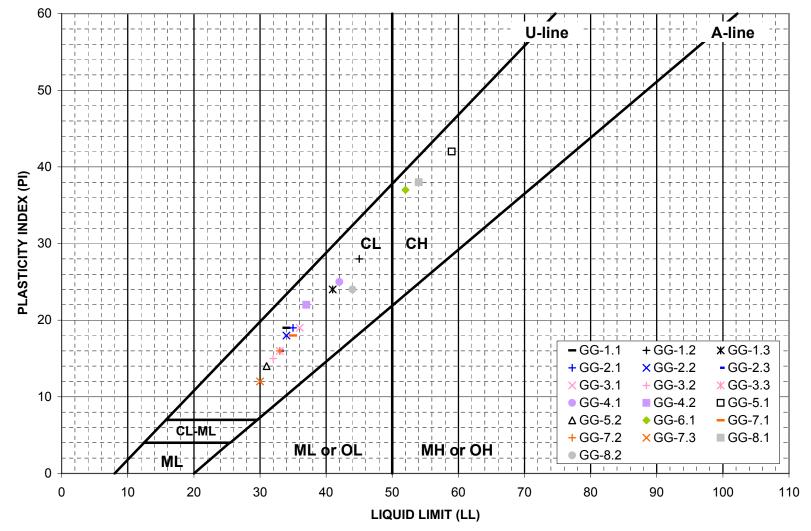


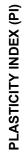
#### **Proposed Impervious Material (Sites Samples)**

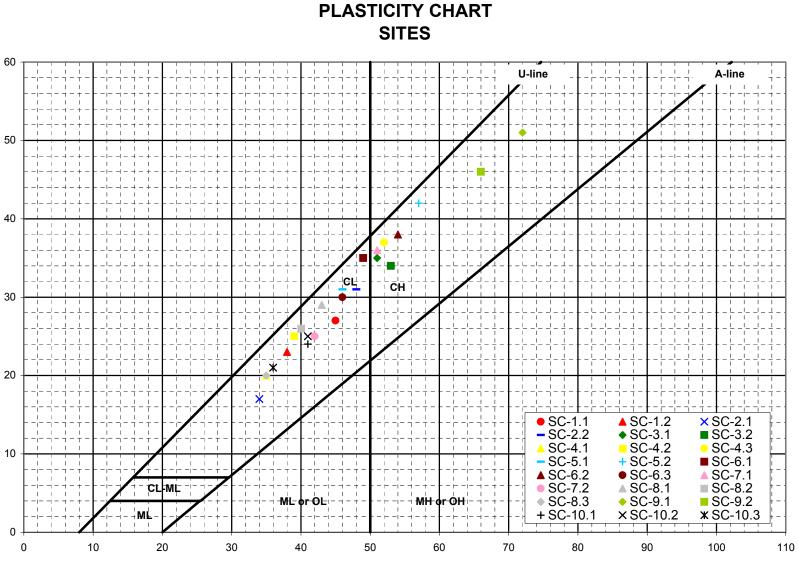


### Proposed Impervious Material (Funks Reservoir Samples)

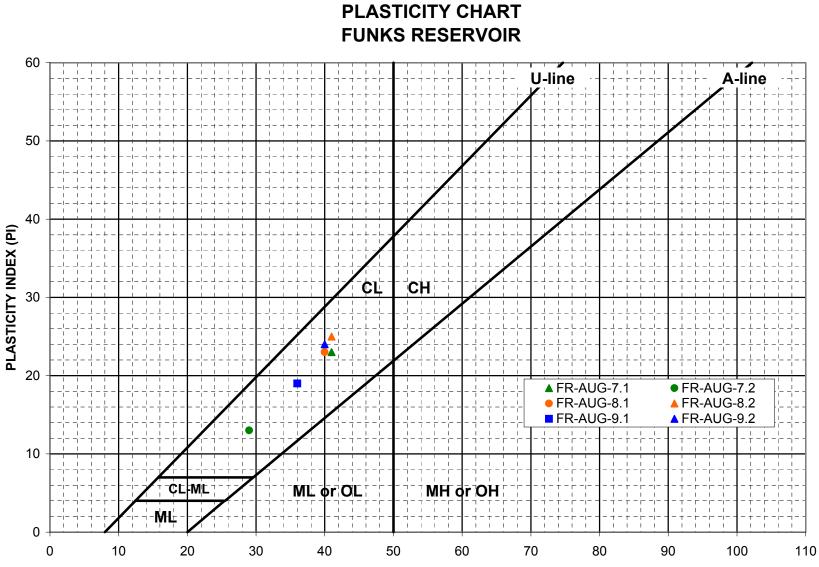








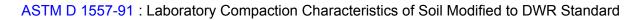
LIQUID LIMIT (LL)

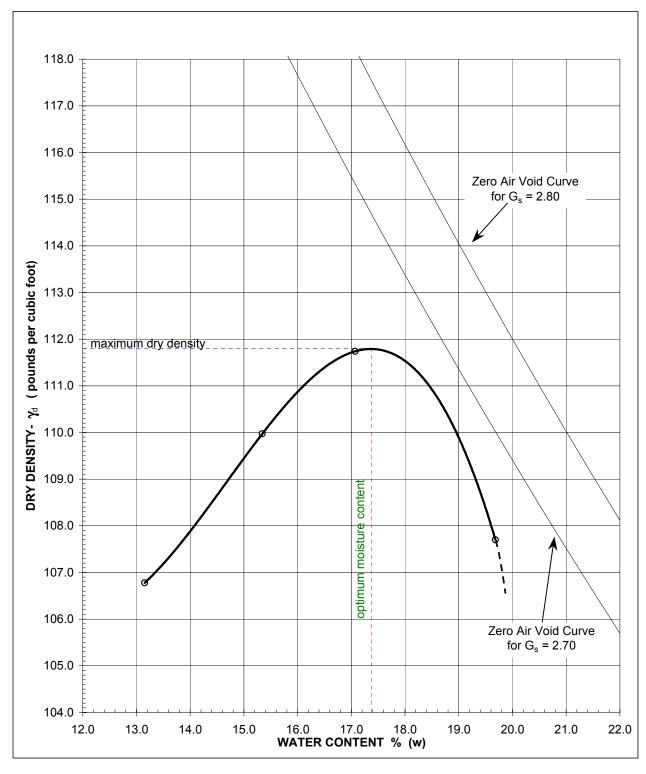


SITES RESERVOIR PROJECT

LIQUID LIMIT (LL)

# COMPACTION TEST



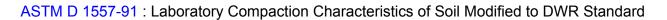


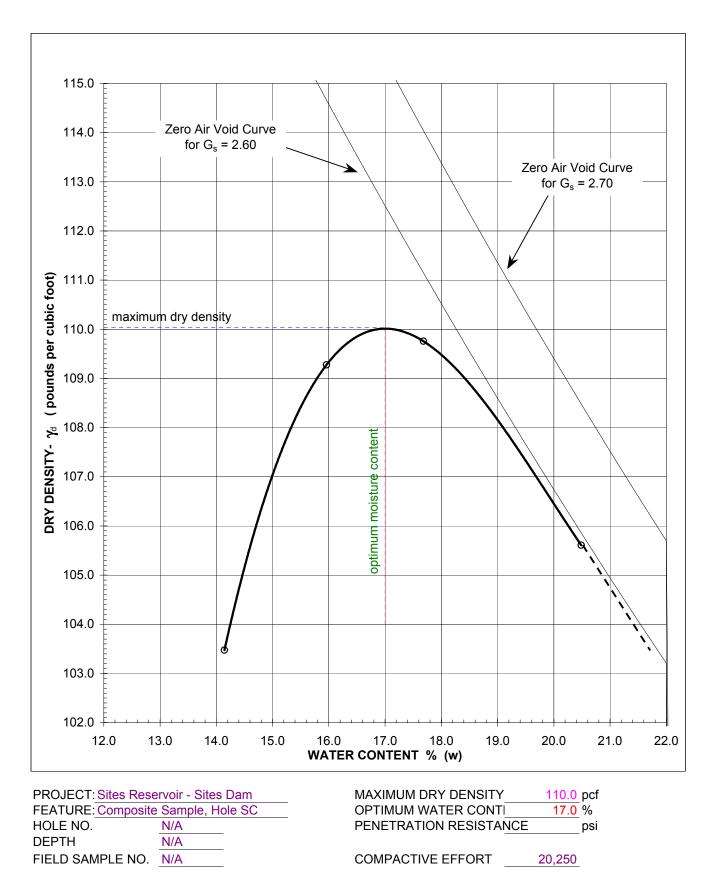
PROJECT: Sites Reservoir - Golden Gate Dam FEATURE: Composite Sample, Hole GG HOLE NO. N/A DEPTH N/A FIELD SAMPLE NO. N/A

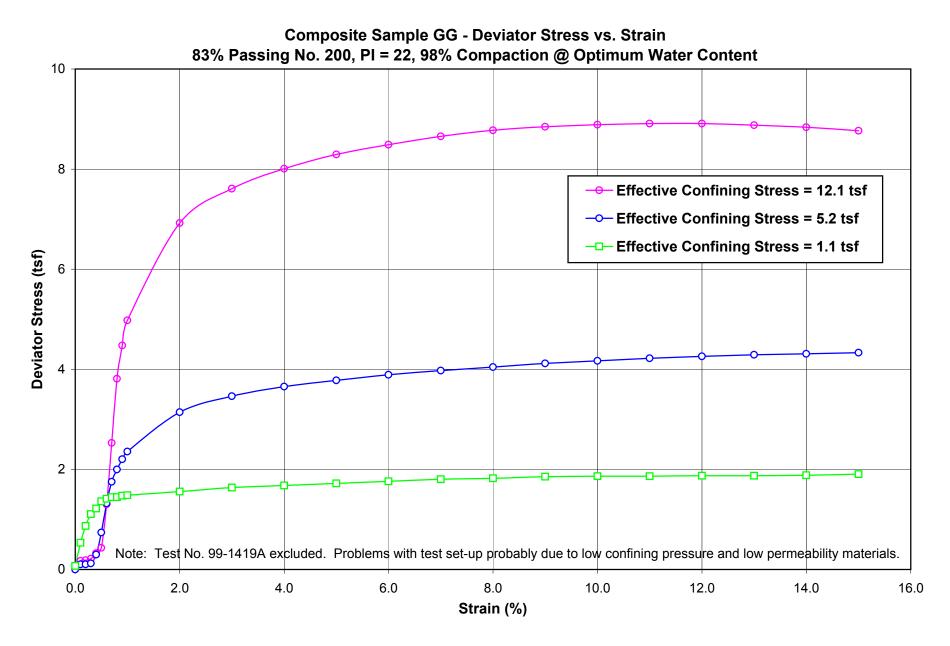
LAB NO. 99-1419 REQUEST NO. 99-51 DATE Sept. 9, 1999 MAXIMUM DRY DENSITY111.8 pcfOPTIMUM WATER CONTEL17.4 %PENETRATION RESISTANCEpsi

COMPACTIVE EFFORT MOLD SIZE SPECIFIC GRAVITY MAX. SIZE TESTED BY 20,250 ft.lb./ft<sup>3</sup> 0.0333 cu. ft. <u>N/A</u> minus No. 4 Dave Tully

# COMPACTION TEST





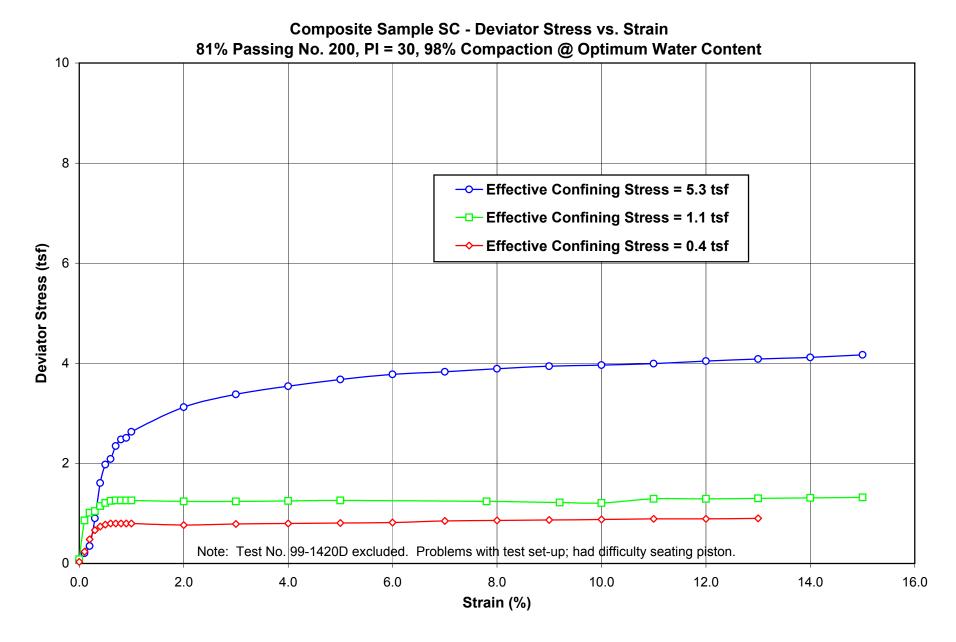


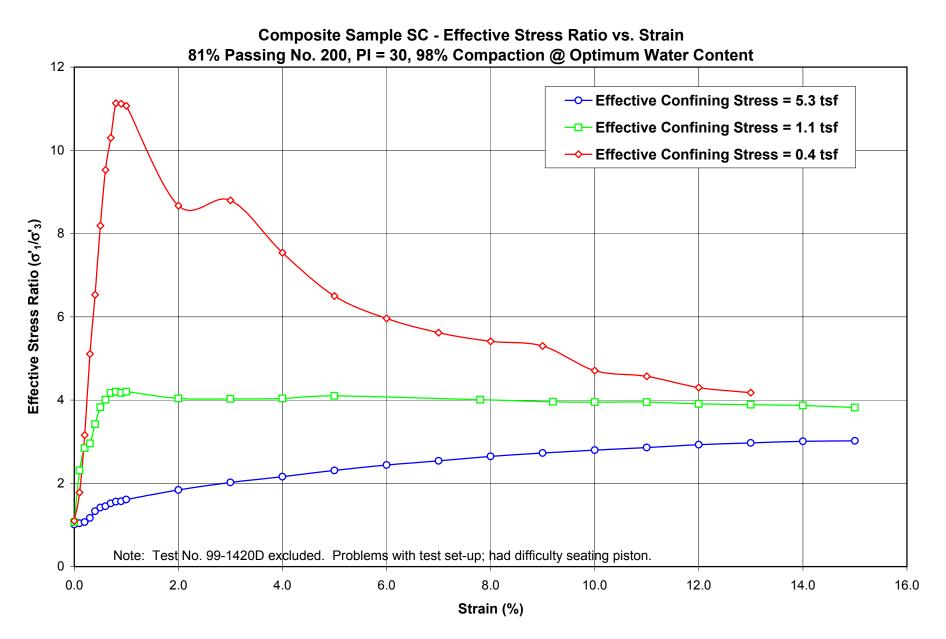
# Composite Sample GG - Effective Stress Ratio vs. Strain 83% Passing No. 200, PI = 22, 98% Compaction @ Optimum Water Content 12 10 Effective Stress Ratio ( $\sigma'_1/\sigma'_3$ ) 8 Effective Confining Stress = 12.1 tsf <del>-</del> 6 -O-Effective Confining Stress = 5.2 tsf -D- Effective Confining Stress = 1.1 tsf 4 2 Note: Test No. 99-1419A excluded. Problems with test set-up probably due to low confining pressure and low permeability materials. 0 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 Strain (%)

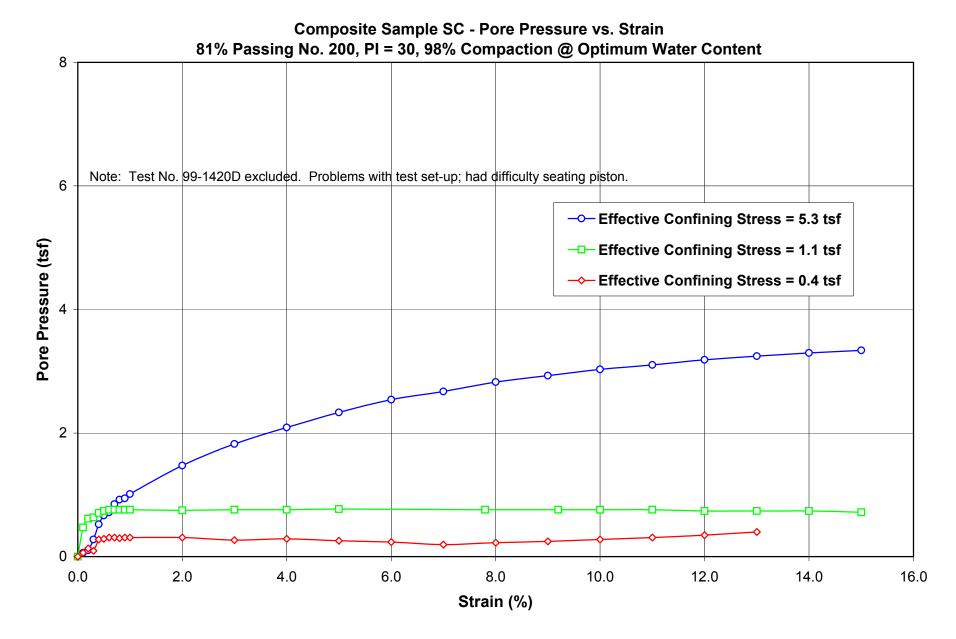
### SITES RESERVOIR - MATERIALS INVESTIGATION

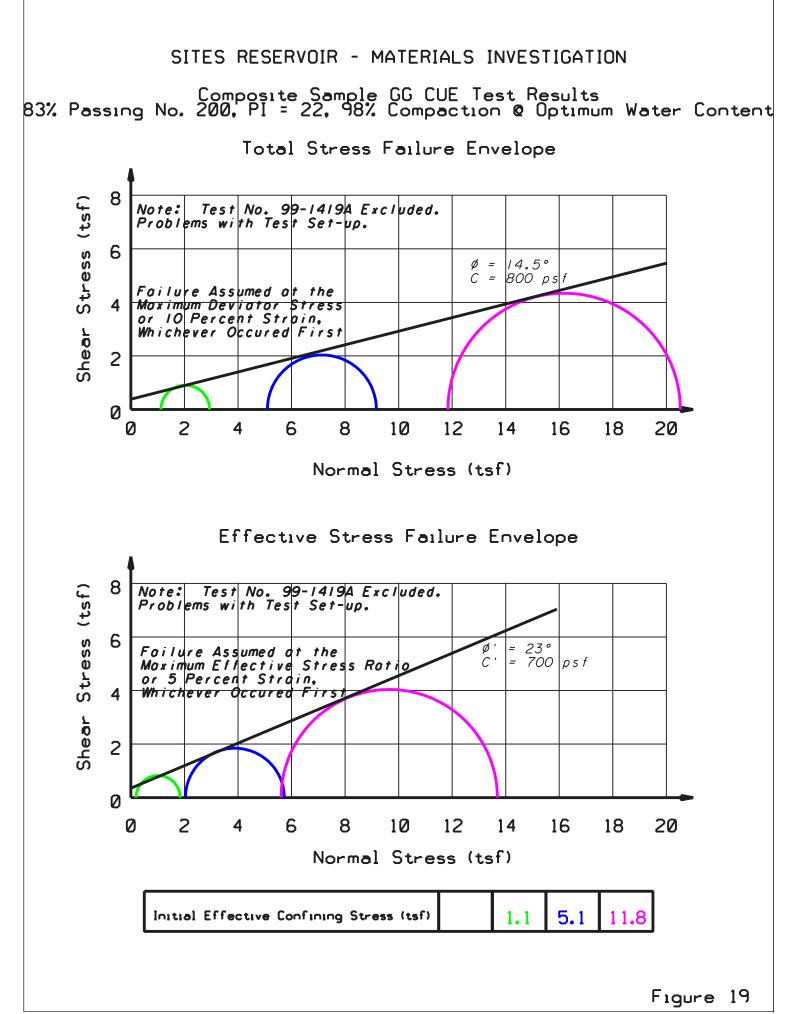
# Composite Sample GG - Pore Pressure vs. Strain 83% Passing No. 200, PI = 22, 98% Compaction @ Optimum Water Content 8 6 ----- Effective Confining Stress = 12.1 tsf Pore Pressure (tsf) ---- Effective Confining Stress = 5.2 tsf -D-Effective Confining Stress = 1.1 tsf 4 2 Note: Test No. 99-1419A excluded. Problems with test set-up probably due to low confining pressure and low permeability materials. 0 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 Strain (%)

### SITES RESERVOIR - MATERIALS INVESTIGATION

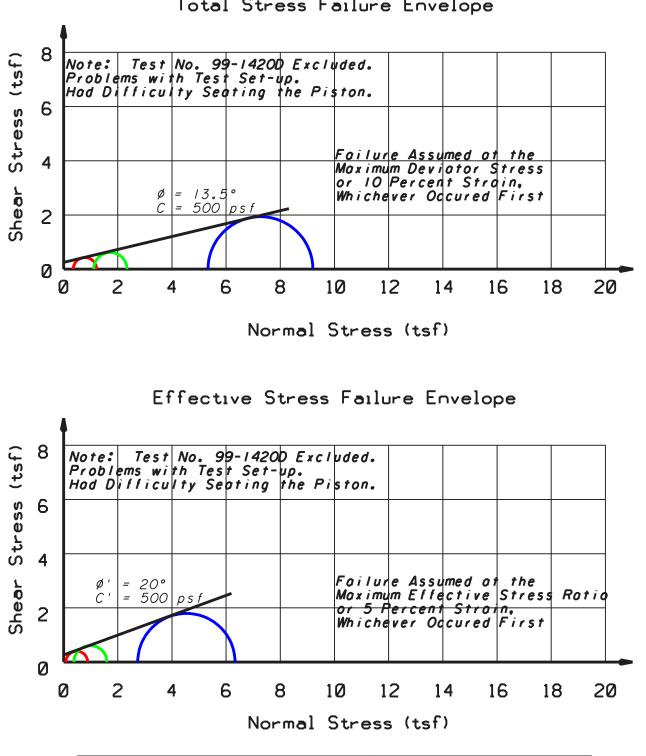




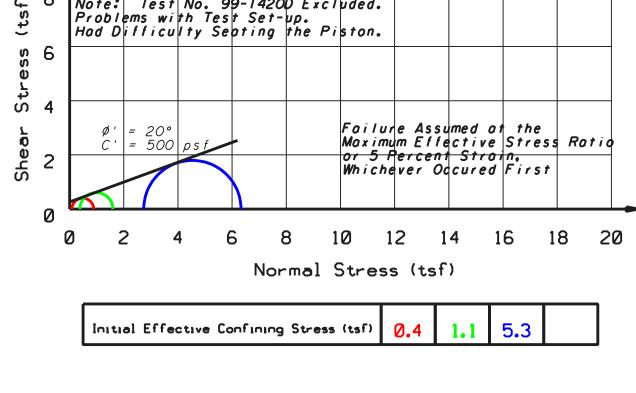




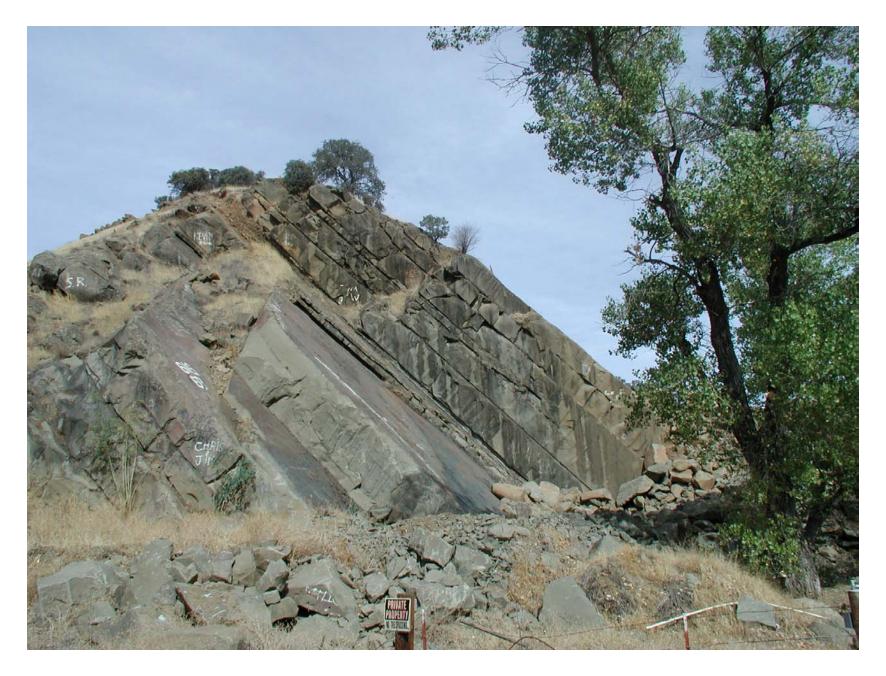
Composite Sample SC CUE Test Results 81% Passing No. 200, PI = 30, 98% Compaction @ Optimum Water Conten

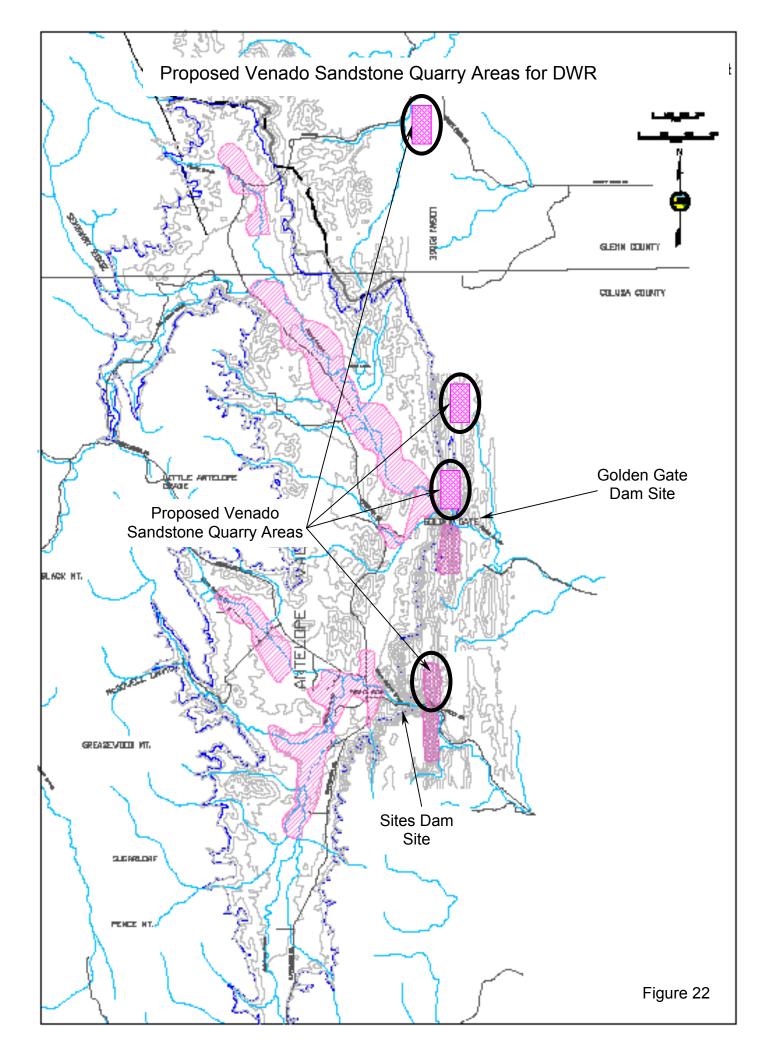


Total Stress Failure Envelope

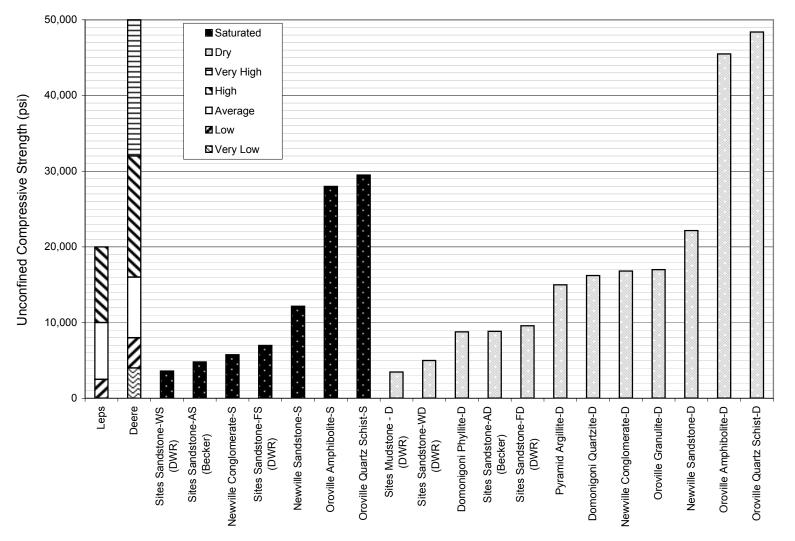


# Venado Sandstone at Sites Quarry





### **Rock Strength and Classification**



F=Fresh, W=Weathered, A=Average, D=Dry, S=Saturated

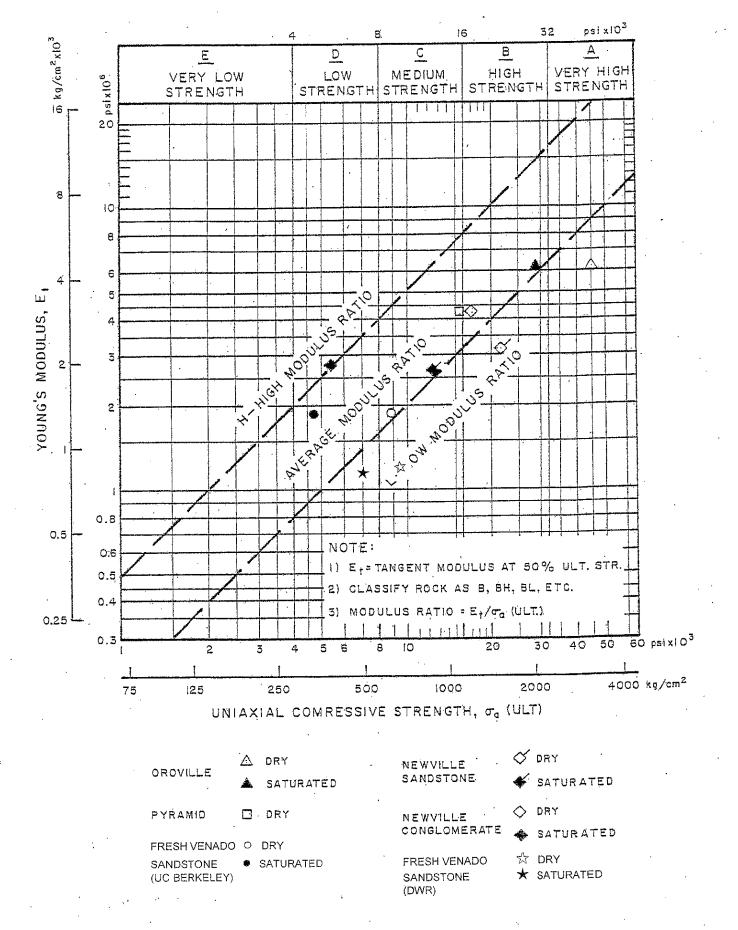
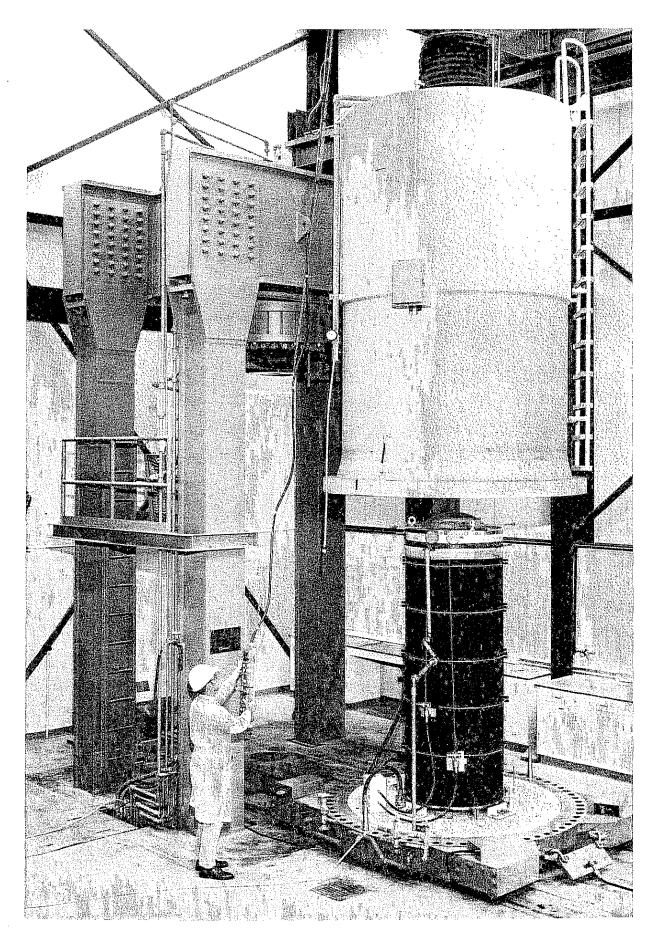
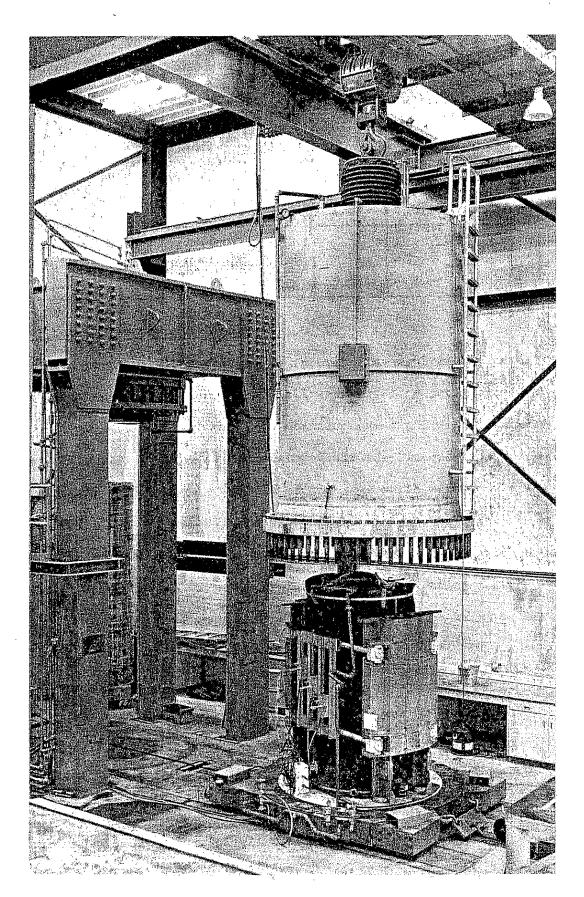


Figure 24

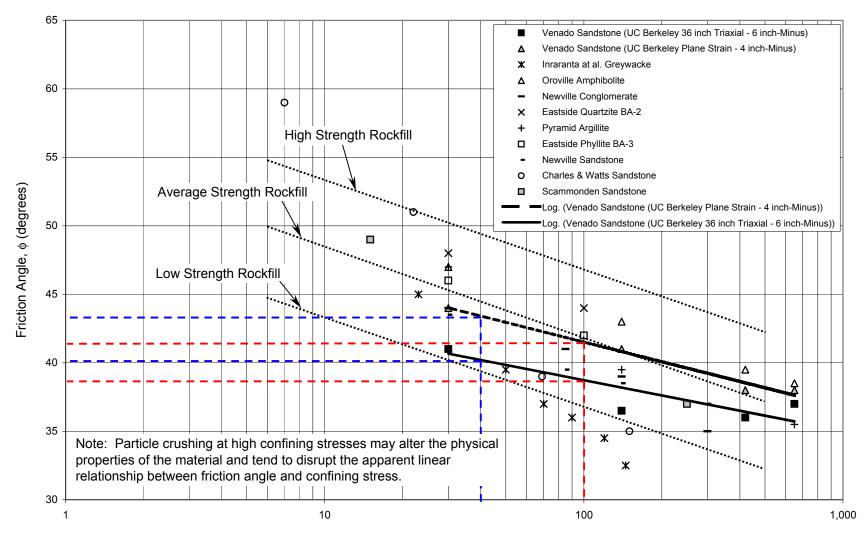
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UC Berkeley Large-Scale Triaxial Testing Apparatus

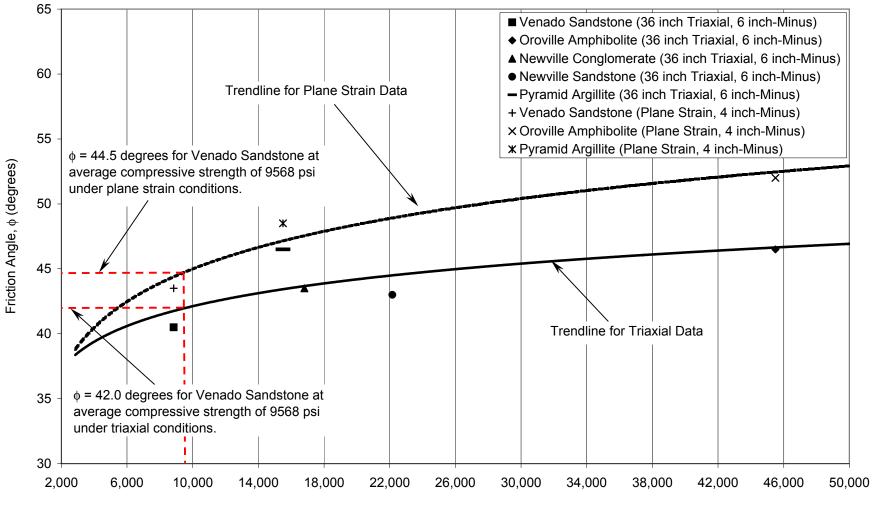


UC Berkeley Large-Scale Plane Strain Testing Apparatus



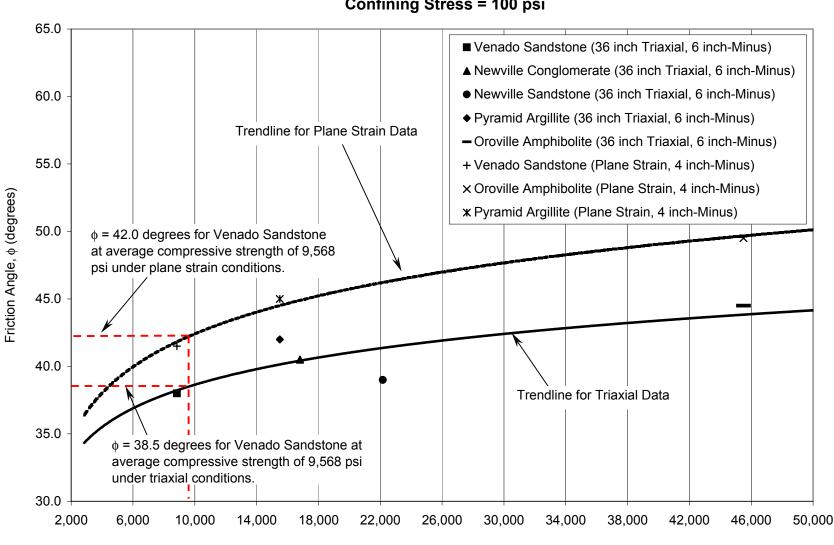
### **Comparison of Confining Stress and Friction Angle for Rockfill Materials**

Confining Stress (psi)



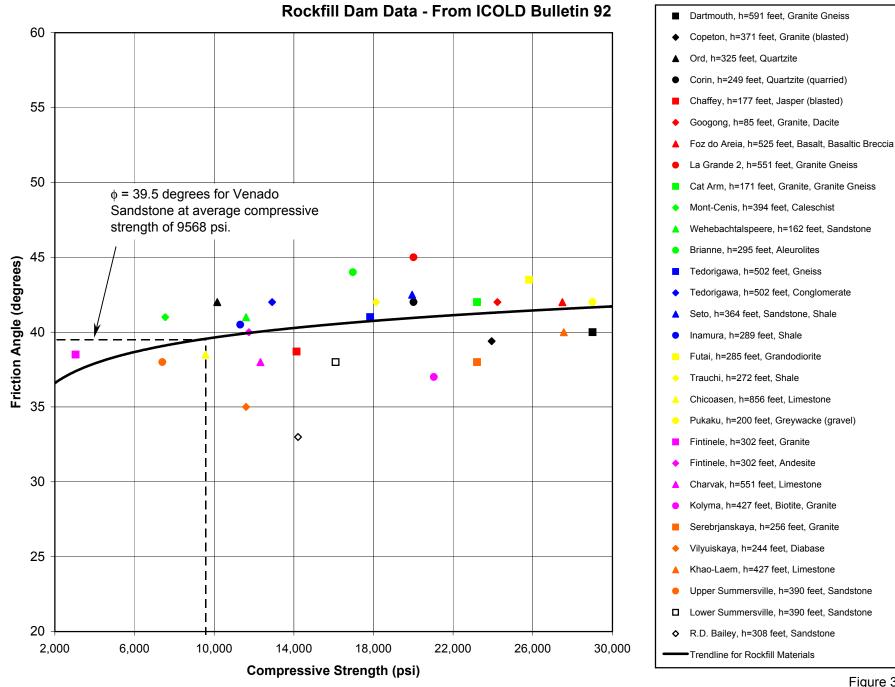
Comparison of Compressive Strength and Friction Angle of Rockfill Materials Confining Stress = 40 psi

Dry Unconfined Compressive Strength (psi)

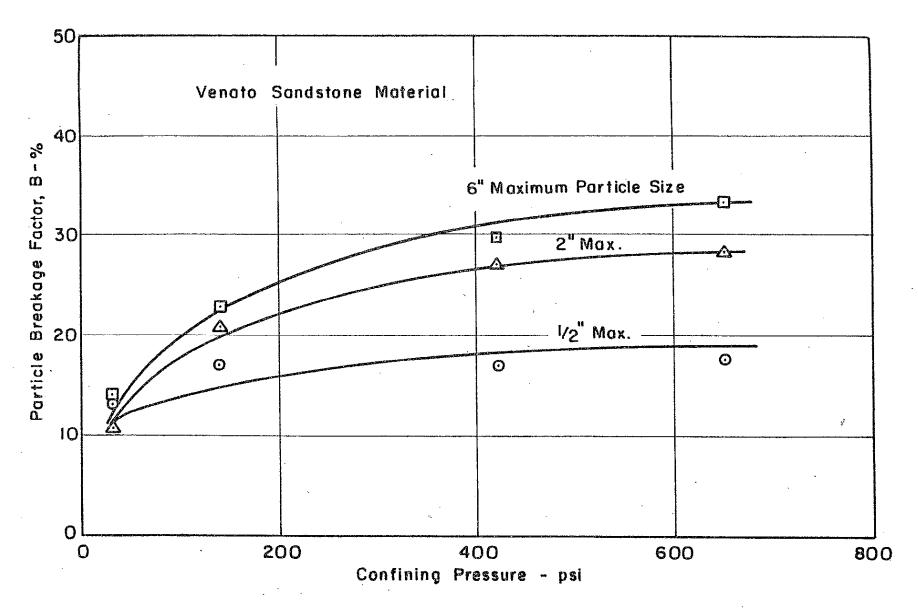


### Comparison of Compressive Strength and Friction Angle of Rockfill Materials Confining Stress = 100 psi

Dry Unconfined Compressive Strength (psi)

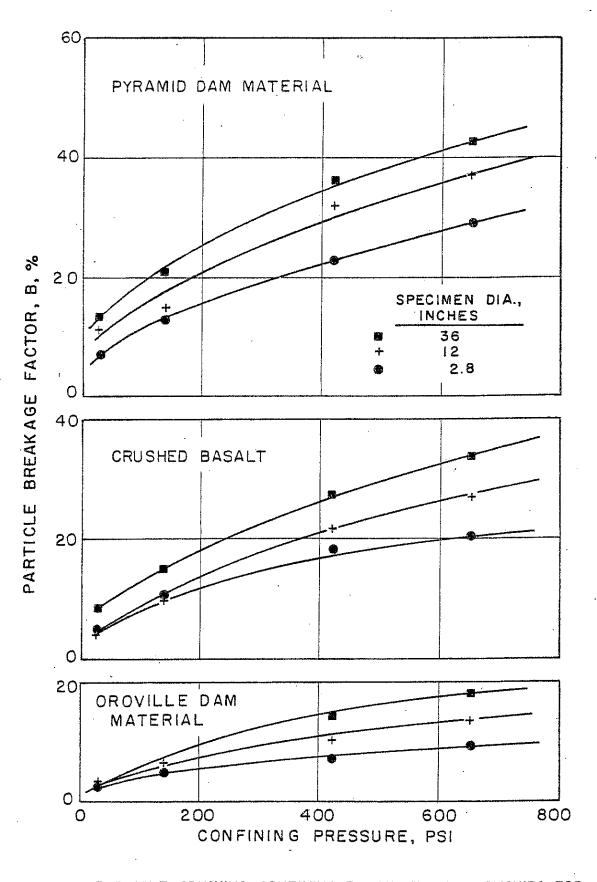


## **Comparison of Compressive Strength and Friction Angle for Rockfill Materials**

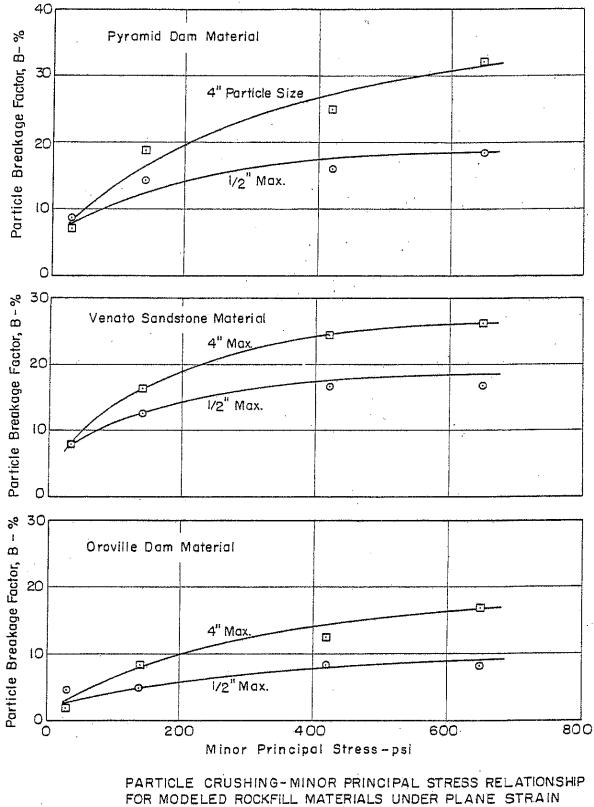


PARTICLE CRUSHING-CONFINING PRESSURE RELATIONSHIP FOR MODELED ROCKFILL MATERIAL UNDER TRIAXIAL CONDITIONS

Figure copied from UC Berkeley report by Becker et. al., 1972.

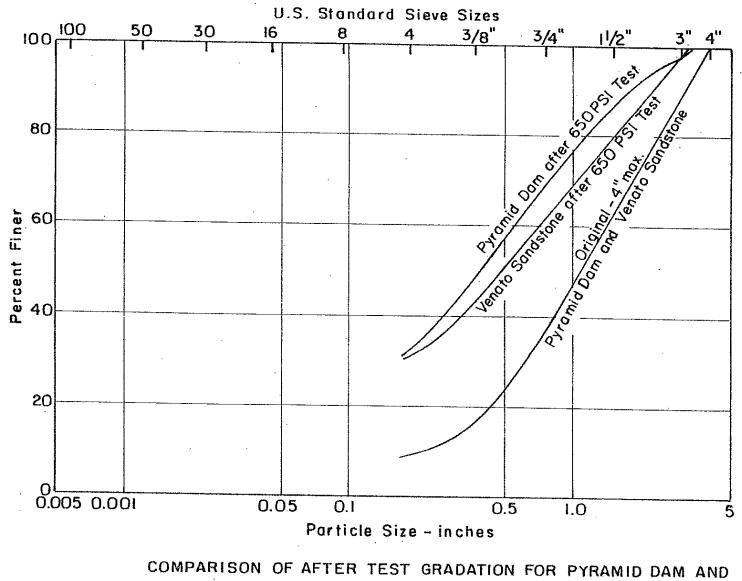


PARTICLE CRUSHING-CONFINING PRESSURE RELATIONSHIPS FOR MODELED ROCKFILL MATERIALS Figure 32



CONDITIONS

Figure copied from UC Berkeley report by Becker et. al., 1972.



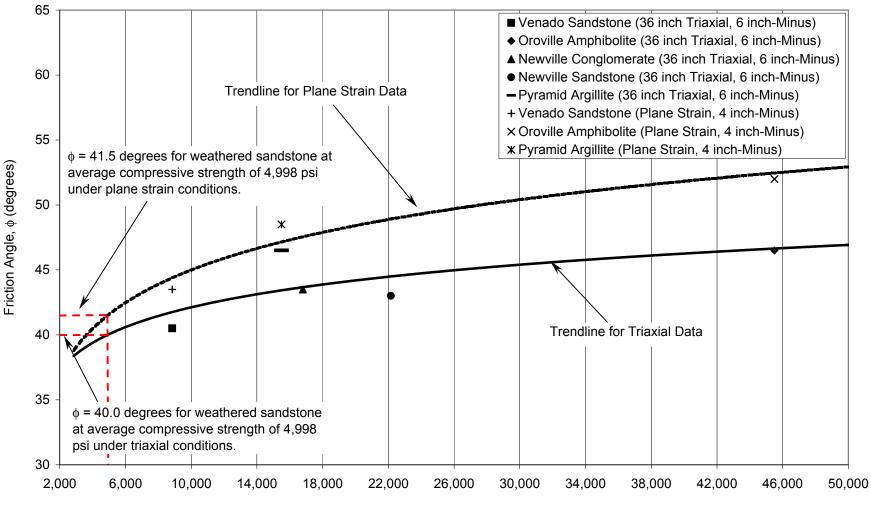
VENATO SANDSTONE MATERIALS UNDER PLANE STRAIN CONDITIONS FOR TESTS AT 650 PSI MINOR PRINCIPAL STRESS

Figure copied from UC Berkeley report by Becker et. al., 1972.

Figure 34

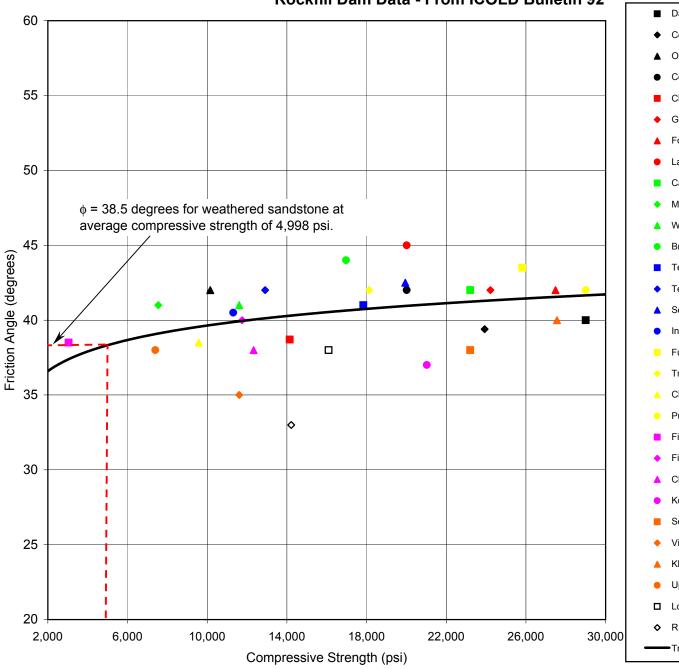
# Venado Sandstone Used as Upstream Slope Protection at Funks Reservoir Dam





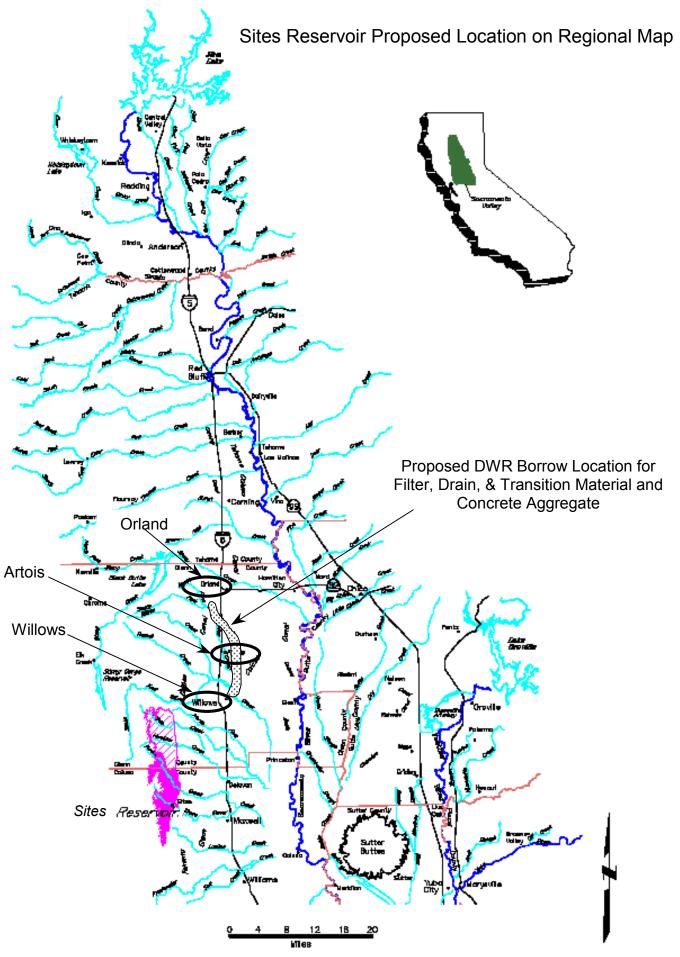
Comparison of Compressive Strength and Friction Angle of Rockfill Materials Confining Stress = 40 psi

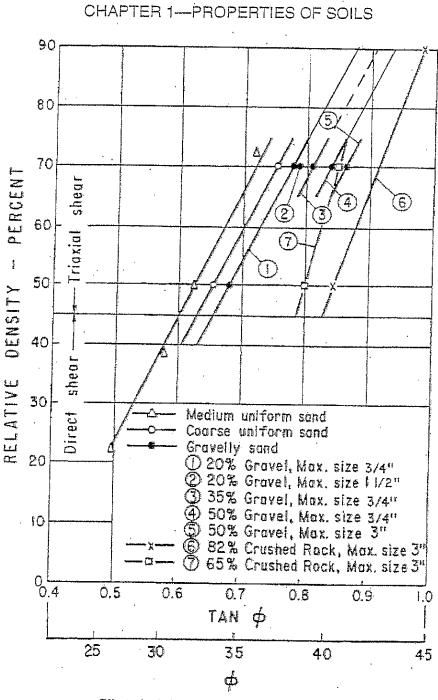
Dry Unconfined Compressive Strength (psi)

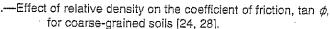


# Comparison of Compressive Strength and Friction Angle for Rockfill Materials Rockfill Dam Data - From ICOLD Bulletin 92

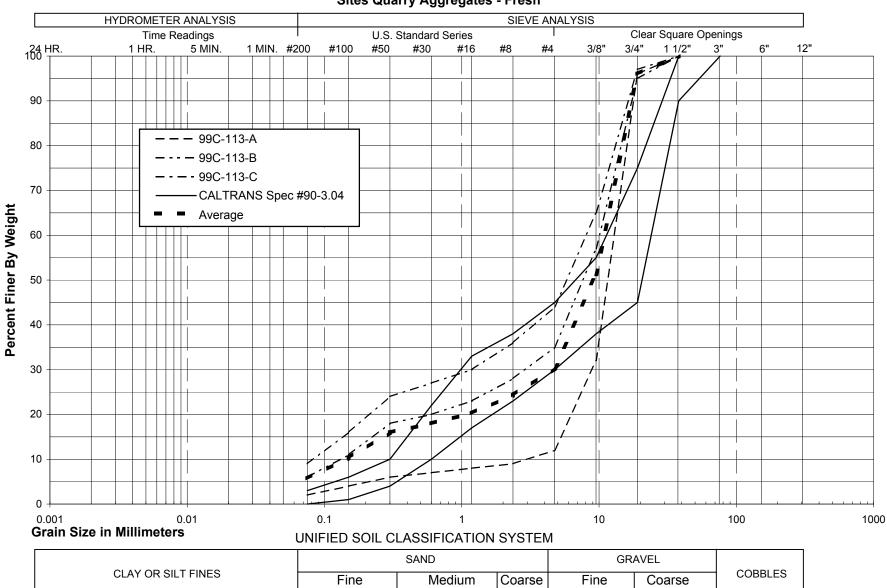
- Dartmouth, h=591 feet, Granite Gneiss
- Copeton, h=371 feet, Granite (blasted)
- ▲ Ord, h=325 feet, Quartzite
- Corin, h=249 feet, Quartzite (quarried)
- Chaffey, h=177 feet, Jasper (blasted)
- Googong, h=85 feet, Granite, Dacite
- ▲ Foz do Areia, h=525 feet, Basalt, Basaltic Breccia
- La Grande 2, h=551 feet, Granite Gneiss
- Cat Arm, h=171 feet, Granite, Granite Gneiss
- Mont-Cenis, h=394 feet, Caleschist
- Wehebachtalspeere, h=162 feet, Sandstone
- Brianne, h=295 feet, Aleurolites
- Tedorigawa, h=502 feet, Gneiss
- Tedorigawa, h=502 feet, Conglomerate
- Seto, h=364 feet, Sandstone, Shale
- Inamura, h=289 feet, Shale
- Futai, h=285 feet, Grandodiorite
- Trauchi, h=272 feet, Shale
- Chicoasen, h=856 feet, Limestone
- Pukaku, h=200 feet, Greywacke (gravel)
- Fintinele, h=302 feet, Granite
- + Fintinele, h=302 feet, Andesite
- ▲ Charvak, h=551 feet, Limestone
- Kolyma, h=427 feet, Biotite, Granite
- Serebrjanskaya, h=256 feet, Granite
- Vilyuiskaya, h=244 feet, Diabase
- Khao-Laem, h=427 feet, Limestone
- Upper Summersville, h=390 feet, Sandstone
- □ Lower Summersville, h=390 feet, Sandstone
- R.D. Bailey, h=308 feet, Sandstone
- Trendline for Rockfill Materials





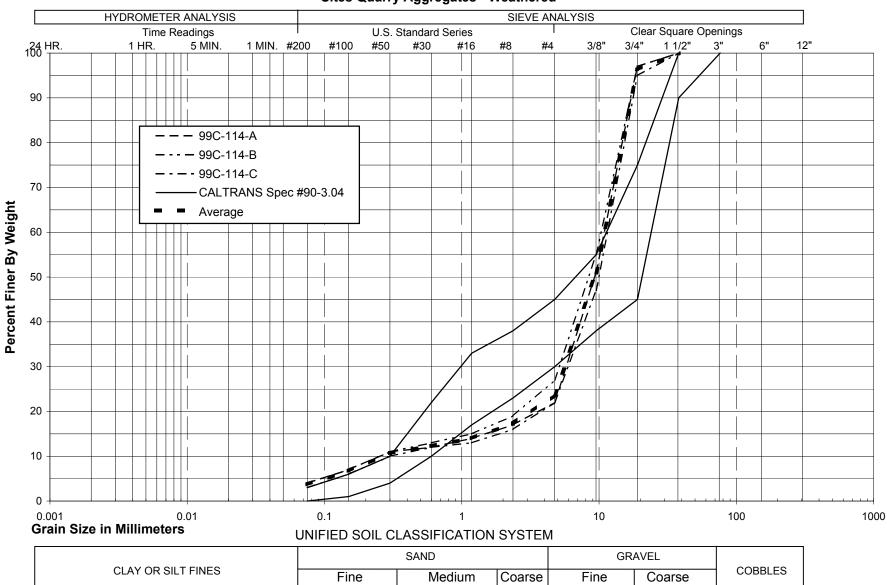


### SITES RESERVOIR



Sites Quarry Aggregates - Fresh

### SITES RESERVOIR



Sites Quarry Aggregates - Weathered

# APPENDIX A

# IMPERVIOUS MATERIAL COMPOSITION OF DWR COMPOSITE SAMPLES

# Composite Sample SC 99-1420

Composite sample with equal portions of the samples shown in bold (samples not used are: 99-749, 99-750, 99-751, and 99-754).

DEPTH (feel)	£	10	15	2	10	S	10	15	5	10	<b>9</b>	10	- <del>12</del>	£	40	2	10	45
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NOLE	SC-4			SC-5		SC-6			SC-7		SC-8			<del>80 8</del>		SC-10		
LAB NO:	99-737	99-738	627-99	99-740	99-741	99-742	99-743	99-744	99-745	99-746	99-747	99-748	<del>99-749</del>	<del>99-750</del>	<del>99 751</del>	99-752	99-753	<del>792-66</del>

# Composite Sample GG 99-1419

Composite sample with equal portions of the samples shown in bold (samples not used are: 99-765, 99-765, 99-767, and 99-768).

DEPTH	(feet)	ц	10	15	5	10	15	5	94	15	4	6	5	45	ო	5	10	15		8
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HOLE	NO	GG-1			GG-2			GG-3			GG-4		GG-5		<del>66 6</del>	GG-7			GG-8	
LAB	NO.	<b>99-755</b>	957-96	99-757	99-758	99-759	99-760	99-761	<u>99 762</u>	99-763	99-764	<del>592-66</del>	99-766	<del>89 767</del>	<del>89/ 66</del>	692-66	022-66	99-771	99-772	<u> 66-773</u>

# APPENDIX B

# IMPERVIOUS MATERIAL CLASSIFICATION, GRADATION, ATTERBERG LIMITS, SPECIFIC GRAVITY, AND ORGANIC CONTENT TEST RESULTS FOR DWR SAMPLES

DIVISION OF ENGINEERING	CIVIL ENGINEERING BRANCH DAMS AND CANALS SECTION				CLASSIFICATION	E. GROUP NAME	Lean clav	Lean clav	Leán clav with sand	Lean clay with sand	Sandy lean clay	Lean clay with sand	Lean clay	Lean clay	Fat clay	Sandy lean clay	Fat clay	Lean clay	Lean clay with sand	Lean clay with sand	Fat clay with sand	LEAD CIAY	IM - INSUFFICIENT MATERIAL NP - NON-PLASTIC NG - NO GOOD								
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CLASSIFICATION TEST SUMMARY		Golden Gate Dam site		HYDROMETER	SILT & CLAY																										
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	DE	PROJECT:			2 			99-/-99		107-88	00-750	09-760	99-761	<u> 99-762</u>	99-763	99-764	99-765	<u> 99-7-66</u>	99-767	99-768	692-66	017-99-770	99-771	99-772							

' / .

يې . **CLASSIFICATION TEST SUMMARY** THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

STATE OF CALIFORNIA

CIVIL ENGINEERING BRANCH DAMS AND CANALS SECTION DIVISION OF ENGINEERING

.

FEATURE: Sites Dam site

Sites Reservoir

PROJECT:

										PERCE	ERCENT FINER	1 1 1										
							MECI	MECHANICAL ANALY	L ANAL	Ysls.					HYDE	HYDROMETER	۹ ۲	ATTERBERG	ERG SPEC			CLASSIFICATION
LAB	HOLE	υ μ			<u>e</u>	GRAVEL					SAND	<u>i</u>			SILT	SILT & CLAY		ELMI3	GRAV	AV ORG	 GROUP	
ğ	Ş	NO.	 	6	1.12	31.	3/8	4	8	16	30	22	100	200	5M	2M	1 ML	LL.	P.I#4	4 %	SYMBOL	GROUP NAME
98-157	SC-1	-						-				100	98	93				45 2	27 2.78	78 4.7	 CL	Lean clay
98-158		10				100	66	66	97	96	95.	5	81	70	 			38	23 2.79	79 3.6	CL	Sandy lean clay
98-159	SC-2	~								100	66	97	80	61				34	17	- 3.7	 СГ	Sandy lean clay
98-160		2						100	96	33	92	6	60	87				48	31	4.4	 CL	. Lean clay
98-161	SC-3	~						100	66	- 26	94	92	60	86				51	35	- 4.9	 CH	Fat clay
98-162		2						100	94	. 68	86	83	81	79				53	34 -	- 5.0	 сн	Fat clay with sand
99-737	SC-4	~	ß						-			100	97	88			 	35 2	20		CL	· Lean Clay
99-738		2	10					100	66	66	80	98	95	87				39	25		 CL	Lean clay
-99-739		e	15					100	66	66	86	97	96	94	   .			52	37		 CH	Fat clay
99-740	SC-5	-	ഹ						100	66	86 08	97	96	9				46	31		 с С	Lean clay
99-741		2	10					100	66	97	95	94	92	87	 			21	42	-	 CH	Fat clay
99-742	SC-6		ъ			100	66	66	98	97	96	94	88	80				49	35		CL	Lean clay with sand
99-743		N	<del>.</del> 0					100	98	97	96	94	89	83	·			5	38		 СН	Fat clay with sand
99-744		с С	15			100	98	97	87	82	79	75	68	60	 		-	46	30		CL	Sandy lean clay
99-745	SC-7	-	പ					100	- <b>6</b> 6	96	94	92	06	88				51 3	36		 СН	Fat clay
99-746		2	10			100	66	66	96	92	87	82	78	73				42	25		 CL	Lean clay with sand
99-747	SC-8	ł	5		100	66	99	98	96	94	91	87	81	74	·			43 2	29		 CL	Lean clay with sand
99-748		2	10			100	66	66	96	93	60	85	72	60				40	26		 сг	Sandy lean cláy
99-749		ę	15		100	98	94	91	78	72	68	61	47	38				35	20		 sc `	Clayey sand
99-750	SC-9		5							100	66	66	<u> 98</u>	97		•		72 1	51		 СН	Fat clay
99-751		2	Ģ						100	66	98	- 98	97	97	<del>.</del>			66	46		 сн	Fat clay
99-752	SC-10	-	ۍ								100	66.	95	85				41	24		 CL	Lean clay with sand
99-753		2	0					<u>10</u> 0	66	66	66	66	95	85				41	25		 CL	Lean clay with sand
99-754		6	15	100	86	86	80	17	02	67	65	-09	53	44			 ·	36	21		 SC	Clayey sand with gravel
						ļ							· · .									. Sheet 1 of 1
DATE:		6/3/98	/98			REM	REMARKS:															IM - INSUFFICIENT MATERIAL
	ļ									·												

NP - NON-PLASTIC GOOD ON : 9N

6/3/98 RGJ 98-18

REQUEST NO.: INITIAL: DATE:

94

DIVISION OF ENGINEERING CIVIL ENGINEERING DAMS AND CANALS SECTION

**CLASSIFICATION TEST SUMMARY** 

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

Page 1 of 1

Page 1 of 1											-																								
				CLASSIFICATION			GROUP NAME	-	Lean clay with sand		Clayey sand		Lean clay	t ann alan with Cand	דבפון כומל אוון סמות	Lean clay with sand		Sandy lean clay	-		•							÷	-		M - INSUFFICIEN   MATERIAL	NP - NON-PLASTIC	NG - NO GOOD		
	1					ROUP.	YMBOL:	 - -	ъ		SC		ರ	5	3	5		ե																	
						RCENT (	CANCS S	_	_			_					 																		
					Moisture	CONTENT RERCENT GROUP	%																			*****	;-								
			 		ERG MC	¢ ç	:		23		13		23		1	19		24					•												
					ATTERBERG	LIMITS	la 11.		41		29		6	17		36		40																	
	1		<u>ع</u> د			0,001	un			,												·.													
			OMETE	S.CLAY	2M	0.002	um									-							• <b>•</b> •••			1								•	
FEATURE: Funks Reservoir			≦id∧H· ∵	SILT & CLAY	\$W	0.005 0	шш						••••• ••		- <u>+</u>								·	•			-	<u> </u>	_						
unks F					2	0.075	шш	_	2		35	-	86	5	3	11		68		,															• .
ц Ц					100	0.15	шШ		88	-	46		86	ž	R	16		79																	
EATU					50	0.3	шШ		93		56		99	00	<u>.</u>	96		85																	
14		LENGER -		:CAND:	30	0.6	шш		95		63		100	ton		97	<u> </u>	87					• • •												
	فجفد أحذمن	FIERCENT FINER			16	1.18	min		96		67					98		89							<b>-</b>										
			AL ANALYSIS-		8	2.36	unu		97		73					86		91																	
			ANICAL		4	4.75	шш		99		85					99	-	76							!										
			:. MECHANICA		3/8"		mm –		66		92				_	-001		98									_					I	I		
					3/4"	: 19	tuur	••••	100		98					<del> </del> -		100																	
				GRAVEL	1,5"	37.5					100																								
					3.0"		աա																							-			08		
ervoir									0-15		15-25		5-20	75.95		0-15		20-30				_		_						10/01/2	NICTIC	đ	2001-08		
Sites Reservoir						E S	0				-				<u> </u>			2																	
<u>क</u>						u Ö	NO: NO: (feet)		FR-Aug 7		FR-Aug 7		FR-Aug 8	0 *** ¢ QU	o finy	FR-Aug 9		FR-Aug 9											—						
PROJECT:						AB. HI	N ON		2001-44 FR-A		2001-45 FR-A		2001-46 FR-4	1001 47 CD		2001-48 FR-		2001-49 FR-				1								ú	 i	INITIAL:	REQUEST NO.:		
РК						, .:.			20		20		20		4	5		20						-					<u> </u>	DATC	Ś		REC		

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**CLASSIFICATION TEST SUMMARY** 

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

DIVISION OF ENGINEERING CIVIL ENGINEERING BRANCH DAMS AND CANALS SECTION

						PERCE	PERCENT FINER	~											
				MECHAN	MECHANICAL ANALYSIS	VLYSIS					HYDRO	HYDROMETER	ATTE	REERG M	ATTERBERG MOISTURE PERCENT	ERCENT			
LAB.	HOLE F.S.	F.S. DEPTH	GRAVEL				SAND	9			SILT & CLAY	CLAY	UT.	ITS C	ONTENT C	LIMITS CONTENT CREANCS GROUP	GROUP	CLASSIFICATION	
ON	ON ON	(feet) 3.0" 1.5"	1.5" 3/4" 3/8"	3/8	4	J6	õ	50	100	2eo -	M. 21	5M 2M 1M		Į.	%		SYMBOL	GROUP NAME	
99-1419	99-1419 GG - Samples	· • · ·	÷		100 99			. <i>16</i>		83 + + + + +	1 33	3 27	- <del>1</del> 81-	22		3.9	-15  5	Lean clay w/sand	
99-1420		یت بن <del>بر</del> ایر ا			100 97	8	95		68	81	48 - 38		45	30		4.2	р!	Lean clay w/sand	1
		. ,	; <i>r</i> .			i 	;	j	 I			÷							i
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	<b> </b>	 :-	 			<b>⊦</b> }	    -	•		يد :	- i	r +		 					ł
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	<del>(</del> -	i. ŀ	·					÷		+ }		,							al mark
		·	: i		 		4	-	+	4		+						-	
DATE:		9/28/99	REMA	REMARKS: 99-	99-1419: Specific Gravity - 2.74; Max. Dry Density - 111.8pcf; Opt. Moist 17.4%	ccific Grav	ity - 2.74	Max Di	ry Density	y - 111.8p	ef, Opt.	Moist 1	7.4%					IM - INSUFFICIENT MATERIAL	
INITIAL.		dmt		-66	99-1420: Specific Gravity - 2.74; Max. Dry Density - 110.0pcf, Opt. Moist 17.0%	cific Grav	ity - 2.74	Max Di	y Density	<u>v - 110.0p</u>	of, Opt.	Moist 1	7.0%					NP - NON-PLASTIC	
	1																		

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

# ATTERBERG LIMITS

Project			Request No79-35	_
Classification			Lob No. 99-737	
Remarks	· · · · · · · · · · · · · · · · · · ·		Date 7/7/99	-
Y Air Dried	🔄 In Situ	Oven Dried	Tested By	
		PLASTIC LIMIT	LIQUID LIMIT	

Determination No.		1	. 2	1	2	3	- 4
No. of Blows		$\triangleright$	$\searrow$	30	22	15	
Container No.		144		PIS	X	EL	
Wt. Container + Wet Soil, gm	(1)	27,17	29.99	24.67	26.83	26.20	
Wt. Container + Dry Soil, gm	(2)	25,67	28,34	24.62	24.71	24.07	
Wt. Water, Ww, gm (1-2)	(3)	1.50	1.65	2.05	2.12	2.13	
Wt. Container, gm	(4)	15.83	17.57	18.74	18.76	18.28	
Wt. Dry Soil, Ws, gm (2-4)	(5)	9.84	10.77	5.88	5.95	5.79	
Water Content, W, % (3+5) x 100	(6)	15.2	15.3	34.9	35.6	36.8	

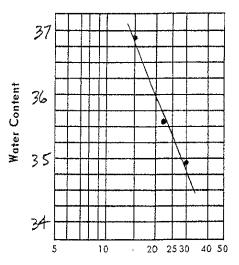
SHRINK	AGE LIMIT		
Determination No.		1	2
Container No.			
Consistency, No. of Blows			
Wt. Container + Wet Soil, gm	(1)		
Wt. Container + Dry Soil, gm	(2)	<u></u>	
Wt. Container, gm	(3)		
Wt. Wet Soil, W <sub>1</sub> , gm (1–3)	(4)		
Wt. Dry Soil, Ws. gm (2-3)	(5)		
Vol. Wet Soil, V1, cc	(6)		<u> </u>
Vol. Dry Soil, V2* cc	(7)		
$W_1 - W_s \qquad (4.5)$	. (8)		· · · · · · · · · · · · · · · · · · ·
$V_1 - V_2$ (6.7)	(9)		
₩% at Shrinkage Limit <u>(8) - (9x∀w)</u> 100 = (5)			
Shrinkage Ratio - (5+7)			

# \*Determination V<sub>2</sub> by Weighing

Wt. of Container + Displaced, Hg,	gm (A)	
Wt. of Container, gm	(B)	· · · · · · · · · · · · · · · · · · ·
Wt. of Mercury, Hg, gm (A-B)	(C)	
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### Flow Curve for Liquid Limit



No. of Blows

Mer	cury, H	lg gi	n/cc =		
				gm/cc	
69°	F_72°	F =	13.54	gm/cc	
73°	F-82°	F≈	13.53	gm/cc	

		(CL)
Plastic Limit	Liquid Limit	Plasticity Index
15	35	20

Request No. \_\_\_\_\_\_ Lab No. \_\_\_\_\_\_

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

# ATTERBERG LIMITS

,			ALL S
Project 514es	Dam		Request No
Classification			Lab No. 99-738
Remarks	······		Date 7/9/99
Air Dried	📋 In Situ	Oven Dried	Tested By
		PLASTIC LIMIT	LIQUID LIMIT

Determination No.		1	2	1	2	3	4
No. of Blows		$\square$	$\square$	35	26	20	
Container No.		P13	PIS	I	146	117	
Wt. Container + Wet Soil, gm	(1)	29.68	29,38	24,79	23,93	25.03	
Wt. Container + Dry Soil, gm	(2)	28.31	28.07	22.74	21.98	23,03	
Wt. Water, Ww, gm (1-2)	(3)	1.37	1.31	2.05	1.95	2.00	`
Wt. Container, gm	(4)	18.63	18.74	17.3/	16.94	18.06	
Wt. Dry Soil, Ws, gm (2-4)	(5)	9.68	9,33	5.43	5.04	4:97	
Water Content, W, % (3÷5) x 100	(6)	14.2	14.0	37.8	38.7	40.2.	-

SHRINKAGE LIMIT						
Determination No.		1	2			
Container No.						
Consistency, No. of Blows						
Wt. Container + Wet Soil, gm	(1)					
Wt. Container + Dry Soil, gm	(2)					
Wt. Container, gm	(3)					
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)					
Wt. Dry Soil, Ws, gm (2-3)	(5)					
Vol. Wet Soil, V1, cc	(6)					
Vol. Dry Soil, V2* cc	(7)					
$\frac{W_1 - W_s}{(4-5)}$	(8)					
$V_1 - V_2$ (6-7)	(9)					
₩% at Shrinkage Limit <u>(8) - (9x∀w)</u> (5) 100 =						
Chatalana Data (5,7)						

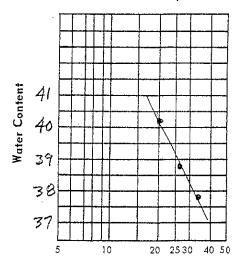
Shrinkage Ratio – (5+7)

\*Determination  $V_{2}$  by Weighing

Wt. of Container + Displaced,	Hg,gm (A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)		
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### Flow Curve for Liquid Limit



No. of Blows

Mercury, Hg gm/cc =	
62° F-68° F = 13.55 gm/cc	
$69^{\circ} \text{ F} - 72^{\circ} \text{ F} = 13.54 \text{ gm/cc}$	
73° F-82° F = 13.53 gm/cc	
	$(\overline{C}\overline{L})$
Plastic Liquid	Flasticity

Plastic Limit	Liquid	Plasticity Index
14	39	25

Request No. \_\_\_\_\_\_ Lab No. \_\_\_\_\_ 29-738

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

DEPARTMENT OF WATER RESOURCES					SOILS L	ABORATORY
		BERG LIN			<u>.</u>	
Project SIFES DAM			Request No.	- 99	35	
Classification		. <u>.</u>	Lab No	<u>99-73</u>	7	
Remarks			Date7	19/99		
Air Dried In Situ	Over	n Dried	, Tested By	PMT	••••••••••••••••••••••••••••••••••••••	
	PLASTI	C LIMIT		LIQUID	LIMIT	
Determination No.	1	2	1	2	3	4
No. of Blows	$\sim$	> < 1	34	27	23	
Container No.	138	145	S	7	351	
Wt. Container + Wet Soil, gm (1)	27.50	30.61	25.02 2	25,80	24.37	
Wt. Container + Dry Soil, gm(1)	26.07	29,30		23,18	21.91	
Wt. Water, Ww, gm (1-2)         (3)	1,43	1.31		2.62	2,46	
Wt. Container, gm (4)	16.53	20,51		18.05	17.22	
Wt. Dry Soil, Ws, gm (2-4)         (5)	9.54	8:79	4,94	5.13	4.69	
Water Content, W, % (3+5) x 100 (6)	15.0	14.9	49.8	51.1	52.5	
		<u> </u>	I			
SHRINKAGE LIM Determination No.		2		Flow Curve	for Liquid	Limit
Container No.						
Consistency, No. of Blows			ļ	+ + + + +		·
Wt. Container + Wet Soil, gm (1)				╅┼╁┼┯┯		
Wt. Container + Dry Soil, gm (2)			± 53-	┽╾┿╄╌┠╌		· · · <b>}</b>
Wt. Container, gm (3)			iter uter			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)			June 22			
Wt. Dry Soil, Ws. gm (2-3) (5)	-		Water Content 75	┥┥┥	╷╷╷╷	
Vol. Wet Soil, V <sub>1</sub> , cc (6)			× –		+	
Vol. Dry Soil, V2* cc (7)			50-	┼╌┽┼┾┼───	┼╍┽╌┼┈┼	÷
$W_1 - W_s$ (4.5) (8)			49			
$V_1 - V_2$ (6-7) (9)						
W% at Shrinkage Limit						
$\frac{(8) - (9 \times 3 \text{ w})}{(5)}  100 =$			5	10	20 2530	
Shrinkage Ratio – (5÷7)				No	of Blows	
*Determination $V_2$ by Weighing			·			,
Wt. of Contairer + Displaced, Hg, gm (A)				, Hg gm∕cc		
Wt. of Container, gm (B)				58° F = 13.5	-	
Wt. of Mercury, Hg, gm (A-B) (C)				$72^{\circ} F = 13.3$		
$V_2^* = C \div Hg gm/cc \tag{D}$			/3 F-8	82° F = 13.5	53 gm/cc	· · ·
						CH)
Shrinkage Shrinkage Limit Ratio	Shrinkage Index		Plastic Limit		iuid nit	Plasticity Index
			15	9	52	37

Request No. 99-35 Lab No. 99-739

**\_\_\_** 

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

		ATTERE					
Project Sites i	Dam			Request	No. 99-	35	
Classification			<u></u>	Lab No.	99-74	<i>FO</i>	
Remarks				Date	7/12/99		
Air Dried	🔄 In Situ	C Over	n Dried	Tested B	зу <u></u> М/7		,,
		PLASTI			LIQUID	LIMIT	
Determination No.		1	2	1	2	3	4

Determination No.			2	ll	2	3	4
No. of Blows				28	20	15	
Container No.		PIS	RI	119	138	117	
Wt. Container + Wet Soil, gm	(1)	27.85	28.29	26.86	22.97	25,63	
Wt. Container + Dry Soil, gm	(2)	26.69	27.05	24,38	20,93	23,18	
Wt. Water, Ww, gm (1-2)	(3)	1.16	1.24	2.48	2,04	2.45	
Wt. Container, gm	(4)	18.74	18.66	18.89	16.54	18.06	
Wt. Dry Soil, Ws, gm (2-4)	(5)	7,95	B.39	5,49	4.39	5,12	
Water Content, W, % (3+5) x 100	(6)	14.6	14.8	45.2	46,5	47.9	

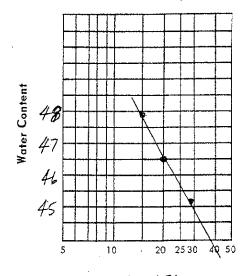
SHRINKAGE LIMIT						
Determination No.		1	2			
Container No.						
Consistency, No. of Blows						
Wt. Container + Wet Soil, gm	(1)					
Wt. Container + Dry Soil, gm	(2)					
Wt. Container, gm	(3)					
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)					
Wt. Dry Soil, Ws, gm (2-3)	(5)					
Vol. Wet Soil, V1, cc	(6)					
Vol. Dry Soil, V2* cc	(7)					
$W_1 - W_s$ (4.5)	. (8)					
$V_1 - V_2$ (6-7)	(9)					
₩% at Shrinkage Limit <u>(8) - (9×∀w)</u> (5) 100 =						
Shrinkage Ratio — (5÷7)						

# \*Determination $V_2$ by Weighing

Wt. of Contairer + Displaced, H	g,gm (A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)	(C)	
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### Flow Curve for Liquid Limit



No. of Blows

Mercury, H	g gm/cc =			
62° F-68°				
	F = 13.54 gm/co			
73° F-82° F = 13.53 gm/cc				
		(CL)		
Plastic	Liquid	Plasticity		
Limit	Limit	index		
15	46	31		

- Lob No. 99-740

99-35 Request No.

Water Content, W, % (3÷5) x 100

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

# ATTERBERG LIMITS

Project Sites Dam			Request	No. 99-	35	
Classification			Lab No. <u>99-741</u>			
Remarks			Lab No. <u>99-741</u> Date <u>7/12/99</u> Tested By <u>DMT</u>			
Air Dried 🔄 In Situ	، O آ O	ven Dried	Tested {	By DM	Ţ	
	PLAS	TIC LIMIT		LIQUI		
Determination No.	1	2	1	2	3	4
No. of Blows			30	21	15	
Container No.	145	J1	VI.	200	I	
Wt. Container + Wet Soil, gm (	1) 30,83	27,39	25.57	24.67	24.58	
	2) 29,41	26:18	23,21	21,90	21.87	
	3) /.37	1.Z	2.36	2.77	2.71	
	(4) 20.52	- 1Bc18	19.04	17.11	17.31	
	5) 8.94		4.17	4.79	4.56	
	0 103	151	0.1	578	594	1

56

15

### SHRINKAGE LIMIT

(6)

Determination No.		1	22
Container No.			
Consistency, No. of Blows			
Wt. Container + Wet Soil, gm	(1)		
Wt. Container + Dry Soil, gm	(2)		
Wt. Container, gm	(3)		
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)		
Wt. Dry Soil, Ws, gm (2-3)	(5)		
Vol. Wet Soil, V1, cc	(6)		
Vol. Dry Soil, V2* cc	(7)		
$W_1 - W_s$ (4-5)	. (8)		
$V_1 - V_2$ (6.7)	(9)		
W% at Shrinkage Limit (8) - (9xXw) 100 =			
(5)			
Shrinkage Ratio — (5÷7)			

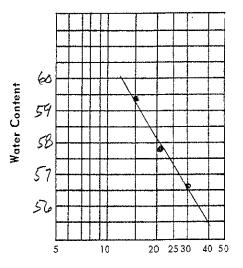
# \*Determination $V_{\mbox{2}}$ by Weighing

Wt. of Container + Displaced, Hg, g	m (A)
Wt. of Container, gm	(B)
Wt. of Mercury, Hg, gm (A-B)	(C)
$V_2^* = C \div Hg gm/cc$	(D)

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### Flow Curve for Liquid Limit

<u>4.14</u> 57,8



### No. of Blows

Mercury, H	g gm/cc =				
62° F-68° F = 13.55 gm/cc					
69° F-72° F = 13.54 gm/cc 73° F-82° F = 13.53 gm/cc					
<u></u>		(CH)			
Plastic Limit	Liquid Limit	Plasticity Index			
15	57	42			

99-741

99-35 Lab No. Request No. .

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

	ATTERBERG	a limits
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Project Sites Da	m		Request No
Classification			Lab No Date7/14/99
Remarks			
Air Dried	🔄 In Situ	Oven Dried	Tested By
		PLASTIC LIMIT	

		1 649 (1)	· · · · · · · · · · · · · · · · · · ·		FIGOL		
Determination No.		1	2	1	2	3	4
No. of Blows		$\searrow$	$\geq$	31	22	18	
Container No.		351	144	142		145	
Wt. Container + Wet Soil, gm	(1)	25.51	25.81	27.36	25,49	27.04	
Wt. Container +, Dry Soil, gm	(2)	24.51	24.75	25.04	22.86	24.84	
Wt. Water, Ww. gm (1-2)	(3)	1.00	1.06	2.32	2.63	2,20	
Wt. Container, gm	· (4)	17.22	16.94	20,17	17.57	20.51	
Wt. Dry Soil, Ws, gm (2-4)	(5)	7.29	7.81	4.87	5,29	4.33	
Water Content, W, % (3+5) x 100	(6)	13.7	13.6	47.6	49,7	50,8	

SHRINKAGE	LIMIT

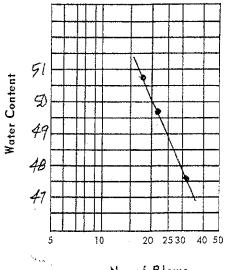
Determination No.		1	2
Container No.			
Consistency, No. of Blows		·	· · · · · · · · · · · · · · · · · · ·
Wt. Container + Wet Soil, gm	(1)		-
Wt. Container + Dry Soil, gm	(2)		
Wt. Container, gm	(3)		
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)		
Wt. Dry Soil, Ws, gm (2-3)	(5)		
Vol. Wet Soil, V1, cc	(6)		
Vol. Dry Soil, V2* cc	(7)		
$W_1 - W_s$ (4-5)	. (8)		
$V_1 - V_2$ (6-7)	(9)		
W% at Shrinkage Limit (8) - (9xXw) 100 =			
$\frac{(5)}{\text{Shrinkage Ratio} = (5 \div 7)}$			

<u> Shrinkage Ratio – (5÷7)</u> \*Determination  $V_2$  by Weighing

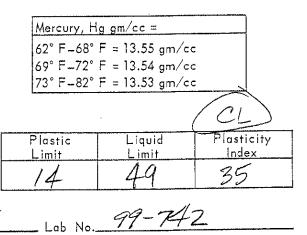
Wt. of Container + Displaced, Hg, gm	n (A)	
Wt. of Contairer, gm	(B)	 
Wt. of Mercury, Hg, gm (A-B)	(C)	
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### Flow Curve for Liquid Limit



No. of Blows



Lab No.

Request No. \_\_\_\_\_\_\_\_\_\_\_\_\_

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

Α.	TT	ER	B	ERC	λL	I MI	Т	S	

Project Gifes Day	Щ		Request No99-35	
Classification			Lab No. <u>99-743</u> Date <u>7/15/49</u>	
Remarks			Date7/15/49	
Air Dried	🔄 In Situ	Oven Dried	Tested By DMT	<u></u>

		PLASTIC LIMIT			LIQUID LIMIT		
Determination No.		1	2	1	2	3	4
No. of Blows			$\triangleright$	32	22	15	
Container No.		JI	117	RI	P15	115	
Wt. Container + Wet Soil, gm	(1)	26.02	27.49	25.02	24.26	25.54	
Wt. Container + Dry Soil, gm	(2)	24.94	26.17	22.83	23.62	23,10	
Wt. Water, Ww, gm (1-2)	(3)	1.08	1.32	2.19	2,64	2.44	
Wt. Container, gm	(4)	18,19	18.06	18.67	18.74	18.70	
Wt. Dry Soil, Ws, gm (2-4)	(5)	6.75	8.11	4.16	4,88	4.40	
Water Content, W, % (3+5) x 100	(6)	16,0	16.3	52.6	54.1	55.5	

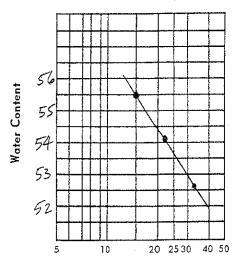
SHRINKA	GE LIMIT		
Determination No.		1	2
Container No.			
Consistency, No. of Blows			
Wt. Container + Wet Soil, gm	(1)		
Wt. Container + Dry Soil, gm	(2)		
Wt. Container, gm	(3)		
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)		
Wt. Dry Soil, Ws, gm (2-3)	(5)		
Vol. Wet Soil, V1, cc	(6)		
Vol. Dry Soil, V2* cc	(7)		
$W_1 - W_s$ (4-5)	. (8)		
$V_1 - V_2$ (6-7)	(9)		-
W% at Shrinkage Limit <u>(8) - (9×3 w)</u> (5) 100 =			
Shrinkage Ratio - (5÷7)			

\*Determination V<sub>2</sub> by Weighing

Wt. of Container + Displaced, Hg, g	m (A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)	(C)	
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index
	• •	

### Flow Curve for Liquid Limit



No. of Blows

Mercury, H	g gm/cc =	
62° F_68°	F = 13.55 gm/c	c
69° F_72°	F = 13.54 gm/c	c
73° F-82°	F = 13.53 gm/c	c
		CA
Plastic	Liquid	Plasticity
Limit	<u>Limit</u>	Index
16	64	38

Request No. 99-35 Lab No. 99-743

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

		ATTERE	BERG LIN	NITS			
Project <u>GItes Dam</u>		<u>~</u>	·····	Request	No. <u>99-</u>	.35	
Classification	<u></u>		<u></u>	— Lab No	99-74	<u>+</u>	
Remarks	<u></u>	<u></u>	· · · · · · · · · · · · · · · · · · ·	Date2	15/99		
Ar Dried	n Situ	Over			y DUIT		
		PLASTI	CLIMIT		LIQUIC		
Determination No.		1	2	1	2	3	4
No. of Blows			$\geq$	25			
Container No.		144	S	145	143	E/	
Wt. Container + Wet Soil, gm	(1)	24.32	26.09	28.55		V	
Wt. Container + Dry Soil, gm	(2)	23.15	24,93	26.04	Ι Å	Δ	
Wt. Water, Ww, gm (1-2)	(3)	1.17	1,16	2.51			
Wt. Container, gm	(4)	15.84	17.62	20.52	14.9%	18,28	
Wt. Dry Soil, Ws, gm (2-4)	(5)	7.31	7,31	5.5Z	ų į		
Water Content, W, % (3÷5) x 100	(6)	16.0	15.9	45.5			
SHRINKA	GE LIMI	Т	•		Flow Curv	e for Liquid L	.imit

SHRINKAGE LIMIT						
Determination No.		1	2			
Container No.						
Consistency, No. of Blows		<u></u>				
Wt. Container + Wet Soil, gm	(1)					
Wt. Container + Dry Soil, gm	(2)					
Wt. Container, gm	(3)					
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)					
Wt. Dry Soil, Ws, gm (2-3)	(5)					
Vol. Wet Soil, V1, cc	(6)					
Vol. Dry Soil, V2* cc	(7)					
$W_1 - W_s$ (4-5)	. (8)					
$V_1 - V_2$ (6-7)	(9)					
₩% at Shrinkage Limit <u>(8) - (9x∀w)</u> (5) 100 =						
Shrinkage Ratio $= (5 \div 7)$						

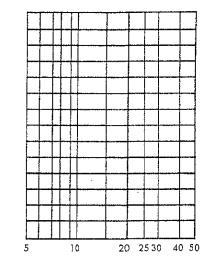
Shrinkage Ratio – (5÷7)

# \*Determination $V_2$ by Weighing

Wt. of Container + Displaced, Hg, g	m (A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)	(C)	
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### ч



Water Content

No. of Blows

<u>Mercury, Hg</u> 62° F_68° F		v/cc
69° F_72° F	= 13.54 gm	n/cc
73° F–82° F	= 13.53 gm	i/cc

	(	
Plastic	Liguid	Plasticity
Limit	Limit	Index
16	46	30

Request No. 99-35 Lab No. 99-744

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

# ATTERBERG LIMITS

Project Sites Da	Ш	·	Request No
Classification			Lab No 29-74-
Remarks			Date7/15/99
🔽 A r Dried	🔄 In Situ	Oven Dried	Tested By
	<u></u>	PLASTIC LIMIT	

Determination No.	· · · · · · · · · · · · · · · · · · ·	1	2	1	2	3	<u>4</u> ·
No. of Blows		$\geq$		31	26	21	
Container No.		143	E	203	146	138	
Wt. Container + Wet Soil, gm	(1)	23.51	25.78	24.96	24.39	24.67	
Wt. Container + Dry Soil, gm	(2)	22,38	24.82	22,35	21,87	Z1.89	
Wt. Water, Ww, gm (1-2)	(3)	1,13	.96	2.61	2,52	2.78	
Wt. Container, gm	(4)	14.91	18.23	17.12	16.94	16.54	
Wt. Dry Soil, Ws, gm (2-4)	(5)	7.47	6.54	5,23	4.93	5,35	
Water Content, W, % (3+5) x 100	(6)	15.1	14.7	49.9	51.1	52.0	

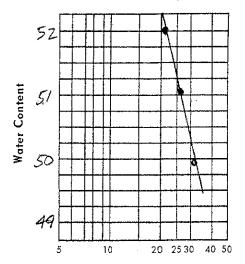
SHRINK	AGE LIMIT		
Determination No.	,	1	2
Container No.			
Consistency, No. of Blows			
Wt. Container + Wet Soil, gm	(1)		
Wt. Container + Dry Soil, gm	(2)		
Wt. Container gm	(3)		
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)		
Wt. Dry Soil, Ws. gm (2–3)	(5)		
Vol. Wet Soil, V1, cc	(6)		
Vol. Dry Soil, V2* cc	(7)		
$W_1 - W_s$ (4-5)	. (8)		
$V_1 - V_2$ (6-7)	(9)		
W% at Shrinkage Limit (8) - (9×yw) (5) 100 =			
Shrinkage Ratio - (5÷7)			

# \*Determination $V_2$ by Weighing

Wt. of Container + Displaced, Hg, g	m (A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)	(C)	
V₂* = C ÷ Hg gm∕cc	(D)	

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

### Flow Curve for Liquid Limit



No. of Blows

Mercury, H	lg gm/cc =	
69° F_72°	F = 13.55 gm/c F = 13.54 gm/c F = 13.53 gm/c	c
<u>}</u>		CH
Plastic	Liquid	Plasticity Index
Limit I<	Limit 51	Z/a

99-35 Lob No. 99-745 Request No.

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

ATTERBERG	LIMITS
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	ALLER	SERG LIN	AITS .			
Project Slifes Dam	<u></u>		Request	No. 99-3	'F	
Classification			Lab No	99-746		
Remarks			Date	7/23/99		
🖌 Air Dried 📃 In Situ	0ver	n Dried	Tested B	y DMT		
	PLASTI	C LIMIT		LIQUID		
Determination No.	1	2	1	2	3	4
No. of Blows	$\geq$	$\searrow$	25	N 7		
Container No.	F/3	. V1	E/	X43	X19	
Wt. Container + Wet Soil, gm (1)	27.38	29.08	2634	$\left  \frac{1}{1} \right $		
Wt. Container + Dry Soil, gm (2)	26.14	27.66	23.95	$ 1 \times 1 $		
Wt. Water, Ww, gm (1-2) (3)	1.24	1.42	2.39	X	///	
Wt. Container, gm (4)	18,63	19.04	18.28	14.91	118.90	
Wt. Dry Soil, Ws, gm (2-4) (5)	7.51	8.62	5.67		/	
Water Content, W, $\%$ (3÷5) x 100 (6)	16.5	8.62	42.2	,		
	· · · · · · · · · · · · · · · · · · ·		· /· ···			
SHRINKAGE LIMI	Τ			Flow Curve	e for Liquid	Limit
Determination No.		2				
Container No.						
Consistency, No. of Blows	· · · · · · · · · · · · · · · · · · ·					
Wt. Container + Wet Soil, gm (1)						
Wt. Container + Dry Soil, gm (2)			Water Content			
Wt. Container, gm (3)	·=		ou			
Wt. Wet Soil, $\forall_{1}, gm(1-3)$ (4)			er (			
$\frac{W_{t}}{W_{t}} \frac{D_{ry} Soil}{Soil} \frac{W_{s}}{W_{t}} \frac{gm}{2-3} $ (5)			Nat			
Vol. Wet Soil, V <sub>1</sub> , cc (6) Vol. Dry Soil, V2* cc (7)			-	<b>┝-  -                   </b>		
				<u>}-+-+</u>		
V <sub>1</sub> - V <sub>2</sub> (6·7) (9) W% at Shrinkage Limit						
$\frac{(8) - (9 \times 3 \text{ w})}{(5)}  100 =$				5 10	20 25 30	40 50
(5) 100 =						
Shrinkage Ratio - (5÷7)				No	o. of Blows	
*Determination $V_2$ by Weighing						
Wt. of Container + Displaced, Hg, gm (A)			Merc	ury, Hg gm/c	c =	
Wt. of Container, gm (B)			62° F	$F = -68^{\circ} F = 13.$	55 gm/cc	
Wt. of Mercury, Hg, gm (A-B) (C)	·		69° F-72° F = 13.54 gm/cc			
$V_2^* = C \div Hg gm/cc$ (D)			73° F	-82° F = 13.	53 gm/cc	
					(	CL
Shrinkage Shrinkage	Shrinkage		Plasti	c Lie	quid	Plasticity
Limit Ratio	Index		Limit	<u> </u>	mit	Index
			17	4	2	25
		11				

Request No. <u>99-35</u> Lab No. <u>99-746</u>

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

			ATTER	BERG LIN	NITS			
Project_	Sites Das	м			Request	No	9-35	
Classifi	cation				Lab No	99-79	47	
Remarks	5				Date7	1/26/90	1	
[	P Air Dried	🔄 In Situ	Ove	n Dried	Tested B	y THU	T	
			PLAST	IC LIMIT		LIG	UID LIMIT	
Determi	nation No.		1	2	1	2	3	4
No. of E	Blows				25	V		/
Contain	er No.		146	I	P15	$ \sqrt{\nu} /$	XI	
Wt. Con	tainer + Wet Soil,	, gm(1)	25.91	25.78	26.53 24.19		<u> </u>	
Wt. Con	tainer + Dry Soil	, gm (2)	24.78	24,72	24.19			
Wt. Wate	er, Ww, gm (1-2)	(3)	1.13	1.06	2,34			<b>\</b>
Wt. Con	tainer, gm	(4)	16:94	17.31	18.74	17.58	18.70	\$
Wt. Dry	Soil, Ws, gm (2-4	(5)	7.84	7.41	5.45	L \	\	
Water C	ontent, W, % (3+5	5) x 100 (6)	14.4	14.3	42.9			
		SHRINKAGE LIM	UT			Elaw C	urve for Liq	ud 1 imit
Determi	nation No.		1	2	]	1104 0		
Contain								
	ency, No. of Blo	ws				┝╍┽╍┦╆┥	┟──┼─┼─┼	<u></u>
	tainer + Wet Soil					┝╍┾╍┝╄╺┽		
	tainer + Dry Soil				te		┼━━ー┾╸┾╍┼	
	tainer, gm	(3)			Water Content			
	Soil, W <sub>1</sub> , gm (1-3	) (4)			ြ ပိ			
	Soil, Ws, gm (2-3				iter	┝┼╍┽┽┦		
	t Soil, V1, cc	(6)			M.	┝┥╸┾╁╺┾	┟──┝──┝	
	y Soil, V2* cc	(7)						
-	s (4-5)	. (8)						
$V_1 - V_2$	2 (6-7)	(9)						
W% at S	hrinkage Limit (8) - (9x) w) (5) (1)	100 =				5 1	0 · 20 25	30 40 50
	(5)						No. of Blo	ws
Shrinka	<u>ge Ratio – (5÷7)</u> *Determination <sup>\</sup>	Vo by Weighing	<u>    I                                </u>	<u>_L</u>	]			
W+ of C	Container + Displ		)		Merc	ury, Hg g	m/cc =	
	Container, gm	(B)			4		13.55 gm/co	:
	Vercury, Hg, gm (				3 1		13.54 gm/co	
	C ÷ Hg gm∕cc	(D)					13.53 gm/c	
			<u>]</u>	<u></u>		<u> </u>		CL
	Shrinkage Limit	Shrinkage Ratio	Shrinkage Index	_	Plast Limit		Liquid Limit	Plasticity Index
	-				14		43	29
	1	1			L		1 7	In the second

Request No. <u>99-35</u> Lab No. <u>99-747</u>

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Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

				ATTER	BERG LIN	NITS			
Project_	Sites Da	ш			<u> </u>	Request	No. 99	-35	
Classific	ation					Lab No	79-74	13	
Remarks						Date	7/23/99	7	
C	Air Dried	In Situ	1	[] 0ve	n Dried	Tested B	, Dur	T	
	·—						1		
				PLAST	IC LIMIT		LIQUI	D LIMIT	
Determin	ation No.			1	2	1	2	3	4
No. of B	lows	<u></u>		$\geq$		29	24	18	
Containe	er No.			J1	351	141	143	119	
Wt. Cont	ainer + Wet Soil	, gm . (	1)	27.48	26.08	24.98	24.05	25.66	)
Wt. Cont	<u>ainer + Dry Soil</u>	,gm (	2)	26.33	25.01	22,78	21,44	23.64	
Wt. Wate	r, Ww, gm (1-2)	(	3)	1.15	1.07	2.20	2.61	1.96 18.8 4.75	
Wt. Cont	ainer, gm	(	4)	18.18	17.22	17.11	14.91	18.8	9
Wt. Dry S	Soil, Ws, gm (2-	4) (	5)	8.15	7.79	5.67	6.53	4.75	
Water Co	ontent, W, % (3÷.	5) × 100 (	6)	14.1	13.7	38.8	40.0	41.3	
		SHRINKAGE L	IMI	т			Elaw Curr	ve for Liqu	:
Determin	lation No.			1	2				
Containe									
Consiste	ncy, No. of Blo	ws					┝┥┥┥┥		
Wt. Cont	ainer + Wet Soil	,gm (	1)			,			+
Wt. Cont	ainer + Dry Soil	, gm (	2)			ta 47	2┝╍┼╸┼┼┼┼┼╍		++
Wt. Cont	ainer, gm	(3	3)			Water Content 4		X	
Wt. Wet S	Soil, W <sub>1</sub> , gm (1-3	3) (4	4)			ů	╵┠━┝╾┝┝┣╺┝	<u> </u>	
Wt. Dry S	Soil, Ws, gm (2-3	3) (.	5)			1ª 40	> <del>┝╶┼╌<u></u>┥┥┥┥</del>		· · · · · · · · · · · · · · · · · · ·
Vol. Wet	Soil, V1, cc	(1	6)			-	<u></u> <u></u>	- + +	++
Vol. Dry	Soil, V2* cc	(	7)			39	╵┝╾┝╾┝┼┝╽┝╼╸		
$W_1 - W_s$	(4-5)	. (	8)			38			X L
$V_1 - V_2$	(6-7)	('	9)			10	° <b>⊢</b> <u>-</u>     _		
	rinkage Limit								
	$\frac{(8) - (9 \times \chi w)}{(5)}$ .	00 =					5 10	- 20 253	
Shrinkag	e Ratio - (5+7)			•			1	lo, of Blov	/5
÷	Determination	V <sub>2</sub> by Weighing							
Wt. of Ca	ontainer + Displ	aced, Hg, gm	(A)			Merc	ury, Hg gm/	cc =	
Wt. of Ca	ontainer, gm		(B)			62° F	F_68° F = 10	8.55 gm/cc	
Wt. of Me	ercury, Hg, gm (	A-B)	(C)				=_72° F = 13	-	
$V_2^* = C$	÷Hg gm∕cc		(D)			73° F	-82° F = 13	8.53 gm/cc	
									(CL)
Г	Shrinkage	Shrinkage	5	Shrinkage	1	Plasti		iquid	Plasticity
ŀ	Limit	Ratio		Index	-			<u>imit</u>	Index
						14	4	Ð	26

Request No. <u>99-35</u> Lab No. <u>19-748</u>

THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES					LABORATO	Services Office DRIES BRANCI
DELARTMENT OF MATER RESOURCES	ATTERF	BERG LIN	NTS		SOILS L	ABORATORY
Project STES			Request N	10. <del>9</del>	9-35	
Classification			Lab No,	99	2-749	
Remarks			Date	7-2	9-99	
Classification Remarks Air Dried [] In Situ	🕅 Oven	Dried	Tested By	. <u> </u>		
	PLASTIC			LIQUI	D LIMIT	
Determination No.	1	2	1	2	3	4
No. of Blows	$\geq$	>>	35	17	23	
Container No.	$\sim$	V1	138	141	140	
Wt. Container + Wet Soil, gm (1)	25.37	25.85	24.44	25.76	210.02	
Wt. Container + Dry Soil, am (2).	24.35	25.00	23.93	23.41	23.61	
Wt. Water, Ww, gm (1-2) (3)	I.DT.	0.85	2.51	2.35	2.41	
Wt. Container, gm (4)	17.57	19.05	112,53	17.11	14.77	
Wt. Dry Soil, Ws, gm (2-4) (5)	10.20	0,95	7:40	6.30	6.84	
Water Content, W, % (3+5) x 100 (6)	15.020	14.300	53.9	17.3	35,2	
SHRINKAGE LIMI	T			Elaw Curv	e for Liquid	1 imit
Determination No.	1 .	. 2				
Container No.			57	┝━┼╍┝┼╸┼╎╴╸		
Consistency, No. of Blows				┟┈┼┉┼┼┼┥┥╌╴	╶╍┫╾╲┟┍╒┠╍┠╸	
Wt. Container + Wet Soil, gm (1)				┝╍╞╍┠╉╺╋╞╼╸		
Wt. Container + Dry Soil, gm (2)			ŧ aut			,
Wt. Container, gm (3)			n br			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)			Ŭ	┠╍┿╍┿╍┝╼┾┝╌╍╸	╾┼╾┼╌┼╌┼╴	
Wt. Dry Soil, Ws. gm (2+3) (5)			Water Content			
Vol. Wet Soil, V1, cc (6)			¥ 36	┝╍╤╪═╾╋╌┽╌╞╍┯╌╸	┼╌┼╌╀┼╴	
Vol. Dry Soil, V2* cc (7)						
$W_1 - W_s$ (2.5) (8)				┝╍┝╍┝┥┥┥	<u> </u>	
$V_1 - V_2$ (6-7) (9)			34	┝╍┨━┥┧┍┼		
W% at Shrinkcge Limit $\frac{(8) - (9 \times 3 \times w)}{(5)}  100 =$	- -			5 10	20 25 30	40 50
(5) Shrinkage Ratio - (5+7)				N	o, of Blows	
*Determination $V_2$ by Weighing		,			·	, 
Wt. of Container + Displaced, Hg, gm (A)			Mercu	ry, Hg gm/c	:c =	-
Wt. of Container, gm (B)				-68° F = 13		-
Wt. of Mercury, Hg, gm (A-B) (C)		· · · · · · · · · · · · · · · · · · ·		-72° F = 13		
$V_2^* = C + Hg gm/cc \qquad (D)$			73° F	-82°F ≈ 13	.53 gm/cc	
				6		
Shrinkage Shrinkage	Shrinkage		Plastic Limit		iquid imit	Plasticity Index
Limit Ratio	Index		15		36	20
			10			, <u> </u>
	Request No.	99-2	5 Lob	No	99-7.	19

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Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

ATTERBERG LIMITS	LIMITS	àL	RG	E	RB	E	ΤT	A
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Project_Sites_	Dam	·	Request No99-35	
Classification			Lob No. 99-750	
Remarks			Date7/29/99	
🔀 Air Dried	[] In Situ	Oven Dried	Tested By	

		PLASTI	C LIMIT	•	LIQUI	LIMIT	
Determination No.		1	2	Ĩ	2	3	4
No. of Blows		$\searrow$	$\mathbb{N}$	32	29	22	19
Container No.		Z	00	ui	EI	X	S
Wt. Container + Wet Soil, gm	(1)	25.41	25,45	25.22	24.98	25.77	25.23
Wt. Container + Dry Soil, gm	(2)	24,29	24.57	22,47	22.19	22.81	22.00
Wt. Water, Ww, gm (1-2)	(3)	1,12	.88	2.75	2,79	2.96	3,23
Wt. Container, gm	(4)	19.04	20.32	18,54	18.28	18.76	17.62
Wt. Dry Soil, Ws, gm (2-4)	(5)	5.25	4.25	3.93	3.91	4,05	4:38
Water Content, W, % (3+5) x 100	(6)	21.3	20.7	70.0	71.3	73,1	73.7

SHRINK	AGE LIMIT		
Determination No.		1	2
Container No.			
Consistency, No. of Blows			
Wt. Container + Wet Soil, gm	(1)		
Wt. Container + Dry Soil, gm	(2)		
Wt. Container, gm	(3)	:	
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)		
Wt. Dry Soil, Ws, gm (2-3)	(5)		
Vol. Wet Soil, V1, cc	(6)		
Vol. Dry Soil, V2* cc	(7)		· · · · · · · · · · · · · · · · · · ·
$W_1 - W_s$ (4-5)	. (8)		
$V_1 - V_2$ (6-7)	(9)		
W% at Shrinkage Limit			
$\frac{(8) - (9 \times 3 \times w)}{(5)} = 100 =$			

<u>Shrinkage Ratio — (5+7)</u>

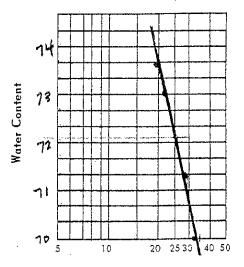
\*Determination V<sub>2</sub> by Weighing

Wt. of Container + Displaced, H	lg,gm (A)		
Wt. of Container, am	(B)		
Wt. of Mercury, Hg, gm (A-B)	(C)	•	
$V_2^* = C \div Hg gm/cc$	(D)		

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

Request No.

### Flow Curve for Liquid Limit



No. of Blows

Mercury,	lg gm∕cc =	
	' F = 13.55 gm/c	
	°F = 13.54 gm/c	
73° F-82°	°F = 13.53 gm/c	c
		TOH
Plastic	Liquid	Clasticity
Limit	Limit	Index
21	72	5

Lab No

50

	ATTERE	BERG LIN	NITS			
Project SItes Dam		· ·	Request	No. 99-	35	
Classification			Lab No	99-73	51	
Remarks		· · · ·	D'ate8	3/10/99	· · ·	
Air Drjed In Situ	Over	n Dried	Tested B	, DMT	·····	
	PLASTI			LIQUI	LIMIT (	/
Determination No.	1	2	]	2	3	4
No. of Blows	$\sim$	> <	29	23	15	
Container No.	5	142	200	119	144	
Wt. Container + Wet Soil, gm (1)	26.13	27.48	25,75	27.56	23.61	
Wt. Container + Dry Soil, gm (2)	24.72	26.27	22.37	24.10	20.43	
Wt. Water, Ww, gm (1-2) (3)	1.41	1.21	3.30	3.40	3.18	
Wt. Container, gm (4)	17.62	20.17	17.11	18.89	15.83	
Wt. Dry Soil, Ws, gm (2-4) (5)	7.10	U.1	5.20	5:21		•
Water Content, W, % (3+5) x 100 (6)	19.9	19.8	64.3	Lele.A	4.00	
SHRINKAGE LIM	ķ.				<u> </u>	· · · ·
Determination No.	1 <u>1</u>	2		Flow Curv	e for Liquid	Limit
Container No.		<u> </u>				
Consistency, No. of Blows			71	,		·
Wt. Container + Wet Soil, gm (1)			1-			
Wt. Container + Dry Soil, gm (2)		Í	+ @ <sup>c</sup>	╮ <del>┝╶┽╶┥┟╽╽</del>		
Wt. Container, gm (3)			Water Content	<u></u> <u></u>		
Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)			Sal Con			
Wt. Dry Soil, Ws. gm (2-3) (5)		<u> </u>	n te	γ <b>  -  </b>		
Vol. Wet Soil, V <sub>1</sub> , cc (6)			° M	╵┠╼┿╍╋┥╏╏╏╴	<u> </u>	
Vol. Dry Soil, $V_2^*$ cc         (0)           (7)         (7)			() () ()	£		
$W_1 - W_s$ (4-5) (8)						
$V_1 - V_2$ (6-7) (9)			UE.			
W% at Shrinkage Limit			. 196			
$\frac{(8) - (9 \times 3 \text{ w})}{(5)}  100 =$			. ur	5 10	20 25 30	40 50
Shrinkage Ratio - (5÷7)			· ·	۲	lo. of Blows	
*Determination V <sub>2</sub> by Weighing						
Wt. of Container + Displaced, Hg, gm (A)			Merc	:ury, Hg gm∕o	cc =	
Wt. of Container, gm (B)			62°	F-68° F = 13	.55 gm/cc	
Wt. of Mercury, Hg, gm (A-B) (C	)			F-72° F = 13	-	
$V_2^* = C \div Hg gm/cc$ (D)	)		73°	F-82°F = 13	.53 gm/cc	]
				M	D	
Shrinkage Shrinkage	Shrinkage	7	Plast		iquid	Plasticity
Limit Ratio	Index	·			imit	Index
			21	0	lle	46
		<u>~</u> ~ .		00	751	
	Request No.	99- 3	<u>&gt;&gt;</u> La	b No. 99	121	

DWR 714 (Rev. 12/66)

State of California

Technical Services Office

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DEPARTMENT OF WATER RESOURCE	S					LABORATOR SOILS LA	RIES BRANCH BORATORY
		ATTERE	BERG LIN	NITS		<u> </u>	
Project SITES I	DAM				No(	<u>19-35</u> 19-75	
					l	19-75	1
Classification				Lab No			<u></u>
Remarks				Date		<u> 199</u>	
X					(A)	TA	/
Air Dried 🗌 In	Situ	C Oven	Dried	Tested B	у <u>— (Ш</u>	<u> </u>	
۰ ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰ - ۱۰۰۰		PLASTIC	CLIMIT	1	LIQUID	LIMIT	v
Determination No.			2	1	2	3	4
No. of Blows				15	21		
Container No.		#140	#48	#136	#351	#143	
Wt. Container + Wet Soil, gm	(1)	24.89	28.15	28.71	29.53	25.40	
Wt. Container + Dry Soil, gm	(2)	23,71	26.78	25.24		22.27 3.13	<u> </u>
Wt. Water, Ww, gm (1-2)	(3)	1.10	1.37	3.47	3.02		
Wt. Container, gm	(4)	14.78	18,81	14.53	17.21	14.91 7.30	
Wt. Dry Soil, Ws, gm (2-4)	(5)	6.93	7.97 17.2	8.71	8.70		
Water Content, W, % (3÷5) x 100	(6)	17.0	17.1	39.0	4.6	42.5	·
SHRINKAG	E LIMI	T		1	Flow Curve	o for Liquid I	_1mit
Determination No.		1	2		r <del>-r-r-r-r</del>		
Container No.						-+	
Consistency, No. of Blows				4	2 -+-++++	+-\+-+	<u>+</u> -  ·
Wt. Container + Wet Soil, gm	(1)						
Wt. Container + Dry Soil, gm	(2)			at t			
Wt. Container, gm	(3)			Water Content	╽┝╍╈╍┿┾┾┾╌╌		
Wt. Wet Soil, Wj, gm (1-3)	(4)			0			+
Wt. Dry Soil, Ws, am (2-3)	(5)			ate			+
Vol. Wet Soil, V1, cc	(6)	· · · · · ·		l ≤ . 4(			
Vol. Dry Soil, V2* cc	(7)		· · · · · · · · · · · · · · · · · · ·	4	╵┝╌┽┽┽┽┽╌╸		
$W_1 - W_s$ (4-5)	. (8)		·		┝╍┼╍┼┝╌┼┤╌╌╸		
$V_1 - V_2$ (6-7)	(9)						
W% at Shrinkcge Limit				30	5 10	20 2530	40 50
$\frac{(8) - (9 \times 3 \text{ w})}{(5)}  100 =$							
Shrinkage Ra·io - (5+7)					. N	o. of Blows	
*Determination V <sub>2</sub> by Weigh	ing						
Wt. of Container + Displaced, Hg, g				Merc	ury, Hg gm/c	c =	
Wt. of Container, gm	(B)			-	F_68° F = 13.		
Wt. of Mercury, Hg, gm (A-B)	(C)				F_72° F = 13.		
$V_2^* = C \div Hg gm/cc$	(D)			73° I	F-82° F = 13	.53 gm/cc	
· · · · · · · · · · · · · · · · · · ·	<u>``````</u>	<u></u>			6	Salar July 200	
			7	<b>FA</b> 1	(11)		Dinatation
Shrinkage Shrinkag	e	Shrinkage		Plast Limit		quid   imit	Plasticity Index
Limit Ratio		Index	-	1	2	1	14
	·	····	]		7. 2	<u>41</u>	
			00	26	1	20-70	-1
		Poquest No.	99	2D La	h No. 7	79-79	24

Request No. \_\_\_\_\_\_ Lab No. \_\_\_\_\_

State of California THE RESOURCES AGENCY	
DEPARTMENT OF WATER RESOURCES	
	ATTERBERG LIMITS
	Λ Δ

Project SITES D	Request 1	No. 90	7-35	•		
Classification			Lab No	90	7-35 1-753	
Remarks			Date	BLID	7/99	
Air Dried In Situ	Cver	n Dried	Tested B	TAL		
	PLÁSTI	C LIMIT		LIQUID		V
Determination No.	1	2	1	2	3	4
No. of Blows		$\geq$	23	20	15	
Container No.	J	VI		P13	EL	
Wt. Container + Wet Soil, gm (1)	13.69	15.14	30.38		30.87	·
Wt. Container + Dry Soil, gm (2)	22.92	24.39	27.06	27.22	27.09	
Wt. Water, Ww, gm (1-2) (3)	D.77	0.85	3.32	3,50	3.78	
Wt. Container, gm (4)	18.19	19.05	18,77	18.64	18.29	
Wt. Dry Soil, Ws, gm (2-4) (5)	4.73	5.34	8.29	8,58	8.00	• .
Water Content, W, % (3+5) × 100 (6)		19.9	A0.0	41.7	43.0	

SHRINKAGE LIMIT					
Determination No.		1	2		
Container No.					
Consistency, No. of Blows					
Wt. Container + Wet Soil, gm	(1)				
Wt. Container + Dry Soil, gm	(2)				
Wt. Container, gm	(3)				
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)				
Wt. Dry Soil, Ws, gm (2-3)	(5)		<u> </u>		
Vol. Wet Soil, V <sub>1</sub> , cc	(6)				
Vol. Dry Soil, V2* cc	(7) .		-		
$W_1 - W_5$ (4-5)	. (8)				
$V_1 - V_2$ (6-7)	(9)				
W% at Shrinkcge Limit <u>(8) - (9×) (9)</u> (5)					
Shrinkage Ratio - (5÷7)					

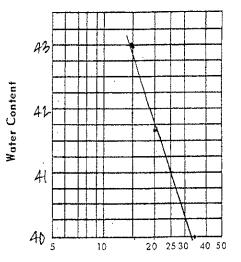
# \*Determination $V_2$ by Weighing

Wt. of Container + Displaced, Hg, s	um (A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)	(C)	
$V_2^* = C \div Hg gm/cc$	(D)	

Shrinkage.	Shrinkage	Shrinkage
Limit	Ratio	Index

# Flow Curve for Liquid Limit

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY



No. of Blows

Mer	cury, H	g gr	n/cc =		
62°	F_68°	F =	13.55	gm/cc	
69°	F_72°	۴ =	13.54	gm/cc	
73°	F-82°	F =	13,53	gm/cc	

	(Ci)	
Plastic Limit	Liquid Limit	Plasticity Index
16	41	15

1

99-35

Request No. .

Lab No.

753

DWR 714 (Rev. 12/66)

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

Α.	ТТ	ERB	ERG	LIMI	TS

Project_	Sites Dam				Request 1	No. 99-2	35	
Classific	ation				Lab No			
						3/10/99		
Remarks.	·				Date2	5/10/19		
[]	Air Dried	In Situ	Over	n Dried	Tested B	y DMT.		/
			PLASTI	C LIMIT		LIQUID		$\sim$
Determin	natior No.		1	2	1	2	3	4
No. of B			$>\!\!\!\!>\!\!\!\!>$	$\geq$	32	23	15	
Containe			143-1	59	V	3	115	
	ainer + Wet Soil, gm	(1)	30-89	29.44	25,86	26.55	27.59	
	ainer + Dry Soil, gm	(2)	29.59	28.07	23,70	24.05	25.13	<u> </u>
	r, Ww, gm (1-2)	(3)	1.20	1.37	2.14	2.5	2.46	
	ainer, gm	(4).	20.70	18.61	17.57	17.25	18.70	
	Soil, Ws, gm (2-4)	(5)	8.09	9.46	10.13	6.80	6.43	·
	ontent, W, % (3÷5) x 1	00 (6)	14.6	14.5	35.2	Bleig	38.3	
	SHR	INKAGE LIMI	ې ۲		7	Flow Curv	e for Liquid	Limit
Determin	nation No.		1	2	-	┟──┲┥╌┟╌┢╶┇╶┨┉╼╸	<del></del>	
Containe						┝┥┥┥┥		
	ency, No. of Blows				35	╮ <b>╞╌┼╌┼┼┼┼┼</b> ┈	-+	╺┼╼┨
	tainer + Wet Soil, gm	(1)				┝╋╍┝╋╡┼╌	-++++++	
Wt. Cont	tainer + Dry Soil, gm	(2)			it i		V	
	tainer, gm	(3)			Mater Content			
	Soil, W <sub>1</sub> , gm (1-3)	(4)						
	Soil, Ws, gm (2-3)	(5)			ater			
	t Soil, V <u>1, cc</u>	(6)						-+
Vol. Dry	/ Soil, V2* cc	(7)			- <u>31</u>			
$W_1 - W_s$	<u>s (4-5)</u>	(8)	<u>}</u>		-		<u> </u>	
$V_1 - V_2$	2 (6-7)	(9)		,		┝╋┥╋		
W% at S	hrinkage Limit				39	5 10	20 25 30	40 50
	$\frac{(8) - (9 \times 3 \times w)}{(5)}  100 =$		·		-		lo. of Blows	
Shrinkag	ge Ratio – (5÷7)		<u> </u>	<u> </u>			to, or bioms	
	*Determination $V_2$ by	Weighing			-			
Wt. of C	Container + Displaced,	Hg,gm (A)	ļ			ury, Hg_gm∕o		
Wt. of C	ontainer, gm	(B)				F-68° F = 13	-	
Wt. of N	<u>Aercury, Hg, gm (A-B)</u>	(C)				F_72° F = 13		
$V_{2}^{*} = C$	2÷Hg gm∕cc	(D)			73	F-82° F = 13	.53 gm/cc	l
	trans. Al					(CL)		
	1 ¥ 1	nrinkage Ratio	Shrinkage Index	]	Plast Limi		iquid imit	Plasticity Index
	Limit				15		3le	21
	t <u></u>	L					a ard	
			Request No	. 99-35	<u> </u>	b No	7-124	

DWR 714 (Rev. 12/66)

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

1 < G	ATTERE	BERG LIN	NITS			
Project Sites Dam			Request 1	No	5	
Classification			Lab No	99-755		<u></u>
Remarks			Date8	10/99		······································
Air Dried In Situ	C Oven	Dried	Tested B			
				/		
·······	PLASTI	·····	1			
Determination No.	1	2	1	2	3	4
No. of Blows		$\geq$	30	20	15	
Container No.	145	146	203	Y	117	
Wt. Container + Wet Soil, gm (1)	28.95	26,56	25,47	26:49	26.00	
Wt. Container + Dry Soil, gm (2)	27.84	25.29	23 40	24.32	23,93	
Wt. Water, Ww, gm (1-2) (3)	<u> </u>	1.27	2.07	2.17	2.07	
Wt. Container, gm (4)	20.51	16,94	17.12	18.05	18.06	·
Wt. Dry Soil, Ws, gm (2-4) (5)	7.33	8.35	10.20	6.27		
Water Content, W, % (3÷5) × 100 (6)	15.1	15.2	33.0	34.6	35.3	
SHRINKAGE LIMI	<u>×</u>	······	7	Flow Curv	e for Liquid I	_imit
Determination No.	1	2				71
Container No.			-			-+
Consistency, No. of Blows			-			
Wt. Container + Wet Soil, gm (1)						
Wt. Container + Dry Soil, gm (2)			ent 25	ʹ┝┿╌┦┥┩╌╴		
Wt. Container, gm (3)			onte			
Wt. Wet Soil, W <sub>1r</sub> gm (1-3) (4)	·······					+ .
Wt. Dry Soil, Ws, gm (2-3) (5)			Water Content			+
Vol. Wet Soil, V <sub>1</sub> , cc (6)			₹ 34			
Vol. Dry Soil, V2* cc (7)						<u></u>
$W_1 - W_s$ (4-5) (8)			4	┝┽┽┼┼┼		
$V_1 - V_2$ (6-7) (9)			-	┝╋╋		- <del>{ -</del> {
W% at Shrinkage Limit			33	5 10	20 25 30	40 50
$\frac{(8) - (9 \times 5 \text{ w})}{(5)}  100 =$			-		o. of Blows	
Shrinkage Ratis — (5÷7)		<u> </u>		Ч	O. OT DIOWS	
*Determination $V_2$ by Weighing		·····	-			
Wt. of Container + Displaced, Hg, gm (A)				:ury, Hg_gm∕o		
Wt. of Container, gm (B)				F-68° F = 13		
Wt. of Mercury, Hg, gm (A-B) (C)				$F_{-72}^{\circ} F = 13$		
$V_2^* = C \div Hg gm/cc$ (D)	<u> </u>		/3-1	$F = 82^{\circ} F = 13$	.53 gm/cc	
2000 C				(l)	D	
Shrinkage Shrinkage	Shrinkage	1	Plast Limit		iquid imit	Plasticity Index
Limit Ratio	Index				34	19
			······································	<u> </u>	<u> </u>	
	Request No.		La	b No	7-755	

State of California THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES		Technical Services Office LABORATORIES BRANCH
· · ·	ATTERBERG LI	SOILS LABORATORY
Project SILES DAM	· · · · · · · · · · · · · · · · · · ·	Request No 99-35
Classification		- Lab No. 99-756
Project_SILES_DAM Classification Remarks		Date 7-28-99
Air Dried In Situ	Uven Dried	Tested By
	PLASTIC LIMIT	LIQUID LIMIT
Determination No.	1 2	1 2 3 4
No. of Blows	>>>>	138/19 18 24
Container No.		142 145 17 119
Wt. Contairer + Wet Soil, gm (1)		23/9 27.85 26.49 25.34
Wt. Container + Dry Soil, gm (2)		1 25.60 23.76 23.29
Wt. Water, Ww, gm (1-2) (3)		1 2.25 2.15 2.05
Wt. Container, gm (4)		20.17 20.51 8.07 18.89
Wt. Dry Soil, Ws, gm (2-4) (5)		5.09 5.09 4.4
Water Content, W, % (3+5) x 100 (6)		1 44.2 48.0 46.6
SHRINKAGE LIMI	Τ	
Determination No.	1 2	
Container No.		
Consistency, No. of Blows		
Wt. Container + Wet Soil, gm (1)		47
Wt. Container + Dry Soil, gm (2)		
Wt. Container, gm (3)		Agter Content
Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)		
Wt. Dry Soil, Ws, gm (2-3) (5)		
Vol. Wet Soil, V <sub>1</sub> , cc (6)		
$\frac{V_{ol.}}{V_{ol.}} \text{ Dry Scil}, V_2^* \text{ cc} \qquad (7)$	······································	
$W_1 - W_s$ (4-5) (8)	· · · · · · · · · · · · · · · · · · ·	
$V_1 - V_2$ (6-7) (9)		
W% at Shrinkage Limit		AA 5 10 20 25 30 41 50
$\frac{(8) - (9 \times 3 \text{ w})}{(5)}  100 =$		
Shrinkage Ratio — (5÷7)		No, of Blows
*Determination $V_2$ by Weighing		
Wt. of Container + Displaced, Hg, gm (A)		Mercury, Hg gm/cc =
Wt. of Container, gm (B)		62°F-68°F = 13.55 gm/cc
Wt. of Mercury, Hg, gm (A-B) (C)		69° F-72° F = 13.54 gm/cc
$V_2^* = C \div Hg gm/cc \tag{D}$		$73^{\circ} F = 82^{\circ} F = 13.53 \text{ gm/cc}$
· · · · · · · · · · · · · · · · · · ·		
	Shrinkage	Plastic Liquid Plasticity
Limit Ratio	Index	Limit Limit Index
Land and the second		
je te state st	Request No	35 Lab No. 99-756

State of California THE RESOURCES AGEN DEPARTMENT OF WATER RES						LABORAT	Services Uffice ORIES BRANCH ABORATORY
		ATTER	BERG LIN	NITS			
		/~```\$ E   600m   1,5m			20	- 25	
Project		`.		Request )	No. 97		
Classification				Lab No	99	-750	
Remarks				Date	7-2	1-99	
		•			/ MANIN		
Project Classification Remarks Air Dried	🔲 In Situ	Over	n Dried	Tested B	y		·····
		PLASTI					
Determination No.		1	2	1	2	3	4
No. of Blows			$\geq$	22	30	16	
Container No.		Y	203	C	<u> </u>	E	
Wt. Container + Wet Soil, gm	(1)	22.95	13.89	210.10	25.5	25.32	
Wt. Container + Dry Soil, gm		22.22	22.90	22,72	22,49	12.22	
Wt. Water, Ww. gm (1-2)	(3)	0.75	0.99	3.38	3.02	3.11	
Wt. Container, gm	(4)	18.05	17.12	15.55	15.97	15.59	
Wt. Dry Soil, Ws, gm (2-4)	(5)	4.17	5.78	7.17	14.52	6.63	
Water Content, W, % (3+5) x	100 (6)	17.510	17.190	47.190	46.370	46.9	70
		÷.				, , , ,	
·····	RINKAGE LIM	1	2	]	Flow Curv	e for Liqui	d Limit
Determination No.		<u> </u>	<del>/</del>				
Container No.		<u> </u>					
Consistency, No. of Blows	(1)	· · · · · · · · · · · · · · · · · · ·		4	<sub>7</sub>		
Wt. Container + Wet Soil, gm				·	·		
Wt. Container + Dry Soil, gm				fen	┟╌╁╍┾╁┾┼╍╸		
Wt. Container, gm	(3)			Water Content			
<u>Wt. Wet Soil, W<sub>1</sub>, gm (1-3)</u>	(4)			er (			
Wt. Dry Soil, Ws, gm (2-3)	(5)			Kat			
Vol. Wet Soil, V <sub>1</sub> , cc	(6)						
Vol. Dry Soil, V2* cc	(7)		<u> </u>				
$W_1 - W_5$ (4-5)	. (8)		· · · · · · · · · · · · · · · · · · ·				
$V_1 - V_2$ (6-7)	(9)			44	° <del>               </del>		
W% at Shrinkage Limit $\frac{(8) - (9 \times \chi w)}{(5)}  100 = 0$	=				5 10	20 25 30	40 50
(5) Shrinkage Ratio — (5÷7)					И	o. of Blow	5
*Determination $V_2$ b	y Weighing						
Wt. of Container + Displaced	l, Hg, gm (A)			Merc	ury, Hg gm/c	c =	
Wt. of Container, gm	(B)			] [62° I	=_68° F = 13	.55 gm/cc	
Wt. of Mercury, Hg, gm (A-B					=_72° F = 13		
$V_2^* = C \div Hg gm/cc$	(D)			73° F	=-82°F = 13	.53 gm/cc	
<u> </u>							
	Shrinkage	Shrinkage	1	Plast Limit		iquid imit	Plasticity Index
	Ratio	Index			<u></u>	<u>, 1997 - English and an </u>	111440

Plastic	Liquid	Plasticity
Limit	Limit	Index

Lab No.

Request No. .

DWR 714 (Rev. 12/66)

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

ATTE	ERBERG	LIMITS	

Project_SH2S			Request	No. 79	-35	
Classification				9.9-	757	
Remarks		·····		<u>8/11/9</u>		
Air Dried In Situ	Tested By					
	PLASTI	C LIMIT		LIQUIC		
Determination No.	1	2	1	2	3	4
No. of Blows		$\geq$	30	23	19	
Container Nc.	140	144	351	200	.119	
	(1) 26.98	25,90	26,95	26.39	28.12	
	(2) 25.56	24,44	24.17	23,69	25.39	
	(3)	·		,		
	(4) 16.77	15.84	17.22	17.11	18.89	
	(5)					
	(6) 16,2	11.0	40	4/	42	

## SHRINKAGE LIMIT

Determination No.		1	22
Container No.			
Consistency, No. of Blows			
Wt. Container + Wet Soil, gm	(1)		
Wt. Container + Dry Soil, gm	(2)		
Wt. Container, gm	(3)		
Wt. Wet Soil, W 1, gm (1-3)	(4)		
Wt. Dry Soil, Ws; gm (2-3)	(5)		
Vol. Wet Soil, V1, cc	(6)		
Vol. Dry Soil, V2* cc	(7)		
$W_1 - W_s$ (4-5)	. (8)		
$V_1 - V_2$ (6-7)	(9)		
W% at Shrinkage Limit $\frac{(8) - (9 \times 3 \times w)}{(5)}  100 =$			
Shrinkage Ratio - (5÷7)			

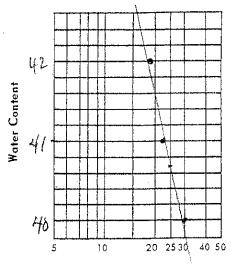
### \*Determination $V_{\rm 2}$ by Weighing

Wt. of Container + Displaced, Hg, gm	(A)	
Wt. of Container, gm	(B)	
Wt. of Mercury, Hg, gm (A-B)	(C)	 
$V_2^* = C + Hg gm/cc$	(D)	

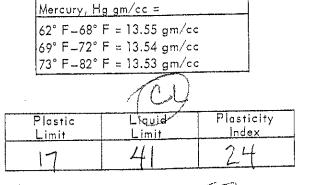
Shrinkage Limit	Shrinkage Ratio	Shrinkage Index

Request No.

### Flow Curve for Liquid Limit



No. of Blows



Lab No

State of California THE RESOURCES AGENCY						Technical S LABORATO	ervices Office RIES BRANCH
DEPARTMENT OF WATER RESOURCES		A TTEPP			,		BORATORY
_	~		BERG LIN				
ProjectSITES	Dł	EM		Request I	No(	19-35	>
Classification				Lab No	99	-758	·
Remarks						79	
		Oven			1.4	EU	······
, ,		PLASTIC			LIQUID		
Determination No.		1	2	1	2	3	4
No. of Blows		$>\!\!\!>\!\!\!<$	$>\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!$	27	23	19	
Container No.		Z	V	G	RI	H.	
Wt. Container + Wet Soil, gm	(1)	28.93	26.61	27.76	28.72	- 29.14	
Wt. Container + Dry Soil, gm	(2)	27.54	25.34	25,13	24,06	26.62	
Wt. Water, Ww, gm (1-2)	(3)	· · · · · · · · · · · · · · · · · · ·					
Wt. Container, gm	(4)	19.04	17.57	17.62	18.67	19.50	
Wt. Dry Soil, Ws, gm (2-4)	(5)						
Water Content, W, % (3+5) x 100	(6)	16.4	U.B	25.0	34.0	200	
SHRINKAGE	1 1411	Γ			EL C	t Étauta	1 ::.
Determination No.	<u> </u>	1 .	2		Flow Curv	e for Liquid	
Container No.							
Consistency, No. of Blows						<del></del>	
Wt. Container + Wet Soil, gm	(1)				<b></b>	┉┟╍┉┠╍┥╴┾┈	
Wt. Container + Dry Soil, gm	(2)			te 37			
Wt. Container, gm	(3)			Water Content			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)			ပိ			
Wt. Dry Soil, Ws, gm (2-3)	(5)	-	i	afer			
Vol. Wet Soil, V1, cc	(6)			× 2,4	· <del>│·┤·│┤</del>	┼─┤┪┤─┼╸	
Vol. Dry Soil, V2* cc	(7)						
$W_1 - W_s$ (4-5)	(8)						<u>_</u>
$V_1 - V_2$ (6-7)	(9)					┈┼──┼─┼╌	
W% at Shrinkage Limit $\frac{(8) - (9 \times 3 \times w)}{(5)} = 100 = 100$				25	5 10	20 25 30	40 50
(5) Shrinkage Ratio - (5+7)					И	o. of Blows	
*Determination $V_2$ by Weighing	l		······································				
Wt. of Container + Displaced, Hg, gm	(A)			Merc	ury, Hg gm/c	c =	
Wt. of Container, gm	(B)				-68° F = 13.		
Wt. of Mercury, Hg, gm (A-B)	(C)				–72° F = 13.	-	
$V_2^* = C \div Hg gm/cc$	(D)			73° F	$-82^{\circ}$ F = 13.	53 gm/cc	
Watan Andrew State Sta						$\supset$	
Shrinkage Shrinkage		Shrinkage		Plasti Limit		quid mit	Plasticity Index
Limit Ratio	-	Index			2	26	19
(	}		00			20	~~~
		Request No.		-35 Lat	No	14-+4	<u>&gt;0</u>

DWR 714 (Rev. 12/66)

State of California THE RESOURCES AGENCY					Technical ABORAT(	Services Office DRIES BRANCH
DEPARTMENT OF WATER RESOURCES	ATTER	BERG LIM	ITS			ABORATORY
SITES T				9	2-2	5
Project SUTES 1	-71104		Request No.			<u> </u>
Classification			— Lab No.——		150	1
Remarks		· · · · · · · · · · · · · · · · · · ·	Data	Blin	199	,
· · · · · · · · · · · · · · · · · · ·				1.010		
Air Dried [] In Situ	u [] Over	n Dried	Tested By		· ·	/
	PLASTI	CLIMIT		LIQUID	.іміт	V
Determination No.	1	2		2	3.	4
No. of Blows			m	24	17	
Container No.	RI	Z		U	<u>H</u>	
Wt. Container + Wet Soil, gm (	(1) 29.33	28.67			30.90	
Wt. Container + Dry Soil, gm	(2) 27.85	27.34			27.90	
Wt. Water, Ww, gm (1-2) (	(3) 1,49	1,33	3.01	2.84	3.00	
Wt. Container, gm	(4) 18.le7	19.03			951	
Wt. Dry Soil, Ws, gm (2-4)	(5) 9.10	8.31	9,01	8.32	8.31	
Water Content, W, % (3+5) x 100 (	(6)      (l   l   l   l   l   l   l   l   l	16.0	33.4	34.4 .	362.8	
SHRINKAGE	LIMIT		. 1	Flow Curve f	or Liquid	Limit
Determination No.	1	2	) · · · ·			
Container No.			·			
Consistency, No. of Blows				┝╍┝┥┥	-\	
	(1)		.	╈╴┝╊╍┝╉╺╴╴┧		
Wt. Container + Dry Soil, gm	(2)		± 35			
Wt. Container, gm	(3)		nte			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)		Mater Content	$\left  \left  \left$		
Wt. Dry Soil, Ws, gm (2-3) (	(5)		ater	┥╍┼╁╌┼		
Vol. Wet Soil, V1, cc	(6)		¥ 34	╅┈┼┼┼┼╌╌╌┾		
Vol. Dry Soil, V2* cc	(7)	Į				
	(8)			┝╍┝┥╷╎┝───┤		
	(9)			┝╍┦┥┝╎──┤		
W% at Shrinkage Limit (8) - (9×3 w) (5) 100 =			32	10	20 25 30	40 50
Shrinkage Ratio - (5+7)				No.	of Blows	
*Determination $V_2$ by Weighing		<del>ار</del>				
Wt. of Container + Displaced, Hg, gm	(A)		Mercury	, Hg gm/cc =		
Wt. of Container, gm	(B)			58°F = 13.55		
Wt. of Mercury, Hg, gm (A-B)	(C)			'2° F = 13.54		
$V_2^* = C \div Hg gm/cc$	(D)		73° F – 8	82°F = 13.53	gm/cc	
igr.	· · · · · · · · · · · · · · · · · · ·	<u></u>		(ND)		
Shrinkage Shrinkage Limit Ratio	Shrinkage Index		Plastic Limit	Liqu		Plasticity Index
			.14	30		18

Request No. \_

99-35

Lab No.

99-759

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

	<i>,</i> ,		ATTER	BERGLIN	NITS	aa	25	
' Project	2/156	·		·····	Request	No	(رهم المر	
Classificati	on				Lab No Date	- 99-	760	
					Data	8/11/9	9	
						1 51	Λ	
	Air Dried	🔄 In Situ	Over	n Dried	Tested B	Y		
						)		
			PLASTI	C LIMIT		LIQUII		
Determinati	on No	······································	1	2	1	2	3	4
No. of Blow			$\searrow$	$\supset$	34	29	20	
Container N			142	203	143-1	115	59	
	ier + Wet Soil,	gm (1 <sup>.</sup> )	26.96	23,90	30,23	25,70	26.48	
	er + Dry Soil,		25.97	22.96	27.93	23.97	24,48	
	∀w, gm (1-2)	(3)						
Wt. Contain	ner, gm	(4)	20.17	17.13	20.71	18,70	18,61	
Wt. Dry Soi	l, Ws, gm (2-4	) (5)						
	ent, W <u>, % (</u> 3+5		117,1	110.1	31,9	32.8	34,	
		SHRINKAGE LIM	<b>нт</b>			Elour Curr	e for Liquid l	imit
Determinati	ion No.		1	2				
Container N						╶╷		
	y, No. of Blo	WS						+{·
	ner + Wet Soil,				34	┝ <del>╞┥╹┥┥</del>		+
	ner + Dry Soil				at a	╵┣┫═╪╢┥┼╍		
Wt. Contain		(3)			nte		· ·	
	) W <sub>1</sub> , gm (1-3	) (4)			ပိ	┝╍┨╍╶┨╸┨╶┨╸┨		
	I. Ws, gm (2-3				Water Content	╷┝╾┽╴┼┾┼┼╍	╾┼╾┼╼┝╲┼╍	
Vol. Wet Sc		(6)			×	╔╼┼╾┝┼╶┼┽╌╴		
	oil, V <u>z* cc</u>	(7)			-			
$W_1 - W_s$		. (8)			-			
$V_1 - V_2$	(6-7)	(9)			33	<sub>┛</sub> ┝╾┿╾┿┽╍┿┿╍┈		4
	nkage Limit					<u> </u>	20 25 30	40 50
<u>(8</u>	$\frac{3) - (9 \times \delta w)}{(5)}$	100 =					20 2000	
				<u> </u>		ł	lo. of Blows	
•	<u>Ratio - (5+7)</u>			<u>_l</u>	4			
		V <sub>2</sub> by Weighing		·   · · · · · · · · · · · · · · · · · ·	1	ury, Hg gm/		J
	tciner + Displ					F_68° F = 10		
Wt. of Cont		<u>(B</u>				F=68 r = 13 F=72° F = 13		
	<u>cury, Hg, gm (</u>					F-82° F = 10		ļ
$V_2^* = C \div$	Hg gm/cc	(D	)					
						1	10	
	Shrinkage	Shrinkage	Shrinkage	· ·	Plas			Plasticity Index
	Limit	Ratio	Index	-	Limi		_imit	1
						7 3	3	16
L				AD a	Lucion	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	1 2/2	
			Request No	. 44-2	<u></u> Lo	15 No. 79	1/201	

State of California THE RESOURCES AGENCY						rvices Office LIES BRANCH
DEPARTMENT OF WATER RESOURCES					SOILS LAI	BORATORY
	ATTERE	BERG LIN	NITS			
ProjectSITES D	AM		Request 1	No	<u>H-35</u>	· · · · · · · · · · · · · · · · · · ·
Classification		-	Lab No	99	-761	
Remarks				,	199.	
				a service	11A	/
Air Dried 🔲 In Situ	C Oven	Dried	Tested B	у(Д	<u>W/</u>	
¢.					. /	
-	PLASTIC				LIMIT V	
Determination No.			- 20-	2	20	4
No. of Blows			29			
Container No.	111	P3	EI		PIB	
Wt. Container + Wet Soil, gm (1)	30.26	33.66	28.03	29.86	27.70	
Wt. Container + Dry Soil, gm (2)	28.61	31.37	25.51	27.0	25.24	
Wt. Water, Ww, gm (1-2) (3)						
Wt. Container, gm (4)	18.55	17.82	18.28	19.04	18.64	
Wt. Dry Soil, Ws, gm (2-4) (5)						
Water Content, W, % (3+5) × 100 (6)	110.4	16.9	34.9	35.9	37.3	
SHRINKAGE LIMI	T			Elaw Curv	e for Liquid L	imi+
Determination No.	1	2				<del></del>
Container No.						·
Consistency, No. of Blows			9,-	╻┝ <del>╶┽╵┥┥</del> ┥┤┼──	_ <u></u>	
Wt. Container + Wet Soil, gm (1)	-		÷	┊┝╾┽╾┼┽╺┿┽╍╍		+
Wt. Container + Dry Soil, gm (2)			*=			
Wt. Container, gm (3)			. nter			
Wt. Wet Soil, Wi, gm (1-3) (4)			Water Content مراج			
Wt. Dry Soil, Ws, gm (2-3) (5)			ter			
Vol. Wet Soil, $V_1$ , $cc$ (6)			Wa			+
Vol. Dry Soil, $V_2^*$ cc         (7)			39	, <del>                                     </del>		+
$W_1 - W_s$ (4-5) . (8)						
$V_1 - V_2$ (6-7) (9)		-				
W% at Shrinkcge Limit			34			
$\frac{(8) - (9 \times 3 \times w)}{(5)} = 100 =$				5 10	20 25 30	40 50
<u> </u>				N	o. of Blows	
Shrinkage Ratio - (5+7)						
*Determination V <sub>2</sub> by Weighing		· · · · · · · · · · · · · · · · · · ·		ury, Hg gm/c		
Wt. of Container + Displaced, Hg, gm (A)						
Wt. of Container, gm (B)			4 / /	F_68° F = 13 F_72° F = 13	-	
Wt. of Mercury, Hg, gm (A-B) (C)		· · · · · · · · · · · · · · · · · · ·		/2 F = 13 82° F = 13	•	
$V_2^* = C \div Hg gm/cc \qquad (D)$				-02 1 -10		
т. Т.				C		
Shrinkage Shrinkage	Shrinkage	ļ	Plast	ic E	iquid I	Plasticity
Limit Ratio	Index	4	<u>r Limit</u>		imit	Index
			17	. 7	36	19
		20	25		20	961
	Request No.		<u>35</u> La	b No		741

DWR 714 (Rev. 12/66)

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State of California THE RESOURCES AGE	NCY					LABORATOR	rvices Office RIES BRANCH
DEPARTMENT OF WATER R	ESUURCES	ATTED	BERGLIN	AITC		SUILS LA	BORATORY
Project_ <u>SHUS</u> Classification	2m	ΑΠ <b>Ε</b> Β	DERG LIN	Request	99.	-35	
Classification	-				99-	762	
	·····				aluta	A	<u></u>
Remarks				Date	8/11/9	7	
Air Dried	🔄 In Situ	Ove	n Dried	Tested B	y/	!	
		PLAST	IC LIMIT		LIQUID		
Determination No.		1	2	1	2	3	4
No. of Blows	<u></u>	$\sim$	$\sim$	34	22	15 I	-
		117	X	143	145	I	
Container No.	m (1)	30 22	30,56	24.67	30,73	27.05	
Wt. Container + Wet Soil, g		2855	28.88	22,36	28.22	24,58	
Wt. Container + Dry Soll, g		2.0, 01	20.00		1201-		
Wt. Water, Ww, gm (1-2)	(3)	10 210	14-71.	14.91	20,52	17,31	
Wt. Container, gm	(4)	18.06	18,76	1-1-7-11	20,00		
Wt. Dry Soil, Ws, gm (2-4)	(5)		······································	710	22 (0	34.0	,
Water Content, W, % (3+5)	<u>x 100 (6)</u>	17.0	16,6	31.0	32.6	27.0	
S	HRINKAGE LIM	ΙT.			Elow Curv	e for Liquid	Limit
Determination No.		1	2			<u></u>	
Container No.				1			
Consistency, No. of Blows		1		34			
Wt. Container + Wet Soil, c				1			
Wt. Container + Dry Soil, c	(3)			1 E 32	╮ <del>┦╍┨╍┝</del> ┧┨┼──		
Wt. Container, gm							
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)			1			
Wt. Dry Soil, Ws, gm (2-3)	(5)			Water Content	╮╺┷╍╾┶┶┷┥┿╍╍		
Vol. Wet Soil, V <sub>1</sub> , cc	(6)			1 2			
Vol. Dry Soil V2* cc	(7)			-			
$W_1 - W_s$ (4-5)	. (8)				$\left  - \right  - \left  + \right  + \left  - \right $		
$V_1 - V_2$ (6-7)	(9)			- 73	·1 <del>- + -   +   + −</del>	<u></u>	
W% at Shrinkage Limit			· .		5 10	20 2530	40 50
$\frac{(8) - (9 \times \chi w)}{(5)}$ 10	0 =				•		
				-	4	lo: of Blows	
Shrinkage Ratio – (5÷7)	1 11/2 1 4			4			
*Determination V <sub>2</sub>	2 by Weighing			<del>م</del>			
Wt. of Container + Displac	ed, Hg, gm (A)				cury, Hg gm∕o		
Wt. of Container, gm	(B)			mi '	$F = 68^{\circ} F = 13$	•	
Wt. of Mercury, Hg, gm (A	-B) (C)	1			$F = 72^{\circ} F = 13$		
$V_2^* = C \div Hg gm/cc$	(D)			73°	$F = 82^{\circ} F = 13$	3.53 gm/cc	
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	· ·			·	Cay	
Shrinkage	Shrinkage	Shrinkage		P las Limi	1 .	iquid .imit	Plasticity Index
Limit	<u>Ratio</u>	Index					15
			Line Line Line Line Line Line Line Line	<u> </u>	<u>`</u>		
			99-	35 .	99	-762	
		Request N	0	<u> </u>	10 INO	- Far Comme	

THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES	AT	TERBERG LI	MITS	·	Technical : LABORAT( SOILS L,	Services O DRIES BRA, ABORATOR .
Project	r.		Request	90	1-35	
Classification	۰. 					
				· · • • •	<u></u> 9 9	
Air Dried In Sit		] Oven Dried	Tested E	1 /	DM	
	PL	LASTIC LIMIT		LIQUI	D LIMIT	
Determination No.	. 1	2	] ]	2	3	4
No. of Blows	>		32	210	15	4
Container No.	JI	Y	121	120	00	
<u>Wt. Container + Wet Soil, gm</u>	(1) 25.	14 24,29	26.55	26,54	28,53	
	(2) 24.1	·····	24,33	24.08		
Wt. Water, Ww, gm (1-2)	(3) .90	7 ,9		-01,00	26.34	
Wt. Container, gm	(4) 18.18		11.25	16.53	20.33	
Wt. Dry Soil, Ws, gm (2-4)	(5) 5.9		1.1,1.82	10,00	20.22	
	6) 16.0		31,4	32.6	36.4	
SHRINKAGE L	IMIT	······································			· · · · · · · · · · · · · · · · · · ·	
Determination No.	1	2		Flow Curve	e for Liquid L	imit
Container No.	·····					
Consistency, No. of Blows						
Wt. Container + Wet Soil, gm (	1)		: ني			
	2)		- -	┿┽┽┼┼┼┼	·	
Wt. Container, gm (3	3)		ten	╞┈╋╌╄┼┝╀┼╌╍	- <u>}-</u>	
111. 11	4)		ater Content	╞╌╁╍╀┽┝┾┾╌╼		
Wt. Dry Soil, Ws. gm (2-3)			e		1-1-1	
	5)		Wat			•
Vol. Dry Scil, V2* cc (7			v.v	┝╼┟╼╎┼╎╎		
$W_1 - W_s$ (4-5) (8	3)		•	┝╍╁╍╁┼╌┟┼╴╸╸		
$V_1 - V_2$ (6-7) (9	))		د.			
W% at Shrinkage Limit			21			
$\frac{(8) - (9 \times 3 \times 3)}{(5)}$ 100 =			31	10	20 25 30 \40	50
(5) Shrinkage Ratio - (5+7)				1	, of Blows	
*Determination $V_2$ by Weighing				07I	OT DIOWS	
	4)		Mana	v H= /		
W	3)			y, Hg gm/cc		
	D)		102°F-	-68° F = 13.5	5 gm/cc	
			73° F	72° F = 13.5 82° F = 13.5	4 gm/cc 2 _m/cc	
	<u> </u>	·		······	S gm/cc	· ·
				2	CL/	
Shrinkage Shrinkage Limit Ratio	Shrinkage Index		Plastic Limit	Liqu		ndex
			17	2		1L
		No 99-23	5.		6.7,-	<u> </u>
	Request	No	Lab	No	1 10	2

State of California THE RESOURCES AGENCY

Technical Services Office
LABORATORIES BRANCH
SOILS LABORATORY

		BERG LIN			$\alpha$ -	
Project	DAN		Request	No	<u>H-35</u>	5
				$\partial \partial$	-7104	2
Classification			Lab No		1100	······································
Remarks			Date		1198	
			Takalo			
Air Dried 🗌 In Situ	L_] Uve	n Dried	iested D	·Y	Lawer /	/
	PLASTI	IC LIMIT		LIQUID		
Determination No.	1	2	1	2	3	4
No. of Blows			30	25	19	
Container No.	E	PIS	*141	#40	#140	
∀t. Container + Wet Soil, gm (1)	26.02	25.33	26.91	27,28	25.62	<u>.</u>
₩t. Container + Dry Soil, gm (2)	2.4.46	24,36	24.06	2.4.76	22.97	
₩t. Water, Ww, gm (1-2) (3)			<u></u>	10.0		
Wt. Container, gm (4)	15.60	18.75	17.11	18.81	16.94	
Wt. Dry Soil, Ws, gm (2-4) (5				101	100	
Water Content, W, % (3÷5) × 100 (6.	7.6	17.3	41.0	42.4	43.9	<u></u>
SHRINKAGE LI	міт			Flow Curv	e for Liquid	Limit
Determination No.	1	2		,		—- <del></del> 1
Сопtainer No.						
Consistency, No. of Blows			A	┦┼╍╍┝╌┥┥┥╌╌		
Wt. Container + Wet Soll, gm (1	)		-			
Wt. Container + Dry Soil, gm (2	)		t t			
Wt. Container, gm (3	)		Water Content	3		
Wt. Wet Soil, W 1, gm (1-3) (4	)					
Wt. Dry Soil, Ws, gm (2-3) (5	)		ate			
Vol. Wet Soil, V1, cc (6			₹   4	,		
Vol. Dry Soil V2* cc (7			4			
$W_1 - W_s$ (4-5) (8					<del></del>	
$V_1 - V_2$ (6-7) (9	)		-	╷┝╍┾╍┼┽┼┼┼		
W% at Shrinkage Limit (8) - (9×γw) 100 =			4	5 10	20 25 30	40 50
$\frac{(0)^2 - (7 \times 6 \times 7)}{(5)}$ 100 =						
Shrinkage Ratio - (5÷7)				N	lo. of Blows	
*Determination V <sub>2</sub> by Weighing						
	۹)	· · · · · · · · · · · · · · · · · · ·	Merc	ury, Hg gm/d	=c =	
	B)			F_68° F = 13		
	C)		69°	F_72° F = 1 <u>3</u>	3.54 gm/cc	
1. 6	D)		73°	$F = 82^{\circ} F = 13$	3.53 gm/cc	
			-	(A)		
· · · · · · · · · · · · · · · · · · ·	<u> </u>		Plas	<u>(U)</u>	iquid	Plasticity
Shrinkage Shrinkage Limit Ratio	Shrinkage Index		Limi		imit	Index
				$1 \qquad l$	11,	16

DWR 714 (Rev. 2/66)

Wt. Container + Wet Soil, gm

Wt. Container + Dry Soil, am

Wt. Water, Ww. gm (1-2)

Wt. Container, gm

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

	ATTER	BERG LIN	IITS			
Project_ <u>SItes Dam</u>			Reques	t No92	-35	
Classification			Lab No	99-76	5	
Remarks			Date	<u>99-76</u> 8/12/99		
🛛 Air Dried 🔄 In Situ	C Over	n Dried	Tested	By DMJ		
	PLASTI	C LIMIT		LIQUI	DLIMIT	
Determination No.	1	2	1	2	3	4
No. of Blows		$\searrow$	25			<u></u>
Container No.	131	143-1	115	\J./	X42/	

29.86

28.65

1,21

20,71

27.18

24.89

2

29

9

18.70

37.0

27.13

25.81

1:32

2

(1)

(2)

(3)

(4)

Wt. Dry Soil, Ws, gm (2-4)	(5)	8.56	7.94	6:
Water Content, W, % (3÷5) x 100	(6)	15.4	15.2	3-
SHRINKA		٢	• •	
Determination No.		1	2	
Container No.				
Consistency, No. of Blows				
Wt. Container + Wet Soil, gm	(1)			
Wt. Container + Dry Soil, gm	(2)			
Wt. Container, gm	(3)			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)			C
Wt. Dry Soil, Ws. gm (2-3)	(5)			
Vol. Wet Soil, V1, cc	(6)			3
Vol. Dry Soll, V2* cc	(7)			
$W_1 - W_s$ (4-5)	. (8)			
$V_1 - V_2$ (6-7)	(9)			
₩% at Shrinkage Limit <u>(8) - (9×3 w)</u> 100 = (5)				
Shrinkage Ratio - (5÷7)				

\*Determination V<sub>2</sub> by Weighing

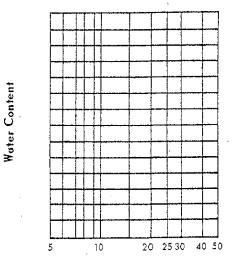
Wt. of Container + Displaced, Hg, g	(A)	 
Wt. of Container, gm	(B)	 
Wt. of Mercury, Hg, gm (A-B)	(C)	 
$V_2^* = C \div Hg gm/cc$	(D)	 

Shrinkage	Shrinkage	Shrinkage
Limit	Ratio	Index

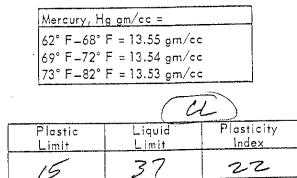
### Flow Curve for Liquid Limit

ZO

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No. of Blows



99-765

Lab No.

Request No. \_\_\_\_\_\_

State of California THE RESOURCES AGENCY

Technico	al Services Office
LABORA	TORIES BRANCH
SOILS	LABORATORY

ProjectGUS Classification Remarks Air Dried In Situ		BERG LIN	Request )	No	1-35	
Project			Request )	107		
Classification					and the second	
Remarks			Lab No	- 99.	- + (e)(e	
Remarks				8/12	199	
				Ann		·····
Air Dried 🗌 In Situ	C Oven	Dried	Tested B	y((	) /	/
	PLASTIC					1
Determination No.	1	2	1	2	3	4
No. of Blows	$\sim$	>	36	13	19	
Container No.	P13	P15	Z	S	P3	
Wt. Container + Wet Soil, gm (1)	31.25	27.13	29.56	26.61p	27.26	
Wt. Container + Dry Soil, gm (2)	19.33	25.91	25.76	23.30	23.68	<u> </u>
Wt. Water, Ww, gm (1-2) (3)						
Wt. Container, gm (4)	18.03	18.75	19.04	17.62	17.82	
Wt. Dry Soil, Ws, gm (2-4) (5)		·				· · · ·
Water Content, W, % (3+5) x 100 (6)	17.9	17.0	64.5	59.2	lel.1	
SHRINKAGE LIN	II T		• ·	Flow Curv	e for Liquid	Limit
Determination No.	1	2		F-T-T-T-T-T-	·	
Container No.				┝╍┼╍┾┽╍┾┥╌╸		
Consistency, No. of Blows				╶┟┯┽╍┼┼┼┼┼	<del>-         -</del>	╺╋━┥
Wt. Container + Wet Soil, gm (1)					<u>\.</u>	
Wt. Container + Dry Soil, gm (2)			t u	`		
Wt. Container, gm (3)			Mater Content	╷┝╍╋╍╋╋╋╋		
Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)						
Wt. Dry Soil, Ws, gm (2-3) (5)			رم te		<u> </u>	
<u>Vol. Wet Soil, V1, cc</u> (6)		/··	- 40	╷┝╾┝╍┽┼╌┝┼┈╍		
Vol. Dry Soil, $V_2^*$ cc (7)				┝┿┿┿┿┿	╾┼╌┼╌┼╌╢╌	
$\frac{W_1 - W_s}{V_1 - V_2}  (4-5) \tag{8}$			6	╵┝╾┿╌┼┽┼┼┼		
Y1 - Y2 (0-7) (7) W% at Shrinkage Limit						
$\frac{(8) - (9 \times 5 \text{ w})}{(9 \times 5 \text{ w})} = 100 =$			51	5 10	20 2530	40 50
(5)	· · · · · · · · · · · · · · · · · · ·		1	N	o, of Blows	
Shrinkage Ratio – (5÷7)				11	0.01 0.000	
*Determination $V_2$ by Weighing						,
Wt. of Container + Displaced, Hg, gm (A	)		-	ury, Hg gm/c		
Wt. of Container, gm (B	)			F_68° F = 13	-	
Wt. of Mercury, Hg, gm (A-B) (C				F_72° F = 13 F_82° F = 13		
$V_2^* = C \div Hg gm/cc$ (D	)		/3	-02 1 - 13		
4 				(CH	)	
Shrinkage Shrinkage	Shrinkage		Plast Limit		iquid imit	Plasticity Index
Limit Ratio	Index	1	17		-23	A7-
		] .	<u> </u>			<u> </u>

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Technical Services Office
LABORATORIES BRANCH
SOILS LABORATORY

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0.1		ALICKI	DERG LI	VILLS			
Project Sites				Request	No. 99-	35	
Classification				Lab No	99-	767	
Remarks				Dete	8/12/9	9	•
Cellidiks	·····						
Air Dried 🔄 In Si	tu	Ove	n Dried	Tested B	yDA	1	
					/		
	·	PLASTI	C LIMIT	•	LIQUII		
Determinatior No.		1	2 ·	1	2	3	4
No. of Blows		$\geq$		35	20	115	
Container No.		B	Ē	VI	Er	146	
Wt. Container + Wet Soil, gm	(1)	21.32	20.93	27,24	27.99	26.20	
Wt. Container + Dry Soil, gm	(2)	20.56	20,18	25,34	25.64	23,90	
Wt. Water, Ww, gm (1-2)	(3)						****
Wt. Container, gm	(4)	16.11	1559	19.04	18.28	16,94	
Wt. Dry Soil, Ws, gm (2-4)	(5)		1				
Water Content, W, % (3+5) x 100	(6)	17.1	17.4	30,2	319	33	
SHRINKAGE	LIMI	r '		-	Elaw Cum	e for Liquid L	imi+
Determination No.		1	2	]	LIOW CUTV	e tor Liquia L	
Container No.				]		<u></u>	
Consistency, No. of Blows				33	<sub>2</sub> ┿╌┼┼┼┼┼		+
Wt. Container + Wet Soil, gm	(1)			) >	╹┝╌┼╾┝┼┼┼┼	- <u></u>	
Wt. Container + Dry Soil, gm	(2)				<u>┣╍┥╾╆╋╶╆</u> ┣━╸		
Wt. Container, gm	(3)			Water Content			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)			e e		<b>N</b>	4{
Wt. Dry Soil, Ws. gm (2-3)	(5)			] ter			
Vol. Wet Soil, V1, cc	(6)			M°	┝┥┥┝		+
Vol. Dry Soil, V2* cc	(7)			3	┍╋╍┼╴┥┥┥┥┥╸╸		+
$W_1 - W_5$ (2-5)	(8)						
$V_1 - V_2$ (6-7)	(9)						+
W% at Shrinkage Limit				30	5 10	20 25 30 4	10 50
$\frac{(8) - (9 \times 3 \times 1)}{(5)}$ 100 =					5 10	. 20 25 30 4	းစ(၁၀
(5) Shrinkage Ratio - (5+7)	· · · · ·			-	И	o, of Blows	
*Determination V <sub>2</sub> by Weighing				4			
		······································		Merc	ury, Hg gm/c	.c =	
Wt. of Container + Displaced, Hg, gm	(A) (B)			-	-68° F = 13		
Wt. of Container, gm	( <u>D)</u> (C)				=08 F = 13 F=72° F = 13	-	
Wt. of Mercury, Hg, gm (A-B) V <sub>2</sub> * = C + Hg gm/cc	(C) (D)		<u> </u>		$=72^{\circ} F = 13^{\circ}$	-	
	/		I.,	4	······	P	$\overline{\Box}$
			7			\	
Shrinkage Shrinkage		Shrinkage Index		Plast Limit		iquid \	<sup>2</sup> lasticit Index
Limit Ratio			1	. ~			116
	· ·				3		14
			an -		. ( <sup>200</sup>	the second second	
i i i i i i i i i i i i i i i i i i i		Request No.	99-3	20 Lol	No. 9	7-16/	
in a constant and the second			-			5	

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Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

	Α	TTERE	BERG LIN	NITS			
Project Siteg Dam				Request	No. 99	-35	
Classification			<del></del>	Request I Lab No Date	99-71	68	
Remarks				Date	8/12/99		
					TYAN T		
Air Dried 🗌 In Situ	J	Dven	Dried	Tested B	y DMJ		<u></u>
		PLASTIC			LIQU	DLIMIT	
Determination No.		1	2	1	2	3	4
No. of Blows		$\geq \leq$	$\geq$	33	Z3 X	15	
Container No.		143	//7	200	<u>X</u> .	γ	
Wt. Container + Wet Soil, gm (	1) 2	13,32	26.38	25.89	27.32	26.68	
Wt. Container + Dry Soil, gm (	(2) Z	2.22	25.30	22.94	24.36	23,61	
Wt. Water, Ww, gm (1-2) (	3)	1.10	1.08	2,95	2.96	3.07	
Wt. Container, gm (	4) [	4,91	18.06	17.11	18.76	18.05	
Wt. Dry Soil, Ws, gm (2-4) (	5)	7.31	7.24	5.83	5.60	5.56	
Water Content, W, % (3÷5) × 100 (	6) /	15.0	14.9	50,6	52.9	55.Z	
SHRINKAGE L	_1MIT				Flow Cu	ve for Liqu	id Limit
Determination No.		1	2				
Container No.				57	6	<u> </u>	
Consistency, No. of Blows					<sub>┛</sub> ┝┿┿┿┿┿	-\-++	
Wt. Container + Wet Soil, gm (	(1)			55	> <mark>┝┼┼┼┼┼</mark>		
Wt. Container + Dry Soil, gm (	2)		· · · · · · · · · · · · · · · · · · ·	tu 54			
Wt. Container, gm (	(3)			Water Content 25	╵┝╾┽╌┼┼╴┽┼	<u> </u>	
Wt. Wet Soil, Wi, gm (1-3) (	(4)			Ŭ 53	₿┝┼┼┼┼		
Wt. Dry Soil, Ws. gm (2-3) (	5)			ate	┝╾┽╼┼┼╴┾┽╸		+
Vol. Wet Soil, V1, cc (	(6)	. <u></u>		¥.52			·
	(7)			51			
	(8)						- <b>A</b>
	(9)			50	┝┼┼┼┼	-+	+
W% at Shrinkage Limit (3) - (9×γw) 100 =					5 10	20 253	30 40 50
(5)						No. of Blov	
Shrinkage Ratio – (5÷7)		<u></u>					
*Determination V <sub>2</sub> by Weighing	:		r	1 P			
Wt. of Container + Displaced, Hg, gm	(A)				ury, Hg gm,		
Wt. of Container, am	<u>(B)</u>			4 I		3.55 gm/cc 3.54 gm/cc	
Wt. of Mercury, Hg, gm (A-B)	(C)			1 1 1		3.54 gm/cc 3.53 gm/cc	)
$V_2^* = C + Hg gm/cc$	(D)						
						/	CH >
Shrinkage Shrinkage		inkage Index		Plast Limit		_iquid Limit	Plasticity Index
Limit Ratio		ndex	1	15		52	37
			]			, _	·

Request No. 99-35 Lab No. 99-768

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

PLASTIC LIMIT       LIQUID LIMIT         Determination No.       1       2       1       2       3       4         No. of Blows       0       1       2       1       2       3       4         No. of Blows       0       1       2       1       2       3       4         No. of Blows       0       1       2       1       2       3       4         Container No.       V       1       1       2       3       4         W1. Container + Wet Soil, gm       (1)       20.12       29.30       27.72       29.33       27.79         W1. Container + Dry Soil, gm       (2)       10.52       19.52       19.52       19.47         W1. Container, gm       (4)       17.57       17.31       19.52       19.47         W1. Container, gm       (3)       17.7       24.0       25.70       10.47       10.47         W1. Container, No.       1       2       17.7       24.0       25.70       10.47       10.17         Determination No.       1       2       17.7       24.0       25.70       10.17       10.17         W1. Container, gm       (3)       1       2	- 6 (	ATTER	BERG LIN	NITS				
Classification       Lob No. $77 - 7427$ Remarks       Date $6/12/99$ Remarks       Date $6/12/99$ Remarks       PLASTIC LIMIT       LiQUID LIMIT         Determination No.       1       2       3       4         No. of Blows       2       3       4       1       2       3       4         Container No.       1       2       3       4       1       1       2       3       4         No. of Blows       1       2       3       4       1       1       1       2       3       4         Wit Container + Wet Soil, gm       (1) $0/12/83/09$ $27.78/20/27.73/20/$	Project SAVS			Request	qc	7-35		
Date       O/12/99         Tested By         In Situ       Oven Dried         PLASTIC LIMIT       LIQUID LIMIT         Date       O/12/99         PLASTIC LIMIT       LIQUID LIMIT         Date       O/12/99         PLASTIC LIMIT       LIQUID LIMIT         Date       O/12/99         Oven Dried       Tested By         PLASTIC LIMIT         Container No.       O/12/93       Q12/725       SHRINKAGE LIMIT <th co<="" td=""><td></td><td></td><td></td><td></td><td></td><td>7-710</td><td>9</td></th>	<td></td> <td></td> <td></td> <td></td> <td></td> <td>7-710</td> <td>9</td>						7-710	9
PLASTIC LIMIT       LiQUID LIMIT         PLASTIC LIMIT       LiQUID LIMIT         Determination No.       1       2       1       2       3       4         No. of Blows       V       T       ULI       H       PLA         Container No.       V       T       ULI       H       PLA         W1. Container + Wet Soil, gm       (1)       20-12       32.09       27.78       29.33       27.79         W1. Container + Dry Soil, gm       (2)       30.74       25.50       2.40.77       15.3.4         W1. Container, gm       (4)       17.67       17.7       32.05       36.7         W1. Container, gm       (4)       17.67       17.7       32.05       36.7         W1. Container, gm       (3)       1       1       1       1         Determination No.       1       2       32.05       36.7       1         Schalarer + Wet Soil, gm       (1)       1       2       1       1       1         V2. Container, gm       (3)       (4)       1       2       32.07       1       1         W1. Container + Wet Soil, ws. gm (2.3)       (5)       1       2       36.07       1       1 <td></td> <td></td> <td>······································</td> <td></td> <td>a /1-</td> <td>1</td> <td></td>			······································		a /1-	1		
PLASTIC LIMIT       LiQUID LIMIT         PLASTIC LIMIT       LiQUID LIMIT         Determination No.       1       2       1       2       3       4         No. of Blows       V       T       ULI       H       PLA         Container No.       V       T       ULI       H       PLA         W1. Container + Wet Soil, gm       (1)       20-12       32.09       27.78       29.33       27.79         W1. Container + Dry Soil, gm       (2)       30.74       25.50       2.40.77       15.3.4         W1. Container, gm       (4)       17.67       17.7       32.05       36.7         W1. Container, gm       (4)       17.67       17.7       32.05       36.7         W1. Container, gm       (3)       1       1       1       1         Determination No.       1       2       32.05       36.7       1         Schalarer + Wet Soil, gm       (1)       1       2       1       1       1         V2. Container, gm       (3)       (4)       1       2       32.07       1       1         W1. Container + Wet Soil, ws. gm (2.3)       (5)       1       2       36.07       1       1 <td>Remarks</td> <td></td> <td></td> <td> Date</td> <td><math>\underline{0}</math></td> <td>99</td> <td></td>	Remarks			Date	$\underline{0}$	99		
PLASTIC LIMIT         LIQUID LIMIT           Determination No.         1         2         1         2         3         4           No. of Blows         V         I         VII         H         R2         1         4           Container No.         V         I         VII         H         R2         17           Container + Wet Soil, gm         (1)         20:12         33.09         27.78         29.33         27.79           Wr. Container, + Wet Soil, gm         (2)         10:30         30.71         25.50         10:47         15.34           Wr. Water, Wax, gm (1-2)         (3)         10:54         19.52         16:47         10:54           Wr. Ory Soil, Ws, gm (2-4)         (5)         17.7         31.05         36.7         36.7           Water Container, W. % (3-5) x 100         (6)         17.0         17.7         31.05         36.7         36.7           Consistency, No. of Blows         1         2         20         35.3         36.7         36.7           Wr. Container + Dry Soil, gm (23)         (5)         1         2         36.0         36.0         36.0         36.0         36.0         36.0         36.0         36.0         3	Air Dried In Situ	Over	n Dried	Tested B				
Determination No.       1       2       1       2       3       4         No. of Blows       V       I       UI       H       Plan         Container No.       V       I       UI       H       Plan         W1. Container + Wer Soil, gm       (1) $20.12$ $33.09$ $27.783$ $29.33$ $27.79$ W1. Container + Dry Soil, gm       (2) $10.30$ $30.742$ $15.50$ $10.47$ $15.94$ W1. Container + Dry Soil, ws, gm (2-4)       (3)       IB.54 $19.524$ $10.47$ W1. Dry Soil, Ws, gm (2-4)       (5)       IB.54 $19.524$ $10.47$ Water Container, gm       (4) $17.57$ $17.51$ $10.54$ $19.524$ $10.47$ W1. Dry Soil, Ws, gm (2-4)       (5)       IB.54 $19.524$ $10.47$ IB.54 $19.524$ $10.47$ W1. Dry Soil, Ws, gm (2-3)       (6)       IP.60 $25.35$ $34.67$ IIIII $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$ $10.20$		·····					/	
Determination No.       1       2       1       2       3       4         No. of Blows       V       I       U1       H       R1         Container No.       1 $20$ $30$ $41$ H       R1         W1. Container + Wert Soil, gm       (1) $50$ $17$ $16$ $27$ $78$ $29$ $32$ $27$ $79$ $17$ $16$ $24$ $79$ $16$ $17$ $77$ $16$ $24$ $77$ $16$ $24$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $77$ $16$ $77$ $7$	~	PLASTI	C LIMIT		LIQUIC		$\vee$	
No. of Blows       V       I       UI       H       R1         Container No.       V       I       UI       H       R1         W1. Container + Wet Soil, gm       (1) $3D$ . 12 $33.09$ $27.78$ $29.33$ $17.79$ W1. Container + Dry Soil, gm       (2) $26.50$ $24.77$ $25.50$ $24.779$ $77.79$ W1. Container, gm       (4) $17.57$ $17.731$ $10.54$ $19.52$ $10.477$ W1. Container, gm       (4) $17.57$ $17.731$ $10.54$ $19.52$ $10.477$ W1. Container, gm       (3) $17.77$ $321.00$ $35.3$ $34.77$ Water Conteiner, W. % (3+5) x 100       (6) $17.77$ $321.00$ $35.3$ $34.77$ Determination No.       1       2 $35.3$ $34.77$ $51.5$	Determination No.	1	2	1	-		4	
Container No.       V       II       H       R1         Wt. Container + Wet Soil, gm       (1) $20 \cdot 12$ $33.09$ $17.73$ $19.33$ $17.77$ Wt. Container + Dry Soil, gm       (2) $10.80$ $30.71$ $15.50$ $10.77$ $77.77$ Wt. Container, gm       (4) $17.57$ $17.57$ $10.47$ $10.47$ Wt. Container, gm       (4) $17.57$ $17.73$ $10.54$ $19.52$ $10.47$ Wt. Container, gm       (4) $17.57$ $17.73$ $10.54$ $19.52$ $10.47$ Wt. Container, gm       (3) $17.77$ $31.00$ $35.73$ $34.77$ SHRINKAGE LIMIT         Determination No.         Container + Met Soil, gm       (1)         Wt. Container + Met Soil, gm       (2) $10.00$ $70.00$ $70.00$ $70.00$ Wt. Container + Dry Soil, gm       (2) $10.00$ $70.00$ $70.00$ $70.00$ $70.00$ $70.00$ Wt. Container + Dry Soil, gm       (2) $10.00$ $10.00$ $10.00$ $10.00$ $10.00$ $10.00$	No. of Blows	$\geq$	$\geq$	15	13	17		
Wit. Container + Dry Soil, gm       (2) $26.80$ $30.72$ $25.50$ $240.77$ $15.34$ Wit. Water, Ww, gm (1-2)       (3)       (3)       (3)       (3)       (4) $17.57$ $17.31$ $18.54$ $19.52$ $16.47$ Wit. Dry Soil, Ws, gm (2-4)       (5)       (6) $17.7$ $31.60$ $25.35$ $346.7$ Flow Curve for Liquid Limit         Determination No.         Container + Wet Soil, gm (1)         Wt. Container + Net Soil, gm (2)       (3)         Wt. Container + Wet Soil, gm (2)       (4)       (4)       (4)         Wt. Container + Wet Soil, gm (23)       (5)       (4)       (4)         Wt. Dry Soil, Vs, gm (2.3)       (5)       (4)       (4)       (4)         Wt. Dry Soil, Vs, gm (2.3)       (5)       (4)       (4)       (4)         Val. We Soil, V1, cc       (6)       (7)       (9)       (4)       (4)       (4)         Val. V2 (6.7)       (7)       (9)       (4)       (4)       (4)       (4)       (4)         Wt. Try Soil, Ws, gm (2.4)       (10.4)       (4)       (4)       (4)       (4)       (4)       (4)       (4) </td <td>Container No.</td> <td>V</td> <td>I</td> <td>UI</td> <td>H</td> <td>RI</td> <td></td>	Container No.	V	I	UI	H	RI		
Wit. Container + Dry Soil, gm       (2) $26.80$ $30.72$ $25.50$ $240.77$ $15.34$ Wit. Water, Ww, gm (1-2)       (3)       (3)       (3)       (3)       (4) $17.57$ $17.31$ $18.54$ $19.52$ $16.47$ Wit. Dry Soil, Ws, gm (2-4)       (5)       (6) $17.7$ $31.60$ $25.35$ $346.7$ Flow Curve for Liquid Limit         Determination No.         Container + Wet Soil, gm (1)         Wt. Container + Net Soil, gm (2)       (3)         Wt. Container + Wet Soil, gm (2)       (4)       (4)       (4)         Wt. Container + Wet Soil, gm (23)       (5)       (4)       (4)         Wt. Dry Soil, Vs, gm (2.3)       (5)       (4)       (4)       (4)         Wt. Dry Soil, Vs, gm (2.3)       (5)       (4)       (4)       (4)         Val. We Soil, V1, cc       (6)       (7)       (9)       (4)       (4)       (4)         Val. V2 (6.7)       (7)       (9)       (4)       (4)       (4)       (4)       (4)         Wt. Try Soil, Ws, gm (2.4)       (10.4)       (4)       (4)       (4)       (4)       (4)       (4)       (4) </td <td>Wt. Container + Wet Soil, gm (1)</td> <td>30.12</td> <td>33.09</td> <td>27.78</td> <td>29.33</td> <td>27.79</td> <td></td>	Wt. Container + Wet Soil, gm (1)	30.12	33.09	27.78	29.33	27.79		
Wit. Container, gm       (4) $17.57$ $17.31$ $19.54$ $19.52$ $18.47$ Wit. Dry Soil, Ws, gm (2-4)       (5)       (6) $17.0$ $17.7$ $31.00$ $35.35$ $346.7$ SHRINKAGE LIMIT         Determination No.         Consistency, No. of Blows         Wt. Container + Wet Soil, gm       (1)         Wt. Container + Wet Soil, gm       (2)         Wt. Container, gm       (3)         Wt. Container, gm       (3)         Wt. Container, gm       (3)         Wt. Container, gm       (3)         Wt. Wet Soil, Ws, gm (2-3)       (5)         Vol. Dry Soil V2* cc       (7)         W1 - Ws       (-5.5)         (6)       (-7)         W1 - Ws       (-5.7)         (5)       100 =         Shrinkage Raito - (5+7)       (5)         *Determination V2 by Weighing       Mercury, Hg. gm/cc =         Wt. of Container, gm       (B)         Wt. of Container, gm </td <td></td> <td></td> <td></td> <td>25,50</td> <td></td> <td>15.34</td> <td></td>				25,50		15.34		
Wt. Dry Soil, Ws, gm (2-4)       (5)         Water Content, W, % (3+5) × 100       (6)       17.7       32.0       36.7         SHRINKAGE LIMIT         Determination No.         Container No.       1       2         Container No.       1       2         Consistency, No. of Blows	Wt. Water, Ww, gm (1-2) (3)							
Water Content, W, % (3+5) x 100       (6)       7.7       34.0       36.7         SHRINKAGE LIMIT         Flow Curve for Liquid Limit         Container No.         Container No.         Consistency, No. of Blows         Wt. Container + Wet Soil, gm       (2)         Wt. Container + Dry Soil, gm       (2)         Wt. Container, gm       (3)         Wt. Wet Soil, W <sub>3</sub> , gm (1-3)       (4)         Wt. Dry Soil, W <sub>3</sub> , gm (2-3)       (5)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Wet Soil, V <sub>2</sub> , cc       (7)         W1 - W <sub>8</sub> (2-5)         (8)       (9)         W2 of Shrinkage Limit       (8)         (8) - (9×8 w)       100 =         (5)       No. of Blows         Wt. of Container + Displaced, H <sub>3</sub> , gm       (A)         Wt. of Container + Displaced, H <sub>3</sub> , gm       (A)         Wt. of Container, gm       (B)         Mercury, H <sub>3</sub> gm/cc	Wt. Container, gm (4)	17.57	17.31	18.54	19.52	18.67		
Water Content, W, % (3+5) x 100       (6)       7.7       34.0       36.7         SHRINKAGE LIMIT         Flow Curve for Liquid Limit         Container No.         Container No.         Consistency, No. of Blows         Wt. Container + Wet Soil, gm       (2)         Wt. Container + Dry Soil, gm       (2)         Wt. Container, gm       (3)         Wt. Wet Soil, W <sub>3</sub> , gm (1-3)       (4)         Wt. Dry Soil, W <sub>3</sub> , gm (2-3)       (5)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Wet Soil, V <sub>2</sub> , cc       (7)         W1 - W <sub>8</sub> (2-5)         (8)       (9)         W2 of Shrinkage Limit       (8)         (8) - (9×8 w)       100 =         (5)       No. of Blows         Wt. of Container + Displaced, H <sub>3</sub> , gm       (A)         Wt. of Container + Displaced, H <sub>3</sub> , gm       (A)         Wt. of Container, gm       (B)         Mercury, H <sub>3</sub> gm/cc	Wt. Dry Soil, Ws, gm (2-4) (5)							
Determination No.12Container No.12Consistency, No. of Blows		17.0	17.7	32.0	35.3	34.7		
Determination No.12Container No.12Consistency, No. of Blows	SHRINKAGE LIM	T			Flow Curv	e for Liquid	Limit	
Consistency, No. of Blows         Wt. Container + Wet Soil, gm         Wt. Container + Dry Soil, gm         Wt. Container, gm         (3)         Wt. Container, gm         (3)         Wt. Container, gm         (3)         Wt. Container, gm         (3)         Wt. Ory Soil, Ws, gm (2-3)         (5)         Vol. Wet Soil, V1, cc         (6)         V1 - V2         (6-7)         (5)         No. of Blows         No. of Blows         Wt. of Container + Displaced, Hg, gm         Wt. of Container, gm         Wt. of Mercury, Hg, gm (A-B)         (C)	Determination No.	1	2					
Wt. Container + Wet Soil, gm       (1)         Wt. Container + Dry Soil, gm       (2)         Wt. Container + Dry Soil, gm       (3)         Wt. Container, gm       (3)         Wt. Dry Soil, W <sub>b</sub> , gm       (1-3)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Dry Soil V <sub>2</sub> * cc       (7)         W <sub>1</sub> - W <sub>s</sub> (4-5)         V <sub>1</sub> - V <sub>2</sub> (6-7)         (8) - (9×Yw)       100 =         (5)       10         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V <sub>2</sub> by Weighing         Wt. of Container, gm       (B)         Wt. of Container, qm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)								
Wt. Container + Wet Soil, gm       (1)         Wt. Container + Dry Soil, gm       (2)         Wt. Container + Dry Soil, gm       (3)         Wt. Container, gm       (3)         Wt. Dry Soil, W <sub>b</sub> , gm       (1-3)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Wet Soil, V <sub>1</sub> , cc       (6)         Vol. Dry Soil V <sub>2</sub> * cc       (7)         W <sub>1</sub> - W <sub>s</sub> (4-5)         V <sub>1</sub> - V <sub>2</sub> (6-7)         (8) - (9×Yw)       100 =         (5)       10         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V <sub>2</sub> by Weighing         Wt. of Container, gm       (B)         Wt. of Container, qm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)	Consistency, No. of Blows			31	₂ <mark>┝╺╈╌┿┽┽┽</mark> ╌╌╸		<b>-</b>	
Wt. Container, gm       (3)         Wt. Container, gm       (3)         Wt. Wet Soil, W1, gm (1-3)       (4)         Wt. Dry Soil, Ws, gm (2-3)       (5)         Vol. Wet Soil, V1, cc       (6)         Vol. Wet Soil, V1, cc       (6)         Vol. Dry Soil V2* cc       (7)         W1 - Ws       (2-5)         (2-5)       (8)         V1 - V2       (6-7)         (8)       (9)         W% at Shrinkage Limit       (8)         (5)       100 =         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V2 by Weighing         Wt. of Container + Displaced, Hg, gm (A)         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)						╶┼╌ <u></u> ╲┤╴┝╴		
Vol. Wet Soll, V1, cc       (0)         Vol. Dry Soll V2* cc       (7) $W_1 - W_s$ (2-5) $V_1 - V_2$ (6-7) $W_3$ at Shrinkage Limit       (8) $(8) - (9 \times 3 w)$ 100 =         (5)       100 =         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V2 by Weighing         Wt. of Container + Displaced, Hg, gm (A)         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)	Wt. Container + Dry Soil, gm (2)			t				
Vol. Wet Soll, V1, cc       (0)         Vol. Dry Soll V2* cc       (7) $W_1 - W_s$ (2-5) $V_1 - V_2$ (6-7) $W_3$ at Shrinkage Limit       (8) $(8) - (9 \times 3 w)$ 100 =         (5)       100 =         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V2 by Weighing         Wt. of Container + Displaced, Hg, gm (A)         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)	Wt. Container, gm (3)			et p	7			
Vol. Wet Soll, V1, cc       (0)         Vol. Dry Soll V2* cc       (7) $W_1 - W_s$ (2-5) $V_1 - V_2$ (6-7) $W_3$ at Shrinkage Limit       (8) $(8) - (9 \times 3 w)$ 100 =         (5)       100 =         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V2 by Weighing         Wt. of Container + Displaced, Hg, gm (A)         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)	Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)			ပိ				
Vol. Wet Soll, V1, cc       (0)         Vol. Dry Soll V2* cc       (7) $W_1 - W_s$ (2-5) $V_1 - V_2$ (6-7) $W_3$ at Shrinkage Limit       (8) $(8) - (9 \times 3 w)$ 100 =         (5)       100 =         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V2 by Weighing         Wt. of Container + Displaced, Hg, gm (A)         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)	Wt. Dry Soil, Ws. gm (2-3) (5)			₹ uter	╕┝╾┽╾┽┾┼┼┼╌╸			
$W_1 - W_s$ (2-5)       (8) $V_1 - V_2$ (6-7)       (9) $W%$ at Shrinkage Limit       (8) - (9x8 w)       (100 = $(S)$ 100 =       (20 25 30 40 50)         Shrinkage Ratio - (5+7)       No. of Blows         *Determination V <sub>2</sub> by Weighing         Wt. of Container + Displaced, Hg, gm (A)       Mercury, Hg gm/cc =         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)	Vol. Wet Soil, V1, cc (6)			Ň.				
$\frac{W_1 - W_s}{V_1 - V_2} (6-7) (9)$ $\frac{W_7}{(5)} 100 = \frac{2}{5} 10 20 2530 40 50$ $\frac{W_7}{(5)} 100 = \frac{2}{5} 10 20 2530 40 50$ No. of Blows $\frac{W_7}{(5)} 100 = \frac{W_7}{(5)} 100 = \frac{1}{5} \frac{10}{5} 20 2530 40 50$ No. of Blows $\frac{W_7}{(5)} 0 = \frac{1}{5} \frac{W_7}{(5)} \frac{10}{(5)} \frac{10}$	Vol. Dry Soil V2* cc (7)							
W% at Shrinkage Limit $(8) - (9x \otimes w)$ $(5)$ $20 2530 4050$ Shrinkage Ratio - (5+7) *Determination V2 by WeighingNo. of BlowsWt. of Container + Displaced, Hg, gm (A) Wt. of Container, gm (B)Mercury, Hg gm/cc = $62^\circ F - 68^\circ F = 13.55 gm/cc$ $69^\circ F - 72^\circ F = 13.54 gm/cc$ Wt. of Mercury, Hg, gm (A-B) (C)Mercury (Hg gm/cc)				14				
$\frac{(8) - (9 \times 8 \times w)}{(5)}  100 =$ $\frac{(8) - (9 \times 8 \times w)}{(5)}  100 =$ $\frac{(5)}{(5)}  100 =$ No. of Blows No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5) - (5 + 7)}{(5)}  100 = 0$ No. of Blows $\frac{(5 + 7)}{(5)}  100 = 0$				l.				
$\frac{1}{(5)} 100 = $ No. of Blows *Determination V <sub>2</sub> by Weighing Wt. of Container + Displaced, Hg, gm (A) Wt. of Container, gm (B) Wt. of Mercury, Hg, gm (A-B) (C) Wt. of Mercury, Hg, gm (A-B) (C) No. of Blows No. of				38			40.50	
Shrinkage Katio = (3+7)         *Determination V2 by Weighing         Wt. of Container + Displaced, Hg, gm (A)         Wt. of Container, gm       (B)         Wt. of Mercury, Hg, gm (A-B)       (C)         Wt. of Mercury, Hg, gm (A-B)       (C)	$\frac{(8) - (9 \times 3 \times w)}{(5)}  100 =$							
Wt. of Container + Displaced, Hg, gm (A)       Mercury, Hg gm/cc =         Wt. of Container, gm       (B)         Wt. of Mercury; Hg, gm (A-B)       (C)         Wt. of Mercury; Hg, gm (A-B)       (C)	Shrinkage Ratio - (5÷7)	<u></u>			N	O, OF DIOWS		
Wt. of Container, gm       (B)         Wt. of Mercury; Hg, gm (A-B)       (C)	*Determination $V_2$ by Weighing			, <u> </u>				
Wt. of Mercury; Hg, gm (A-B) (C) 69° F − 72° F ≈ 13.54 gm/cc	Wt. of Container + Displaced, Hg, gm (A)			Merc	ury, Hg gm∕c	c =		
	Wt. of Container, gm (B)					-		
$V_2^* = C \div Hg gm/cc$ (D) 73° F - 82° F = 13.53 gm/cc	Wt. of Mercury; Hg, gm (A-B) (C)							
best,	$V_2^* = C \div Hg gm/cc \tag{D}$		<u>_</u>	73-1		.53 gm/cc		
$\tilde{O}$	2005.				. Ol			
Shrinkage Shrinkage Plastic Liquid Plasticity			7					
Limit Ratio Index Limit Limit Index 17 35 18	Limit Ratio	Index			2	imit i		
					/	/	. 0	
Request No Lab No 99-769		Request No.	99.	- <u>35</u> Lol	> No	99-:	269	

DWR 714 (Rev. 12/66)

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

A			BERG LIN				ABORATORY
Project_GHCS				Request	No. <u>99-</u>	-35	
Classification	·····	<u></u>		Lab No		770	
Remarks					8/12/99		
Classification Remarks Air Dried	] In Situ	[] Ove	n Dried	Tested B	y DRY	-, , . <u></u>	
		PLAST	IC LIMIT		LIQUID		
Determination No.		1	2	1	2	3	4
No. of Blows		$\searrow$		25			
Container No.		145	144	138			
Wt. Container + Wet Soil, gm	(1)	21.57	22.26	28.89			
Wt. Container + Dry Soil, gm	(2)	26.51	21,33	25.8			
Wt. Water, Ww. gm (1-2)	(3)	<b>4</b> <i>V</i>					
Wt. Container, gm	(4)	20.52	15.84	16.53			
Wt. Dry Soil, Ws, gm (2-4)	(5)						·
Water Content, W, % (3÷5) x 100	(6)	17.7	16,9	33.2			
SHRIN	KAGE LIMI	T			Flow Curve	for Liquid	Limit
Determination No.		1	2				<del></del>
Container No.						┦╍┦┙┼╸	
Consistency, No. of Blows			7				····
Wt. Container + Wet Soil, gm	(1)					┼──┼─┼─┼	
Wt. Container + Dry Soil, gm	(2)			ŧ			
Wt. Container, gm	(3)			nte			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)			Water Content			
Wt. Dry Soil, Ws, gm (2-3)	(5)			iter			
Vol. Wet Soil, V <sub>1</sub> , cc	(6)			×		┼╍┼╌┼╌┼╴	
Vol. Dry Soil, V2* cc	(7)						
$W_1 - W_s$ (4.5)	. (8)						
$V_1 - V_2$ (6.7)	(9)					<u></u>	
W% at Shrinkage Limit							
$\frac{(8) - (9 \times 3 \times 10)}{(5)}$ 100 =					5 10	20 2530	40 50
(3)					No	. of Blows	
<u>Shrinkage Ratio - (5÷7)</u> *Determination V <sub>2</sub> by W	lotalota a		.i				
				Marc	ury, Hg gm/cc	_	
Wt. of Container + Displaced, h					=_68° F = 13.5		
Wt. of Container, gm	(B)			f I	68 F = 13.5 72° F = 13.5	•	
Wt. of Mercury, Hg, gm (A-B)	(C) (D)				=72 F = 13.5 F = 13.5		
V2*_= C ÷ Hg gm/cc	(U)						d
			·			(14)	
	nkage atio	Shrinkage Index		Plast Limit			Plasticity Index
		<u></u>		. [17]	3:		10
L	<u> </u>						. <u></u>
		Request No	99-2	3 <u>5</u> La	ь No. <u>29</u>	-170	?

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Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

	ATTER	BERG LI				
ProjectSHUS			Request	No. 99-3.	5	
Classification		, 	Lab No	99-77 8/12/99 Tru	<u></u>	
			_	8/12/99		
Remarks			Date		····	<u></u>
Air Dried 📋 In Situ	C Ove	n Dried	Tested B	y		
		IC LIMIT				
Determination No.	1	2	1	2	3	4
No. of Blows	$\triangleright$		35	25		
Container No.	119	140	351	141		
Wt. Container + Wet Soil, gm (1)	26.31	24,03	29-7B	30,15		
Wt. Container + Dry Soil, gm (2)	25.18	22,9	26,99	27.10		
Wt. Water, Ww., gm (1-2) (3)		, , , , , , , , , , , , , , , , , , ,				
Wt. Container, gm (4)	18,89	14,78	17.22	17.11		
Wt. Dry Soil, Ws, gm (2-4) (5)						
Water Content, W, % (3+5) x 100 (6)	18.0	18.5	28.6	29.0		
SHRINKAGE LIMI	Т		<b>-</b> , <sup>.</sup>	Flow Curve	for Liquid	Limit
Determinat on No.	<u> </u>	2			<del></del>	
Container No.			4		╾┝╾╾┝╼╍┝╼╺┝╸	
Consistency, No. of Blows			_		┽╾┼╍┼╶┼	
Wt. Container + Wet Soil, gm (1)					╶╁╌╌┼╌┤╾╀╸	
Wt. Container + Dry Soil, gm (2)			_ t			
Wt. Container, gm (3)			Water Content		╺╁──┼╍┼╍┼╸	
Wt. Wet Soil, W <sub>1</sub> , gm (1-3) (4)			ບັ	╞━╋╼╂╬╌╂╂╺┉┉		
Wt. Dry Soil, Ws, gm (2-3) (5)			ater 1	┝╾┾╾┾┾╞┾┿╍╍╸		
Vol. Wet Soil, V <sub>1</sub> , cc (6)			>			
Vol. Dry Soil, V2* cc (7)			-			
$W_1 - W_s$ (4-5) (8)			_			
$V_1 - V_2$ (6-7) (9)	<u> </u>		-			
W% at Shrinkage Limit				5 10	20 25 30	40.50
$\frac{(8) - (9 \times 5 \times)}{(5)}  100 =$			-		o, of Blows	
Shrinkage Ratio - (5+7)				N	), of Diows	
*Determination $V_2$ by Weighing						
Wt. of Container + Displaced, Hg, gm (A)				oury, Hg gm∕c∢		
Wt. of Container, gm (B)				F_68° F = 13.	-	
Wt. of Mercury, Hg, gm (A-B) (C)				$F - 72^{\circ} F = 13.$		
$V_2^* = C + Hg gm/cc \qquad (D)$			73°	$F - 82^{\circ} F = 13.$	53 gm/cc	
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					الح م	
Shrinkage Shrinkage	Shrinkage		Plast Limi	•	quid mit	Plasticity Index
Limit Ratio	ndex	-	18	3		(2_
	<u></u>		L			
	Request No	99-	35 La	15 No. 99	-77/	· · · · · · · · · · · · · · · · · · ·

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DWR 714 (Rev. 12/66)

State of California THE RESOURCES AGENCY

Technical Services Office LABORATORIES BRANCH SOILS LABORATORY

DEPARTMENT OF WATER RESO	URCES			alte		SOILS LA	BORATORY
n-t-		ALICA	BERG LIN	VIII 3	1	GOE	
Project Sites				Request	No2	(-42	
Classification				Lab No		-772	
Remarks	<u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>			Request   Lab No Date_ <u>8</u>	112/99		
Remarks Air Dried	🔄 In Situ	C Ovei	n Dried	Tested B	y DM:	<u></u>	,-,-
			C LIMIT		LIQUID		
Determination No.		1	2	1	2	3	4
No. of Blows		$\mathbb{N}$	$\geq$	25			 
Container No.		203	00	59 28.90			
Wt. Container + Wet Soil, gm	(1)	23.80	26,51	28.90			
Wt. Container + Dry Soil, am	(2)	22,89	25.65	15.28			
Wt. Water, Ww, gm (1-2)	(3)	,				<u></u>	
Wt. Container, gm	(4)	17.13	20.33	18,61			
Wt. Dry Soil, Ws, gm (2-4)	(5)						, ,
Water Conten-, W, % (3+5) x 1(	00 (6)	15,6	(6.2	54.3			
SHR	INKAGE LIMI	Т			Elow Curve	e for Liquid	Limit
Determination No.		1	2		r	· · · · · · · · · · · · · · · · · · ·	
Container No.							
Consistency, No. of Blows				_			
Wt. Container + Wet Soil, gm	(1)				┝╼┾╸┝┼╺┿┼╌╼		
Wt. Container + Dry Soil, gm	(2)		`	at 1			
Wt. Container, gm	(3)			Water Content			
Wt. Wet Soil, W <sub>1</sub> , gm (1-3)	(4)			၂ ပိ	<b>┝-</b> <del>}</del> <b>-}-}-}-</b>		
Wt. Dry Soil, Ws, gm (2-3)	(5)			ater			
Vol. Wet Soil, V1, cc	<u>(6)</u>			×			-+
Vol. Dry Soil, V2* cc	(7)	· •					
$W_1 - W_s$ (4-5)	. (8)			-			
$V_1 - V_2$ (6-7)	(9)			-			
W% at Shrinkage Limit $\frac{(8) - (9 \times 3 \times w)}{(8) - (9 \times 3 \times w)} = 100 = 100$					5 10	20 25 30	40 50
(5)				-	И	o, of Blows	
<u>Shrinkage Ratio – (5+7)</u>			1	_			
*Determination V <sub>2</sub> by	Weighing					······	
Wt. of Container + Displaced,	Hg,gm (A)			-	ury, Hg gm/c		
Wt. of Container, gm	(B)				$F = 68^{\circ} F = 13$	_	
Wt. of Mercury, Hg, gm (A-B)	(C)				F_72° F = 13. F_82° F = 13.		
$V_2^* = C \div Hg gm/cc$	(D)			/3	r = 13	55 gm/cc	
"at 1 <sub>2.</sub> ".				•		40	itt
Shrinkage Sh	rinkage	Shrinkage	٦	Plast			Plasticity
	Ratio	Index				imit	Index
				16	154	P	<u>38</u>
L.,		<u> </u>	<b>.</b>	·			
		Request No	99-3	5 Lo	6 No. 90	7-72:	2
		Rednesi Ho	·				

State of California THE RESOURCES AGENCY						Technical LABORATO	Services Office DRIES BRANCH
DEPARTMENT OF WATER RESOU	RCES	ATTER	BERG LIN	MTG		SOILS L	ABORATORY
Di GIT	KA T					2025	
ProjectG(T						~	
Classification				Lab No	90	1-773	<u> </u>
Remarks				Data	81	1199	
/					1	TIL .	
Air Dried	In Situ	Over	n Dried	Tested B	y{ll		
					~~~		
		PLASTI	CLIMIT		LIQUIC		
Determination No.			2	1	2	3	4
No. of Blows				33	27	10	
Container No.		#145	#48	#119	#138	#144	
Wt. Container + Wet Soil, gm	(1)	29.61	33.40	28.79	26.07	24.69	/
Wt. Container + Dry Soil, gm	(2)	28.09	31.02	25.85	23.20	21.99	
Wt. Water, Ww, gm (1-2)	(3)	1.52	2.38	2.94	2.87	2.70	
Wt. Container, gm	(4)	20.52	18.81	18.90	16:55	15.84	·
Wt. Dry So I, Ws, gm (2-4)		7.51	12.21	6.95	6.65	6.15	
Water Content, W, % (3÷5) x 100	(6)	20.0	19.5	42.3	43.2	43.9	
SHRINI	KAGE LIMI	Τ	r=		Flow Curve	e for Liquid	Limit
Determination No.		1	2		r - r - r <del>r</del>		
Container No.						╌┼╾╾┼╍┼╍┼╸	
Consistency, No. of Blows							
Wt, Container + Wet Soil, gm	(1)			. 44			
Wt. Container + Dry Soil, gm	(2)			tu a	╵┝╼┥╌┥┥┥		
Wt. Container, gm	(3)			onte	┝┥┥		
<u>Wt. Wet So I, W<sub>1</sub>, gm (1-3)</u>	(4)			Water Content			
Wt. Dry Soil, Ws, gm (2-3)	(5)			ate			
Vol. Wet Soil, V <sub>1</sub> , cc	(6)	······		¥ AZ		Ň	
Vol. Dry Soil, V2* cc	(7)						
$\frac{W_1 - W_s}{W_1 - W_s}  (4-5)$	. (8)				┝╍┼╌┼┼╌┼┼		<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>
$\frac{V_1 - V_2}{V_1 - V_2} $ (6-7)	(9)		·	• 0		+-+-+-	+
W% at Shrinkage Limit $\frac{(8) - (9 \times 3 \text{ w})}{(5)}  100 =$				· A2	5 10	20 25 30	40 50
(5) 100 =						( 5)	
<u>Shrinkage Ratio – (5÷7)</u>					N	o, of Blows	
*Determination $V_2$ by We	ighing				·		
Wt. of Container + Displaced, Hg	7, gm (A)	······		Mercu	ury, Hg gm∕c	c =	
Wt. of Container, gm	(B)			62° F	-68° F = 13.	55 gm/cc	
Wt. of Mercury, Hg, gm (A-B)	(C)			69° F	-72° F = 13.	54 gm/cc	
$V_2^* = C \div Hg gm/cc$	. (D)			73° F	-82°F = 13.	53 gm/cc	
·		· ·			(m)		
CI			1	Plasti		quid	Plasticity
Shrinkage Shrin Limit Ra		Shrinkage Index				mit	Index
				1.0		+A	24
			]		t	<u>1                                    </u>	K

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Request No. .

99-35

Lab No.\_\_

99-773

State of California	
THE RESOURCES AGENCY	
DEPARTMENT OF WATER RESOURCE	Ş

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				·		Reques	No. <u>9</u>	8-18
Project			5					
Classification		:	- }		r	Date	5/20	1
								6
						iested	в <u>у <i>Д</i>и</u>	
Flask No.				15				
Тетр. ° <b>Е</b>	<u></u>			28			·.	
Wt. Tare + Dry Soil			12	272.51		·····		-
Wt. Tare				70,46				
Wt. Dry Soil	(	(W <sub>s</sub> )	/	102.05				
Wt. Flask + Water	(\	W <sub>2</sub> )	6	67.94				
$W_s + W_2$			7	69.99	.:		9 19 1	
Wt. Flask + Water + Dry Soil	()	₩1)		33,28			ų s	
$W_s + W_2 \cdot W_1$				36.71				Gs
Specific Gravity = $\frac{W_s}{W_s + W_2 - W_1}$	≈ (G	s)	2	.780				
		% C	OMBUSTI	BLE ORGAN	IC	Remarks:	<del>40.8.10.1</del>	v -
							· · ·	
Date	ŕ		т	ested By				·
		1	······································	ested By				
, Trial					2		3	
		I IN	ruo	IN		ון דו		out
Time	·			·····				
Temp.								:
∦t. Container + Oven Dry Söll	(1)							
<u> Wt. Container + Burned Soil</u>	(2)							
Organic Loss (1-2)	(3)							1
Yt. Container	(4)							
Nt. of Oven Dry Soil (1-4)	(5)						1	
% Organic (3÷5) x 1	00							
			.   . [	Request No	18-18			-167
DWR 713 (Rev. 4/66)			1	vednezi No	<u> </u>		، <i>۲۲۴ کول</i> یس	0 - 1

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## SPECIFIC GRAVITY TEST FOR SOILS

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Project Classification				i	La	b No	<u>    98</u> <u>    98                                </u>	68
				· (			pur	
			10		İ.	-		
Temp. ° <b>E</b>			1 <u>8</u> 28	•				м.
Wt. Tare + Dry Soil		1		-				
<u>Wt. Tare</u>			9.45					
Wt. Dry Soil	(W <sub>s</sub> )		0,36					
Wt. Flask + Water (	₩₂)		6.80					·
$W_s + W_2$		1.	7,16					
Wt. Flask + Water + Dry Soil (	₩1)		1.27					
$W_s + W_2 \cdot W_1$			5.89	•				Gs
Specific Gravity = $\frac{W_s}{W_s + W_2 - W_1} = (C_s)$	; ;;)	2.	796	· ·		1		
Date	·····	DMBUSTIBL	ited By		Remark	(S)		-
Trial		1		2			3	
	IN	ΟυΤ	IN	0	JT	. IN	ou.	r l
Time							2	
Temp.	-							
Wt. Container + Oven Dry Soil (1)			- 1					
Wt. Container + Burned Soil (2)		-					-	
Orgonic Loss (1–2) (3)								
Wt. Container (4)								
Wt. of Oven Dry Soil (1-4) (5)	:							
% Organic (3÷5) x 100			ļ			, <del>  - (</del> 		
DWR 713 (Rev. 4/66)		Red	quest No. 9	P8 16	Lo:	N 7	8-16	B

Stat	te of California	
THE RES	SOURCES AGENCY	
DEPARTMENT	OF WATER RESOURCES	

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			-		1	1		.				
			1				Re	qųe	s No	، •	18-18	); 
Project	······				-	• ]	L.c	¦ і іЬ N	o	<u>98</u>	-157	
Classification			1		;		Da	ite)	5	/20)	198	
			:		;	I.		1			MT	
			<u>.</u>				I.¢	ste	а <u>Бу</u>			
Flask No.			1	7			Ì		1	ĺ		
Temp. °E			20	3		.			-			
<u>Wt. Tare + Dry Soil</u>			271.	96							a t	:
Wt. Tare			172	47						· 1 <u>.</u>		
Wt. Dry Soil (	W <sub>s</sub> )		99	49		8 1		· •	1	:	1	
Wt. Flask + Water ()	₩₂)		669.	81			į		-			-
$W_s + W_2$			769	.30	•		:	-	4	i		
Wt. Flask + Water + Dry Soil ()	W1)		733.	57			1	i				
W <sub>s</sub> +W <sub>2</sub> -W <sub>1</sub>			35.	.74	5				1		G <sub>5</sub>	
Specific Gravity = $\frac{W_s}{W_s + W_2 - W_1} = (G$	s.)		2.78	34	. :		1		с Г.			
	% C(	OMBUS	TIBLE	ORGÁNI	С	il Ii	Rema	rks:	<del></del> .			<u></u>
				:	1		1					
Date	-		Teste		1						<b>N</b>	
	1		I Teste									
Tria		1	· ·		2	1				3		
	IN	0	ΨT	IN	·		T		IN		OUT	
Time			 	· · · ·		i i						
Temp.											·	
Wt. Container' + Oven Dry Soil (1)	······································			-			·				·	
Wt. Container + Burned Soil (2)				-	;					ت .		-
Organic Loss (1-2) (3)		 				1						
Wt. Container (4)										and the state of the second second	· · · ·	
Wt. of Oven Dry Soil (1-4) (5)				· · · ·								
% Organic (3÷5) x 100			1								Î	
• •					78	1	7		10.	78	-15-	. 7
DWR 713 (Rev. 4/66)			requ	est No.					بلغ، جلا	<u> </u>	<u> </u>	Ŧ
								1.11				

	State of	Californ	lia
THE	RESOU	RCES AC	GENCY
DEPARTNE	ENT OF	WATER	RESOURCES

		т. 					<u>90-18</u>
Project Classification		· · ·	·	: 	Lab N Date		-158 20/98
	······································		<del></del>	,	Teiste	d <sup>'</sup> B <u>y</u>	Dreit_
Flask No.	-	C	7				
Temp. °E		20	3.5				
Wt. Tare + Dry Soil		27	z,09				
Wt. Tare		172	2,86	1			
Wt. Dry Soil (1	W <sub>s</sub> )	99	7,23	•			
<u>Wt. Flask + Water</u> (V	₩ <sub>2</sub> )	670	,40				
$W_s + W_2$		769	.63				
Wt. Flask + Water + Dry Soil (V	V <sub>t</sub> )	734	-,10				
W <sub>s</sub> -W <sub>2</sub> .W <sub>1</sub>	·	. 35	753 I				G <sub>s</sub>
Specific Gravity = $\frac{W_s}{W_s + W_2 - W_1} = (G_s)$	s')	2.7	793	State and			1
Date	% CC	MBUSTIBLE	ed By		emarks:		
Trial		1     !		2	•	3	
	IN	OUT	IN	ι ου	T	IN	OUT
Time							
Temp.	-	·		and the second se			
Wt. Container + Oven.Dry Soll (1)							
Wt. Container + Burned Soil (2)							
Organic Loss (1-2) (3)							
Wt. Container (4)							
Wt. of Oven Dry Soil (1-4) (5)	1						
% Organic (3+5) x 100		A CONTRACTOR					
DWR 713 (Rev. 4/66)		Req	uest No		L_ab_N	10.98-	158

				Re	quest No	99-51
Project_ <u>Sites</u>				La	6 No. 9	9-1419
Classification				Da	te9/14	9-1419 199
				Te	sted By	MT
Flask No.		7	7			
Temp. °E		Z	6			
Wt. Tare + Dry Soil			2,48			
Wt. Tare		172	- 48			,
Wt. Dry Soil (W	s)	100	.00			
Wt. Flask + Water (W	Yt. Flask + Water (W <sub>2</sub> )		0.08			
W <sub>s</sub> + W <sub>2</sub>		770	0.08			
Wt. Flask + Water + Dry Soil (W <sub>1</sub>	=lask + Water + Dry Soil (W1)		.64			
$W_{s} + W_{2} \cdot W_{1}$		36	. 44			Gs
Specific Gravity = $\frac{W_s}{W_s + W_2 - W_1} = (G_s)$	)	2:	74			~
	% COI	MBUSTIBLE	ORGANIC	Remarl	ks:	
		•				
Date9 (15/99	······	Test	ed By D	MT		
Trial 22	1			2		3
	IN	ουτ	IN	ОИТ	IN	OUT
Time						
Temp.		•				
Vt. Container + Oven Dry Soil (1)	47.	85				
Vt. Container + Burned Soil (2)	47,	10				
Organic Loss (1-2) (3)	-	75				
Vt. Container (4)	28,	89	a.			
Vt. of Oven Dry Soil (1-4) (5)	19.0	25				
% Organic (3÷5) x 100	3,0					-

DWR 713 (Rev. 4/66)

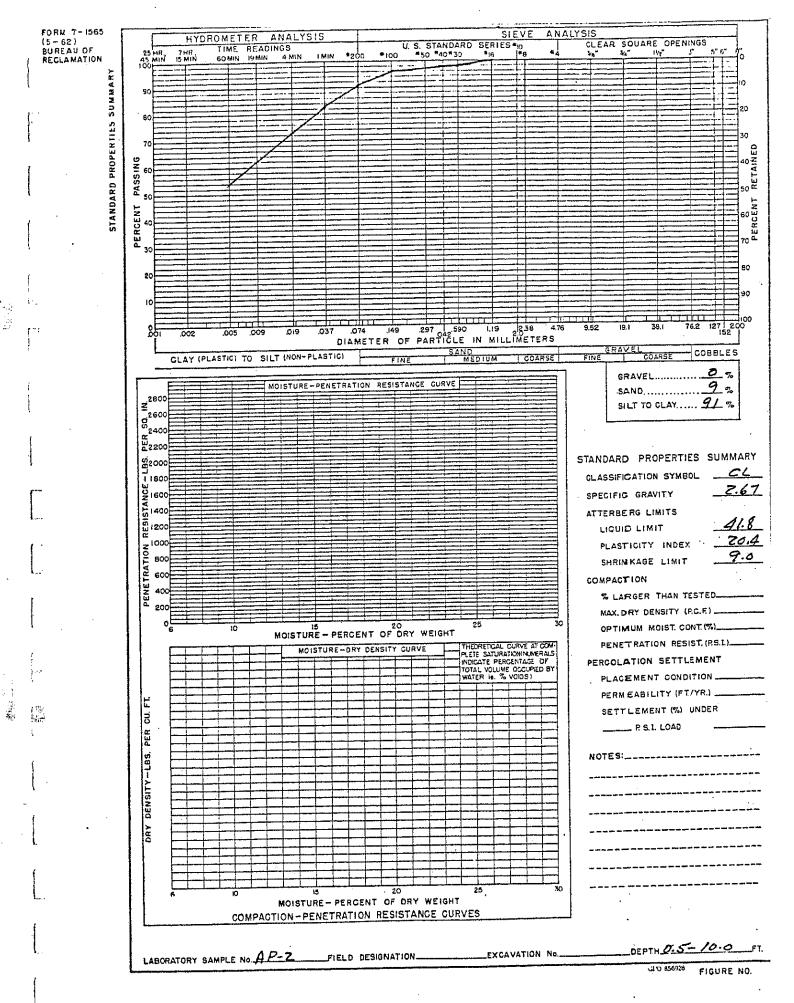
Project				Re La	quest No b No q / 14	99-51 19-1420 199
					sted By	DUIT
Flask No.		B	-			
Temp. °E		27.	5			
Wt. Tare + Dry Soil		2.71	,95			
Wt. Tare		179	.04			
Wt. Dry Soil (W <sub>s</sub>	)	92	,91			
Wt. Flask + Water (W <sub>2</sub>	)	676.	56			
$W_s + W_2$	······································	769.	47			
Wt. Flask + Water + Dry Soil (W <sub>1</sub>	735,	.51				
$W_s + W_2 \cdot W_3$		3.3	,96			Gs
Specific Gravity = $\frac{W_s}{W_s + W_2 - W_1} = (G_s)$	•	2.7	·4			
· · ·	% COI	MBUSTIBLE	ORGANIC	Remar	ks:	<u></u>
Date9/15/99		Teste	ed By7	MT		
Trial 33	1	-		2		3
	ÎN	ĢUТ	IN	OUT	IN	Ουτ
Time			ł	-		
Temp.		•				
Wt. Container + Oven Dry Soil (1)	44	.49				
Wt. Container + Burned Soil (2)	43,	78 .				
Organic Loss (1-2) (3)		71				
Wt. Container (4)	27.	39				
Wt. of Gven Dry Soil (1-4) (5)	17.	10				
% Organic (3÷5) x 100	4.	2				

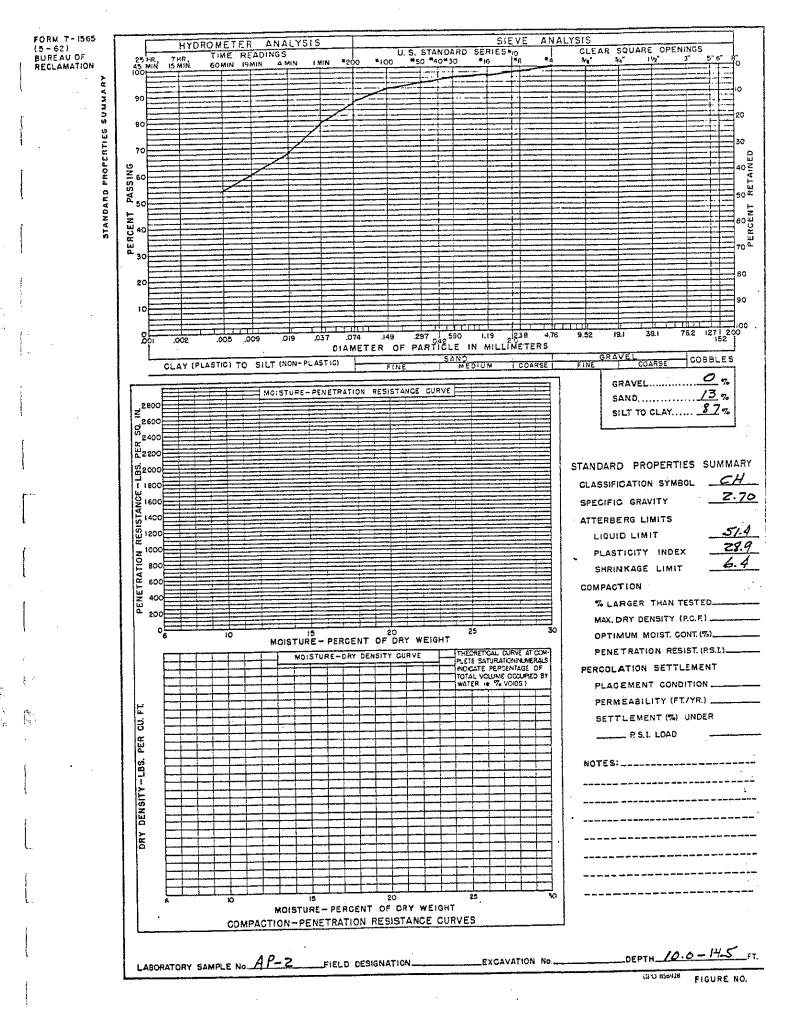
Request No. <u>99-51</u> Lab No. <u>99-1420</u>

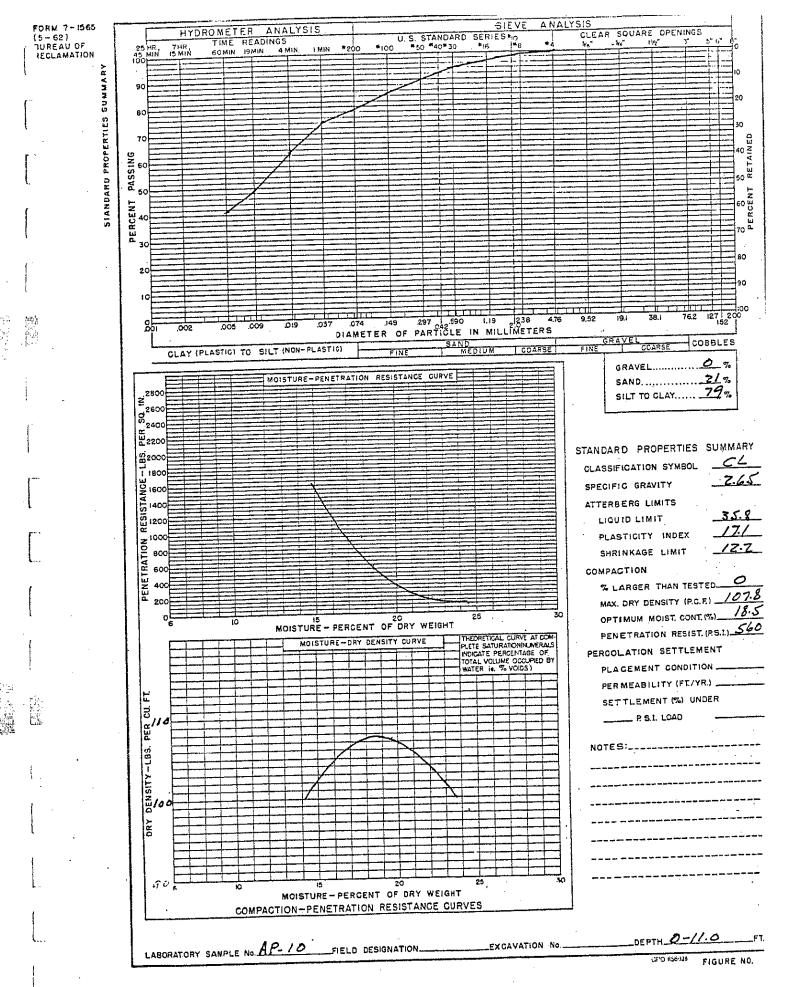
DWR 713 (Rev. 4/66)

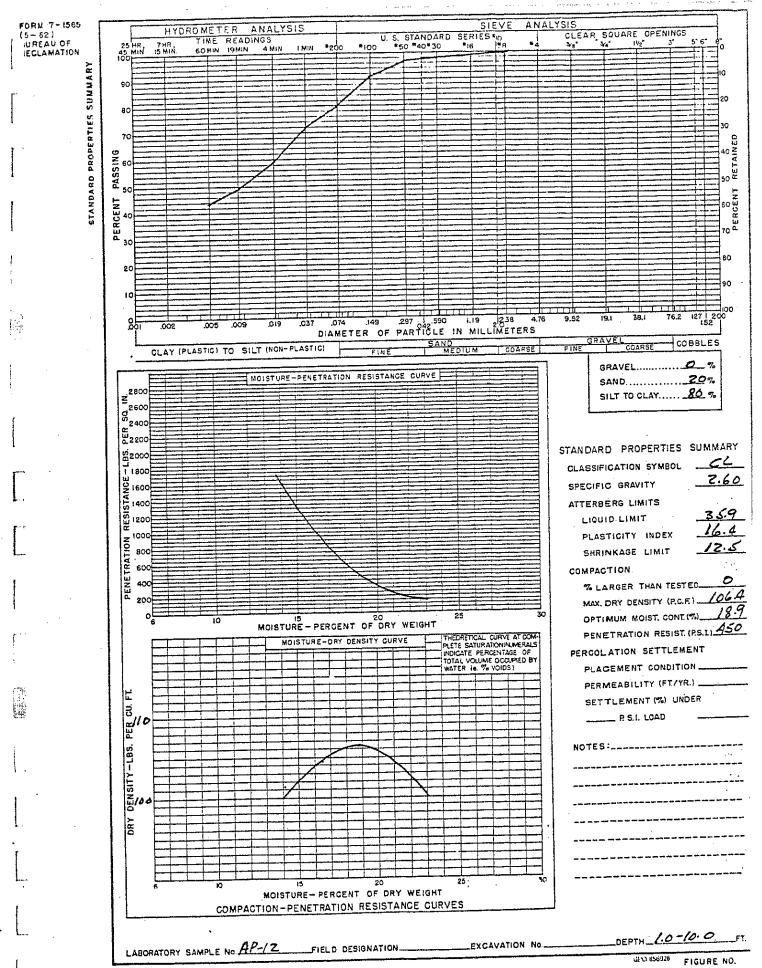
### APPENDIX C

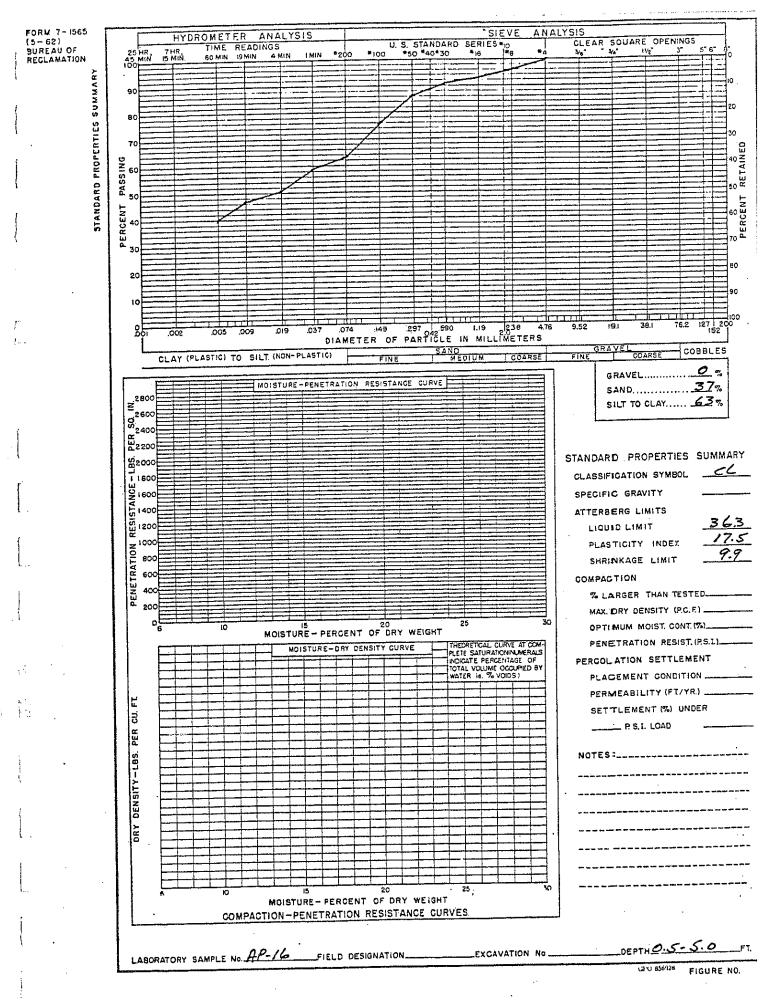
### IMPERVIOUS MATERIAL CLASSIFICATION, GRADATION, ATTERBERG LIMITS, SPECIFIC GRAVITY, AND COMPACTION TEST RESULTS FOR USBR SAMPLES

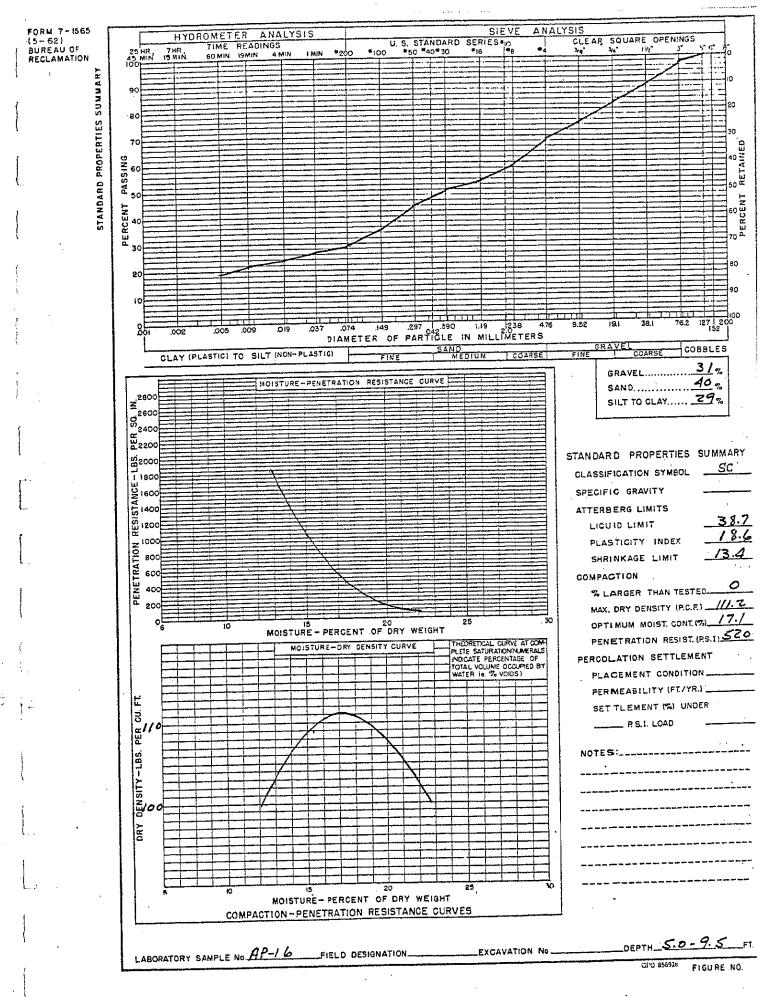




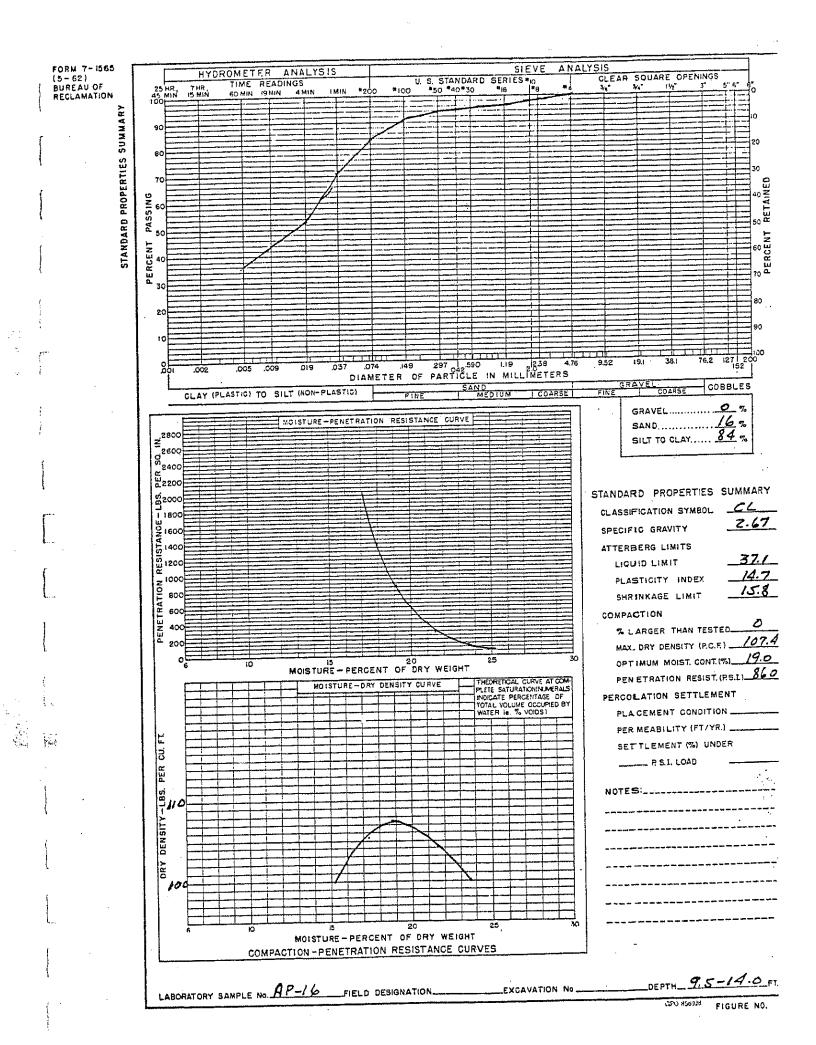


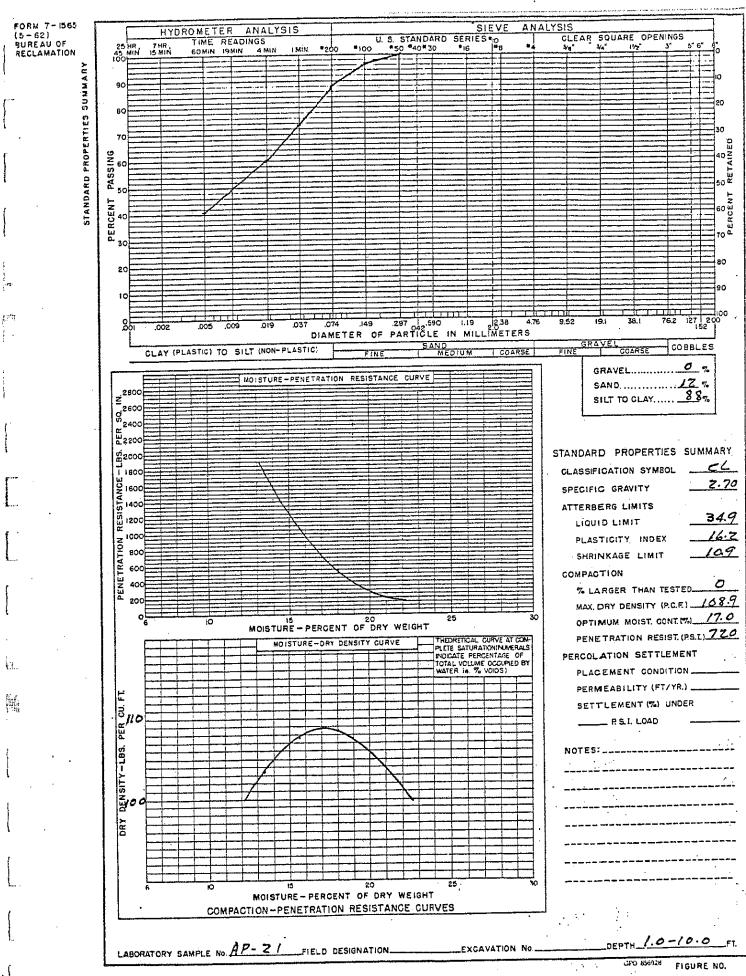




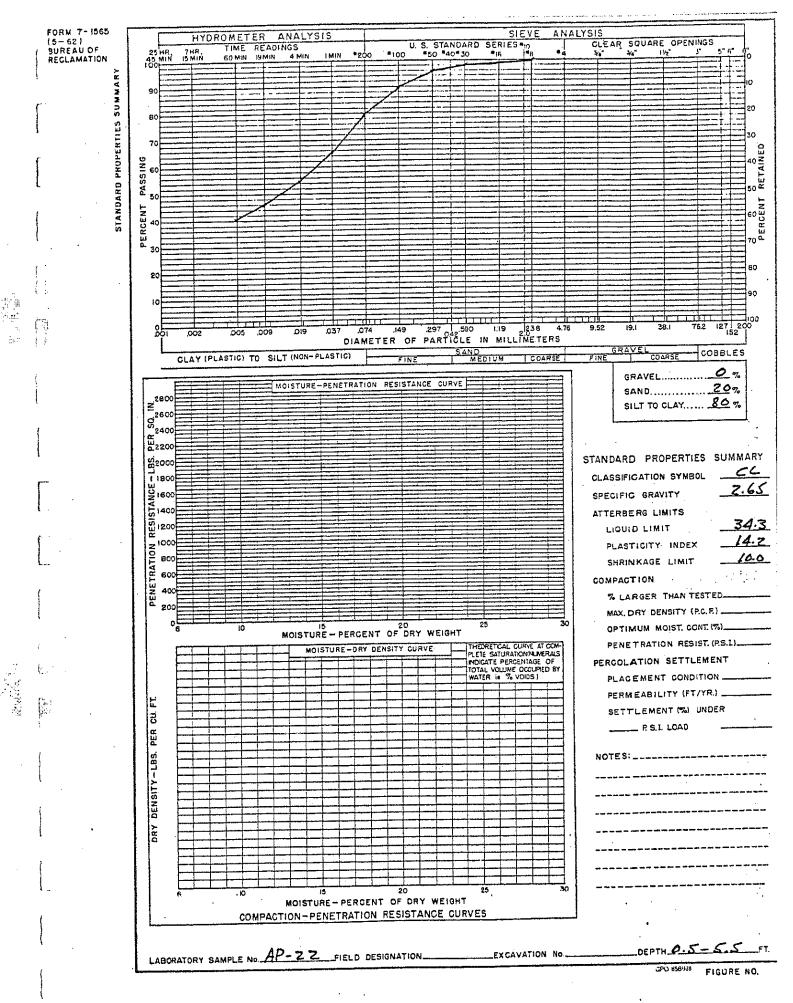


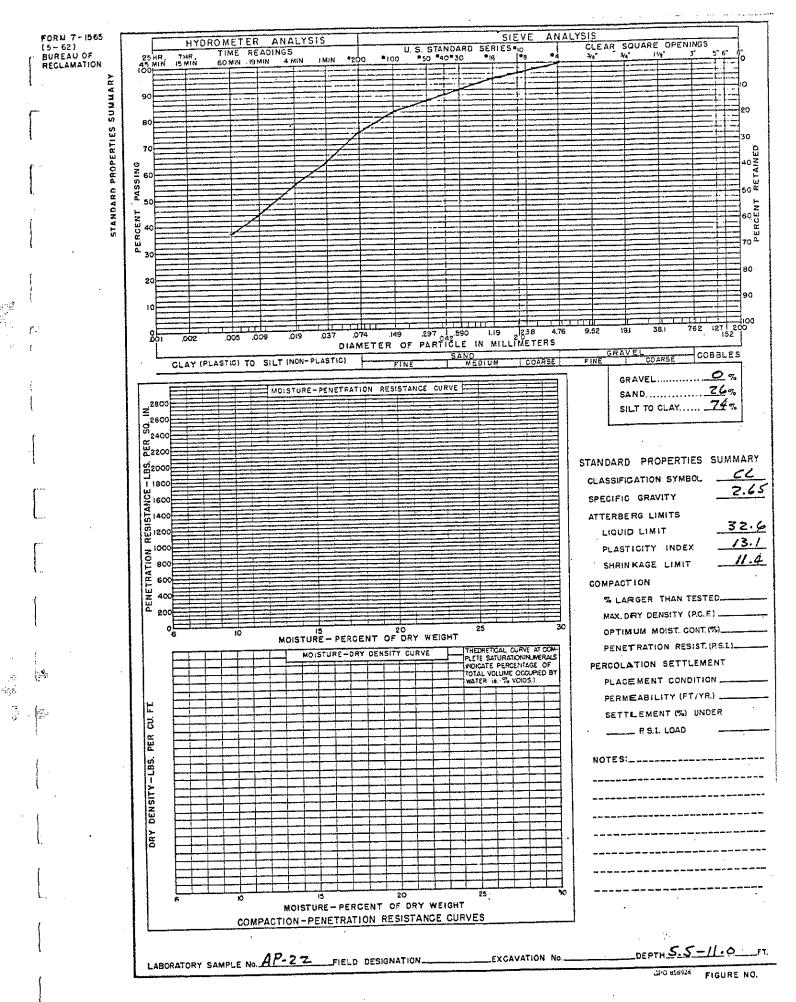
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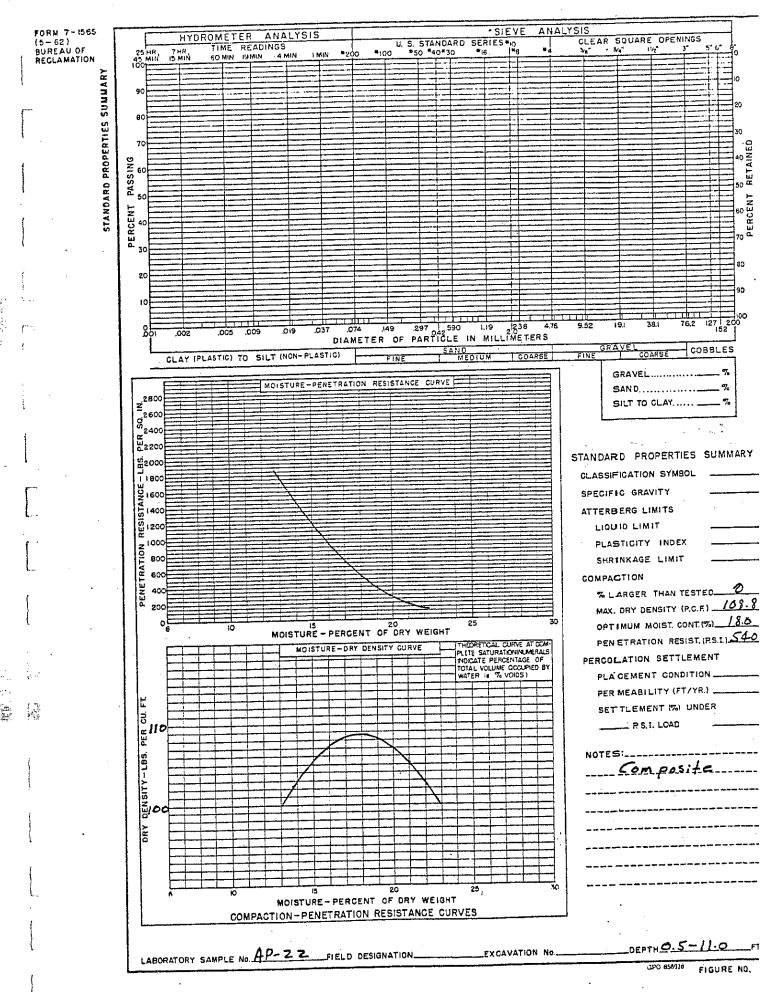


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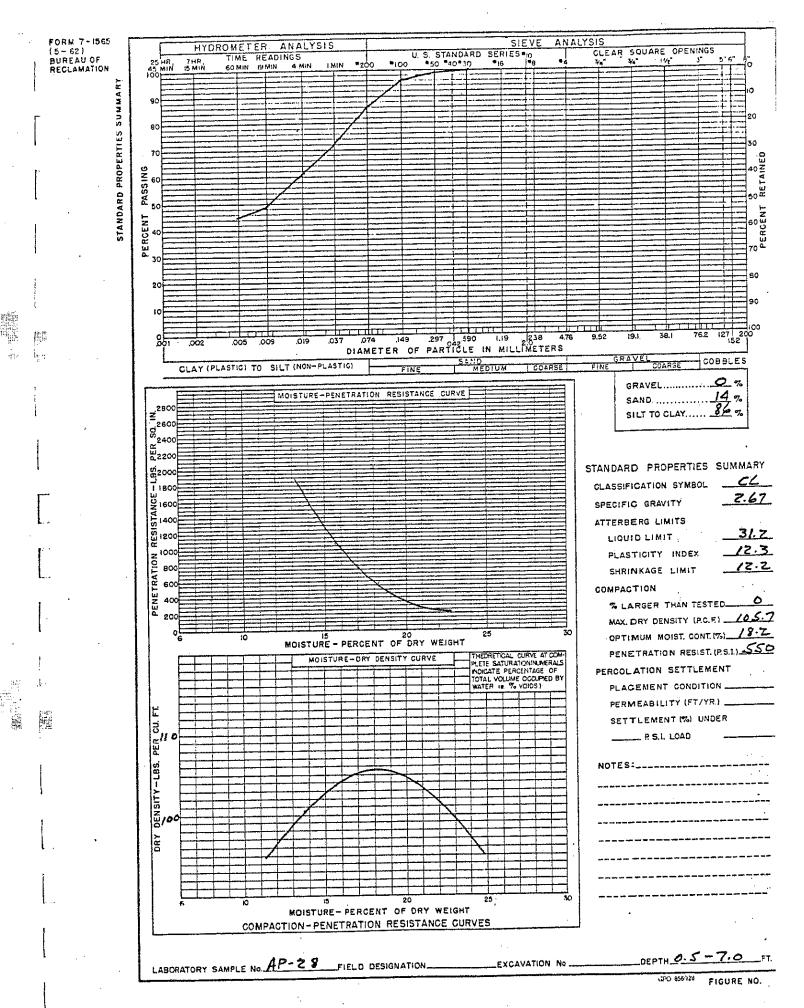


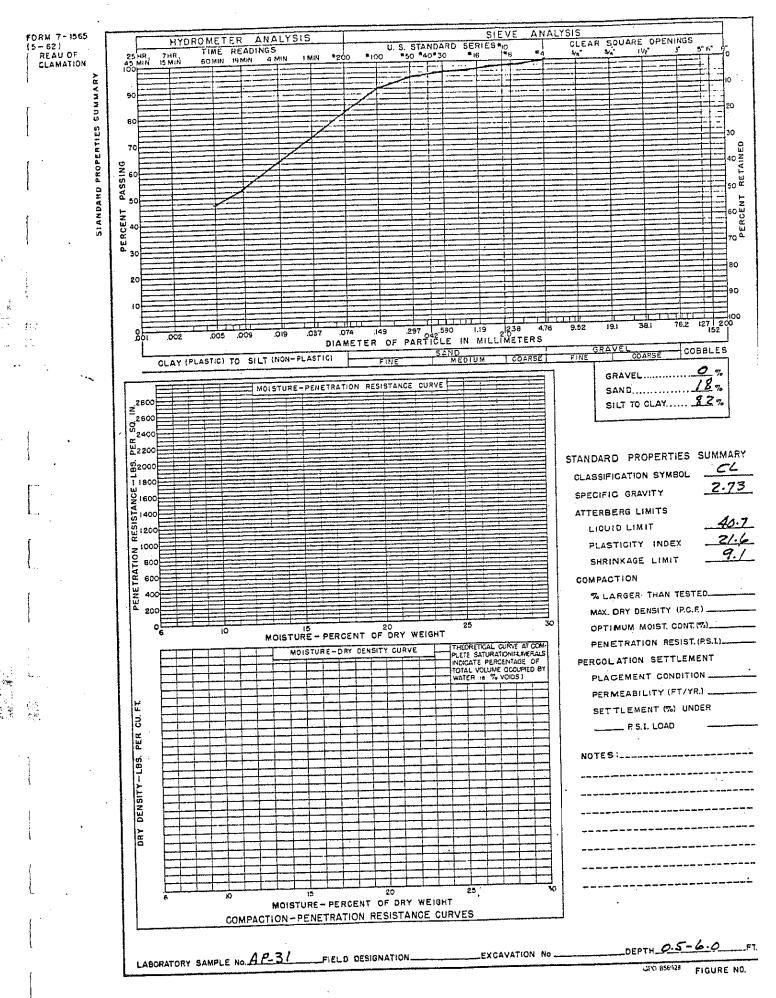


<sup>\*</sup> 

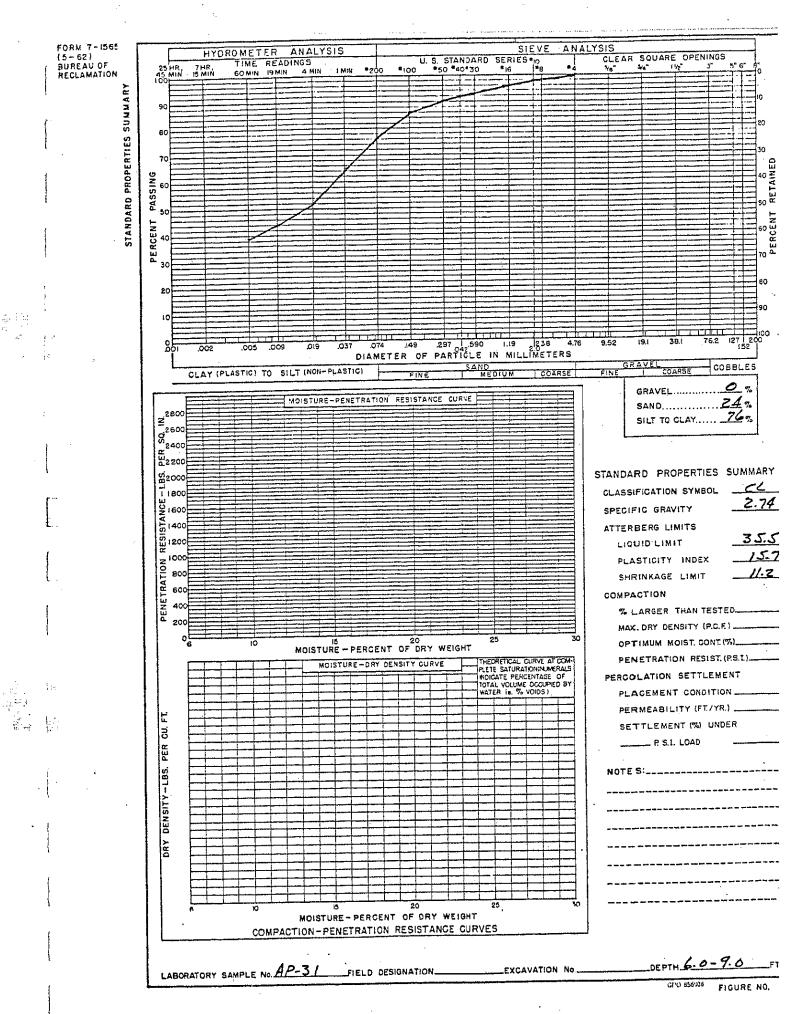


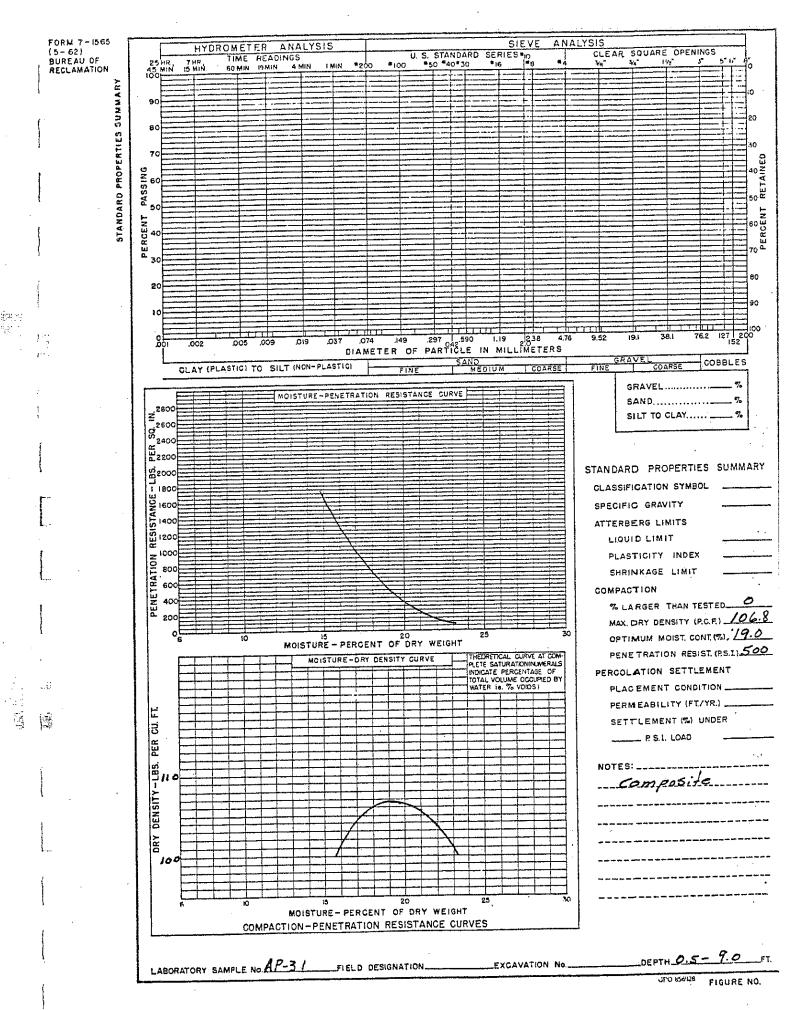
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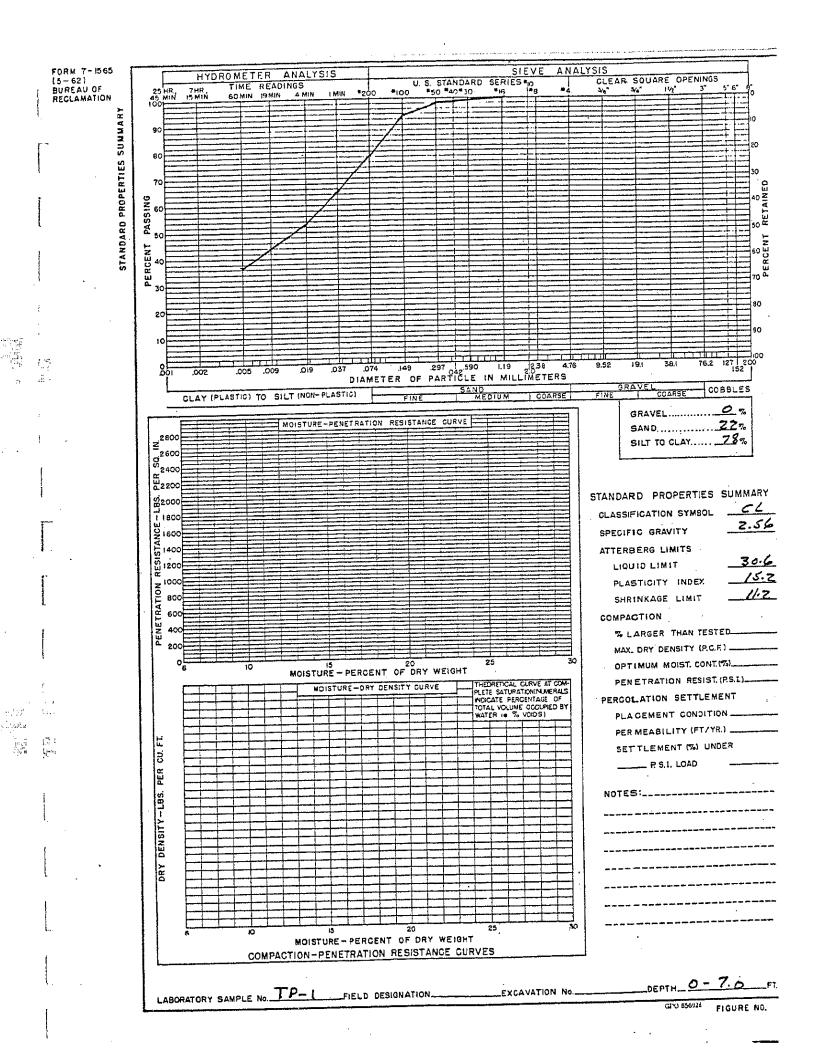


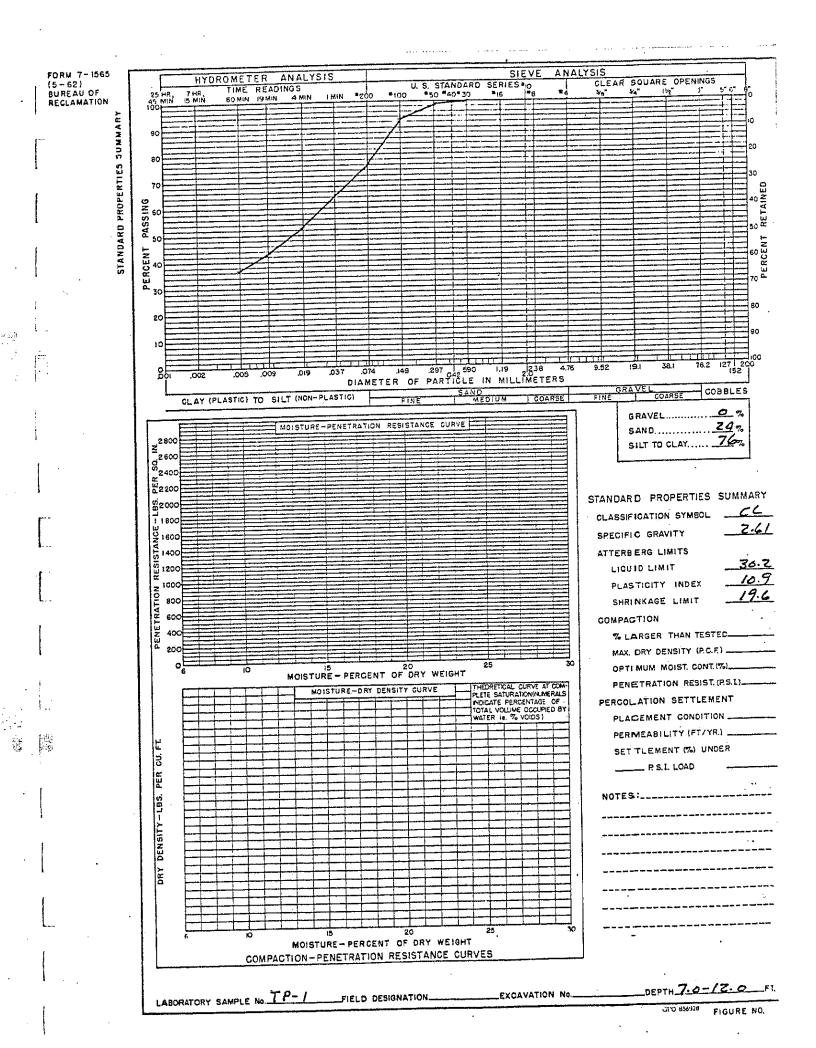


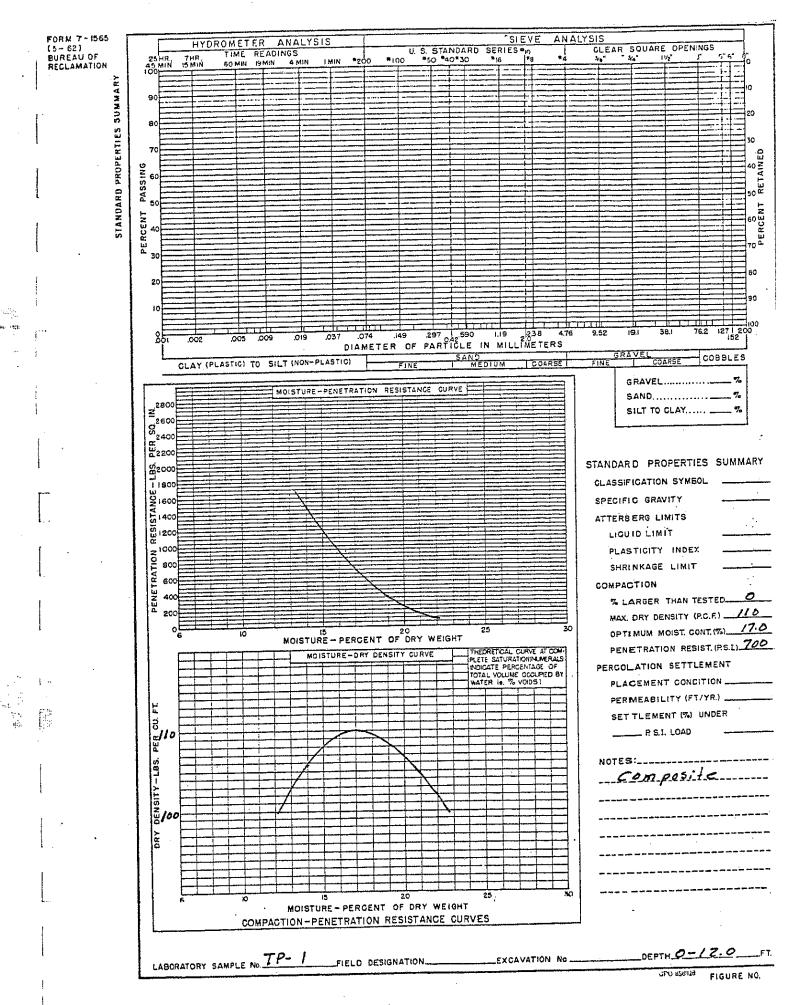
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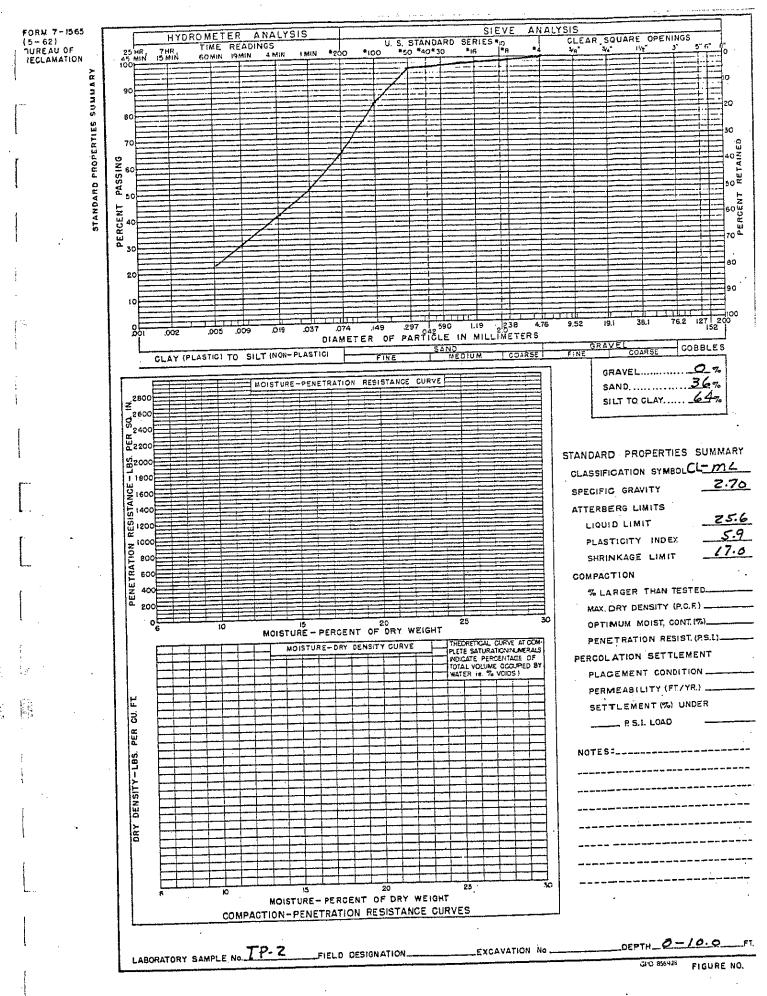




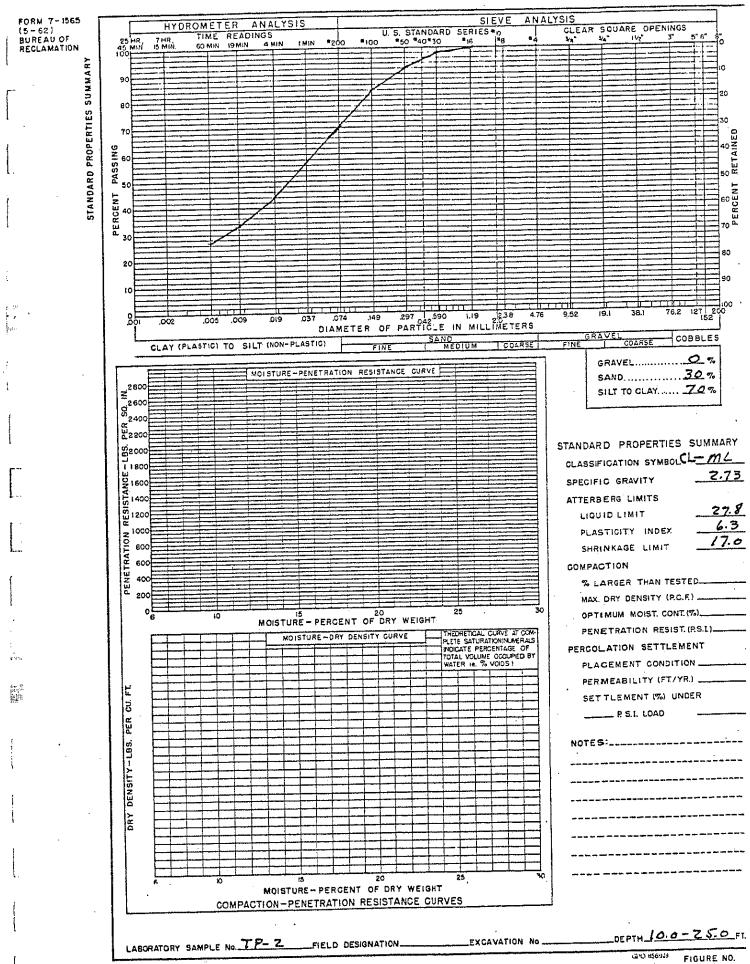


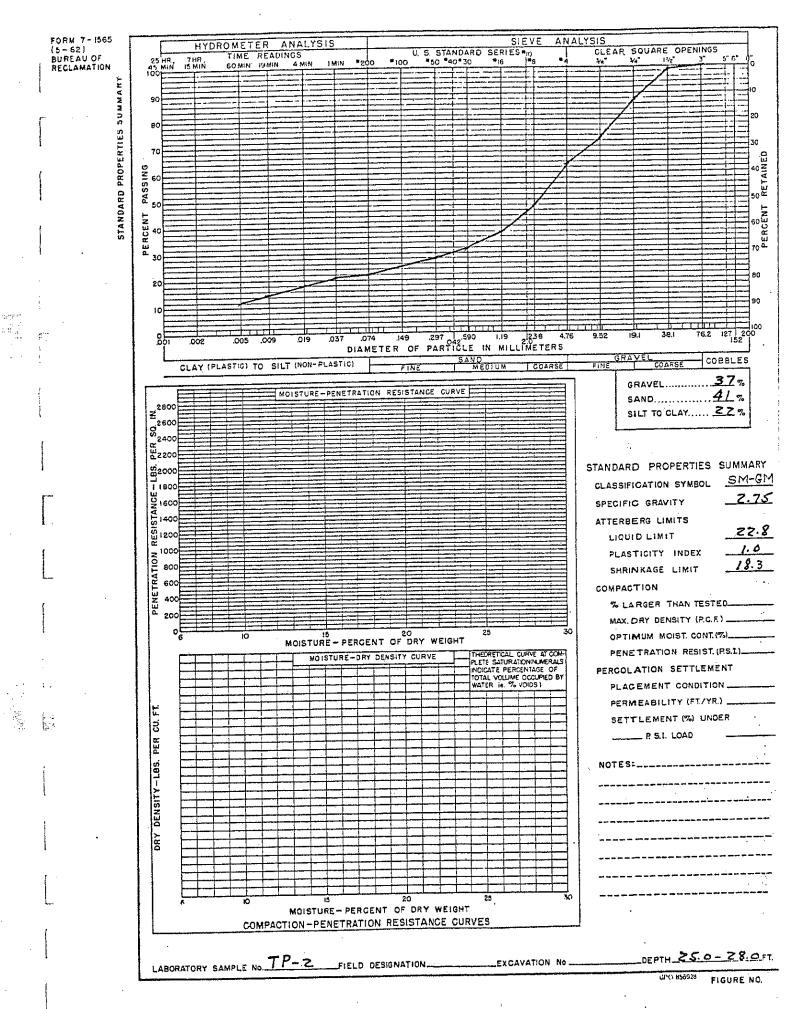




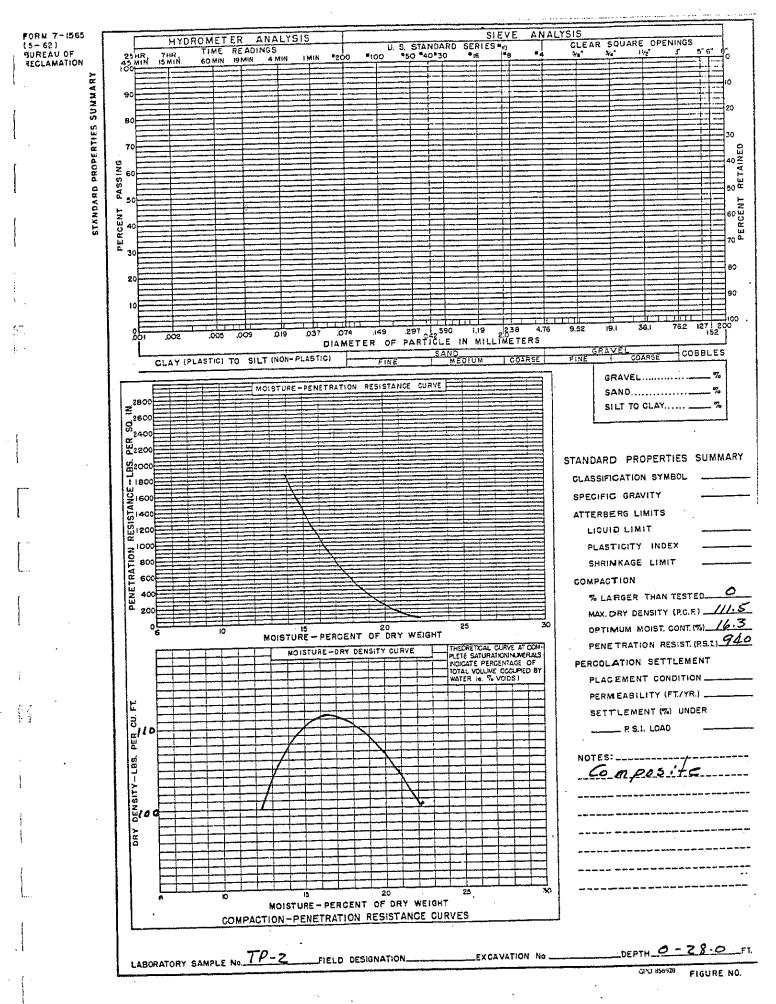


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<sup>\*</sup> 

# APPENDIX D

# IMPERVIOUS MATERIAL PERMEABILITY TEST RESULTS FOR DWR SAMPLES

STATE OF CALIFORNIA THE RESCURCES AGENCY

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DIVISION OF DESIGN AND CONSTRUCTION CIVIL DESIGN BRANCH BRYTE SOILS AND CONCRETE LAB

DEPARTMENT OF WATE	R RESOURCES		BRYTE SO	LS AND CONCRE	TE LAB
• • •		ASTM D5084-90: PERMEABILITY "Falling Head Test - (Method C)"	BEFORE	AFTER	AFTER
•			CONS.	CONS.	TEST
PROJECT: REQUEST NO. LAB SAMPLE HOLE NO. F.S. NO. DEPTH:	Sites Dam 99-51 99-1419 "GG" composite 5 feet	SAMPLE LENGTH, L (cm) SAMPLE DIAMETER, D (cm) SAMPLE AREA, cm <sup>2</sup> SAMPLE VOL., cm <sup>3</sup> AL.cm AD.cm	15.25 7.14 40.04 610.60	15.30 7.14 40.04 612.52 0.05 0.00	15.27 7.14 40.04 611.31 . 0.02.
VIS. DESCRIPTION	•	TEMPERATURE, °C TEMP, CORRECTION CONSOLIDATION STRESS (ksc)	22.D 0.956	0.50	

<u> </u>	Duratte	Burette	Added	Inflow to		· [	······	Elapsed	1	AVERAGE	PERM
	Burette		Pressure	Outflow		ľ	log	Time		GRADIENT	RATE
TIME (sec)	Reading "IN"	Reading "OUT"	"IN"	Rate Ratio	h,	h <sub>2</sub>	$(h_1/h_2)$	t (sec)	, h₂/h₁ init.	(h1+h2)/2L	. k <sub>20</sub> ≖cm/sec
0	49.1	0,6	105	-	•			0			
506040	48,7	3.1	105	0.16	153.5	150.6	0.0191	· 506040	0.98	9.94	6.9E-09
		<u></u>		Average	153.5	150.6	D.0191	506040	0;98	9,94	6.9E-09

· . .

TIME (sec)	Burette Reading "IN"	Burette Reading "OUT"	Added Pressure ''IN"	Inflow to Outflow Rate Ratio	h <sub>1</sub>	h <sub>2</sub>	in (h <sub>1</sub> /h <sub>2</sub> )	Elapsed Time t (sec)	h <sub>2</sub> /h <sub>1</sub> init.	AVERAGE GRADIENT (h1+h2)/2L	PERM RATE k <sub>20</sub> =crt/sec
Ö ·	48.7	3.1	· 260					0		. 19.77	1.1E-08
342360	46.2	6,8	260	0,68	305.6	299.4	0.0205	342360	0.98	. 19.77	,,,, <u>,</u> ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
·					1	 	<u>````</u>	 			
					<u> </u>		· · ·				
<b></b>	<u> </u>			Average	305.6	299.4	0.0205	342360	0.98	19.77	1.1E-08

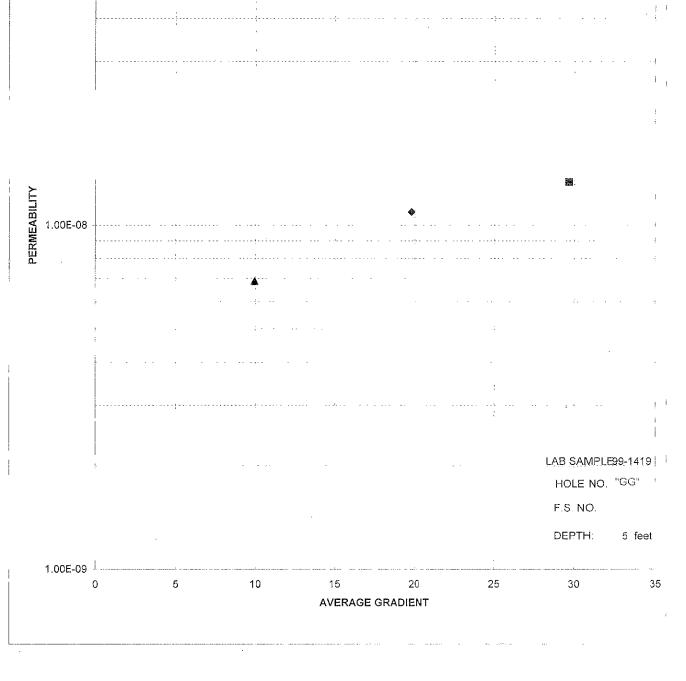
	<u> </u>			Áveráge	459,4	447.9	0.0254	345960	0.97	29.65	1.3E-08
		<u> </u>									<u> </u>
								<u> </u>		<u>.</u>	
								·		· .	<u> </u>
				<u></u>				<u> </u>	<u> </u>		
				<u> </u>			<u></u>	/ . 	1		<u></u>
	]				· · · · · · · · · · · · · · · · · · ·		· .		<u></u>		
							· · · · · · · · · · · · · · · · · · ·				
345960	40.7 .	12.8	420	0.92	459,4	447.9	0.0254	345960	0.87		
D	46.2	6.8	420				0.0054	0 345960	0.97	29.65	1.3E-08
(sec)	"IN"-	"OUT"	"IN"	Rate Ratio	hi	h <sub>z</sub>	In (h <sub>1</sub> /h <sub>2</sub> )	t (sec)	112/113 1011.	1	
TIME	Reading	Reading	Pressure	Outflow	, ·		L. G. R. S	Time	h₂/h₁ inli.	(h1+h2)/2L	k <sub>26</sub> ≖cm/se
	Burette	Burette	Added	infiow to				Elapsed	-	AVERAGE GRADIENT	PERM RATE



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## Sites Dam GG Composite

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#### STATE OF CALIFORNIA. THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

DIVISION OF DESIGN AND CONSTRUCTION . CIVIL DESIGN BRANCH

BRYTE SOILS AND CONCRETE LAB

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#### ASTM D5084-90: PERMEABILITY "Falling Head Test - (Method C)"

, ,			BEFORE CONS.	AFTER CONS.	AFTER TEST
PROJECT:	Sites Dam	SAMPLE LENGTH, L (cm)	14.24	14.27	14.02
REQUEST NO.	99-51	SAMPLE DIAMETER, D (cm)	7.13	7.13	7.13
LAB SAMPLE	.99-1420	SAMPLE AREA, cm2	39.93	39,93	39,93
HOLE NO.	"SC" composite	SAMPLE, VOL., cm <sup>3</sup>	568,56	569.56	559,62
F.S. NO.	· , ·	ΔL.cm		0.03	D.22
DEPTH:	5 feet	∆D,cm		0:00	
VIS. DESCRIPTION:	Lean clay	TEMPERATURE, °C	22.B		
	· .	TEMP. CORRECTION	0,936		
		CONSOLIDATION STRESS (ksc)		0.50	

	No. was Man	Duratio	المعامله م	Infinutio		Einpeed		AVERAGE	PERM
•									
	• •								
						,			
				,	•	4	•		`
		•				-			•

				Average	142.7	142.1	0.0042	344940	- 1.00	9.98	2.0E-09
							·				
344940	: 42.4	0.3	100	-4.00	142.7	142.1	0.0042	344940	1.00	9,98	2.0E-09
D	43.2	0.5	100					0		· ·	
(sec)	"IN"	"OUT"	*'IN"	Rate Ratio	h,	h <sub>2</sub>	(h <sub>1</sub> /h <sub>2</sub> )	t (sec)	h <sub>2</sub> /h <sub>1</sub> init.	(h1+h2)/2L	k <sub>20</sub> =cm/se0
TIME	Reading	Reading	Pressure	Outflow			log <sub>n</sub>	Time		GRADIENT	RATE
	3urette	Burette	Added	inflow to				Elapsed	· ·	AVERAGE	

TIME (sec)	Burette Reading "IN"	Burette Reading "OUT"	Added Pressure "IN"	Inflow to Outflow Rate Ratio	h <sub>1</sub>	h <sub>2</sub>	ln (h <sub>1</sub> /h <sub>2</sub> )	Elapsed Time t (sec)	h <sub>2</sub> /h <sub>1</sub> inlt.	AVERAGE GRADIENT (h1+h2)/2L	PERM RATE k <sub>20</sub> =cm/sec
0	42.4	1.5	244.5	•.				Ö	1		
867720	39.5	3.2	244.5	1.71	285.4	280.8	0.0162	867720	D.98	19.85	3,1E-09
	•	_				;	3				
		•		•		·	• .				
-							,				
			1	Average	285.4	280.8	0.0162	867720	0.98	19.85	3.1E-09

TIME (sec)	Burette Reading "IN"	Burette Reading "OUT"	Added Pressure "IN"	Inflow to Outflow Rate Ratio	h <sub>1</sub>	h <sub>2</sub>	ln (h <sub>1</sub> /h <sub>2</sub> )	Elapsed Time t (sec)	h₂/h₁ init.	AVERAGE GRADIENT (h1+h2)/2L	PERM RATE k20=cm/sec
86400	48.D	3,9	382,8		•			٥			
693240	45.2	5.9	382.8	1.40	426.9	422.1	0.0113	606840	0.99	29.76	3.1E-09
											·
											· · · · · · · · · · · · · · · · · · ·
					•	-					
									· · · · · · · · · · · · · · · · · · ·		ļ
		·					-		<u> </u>		
		, <u>,</u>		Average	426.9	422.1	0,0113	606840	0.99 ·	29,76	3.1E-09

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			SC	composite				
1.00E-07			·····					
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					-; -		LAB SAMPL	
							HOLE NO F.S. NO.	. 55
								<i></i>
							DEPTH:	5 feet i
1.00E-09	L	5	10	15	20	25	30	3!
	0	5	10	AVERAGE GRA		20	50	0.

DEPARTMENT OF WATER RESOURCES BRYTE SOILS AND CONCRETE LAB

# APPENDIX E

# IMPERVIOUS MATERIAL CUE TRIAXIAL TEST RESULTS FOR DWR SAMPLES

DEPARTMENT OF WATER RESOURCES

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SOILS LABORATORY

· · · · · · · · · · · · · · · · · · ·		100 8 2 1	RESSION TEST
	Т Т	YELE	r <u>55 S I</u>
DIAM. OF SPECIMEN 2.809" = 7.	135 cm.	••	DATE 5-2-00
	5.24cm.	- ·	TESTED BY AL CHECKED BY
AREA OF SAMPLE 39.98 cm <sup>2</sup>		<b>-</b> .	SPECIFIC GRAVITY 2.74
VOLUME OF SAMPLE 609.35 CM	3		WET DENSITY 128.06 pet
WT. + TARE	• • • • • • • • • • • • • • • • • • •	<b></b>	DRY DENSITY 109.17 pct
TARE	<u></u>	<b>.</b>	WATER CONTENT 17.3%
WT. OF SAMPLE 1250.5	1298.5	- •	WATER CONTENT FOR SAT. 20,7%
MAX. SIZE 1066.		_	% SAT. 83.6 /0
184.40			VOID RATIO, - 0.565
	,		AFTER CONSOLIDATION
σ <sub>s</sub> DIAL	PIPETTE	Δ VOĽ.	1 ENGTH 15.29 CM
DATE TIME Kg/cm <sup>2</sup> READI	1		40.26 cm <sup>2</sup>
5/18 .5 .092		. <u></u>	- 1 1 K VOLUME 615.64 CW
			DRY DENSITY 108.06
5/30 .09 5/31 .074			WATER CONTENT 21.8
5/7 ,	<u></u>		WT. CONT. FOR SAT. 2
			- 102.8%
A:L= t.02" = .053 cm. (5.240	7.135	<u>,</u>	VOID RATIO, - 0, 582
AL=	.025		A VOL. 70 _1.0%
15.293	7-160	• •	
	· · ·		
		••• 1	SAMPLE DESCRIPTION:
WATER CONTENT: BEFORE CONTAINER NO.	ÂG	1	VIS. CLASS COLOR
WT. CONT. + WET SOIL	1179.4		STRUCTURE
WT. CONT. + DRY 501L	993.9		GEMENT FISS CALC MOTT PEOOTS VOIDS OTH
WT. OF WATER	185.5		
WT. OF CONTAINER	141.3		CONSISTENCY V. SOFT FIRM HARD RO
WT. DRY SOIL	852.6	<u> </u>	REMARKS
WATER CONTENT %	21.8		
MAIER CONTENT			
		• •	
НҮБ. М.	A GS	Pl	C. tax Dravas
CLASSIFICATION TESTS		$\Box$ ·	FEATURE SITES DAM
	Λ. ·	· .	HOLE NO F.S. N. O
TYPE OF SAMPLE Remolder	<u> </u>	·	DEPTH
	-		98 CHAMBER NO A LAB. NO. 99-1

#### ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:	5/31/00	TIME:	8:00am		
SPECIMEN:		MEMBRANE and FILTI	ER STRIPS:	EQUIPMENT:	
New Length *:	15.293 (cm)	Thickness (mem):	0.024 (cm)	Frame No.	87900
New Diameter *:	7,160 (cm)	E Modulus (mem):	14.0 (kg/cm2)	Load Cell #:	A96356
New Area, A <sub>o</sub> *:	40.26 (cm <sup>2</sup> )	K <sub>fp</sub> (fs)	0.196 (kg/cm)	Initial <sub>σ3</sub> ' (ksc)	0.09
B-Value:	95.0	P <sub>fp</sub> (fs) @:	10.0 (cm)	Axial Strain Rate:	0.0033 (% / min)
(* After consolidation)		(@ Perimeter length of filter s			

				Тор	Bottom				Effective		
	Axial	Axial	Chamber	Pore	Pore	Corrected	Membrane	Pore	Confining	Stress	Deviato
Displacement ∆H	Strain	Load P	Pressure	Pressure UT	Pressure	Area A <sub>o</sub> /(1-e)	Correction $\Delta(\sigma_1 - \sigma_3)$	Pressure	Stress	Ratio σ <sub>1</sub> '/σ <sub>3</sub> '	Stress
۵ח (cm)	ε (%)	(kg-f)	σ <sub>3T</sub> (ksc)	ut (ksc)	U <sub>B</sub> (ksc)	(cm <sup>2</sup> )	(ksc)	∆u (ksc)	σ <sub>3</sub> ' (ksc)	01/03	(σ <sub>1</sub> – σ <sub>3</sub> i (ksc)
0.000	0.0	0:09	6.02	5.97	5.89	40.26	0.00	0.00	0.09	1.02	0.00
0.015	0 1	13.65	6.03	6.05	5.96	40.30	0.00	0.07	0.02	14.76	0.34
0:030	02	19.60	6:03	6.05	5.97	40.34	0.00	0.08	0.01	35.52	0.49
0.046	03	24.00	6.03	6:06	5.98	40.39	0.00	0.09	0.01	85.43	0.59
0.061	04	27.12	6.03	6.06	5.98	40.42	0.00	0.09	0.01	96.34	0.67
0.076	05	29.94	6.03	6.06	5.98	40,46	0.00	0.09	. 0.01 -	106.10	0.74
0.091	06	32.11	6.03	6.06	5.97	40.51	0.00	0.09	. 0.01	76.07	0.79
0.107	07	33,38	6.03	6.05	5.96	40.54	0.00	0.08	 0.02	47.77	0.82
0.124	0.8	34.34	6.03	6.05	5.95	40.59	0.00	0.08		31.03	0.84
0.137	09	35.02	6:03	6.03	5,94	40.63	0.00	0.06	0.04	21.39	0.86
0.152	10	35,74	6.02	6.02	5.93	40.67	0.00	0.05	0.05	20.19	0.88
0.307	20	39.42	6.03	5.93	5.84	41.08	0.00	-0.04	0.15	7.32	0.96
0.460	30	40.96	6.03	5.87	5.78	41.51	-0.01	-0.10	0.20	5.90	0.98
0.612	40	42.59	6.03	5.83	5.74	41.94	-0.01	-0.14	0.24	5.16	1.01
0.765	50	43.73	6.02	5.80	5.71	42.38	-0.01	-0.17	0.26	4.88	1.02
0.917	60	44,77	6:02	5.78	5.68	42.83	-0.01	-0.19	0.29	4.59	1.03
1.072	70	45.90	6.02	5.77	5.67	43.29	-0.01	-0.20	0.30	4.55	1.05
1.224	80	47.04	6.02	5.75	5.65	43.77	-0.01	-0.22	0.32	4.35	1.06
1,379	90	47.99	6.02	5.74	5,64	44.25	-0.02	-0.23	0.33	4.23	1.07
1.529	10.0	49.08	6.02	5 72	5,62	44.73	-0.02	-0.25	0.35	4.10	1.08
1.681	11.0	50.17	6.03	5.72	5.61	45.24	-0.02	-0.25	0.36	4.01	1.09
1.836	12.0	50,94	6.02	5 70	5.60	45.75	-0.02	-0.27	0.37	3.96	1.09
1.989	13.0	51.80	6.02	5.68	5:59	46.28	-0.02	-0.29	0.38	3.86	1.10
2.141	14.0	52.80	6.02	5.67	5.58	46.82	-0.02	-0.30	0.39	3.80	1.10
2.296	15.0	53.71	6.01	5.66	5.56	47.37	-0.03	-0.31	0.40	3.76	1.11
· · · · · · · · · · · · · · · · · · ·		••••••••••••••••••••••••••••••••••••••	• • • • • •	,		1.					
				· · · · · · · · · · · · · · · · · · ·		i			······································		

Remarks:
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Composite Sample, GG, remolded @ 98.0% of the maximum dry density

Confining Pressure Requested - 0.05 tsf (0.05 ksc)		
This test excluded. Problems with test set-up probably due to low confining pressure and low	Request #:	99-51
permeability materials.	Lab #:	99-1419A

		IPRESSION TES	
	Ŭ.	OF TEST	· · · · ·
DIAM, OF SPECIMEN 2.508" =	6.370 cm.	DATE 4/4/	0/
	-15.283 cm.	TESTED BY AN	CHECKED BY
AREA OF SAMPLE 31.87 CM		SPECIFIC GRAVITY	
VOLUME OF SAMPLE 486.07	cm <sup>3</sup>		29.08 pct
WT. + TARE		DRY DENSITY	0.51 pet
TARE		WITED CONTENT	16.8%
WT. OF SAMPLE 1005.59.	1043.4.	WATER CONTENT	FOR SAT. 20.070
MAX. SIZE 860.9	1	% SAT. 84.0	00
144.6		VOID RATIO, . O	.547
σ <sub>3</sub> DIA			AFTER CONSOLIDATIC
DATE TIME Kg/cm <sup>2</sup> REAL			LENGTH 12.612 C
			AREA
	189		DRY DENSITY 10.4
	87		WATER CONTENT 22
6/13 47 11	03		WT. CO NT. FOR SAT.
			7 SAT: 106.0%
AT = 003" = 008 cm. 6.01	7 15283 6.	370	VOID RATIO,
AL= 003" = 008 cm. 6.01	<u>300.</u>	003	A VOL. , %
6.01	4 15.275 6.	367	· ·
		· · ·	•
· · · · · · · · · · · · · · · · · · ·	1	SAMPLE DESCRIPTIO	N
WATER CONTENT: BEFOR	RE AFTER .	YIS. CLASS	
CONTAINER NO.	11834		TERO BAND S TRAT LAMIN L
WT. CONT. + WET SOIL	1001.1		LL MOTT ROOTS VOIDS
	182.3		
WT. OF WATER	141.7	CONSISTENCY	SOFT SOFT FIRM HARD
WT. OF CONTAINER	859.4	REMARKS	
WT. DRY SOIL	21.2	• • • •	
WATER CONTERT 2			·
· · ·			
·	A GS PI	Ć. La .	
CLASSIFICATION TESTS		FEATURE Site	,
- 11	·	HOLE NO.	F.S. N€0
TYPE OF SAMPLE Remold	led	DEPTH	

### TRIAXIAL COMPRESSION

## ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Solls

DATE:	6/13/01	TIME:	<u>8:42am</u>		
SPECIMEN:	<b>x</b>	MEMBRANE and FILT	ER STRIPS:	EQUIPMENT:	
New Length *:	15.275 (cm)	Thickness (mem):	0.024 (cm)	Frame No.	87899
New Diameter *:	6.367 (cm)	E Modulus (mem):	14.0 (kg/cm2)	Load Cell #:	A96370
New Area, A <sub>e</sub> *:	31.87 (cm <sup>2</sup> )	K <sub>fp</sub> (fs)	0.196 (kg/cm)	Initia∣ <sub>σ3</sub> ' (ksc)	1.12
B-Value:	96.0	P <sub>fp</sub> (fs) @:	10.0 (cm)	Axial Strain Rate:	0.0030 (in. / min )
(* After consolidation)		(@ Perimeter length of filter	strips)	•	

				Тор	Bottom	s			Effective		
	Axial	Axiai	Chamber	Pore	Pore	Corrected	Membrane	Pore	Confining	Stress	Deviator
Displacement	Strain	Load	Pressure	Pressure	Pressure	Area	Correction	' Pressure	Stress	Ratio	Stress
ΔH	Ê	P	o <sub>31</sub>	u <sub>T</sub>	u <sub>B</sub>	A <sub>o</sub> /(1-e)	$\Delta(\sigma_1 - \sigma_3)$	Δu	σ <sub>3</sub> '	σ <sub>1</sub> '/σ <sub>3</sub> '	$(\sigma_1 - \sigma_3)$
(cm)	(%)	(kg-f)	(ksc)	(ksc)	(ksc)	(cm <sup>2</sup> )	(ksc)	(ksc)	(ksc)		(ksc)
0:000	0.0	2.36	4,70	3.56	3 60	31.87	0.00	0.00	1,12	1.07	0.07
0:015	0.1	16.69	4.70	9,79	3,82	31.90	0.00	0.22	0.89	1.59	0.52
0.030	0.2	27:26	4.70	3.99	3:99	31.93	0.00	0.43	0.71	2.20	0.85
.0.046	0.3	34.61	4.70	4.16	4.12	31.97	0.00	0.60	0.56	2.94	1.08
0.064	0,4	38,15	4.70	4.24	4.19	32.00	0.00	0.68	0.49	3.44	1.19
0.079	0.5	42,55	4,70	4,35	4.27	32.04	0.00	0.79	0.38	4.46	1.33
0.099	0.6	44.27	4.70	4.39	4.32	32.08	0.00	0.83	0.34	5.04	1.38
0.109	0.7	45.36	4.70	4.42	4,34	32.10	0.00	0.86	0.32	5.46	1.41
0.127	0.8	45:45	4.70	4.42	4.34	32.13	0.00	0.86	0.32	5.37	1.41
0.137	0.9	46.40	4,70	4.45	4.36	32.16	0.00	0.89	0.29	5.94	1.44
0,152	1.0	46.67	4.70	4.46	4.37	32.19	0.00	0,90	0.28	6.15	1.45
0,310	2.0	49.67	4.70	4.53	4.42	32.53	0.00	0.97	0.22	7.77	1.52
0.460	3.0	52.66	4.70	4.56	4:42	32.86	-0.01	1.00	0.21	8.70	1.60
0.612	4.0	54.66	4.70	4.58	4,43	33.20	-0.01	1.02	0.20	9.32	1.64
	5.0	56.74	4,70	4.60		33,55	-0.01	1.04	0.19	9.70	1.68
0.917	6.0	58.88	4.70	4.61	4.41	33.91	-0.01	1.05	0.20	9.76	1.72
1.072	7.0	60.65		4,61	4.39	34,28	-0.01	1.05	0.20	9.76	1.76
1.222	. 8.0	62.37	4,70	4 61	4,38	34.64	-0.02	1.05	0.20	9.75	1.78
- 1.377	9.0	63.87	4.70	4,60	4,36	35.03	-0.02	1.04	0.22	9.02	1.81
.1.534	10.0	65.14	4 70	4:58	4.33	35.43	-0.02	1.02	0.25	8.39	1.82
1.681	11.0	66.09	4:70	4.56	4.30	35.81	-0.02	1.00	0.27	7,74	1.82
1.834	12.0	67.22	4,70	4.53	4,27	36.22	-0.02	0.97	0.30	7.13	1.83
1.989	13 0	68.13	4:70	4:52	4:25	36.64	-0.03	0.96	0.32	6.80	1.83
2,144	14.0	69.35	4,70	4.50	4.23	37.08	-0.03	0.94	0.34	6.41	1.84
2.301	151	70.90	4,70	4:49	4.20	37.53	-0.03	0.93	0.35	6,29	1.86
			\$8.77F								
									Í		

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Remarks:

Composite Sample, GG, remolded @ 98.0 % of the maximum dry density

Confining Pressure Requested - 1.2 tsf (1.17 ksc), Retest

99-51 Request #: 1419B1 Lab #:

THE RESOURCES AGENCY DEPARTMENT OF WAVER RESOURCES LABURA DULL DAANA SOILS LABORATORY TRIAXIAL COMPRESSION TEST TYPE OF TEST DATE 6-6-00 DIAM. OF SPECIMEN 2.810" 7.137 CM LENGTH OF SPECIMEN 6.000 7 15.240 CM. AN TESTED BY CHECKED BY 40.01 cm2 74 SPECIFIC GRAVITY AREA OF SAMPLE\_\_\_\_ VOLUME OF SAMPLE 609.69 Cm3 WET DENSITY 128.37 net DRY DENSITY 109 44 Det WT. + TARE. 17.3 % WATER CONTENT TARE WATER CONTENT FOR SAT. 20.5% 1254.3.0 271.7 g. WT. OF SAMPLE\_ 7 SAT. 84.4% 1069:60 MAX. SIZE 184.7 VOID RATIO, - 0.562 AFTER CONSOLIDATION LENGTH 15.05 cm PIPETTE Δ VOL. DIAL σ, DATE TIME Kg/cm<sup>2</sup> READING c.c. c.c. 39.03 CM AREA \_\_\_\_ 616 .100 Ô VOLUME 587.33 CM 5 092 DRY DENSITY 113.63 pet 7/25 : .133 9.60 WATER CONTENT 18.9% .174 7/26 WT. CO NT. FOR SAT. 18-49 % SAT. 102.7% VOID R ATIO, . 0.505 15.240 A.L= 1074" = 188cm. 7.137 A VOL . 7 3.7 .188 . 088 - .088 Δ D=\_\_\_\_ 5.052 7.049 SAMPLE DESCRIPTION: AFTER BEFORE WATER CONTENT: 97 COL OR VIS. CLASS\_ CONTAINER NO .-LENSES STRAT LAMIN HOMO HETERO BAND ODRZ STRUCTURE WT. CONT. + WET SOIL OTHER ROOTS VOIDS CEMENT FISS CALC мотт WT. CONT. + DRY SOIL WT. OF WATER ROCK HARD FIRM V SOFT SOFT 135.7 CONSISTENCY Ē WT. OF CONTAINER\_ 134 REMARKS\_ WT. DRY SOIL ..... 8.9 WATER CONTENT %\_ FEATURE SITES CLASSIFICATION TESTS \_ F.S. N 0. HOLE NO. TYPE OF SAMPLE Remolded DEP.TH\_ LAB. NO. 99-14190 107 99-51 CHAMBER NO. REQUEST NO. DWR 720 (REV. 3/66)

#### ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:	7/26/00	TIME:	8:15am	•				
SPECIMEN		MEMBRANE and FILT	TER STRIPS		EQUIPMEN	IT: -		
New Length *:	15.052 (cm)	Thickness (mem):		(cm)	Frame No		87900	
New Diameter *:	7.049 (cm)	E Modulus (mem):		(kg/cm2)	Load Cell		A96356	-
New Area, A <sub>o</sub> *:	39.03 (cm <sup>2</sup> )	K <sub>fp</sub> (fs)	0.196	(kg/cm)	Initial o <sub>3</sub> '	(ksc)	8.96	
B-Value:	95.0	P <sub>fp</sub> (fs) @:	10.0	(cm)	Axial Stra	in Rate:	0.0028	(% / min)
(* After consolidation)	<u>.</u>	(@ Perimeter length of filter	strips)			-		-
		Top Bottom				Effective		
Axial	Axial Chamber	Pore Pore	Corrected	Membrane	Pore	Confining	Stress	Deviator
Displacement Strain	Load Pressure	Pressure Pressure	Area	Correction	Pressure	Stress	Ratio	Stress
αΗ ε	P σ <sub>ar</sub>	ໍ່ປ <sub>ິ</sub> ປ <sub>ິ</sub>	A <sub>o</sub> /(1-e)	$\Delta(\sigma_1 - \sigma_3)$	∆u ⁻	σ <sub>3</sub> '	σ1'/σ3'	$(\sigma_1 - \sigma_3)$
(cm) (%)	· (kg-f) (ksc)	(kşc) (ksc)	(cm <sup>2</sup> )	(ksc)	(ksc)	(ksc)		(ksc)
0.000.0	2.31 8.97	3.83	39,03	0.00	0.00	5,10	1.00	0.00
0.015 0.1	3.81 8.96	3.96 3.85	39.07	0.00	0.04	5.06	1.02	0.10
0.030 0.2	4.08	3.97 3.86	39.11	0.00	0.14	5.05	1.02	0.10
0.046 0.3	4.72 8.96	3.98 3.88	39.15	0.00	0,15	5.03	1.02	0.12
0.061 0.4	11 57 8 96	4.06 3.99	39.19	0,00	0.23	4.94 ·	1.06	0.29
0.076 0.5	28.26 8.96	4,23 4,25	39.23	0.00	0.40	4.72	1.15	0.72
0.091 0.5	50,71 8.96	4:51 4:58	39.27	0.00	0.68	4.42	1.29	1.29
0.107 0.7	67,40 8,96	4.77 4.84	39.31	0.00	0.94	4.16	1.41	1.71
0.122 0.8	76.61 8.96	4.94 5.00	39.35	0.00	1.11	3.99	1.49	1.95
0.137 0.9	84.69 8.96	5.11 5.17	39.38	0.00	1.28	3.82	1,56	2:15
0.150 1.0	.90.95 8.96	5.25 5.33	39.42	0.00	1.42 .	3.67	1.63	2.30
0.302 2.0	122:56 8.96	6.10 6.29	39.83	0.00	2.27	2.77	2.11	3.07
0.452 3.0	136.35 8.96	6.50 6,74	40.24	-0.01	2.67	2.34	2.44	3.38 .
0,602 4.0	145.38 8,96	6.64 7.01	40.66	-0.01	2.81	2.14	2.67	3.57
0.752 5.0	152.09 8:96	6.70 7.15	41.08	-0.01	2.87	2.04	2.81	3.69
01904 6.0	158.17 8:96	6.79 7.23	41.53	-0.01	2.96	1.95	2.94	3.80
1.054 7.0	163.47 8.96	6.81 7,26	41.97	-0.01	2.98	1.93	3.01	3.88
1.204 8.0	168.33 8.96	6.82 / 7.26	42.43 .	-0.01	2.99	1.92	3.06 .	3.95
1,354 9.0	172,91 8,96	6.83 7.26	42.89	-0.02	3.00	1.92	3.09	4.02
1.506 10.0	177.40 8.96	6.84 7.23	43.37	-0.02	3.01	1.93	3.11	4.07
1.656 11.0	181.66 8.96	6.95 7.22	43.86	-0.02	3,12	1.88	3.20	4.12
1.808 12.0	185.52 8.96	6.90 7.20	44.36	-0.02	3.07	1.92	3.17	4.16
1.958 13.0	188.97 8.96	6:88 7:17	44.87	-0.02	3.05	1.94	3.16	4.19
2,108 14.0	4192.37 8.96	6.85 7.14	45.39	-0.02	3.02	1.97	3.14	4.21
2.258 15.0	195.45 8.96	6.94	45.92	-0.03	3.11	1.94	3.18	4.23
			h.			_		
								-

Remarks:

Composite Sample, GG, remolded sample @ 98.0% of the maximum dry density

Confining Pressure Requested - 5.6 tsf (5.47 ksc)

Request #: 99-51 Lab #: 99-1419C

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THE RESOURCES AVENU DEPARTMENT OF WATER RESOURCES SOILS LABORATORY TRIAXIAL COMPRESSION TEST TYPE OF TEST DATE 7-18-00 DIAM. OF SPECIMEN 2.8071 : 7.130 EM. TESTED BY AN : RS LENGTH OF SPECIMEN 6.002": 15.245 cm. -CHECKED BY. SPECIFIC GRAVITY AREA OF SAMPLE 3993 Cm. WET DENSITY 128.40 ACT VOLUME OF SAMPLE 608.69 CM DRY DENSITY 109.26 WT: + TARE\_ WATER CONTENT 17.5% TARE WATER CONTENT FOR SAT. 20.6 To WT. OF SAMPLE 12525 1241. % SAT. 85.0 % 1065.8 MAX. SIZE VOID RATIO, - 0.565 186.7 AFTER CONSOLIDATION PIPETTE A VOL. 14727 6.1994 σ. DIAL LENGTH. Kg/cmª READING c.c. TIME c.c. DATE 37.31 AREA 7/18 .100 0 VOLUME 549 78 cm 103 6 812 DRY DENSITY 120.97 8/10 300 14:0° WATER CONTENT 16.5 % 15.5 WT. CO NT. FOR SAT. 15.1% % SAT. 109.3% VOID RATIO, A.L=": 200" = . 508 cm. A VOL . % 4.7 5.738 cm. ∧ D=\_\_\_\_\_ SAMPLE DESCRIPTION: AFTER BEFORE WATER CONTENT: COL OR. STRUCTURE VIS. CLASS. CONTAINER NO. 1279.5 WT. CONT. + WET SOIL . OTHER FROOTS VOIDS мотт CALC CEMENT FISS WT. CONT. + DRY SOIL . . WT. OF WATER FIRM HARD ROCK V. SOFT SOFT CONSISTENCY -. 🛄 WT. OF CONTAINER\_ 1062.7 REMARKS\_ WT. DRY SOIL 16.5 WATER CONTENT %\_ Sites Marke CLASSIFICATION TESTS FEATURE F.S. NEC. HOLE NO .. Remolded DEPTH\_ TYPE OF SAMPLE LAB. NO. 99-1419 99-51 CHAMBER NO. REQUEST NO .. DWR 720 (REV: 3/66)

#### ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:	8/10/00	:	TIME:		9:30am					
SPECIMEN			MEMBRAI	NE and FILT	ER STRIPS	S:	EQUIPMEN	NT:		
New Length *:	14.737	(cm)		ss (mem):	0.024	(cm) .	Frame No		87900	
New Diameter *:	6.892	(cm)		us (mem):	14.0	(kg/cm2)	Load Cell		A96356	-
New Area, A <sub>o</sub> *:	37.31	(cm <sup>2</sup> )	K <sub>fp</sub> (fs)	. 1	0.196	(kg/cm)	. Initial <sub>03</sub> '	(ksc)	11.84	-
B-Value:	97.0	. ,	P <sub>fp</sub> (fs)	<u>@</u> :	10.0	(cm)	Axial Stra	un Rate:	0.0024	(% / min)
(* After consolidation)	<u>.</u>		•	er length of filter :	strips)		-			-
			Тор	Bottom				Effective		
<ul> <li>Axial</li> </ul>	Axial	Chamber	Pore	Pore	Corrected	Membrane	Pore	Confining	Stress	Deviator
Displacement Strain	Load	Pressure	Pressure	Pressure	Area	Correction	Pressure	Stress	Ratio	Stress
αΗ ε	P	σ <sub>3T</sub>	uT	υ <sub>B</sub>	A <sub>o</sub> /(1-e)	$\Delta(\sigma_1 - \sigma_3)$	∆u	σ <u>3</u> '	$\sigma_1 ' \sigma_3 '$	$(\sigma_1 - \sigma_3)$
(cm) (%)	(kg-f)	(ksc)	(ksc)	(ksc)	(cm²)	(ksc)	(ksc)	(ksc)		(ksc)
0.000 0.0	5.81	15:48	3:66	3.63	37.31	0.00	0.00	11.84	1.00	0.00
0.015 0.1	6.30	15.49	3.66	3.63	37.35	0.00	0.00	11.84	1.01	0.17
0.030 0.2	6.80	15.49	3.66	3.63	37.38	0.00	0.00	11.84	1.02	0.18
0.046 0.3	8,03	15.49	3:68	3.65	37.42	0.00	0.02	11.83	1.02	0.21
0.061 0.4	12.02	15.49	3.71	3.70	37.46	0.00	0,05	11.79	1.03	0.32
0.076 0.5	15.88	15,49	3.73	3,74	37.50	0.00	0.07	11,75	1.04	0.42
0.0 089 0.6	47.67	15.48		~ 4:15	37.54	0.00	0.30	11,43	1.11	1.27
0.104 0.7	93.03	15.48	4.37	4.70	37.57	0.00	0.71	10,95	1.23	2.47
0.117 0.8	139.89	15.48	4.87	5.30	37.61	0.00	1.21	10.39	1.36	3.72
0.132 0.9	164.52	15.48	5.20	5.67	37.65	0.00	1.54	10.04	1.43	4.37
0.147 1.0	183.30	15.47	.5.48	6:00	37.69	0.00 .	1.82	9.73	1.50	4.86
0.295 2.0	257.50	15.48	7.24	8.18	38.08	0.00	3.58	7.77	1.87	6.76
0:445 3.0	285.94	15.56	8.28	9.36	38.47	-0.01	4.62	6.74	2.10	7.43
0.589 4.0	304:22	15.55	8,98	10.01	38.87	-0.01	5,32	6.06	2.29	7.82
0.737 5.0	318,33	15.54	9.46	40.42	39.27	-0.01	5.80	5.61	2.44	8.10
0:884 6.0	329:67	.15.56	9.76	10.66	39.69	-0.01	6.10	, 5.35	2.55	8.29
1.031 7.0	339:51	15.56	9.93	10,79	40.12	-0.01	6.27	5.20	2.63	8.45
1.179 8.0	348.09	15:55	10.09	10.86	40.55	-0.01	6.43	5.08	2.69	8.57
1.326 9.0	354.94	15.54	10:21	10.90	41.00	-0,02	6.55	4.99	2.73	8.64
1.476 10.0	360.56	15:56	10:33	10,92	41.46	-0.02	6.67	4.94	2.76	8.68
4:623 11.0	365.69	15.56	10.29	10.91	41.93	-0.02	6.63	4.96	2.75	8.70
1.768 12.0	369.77	15.56 /	10.22	10,88 :	42.40	-0.02	6,56	5.01	2.74	8.70
1.918 13.0	373.08	15.55	10.10	.10,83	42.89	-0.02	6.44	5.08	2.71	8.67
2.062 14.0	375.57	15.56	10.07	10.76	43.38	-0.03	6.41	5,14	2.68	8.63
2.212 15.0	376,98	15.56	9,92	10.69	43.89	· -0.03	6.26	5.25	2.63	8.56
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Remarks:

Composite Sample. GG, remolded @ 98.0% of the maximum dry density

Confining Pressure Requested - 14.0 tsf (13.67 ksc)

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Request #: \_\_\_\_\_99-51 Lab #: \_\_\_99-1419D

TRIAXIAL COMPRESSION TEST PE OF TEST DIAM. OF SPECIMEN 1.510" = 6.375 CM DATE 2-16-01 LENGTH OF SPECIMEN 6.028" = 15.311 cm. TESTED BY CHECKED BY SPECIFIC GRAVITY 2.74 AREA OF SAMPLE 31.92 CM. VOLUME OF SAMPLE 488.70 CM WET DENSITY 126.17 set DRY DENSITY 10175 OCT WT. + TARE \_ WATER CONTENT 17.1 0% TARE WATER CONTENT FOR SAT. 21.49. WT. OF SAMPLE 988.1 1038.1 7 SAT. 79.9% 844.0 MAX, SIZE VOID RATIO, . 0.587 144.1 AFTER CONSOLIDATION LENGTH 15.434 DIAL PIPETTE A YOL.  $\sigma_{s}$ DATE TIME Ko/cm² READING cic. a.c. AREA 32.44 16 0 .100 YOLUME 500.68 5 043 23 DRY DENSITY 105.19 : 054 26 5 WATER CONTENT 13.0 6.3 21 .051 WT. CONET. FOR SAT. 22.8 % SAT. 100.9 VOID RA. TIO, . 0.625 01=+.049" = 124cm. 6.028 6.375 . 049 A YOL. 7 15 052 5.052 CM+ 6,017 6.427 SAMPLE DESCRIPTION: WATER CONTENT BEFORE AFTER 1 Y VIS. CLASS COLOR. CONTAINER NO. RAT LAMIN LENSES STRUCTURE  $\Box$ WT. CONT. + WET SOIL . OTHER REPOTS VOIDS CEMENT FISS DALC MOTT WT. CONT. + DRY SOIL. • 🗆 - 🗖 193.5 WT. OF WATER \_\_\_\_ ਸ - ਵ ਸ ਮ HARD ROCK. V. SOFT SOFT 142.2 CONSISTENCY WT. OF CONTAINER\_ 840.5 REMARKS\_ WT. DRY SOIL. 120 WATER CONTENT %. FEATURE Sites CLASSIFICATION TESTS F.S. NO. HOLE NO .. TYPE OF SAMPLE Remolded DEPTH 1420A CHAMBER NO. 99-51 LAB. NO. DWR 720 (REV. 3/66) REQUEST NO.

#### ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:	2/27/01	TIME:	8:30am		
SPECIMEN:		MEMBRANE and FILT	ER STRIPS:	EQUIPMENT:	
New Length *:	15.434 (cm)	Thickness (mem):	0.024 (cm)	Frame No.	87899
New Diameter *:	6.427 (cm)	E Modulus (mem):	14.0 (kg/cm2)	Load Cell #:	A96370
New Area, A, *:	32.44 (cm <sup>2</sup> )	K <sub>fp</sub> (fs)	0.196 (kg/cm)	Initial <sub>σ3</sub> ' (ksc)	0.36
B-Value:	94.60	P <sub>fp</sub> (fs) @:	10.0 (cm)	Axial Strain Rate:	0.0016 (% / mìn)
(* After consolidation)	······································	(@ Perimeter length of filter	strips)		

	Axial	Axial '	Chamber	Top Pore	Bottom	Corrected	Membrane	Pore	Effective	Channel	Deviator
Displacement	Strein	Load	Pressure	Pressure	Pressure	Area	Correction	Pore Pressure	Confining Stress	Stress Ratio	Stress
ΔH	ŝ.	Р	σ <sub>3T</sub>	υ <sub>T</sub>	u <sub>B</sub>	A <sub>o</sub> /(1-e)	$\Delta(\sigma_1 - \sigma_3)$	Δu	σ3'	σ <sub>1</sub> /σ <sub>3</sub> '	$(\sigma_1 - \sigma_3)$
(cm)	(%)	(kg-f)	(ksc)	(KSC)	(ksc)	(cm <sup>2</sup> )	(ksc)	(ksc)	(ksc)		(ksc)
0.000	0.0	1.13	6.32	6.01	5,91	32.44	0.00	0.00	0.36	,1.10	0.03
-0.015	0.1	7.53	6.31	6.07	5.97	32.47	0.00	0.06	0.30	1.78	0.23
0.033	0.2	15.29	6,31	6,14	6.04	32.51	0.00	0.13	0.22	3.16	0.47
0.046	0.3	21.18	6.20	6.10	5.99	32,54	0.00	0.09	0.16	5.11	0.65
-0.064	0.4	23:45	6.36	6.28	6.19	32.57	0.00	0.27	0.13	6.53	0.72
0.079	0.5	24,77	6,35	6.29	6.19	32.60	0.00	0.28	0.11	8.19	0.76
0.094	0.6	25.49	6.35	6:31	6.21	32.64	0,00	0.30	0.09	9,53	0.78
0.109	0.7	25.67	6.34	6.31	6.21	32.67	0.00	0.30	0.08	10.30	0.78
0.124	0.8	25.67	6.33	6.30	6.20	32.70	0.00	0.29	0.08	11.13	0.78
0.140	0.9	25.67	6.33	6.31	6.21	32.73	0.00	0.30	0.08	11.12	0.78
0,155	1.0	25:58	6.33	6.31	6.21	32.77	0.00	0.30	0.08	11.07	0.78
0.310	2.0	25.13	6.36	6.31	6.22	33.11	· 0.00	0.30	0.10	8.67	0.75
0,465	3.0	25.90	6.32	6.27	6.17	33.45	-0.01	0.26	0,10	8.80	0.77
0.617	4.0	26.67	6.36	6,29		33.79	-0.01	0.28	0.12	7.54	0.78
0.775	5.0	27.44	6.36	6.26	· · · · 6:17 · · ·	34.15	-0.01	0.25	0.14	6.50	0.79
0.927	6.0	28.12	6.35	6.24	6.14	34.51	-0.01	0.23	0.16	5.96	0.80
1.080	7.0	29:39	6.33	6.20	6.11	34.88	-0.01	0.19	0.18	5.62	0.83
1.237	8.0	30:07	6.37	6.23	6:13	35.27	-0.02	0.22	0.19	5,41	0.84
1,392	9.0	30,84	6.40	-6.25	- (6.17	35.65	-0.02	0.24	0.20	5.30	0.85
1.547	10.0	31.75	6.47	6.28	6.19	36.05	-0:02	0.27	0.23	4.71	0.86
1.699	11.0	32.39	6.51	6:31	6.22	36.45	-0.02	0.30	0.24	4.57	0.87
1.854	12.0	32,93	6.57	6,35	6.26	36.87	-0.02	0.34	0.26	4.30	0.87
2:009	13.0	33:88	6.64	6:40	<i>്</i> 6,32	37.30	-0.03	0.39	0.28	4.18	0.88
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Remarks: Composite Sample, SC, remolded @ 98.0 % of the maximum dry density.

Confining Pressure Requested - 0.05 tsf (0.05 ksc), Retest

99-51 Request #:

Lab #: 1420A1

DEFARTMENT OF WILLE	R RESOURCES	SOILS LABORATOR'
	TRIAXIAL COM	PRESSION TEST
	THE	FTEST
· · · · · · · · · · · · · · · · · · ·		DATE 7-26-00
DIAM. DE SPECIMEN 2. BOR	$\frac{1104}{100}$	
LENGTH OF SPECIMEN 6.011		TESTED BY AN: RS CHECKED BY
AREA OF SAMPLE 39.95	<u>CMA.</u>	SPECIFIC GRAVITY 2.74
VOLUME OF SAMPLE 609.9	<u>5 cm</u>	WET DENSITY 12649 per
WT. + TARE	<del></del>	DRY DENSITY 108.11 Set
TARE		WATER CONTENT 120%
WT. OF SAMPLE 1236.4	1300.6	WATER CONTENT FOR SAT. 21.2 10
HAX. SIZE 1056.6		% SAT. 80.2 10
179.5		VOID RATID, . 0. 582
		AFTER CONSOLIDATION
	DIAL PIPETTE A YO.	- 1 15396 L
		4057 0
0	.100	VOLUME 624.14
		1 DRY DENSITY 105.6
<u> </u>	.054	WATER CONTENT 23
		WT. CON T. FOR SAT.
		7 SAT. 102.2%
in a self la setterne		VOID RA TIO, . 0.619
ALE <u>4.046" ? .117</u> CM.		Δ VOL., 7 2.3%
	· · · · · · · · · · · · · · · · · · ·	
WATER CONTENT: BEI	FORE AFTER	SAMPLE DESCRIPTION
CONTAINER NO.		VIS. CLASS COLOR
WT. CONT. + WET SOIL	926.8	
WT. CONT. + DRY SOIL	<u> </u>	CEMENT FISS "LALC MOTT RO-OTS VOIDS OT
WT. OF WATER	146.9	
WT. OF CONTAINER	1439	CONSISTENCY V SOFT SOFT FERM HARD
WT. DRY SOIL	636.0	REMARKS
WATER CONTENT %	23.	
1 · ·		
		citar Arma
HYD.	MA OS PI	
CLASSIFICATION TESTS	M.A GS P1	FEATURE
		HOLE NO F.S. NO
CLASSIFICATION TESTS	M.A GS P1	

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## ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:	9/21/00	*1	TIME:		8:00am					
SPECIMEN:			MEMBRA	NE and FILTI	ER STRIPS	5:	EQUIPMEN	IT:	÷	
New Length *:	15.385	(cm)	Thickne	ss (mem):	0.024	(cm)	Frame No	λ.	87900	
New Diameter *;	7.187	(cm)		us (mem):	14.0	(kg/cm2)	Load Cell		A96356	
New Area, A <sub>o</sub> *;	40.57	(cm <sup>2</sup> )	K <sub>fp</sub> (fs)		0.196	(kg/cm)	Initial o <sub>3</sub>		1.11	
B-Value:	95.20%		P <sub>fp</sub> (fs)	@.	10.0	(cm)	Axial Stra		0.0033	-(% / min)
(* After consolidation)		-		er length of filter s						-
	T		Тор	Bottom		-		Effective		
Axial	Axial	Chamber	Pore	Porë	Corrected	Membrane	Pore	Confining	Stress	Deviator
Displacement Strain	Load	Pressure	Pressure	Pressure	Area	Correction	Pressure	Stress	Ratio	Stress
ΔH ε	Р	σ <sub>3T</sub>	μ <sub>T</sub>	u <sub>B</sub>	A <sub>o</sub> /(1-e)	$\Delta(\sigma_1 - \sigma_3)$	∆u	σ3'	σ <sub>1</sub> '/σ <sub>3</sub> '	$(\sigma_1 - \sigma_3)$
(cm) (%)	(kg-1)	(ksc)	(ksc)	(ksc)	(cm <sup>2</sup> )	(ksc)	(ksc)	(ksc)		(ksc)
0.0	3.27	5.65	(4.62	4.46	40.57	0.00	0.00	1.11	1.07	0.08
0.015 0.1	34,29	5:65	5.12	4.89	40.61	0.00	0,46	0.64	2.31	0.84
0.046 0.3	40.51	5.64	5.22	4:98	40.69	0.00	0.60	0.54	2.85	0.99
0.046 0.3	41,59	5,64	5.24	4.99	40.69	0.00	0.62	0.52	2,96	1.02
0.064 0.4	45,81	5.65	531	5.06	40.74	0.00	0.69	0.46	3.42	1.12
0.079 0.5	48,26	5,64	5.34	5,10	40.77	: 0.00	0.72	0.42	3,83	1.18
0.094 0.6	49.67	5.65	5.36	5 13	40.82	0.00	0.74	0.40	4.01	1.22
0.7	50.12	5,64	5.36	5.14	40.86	0.00	0.74	0.39	4.17	1.23
0124 0.8	50.17	5.64	5.36	5.15	40.90	0,00	0.74	0.38	4.20	1.23
0.140 0.9	50.26	5.64	5.36	5.15	40.94	0.00	0.74	0.39	4.17	1.23
0.155 1.0	50,35	5.65	5,36	5.16	40.98	0.00	0.74	0.38 ,	4.20	1.23
0.307 2.0	50.21	5:65	5.35	5.15	41.40	0.00	0.73	0.40	4.04	1.21
0:462 3.0	51.03	5.65	5:36	;5.15	41.82	-0.01	0.74 ·	0.40	4.03	1.21
0:615 4.0	.51.85	5.65	5.36	5.13	42.26	-0.01	0.74	0.40	4.04	1.22
0.770 5.0	52.98	5,65	5.37	5.14	42,71	-0.01	0.75	0.40	4.10	1.23
1.199 7.8	53.75	5.65	5.36	5.13	44.00	-0.01 ·	0.74	0.40	4.01	1.21
9.2	53,80	5.65	5.36		44.67	-0.02	0.74	0.40	3.96	1.19
10.0	54:16	5.64	5,36	3.12	45.08	-0.02	0.74	0.40	3,95	1.18
1.694 11.0	58.15	5,65	5.36	5.08	45.59	-0.02	0.74	0.43	.3.95	1.26
1,847 12.0	58.92	5.64	5,34	5.07	46.10	-0.02	0,72	0.43	3.91	. 1.26
2.002 13.0	60.24	5,64	5.34	5.06	46.63	-0.02	0.72 ·	0.44	3.89	1.27
2.154 14.0	61.60	5.65	5.34	5:06	47:18	-0.02	0.72	0.45	3.87	1.28
2.309 15.0	62.78	5,65	5.32	5.06	47.73	-0.03	0,70	0.46	3.82	1.29

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#### Remarks:

Composite Sample, SC, remolded @ 98.0% of the maximum dry density

Confining Pressure Requested - 1.2 tsf (1.17 ksc)

Request #: 99-51 Lab #: 99-1420B

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TRIAXIAL COMP	
THE	TEST
DIAM. OF SPECIMEN 2.510" - 6.315 CM	DATE 2-20-01
LENGTH OF SPECIMEN 6.00 8" = 15:260 CM.	TESTED BY AN CHECKED BY
AREA OF SAMPLE 31.92 cm.	SPECIFIC GRAVITY 2.14
VOLUME OF SAMPLE 48710 cm 3	WET DENSITY 125.49 pet
WT: + TARE	DRY DENSITY 107.35 pct
TARE	WATER CONTENT 16.9%
WT. OF SAMPLE 979.6 9 1004.9	WATER CONTENT FOR SAT. 21.6%
MAX. SIZE 838.1	7 SAT. 78.210
141.5	VOID RATIO, . 0.593
σ <sub>s</sub> DIAL PIPETTE Δ YOL.	
DATE TIME Kg/cm2 READING c.c. c.c.	75-10
420 0 .100	AREA 50.19 VOLUME 478.23
20 .5 .045 3/12 35 .051	DRY DENSITY 109.36
	WATER CONTENT 19.9
	60 WT. CON T. FOR SAT. 20.6
10 .201	7 SAT. 96.6
AL= 107" = 172 cm. 15260 6.375	VOID RA TIO, 4 0,563
	1 VOL., % _1.8
15.332 6261	
	SAMPLE DESCRIPTION:
	VIS CLASS COLOR
CONTAINER NO.	VIS. CLASS COLOR
AT. COIST. T.B.LT SOIL ATT.1	
AT. CUNT. TORT SUIL	CEMENT FISS CALC MOTT ROOTS COLD
	CONSISTENCY Y, SOFT SOFT FI RM HARD ROCK
69C1	
10a	AEMADD'S
WATER CONTENT %	
CLASSIFICATION TESTS	FEATURE SITES BAM
	KOLE NO F.S. NO
TYPE OF SAMPLE Remolded	DEPTH
	IN the second second second second second second second second second second second second second second second
DWR 720 (REV. 5/66) REQUEST NO. 99-5	CHAMBER NO LAB. NO. 1420C1

# ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:	2/20/01	TIME:	9:00am			
SPECIMEN: New Length *:	14.945 (cm)	MEMBRANE and FILT Thickness (mem):	ER STRIPS: 0.024 (cm)	EQUIPMENT: Frame No.	87899	
New Diameter *: New Area, A <sub>o</sub> *;	<u>6.978</u> (cm)	E Modulus (mem):	14.0 (kg/cm2)	Load Cell #:	A96370	
B-Value: (* After consolidation)	<u>38.24</u> (cm <sup>2</sup> ) <u>96.0</u>	K <sub>fp</sub> (fs) P <sub>fp</sub> (fs) @: (@ Perimeter length of filters	0.196 (kg/cm) 10.0 (cm)	Initial <sub>σ3</sub> ' (ksc) Axial Strain Rate:	<u>5.30</u> 0.0041 (% / min	ı)

				Тор	Bottom				Effective		<u> </u>
Displacement	`Axial Strain	Axial Load	Chamber Pressure	Pore Pressure	Pore Pressure	Corrected Area	Membrane	Pore	Confining	Stress	Deviator
ΔH	8	P	O <sub>3T</sub>	Liessule U <sub>T</sub>	Ug	Area A <sub>o</sub> /(1-e)	Correction $\Delta(\sigma_1 - \sigma_3)$	Pressure Au	Stress σ <sub>3</sub> '	Ratio σ <sub>1</sub> '/σ <sub>3</sub> '	Stress $(\sigma_1 - \sigma_3)$
(cm)	· (%)	(kg-f)	(ksc)	(ksc)	(ksc)	(cm <sup>2</sup> )	(ksc)	(ksc)	(ksc)	01/03	(01 - 03) (ksc)
0:000	0.0	0.14	9:95	4.65	4.66	38.24	0.00	0.00	5.30	1.00	0.00
0.015	0.1	0.18	9.96	4:68	4.70	38.28	0.00	0.03	5.27	1.00	0:00
0.033	0.2	0.27	9.96	4,68	4,70	38.32	0.00	0.03	5.26	1.00	0.01
0.046	0,3	0.50	9.96	4.70	4.71	38.36	0.00	0.05	5.25	1.00	0.01
0.063	0.4	0.23	9.96	4.71	4.72	38.40	0.00	0.06	5.24	1.00	0.01
0:076	0.5	0.36	9.95	4.72	4,73	38.43	0.00	0.07	5.22	1.00	.0.01
0/089	0.6	1.50	9.95	4,75	4.75	38.47	0.00	0.10	5.20	1.01	0.04
0:104	0.7	3.13	9.96	4.77	4.78	38.51	0,00	0.12	5.18	1.02	0.08
0.119	0.8	3.76	9.95	4.79	4.79	38,55	0.00	0.14	5.16	1.02	0.10
0/135	0.9	5.17	9.95	4.81	4,82	38.59	0.00	0.16	5.14	1.03	0.13
0.150	1.0	5.99	9.95	4:82	4,82	38.63	0.00	0.17	5.13	1.03	0.15
0.300	2.0	103:51	9.95	6.03	:6.29	39.02	0.00	1.38	- 3.79	1.70	2.65
.0.450	3.0	.131.77	9,95	6.73	7.10	39.42	-0.01	2.08	3.03	2.10	3.34
0.597	4.0	142:97	9.94	7.09	7.49	39.83	-0.01	2.44	2.65	2.35	3.58
0.749	5.0	150:00	9.95	7.33	7.73	40.26	-0.01	2.68	2.42	2.54	3.72
0.899	6.0	al55.76	9.95	7:51	7.90	40.69	-0.01	2.86	2.25	2.70	3,82
1.049	7.0	160.34	9.96	7.64	8.01	41.12	-0.01	2.99	2.13	2.82	3.89
1.196	8.0	164.52	9.95	7.74	8,11	41.57	-0.01	3.09	2.02	2.95	3.94
1.346	9.0	167.78	9.94	7,83	8,19	42.02	-0.02	3.18	1.93	3.06	3.98
1.496	10.0	170.91	9.94	7.91	8.25	42.49	-0.02	3.26	1.86	3.15	4.00
1.654	11.1	173.59	9.95	7.97	831	43.00	-0.02	3.32	1.81	3.22	4.02
1.793	12.0	176.04	9.95	8.01	8.35	43.46	-0.02	3.36	1.77	3.28	4.03
1.943	13.0	178.31	9,96	8:04	8,35	43.96	-0.02	3.39	1.76	3.29	4.03
2.096	14.0	180.39	9.96	8.11	8.3.6	44.47	-0.03	3.46	1.72	3.34	4.03
2.243	15.0	181.85	9.94	8.16	8.37	44.99	-0.03	3,51	1.68	3.39	4.02
									•		
			an ta an an an an an an an an an an an an an	A LAND COMMAN	and the state of the						

#### Remarks:

Composite Sample, SC, remolded @ 98.0 % of the maximum dry density

Confining Pressure Requested - 5.6 tsf (5.47 ksc)

Request #: 99-51 99-1420C Lab #:

JJJ

DEPARTMENT OF WATER RESOURCES

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TRIAXIAL COMPR	RESSION TEST
TYPE	
A 740" - 1 777	
DIAM. OF SPECIMEN 2.509 = 6.373 CM.	DATE 2/21/01
LENGTR OF SPECIMER	TESTED BY AN CHECKED BY
AREA OF SAMPLE <u>31.90 cm<sup>2</sup></u>	WET DENSITY 125.69 PCT
	INT D ANT
WT. + TARE	WATER CONTENT 16.5%
TARE9818 0 9985	WATER CONTENT FOR SAT. 11.3%
WT. OF SAMPLE 181.00 TR.7	7 SAT. 77.5%
HAX. SIZE 672.0 138.8	VOID RATIO,
σ <sub>3</sub> DIAL PIPETTE Δ VOL.	LENGTH 14748 CM
DATE TIME Kg/cm <sup>2</sup> READING C.C. C.C.	- 29.715 cm <sup>2</sup>
0 .100	AREA
2/21 .5 .030 4/6 6.5 .042	DRY DENSITY 120.03 PCT
416 0.3 .040	WATER CONTENT 17.5 70
19.7 .310	WT. CO NT. FOR SAT. 15.5%
AL = 110" = 533 cm. 6.016 15.281 6.373	VOID RATIO, 0.424
AL=	A YOL-, 7 10.1 %
WATER CONTENT; BEFORE AFTER	SAMPLE DESCRIPTION:
WT. CONT. + DRY SOIL	CEMENT FISS CALC MOTT POOTS VOIDS DTHER
WT. OF WATER	V. SOFT SOFT FIRM HARD ROCK
RI. OF CONTAINER	
WT. DRY SOIL	REMARKS
WATER CONTENT %	
	- i
CLASSIFICATION TESTS	FEATURE Sites Bam
	HOLE NO F.S. N O
TYPE OF SAMPLE Remolded	DEPTH
	2
DWR 7 20 (REV. 3/06) REQUEST NO. 99-51	CHAMBER NO LAB. NO. 99-1429)

## ASTM 4767 : Consolidated-Undrained Triaxial Compression Test on Cohesive Soils

DATE:		5/10/01		TIME:		8:30am	••	•			
SPECIMEN: New Length New Diamet	.et ":	<u>14.748</u> 6.151	(cm) (cm)	Thicknes	NE and FILTi ss (mem): us (mem):	ER STRIPS 0.024 14.0	5: (čm) (kg/cm2)	EQUIPMEN Frame No Load Cell	<b>)</b> .	87900 A96356	
New Area, A	۱۵*:	29.72	(cm <sup>2</sup> )	K <sub>fp</sub> (fs)		0.196	(kg/cm)	Initial <sub>03</sub> '	(ksc)	13.31	
B-Value:		100.0		P <sub>fp</sub> (fs)	0:	10.0	(cm)	Axial Stra	in Rate:	0.0036	( in. / min )
. (* After consolida	ition)			(@ Perimet	er length of filter :	strips)					
		1		Тор	Bottom	· · · · · ·			Effective		r1
	Axial	Axial	Chamber	Pore	Pore	Corrected	Membrane	Pore	Confining	Stress	Deviator
Displacement	Strain	Load	Pressure	Pressure	Pressure	Area	Correction	Pressure	Stress	Ratio	Stress
ΔН	ε	P	σ <sub>st</sub>	ЦŢ	Ц <sub>В</sub>	A₀/(1-e)	$\Delta(\sigma_1 - \sigma_3)$	∆u	σ3'	σ <sub>1</sub> /σ <sub>3</sub> '	$(\sigma_1 - \sigma_3)$
(cm)	(%)	(kg-f)	(ksc)	(ksc)	(ksc)	(cm <sup>2</sup> )	(ksc)	(ksc)	(ksc)		(ksc)
0.000	0.0	0.00	. 19:33	6.00	-6:05	29.72	0.00	0.00	13.31	1.00	0.00
0.018	0,1	-0.64	19.27	5:99	6.03	· 29.76	0.00	-0.01	13.26	1.00	+0.02
0:030	0.2	-1.04	19,21	5.96	5,99	29.78	0.00	-0.04	13.24	1.00	-0.04
0.046	0.3	-0.82	19.14	5:93	5.96	29.81	0.00	-0,07	13.20	. 1.00	-0.03
0.061	0.4	-0.95	19.05	5.88	5.90	29.84	0.00	-0.12	13.16	1.00	-0.03
0:074	0.5	-0.73	18,98	5.84	5.86	29.87	0.00	-0.16	13.12	1.00	-0.03
0.091	0.6	1.59	18:87	5,80	5.82	29.90	0.00	-0.20	13.06	1.00	0.05
0.104	0.7	2,27	18.77	5.76	5.76	29.93	0.00	-0.24	13.01	1.01	Ó.07
0.419	0.8	2.95	18:68	5.72	5,70	29.96	0.00	-0.28	i2.97	1.01	0.10
0.135	0.9	3.22	18:65	5,69		29.99	0.00	-0.31	12.97	1.01	0.11
0.147	1.0	3.04	18.58	5.66	5.61	30.02	0.00	-0.34	12.94	1.01	0.10
0.307	2.1	188.01	. 19.65	7.64	9.78	30,35	0:00	1,64	10.94	1.57	6.19
.0 442	3.0	220.22	19:52	8:45	11.05	30.64 .	-0.01	2.45	9.78	1.73	7.18
0.589	4.0	234.78	18.86	8:66	11/23	30.96	-0.01	2.66	8.91	1.85	7.58
0.742	5.0	247,80	19.78	9,71	12.61	31.29	-0.01	3.71	8.62	1.92	7.91
0.884	6.0	256.73	19.67	10.19	13.03	31.62	-0.01	4.19	8.06	2.01	8.11
1.034	7.0	263,13	19.61	10.60	13.31	31.96	-0.01	4.60	7.65	2.07	8.22
1,181	8.0	266,53	18.79	10.53	12,94	32.31	-0.02	4.53	7.05	2.17	8.23
1.328	9.0	272.75	19.78	11.31	13.79	32.66	-0.02	5.31	7,22	2,15	8.33
1.476	10.0	279.87	19.67	11.60	13:84	33.02	-0.02	5.60	6.95	2.22	8.45
1:623	11.0	284.27	19:61	11.79	13.81	33.40	-0.02	5.79	6.81	2.25	8.49
1 770	12.0	292.02	19.76	12.18	13.85	33.77	-0.02	6.18	6.74	2,28	8.62
1.918	13.0	296:88	18.84	12.04	13.09	34.16	-0.03	6.04	6.27	2.38	8,66
2.068	14.0	-301.14	19,79	12:53	13.28	34.57	-0.03	6.53	6.89	2.26	8.68
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Remarks: Composite San

Composite Sample, SC, remolded @ 98:0 % of the maximum dry density

Confining Pressure Requested - 14.0 tsf (13.67 ksc)

(had difficulty seating the piston - maybe due to the high chamber pressure pushing on the piston)

(Air compressor was unstable, chamber pressure fluctuated)

Request #: 99-51 Lab #: 99-1420D

# APPENDIX F

# VENADO SANDSTONE QUALITY TEST RESULTS FOR DWR SAMPLES

3-Inch Cube Samples from Sites Quarry

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

SANDSTONE TEST SUMMARY

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

PROJECT: Sites and Golden Gate Dans

FEATURE Sandstone Quality for Rip-Rap and RCC Aggregate

	ent CLASSIFICATION	, apas																	~	~									Street 1 of 2	IM - INSUFFICIENT MATERIAL
3-inch CUBE SAMPLES	fic percent					8 2.6	8 2.8	0 2.5	0 2.5	_	*	*	*	0 2.4	0 2.5	*	3	5 2.8	5 2.8	5 2.8		5 2.9	2 2.5		) 2.7	3 2.3	9 2.5	9 2.4		uneven.
h CUBE	8 specific	<u> 2000</u>	(pss)		2.50	2.48	2.48	2.50	2.50	2.49	*	*	*	2.50	2.50	*	2.46	2.45	2.45	2.45	2.45	2.45	2.52	2.51	2.50	2.48	2.49	2.49		ed and
3-jije	compressive	strength	(Isd)		11130	0966	10830	11840	11690	12370	¥	*	*	11830	11630	* *	10160	10200	10820	9940	9910	10990	11220	10320	10740	12690	12130	12060		REMARKS. * Unable to obtain cube sample. One side of slab is fractured and uneven.
			20						-												-									e of sla
			<u>19</u>	-+		•/													 											One sid
		SAND	35																											ample. (
		5	8		_					 									 											cube so
VER	of YSIS		9		_								 					 					 							obtain
PERCENT FINER	MECHANICAL ANALYSIS		8							 			<u> </u>																	able to
PERC	CHANE		*										 																	* Un
	Z	VEL	" <sup>8</sup> / <sub>6</sub> ","/ <sub>6</sub>									 																		EMARKS
		GRAVE	1 <sup>1</sup> / <sub>2</sub> <sup>3</sup> /																		-								•	æ
			 %				<del></del>																							866
		E.S.	2		4	m	 ບ	A	В	c	A	В	с U	A	B	U U	A	B	с С	A	В	<u></u>	A	B	ບ	A	B	<u>ט</u>		5/25/1998
		HOLE	ý	1 000	1-7722	•	¥	SSQ-2	æ	Ŧ	SSQ-3	29	*	SSQ-4	3	I	SSQ-5	3	×	SSQ-6	z	=	SSQ-7	#	-	SSQ-8	2	-		
		LAB	ý		<u>4</u>		-	98-175	I .	Ξ.	98-176	*	я	98-177	z	#	98-178	2	Ŧ	641-86	32	¥	98-180	3		8-181	æ	*		DATE

\* Unable to obtain cube sample. One side of slab is fracture \*\* can only secure two cube specimens from slab.

NP - NON-PLASTIC NG - NO GOOD

DATE 5/25/1998 INITAL: RGJ REQUEST NO: 98-18 SANDSTONE TEST SUMMARY

DEPARTMENT OF WALER RESOURCES THE RESOURCES AGENCY STATE OF CALIFORNIA.

Sites and Golden Gate Dams

**PROJECT:** 

FEATURE Sandstone Quality for Rip-Rap and RCC Aggregate

CANALS AND LEVEES SECTION

DIVISION OF ENGINEERING **CIVIL ENGINEERING** 

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XSIS		16						
LANAL		8						
TANICA		4						
MECI		3/ <sub>6</sub> "						
	SRAVEI	-''le						
		a,						
	E.S.	Ŷ		A	с,	υ	A	
	HOLE	NO.		SSQ-9	z	7	SSQ-10	
	<b>IAB</b>	Ň		98-182		Ŧ	98-183	,
	MECHANICAL ANALYSIS	HOLE E.S. GRAVEL	HOLE F.S. MECHANICAL ANALYSIS HOLE 71/2 7/2 7/2 7/2 7/2 7/2 7/2 7/2 7/2 7/2 7	HOLE E.S. MECHANICAL ANALYSIS HOLE NO. NO. 3" 1 <sup>1</sup> 1" 3 <sup>1</sup> " 4 8 16 3	HOLE E.S. MECHANICAL ANALYSIS HOLE E.S. GRAVEL NO NO 3" 1 <sup>1</sup> 1" <sup>3</sup> 1" <sup>4</sup> 8 16 3 2 SSQ-9 Å	MECHANICAL ANALYSIS           E.S.         CRANEL           NO         3"         1 <sup>1</sup> l <sub>2</sub> " <sup>3</sup> l <sub>4</sub> "         4         8         16         3           A         1 <sup>3</sup> l <sub>4</sub> " <sup>3</sup> l <sub>4</sub> "         4         8         16         3           B         1 <sup>1</sup> l <sub>4</sub> " <sup>3</sup> l <sub>4</sub> " <sup>3</sup> l <sub>4</sub> "         4         8         16         3	MECHANICAL ANALYSIS           MECHANICAL ANALYSIS           E.S.         GRAVEL           NO.         3"         11/2"         3"         16         3           NO.         3"         11/2"         3"         4         8         16         3           A         A         1         1"         3"         4         8         16         3           B         C </td <td>MECHANICAL ANALYSIS           E.S.         GRANEL           NO.         3"         1<sup>1</sup>/<sub>2</sub>"         3<sub>1</sub>"         4         8         16         3           NO.         3"         1<sup>1</sup>/<sub>2</sub>"         3<sub>1</sub>"         4         8         16         3           A         B         1</td>	MECHANICAL ANALYSIS           E.S.         GRANEL           NO.         3"         1 <sup>1</sup> / <sub>2</sub> "         3 <sub>1</sub> "         4         8         16         3           NO.         3"         1 <sup>1</sup> / <sub>2</sub> "         3 <sub>1</sub> "         4         8         16         3           A         B         1

CLASSIFICATION GROUP NAME SYMBOL GROUP ubsorption percent 2.6 2.8 2.62.8 2.7 2.7 \* 3-inch CUBE SAMPLES Specific Gravity and Absorption tests before performing Coarse Durability Index specific 2.49 gravity 2.49 2.48 2.45 2.462.46(pss) 1. ASTM C-131 Los Angeles Rattler Test (Grading A =  $1^{4}/_{2} \times 3/8$  size fraction): compressive strength 11250 11040 11360 11240 10970 11490 RESULTS OF QUALITY TESTS ON CRUSHED SANDSTONE (Isd Specific Gravity and Absorption tests before performing LART 200 8 2. ASTM C-Durabilitly Index (3/4 x #4 size fration) 8 SAND 100 revolutions = 11.4 percent loss500 revolutions = 43.4 percent loss Absorption = 4.2 percent Absorption = 4.1 percent Durability Index, Dc = 42 Spec. Grav. = 2.48Spec. Grav. = 2.50---ш υ x ± z

REMARKS: In determining the absorption, the strength samples (cubes) were oven dried at 160 °F. The crushed samples were oven dried at 230 °F. All samples

were soaked for 24 hours.

98-18 RG 5/25/1998 REQUEST NO.: INITIAL DATE

IM - INSUFFICIENT MATERIAL

Sheet 2 of 2

NP - NON-PLASTIC

NG - NO GOOD

Hole number		SSQ-1			SSQ-2			SSQ-3			SSQ-4			SSQ-5	
laboratory number		98-174			98-175			98-176			98-177			98-178	
	V	а	ပ	¥	6	0	A	8	D.	×	8	د	Y	в	ပ
Wt. Saturated surface dry sample	1201	1206	1157	833	818	832				- 1111	1108		1115	1101	1108
Wt. Oven Dry sample	1170	1175	1126	813	798	811				1085	1081		1082	1071	1078
Wt. water absorbed	31	31	31	20	20	21	0	0 0	0	26	27	0	33	30	30
% water absorbed	2.6	2.6	2.8	2.5	2.5	2.6	#DIV/0f	10//NIC#	#DIV/0	2.4	2.5	#DIV/0	3.0	2.8	2.8
Wt. S.S.D. sample suspended in water	720	719	691	500	491	498				999	664		662	652	656
Wt. Water Displaced by S.S.D. sample	481	487	466	333	327	334	0	0	0	445	444	0	453	449	452
Wt. Water Displaced by Solid sample	450	456	435	313	307	313	0	0	0	419	417	0	420	419	422
Bulk Specific Gravity (Dry Basis)	2.43	2.41	2.42	2.44	2.44	2.43	#DIV/0	#DIV/0	i0//IC#	2.44	2.43	#DIV/0	2.39	2.39	2.38
Bulk Specific Gravity (S.S.D. Basis)	2.50	2.48	2.48	2.50	2.50	2.49	#DIV/0	#DIV/0	j0//IC#	2.50	2.50	#DIV/IO	2.46	2.45	2.45
Apparent Specific Gravity	2.60	2.58	2.59	2.60	2.60	2.59	10//\IC#	#DIV/0	i0//IC#	2.59	2.59	#DIV/IO	2.58	2.56	2.55
Total load to failure (pounds)	107000	96000	101000	88000	86500	92500				107500	105000		93000	93000	00066
Calc. area of bearing surface (in2)	9.61	9.64	9.33	7.43	74	7.48				<del>60</del> .6	9.03		9.15	9.12	9.15
Comp. strength (psi	11134	9959	10825	11844	11689	12366	#DIV/0	#DIV/0	#DIV/0	11826	11628	#DIVIO	10164	10197	10820
identification number		SSQ-6			SSQ-7			SSQ-8			SSQ-9			SSQ-10	
laboratory number		98-179			98-180			98-181			98-182			98-184	
	A	B	c	A	В	c	A	8	ပ	A	B	ပ	۲	B	с
Wt. Saturated surface dry sample	1114	1115	1128	1085	1070	1079	1115	1126	1131	963	976	977	1094	1103	1102
Wt. Oven Dry sample	1084	1084	1096	1059	1046	1054	1090	1098	1105	941	953	955	1065	1074	1073
Wt. water absorbed	30	31	32	26	24	33	25	28	26	23	23	ส	প্ন	53	30
% water absorbed	2.8	2.9	29	2.5	2.3	2.4	2.3	2.6	2.4	2.3	2.4	2.3	2.7	2.7	2.7
Wt. S.S.D. sample suspended in water	660	660	668	654	643	648	666	671	676	577	584	583	648	655	654
Wt. Water Displaced by S.S.D. sample	454	455	460	431	427	431	449	455	455	386	392	394	446	448	448
Wt. Water Displaced by Solid sample	424	424	428	405	403	406	424	427	429	364	369	372	417	419	419
Bulk Specific Gravity (Dry Basis)	2.39	2.38	2.38	2.46	2.45	2.45	2.43	2.41	2.43	2.44	2.43	2.42	2.39	2.40	2.40
Bulk Specific Gravity (S.S.D. Basis)	2.45	2.45	2.45	2.52	2.51	2.50	2.48	2.47	2.49	2.49	2.49	2.48	2.45	2.46	2.46
Apparent Specific Gravity	2.56	2.56	2.56	2.61	2.60	2.60	2.57	2.57	2.58	2.50	2.58	2.57	2.55	2.56	2.56
Total load to failure (pounds)	91000	91000	101500	102000	93500	97000	11500	111000	111500	93000	92500	94500	102500	101000	105500
Catc. area of bearing surface (in2)	9.15	9.18	9.24	60'6	90.6	9.03	90.6	9.15	9.24	8.27	8.38	8.32	9.12	9.21	9.18
Comp. strength (psi	9945	9913	10985	11221	10320	10742	1269	12131	12067	11245	11038	11358	11239	10966	11492

Sites and Golden Gate Damsites Project:

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 Feature:
 Sandstone quality for aggregate (Rip-rap and RCC use)

 Request No:
 <u>98-18</u>
 Feature:

	L	Wt in Air (GGD) (games)	WH. Under Water (groms)	WH Water displaced by 55.5 Sample	Gpg GSO	Oven duy wt. © 100°C 24H	2. 3 
5Q-1	Ą	1201	7/190	481	2,50	1170	
	B	12000	719	487	2.48	1175	
	C	1157	691	466	2,48	1120	 
5Q-Z	Д	833	50D			813	
	B	818	491			298	
	С	832	498	} ↓ ↓		811	 
3Q-4	A	1111	666			1085	
- 	В	1108	664	·	-	1081	
5Q-5	A	1115	662			1082	
·	В	1101	653			1071	
	C	1108	456			1078	 
5R-4		1114-	440		!	1084	
	B	1115	660			1084	
	C	1128	468			1096	un an
,5Q-7	A	1085	654			1059	
	В	1070	6473	2	:	1046	
	C	1079	448			1054	 ······
5Q-B		1115	646			1090	
	B	1126	671		I	1098	
	C	1131	676			1105	
5R-9		963	577			941	
· ·	B	976	584		¢ }	953	
	C	977	583			965	 
15Q-10	A	109.4	448			1065	
- \ -	B		466			1074	,
		1102	654	are and an area of the		1073	

								Can't maran					4 <sup>15</sup>
							V	air dry over )					
						1		fter sour-cutting Friday	\$ TUDIOR	KAB QU	rensions	U.W	× (ر
1		H	,	width		Depth	1	(Jbs)	H (tw	w W	D	pef	spor
1	-	3.074	3:089			3,075 30		-				,	
45Q-1	A	3.086	3,095	344	3,121	3.074 3.0		2,580	3.09	3.13	3.07	150,2	2,41
		3,104			3069 3078	3127 31 3159 31	23	2,590	3.10	3:07	3:14	149.8	2.40
		3.084	3081	3118	3/22	2955 3.	000	2 .478	3:08	3113	2198	149.1	2.39
	مإدر ومعاود والم	3087 2743	3071	2719	2721	2946 3.0	140			271	7.7/L		2.43
55Q-2	, l	2744	2736 2732	2712		2738 27	7300 135	1786	2.74		;	151.7	
1	3	nn	2728	2705	2708	272027	729	1754	2.72	2.71	2.73	150.6	12.41
			V755 V749	2750 2753	27125	2730 27	132	1.782	2,75	2.74	2.73	149.7	2.40
55Q-4		3007	3023	3001	2997 3003	3015 30 3000 Z	213 994	78 23 <b>55</b>	3.02	3,00	3.01	150.7	2.42
·		3017	3021	3001 30(1	3009		214	Z.388		2.61	3.02		
·	A	3023	3013	3008		وروا المراجع والمراجع	000	2,508	3.02	<b>7.</b> 01	5.06	15013	2.41
95Q-5	À	3055	3042	3032	3034	3023 3	012	2384	3.04	3.03	3,02	148.1	2137
	B	3020	3039 3032	3014	3010 3020		013	2,358	3.03	3.02	3,02	147.4	2:36
	0	3037	3038 3041	302 <b>8</b>	3023 3014	3019 30	032	2376	3.04	3.02	5.03	147.6	2:37.
\$		3046	3043		2998	305630		4			± ار مرا	  .	
. 55Q-4	Д	3063	3050	3030 3012	3020	3033 30	<b>30</b> 045,	2.340	3.05	3,01	3.04	148,0	ر <u>ک</u> ، ک
	B	3046	3094 3064	3014	301Z 3005	3023 30	058	2.390	3.00	3.01	3,05	147,0	2.36
	C	3068 3064	3045 3059	3076	3064 3038	3017 30		2.410	3.06	3.06	3,02	147,6	2.37
		2924	2924	3031	3032	2995 20	998	••••••••••••••••••••••••••••••••••••••	100	3.03	3.00	151,2	2,42
.45 Q-7		2930 2892	2927 2913	3028		3023 30		2,330	2.93		}		
		2904	29160 2924		2993	3032 3		2,302	2.91	2.99	3.03	150.9	2.42
	$\mathcal{O}$	2920 2925	2924 2928	2991	2989	30223 30173	2025	2:318	2,92	Z.99	3.02	151.9	2.44
44 Q- B	Δ	3052 3048	3054 3049		3 <i>2980</i> 3021	3003 3 3020 3		2.402	3.05	3.00	3,02	150.Z	z.41
14	-	3040	3047	3026	, 3018	3 3039 3	039	'	i,			150.5	2.41
	B	3043	3043 3050	30Z/ 3030	3029 3029	3043 3	032	2.422	3.04	3,02	L		
	C		3048	3028	3025	5 3038 3	029	2.430	3.05	3,03	3.04	149.8	2.40
660 8	٨	2864		2894	- Z898 Z891	" 2870 Z	857	2.046	2.86	2.89	2.86	151.0	2.42
.55Q-9	Д 2	2859 2872		289/ 2894						1		1	
	B	2875	2864	2903				2094	: 2,87	2,90	4.89	150.6	2.41
	Ċ	2900 2829	28 88 2875		2899	0 2905 2 2898 2	••	2,098	2.89	2.87	2,90	150.7	2.42
aco in	•	3007	3004	3028	3025	3015 3	019	2.344	3.00	3,07	3,02	148.2	777
95Q 10	A	3005				. 3018 31 5 3123 31		- <del> +</del>			ļ	4	2.37
	В	3003	3002	303z	- 303	5 3025 7	3023	2,348	3,00	3.04	3.03	148.0	2.37
<sup>1</sup>	V	2994	2994	304Z	- 3030 3nz.c	3032 2	3028 SM27	2.364	3.00	3.03	3.03	. 148.4	2,38

### Crushed Sandstone from Drill Cores

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 Project:
 Sites and Golden Gate Damsites

 Feature:
 Sandstone quality for aggregate (Rip-rap and RCC use)

 Request No:
 99-18

Hole number	1.5 c 3/8 fraction graded for	3/4 x #4
laboratory number	LA. Rattler	Coarse I
	<	
Wt. Saturated surface dry sample.	5249	
Wt. Oven Dry sample	5037	
Wft. wafer absorbed	212	
% water absorbed	4.2	
Wt. S.S.D. sample suspended in water	3136	
Wt. Water Displaced by S.S.D. sample	2113	
Wt. Water Displaced by Solid sample	1901	
Bulk Specific Gravity (Dry Basis)	238	
Bulk Specific Gravity (S.S.D. Basis)	2.48	
Apparent Specific Gravity	2.65	

LA. Rattler Test Results ASTM C-131 grading A

<u> </u>				h
Percent	of Wear	11.4	43.4	
Loss	(grams)	569	2176	
Final WT.	(grams)	4440	2833	
Original Wt.	(grams)	5009	5003	
No. of	Revolutions	<del>1</del> 00	200	

<b></b>			29	55	101	4.1	8	24	923	<del>Q</del>	2.50	2.66
led for	еX	A	2556	2455	1	v	1532	1024	හ	2.40	5	รั
3/4 x #4 fraction graded for	<b>Coarse Durability Index</b>											
#4 fract	e Dural											
3/4 X 3	Coars											

#### TEST FOR "ABRASION OF COARSE AGGREGATE" ASTMC-131-76 -535-76

PROJECT					LABORATOR	Y NO				
FEATURE Sand stor	<u>e for</u>	Rip Rap.	YRCC	······································	FIELD SAMPI	LENO.	desendantd			
SOURCE OF MATERIAL										
SIZE FRACTION TESTED	1/2 ×	1/2 69	tovers from	Saudst	one slabs	were	. crushed	1 _ (+rni	nings	from
WORK ORDER ND.	cutting	cubes f	or Comp, S	itr.	compressive	ctr.	specimens	were	also	conshed
VISUAL DESCRIPTION	dy cris	ive			, 		1			·····

TABLE 1 - GRADING OF TEST SAMPLES

\$1 E \	ESIZE		Waight	& Grad	ing of T	est Samp	les - g	
PASSING	RETAINED	A	В	с	D	I	II	III
3 111.	25 IN.	<u> </u>				2500*		
214 IN.	2 IN.					2500*		
2 JN.	16 IN.					5000*	5000+	
115 IN.	1 IN. ±29	1250					5000+	5000*
או 1.	14 IN. ±25/	1250						5000*
<u>4 IN,</u>	13 IN. 210	1250	2500					
15 IN.	3 18 IN. 10	1250	2500			1		
3 8 114,	NO. 3			2500				
110.3	NO. 4			2500				
HO. 4	NO. B				5000			

4A	BRASIVE CHA	RGE
Grading	No. of Spheres	Weight of Chorge - a
$\mathbf{A}$	12	5000± 25
8	11	4584 25
с	8	3330 - 20
D	6	2500-1-15
E	12	5000 ± 25
F	12	5000 ± 25
Ġ	. 12	5000 ± 25

\* Tolerance of 25 permitted

5000±10

1	· T	EST RESULTS		
NO. OF REV.	ORIGINAL WT-g	₽INAL ₩T.g	LOSS OF WT. o	PERCENT OF WEAR
100	5009	4440	569	11.4
500	5009	2833	2176	43,4

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.

1/2-1 1252 1-3/4 1257 3/4-1/2 1249 1/2-3/8 125 5000

TESTED BY <u>Roland</u> DATE TESTED <u>5/20/98</u> COMPUTED BY \_\_\_\_\_ CHECKED BY \_\_\_\_\_

¥.

W.S

#### SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

TEST METHOD: ASTM C 127-

State of California THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES TECHNICAL SERVICES OFFICE CONCRETE LABORATORY

Proje	96†		·	Laboratory No	501	Req.	98-	18
Feat	ure							
Hole	No Elev. Top of Hole							
Visu	al Description							
			٠	· · ·				
DE	TERMINATION NO.							
DA	TE TESTED							
TE	STED BY							
сq	MPUTED BY		LART	COARSE DC				
СН	ECKED BY		Epecine					
SIZ	ZE FRACTION	- -	1/hx 3/9	7/4 × 4				
PR	OCESSING		•					
A	WT. SATURATED SURFACE DRY SAMPLE		5249	25520				
В	WT. OVEN DRY SAMPLE		5037	2455.				
С	WT. WATER ABSORBED	A <sub>→</sub> B	212	101				
D	% WATER ABSORBED	<sup>2</sup> /B ¥ × 100	4.2	. 4,1			-	
E	WT. S.S.D. SAMPLE SUSPENDED IN WATER		3136	1532				
F	WT. WATER DISPLACED BY S.S.D. SAMPLE	A-E	2113	# 10	24			
Ģ	WT. WATER DISPLACED BY SOLID SAMPLE	F-C	1901	923				
н	BULK SPECIFIC GRAVITY (DRY BASIS)	B	2:38	2.40				
1	BULK SPECIFIC GRAVITY (S.S.D. BASIS)	Å.	2:48	2,50			-	
J	APPARENT SPECIFIC GRAVITY	<u>B</u> G	2,65	2.66				

REMARKS:

.

			C DI 43	#2
1/2 × 3/4	3/4 × 3/2	Dur Index	RO	
· 2624-65d	2625	2550	10 min = 2.7	
1567 in water	1569	1532	20 min	abmin
2520 od	2517	2455	5.11.=5.5'' D=40	5.H.= 5.4" D= 42
1057	1056	1024		
2.48 ssd	2,49	2,50		
104				
4.1 %	4.3%	4.1%		

O Potrographic provide info indicate -

h. A Rattler 5005 - I blew it. 100 REV DID NOT PROPERTY GET - TIMER DIVEY <u>3193</u> did not get to 100 to NEED TO REDO 1812

.

$$\frac{1}{2}$$
 - 1  $\frac{72}{1252}$   
 $1 - \frac{3}{4}$  1258  $\frac{1009}{1258}$   
 $\frac{3}{4} - \frac{1}{2}$  1249  $\frac{4440}{4440} = 100 \text{ ReV} = 11.4\%$   
 $\frac{12}{2} - \frac{3}{8}$   $\frac{1251}{2833} = 500 \text{ Rev} = 43.4\%$ 

11/2-Inch Minus Crushed Sandstone from Sites Quarry

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SANDS

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

SANDSTONE TEST SUMMARY

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

PROJECT: Sites and Golden Gate Dams

FEATURE: Venado Sandstone Quality for Rip-Rap and RCC Aggregate

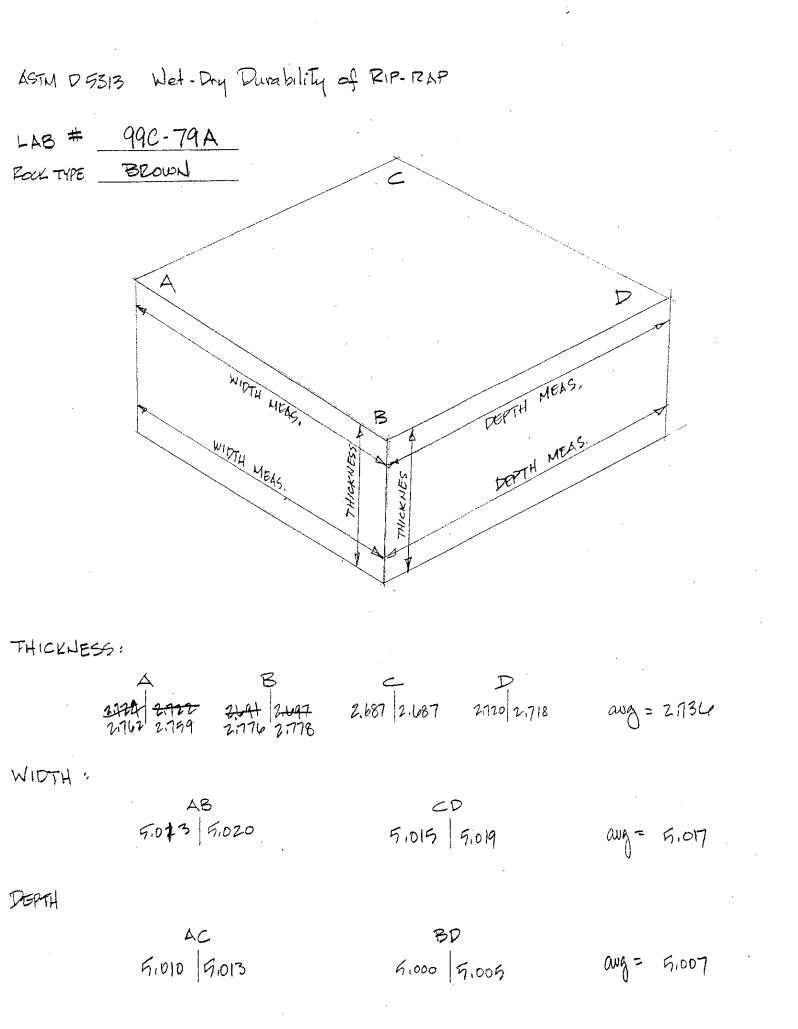
						PERCE	PERCENT FINER.	ff					VSTM:	ASTM C-40	>40			STM C-1	ASTM C-127 & 128			MISY	ASTM C-131	¥	STM C-14	
					NEC.	HANNOV	MECHANICAL ANALYSIS	YSIS				na Ann Ann Ing Ing Th	C-29	M	washed	3/4" × 3/8"	3/8/	3/8": X #4	¢#4	#4 X #200	#200	001	002	3/4× 3/8	3/4× 3/8 3/8× #4. #4×#8	#4x#8
LAB. HOLE	Es			GRAVEL					SAND	Q		Ċ,	H.U.W.	as.	tines	5b3	% abs.	spg	»	bds	%	Ţēč	tev	% C	% clay lumps and	and
NO.	NON	°.	11/2	3/4"	3/8"	4	8	16	30	50	100 2	200	(bċti)	réčď	removed.	(ssd)	scie	(ssd)	aps	(ssd)	abs	· % loss:	÷.		friable particles.	es.
99C-113	A		100	96	32	12	6	∞	7	9	4		88.3 0	clear (		2.48	4.9	2.48	6.3	2.57	2.40	11.4	50.8	1.0	2.1	6.5
-	B		100	95	57	35	28	23	20	18	11			clear	clear	2.49	5.0	2.48	6.3	2.58	2.30	7.3	36.9	0.2	0.1	1.7
-	ပ —	<u></u>	100	67	65	4	36	30	27	77	16	6		clear		2.48	5.4	2.48	6.2	2.58	2.50	11.5	49.5	0.2	0.1	1.3
99C-114	A		100	97	51	22	17	14	12	11	- 2		86.2	2	clear	2.45	6.2	2.47	6.6	2.56	2.70	13.7	56.0	1.7	3.3	8.6
=	B		100	97	55	27	19	15	13	11	7		86.4		clear	2.46	6.0	2.47	6.6	2.57	2.70	9.2	43.5	0.2	0.4	ю
	c		100	95	47	22	16	13	12	10	6	ε	87.5	ب س	clear	2.46	6.0	2.46	6.6	2.57	2.70	12.5	54.5	0.4	6.0	3.7
	**************************************		in de la constante																							
				100	PERC	ENT C	OARS	100 PERCENT COARSE AGGREGATE	<b>BREGA</b>	ΞE		-														
		÷	1/2	6	3/#	ম	8	\$	90 90	50	100	200							untant Marakakov							
99C-113	A		100	95	22	0																				
=	B		100	92	34	0																				
-	C		100	95	38	0																				
99C-114	¥		100	96	37	0																				
Ŧ	B		100	96	39	0			1									fut fut								
	ں ا		100	93	33	0																				
				1	DO PER	CENT	FINE	100 PERCENT FINE AGGREGATE	EGAT	El																
		3,	11/2	3j."	3/.n	4	8	16	30:	50	100	200														
99C-113	A					100	73	61	56	50		18														
-	B					100	78	65	58	51	32	16														
-	ပ 					100	81	68	61	54		21														
99C-114	V					100	76	62	54	47		16								,						ļ
=	B					100	68	55	47	40		16														
F	U					100	74	60	53	45	29	16														
														÷												
																									Shee	Sheet 1 of 1
DATE:	(9	6/12/1999	66	REI	WARKS:	99c-11	13 = fre	REMARKS: 99c-113 = fresh crushed sandstone	ed sands	tone.														NSNI - WI	IM - INSUFFICIENT MATERIAL	<b>ATERIAL</b>
INITIAL:		×	RGJ			<u>99c-11</u>	l4 = we	athered (	marked	99c-114 = weathered crushed sandstone.	e.													NDN - AN	NP - NON-PLASTIC	
REQUEST NO.:		99-19	<u>19</u>																					NG - NO GOOD	000	

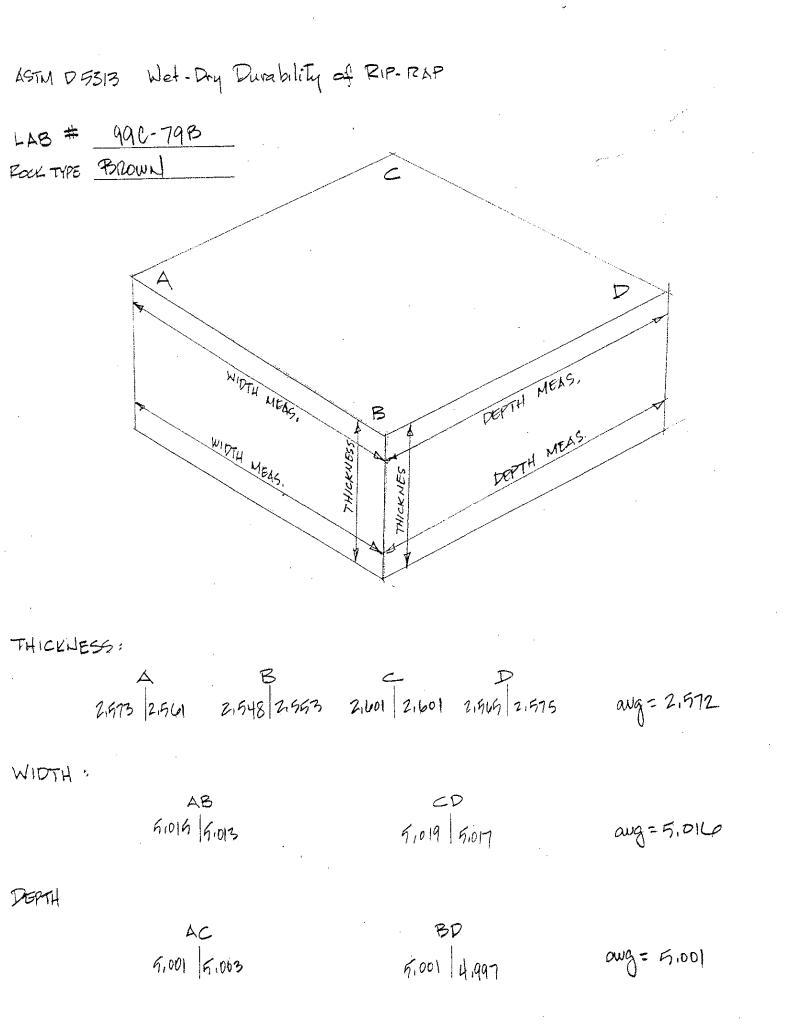
-	#+ - # - #	ک وہ ا	117	M	9	ő	ć	· .	- <b>1</b>												
2-142			<u> </u>	0-1	2 19 80	014 3	0.9 3.														
2	3/1 x 3/2 3/2 v 4 1		2.0	012	L.	0,7	01+0		-	,	_							-			
	······································	23	502			,	**		<u> </u>			F.M.	2.1.9	2 In	0012	123	2163	62:2	;		
12-21-151	Cas OA	11.4 50.B	02: 67% 82	11. 6 49.5 123	(3.7 54.0 .24	95 43.5 , 21	12.5 94.5 .23		1			A THE	<u>00</u>	9.7	 J	116	4	011		i	
- G21	sher geals	24	2:3	2		=	12			n 19 in 19 a grademaar	- 	#10 # 100 #	16 lit	10 C	2	T I	12	10 13			
	it San	42 141 2H	CIEVE EVENE 2,44 6,0 2,48 4.3 2.48 2.3	41 842 Zig	CUAR 2.45 6.22 2.47 6.60 2.66 2.17	ation 2.46 Lip 2.47 4.6 2.57 2.7	240 6.6 7.47 2.7				% EACH	#20 450	e a		••• •• ••	6 7	6 6 5	<b>a</b>	· ·		
121-J4254	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		8ti2 0	8472 1	547	C4.2	2.46	PtC)	60 F	9		Ŧ		<u>u</u> u		する	E E		-		
n15y	586 96abs 3/4 × 3/8	2.48 H	2,49 5.	248 5.1	2,45 6.	2 ylo fre	cuar Zitle C.D		00 × 20	68.46	,	4 48	LZ Ø	0 22 0		0 5	0 22		06.2	8112 112	
	Dahsym Vs kec <sup>1</sup> D	cutter crear 2,48 4,9	CNEAR CLEAR	CLEAR CUBAR 2495 5.44 2.48	2 cuar	1	5 CUAR	DR	-		1	-		·	F I I I I	-					
	00 3/4 3/8 # # # # # 10 # 30 # 400 # 100 # 201	87042	<u>ا</u> =		+ + -	4	03	11/2 3/4 3/2 #11	0 258 34	0 5 57 38	4	# 20 # 0 # 02 Teo		22 10				1/2 3/4 3/8 #11	4 59 37		
	r04 €00	5	<u>8</u>	100 41 45 44 30 30 27 24 10 9	2 11	2 11	at al. al. a.	11/2 2	2 90 2	5	"10 1/4991 NG	\$ \$ \$ \$	100 73 61 54 50 32	100 78 69 58 51 32 16	· · · · · · · · · · · · · · · · · · ·	- <del>-</del> -	ある日	r 3/4 7			
	#10 #	8	100 45 67 35 28 23 20 13	30 2	T T	<u>v</u>	し で 二 二	= .'		, U	N/ ala			C 70 2 2			14 40 m 11 00	*	9	0	
	井山 林9	17	55 28	14 30	11 2	5	1	₹ c	0	Q		# t # 8 #	60 12 00 12	12 00		2 2 2	01 12 00	÷		6	
	3/4 +	6 71 72 76 0al	15	C5 4	2	56 7	2/2	116.01	34	1 38	4							3/8 4	96 37 0	43 (	
	1/2 2/1	nb aal	100 45	600	100 97 51 72 11 11 11 12 15 16 001	1 L 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	al 001	10 06 77 0	0 15 76 001	00						•		1/1 3/2 1/6 2/1	0 66 910 001	100 93 33 0	
		<sup>3</sup> A		اد		III C.	>	1PA		ు		SAND GNUY	112.02	1130		114 B	ILA C		44C-114A B	C	
		MC-113A	- 1120		AC-114A		l Čš	000-112	<u>&gt;</u>		ţ	SAND 2006.		o Shi					da C.		

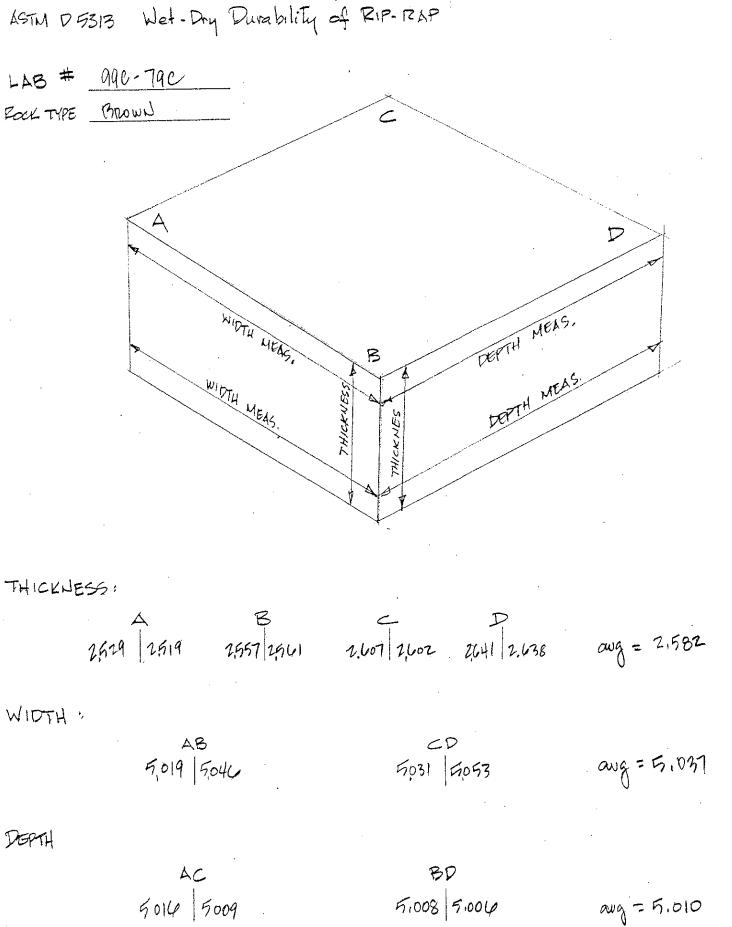
	QQ,	C-113					990-114		
	A	B	Ċ,			A	15 IT	C	
3/4×1/2	2603	2502	2501	2502		2507	2502	2500	
total wt	500)	5003	500Z			5003	5006		
ter 100 rev	4433	4036	4644			317	4545		
her Floo rev	2460	3174	2789*	f		202	2831	1	
.095 100 rw	11.4	1,3	7.2	11.5		13.7	9.2	12.5	
1055 GOO TEU	50.8	367		49.5	1	56.0	43,55	54.5	
0/15,00 logs nation	,23	.20		.23		.25	.21	,23	
		12EV = toto				- *			
C-29 Roddin	Unit. W 9 Proces	$H \neq Ve$ we s R C-113	ords of ed 10	agg	k,		990-11	1	
At of Rodded agg + Measure (1	v In t	g 60,40	10.55			1925	59.45		
T MENTINE (	16.3	1	QU177		· ·	6.35	1/117/	40,00	
ut of Weagures						43.0	43.1	5 (24)	
								and a state of the	
wt of Measure( wt of Radded Aap Vol of Neasist	5 ,499	<b>\</b>				_	011	07-	
N'Y of Radded Aug Vol of Neasist	t 1999		8816			862	0614	87.5	
N'J of Rodded Ago	t 1999		8816			8612	8614	6110	
u'f of Radded Aqu Vol of Neasist	t 1999		8816			862	Oleint	01.2	

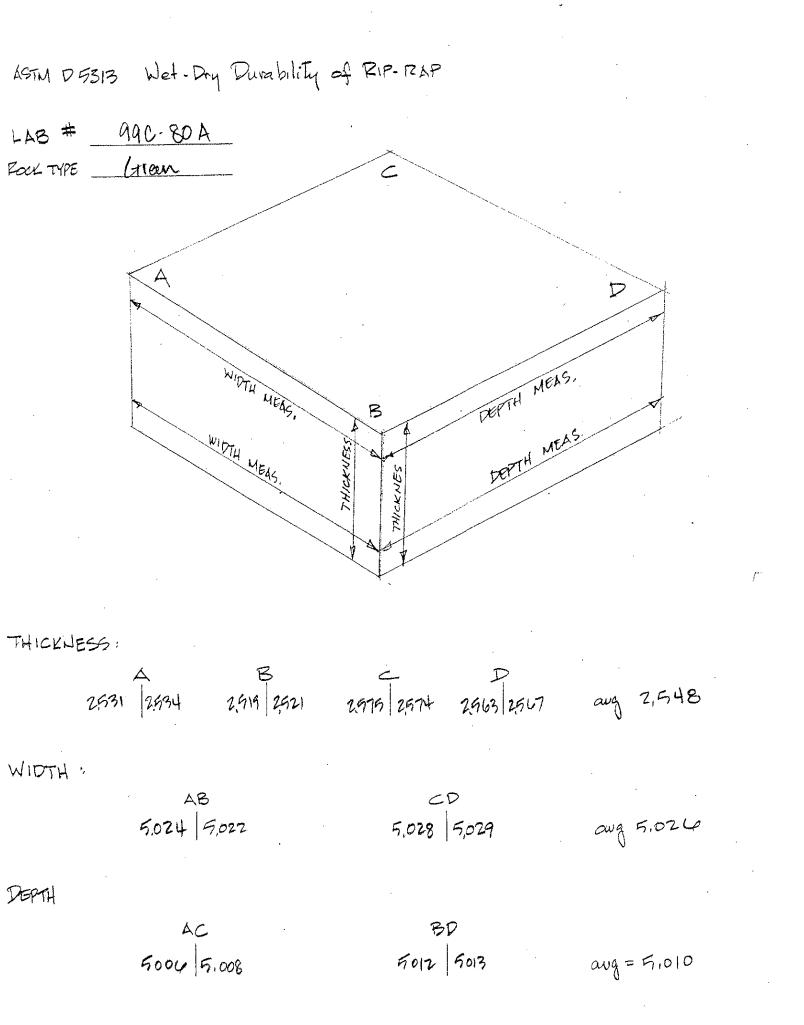
2.5-Inch x 5-Inch x 5-Inch Cubes from Sites Quarry

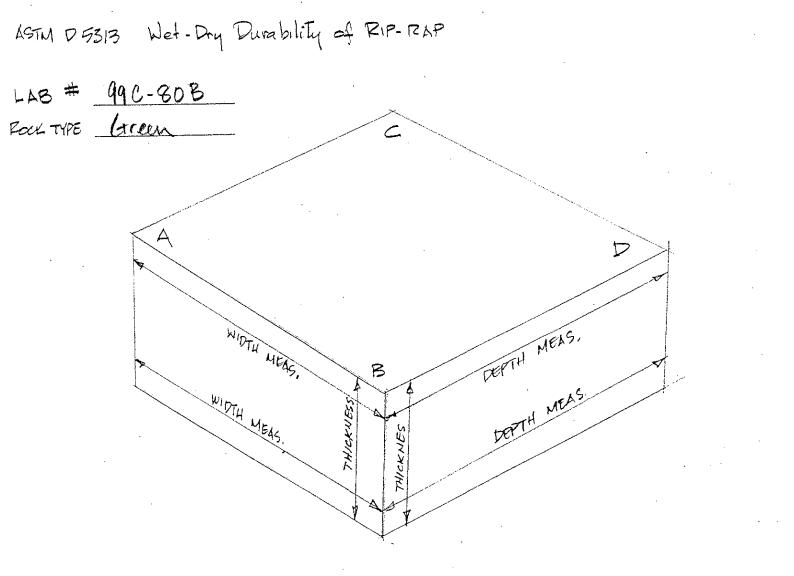
- - - - - - - - 	Avg Thick (Inch)	Aug Width (In)	Aug Depth, (m)	5/4/99 AIR DZY Wt. (165)	Vol (en FF)	Unit Wt (Pof)	Unit Wt (Ssd)	colourine front Airt esst wit % booption	0,00 120°F % absorp	· · · · · · · · · · · · · · · · · · ·	
99C-79 A	2,730	5,017	5.007	5.844	.03977	1469	151.3	3.2	4.7		
					103734		151.0	3,0	4,7		
C	2,582	5,037	5,010	5,530	,03771	146.7	151.8	3,3	4.7		
						· · ·					
99C-80 A	2548	5.026	5,010	5,622	103713	151.4	156.0	3,0	3.2	:	
B	2.565	5,024	5,021	5,666	103744	151.3	155.4	217	33		
C	2.569	5,006	5,017	5,650	,03734	151.3	166.4	2.7	3.3		
SOAKED	-					0-0		. ]	643	- 4407	
LAB#		79B			BOA	80B	800				
used with (gras						2634					
dry wt. (gms					2532	1	1				
absorb water						83					
% absorption					312	33	43				
ssd wt in water	;				15.66	1517	1572				
water displaced by 150		1058	1062		1047	1091	1055				
H H H Solid							<b>1</b>			MCE-3	6760
GPG (drybasis)		0.10	0.10	x	2,50	2,49	n da				9680
4PG (G15.d.)	2143	2,42	, XHЭ		2190	- ۲۱۲ (L	~ ~ 1 1			,	
5P6 (apparent)			<i>,</i>				:				
00 after whe	Vono	2434	24(01		2619	2538	2631				
wt loss		15			13		13				
% 1045		e Dile			0,6	0.4	0.5	·			

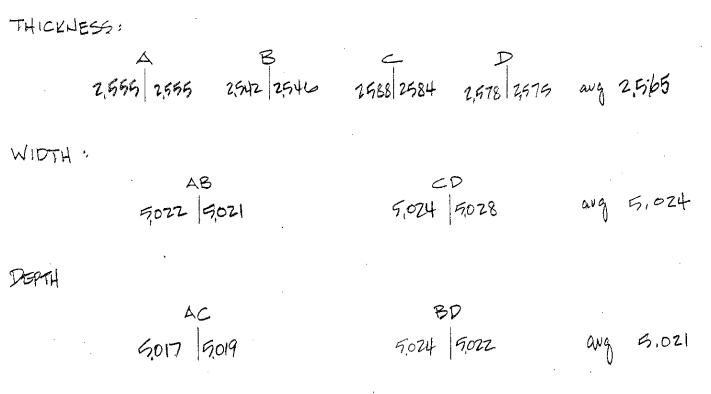


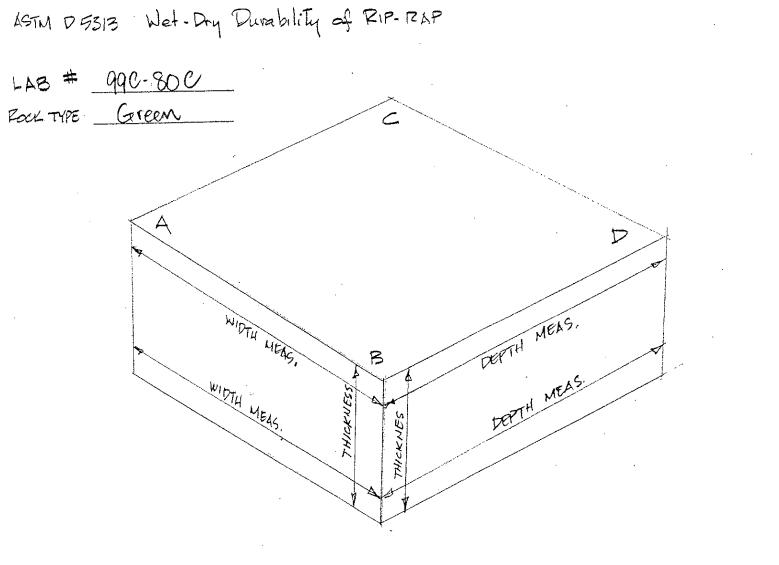




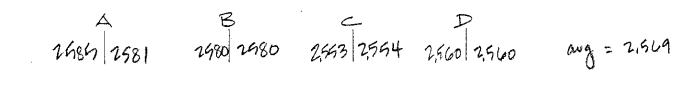








THICKNESS :



WIDTH :

DEPTH

2.5-Inch Diameter Drill Cores from Geologic Exploration

,

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES<sup>-</sup>

**PROJECT: SITES RESERVOIR** 

DIVISION OF FNGINFFRING CAVL ENGINEERING CANALS AND LEVEES SECTION

FEATURE: 2.5" DIAMETER ROCK CORES

		1 1			· · · · ·	<del></del>			· · · · ·			
ASTM C-97 SPG % (sed) ABS			3.5 2.5	.2	3.7	5.4	3		;	1   /		
ASTN SPG (ssd)	2.74	2.47	2.50	2.66	2.52	2.41						
REMARKS	Good Test	Good Test	Good Test Good Test	Good Test	Good Test Good Test	Good Test	Good Test	Good Test				
de la presentation	Goo	000	000	G000	000	Good	Good	Good				
ASTM D-2938 COMPRESSIVE STRENGTH (bsi)		30	0.0	00		.0	0	0	1			
ASTM D-2938 OMPRESSIVI STRENGTH (psi)	17,910	13,080	7,230 13,120	16,850	4, <u>620</u> 11,270	7,290	5,390	1,180	:	1		
		, ,	÷ z. v		++++++++++++++++++++++++++++++++++			1 ' - + + - -	- شر .	1 	 	į
MOISTURE	Wet	Dιγ	Wet Dry	Dy	Wet Dry	Dıy	Dŋ	Dιγ				
LOAD (applied to failure) ((bs.)	78,700	58,800	32,500 59,000	75,600	21,200 50,150	32,550	24,200	5,250				
LZD RATIO	2.0	2.1	1.9	5.1	1.9	2.1	2.1	1.9	· []	<u>}</u> -	+	
	5		392				1 1	L (	i r			-
1 DIAN	2.365	2.392	500	2.390	2.377	2.385	2.390	2.385				
LENGTH DIAM (mich) (inch)	4.733	5.010	4.521 5.009	5.018	4.010	5.013	5.038	4.555			-	
	je -			······	• · · · · · · · · · · · · · · · · · · ·				- • • • •			_
	andstone			tting		red		led	· · · ·			
NOTES	er-bed, /e of sa	ł		hered, /e of pi	hered	veather		veather	• •	I	1	
	Fresh, 45° per-bed, representative of sa	******	and the state	Slightly weathered, representative of pitting	Slightly weathered	Moderately weather		Moderately weather				
	Fresh	Fresh	Fresh	Slight	Slight	Mode	Fresh	Mode				
воскалье	Ss	Ss	SS	Ss	Ss	Ss	Ms	Ms				
Ës	52.0	52.3	54.2	36.3	28.4	17.2	200.3	23.8				
DEPTH (feet)	51.3-52.0	51.0-52.3	53.4-54.2	35.6-36.3	27.8-28.4	16.2-17.2	199.5-200.3	23.2-23.8				
© ∞	· ·· ·		< В	· ·	, œ		÷	,				
SITE HOLE F.S.	LC-2	RA-1	RA-1	LC-1		RA-1	LC-1	LC-1		! ·	1 4. . l	-
μ. 	Sites 1	66 F	99	- <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u>	09	99	99	<u>66 L</u>	;	<b>.</b>	+ -+ - 	
			┼╌┾─╌┾	+				+				-
<b>9</b> 2	99C-110	99C-91	99C-92	99 <u>C-88</u>	99C-84	99C-90	99C-89	<u>99C-87</u>				

REMARKS: Rock Types - Ms=Mudstone, Ss=Sandstone, I = Interbedded Mudstone/Siltstone

DATE: INITIAL: RGJ/TEC REQUEST NO.: 99-19

SHEET 1 of 1

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA THE RESOURCES AGENCY

SITES RESERVOIR **PROJECT:** 

2.5" DIAMETER ROCK CORES FEATURE:

CANALS AND LEVEES SECTION

DIVISION OF ENGINEERING

CIVIL ÉNGINEERING

ASTM C.97 SPG %	256 2.9 256 2.9 2.57 2.8 2.57 4.6	+	2.56 <sup>A</sup> 3.6	2.53 <sup>A</sup> 4.6	253 253 258 3.0 2555 3.1 2555 3.0	SHEET 1 of 5
						Siltstone
le Regereration de la companya de la companya de la companya de la companya de la companya de la companya de la Regereration de la companya de la companya de la companya de la companya de la companya de la companya de la comp	· · · · ·			• ••• •••	· · · · · · · · · · · · · · · · · · ·	I = Interbedded Mudstone/Siltstone
ASTM D-3967 SPLITTING TENSILE (ps)						= Interbec
MOISTURE COMPRESSIVE COMPRESSIVE STRENGTH	5703 10125	4693 9791		3980		Rock Types Ms=Mudstone Ss=Sandstone I = I A - broken and/or end pieces used for specific gravity and absorption
MDISTURE (	WET	WET		DRY		I for specific g
LOAD (applied io failure) (l0s)	25650 45500	22800 47600		19350		Ms=Mudsto pieces useo
(LD MATIO	2.04 2.03 0.78	2.01	2.03 0.62	1.98 2.01 1.42	2.01	s and/or end
(finch)	2.392 2.393 2.392 2.387	2.487 2.488	2.492	2.488 2.487 2.487 2.487	2.494 2.493 2.493	Rock Type A - broken
(Indit)	4.884 4.883 4.861 1.866	5.007 5.020	5.047 1.556	4.919 4.990 3.535	5.024 5.027 1.545	REMARKS:
BEPH Hock TYPE	75.8-77.3 Ss Ss Ss 163.3-164.4 Ms		146.7-147.7 Ms Ms	140.1-141.3 Ms Ms Ms	70.8-71.9 Ss Ss Ss	rgj 2001-08
H S S S S S S S S S S S S S S S S S S S		<[8]	A W		Z C C C B B V	
NO	GGC-LA1 GGC-LA1	GGC-RC1	GGC-RC1	GGC-RC2	00 	ŏ
LAB. NO	2001-28	2001-30	2001-31	2001-32	2001-33	DATE: INITIAL: REQUEST NO.

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA THE RESOURCES AGENCY

CANALS AND LEVEES SECTION DIVISION OF ENGINEERING CIVIL ENGINEERING

> SITES RESERVOIR **PROJECT:**

2.5" DIAMETER ROCK CORES FEATURE:

SHEET 2 of 5	l = Interbedded Mudstone/Sittstone	ypes Ms=Mudstone Ss=Sandstone I = Ir ken and/or end pieces used for specific gravity and absorption	tone ed for speci	Ms=Mudstone	s and/or enc	Rock Types A - broken ar	REMARKS:	1 <u>01</u>		DATE: INITIAL:
			~		0.50	2.493	1.238			
		5238	DRY	26150	1.68	2.493	4.193			
				      -	0.54	2.493	1.347		<u>م</u>	
and the second second		• • • • •	-		0.51	2.493	1.283	120.4-121.4 Ms	SSD9-1 A	2001-40
1 <sup>A</sup> 6.8							***	63.0-64.0 Ms	SSD8-5	2001-39
9 6.7	2.3				0.60	2.488	1.505	Ss		
8 8.3	2.28				0.51	2.480 2.488	3.588 1.258	• • • • • • • • • • • • • • • • • • •	ט מ 	
		; ; ; ; ; ; ; ; ;		i :	0.60	2.478	1.480	97.1-99.0	SSD5-3 A	2001-38
3 <sup>A +</sup> 8.4	2.40		-	·* ··÷				140.1-140.0 Ms	SSD3-4	2001-37
8 2.3	2.48	· · · · · · ·		ا ة به مزم مايد	2.02 2.01	2.491 2.491	5.024	45.0-46.0 Ss Ss	GO-DHS-3 A	2001-36
2^ 3.9	2.52	2184	DRY	9800	2.09	2:390	4.996	146.3-147.5 Ms	GGC-RA1 A	2001-35
33 2.6 5 2.6 6 2.6 - 2.8	2.55		WET	21650	0.62 2.10 0.58	2.394 2.394 2.394 2.394	1.495 5.019 5.019 1.398	59.9-61.0 Ss Ss Ss Ss Ss Ss Ss	GGC-RA1 A	2001-34 0
% % E	SPELITEING TENSILE (psi) (std)	COMPRESSIVE STRENGTH (psl)	MOISTURE	(applied to failure) (lbs.)	LØ KATIO	DIAM. (mch)	(IENGTH	ROCK TYI	HOLE E.S. NO	and N
ASTM 0-97	ASTM D 3967	ASTM D 2938 AST		LOAD				BE:		

2001-08

REQUEST NO. INITIAL: DATE

SHEET 2 of 5

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

SITES RESERVOIR ł **PROJECT:** 

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2.5" DIAMETER ROCK CORES FEATURE:

CANALS AND LEVEES SECTION

CIVIL ENGINEERING

DIVISION OF ENGINEERING

			_									•
the second secon				-	0.61	2.491	1.523	0 Ms	26.5-27.0	-	2001-54 GGO-DHS4	2001-54
				e sketch)	ecimen- se	(can not obtain test specimen- see sketch)	(can not ob	7 Ms	57.0-57.7		2001-53 : GGO-DHS4	2001-53
2.66 0.8	! 	6861	WET	33750	1.84	2.490	4.593			ပ		
	2480		ркγ	4910	0.64	2.486	1.593	0 Ss	56.0-57.0	8	2001-52 GGO-DHS4	2001-52
				a a constante de la constante d	(	eive sample	(did not receive sample)	Ss	45.0-46.0		2001-51 GGO-DHS3	2001-51
	4. · · · · · · · · · · · · · · · · · · ·				ļ						r	i
2.43 3.5 2.43 3.9				· - T	0.56	2,492	1.520	လို လို		വവ		
+ +					501	2.492	5.021	SS SS	0.012-0.212	< 🗠		2001-43
4	<b>_</b>					;					;	
2.57 <sup>A</sup> 3.9 2.57 <sup>A</sup> 3.9	. I read		and a second a		<u>1.51</u> 2.00	2.490 2.491	3.762 4.980	6 Ms Ms	206.5-207.6	A 10	2001-42 GO-DHT3	2001-42
2.42 3.3		5226		25450	2.02	2.490	5.033 1.448	SS		ωU		; ;
2.48 4.2	1776		WET	3630	0.66	2.491	1.641	2 Ss	71.0-72.2	Y	GO-DHT3	2001-41
SPG %	SPLITTING TENSILE (psi)	COMPRESSIVE STRENGTH (psi)	MOISTURE CONDITION	to failure) ([bs])	L/D RATIO	DIAM (mch)	LENGTH (frich)	L XOCH	DEPTH ((eet)	<sup>н</sup> ЛО С	HOLE NO	LAB NO
ASTM 0:97	M.D.3967	ASTM D-2936 ASTM D-3967		LOAD				Эну				

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r<u>gj</u> 2001-08 i

INITIAL: REQUEST NO. DATE

DEPARTMENT OF WATER RESOURCES THE RESOURCES AGENCY STATE OF CALIFORNIA

CANALS AND LEVEES SECTION DIVISION OF ENGINEERING CIVIL ENGINEERING

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SITES RESERVOIR	
PROJECT:	

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FEATURE:

2.5" DIAMETER ROCK CORES	
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% ABS:

SPG (ssd)

ASTM C-97

ASTM D-3967

ASTM D-2938

SPEITTING TENSILE

MOISTURE COMPRESSIVE

applied

EOAD

STRENGTH

CONDITION

failure).

L(D) RATIO

DIAM. (inch)

LENGTH (inch)

DEPTH (feet)

NO NO

HOLE NO

LAB NO

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(DSI)

(isu)

1.5 0.5

2.58 2.66

(mudstone separated-water damaged)

0 11988

WET DRY

0 59700

1.95 1.81

2.497 2.502

4.860 4.518

S: Ss

176.0-177.2

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2001-56 GGO-DHT1

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DRY

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Ms Ms

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2001-55 GGO-DHT1

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WET DRY

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2001-58 GGO-DHT3

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0.62 0.61 0.62

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1.552

Ms

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2001-59 GGO-DHT4

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2001-57 GGO-DHT3

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2.50 2.59

Ss=Sandstone I = Interbedded Mudstone/Siltstone 
 Rock Types
 Ms=Mudstone
 Ss=Sandstone
 I = I

 A - broken and/or end pieces used for specific gravity and absorption
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 I< REMARKS:

rgj 2001-08 REQUEST NO. INITIAL: DATE:

SHEET 4 of 5

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA THE RESOURCES AGENCY

CANALS AND LEVEES SECTION DIVISION OF ENGINEERING CIVIL ENGINEERING

SITES RESERVOIR

**PROJECT:** 

2.5" DIAMETER ROCK CORES

FEATURE:

ASTM C-97 PG std) ABS	2.1									-		:	SHEET 5 of 5
(Das) Das	2.63 2.53 2.54 2.54 2.54												tone
	<b></b>				-				÷				Mudstone/Silts
ASTM D-3967 SPLITTING TENSILE (ps)	1700	i	1393	i	utatan in ity i						an an an an an an an an an an an an an a		l = Interbedded
MDISTURE COMPRESSIVE ASTM D-3907 MDISTURE COMPRESSIVE ASTM D-3907 COMDITION STRENGTH FENSILE TENSILE (psi)	5745 8803 8803	aad I I	3856			· · ·						-	Rock Types Ms=Mudstone Ss=Sandstone I = Interbedded Mudstone/Siltstone A - broken and/or end pieces used for specific gravity and absorption
MOISTURE C	WET WET DRY		DRY DRY		·								me S I for specific gr
LOAD (appled to failure) (l0s.)	3200 28000 42900		18900 2700			· · ·					+ +		Ms=Mudsto d pieces used
E E	0.61 2.02 2.01 2.02	1.92	1.92				ł					i	pes en and/or er
DIAM: (mch)	2.491 2.491 2.491 2.491 2.491	2.495	2.492		-							 	
LENGTH (inch)	1.512 5.028 5.016 5.023	4.786	4.788									-	REMARKS.
ROCK TYPE	430.5-432.0 Ss	535.4-536.4 Ms	556.3-557.3 Ms	: * *		÷ - 4.						1	D
NO NO NO NO	2001-61 GGO-DHT5 A	2001-62 GGO-DHT6 A	2001-63 GGO-DHT6 A										
Real Providence	2001-61	2001-62 (	2001-63 (			-	i 	i :		- i.	 		DATE: INITJAL.

A - broken and/or end pieces used for specific gravity and absorption ļ ļ ł . l <u>2001-08</u>

REQUEST NO.

Absorption		2.82	8, P	2.79			4,63		. 1		258	11			226		8.39		B.25	1	6.75				3.30	1	38	3.86	3.72	11		_	0.76					1	3.42	11		. 1 1
Tensile SPG	255	258	2.51	2.49	2.56		2.53		2.63	255	253	2.50	52	2.52	2.46		42		228	1	2.41		_ <u>`</u> _		243	-	2.57	2.57	2.45	2.44	12,43	2,480	28			649	258	28	2.42	1,467 2,44		55
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Compressive Corrected																											 															
Compressive		5,703 10,126		4,693			3,980				CI P D	156'6		2,184									5,238		6.226		1						6.861		3,170			11,968			4,548	4,600
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C-3148 C-2938																+	<u> </u>					-	÷		+							÷	~						-			i-d-ul
Molchure C	+	WET DRV		WET			DRY			~	WE	<u>ک</u> ر		DRV		-						_	DRV		BW							D2∆	EN N		DRY	ž į		۶.		WE	VEI OS	Day Day
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	28	4.86		5.01	<del>8</del> 65	12	4.92	40	36	1.5.0		25	ч -	6.00	2.9	6		12	2	2		2	14	2	$\uparrow \uparrow$		8	4.5	99	1	71	2	4.	;				4 1	19: N		2 8	4
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thư Depth	17.3	77.3	164.4	5	147.7	<i>1.71</i>	21.3	6.121 1.3	71.9	21.9	5 5	5	5	147.5	8	9 <sup>:</sup>	5	88	8 8	*	8	1214	121.4	121.4	122		97.02	207.6	513 641	523	273	6	23	63 6	156.7	295	711	317.2	317.7	317.7	329	329 116.7
Start Dopth	76.8	75.8	163.3	8 8	146.7	146.7	140.}	140.1	70.8	8.07 70.8	59.9	59.9	20.0	146.3	8	<del>g</del> :	140.1	1.19	97.1		8	120.4	120.4	120.4	: R		2065	206.5	272	272	272 45	39	3	63	155.7	156.7	8	316.3	316.5	316.3	327.7	327.7
후 아귀 많 값	CIAI	GGC-LAT GGC-LAT	66C-IA1	GGC-RC1	(08-095	Gecarci	GGC-RC2	C-RC2	2 2 2 2	0-RC2	C-RA1	C-RM1	CIRI	GGC-RA1	GO-DHS-3		SSD0-4	SSD6-3 SSD6-3	\$06-3 %	2			1-6055	I	60-DH13		GO-DH13	GO-DH13	5DHU3	EHI3	C DHIS	D-DHSH	ISH0-0	GGO-DHS4	EHO	undo	- min	CHO-C		CIHO-C	STH0-0	O-DHTS
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<u>।</u> हे	Gafe Cur	Golden Gate Curved Golden Gate Curved	Gotten Gate Curved	Gottlen Gate Curved Cottlen Gate Curved	Gotten Gale Curved	Golden Gate Curved	Golden Gate Carved	Gote Cur	Gate Cur Gate Cur	Gote Cur Fote Cur	Gate Cur Gate Cur	Gole Cu	ng alogi	Galden Gafe Curved	Sotten Gate Intel Outer	2010-2010-2	Northern Saddle Dams	Northein Social Dans Northein Social Dans	Northern Soldle Doms Northern Soldle Doms	A NUMBER OF STREET	Morthern Saddle Dame	Marthern Saddle Crans	Northern Sociole Doma Northern Sociole Doma	Morthern Societle Doms	Solden Gate Inlet Outla		Solden Gate Inlet Outle	Solden Gate Intel: Outle	ate triat	acte Intel	Sofe Intel Tote Intel (	Sate Iniot	acte triet	aden Gate Iniot Outro		Softe Inlet	101010100	Sate Inlet Pate Inlet	Cate Into?	actie true	Sote Intel .	Sate Intel
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Sample Comments				÷			;-					Can't secure test sample	Cont secure lest complet		4 6 4 5 fest	con't get pood somple		con't get good somple ;	4.6*	S" good sample	C <sup>n</sup> fair to need comple	Cut into 2 samples	Cid into 9 somelas		2 tomples 4 5" & 5"		2 samples 4.5" & 5"	Con't secure somple-	eiddxii	can't secure sample- fractuing		cut into two somptos conit secure	cut into 2 samples 5"		Shecred trohwoon \$5.6. Sh	Cut into 2 somples (j'es)		n na manana manana manana na ma	Can't secure sample Can't secure sample	3.7" 8.5" somple	3.7 <sup>-</sup> & 5 <sup>-</sup> somple	At fair to coord comoto	we have a second state of a local second sec	Cut into 2 samples yes	Cut Into 2 scenatos yos	Contraction for the former		5" fair to good sample	5" gend komple		4.5° not too geed
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Rock Description				.÷							interest weathered	cond/sit stone	intensely weathered	scrol/silt stone	Sandstone.	che (mudstone?)	Shale with sitt interbeds	and shear.	Weothered shale	presoniotive of	Points.	thered sandshine	1/m//pdthproc	Sandshane.	Unweathered	Jinwadharad	Sandstone.	450 portpool Shole in	Machtones	interhoriced interhoriced	Weathered	interbedided sorctione ond sholo	Signity weathered Interbedded	scrydsforre and shale	Sightly weathered Marbadalad sandshare and shale	Sandstone. Thickly	Sendstone. Thickly	bedded (opprox 50c)	Fractivied shale. Fractional shale	Fresh sholle. Thinly edicled (cipping 600),	some fossis. Frech thalle. Rhinly vecklad (cinnicy 600),	some rosse. Fresh shale. Thinly action forcers. And	some soft interbects	Freehshole.	Frosth sholo.	Month - Constitution		Plereur sondstone. Thiny bedded fanner Mol.	Soft-sediment leafures	450 poip bod.	Mediment more 45o perp-bed. Mediment shale
Rock Type (MS - Mudstone SS P		N N	8	3		 8	3	St.	*	2 1	- in - i	Se/Mts	Some inte	÷	а а			5W	Ms W			55 Mex			 23		 31	Ms 15C		Sk/Ms	1	St/Ms	Shites	SG	St/Ms St/Ms	8 8	÷		24 ¥		4 2 2 2 4	F Poor		Ns.	2 0			8 8	Ss/Ms Soft		× ×
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Stort ferd Depth		1155	÷	24.5	20.5	30.5	50.6	30.5	95.4			÷.	42			60.7		165.2	23.2	35.0	- 199	+		÷	53.4	÷	4	30.5	-	19.7	-	20.7	515		65.8	172.7			199.2 2019	. <u>.</u>	29.6	1 68			115.1			5,65	¢9:1		1.36.1
				PTHO-O	O CHILL 4	91HO CA	DUDHUS.	10-DHI5	91HG-O		÷.,	GGLA-1	GCIA.7			GGLC-1	Ļ	GelA-1	GelCI	eerc-1	+		ļ	÷	GGRA-1		CC-109-1	GGRC-)		KOLA-1		HOCA-1	HOIA-1		HOIA-1	HOLA-1	.÷		HOLA-1 HOLA-1		нопс-1	100		HOLC-1	HOLC-1			HORA-1	HORA-1		HORC-1
e e	00 100 100 100 100 100	Star Benerican Contract Cata Mater Cata (2000)	Ten Grie Iniei O. Ile GC	den Gote Inlei Oulle GG	Gan Grate Intel Oute GG	Con Octo Inlet Cafe OC	con Gote thirt Cutto GC	<ul> <li>Stess Reservoir Solden Gate Inlet Outal GGO-DHI5 4.</li> </ul>	den Gate Intel Oxfa GG	Policion Sotia Inier Outle GGO-OHIO	den ware iner care wa	Golden Gate Straight G	Gobleo Goto Strolont G		Gotten Gato Sholight G	·	÷	Golden Gate Straight	Golden Gote Skriight G	Golden Gate Sheight	Colores Ceta Strandsh		÷		Golden Gole Strictjhi G		Giolden Gade Stroght G	Golden Gate Straight G		Owens H		Owen:	Qwens H		Swens	H Snewo	·÷		Owens Pueses		±	2000		H	Owens H			Owens	Owens		Owen: H
Project		Stor Reserves 200	Stat Decenorin Poly	Stes Reservoir 204	Stres Rensenvolt 9:04	Stres Reservoir II-oli	Stos Posonoir 20	Stas Reservoir 201	Stes Reservoir Ro	STOCKARD CONCOL THE		Sittes Reservoir G	These States rate		Ster Brench	****	·	Sites Reservoir	Sites Peservoir G	Sites Reserves		···÷-··	†		Siles Reservoir   G	- ÷	Steel versencer	Stot Reservoir Gr		Catulica Rosenulos		Cotisto Reservoir	Cottisa Receivair		Coluso Reservoir	Coluso Reservol-			Cotted Reconcil: Cotted Reconcil:	Coluso Reservoir	Column Reserved	Council Processor		HYPAC 103A Coluse Reserver	1990C-1016 Collect Recevoir 1990C-1016 Collect Recevoir	Col no Docorrele		1999C-106 Coluad Reservoir	1999C-107 COULD RESPONDE	1990C-108 Cotuso Peservoir	19960-109 Column Reservoir
Bryle Code	000 000	100,100	AD1-100C	2001-008	2001-01A	2001-018	2001-01C	200-010	2001-624	2001002	7001-020	1999C-82	10000-31		1999C 54A	10000-85		10000-68	1999C-87	19990-58		19900-90	10000-01		1999C-92A		526-2560	10000-03		165-26651		1990C-55	10000-06		1999C-97	viso-3660.€		900-Yuu	19000-09	1979C-101A	10000-1018	10000-100	201-7 VII-0	MOL DOW	19900-1679	And Total		1999C-196	10000107	1990-108	19960-109

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	1999C-112	111-20061	19990;;-110	Byte Codo
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### Bryle\_Samples

#### APPENDIX G

#### VENADO SANDSTONE PETROGRAPHIC AND QUALITY TEST RESULTS USACE SAMPLES

U. S. ANNY INGINIER DIVISION LASCRATORY SOUTH PACIFIC CORPS OF LANDINEEUS SAUSALITC, CALIFOLIUA 00.0

PETROURLENIC HERVET OLD SITES CUARIX SACEATENTO VIN EN PROPORT

March 1962

1. Sumple. A sample of quarry rock, consisting of cobole size particles weighing approximately one hundred pounds was received from the Sacramento Alstrict on 8 February 1962, for petrographic analysis, specific gravity and absorption, abrasion, wetting and drying, sound-ness and x-ray diffraction analysis. The sample represents rock material being considered for possible use as miprap for slope protection on Sacramento liver Projects.

2. Summary. Petrographic analysis, x-ray diffraction, wetting and drying Test, specific gravity, soundness and abrasion have been completed on the Old Sites Quarry rock sample. The rock sample wacks. The component minerals are quartz, felds, r, biotite, chlorite wacks. The component minerals are quartz, felds, r, biotite, chlorite wathing and drying test caused a noticeable loosenting agent. The but did not result in a complete districeable loosenting of surface grains Angeles rattler abrasion test on the leboxatory cruched rock showed a loss of 45%, indicating a relatively soft work. Frediminary results of magnesium sulphate coundress tests on the laboratory crushed cuarry rock show high loss in the coarse and fire sizes.

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1. Test Procedure. Selected spectaene of the sample were prepared into this sample were prepared and used for the wetting and drying test. In from and selt water, material for prevention were any drying test. In from and selt water, material for array diffraction was prepared by granding whole rock and passed through the No. 325 sleve. From diffraction dependent by whole rock powder supported to the rock powder and second on the antarial of the wetting and according to standard test action was provided in distilled approximately on while gravity and according to standard test action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent of the second action dependent action dependent of the second action dependent action dependent action dependent actions action dependent actions action dependent action dependent action action dependent actions action a

## 2. Composition.

a. Megascopic Characteristics. The rock has a dark graviahgreen color, and has a fine to medium grained circuture. Cossional dark rounded spots approximately one contineter in diameter occur scattered throughout the rock mass. These spots gopeor to be composed of dark yellowish-green miceacous minerals. A few lans shaped fractures appear filled with a soft clay type mineral. These longes were found in several specimens of the sumple. The rock material is easily scratched with a steel needle. A slight frimility of the rock is noticeable when fresh surfaces are rubbed with U-s fingers.

b. Microscopic Characteristics. In thin Sections the rock is composed of angular to subangular grains of charts, plagicelase feldepar, crumpled and weathard biotite, green chlorite and a yellowishgreen clay mineral. The quartz grains appear clear, with a few showing microfractures. The feldepar grains show some cloudiness and have extinction angles of albite, cligoclase and andesine. The blotite greent, closely easedlated with the blotite spreaded. Green chlorite is bictite is shredded and streaked around quartz and feldspar grains. The cementing upent is an angillaceous and chloritte mixture and is seen as dark isotrophic material around the quartz and feldspar grains. A rough estimate of the percentage of the component minerals and all of biotite, chlorite is approximately for quartz, 39 feldsjar and is biotite, by x-ray diffraction. The rock is considered to be arked to be graywacke.

3. Hesults of X-ray Diffraction Analysis. X-ruy diffraction patterns show provinent reflections of beidellite, quarts, playicalse, trace quantities of orthoclass, otherites and biotize. Diffraction patterns on glycerino paturated samples showed no swelling type city ninerals.

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		Abrasson Teat Call Lit-50. The result of the abrasion test showed a loss of 45% on the laboratory crushed quarky rock. Sulphate Soundness Test CMD-115-455. Freliminary results indicate a rolatively bigh loss in poarse and The sieve sizes.	32,546 7746	HERUITS OF FHISICAL TESTS	TABLE 1	U. S. AMMI BROINDRY DIVISION LANATARONY SOUTH PACIFIC CONFS OF BRAINS SAUGALITO, CALLECHNIA	

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PETHOGRAPHIC REPORT

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## SITES QUARKY

UNIT 22 SACRAMENTO RIVER PROJECT CONVER AND SUTTER COUNTIES, CALLFORNIA CONVERSE NO. DACHO5-72-C-0057

## April 1972

## AUTIN RIZATION

District. 1. Results of tests reported herein were requested by DA Form 2544, Work Order VR0-72-3 (72-0-0057-1), 15 March 1972, from the Sacramento

### ES OERIAL

2. Furpose of this study was to determine the quality of the material purposed for use as protection stone on both banks of the Sacramento River at various locations between mile 110.8 and 143.8 in Colusa and Satter Countles.

### STANDEL E

3. A shipment of approximately 200 pounds of rock was received on 15 March 1972. The sample was from Sites Quarry Located approximately 1 mile east of Sites, California.

### TESTS

F Tests were performed as follows:

¢۲ Petrographic analysis (including x-ray diffraction) ChD-C 127

5 Abrasion (L.A. Rattler) gradation 1, ORD-C 145

Specific gravity and absorption, CHD+C 107

Magnesium sulfate soundness test, CNU-C 137

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e. Simple wetting and drying test run as follows: Chunks and one-inch thick slabs were subjected to 15 cycles of wetting and drying, one scries in iresh water, the other in salt water. Nach cycle consisted of soaking the sample overnight at rocm temperature and then drying it in an oven for eight hours at 140°F. Samples were weighed and photographed before and after the

Salt water was prepared under ASIM Specification Dll41-52, Substitute

Ocean Water.

计算题计:

11. Magneatum Sulfate Soundness Loss, percent	10. <u>Los Angeles Abrasion (Cradation 1</u> ) Loss, percent	9. Specific Cravity a. Bulk Specific Cravity b. Bulk Specific Gravity c. Apparent Specific Gravity d. Absorption, percent	RESULTS OF FRISTOAL	8. Composition by X-Eav Diffraction. Minerals feldspar, biotite, oblorite and montmorillonite	7. <u>Microscopic Characteristics</u> . The rock contained grains of feldayar, biotize and chlorite and fragments of rocks in a fin matrix. The feldsyar occurred as oligoelase and orthoclase an generally cloudy and partially altered to sericite. Biotite g were generally stretched with some bont around other grains. have been caused by low grade metamorphism. The rock fragment principally chert with some shale, metafolcanic and claystone. the metavolcanic rock fragments contained secondary epidote. was compused of clay, chlorite and sericite and comprised from percent of the sample. The sample was an argillaceous, arkedi	6. Megascovic Characteristics, The rock was to slightly weathered: It was generally fine grain fragments up to 0.5 centimeters in length. The and could be scretched with the hardness tester, clay could be scretched with the hardness tester, clay could no at least one side and many parti-	. Summary, The sample wa rinnarily composed of angul ad different rock types in arcmorillonite. The samplar arcmorillon of 2.2 percent. the segmestion sulfate so the segmestion sulfate and the wetting and dryin d numerous small pieces.	ア正打光の
ц У У	,	2.47 2.47 2.47 2.47 2.47 2.47 2.47 2.47	SICAL TISTS	Minerals identified were quartz, morillonite type clay.	7. <u>Microscopic Characteristics</u> . The rock contained grains of quartz, feldspar, biotite and chlorite and fragments of rocks in a fine-grained matrix. The feldspar occurred as oligoelase and orthoclase and was generally cloudy and partially altered to sericite. Biotite grains were generally stretched with some bent around other grains. This could have been caused by Low grade metamorphism. The rock fragments were of the metavolcanic rock fragments contained secondary epidote. Some of the metavolcanic rock fragments were start with some shale, metavolcanic and claystone. Some of the metavolcanic rock fragments were been caused of clay, chlorite and secondary epidote. The matrix was composed of clay, chlorite and secondary epidote, arkosic graywacke.	Megascovic Characteristics. The rock was tanish-screenish gray and bubby washerror It was generally fine grained with some larger shale , ments up to 0.5 centimeters in length. The rock was relatively soft could be scretched with the hardness tester. All particles had a coating on at least one side and many particles had open and clay ed fractures.	ule was an argillaceous, arkosic graywacke. It was angular to subangular grains of feldspar, quartz pes in a chlorite-clay matrix. The clay was expansive sample was relatively soft and broke easily when Average was relatively soft and broke easily when Average apparent specific gravity was 2.54 with an cent. Loss due to abrasion was 27 percent. The loss ate soundness test was an extremely high 39 percent Ilaking due to the breakdown of their matrix, i drying test, one of the specimens broke in 3 large arces. The other specimens aboved only minor flaking.	FETHOGRAFHY

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12. <u>Simple Wetting and Drying Test</u>. The freshwater slab broke into 3 large frequents during the fifth to seventh cycles, additional flaking occurred for the duration of the test. The other specimens aboved only mimor flaking during the test. Defore and after photographs of the test specimen follow.

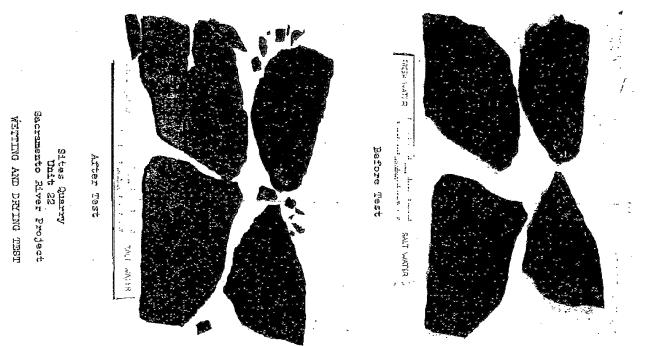
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e. Shy in wetting and drylar tost run as follows: Chunks and one-ine thick slabs were subjected to be evelow of webbling and drying, one series fresh water, the other in solut water, then cycle consisted of seaking the sample over light at room temperature and then drying it in an oven for eig hours at 14 PF. Samples were welghed and photographed before and after th test. Salt water was prepared under ASTM Specification D1141-52, Substitue Ocean Water.	e. Specific gravity and absorption, CRD-C 107 d. Magnesium sulfate soundness test, CRD-C 137	a. Petrographic analysis (including x-ray diffraction) CMD-C 127 b. Ahresion (L.A. Mattler) gradation 1, CMD-C 145	TESTS	SAMPLE 3. A shipm nt of approximately 500 pounds of rock was received on 7 in 1972. The carpie was from Sites Guarry Located approximately 1 mile co of Sites, C. Lifornia. It was divided into three catagories: "Blue", "Better of the Brown" and "Poorer of The Brown".	FURPOSE 2. Purpose of this study was to determine the quality of the material purposed for use as protection stone on both banks of the Sacrazona River at various locations butween mile 110.8 and 143.8 in Colusa and Sutter Counties.	AUTHORIZATION . 1. Results of tests reported harain were requested by DA Form 2544, Work Order Nav-72-4 (72-0-0057-2), 6 June 1972 and Change 1, 14 June 1972, from the Sacramento District.	<u>1017 1972</u>	GITES QUARRY, UNTER QUARRY, SACRAMENTO RIVER PROJECT COLUSA AND SUFFER COUNTERS, CALIFORNIA Contract No. DACHO5-72-C-0057	FIGURE 1 FETROGRAPHIC REPORT
and one-thei one series in seaking the Norm for the nd after the 2, Substitute		127		a 7 June 11e caus 1ue",		544., June			

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### PETROGRAPICY

flaked throughout the test. alon; joint: in the tweifth cycle. The moderately weathered material drying test the fresh material flaked slightly with both slabs parting material all eady has a comparitively high loss. During the wetting and material appears to be relatively low while the "Better of the Brown" the "Blue" and 39 percent for the "Retter of The Brown". The magnesium sulfate som does test is still in progress but the loss in the "Blue" 4.4 percent and 5.5 percent. Losses due to abrasion were the [Blue] and 39 percent for the "Better of The Brown". when struck with a hourner. Average apparent specific gravity was; for the "Blue" scherich 2.39, for "Better of The Brown" 2.60, and for the "Poorer of the Brown" 2.64. Respective absorptions were; 3,4 percent, calcite. which were fresh mater al was generally sound. Expansive montherillonite was the principal clay mineral present. The of quartz, vica, feldspar and rock fragments in a chlorite-clay macrix. argillaccou : arlosic graywacke composed of angular to subangular grains was done to this material. The rock in all three catagories was an determination of absorption and specific gravity so no further testing Brown" was noderately weathered and the "Foorer of The Brown weathered. degree of whithering. The "blue" rook was fromh, Summary . re light and a lev contained minor quantities of secondary The weathered material was relatively soft and broke easily The poorer material fell apart while soaking for the The sample was divided into three catagories based on the losses due to abrasion were 26 percent for Some particles had joints, most of the "Better of The ı" was deeply

6. Megascoric Characteristics. The fresh material was greenish-blue and the moder-tally weathered material was from greenish-redish-yellow to redish yellow. Both types were fine grained except for medium sized mice grains and shale fragments. All types could be scratched by the harness testor. Most particles had a cluy coating.

higher percentage of matrix than the fresh. and the iron has been tension on a more the form of iron exide, this deposited in with surrounding matrix in the form of iron exide, this deposited in with the surrounding matrix in the form of iron exide, this Claystone also present. Were prodoni mbely chert and shale with some metavoleanic rock and argillaceous, arkosic graywacke. clay, chloring and sericito. individual particles with the weathered material generally containing a the sample most of the feldmar has been partially altered to sericite varities. Nictite was the principal mica. In the weathered portion of matrix. Felipar and present as both the plagioclase and potassium quartz, mice, foldspor and enlorite and rock fragments in a fine grained Microsechie Characteristics. The matrix was composed of montmorillonite type It commutes from 5 to 30 percent of the Both types were composed of grains of The sample was an

8. <u>Composition by X-Ray Diffraction</u>. Minerals identified were quartz, feldspar, biotite, chlorite and montmorillonite type clay.

# RESULTS OF PHYSICAL TESTS

## Specific Gravity

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	"Blue"	"Better of The Brown"	"Poorer of The Brown"	Rock Type
An To Los	(2) (2)	(μ) (μ) (μ) (μ) (μ) (μ) (μ) (μ) (μ) (μ)		Poe
10. Ins Anyolos Abrision (Gradation 1), percent loss	2.33 2.423	ស ល ល ស ល ល ស ស ស	2.21 2.21 2.27	Bulk Specific Gravity
ion 1), percent	:: 2,50 5,50	14°2 14°2 5°111 5°111	2,42 2,42 41	Bulk SSD Specific Gravity
1053	2.58 2.58 2.56	2.62 2.63	2.64 2.65	
	3.2 2.9 1	,1 8 4,8 4,8	6.00 30.1	Absorption, Percent

10. Los Angeles Abrasion (Gradation 1), percent loss

a. "Better of The Brown" - 39 b. "Blut" - 26

11. Simple Witting and Drying Test. Both the fresh water and salt water slab test special us of the "Flue" rock parted along joints during the twelfth cycle. Minor flaking occurred to all "Flue" specimens throughout the test. The "Better of he Brown" specimens flaked during the entire test. Before and after photographs of all test specimens follow.

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	Test Data,	
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	ok from Old Sites 6	
	Quarry	

Tests	Sample #1 & (Weathered sandstore)	Sample #2 a/ (Fresh sand- stone) c/	Sample #3 b/ (Fresh sand- stone) c/
Specific Gravity (S.S.D.)	2,44	2,58	2.504%
Absorption	3.4%	3.3%	3.5%
Abrasion (L.A. Rattler)	45% loss	39.1%	34.1% loss
Soundness (Mg SO <sub>4</sub> )	"Relatively high loss"	92,5%	15% loss
Wetting and Drying	"after 15 cycles in fresh & salt water a noticeable softening and loosening of sur- face grains is evident"	"Slight surface sloughing"	Not Reported

L Test by U.S.C.E. laboratory, Sausalito, California.

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b Test by Hales Testing Laboratory, Sacramento, California

C Probably lightly weathered rock in U.S.B.R. classification.

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to be	cher:, plagioclase and orthoclase feldspar, blotite, hornblende, calcite, iron oxide, clay, and a few sca The fragment size more oxide, clay, and a few sca	fresh and contain some tight, well-healed fractures. The rock fragments that app grained, homogeneous, moderately to highly porous and absorbeits.			I T		1	H.		METER			<	LOSS, 100 REV.	LA LABASION INC. WOT'D. & LOSS (DES. 19)	SAND EQUIVALENT	CLAY LUMPS, % (DES.	LIGHTER - SP. GR.	PERCENT SILT (DES. 181	DERVED ORGANIC IMPURITIES (DES. 9, 10)	ABS0007104 (DES. 9,10)	11	TEST RESULTS	M-6399, Report No. C-1127 EV		ъ	e (right	1		Quarry	SOURCE NO	L.,	n.	BUREAU OF RECLAMATION	e	Ч	
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1/ Average for two cubes.

<u>Conclusions</u>: Rock comparable to Sample No. M-6547 is of poor quality for usa

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fragment size appears to be genarally controlled by jointing. appear fresh and contain some tight, well-healed fractures. hornblende, calcite, iron oxide, clay, and a few scattered rock fragments. chert, plagioclase and orthoclase feldspar, biotite, muscovite, magnetite, and are composed of mostly angular and subangular to rounded grains of quartz, grained, homogeneous, moderately to highly porous and absorptive, somewhat friable The rocks are fine-The

Conclusions: riprap. Rock comparable to Sample No. M-6548 is of poor quality for use as

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1/ Average for two cubes.

C. A. Bechtold

The examined arkosic sandstone consists of angular and slabby rock fragments that

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IMPORTANT NOTICE

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UNITED STATES

FIGURE 3

BUREAU OF RECLAMATION

BRANCH FILE NO. C-\_\_1127 I

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DATE Dec 1771 ENGINEERING AND RESEARCH CENTER DIVISION OF GENERAL RESEARCH CONCRETE AND STRUCTURAL BRANCH

RIPRAP

COMPLED BY ......

	Use: Rejected Geology: The rook is a grayish-greep greywacks sandstone, fine to medium-grained in texture. The rock has been used for many years in construction of buildings in San Francisco, such as the Ferry Building and the U.S. Fost Office. It has also been used in Coluse and Glenn Counties for construction of various drainage structures. Results of the petrographic examination are given in the SFD Lab reports.	Specific Gravity 2.44 2.50 2.46 IA Abrasion Test Loss 45% 34.5% "A" 39.1% Magnesium Sulfate Test Loss Ral. high 15.0% 92.5% Wetting and Drying Test Loosening of Slight surface Fresh Water Ecosening of Slight surface Salt Water Surface grains Stughing Absorption 3.4% 3.5% 3.5%	Laboratory Reports: SPD Lab, March 1962 and Juna 1962 Hales Testing Lab, Sacramento, February 1962 Summary of Test Results: Mar 62 Feb 62 Jun 62	Location: One mile east of Sites, California, Colusa County, T 17 N, R L W, Sec 20 and 21, Sites 7.5' Quad. Rock Type: Sandstone (Graywacke)	Lessee: James L. Ferry & Son Secramento, Callfornia	SITES QUARRY (Cron)	
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Wetting & Drying Test Fresh Water Salt Water Absorption Petrographic Analysis	Specific Gravity (Bulk SSD) L.A. Abrasion Test Loss Magnesium Sulfate Test Loss	Summary of Test Results:	LESSEE: Teichert Construction Company 8811 Kiefer Boulevard Sacramento, California NG ECUNAMENT OCLUSING OF BRATION TOWN TITN, LOCATION: One mile east of Sites, California, Colusa County, TITN, LAT MAN, Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle. LAT MAN: Sections 28 & 29, Sites 7.5' Quadrangle.
Fractured Sth Cycle Minor Flaking 1.9-2.4%	2.45-2.47 "11" 27% 39%	Apr11 1972	alchert Construction Company Bil Riefer Boulevard acramento, California C. L.C. A.M. C. T. C. L. C. L. C. L. C. L. C. L. C. C. L. C. C. L. C. C. L. C. C. L. C. C. L. C. C. L. C. C. C. C. C. C. C. C. C. C. C. C. C.
Fractured 12th Cycle " 2.9-4.1% Chlorice and Montmorillonite	2.43-2.50 "1" 26%	July 1972 Blue Rock	rnan an ann an ann an ann an ann an ann an a

SITES (WELCH)

(23/7 A)

USE: Levee protection Upper Sacramento River. Rejected for contracts awarded after 1 October 1972.

present

GEOLOGY: In October 1972, a quarry face about 75 feet high and 200 feet long was exposed. It is a bedding plane face that slopes to the east at about 45 degrees. The top half of the face is weathered and discolored tan to rown sandstone which is unsuitable for riprap. The bottom half is fresh bluish gray sandstone. Layers of shale are interbedded with the sandstone. The shale is fissile, soft, and unsuitable for use as riprap. Results of the petrographic examination are given in the SPD Lab reports.

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#### **APPENDIX H**

#### VENADO SANDSTONE PHYSICAL PROPERTIES AND ROCK STRENGTH (DWR SAMPLES)

2.5-Inch Diameter Drill Cores from Geologic Exploration

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SHEE	
SUMMARY	

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

**PROJECT: SITES RESERVOIR** 

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

FEATURE: 2.5" DIAMETER ROCK CORES

ASTM C-97

ASTMD-2938

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	LC-2         51.3-52.0         Ss         Fresh, 45° per-bed,         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           representative of sandstone	Sites         LC-2         51.3-52.0         Ss         Fresh, 45° per-bed,         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           Fresh         representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           Fresh         representative of sandstone         5.010         2.392         2.1         58,800         Dry         13,080         Good Test         2.47	Sites         LC-2         51.3-52.0         Ss         Fresh, 45° per-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           GG         RA-1         51.0-52.3         Ss         Fresh         4.5010         2.392         2.1         58,800         Dny         13,080         Good Test         2.47           GG         RA-1         A         53.4-54.2         Ss         Fresh         4.521         2.392         2.1         58,800         Dny         13,080         Good Test         2.47           GG         RA-1         B         53.4-54.2         Ss         Fresh         4.521         2.392         2.1         59,000         Met         7,230         Good Test         2.50           GG         RA-1         B         53.4-54.2         Ss         Fresh         4.521         2.392         2.1         59,000         Met         7,230         Good Test         2.50	Sites         LC-2         51.3-52.0         Ss         Fresh, 45°         Per-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           GG         RA-1         51.0-52.3         Ss         Fresh         5.010         2.392         2.1         58,800         Dry         13,080         Good Test         2.47           GG         RA-1         B         53.4.54.2         Ss         Fresh         4.521         2.392         1.9         32,500         Wet         7,230         Good Test         2.50           GG         RA-1         B         53.4.54.2         Ss         Fresh         4.521         2.392         2.1         59,000         Dry         13,120         Good Test         2.50           GG         IC-1         35.6.36.3         Ss         Slightly weathered,         5.018         2.390         2.1         56,000         Dry         13,120         Good Test         2.50           GG         LC-1         35.6.36.3         Ss         Slightly weathered,         5.018         2.390         2.1         75,600         Dry         16,850         Good Test         2.66	Sites         LC-2 $51.3-52.0$ Ss         Fresh, 45° $4.733$ $2.365$ $2.0$ $78/700$ Wet $17,910$ $Good Test$ $2.74$ GG         RA-1 $51.0-52.3$ Ss         Fresh $5.010$ $2.392$ $2.1$ $58,800$ Dry $13,080$ Good Test $2.47$ GG         RA-1 $B$ $53.4-54.2$ Ss         Fresh $5.010$ $2.392$ $2.1$ $58,800$ Dry $13,080$ Good Test $2.47$ GG         RA-1 $B$ $53.4-54.2$ Ss         Fresh $4.521$ $2.392$ $2.1$ $58,000$ Dry $13,120$ Good Test $2.50$ GG         LC-1 $35.6-36.3$ Ss         Slightly weathered, $5.018$ $2.392$ $2.1$ $75,000$ $Wet$ $7,230$ Good Test $2.66$ $6004$ Test $2.50$ $60.1500$ $10,100$ $7,2300$ $10,100$ $7,2300$ $10,100$ $7,2300$ $10,100$ $10,100$ $10,100$ $10,100$ </td <td>Sites         LC-2         51.3-52.0         Ss         Fresh, 45° per-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           GG         RA-1         51.0-52.3         Ss         Fresh         5.010         2.392         2.1         58,800         Dry         13,080         Good Test         2.47           GG         RA-1         B         53.4-54.2         Ss         Fresh         5.009         2.392         2.1         58,800         Dry         13,080         Good Test         2.50           GG         RA-1         B         53.4-54.2         Ss         Sighthy weathered, E.009         2.392         2.1         58,600         Dry         13,720         Good Test         2.50           GG         LC-1         35.6-36.3         Ss         Sighthy weathered, expresentative of pitting         5.018         2.390         2.1         75,600         Dry         16,850         Good Test         2.66           GG         LC-1         35.6-36.3         Ss         Sighthy weathered, expresentative of pitting         5.018         2.390         2.1         72,600         Dry         16,850         Good Test         2.66</td> <td>SitesLC-2<math>51.3-52.0</math>SsFresh, <math>45^{\circ}</math> per-bed, representative of sandstore<math>4.733</math><math>2.365</math><math>2.0</math><math>78,700</math>Wet<math>17,910</math>Good Test<math>2.74</math>GGRA-1<math>5</math><math>51.0-52.3</math>SsFresh<math>5.010</math><math>2.392</math><math>2.1</math><math>58.800</math>Dry<math>13,080</math><math>600d</math> Test<math>2.47</math>GGRA-1<math>B</math><math>53.4-54.2</math>SsFresh<math>5.010</math><math>2.392</math><math>2.1</math><math>56.300</math>Dry<math>13,020</math><math>600d</math> Test<math>2.50</math>GGLC-1<math>35.6-36.3</math>SsSlightly weathered<math>5.018</math><math>2.392</math><math>2.1</math><math>75.600</math>Dry<math>16,850</math><math>600d</math> Test<math>2.66</math>GGLC-1<math>35.6-36.3</math>SsSlightly weathered<math>4.010</math><math>2.377</math><math>1.7</math><math>71.200</math>Wet<math>7,230</math><math>600d</math> Test<math>2.66</math>GGLA-1<math>B</math><math>27.8-28.4</math>SsSlightly weathered<math>4.610</math><math>2.377</math><math>1.7</math><math>21.200</math>Wet<math>1.270</math><math>600d</math> Test<math>2.66</math>GGRA-1<math>B</math><math>27.8-28.4</math>SsSlightly weathered<math>4.610</math><math>2.377</math><math>1.7</math><math>21.2200</math>Wet<math>1.270</math><math>600d</math> Test<math>2.66</math>GGRA-1<math>B</math><math>27.8-28.4</math>SsSlightly weathered<math>5.013</math><math>2.385</math><math>2.1</math><math>32.550</math><math>Wet</math><math>7.290</math><math>600d</math> Test<math>2.66</math>GGRA-1<math>B</math><math>27.8-28.4</math>Ss<math>8.6160</math><math>Dry</math><math>7.290</math><math>600d</math> Test<math>2.66</math>GGLA-1<math>5.038</math><math>2.1</math></td> <td>Sites         LC-2         51.3-52.0         Ss         Fresh, 45°         er-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.47           GG         RA-1         510-52.3         Ss         Fresh         5.010         2.392         2.1         58.800         Dry         13,080         Good Test         2.47           GG         RA-1         A         534-54.2         Ss         Fresh         5.010         2.392         2.1         58.800         Dry         13,080         Good Test         2.50           GG         RA-1         B         534-54.2         Ss         Sightly weathered, fepresentative of pitting         5.018         2.392         2.1         56.000         Dry         13,120         Good Test         2.60           GG         LA-1         B         53.633         Ss         Sightly weathered, fepresentative of pitting         5.018         2.330         2.1         7.2600         Dry         16,850         Good Test         2.60           GG         LA-1         A         27.8         Sightly weathered, febresentative of pitting         5.010         2.330         1.9         5.0150         Mot</td> <td>Sites         LC-2         51.3-22.0         Ss         Fresh, 45° per-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           GG         RA-1         510-52.3         Ss         Fresh         5.010         2.392         2.1         58.000         Dry         13.050         Good Test         2.47           GG         RA-1         8         53.454.2         Ss         Fresh         5.010         2.332         2.1         56.000         Dry         13.050         Good Test         2.50           GG         IA-1         8         53.454.2         Ss         Fresh         5.018         2.300         Dry         13.120         Good Test         2.50           GG         IA-1         8         5.018         2.380         2.1         75.00         Wet         13.720         Good Test         2.50           GG         IA-1         8         2.18         2.350         Wet         16.850         Good Test         2.50           GG         IA-1         8         2.18         2.350         Wet         16.850         Good Test         2.66           GG         I</td> <td>Sites         LC-2         51.3-52.0         Ss         Fresh, 45°         per-bed.         4.733         2.365         2.0         78.700         Wet         17.910         Good Test         2.74           GG         RA:1         51.0-52.3         Ss         Fresh         5.010         2.392         2.1         58.800         Dty         13.050         Good Test         2.50           GG         RA:1         A         53.4 54.2         Ss         Fresh         5.010         2.332         2.1         58.00         Dty         13.120         Good Test         2.50           GG         LC:1         B         35.6-36.3         Ss         Sightly weathered.         5.016         2.302         2.1         7.500         Dty         13.120         Good Test         2.66           GG         LC:1         B         35.6-36.3         Ss         Sightly weathered.         5.016         2.30         1         7.500         Mot         13.120         Good Test         2.66           GG         LC:1         B         2.78         Si         2.300         Vist         16.500         Dty         112.70         Good Test         2.66           GG         RM:1         1.1&lt;</td> <td>Stee         LC-2         51.3-52.0         Sis         Freeh.         4.733         2.365         2.0         78.00         Weit         17.910         Good Test         2.74           CG         RA1         51.0-52.3         Sis         Freeh.         5010         2.392         2.1         58.00         Diy         13.060         Good Test         2.47           CG         RA1         B         53.4 44.2         Sis         Signity weathered.         5.010         2.392         2.1         59.000         Diy         13.020         Good Test         2.50           GG         LC-1         Sis         Signity weathered.         5.018         2.392         2.1         75.00         Weit         17.310         Good Test         2.60           GG         LC-1         Sis         Signity weathered.         5.018         2.390         2.1         75.00         Weit         13.120         Good Test         2.60           GG         LC-1         A         218.238         2.19         2.300         Weit         15.700         Meit         2.50           GG         LC-1         B         Signity weathered         5.018         2.30         Diy         1.500         Good Test</td>	Sites         LC-2         51.3-52.0         Ss         Fresh, 45° per-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           GG         RA-1         51.0-52.3         Ss         Fresh         5.010         2.392         2.1         58,800         Dry         13,080         Good Test         2.47           GG         RA-1         B         53.4-54.2         Ss         Fresh         5.009         2.392         2.1         58,800         Dry         13,080         Good Test         2.50           GG         RA-1         B         53.4-54.2         Ss         Sighthy weathered, E.009         2.392         2.1         58,600         Dry         13,720         Good Test         2.50           GG         LC-1         35.6-36.3         Ss         Sighthy weathered, expresentative of pitting         5.018         2.390         2.1         75,600         Dry         16,850         Good Test         2.66           GG         LC-1         35.6-36.3         Ss         Sighthy weathered, expresentative of pitting         5.018         2.390         2.1         72,600         Dry         16,850         Good Test         2.66	SitesLC-2 $51.3-52.0$ SsFresh, $45^{\circ}$ per-bed, representative of sandstore $4.733$ $2.365$ $2.0$ $78,700$ Wet $17,910$ Good Test $2.74$ GGRA-1 $5$ $51.0-52.3$ SsFresh $5.010$ $2.392$ $2.1$ $58.800$ Dry $13,080$ $600d$ Test $2.47$ GGRA-1 $B$ $53.4-54.2$ SsFresh $5.010$ $2.392$ $2.1$ $56.300$ Dry $13,020$ $600d$ Test $2.50$ GGLC-1 $35.6-36.3$ SsSlightly weathered $5.018$ $2.392$ $2.1$ $75.600$ Dry $16,850$ $600d$ Test $2.66$ GGLC-1 $35.6-36.3$ SsSlightly weathered $4.010$ $2.377$ $1.7$ $71.200$ Wet $7,230$ $600d$ Test $2.66$ GGLA-1 $B$ $27.8-28.4$ SsSlightly weathered $4.610$ $2.377$ $1.7$ $21.200$ Wet $1.270$ $600d$ Test $2.66$ GGRA-1 $B$ $27.8-28.4$ SsSlightly weathered $4.610$ $2.377$ $1.7$ $21.2200$ Wet $1.270$ $600d$ Test $2.66$ GGRA-1 $B$ $27.8-28.4$ SsSlightly weathered $5.013$ $2.385$ $2.1$ $32.550$ $Wet$ $7.290$ $600d$ Test $2.66$ GGRA-1 $B$ $27.8-28.4$ Ss $8.6160$ $Dry$ $7.290$ $600d$ Test $2.66$ GGLA-1 $5.038$ $2.1$	Sites         LC-2         51.3-52.0         Ss         Fresh, 45°         er-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.47           GG         RA-1         510-52.3         Ss         Fresh         5.010         2.392         2.1         58.800         Dry         13,080         Good Test         2.47           GG         RA-1         A         534-54.2         Ss         Fresh         5.010         2.392         2.1         58.800         Dry         13,080         Good Test         2.50           GG         RA-1         B         534-54.2         Ss         Sightly weathered, fepresentative of pitting         5.018         2.392         2.1         56.000         Dry         13,120         Good Test         2.60           GG         LA-1         B         53.633         Ss         Sightly weathered, fepresentative of pitting         5.018         2.330         2.1         7.2600         Dry         16,850         Good Test         2.60           GG         LA-1         A         27.8         Sightly weathered, febresentative of pitting         5.010         2.330         1.9         5.0150         Mot	Sites         LC-2         51.3-22.0         Ss         Fresh, 45° per-bed, representative of sandstone         4.733         2.365         2.0         78,700         Wet         17,910         Good Test         2.74           GG         RA-1         510-52.3         Ss         Fresh         5.010         2.392         2.1         58.000         Dry         13.050         Good Test         2.47           GG         RA-1         8         53.454.2         Ss         Fresh         5.010         2.332         2.1         56.000         Dry         13.050         Good Test         2.50           GG         IA-1         8         53.454.2         Ss         Fresh         5.018         2.300         Dry         13.120         Good Test         2.50           GG         IA-1         8         5.018         2.380         2.1         75.00         Wet         13.720         Good Test         2.50           GG         IA-1         8         2.18         2.350         Wet         16.850         Good Test         2.50           GG         IA-1         8         2.18         2.350         Wet         16.850         Good Test         2.66           GG         I	Sites         LC-2         51.3-52.0         Ss         Fresh, 45°         per-bed.         4.733         2.365         2.0         78.700         Wet         17.910         Good Test         2.74           GG         RA:1         51.0-52.3         Ss         Fresh         5.010         2.392         2.1         58.800         Dty         13.050         Good Test         2.50           GG         RA:1         A         53.4 54.2         Ss         Fresh         5.010         2.332         2.1         58.00         Dty         13.120         Good Test         2.50           GG         LC:1         B         35.6-36.3         Ss         Sightly weathered.         5.016         2.302         2.1         7.500         Dty         13.120         Good Test         2.66           GG         LC:1         B         35.6-36.3         Ss         Sightly weathered.         5.016         2.30         1         7.500         Mot         13.120         Good Test         2.66           GG         LC:1         B         2.78         Si         2.300         Vist         16.500         Dty         112.70         Good Test         2.66           GG         RM:1         1.1<	Stee         LC-2         51.3-52.0         Sis         Freeh.         4.733         2.365         2.0         78.00         Weit         17.910         Good Test         2.74           CG         RA1         51.0-52.3         Sis         Freeh.         5010         2.392         2.1         58.00         Diy         13.060         Good Test         2.47           CG         RA1         B         53.4 44.2         Sis         Signity weathered.         5.010         2.392         2.1         59.000         Diy         13.020         Good Test         2.50           GG         LC-1         Sis         Signity weathered.         5.018         2.392         2.1         75.00         Weit         17.310         Good Test         2.60           GG         LC-1         Sis         Signity weathered.         5.018         2.390         2.1         75.00         Weit         13.120         Good Test         2.60           GG         LC-1         A         218.238         2.19         2.300         Weit         15.700         Meit         2.50           GG         LC-1         B         Signity weathered         5.018         2.30         Diy         1.500         Good Test

REMARKS: Rock Types - Ms=Mudstone, Ss=Sandstone, I = Interbedded Mudstone/Siltstone

DATE: INITIAL: RGJ/TEC REQUEST NO.: 99-19

DEPARTMENT OF WATER RESOURCES THE RESOURCES AGENCY STATE OF CALIFORNIA

CANALS AND LEVEES SECTION DIVISION OF ENGINEERING CIVIL ENGINEERING

> 2.5" DIAMETER ROCK CORES FEATURE:

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SITES RESERVOIR

**PROJECT:** 

201 201 201 201 201 201 201 201 201 201	2.9 2.9 2.8	4.6	2.9	3.6	4.6	3.1	0.	
ASTM C-97 SPG		};}	2.50	2.56	2.53 <sup>A</sup>	2.53		
	7 2 2	2		2	5		7	
		, ! 						
		,		1		1 <u>1</u> 1		
3987 110 日 日			-		· · · · ·		· · · ·	-
ASTM D.2938 ASTM D.3967 COMPRESSIVE SPLITTING STRENGTH TENSILE (ps) (ps)								
and the second								
MOISTURE COMPRESSIVE COMPRESSIVE STRENGTH (ps))	5703 10125		4693 9791		3980			
				 40 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 400 - 				
MOISTURE	WET		WET		DRY			
LOAD LOAD (applied to failure) (lbs.)	25650 45500		22800		19350			
trib RATIO	2.04 2.03	0.78	2.01	0.62	1.98 2.01	2.01 2.02 0.62		
	aaren 6	0, 		;	، چرې شاه مور او	; 		: :
DIAM.	2.392 2.393 2.392	2.387	2.487 2.488	2.492 2.493	2.488 2.487 2.487	2.494 2.493 2.493		
ENOTH	4.884 4.883 4.861	1.866	5.007	5.047 1.556	4.919 4.990 3.535	5.024 5.027 1.545		
воск түес	S S S	Ms	Ss	Ms	Ms sw	လိုလိုလို		
<u> </u>	75.8-77.3		56.0-57.0	46.7-147.7	140.1-141.3	70.8-71.9		
(feet)	12	163.3	26.	146.7	140.1-	70.8		Annual and an and an and an and an an an an an an an an an an an an an
с ND S S CQ			BA	B		< m U		
H C C C C C C C C C C C C C C C C C C C	GGC-LA1	GGC-LA1	GGC-RC1	2001-31 GGC-RC1	ĠĠĊ- <u>ŔĊ2</u>	<u>GGC-RC2</u>		
NO B B B C N	2001-28 0		2001-30 G	1-31	2001-32 G	2001-33 G		<b>*** ***</b>
	200	200	200	200	200	200		-

REMARKS: Rock Types Ms=Mudstone Ss=Sandstone I = Interbedded Mudstone/Siltstone A - broken and/or end pieces used for specific gravity and absorption

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SHEET 1 of 5

rgj 2001-08 ----ţ

REQUEST NO. INITIAL: DATE:

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA THE RESOURCES AGENCY

CIVIL ENGINEERING CANALS AND LEVEES SECTION DIVISION OF ENGINEERING

SITES RESERVOIR

**PROJECT:** 

2.5" DIAMETER ROCK CORES

FEATURE:

<u>6-97</u> 85 ABS	2.6 2.6 2.8 2.8	3.9	23	8,4	1	8.3 6.7	9.8	
ASTM C-97 ASTM C-97 SPG % (ssd) ABS	2.55 2.55 2.56 2.56 2.56	2.52 <sup>A</sup>	2.48 2.48	2.40 <sup>A</sup>		2.28 2.39	2.41 <sup>A</sup>	
		• •	а <sup>н</sup> т		i i			• = • =
983 NG								
ASTM P.3967 SPLITTING TENSILE ((a)					W/Yelling			
derates with the second second second			· :		. <u>.</u>	4	ΓŢ	
ASTM/D.2936 OMPRESSIVE STRENGTH (psi)	4810 9997	2184		1	i 1		-	5238
ASTMD 2938 MOISTURE COMPRESSIVE CONDITION STRENGTH (ps)	WET DRY	DRY						
LOAD (applied to failure) (lbsi)	+	800	·	. :	-   _ i . i		- I	26150
L/B RATIO	0.62 2.10 0.58	2.09	2.02		0.60	0.60		0.51 0.54 1.68 0.50
(inch)	2.394 2.394 2.394 2.394	2.390	2.491 2.491		2.478	2.488		2.493 2.493 2.493 2.493
(inch)	1,495 5.019 5.019 1.398	4.996	5.024 5.018		1.480 3.588	1.505	d same an	1.283 1.347 4.193 1.238
BOCKLABE	SS SS SS SS	5 Ms	0 Ss	0 Ms	* * *	Ss	0 Ms	4 Ms Ms
	59.9-61.0	146.3-147.5	45.0-46.0	140.1-140.0 Ms	97.1-99.0		63.0-64.0 Ms	120.4-121.4
S of the second		j	33 B					
별 <mark>알</mark>	GGC-RA1	GGC-RA1	GO-DHS-3	SSD3-4	SSD5-3		SSD8-5	SSD9-1
S. S.	2001-34	2001-35	2001-36	2001-37	2001-38		2001-39	2001-40

Ss=Sandstone I = Interbedded Mudstone/Sittstone į Rock TypesMs=MudstoneSs=SandstoneI = InA - broken and/or end pieces used for specific gravity and absorption REMARKS:

SHEET 2 of 5

2001-08 <u>6</u> REQUEST NO.

INITIAL DATE:

DEPARTMENT OF WATER RESOURCES THE RESOURCES AGENCY STATE OF CALIFORNIA

SITES RESERVOIR

**PROJECT:** 

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2.5" DIAMETER ROCK CORES FEATURE:

CANALS AND LEVEES SECTION

DIVISION OF ENGINEERING

CIVIL ENGINEERING

SHEET 3 of 5	tone/Siltstone	1 = Interbedded Mudstone/Sittstone	Ss=Sandstone		Ms=Mudstone		Rock Types	REMARKS:			1		DATE
			-			*							
NA													
	. 4	-					.į.	-				1	
2 		· · ·				0.61	2.491	1.523	Ms	26.5-27.0		2001-54 GGO-DHS4	2001-54
					e sketch)	ecimen- se	(can not obtain test specimen- see sketch)	(can not ob	Ms	57.0-57.7		2001-53 GGO-DHS4	2001-53
2.66 0.8			6861	WET	33750	1.84	2.490	4.593				1	
-		2480		DRY	4910	0.64	2.486	1.593	Ss	56.0-57.0	m	2001-52 GGO-DHS4	2001-52
						(	(did not receive sample)	(did not rec	Ss	45.0-46.0		2001-51 GGO-DHS3	2001-51
ļ			······										
2.44 3.5 2.43 3.9				,		0.56	2.492	1.398	SS				: 
+					1	503	2.492	5.021	ŝ		۵C		i
2.45 3.7	- 1 - 1 - 1					2.01	2.492	5.020	Ss	272.0-273.0	∢ ک	GO-DHT3	2001-43
2.57 <sup>A</sup> 3.9	*** <u>e</u> i		***	1		2.00	2.491	4.980	NS NS		ם י ג		.!
·	- :	-			,	1.51	2.490	3.762	Ms	206.5-207.6	<  0	GO-DHT3	2001-42
2.42 3.3			·····	1		8 <u>6</u> .0	2.49U		ŝ	1	<u>ر</u>		1
2.43 3.3	• •		5226	WET	25450	2.02	2.490	5.033	နှိုပ်		m (		:
	j	1776		WET	3630	0.66	2 491	1.641	Ss	71.0-72.2	<	GO-DHT3	2001-41
SFU (ssu) ABS			(bs))		(lbs)		(nch)	(inch)	<u>うお</u>		Q		ON
			MOISTURE COMPRESSIVE	MOISTURE	ц ц	Ú, na star		I EMCTH	жЭ	DEDTH	प	11CH	AR AR
ASTM C-97		ASTM D 3967	ASIM D-2938		(applied				Чүт				

REMARKS: Rock Types Ms=Mudstone Ss=Sandstone I = Interbedded Mudstone/Sittstone A - broken and/or end pieces used for specific gravity and absorption rgj 2001-08 ......

REQUEST NO.

INITIAL:

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SHEET 3 of 5

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES SITES RESERVOIR

**PROJECT:** 

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

76-0

% ABS

1.5 0.5

3.4 3.5 3.6 2.7

4,4

2.0

2.7

CORES	
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ETER ROCK	
AMETEI	
ā	-
2.5" DIAME	
FEATURE:	

ASTM Spg		2.42 2.42	2.43 2.44 2.46	2.49		2.50
			· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·		
ASTM D:3967 ASTM D:3967 SPLITTING TENSILE (usi)	649		1467		922	
MOTISTURE (201) MOTSTURE COMPRESSIVE STRENGT	3170 0	11988 1988 1988		4548		2816 9264 7740
MOISTURE	DRY DRY WET	DRY	WET DRY	WET	DRY	
LOAD (applied to failure) (los))	15400 1140 0	29700	<u>2740</u> 5220	22200 22400	1780 1380	45150
RATIO 10	2.00 0.57 1.95	<b>1.81</b> 2.01 2.01	0.60	2.04 1.99	0.62 0.61 0.62 2.02	2.01
D AM	2.487 2.485 2.497	2.491 2.491 2.491	2.492	2.493	2.487 2.487 2.491 2.489	2.491 2.492
(incit)	4.980	4.999 4.999 4.993	1.499	5.081 4.948	1.552 1.521 1.551 5.029	5.023
BOCKTADE (PH) (PH) (PH) (PH) (PH) (PH) (PH) (PH)	155.7-156.7 Ms Ms 176.0-177.2 Ss	316.3-317.7 Ss Ss		327.7-329.0 Ss Ss	115.5-116.7 Ms Ms Ms Ms	124.5-125.5 Ss
NO NO NO NO	2001-55 GGO-DHT1 A 2001-56 GGO-DHT1 A 2001-56 GGO-DHT1 A B	2001-57 GGO-DHT3 A			2001-59   GGO-DHT4 A	2001-60 GGO-DHT4 A B

SHEET 4 of 5 Rock Types Ms=Mudstone Ss=Sandstone I = Interbedded Mudstone/Siltstone A - broken and/or end pieces used for specific gravity and absorption

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DATE: INITIAL: <u>rgj</u> REQUEST NO. 2001-08

REMARKS:

THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

SITES RESERVOIR

**PROJECT:** 

CANALS AND LEVEES SECTION DIVISION OF ENGINEERING CIVIL ENGINEERING

2.5" DIAMETER ROCK CORES FEATURE:

ASTM C.97 PG 85 SPG 85	2.5		· · ·			
AST SPG (1980)	2.53 2.54 2.54 2.52					
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S 2 11	<del></del>	·· ·		' <b>:</b> !	· · · · ·	* 1 * 4
ASTM D. 3967 SPLITTING TENSILE TENSILE	1700	1393				
	<u>574</u> 5 8803	3856	: <del>:</del> : :	*		
			: 4			
ASTM D-2938 MDISTURE COMPRESSIVE CONDITION STRENGTH (ps)	WET WET DRY	DRY DRY				
LOAD (applied to failure) (()s;)	3200 28000 42900	18900				
1.0 MATO	0.61 2.02 2.02 1.92	1.92	i .			· · · · ·
DiAM	2.491 2.491 2.491 2.491 2.495	2.492	:			
(inch)	1.512           5.028           5.023           5.023           4.786	4.788	на (1114 раз на рад			
носк туре	6.4 Ms	7.3 Ms +	tern op 2 - <del>han</del> nd av fr		·····	
DEPTH (feet)	<u>430.5432.0</u> 535.4-536.4	556.3-557.3				
ο o L				n - r		
щ Дор И	2001-61 GGO-DHT5	GGO- <u>DH1</u>	i I		Year Vilan	41 Marco
B C N	2001-61	2001-63 GGO-DHT6	• • •	· · · ·	• . <u>i.</u>	• • • •

SHEET 5 of 5 REMARKS: Rock Types Ms=Mudstone Ss=Sandstone I = Interbedded Mudstone/Siltstone A - broken and/or end pieces used for specific gravity and absorption rgj 2001-08 REQUEST NO.

INITIAL. DATE:

Absorption	2.93 2.92	468	2.79	3.55		4.63		275	3.08	8 5	2.62	197	2.76	3.87	2.26	2.18	6.39	·	8.25	6.09	å.75				3.30	200	3.65		372	3.63	3.85		0.76	••••			147		0.47	3.5	3.36	3.55	28		
	2.56		2.50	38		2.53			11		2.55			2.52	2.46	i	2.40	+	2.28		2.41		+		2.43		5:57	2.67	345				8			_	1		88	Ε.	. 1		1		-
Tensile 5	9 19 6		10								100							+				T			2							2,480				640	1					1,467		1	8
Compressive Conected								<u>5</u> -1 - 4			. <u>.</u>																	÷																÷	
Compressive	5,703		4,093			3,980		-			4,810	9.997		2164		+-							5.238		5,226								6,961	<del> </del>		3,170			895 11				4,548	4,600	
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C-2938 Tost CC	+						1	;			- <u>-</u>					+			-	_								<u>.</u>	+-+	5					H		_	_	+		i			<b>.</b>	
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Site		Golden Gafe Curved	Stor Reservoir Gooten Gate Curved GGC-RC Sites Reservoir Golden Gate Curved GGC-RC	Goldon Gate Curved	Sites Reservoir Golden Gate Curved GG	Sites Presvor Galden Gate Curved G	Golden Gote Curved	۰÷۰۰		Ster Reservol: Golden Gote Curved	Stes Reservoir Golden Golden Gole Curved	1	Stiss Preservoir Golden Gate Cuived	Sites Reservoir Golden Gale Curved		Sites Reserveir Bolicion Gato Inlet Outle	Sitos Roterveir Neutren Socialo Dom	Ster Preservoir Northeen Sociole Ocorn	the Received - Northern Scolate Dome	Shee Reservesi i Northern Seciele	Stes Reservole Northern Sortcle Dom-	Sites Reservoir Northern Saccle Dams	Shas Reservoir Incernain Sociale Doms Shas Reservoir Northern Sociale Doms	Sters Reservoir Northern Societie Domy	Sites Reservoir Soldion Gote Inlet Cotto Sites Reservoir Soldion Gote Inlet Outlo	n elos reeles reeles el serve	Sites Receivoir Rolden Gate Inlet Outle	Stres Reservoir Solden Gate Intel Outle	Stes Deservor Scolen Gate Intel Outle GO [1413	Stes Reservor Golden Golden Reiservor	Sites Perenvoir Solden Gate In	Sites Reservoir Polition Gate tra	Stes Resorvale Solition Gate Int			Stes Reservair Polden Gate Inlet Outle; GGO-DHID Stes Reservair Baiden Gate Inlet Outle; GGO-DHID Stes Reservair Baiden Gate Inlet Outle; GGO-DHID		Man 1910 Strategic Strategic Strategics	<ol> <li>Stes Reservel: Solden Octe Intel Outle' OCO: Dit11</li> <li>Stes Reserve: Solden Octe Intel Outle' GOO-Dit13</li> </ol>	Stea Reserves Posten Gate Intel Outle SGO DHI3	Stes Reservoir Soldon Clate inter	Stlas Reserves' Solston Sister that Outer GRO-DHIS	Stes Projection Soloon Code The Stas Reservoir Solden Gode Thiel	ites Reservoir Solden Gate Inter	Stes Reservoir Soldon Octo Ir

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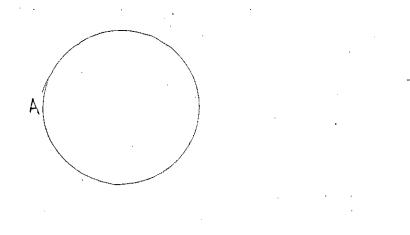
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Monturo C.3145 C.2388						_																	δ				-				Dry (no)	Dry(na)				: }						é		5						_
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Bog	100 E E	13.140	37,760	3,200	26,000	42,900			16.900	2,700				21,200	S0.150 W						N 002 FC	10070	56,600	32,500		4,499 59,000	÷					3,100		2 950	28,000	59,100			4,850	23.200	21.850 %	6,200		14,750 W		V 009/2	N 05V UV			A NY XC.
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Sample Convinents 2			;				•				2º available		1.7 available			4.5 GVOI	0	d 5 (hostured) fair		.	7 sock ends		S good sample				7.8	2	4. 3/3		7.7° avat	50		7.9*	10+1	đ	3.6	4,Y	stoak ends	sock ends	6.7" soak ends	2.5 <sup>-</sup> samples		touring n 7	4	6.5	22	*		2
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Somple Commants											Con't secure test somple		Can't secure fest somply	4 & 4.5" test	4 & 4.5 tost	con 1 get pood sample	con't get good sample	4.6	A more more		5 fair to good sample	con Inte z somples	Cut into 2 sampios	2 samples 4.5" & 5		2 samples 4.5" & 5"	Can't secure somple	fricthio	can't sectile somole. Itoctuing		cut inte two samples conit secure	cut into 2 samples 5" cood		Shecred between SS &	Cut into 2 samples (yes)	Cut Into 2 semptes (yer)	Can't secure som	Con't secure sample	3.7 & 6' sample	3.7" & 5" sampe	5 <sup>+</sup> fair to good sample	Cut into 2 samples yes		edmos podo "g	Con't tective test sampl	6" fair to good sample	alasta total			4.6" not too good
Conformor	. \$	ο.	o ; •	\$	\$	ŝ	\$	÷	-9	5		1	N	4	4	2	s	4	5	••••	5	2	ŝ		,	÷	~	,	m		n	4		ম	s	us.	5	\$	4	4	s	2		>  <del>-</del>	4	4	4	• •		4
Rock Description						-	÷				intercely wenthored	SUSSERVAIR STOTUP	surgentions fighted	Soncetone.	Sandstane.	Shale (muctione?)	well se internets	Worthead shale	Representative of	pilting.	Fresh shoke	- enorman variation	Sandstone.	Inwedhered	Sandshone.	Sandstone.	dSe poi-bed Shole in	shedr zone.	Wenthered	elons byo enors	Weatherod interbedaed sandsfore and shale	htty weathered nterbedded	sandstone and shale	interbedded dstong and shale	Sandstone, Thickly bettled (approx 50o).	dstone. Thickly	ed (opprox 500) F actured shale.	Fractured shale.	Fresh shole Thirty bedded (approx 600), some fossis.	Freah shole. Priny biochard (opprox. 600), some faste	Fresh shale. Thinky bedded (opryor 50o),	resh shale.		Sandstane.	Fossiferous Sandshone	Fossiliterous sandstone. Thinly bedded	approx 50c).	450 pert-bed	Wepthered shale 450 perp-bed	withered shale
			÷				÷					1		-		5	10 N	We	Ra		1			-			45			SCD2			200 City		3 ¥	8	000	Ľ.	2 00 0	Pood Dood	Pado Dado	ŝ		÷	FCesta	Fossi		1	×,	ž
Rock Type Rock Type (MS.* Ruddone S	Ms	2	8:0	1 8	3	3	3	Ŵ	M8	¥V V	58/MIS		Sicilities	8	33	W	₩a	NIS	ð	  i	5 2 2	8	3	8	5	8	ž		Staffals		\$kilaits	Su/Ms		Ss/Mts	8	83 ;	- W	2	2	¥	ž	Ŵ		§ Л.	8	8	2.84	NMA		ž
End Depth	116.7	116.7	9.62	200 100	332	432	432	536.4	557.3	6.73	3		^	28.4	29.0	69.2	188.9	23.8	24.9		2003	771	52.3	8		542	5		20.5		21.8	52.4		56.8	173.8	173.8	199.8	209.6	30.6	30.5	82.9	116.2		14.3	33.8	35	499	ŝ	ŝ	ŝ
Stort Stort	115.5	115.5	5 0 0	4305	430.5	430.5	430.5	535.4	556.3	550.3	ī		\$	27.8	27.8	\$	188.2	23.2	**	1	500	701	5	83.4		53.4	ž		19.7		20.7	ŝ		833	172.7	172.7	199.2	208	29.6	29.6	1.23	115.1		19.5	\$3.4	34.3	Ş	842		18
Drill Hole	PLHO-CHI4	SGO-DHIA	PCO Dida	XCO-DHT5	300 DH2	STHC-ODE	SCO-DHT6						GGLA-2	CGLA-1	GGLA-1	ଡଣଦା	GGLA-1	GetC-1	10.50	, ,	69001	140100	CCRA-1	GGPM-1		GGRA-1	1.000		HOLA-1	-	HOLA-1	I-AIOH		L-AJOH	HOLA-1	HOLA-1	HOIA-1	I-VIOH	HOLC-J	HOLC-1	HOLC-1	HOLC-1		1-980H	HORA-1	HORA-1		1-Value		HORC-1
å	Ster Reservoir Solution Gode Inter Outer GGO-OH14	olden Gote Intel Culter (	Man Gate Inlet Carles 1	iden Gote Inlet Oxfo 6	Idan Gate Inlet Outlet C	Iden Gate Inlet Outle C	Solden Opte Inlet Outle, COO DHIS	Polden Gate Inlet Oute: GGO-DHI6	Edidan Gate Inlet Outlei GGO-DH16	Soldon Gate Inlat Dute GGO-DH16	Golden Gate Straight		Goldon Goto Straight		<i>i</i> ,	Goldon Gato Sholght	Golden Gate Skaight	Golden Gate Straight			Golden Gote Straght		Golden Gate Straight	Goldno Gote Strainht		Golden Gale Straight	Colden Gole Stolinet		Owens		SMONS	Swens		Owens	Owens	Owers				Owens	Smens	Owens		Owens	Oward	Ówens		super-		Swens
Project	Stor Posonoir 30	Stes Reservoir 10	Sites kesekvolt	Strefterenting 20	Stes Reservoir Co	Sites Reservoir Po	Sites Reservely Ed						Stat Rosinveir	biles Peservoir	Silor Posevok	Stor Parenvoir	Siles Peservoir G	Siles Reservoir 6	1		Ster Peranoli O	- 7	Stes Reservoir G	Stes Brackvinit G	- 1	Stes Peservolr G	Shar Donarunia	ş-	Colusa Reservat		Coluro Receiver	Coluso Reserver		Coluca Reservoir	Coluso Peservoir	Calusa Reservoir	Column Passavoir	1990C-100 Cokisci Resonreoir	999C-101A Cokisa Reservoir	Cotaci Reservoir	Coluca Reservoli	1799C-108A Cotudo Reservoir		1009C-104 Coluso Reservoir	Coluso Reservoir	1999C-10/4 Colusa Reservali	10000 M3 Colum Barnels	1000C-MS Colum Beaning		19990-109 Coluca Received
Bryte Code	2001-59C	2001660	2001-005	ALAL DOC	2001-618	2001-61C	2001-61D	d and	L				1999C-25	1999C-84A	1999C-54B	19990-85	19990-86	1990C-87	<b></b>		66-0666		19090-91	10000-076		19990-928	10001		19900-94		56-C0061	1999C-95		19990-97 (	10090-084	1990-7669	10002-001	19990-100	1999C-301A (	19000-1018	19990-102	V VOIT-Dookst		1000-101	10000-105	1999C-105		Number of State		19990-129

Page 2

Absorption	0.20	4.70	1.00
	2.74	2.43	2.65
Fendle			
Compositive Corrected			
Compressive	D16'21	16,310	17,870
Test Commans Competitive	Good Test	Good Test	Good Fest
Mediture C-3148 C-2738	Nel Nel		à
C-3148		DRV Dry/Wet	
Volshure	WET	ρű	DRV
tood feit Type	Tinius Oten	Tinkus Oteen	Tinius Olsen
Loosi	78,700	73,400	80,300
Sample	569 4.393 76.700	S27 4.501 73.400	509 4.494 20,300
Somple		223	<u>8</u>
a Somple Somple Dry Somple Somple	\$25	<b>%</b> 3	8
vos skornos w vigiew	326	BQ5	\$
Sample Sample Sample Somple Somple Sample	2.00	2.10	2.10
Sample			
Sample Longth C	0.70	8	08.0
Sample Commants 2	7.8	<b>3</b> 38	7.5
Sample Comments	4.7° good sample	elitimos poot ș	e, ŭoca samble
COMMUNE 1 Another Anterest An environment An environment An environment	v	یں۔	ca
Rack Description	450 per-bed. Representative m sondstone.	450 per bed. Representative of sandstone.	dão pertod Poperentative of emotione
Rock Type (MS = mustore SS = sondtore)	Я	Я	ä
54 Deeph	8	54 E	8
Start	513		61.2
이어 몸-1	rc ?	KOLC-1	HOLC:2
9 83	Sites		Owens
Project	999C-110 Sifes Reservoir	900C-111 Coluid Reservoir	10000-112 Colusa Reservati
Bryte Code	1990-110	III-Doool	10000-112



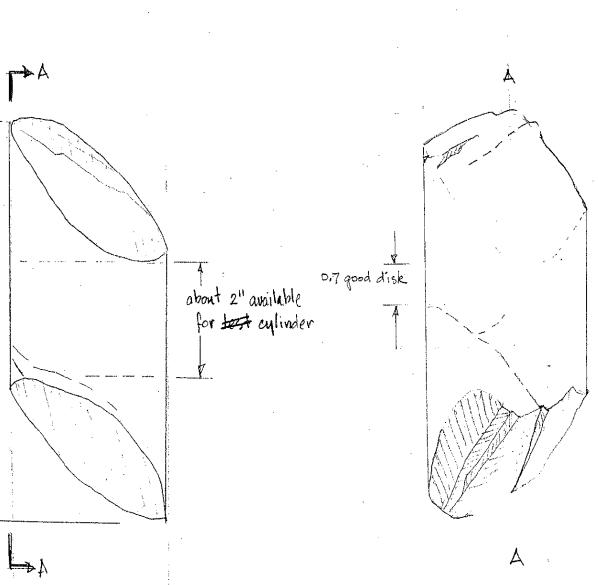
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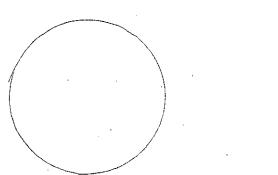
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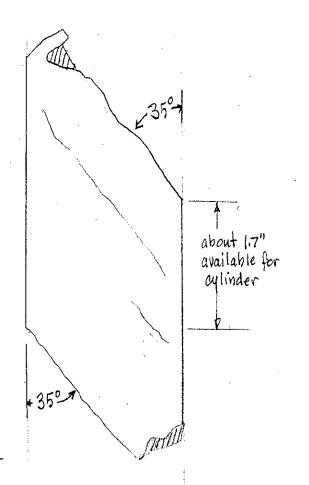
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LAB # 99C - 82 ROCK DESCRIPTION: intensely weathered saud/SILT STONE (brown) HOLE : LA-1 DEPTH: 61~6.4

GOLDEN Gates



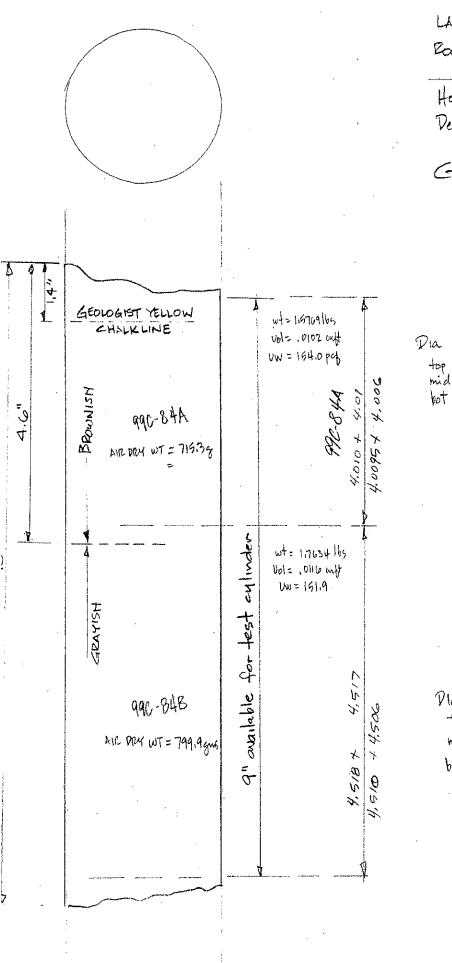




LAB # 99C-83 BOCK DESCRIPTION: infunsely weathered sand/sult stone (brown) HOLE: LA-1 Repth: 4.7~7.0

Golden Gate

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LAB # 99C - 84

ROCK DESCRIPTION : Soustone

Hole: LA-1 Depth: 27.8~28.4

Golden Gete

2,376

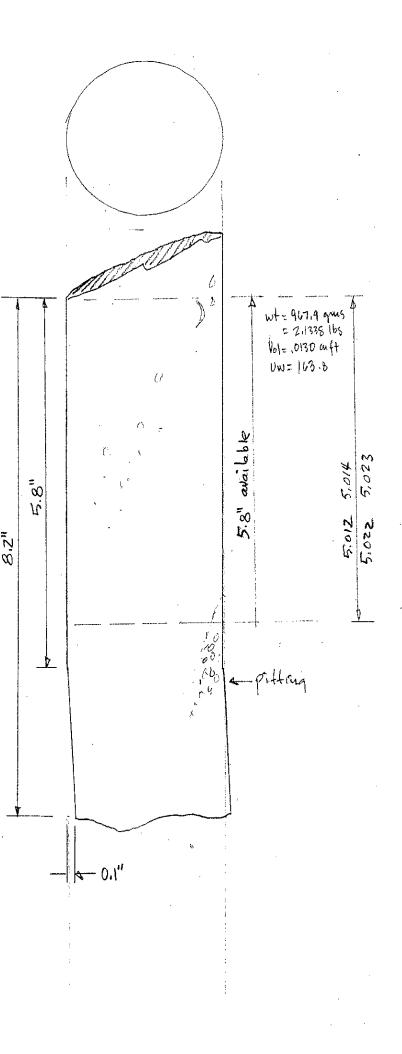
21379

L = 4.01 D = 2.377Area = 4.4376 L/D = 1.69 + 21,200 lbs

> $L_{avg} = 4.51$   $D_{avg} = 2.3390$  Area = 4.499Load = 50150 lbs

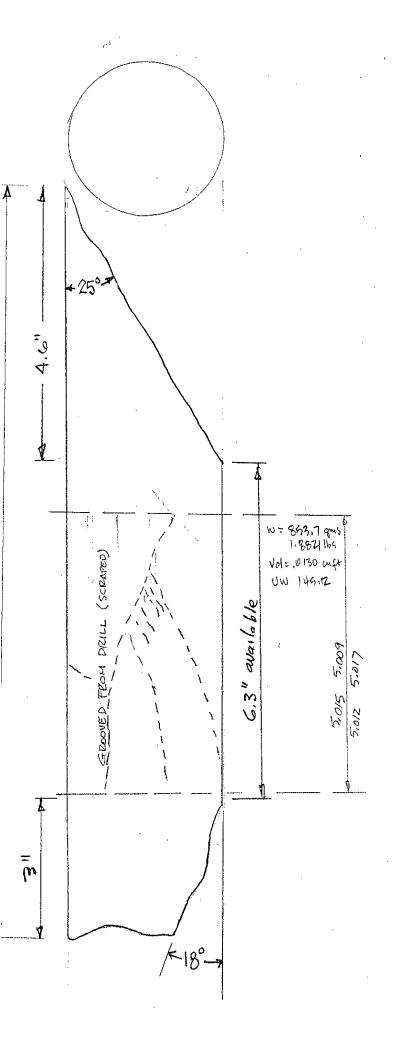
Comp Str =

Pla top 2,2799 mid 2,378 bott 2,382



LAB # 990-88 ROCK DESCRIPTION: Soustone (representative of pitting) Hole: LC-1 Depth: 35.6~36.3 Golden Grate

 $L = F_{10}18 \qquad 4/D = 2.10$   $D = 2.390 \qquad 4/D = 2.10$   $Tia \qquad 4vea = 4.486$   $to P 2.392 \qquad boad 75600$   $mid 2.390 \qquad boad 75600$  fott 2.389

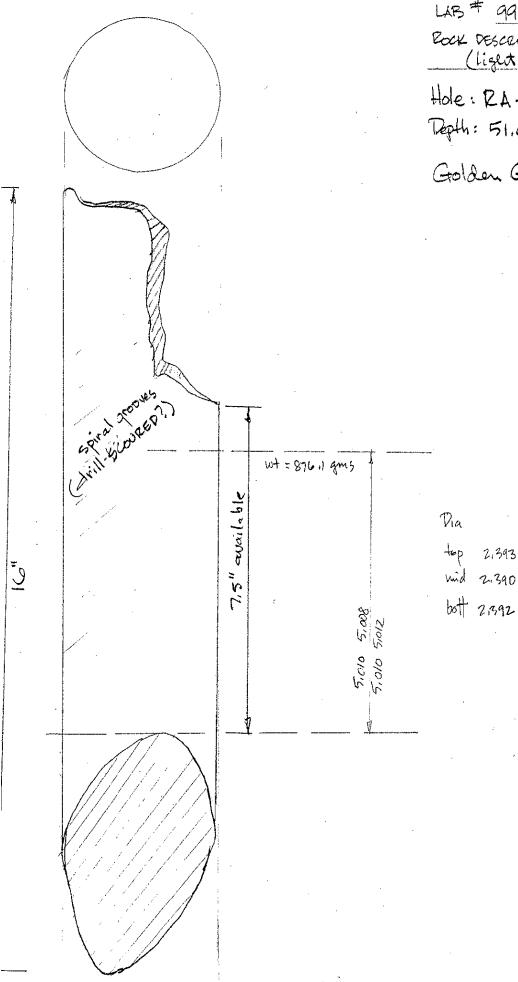


Golden Gate 5,013 awg L= Dia aug D= 2,385 top 2:3824 frea = 4.468 mid 2,383 4/0= 2,10 bott 2.387. 32660 lbs

ROCK DESCRIPTION: Neathered Sandstone

Depth: 16.2~17.2

LAB # 990-90

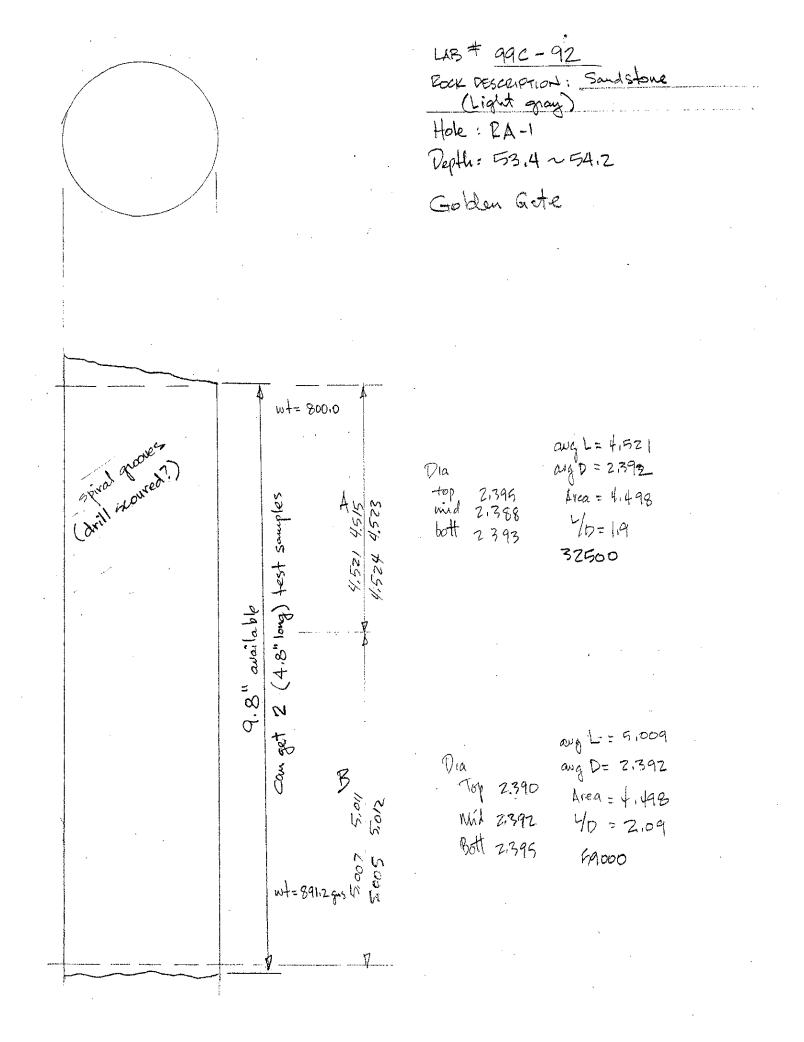


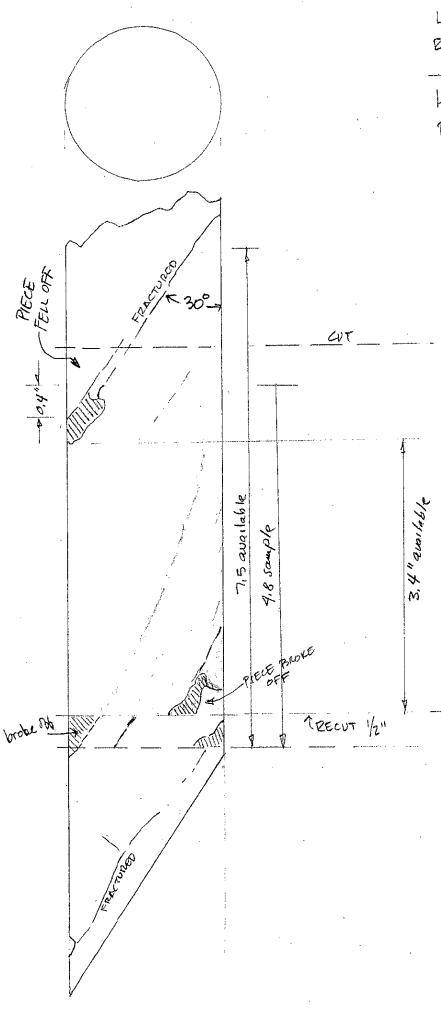
LAB # 99C-91 ROCK DESCRIPTION: Sand stone (light gray) Hole: RA-1 Repth: 51.0~52.3

Golden Grate

aug L = 5,010 aug D = 2,392 Avea = 4,494# 40 = 2,09

58800



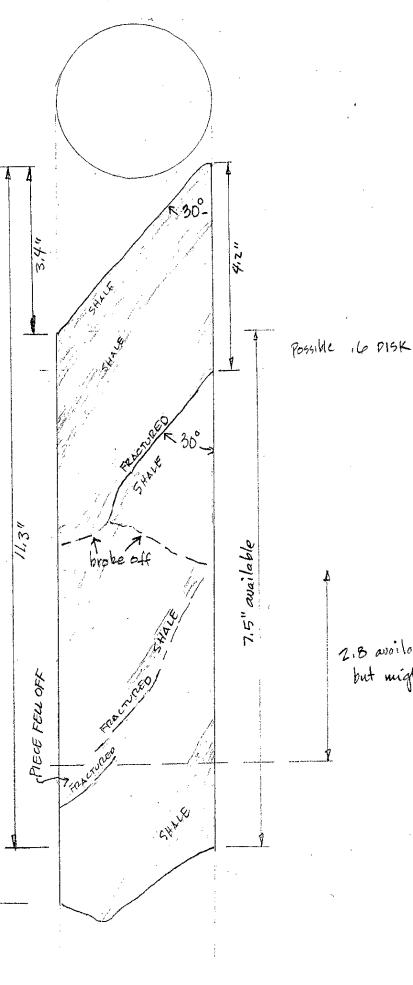


LAB # 990-94 POCK DESCRIPTION : \_\_\_\_

#### Hde: LA-1 Depth: 19.7~20,5

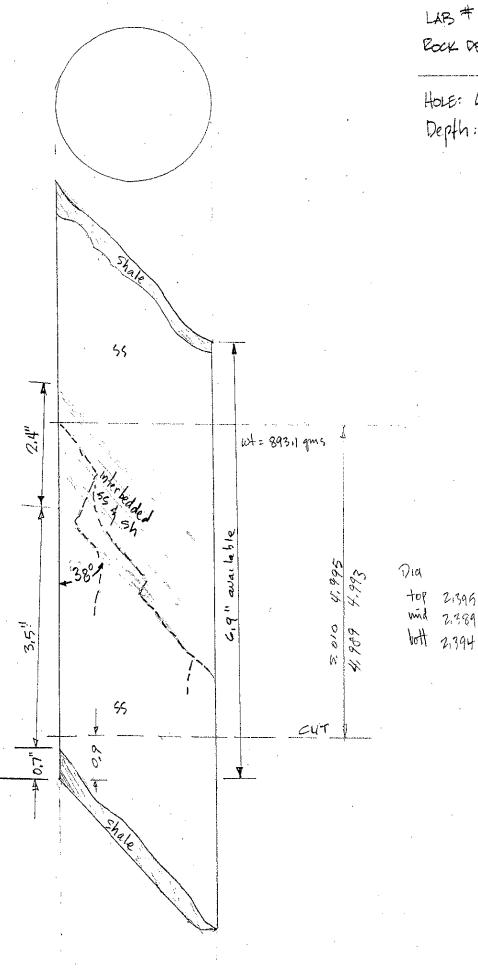
ĥ

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LAB # 990-95 ROCK DESCRIPTION: Webthered interbedded 55 \$ 5h Hole: LA-1 Depth: 20.7~21.8

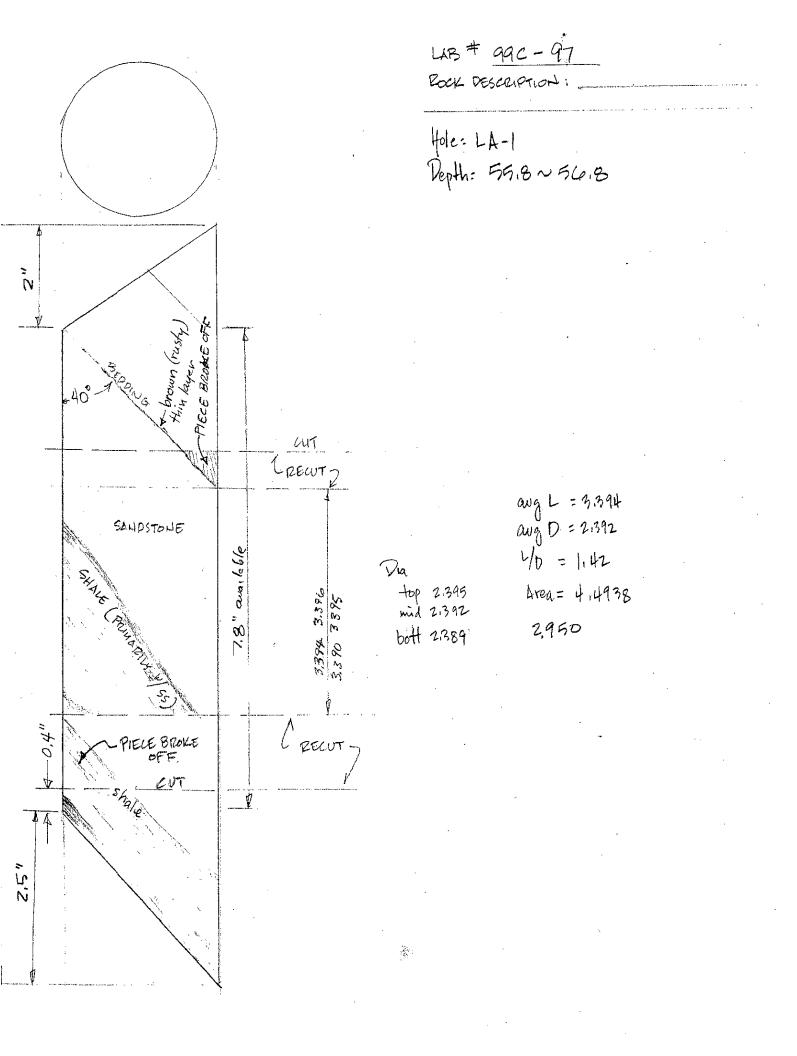
2.8 avoiloble but might separate

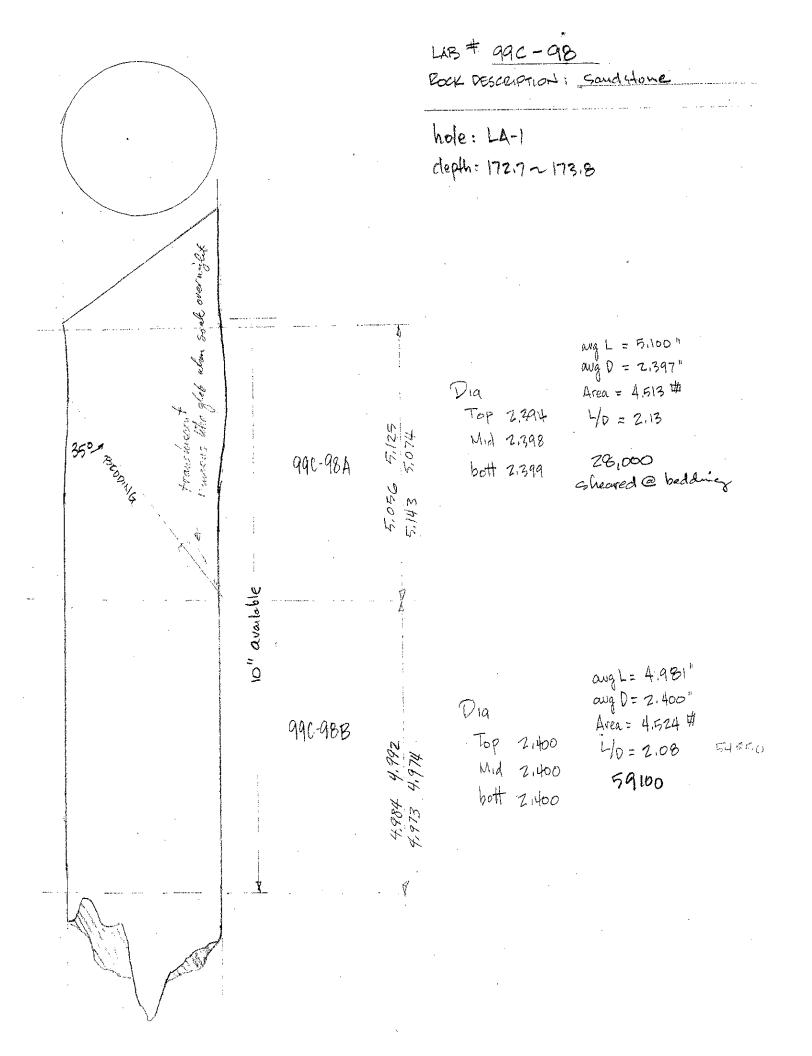


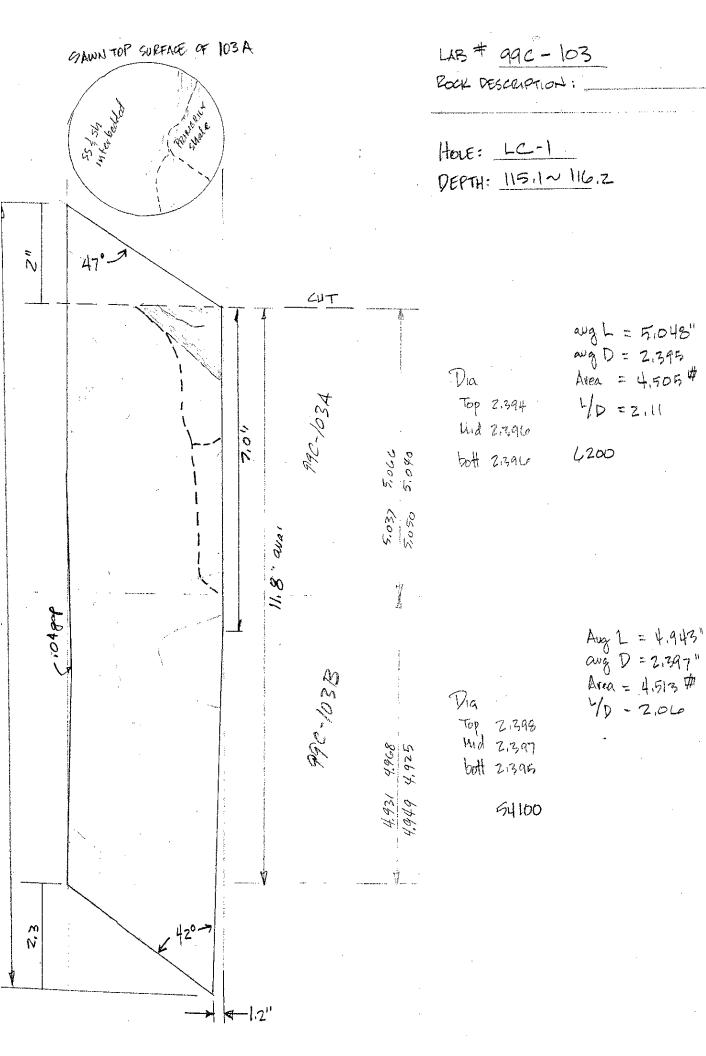
LAB # 990-96 POCK DESCRIPTION : HOLE: LA-1 Depth: 51.5~52.4

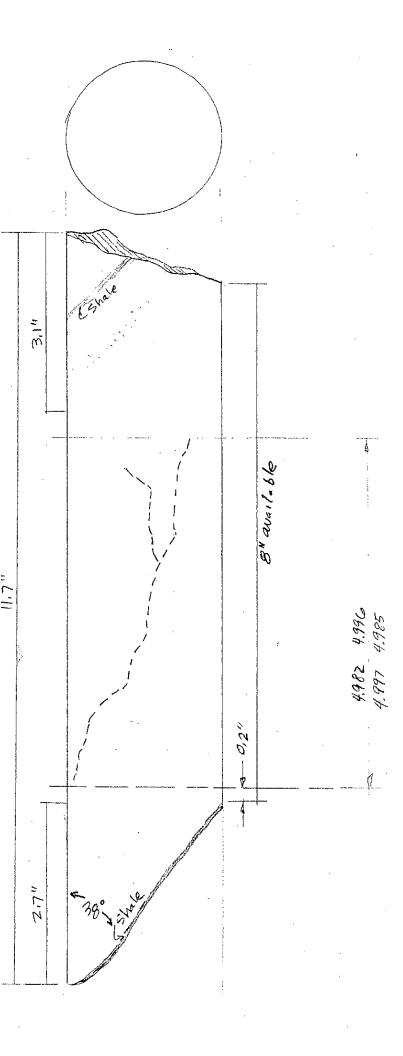
3100/65

aug L = 4.997"aug D = 2.393"Area = 4.498# 4/0 = 2.09









LAB # 99C-104 ROCK DESCRIPTION : Sandstone (brown)

HOLE: RA-1 DEPTH: 13,5~14,3

aug L = 4.990 aug D = 2.395 Area = 4,505 # L/D = 2.08 14750

Via

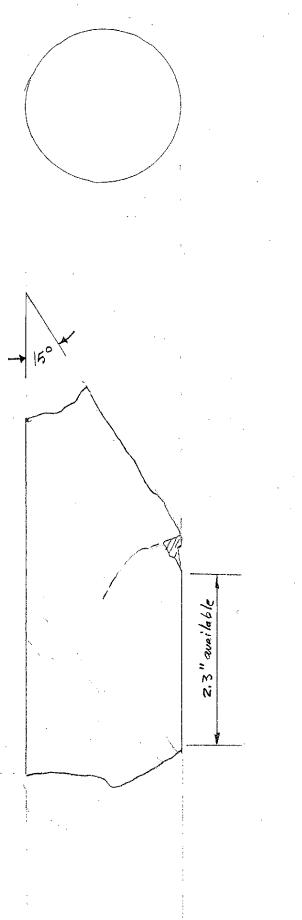
Тор

mid

2,394

2,399

bott 2,392



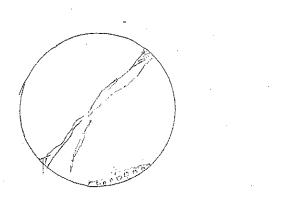
×.8 \*

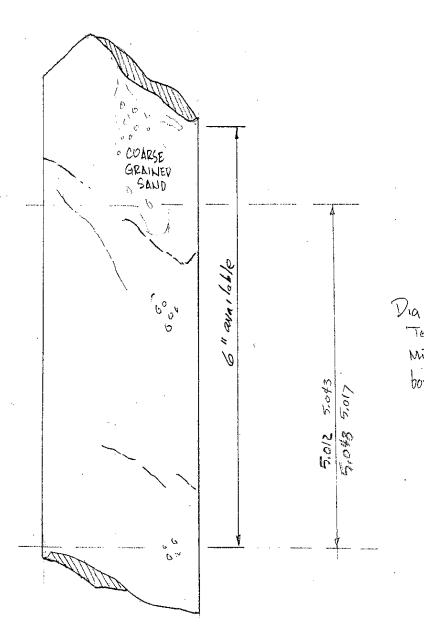
LAB # 99C-105. ROCK DESCRIPTION: Fossiliferous 55

HOLE: RA-1 DEPTH: 33,4~33,8

4

.





LAB # 99C-10Co ROCK DESCRIPTION: Fossiliferous 55

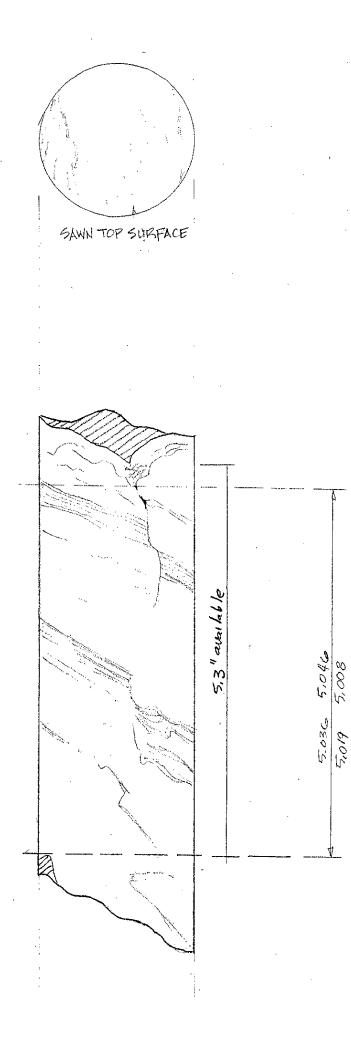
HOLE: RA-1 DEPTH: 34,3~35,0

7600 lbs

ωg L= 5,030 ang D= 2,381 Area= 4,453# L/D= 2,11

Top 2:381 Mid 2:384

bott 2:379



LAB # 99C - 107 ROCK DESCRIPTION :

HOLE: RA-1 DEPTH: 69.1~69.6

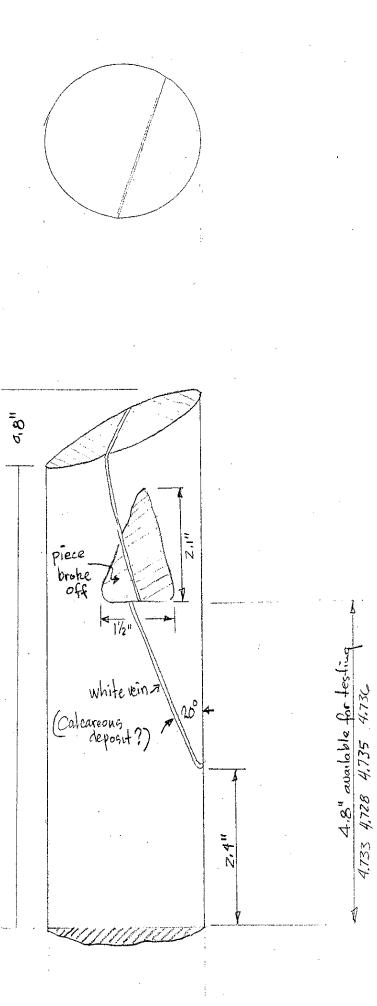
aug L= 5,027 and D= 2,391 Area = 4,490 4p=2,10

bott 2,392

40690168

Top 2,390 mid 2,391

Viq



LAB # 99C-110 ROCK DESCRIPTION : Sandestone

## HOVE: LC-2 Depth: 51.3~52.0

Sites

Dia

Top mid

bott

2373 2,362

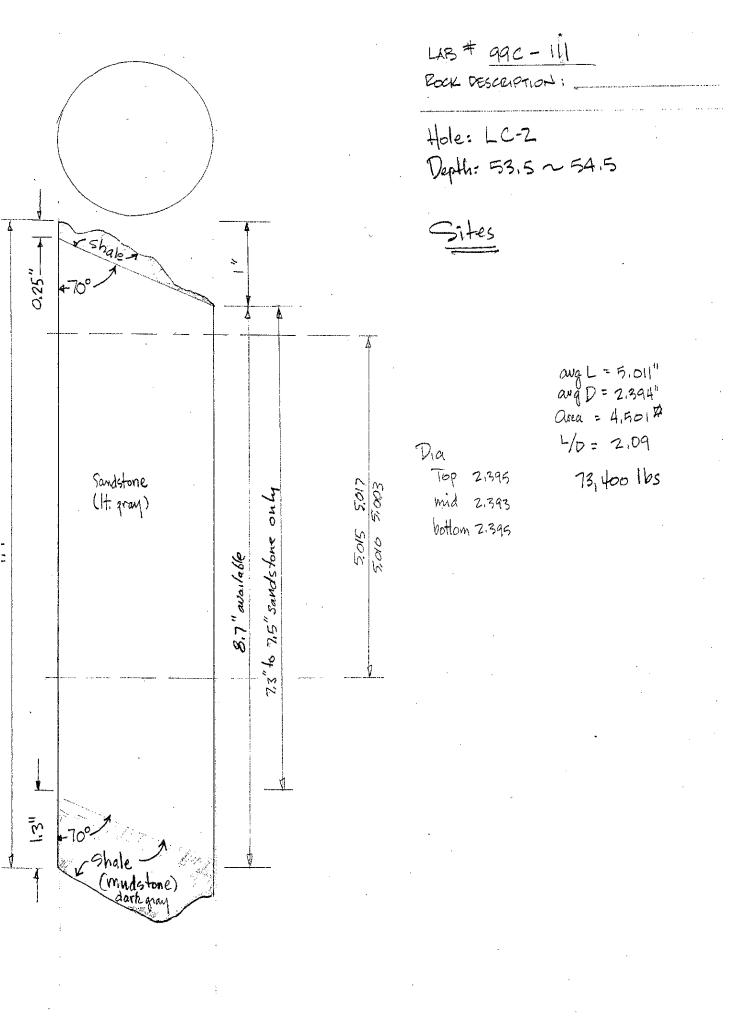
2:361

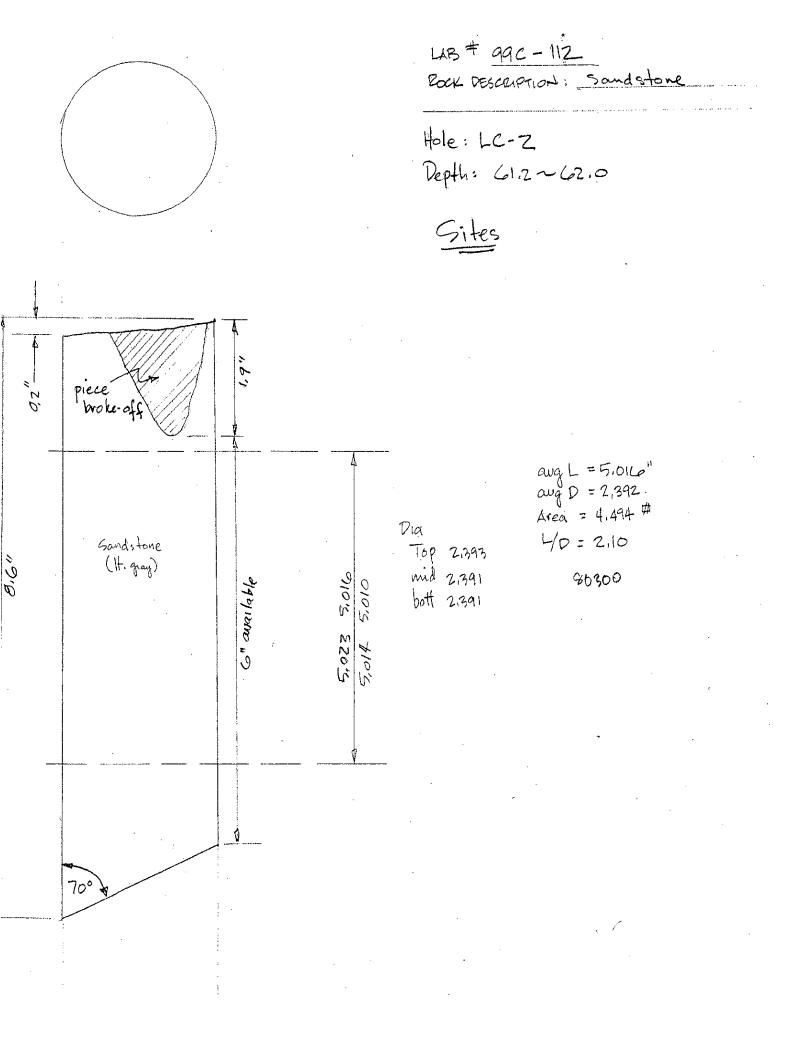
.

owg L = 4.733"

aug L = 4.733'' aug D = 2.345'' Area = 4.393 #L/D = 2.00

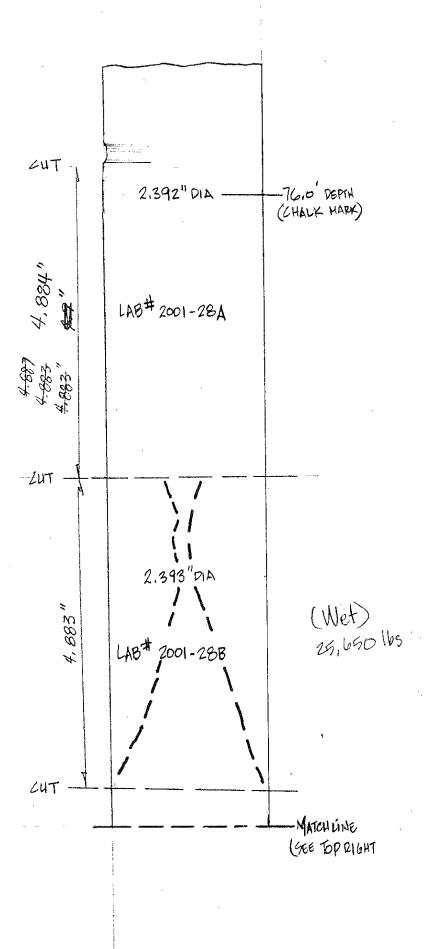
78700

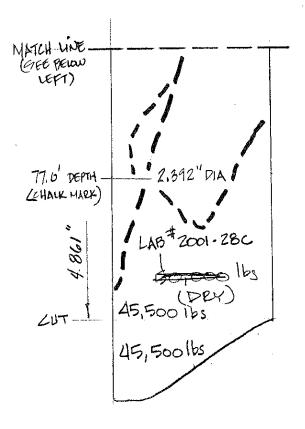




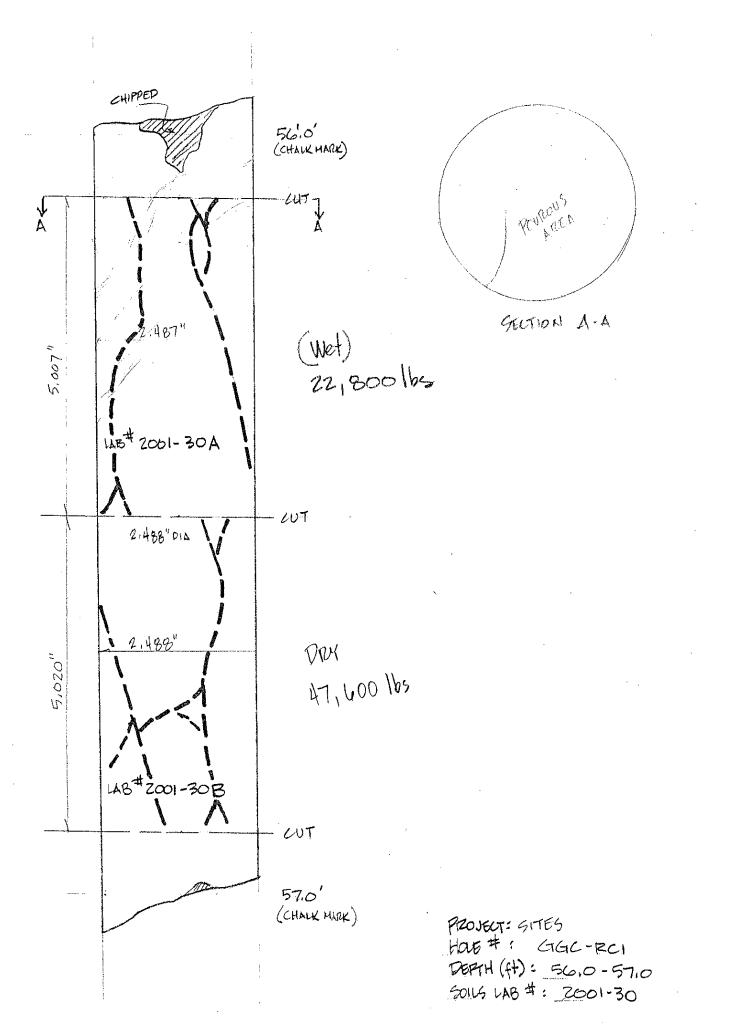
	r Iltier 's)		seteu )	condi				D 2938 1	Unconfined Compr	essive Stren	<b>at</b> h	
	WH in Air (55d condition (grus)	230°E	wt in water (guns)	5PC7 (55000	olo abs	REMARKS	Moustare condition	4/D RATIO	LOAD (165)	AREA #	COMP. STR. (PSI)	
'C-111	895	856	627	2,43	4.7	6000 TEST	DRY	21	73400 4	4.501	16310	
-112	936	921	569	2.55	ا،نه	GOOD TEST	DRY	21	803004	4.494	17870	
-110	928	926	589	2.74	D.2	GOOD TEST	Wet	2.0	78700 <sup>A</sup>	4,393	17910	
-98A	985	965	409	2.62	2.1	EAILED @ bedd ing	wlet	2.1	28.000	4.513	6200	
-98**	931	901	544	2.64.	3.3	GOOD TEST	<b>D</b> H	2,1	59100 <sup>A</sup>	4.524	13060	•
-91	901	869	630	2.47	37	6000 TEST	PRY	2.1	588004	4.494	13080	
-922	821	793	493	2,50	3.5	GOOD TEST	Wet	1.9	32500 <sup>A</sup>	4.498	7230	
-92B	914	884	549	2,50	3,4	GOOP TEST	Dry	21	59000 <sup>A</sup>	4.498	13120	۰.
-106	·						Pry	2,1	7600	4.453	1710	
-88	978	964	610	2.66	1,5	6000 TEST	Dry	2,1	75600	4.486	16850	
-844	732	706	441	2,52	3.7	GOOD TEST	Wet	177*	212004	4.438	4725/4620*	
-84B	923	793	494	2.50	3.8	6000 TEST	Ory	1.9	50150	4.449	11270.	
-104	892	848	525	2.43	5.2	GOOD TEST	Wet	2,1	14750	4.505	3270	
-90	884	839	517	2.41	5.4	GOOD TELT	Dry	2,1	32550	4.468	7290	
-107	908	859	5037	2,45	5.7	GOOD TEST	Dry	Zrl	40660	4.490	9050	
89						GOOD TEST	Dry	2.1	24200	4.486	5390	
-103A	944	914	571	2.53	3.2	shale beddin gave up first	Wet	211	6200	4.505	1380	
-103B	954	939	591	2.63	1.6	GOOD TEST	Dry	2.1	, 54100	4,513	11990	
-102						GOOD TEST	Pry	2.0	21850	4.498	4860	
-109						°.	Dry	19	39700	4.490	8840	
- 101A						GOOD TEST	Wet	1.6*	4850	4.475	1084/1050*	
- 101 B						GOOD TEST	Dry	2.1	23200	4.464	5200	
- 87			-			GOOD TEST	Dry	1.9	5250	4.468	1180	
-96		-				GOOD TEST	Dry	2,1	3100	4.498	690	
-97	621	590	369	2.46	53	Sheared between 55 f Sh	wot	1.4*	2950	4.494	656/630*	
*	correct	d for L	10 22,	see formul	la, sec			/ (0.88+	(0,24岁/内))			

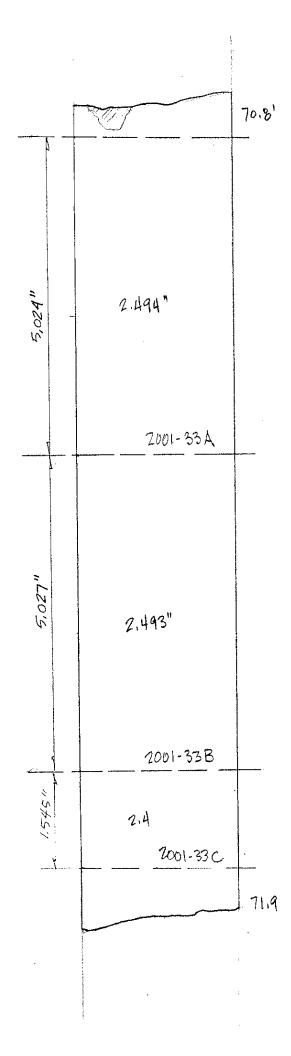
\* corrected for 40 < 2, see formula, section 1,19 (= (a) (= (b) (



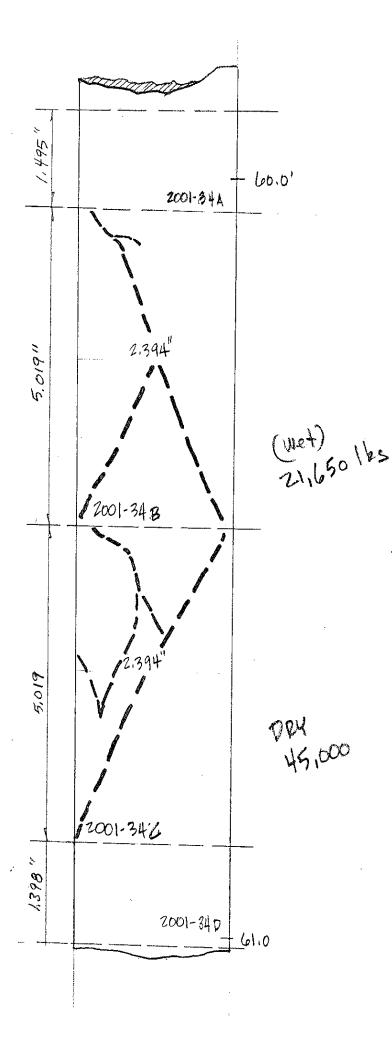


PROJECT: GITES RESERVOIR-HOLE #: GGC - LAI DEPTH (ft): 75.8 -77.3 SOING LAB #: 2001-28

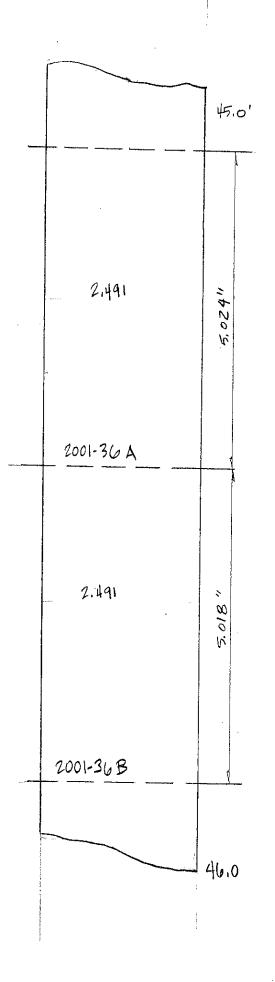




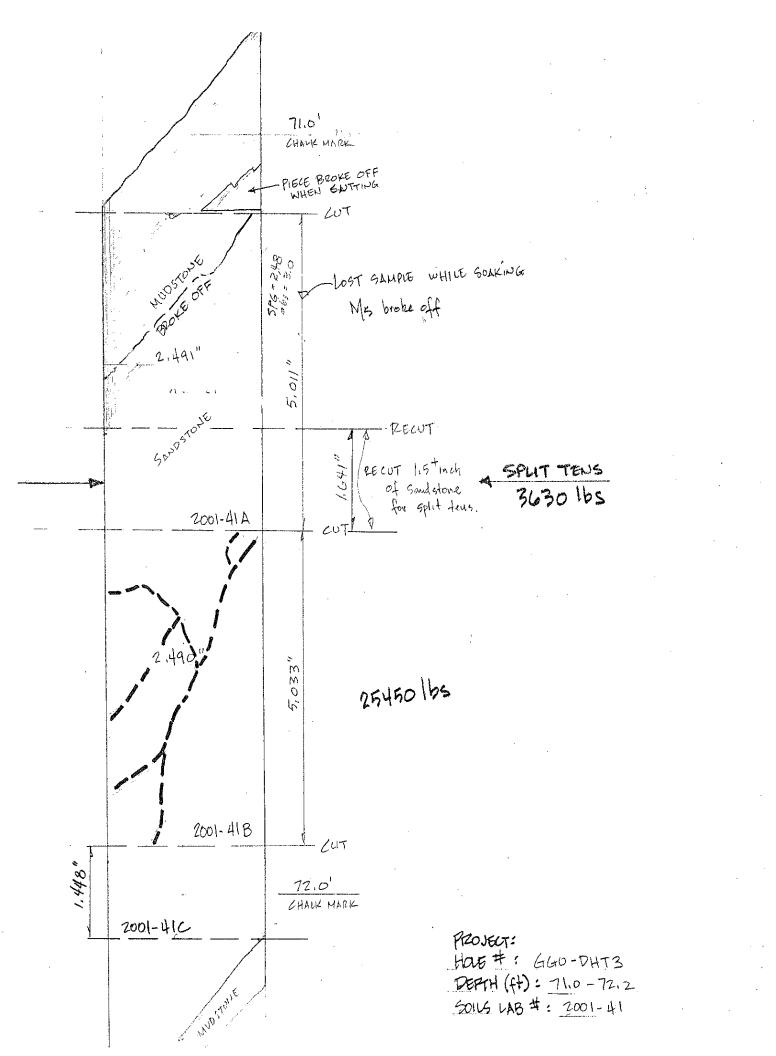
PROJECT: GITES HOLE # : GGC-RC2 DEPTH (ft) = 70.8 -71.9 SOILS LAB # : 2001-33

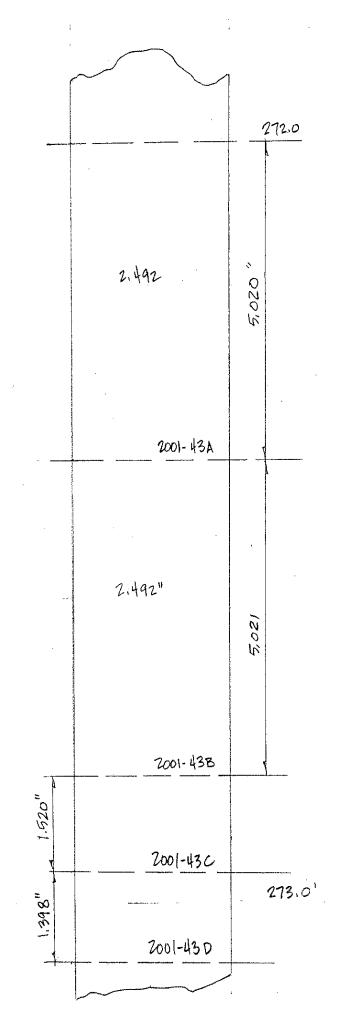


PIZOJECT: HOLE #: GGC-PAI DEPTH (ft): 59.9-61.0 SOILS LAB #: 2001-34 - Andrew Martin

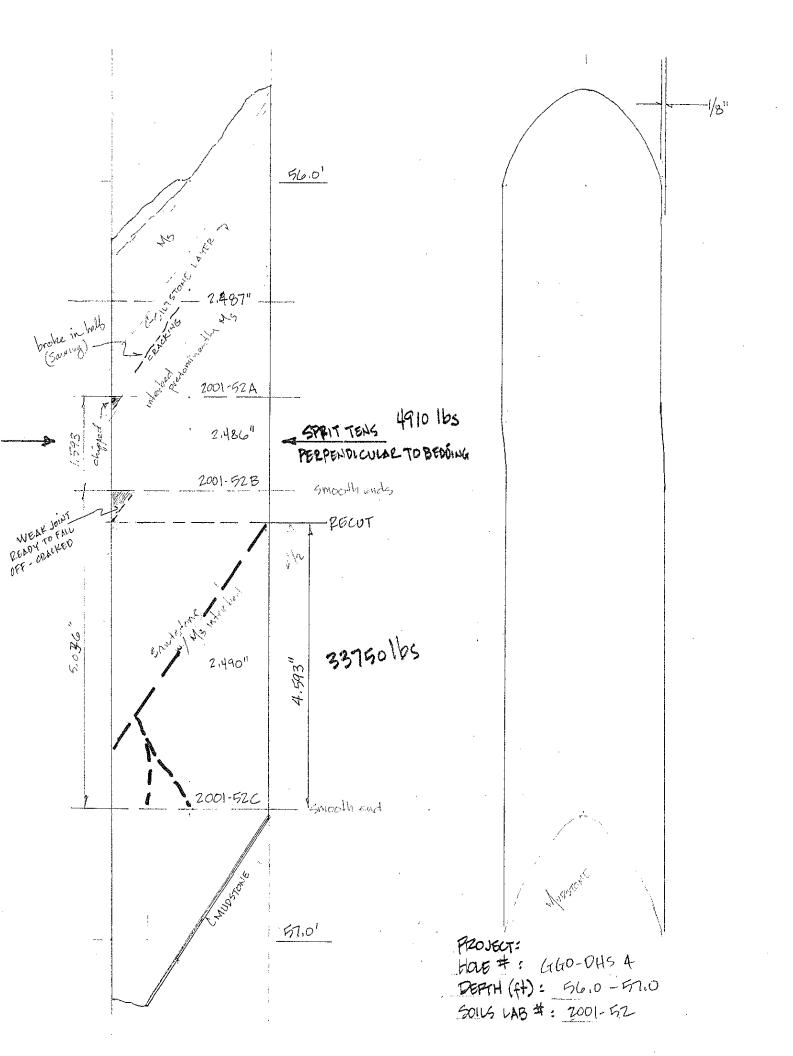


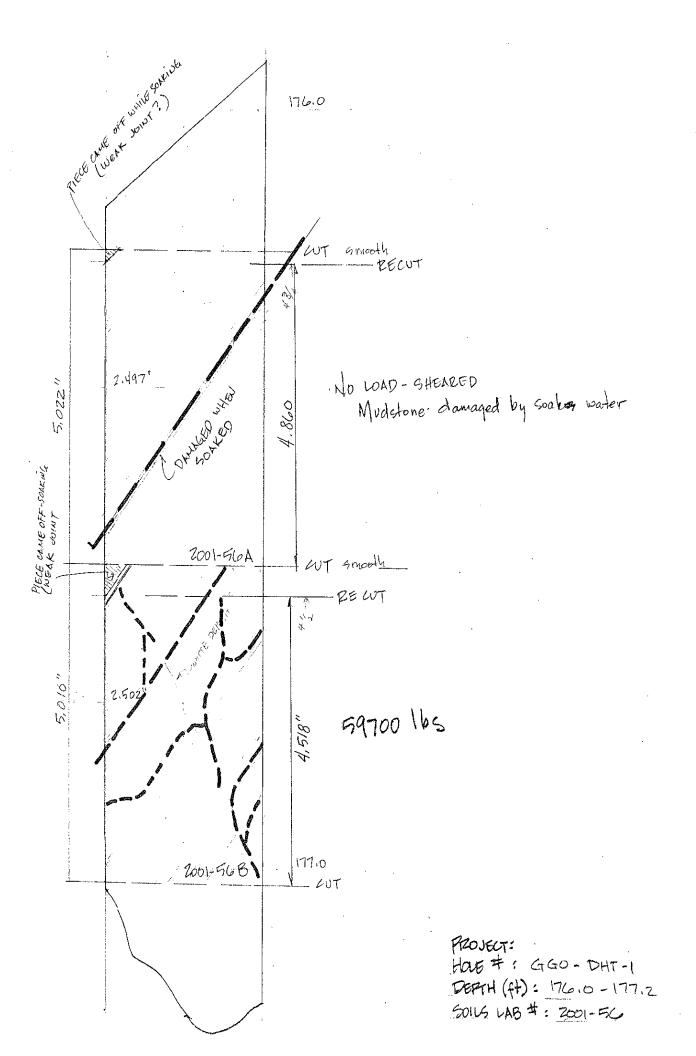
PROJECT: HOLE # : GGO - DHS - 3 DEPTH (ft) : 45,0 - 46.0 SOILG LAB # : 2001-36

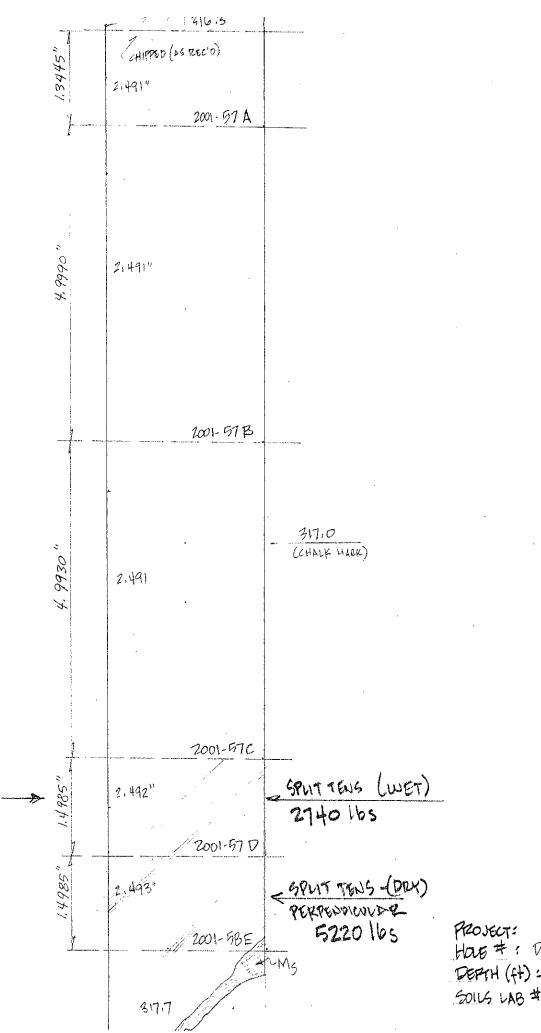




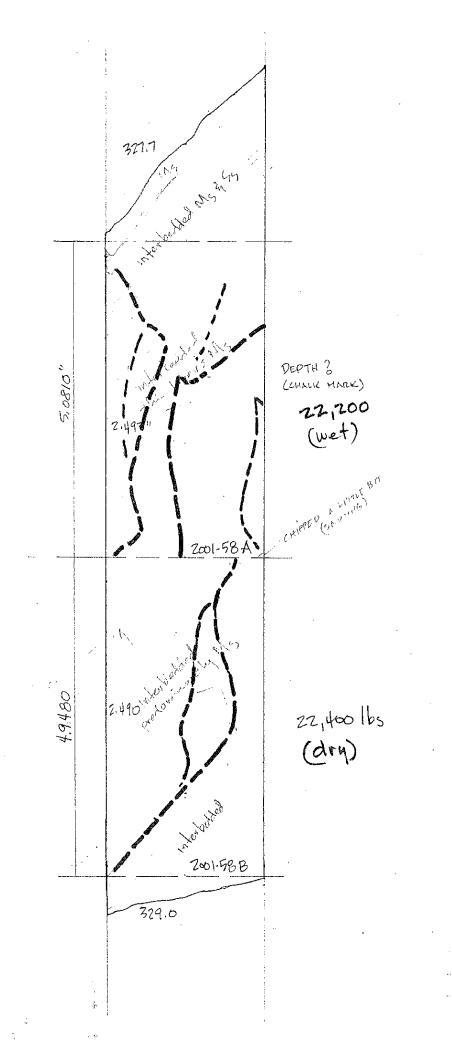
PZOJECT: Hat #: GGO DHT 3 DEPTH (ft): 272.0-273.0' 50116 LAB #: 2001-43



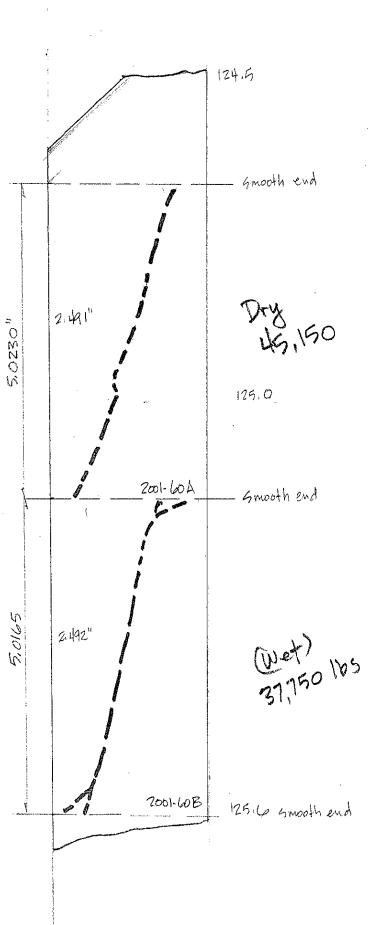




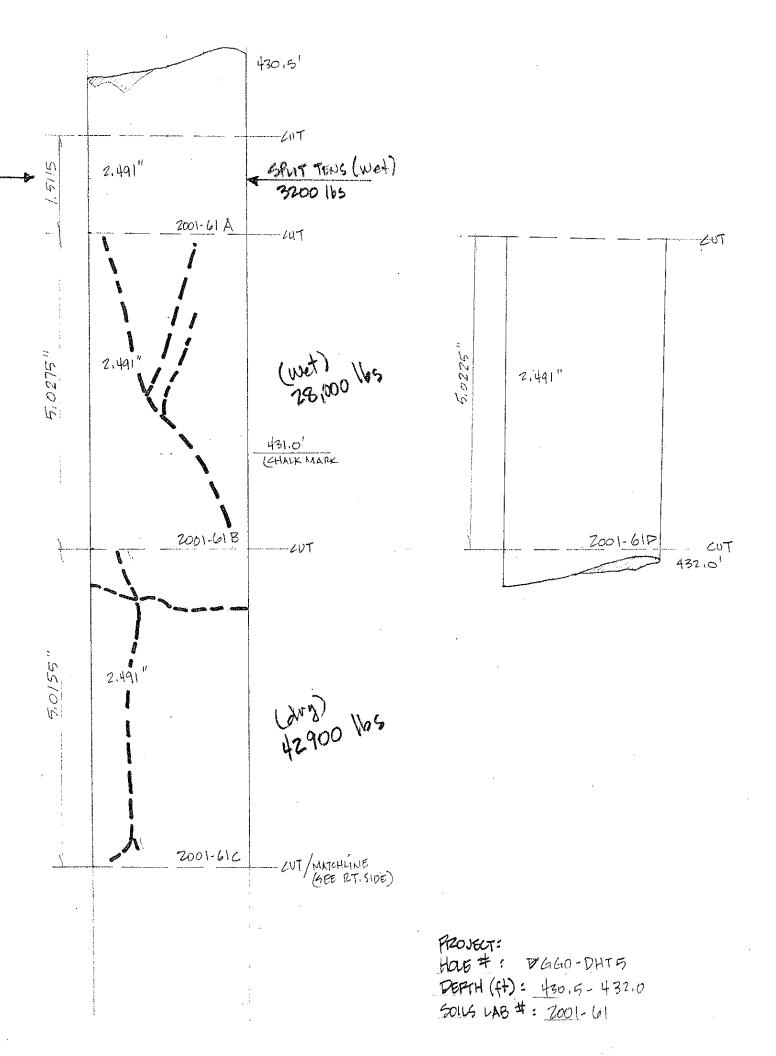
PROJECT: HOLE # : DHT-3 DEPTH (ft): 316.3 - 317.7 SOILS LAB # : 2001-67



PIZOJECT: HOUE # : 660-DHT3 DEPTH (ft): 3727.7-329.0 SOILS LAB # : 2001-578



PROJECT: Have #: GGO-DHT-4 DEPTH (ft): 124.5-125.5 SOILS LAB #: 2001-60



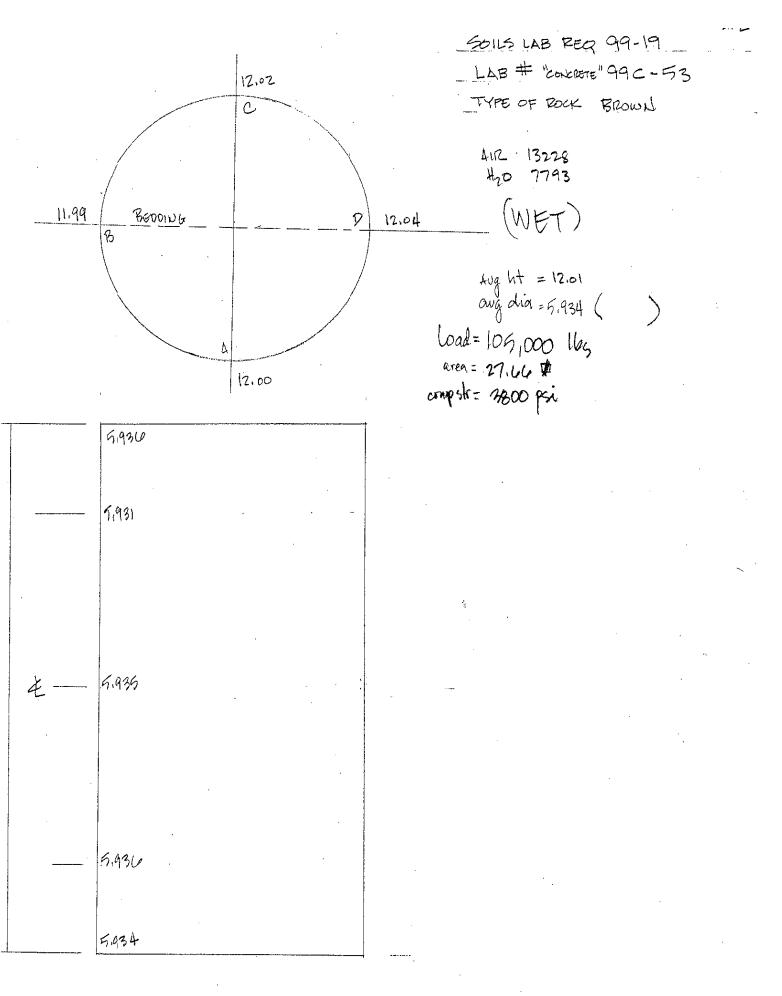
6-Inch Diameter x 12-Inch Long Cores from Sites Quarry

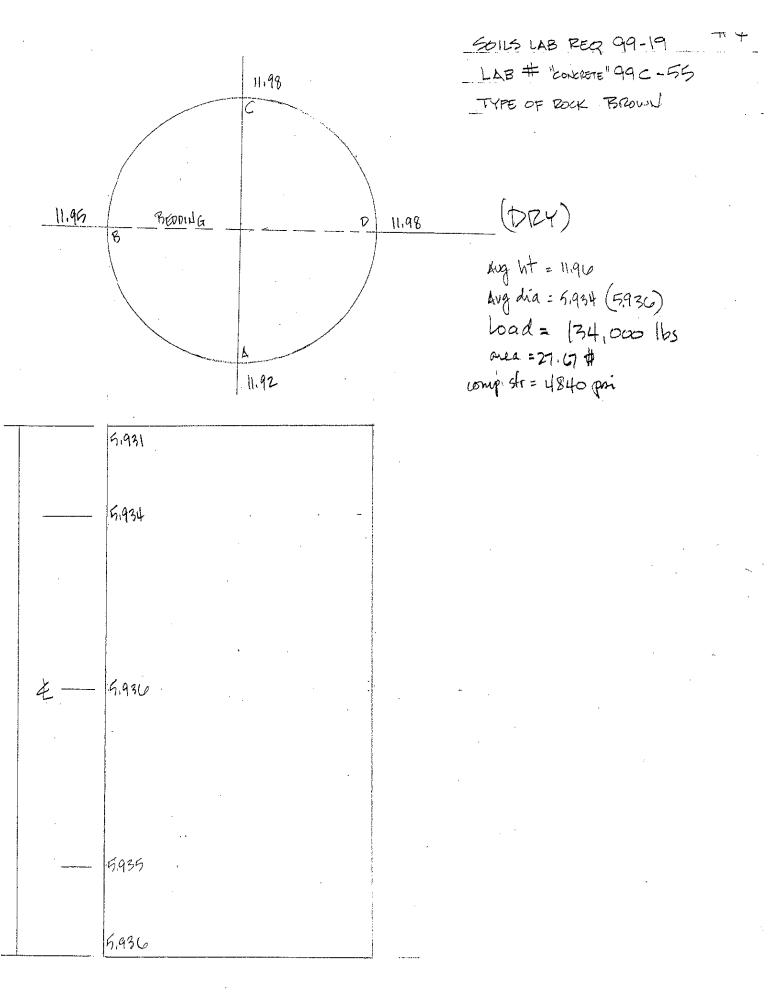
.

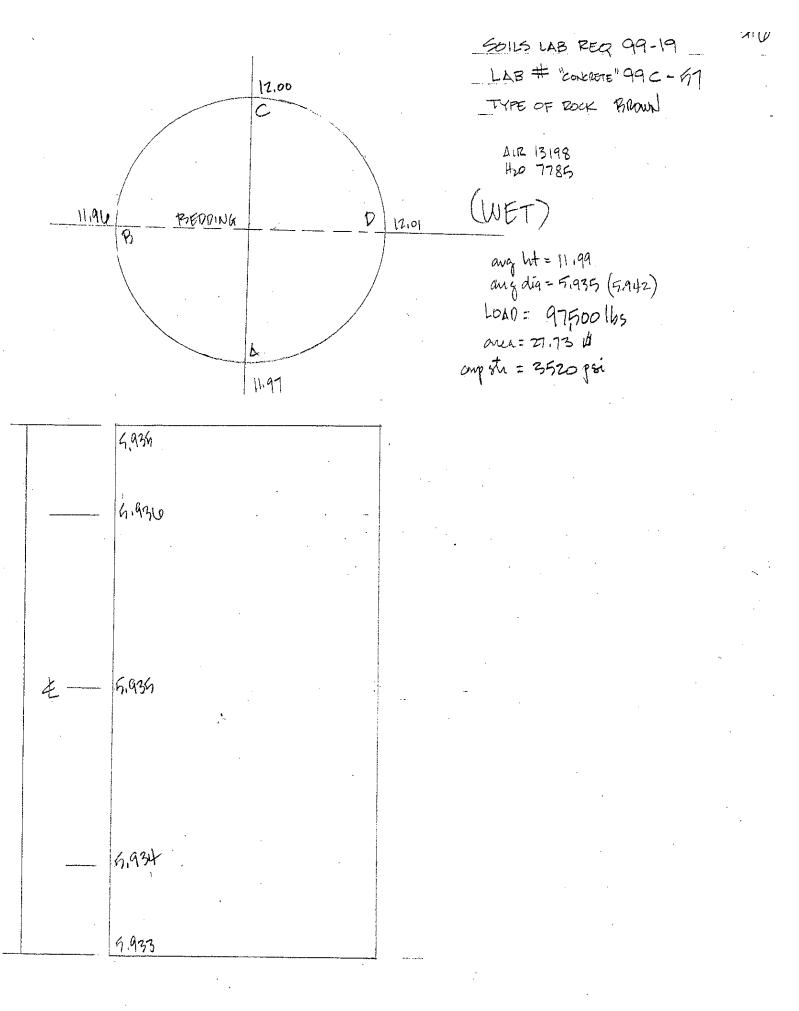
Orientation to Bedding													narallel	nernendirular	parallal	nernendirular	Darallal	perpendicular	narallel	percention	perpenductal narallat	oeroendicular	per per allel	percendicular	l perpendicular parallal	nerrendicular	perpension	paramet	Darallal	pernendicular	per per acara	perpendicular	Daralel	perpendicular	parallel	perpendicular	parallel	perpendicular		perpendicular	parallel	nerrendirular		paraliei	perpendicular	
trazilian Tensi Strength (psi)	Dry Wet												182	272	247	450		278		415	174			461		301		470		577		763	433	612	561	798	342	367		629		508		208	4c/	
<sup>o</sup> oisson's Ratic I	Wet			0.10	0.11	0.15				0.22	0.14	0.13																													<u> </u>					
	Dry	0.06	0.10				0.22	0.15	0.14																																				_	
Young's Modulus (×10 <sup>6</sup> psi)	Wet			0.663	0.730	0.813				1.157	1.188	1.196																			-															
Xoung's	Dry	0.945 0.896	0.906				1.303	1.262	1.209																																				_	
compressive ith (psi)	Wet			3,790	3,516	3,461				6,904	6,818	7,227																																		
Unconfined Compressive Strength (psi) Dry Met	Dry	5,511 4,842	4,640				8,994	9,983	9,727																						-														_	
weamening		Mod. Weathered Mod Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Mod. Weathered	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh		
		99C-62 99C-55	99C-59	99C-53	99C-59	99C-61	99C-66	69-066	99C-73	99C-70	99C-72	99C-74	99C-54-3A	99C-54-3B	99C-54-3C	99C-54-3D	99C-56-5A	99C-56-5B	99C-56-5C	99C-56-5D	99C-58-7A	99C-58-7B	99C-58-7C	99C-58-7D	89C-60-9A	39C-60-9B	39C-60-9C	99C-60-9D	99C-67-2A	99C-67-2B	99C-67-2C	99C-67-2D	99C-71-6A	99C-71-6B	99C-/1-6C	99C-/1-6D	99C-75-10A	99C-75-10B	99C-75-10C	99C-75-10D	99C-78-13A	99C-78-13B	99C-78-13C	99C-78-13D		

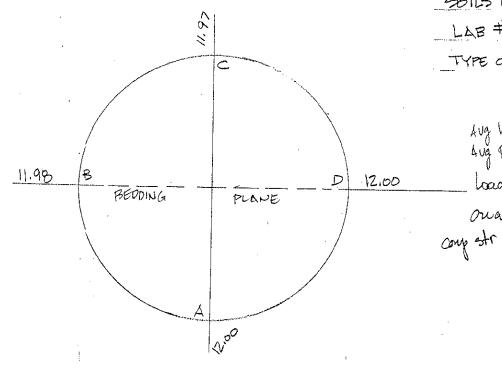
Physical Properties of 6-Inch Diameter Sandstone Rock Cores from Sites Quarry

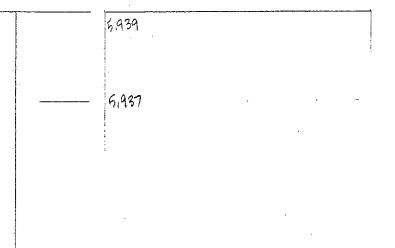
		(Inches) AVG LENIGTH	LUG	(5q.in) Area	· (en ft.) Volume	ALE DRY WT. (Lbs)	had AIROX	Umit (peg) 660;		Madulus	!	-/0
1-52	ĺ	PORDIA			<b>C</b> /, <b>C</b>			Y		3 1 1		
-53	2	12.01	5,934	27.07	1923	28,468	148.0	151.9	3800 pri	63	Wet 2	2.02
-54	3	SPLIT T		. T85B5PEC					ť			
-55	4	11.96	5,934	27,66		28,514		<u></u>	4840 15	63	dry -	2.02
-56	5	SPUT	TENSILE					:	,	. 1		
-57	(p	11.99	5,935	27,107	,1920	28,396	147,9	152.1	3520 pri	5/3	Wet	
-58	7	SPUT-	TENSILE									
-59	B	11.199	5.938	27,69	.1922	28,424	147.9	• • • • • • · · · · · · · · · · · · · ·	4640 pri	5/3	dry	2.02
-60	9	SPUIT -	TENSIVE									
-61	10	11.98	5.937	27.68	.1919	28,420	148.1	152.0	3470 pri	5/3	wat	2.02
-62		12.04	5.938	27,69	1930	28,762	149.0		5490psi	5/3	dry	2.03
-63		Petre	graphic	0	. last!	بە ھىلە	Laburtier	الم معالي	ø		· ·	
-64	13	11.98	5 939	strength 1	n-test oni refore per	y-tode	madulus c	of elastig	ily 4240 pri	5/3	wet	2.02
-65	14				·			-				
			1			And a series of					:	
- (00		11.67	5,937	27.68	,1870	28.220	50-9		9020		Rry	1.97
- 67	Z	SPLIT	TOUSILE	in or cha	يتوصل المراس	the ult.	marile					
-68	3	11.85	5,945	Lowp ST	to actern	me ur	strength		6910 psi	ł	wet	
- 69	4	12.08	5,933	27.65	, 1933	28.962	149,9		9980	4 .	Dry	
-70	5	12.07	6,936	27.67	,1932	29.070	150.4	154.1	6900	5/11	Wet	2,03
-71	10	SPUT	TENSILE			÷		1				
-72	7	11.71	5.933	27,65	11873	28.366	151,4	154.8	6820		Wet	
-73	B	11.93	6,934	27,60	1909	28.870	151.2	<b>م پ ک م</b> ر	9730		Dry	
-74	9	12.00	6.930	27,66	1922	29.092	. 151.2	154.8	7230	5/11	Wet	2,02
-75	10	SPLIT	TENSILE			:					1	
-76	11			<b>^</b>								
-77			graphic 1	Analysi	5			:		j		
-78	13	SPUT	TENKILE			1		i				

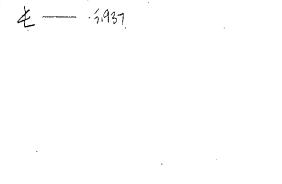




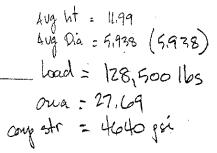


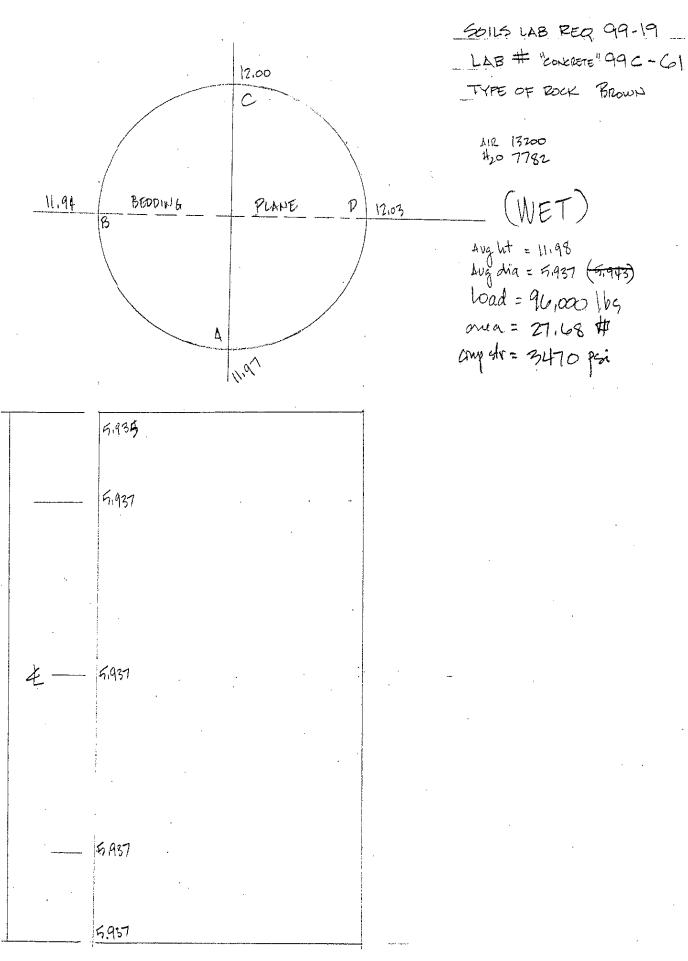


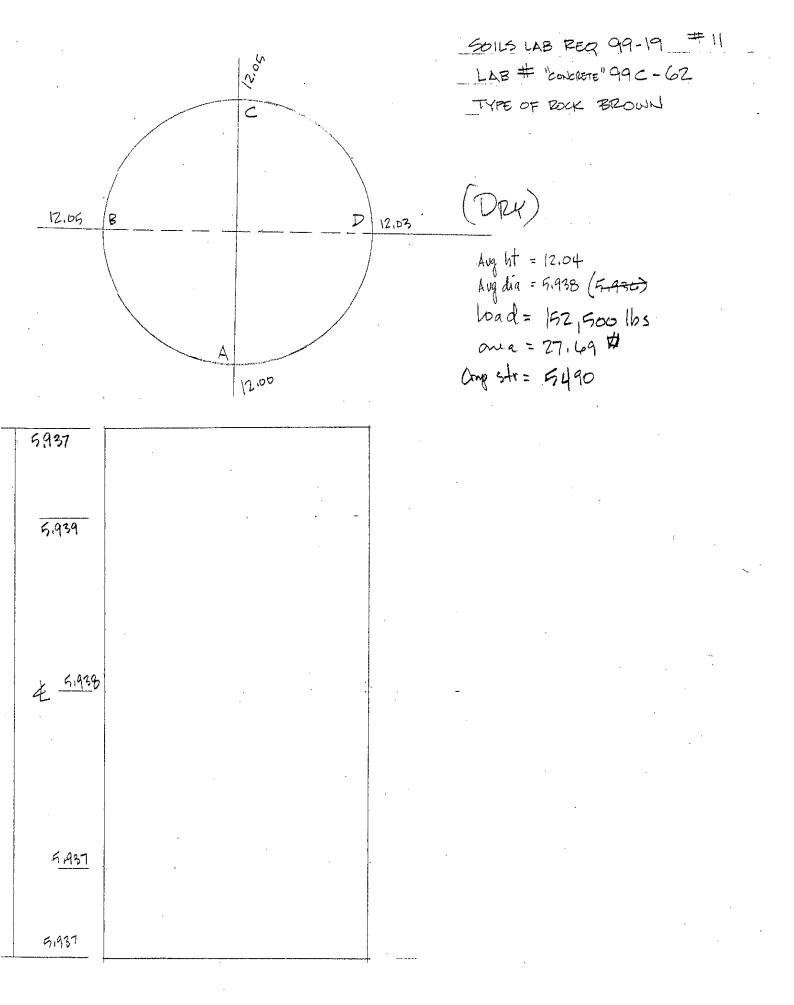


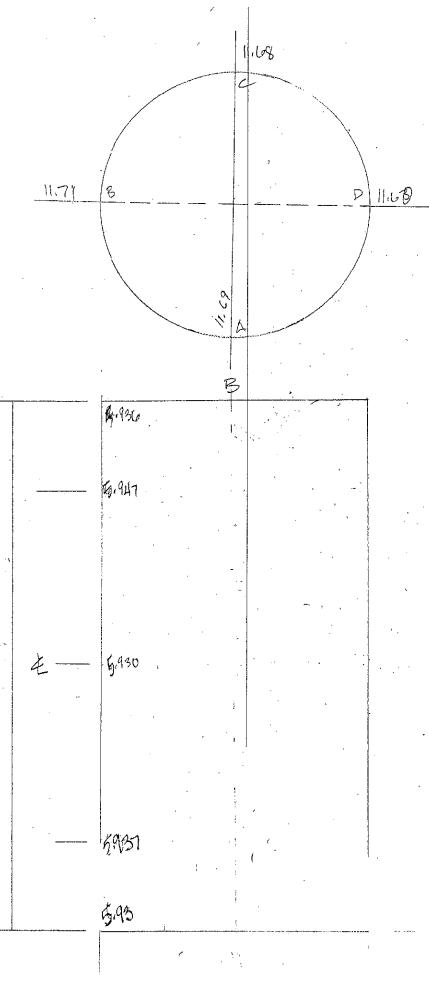


----- · 61937 | 61938 50115 LAB REQ 99-19 #8 LAB # "CONCRETE" 99 C-59 TYPE OF ROCK BROWN





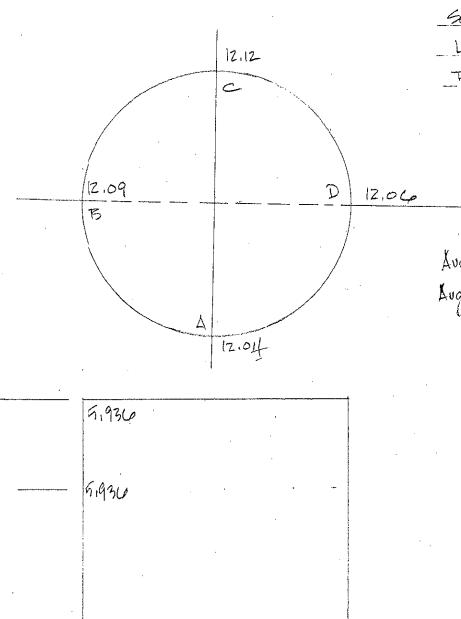




TYPE OF BOCK Geteen aug ht = 11.67 aug dia = **\$**,937

50115 LAB REQ 99-19

LAB # "CONCRETE" 99 C - 66



F.93F F.928

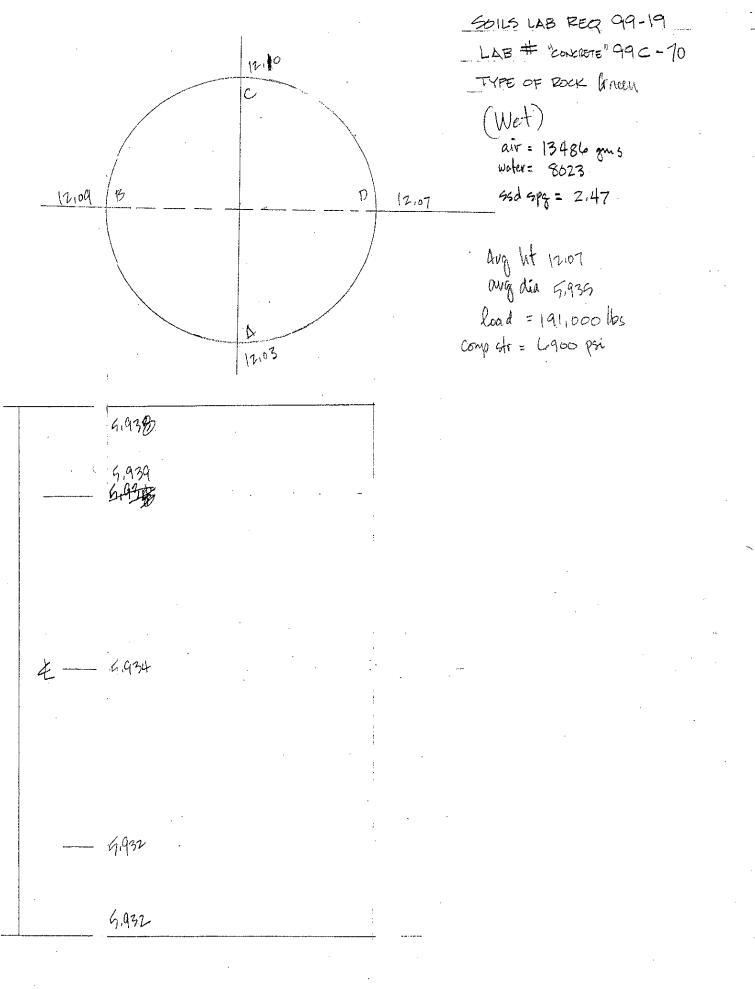
69130

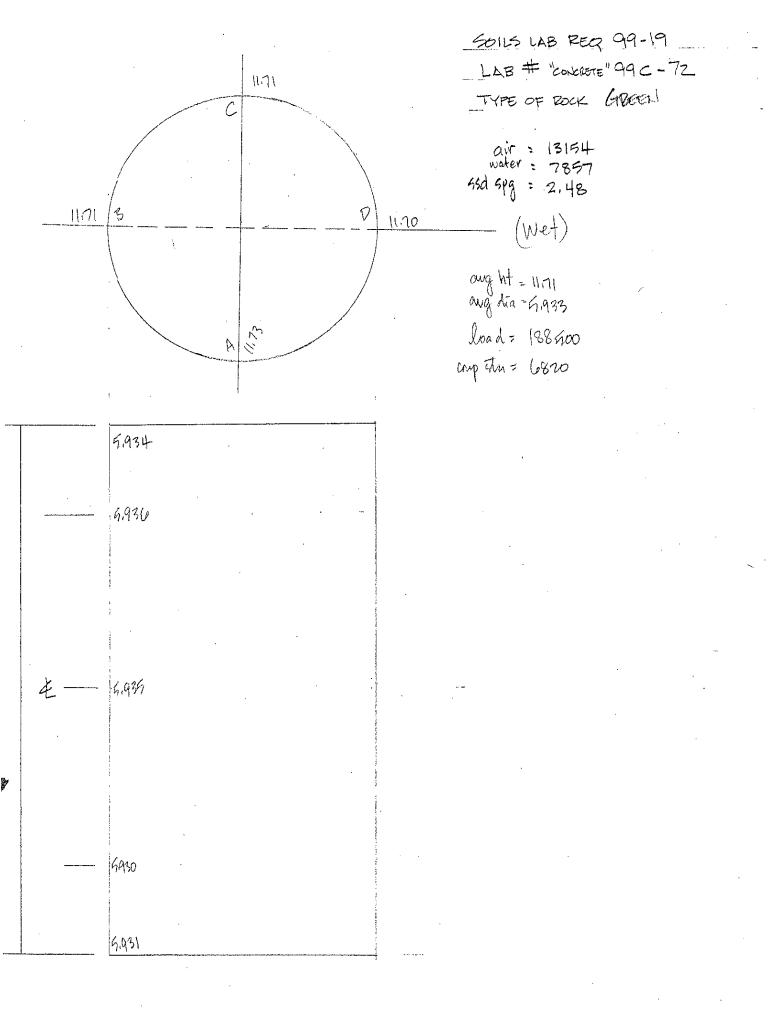
Ł.

50115 LAB REQ 99-19 LAB # "CONCRETE" 99 C - 69 TYPE OF ROCK GREEN

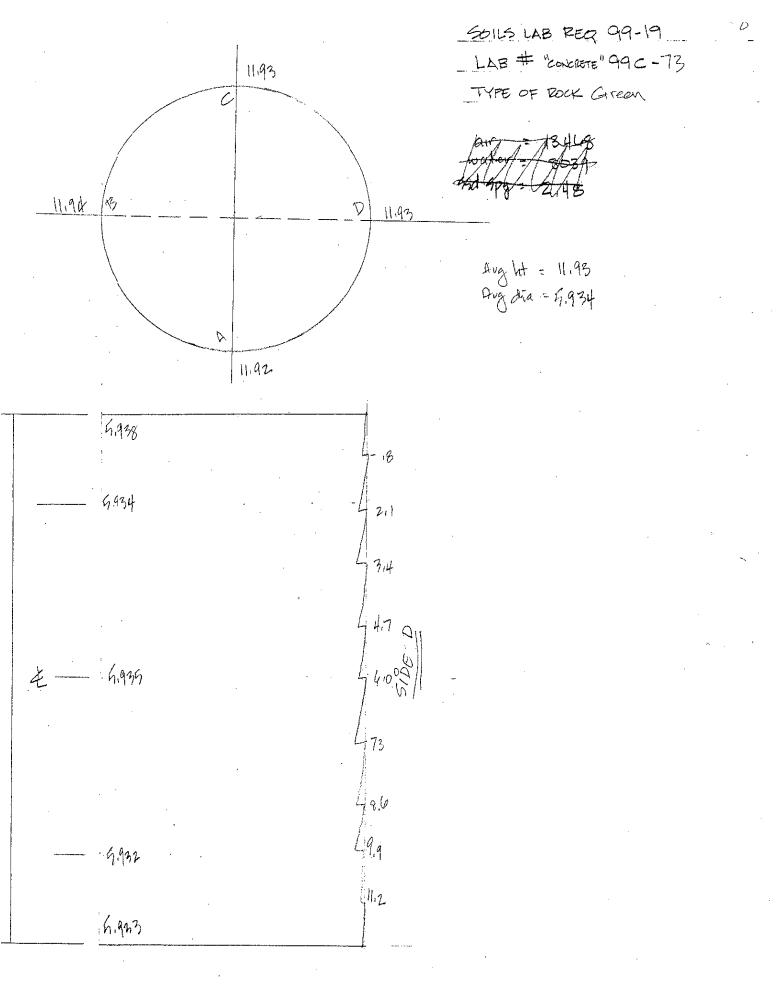
Aught = 12.08Augdia = 5.933

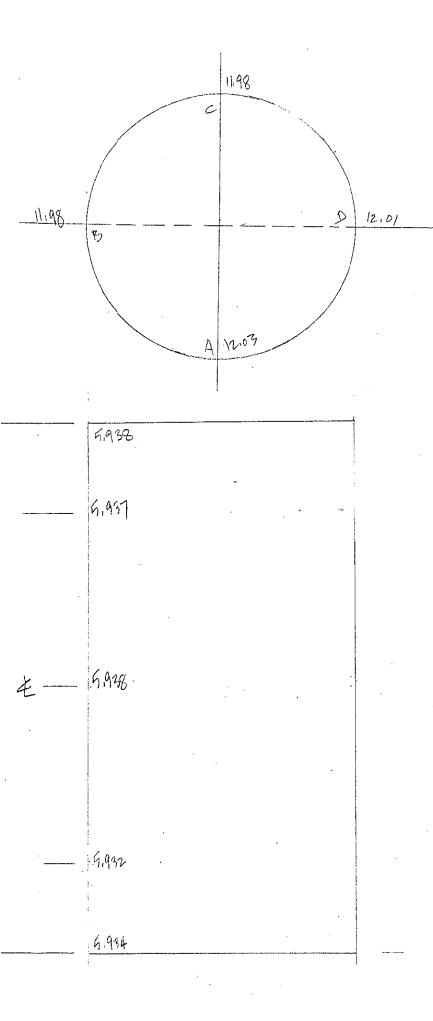
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LAB # "CONCRETE" 99 C - 74 TYPE OF BOCK GAREEN air = 13468 Wath = 8039 Spg = 2.48 ang ht = 12.00 ang ht = 12.00 ang dia = 6930

50115 LAB REQ 49-19

August - 200,000 Comp Ar = 1230 44C-55 Brown - wet

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5-3-99

\$=5.939 P= 10500016

Lateral Gage tocal 1 toral 2 triel 3 99 0.2  $\mathcal{O}$ 99 Ô,Z Ó 99 0.2 0 99 6 0 97.8 99,2 98.2 95.6 96 97,8 95.6 93 93 90 90 92.4 90 87:6 87.4 86.6 84.8 84.6 82.4 81.z 80.8 82.6 81.8 81.2 83 40. 83-2 84 85 85,8 35 85 66.8 87.6 87 89.4 89 89 91,4 91.4 91.4 94.6 94,2 94,2 97,8 22 96.6 Baldry 99 98.Z 99.8 0.2 99 Ĭ

99C-53 #2

6.1												
	1	/		2	3							
0	-0-	,0016	.0016	.0020	.0020	,0022						
5,000	,0039	.0082	.0059	.0088	.0063	,0091						
10	074	124	095	130	102	134						
15	102	154	126	160	33	167						
20	128	178	154	185	162	189						
25	.0 [5]	.0199	,0180	.0207	.0187	.0212						
30	176	219	203	226	211	231						
35	201	235	225	243	232	248						
40	224	250	244	258	251	263						
45	249	,0263	263	-0271	270	.0276						
50,000	,0275	a make a second	,0284		,0289	<ul> <li>per la computational de la computation de la comput Esta computation de la computation de la computation de la computation de la computation de la computation de la computation de la computation de la computation de la computation de la computation de la computation de la computation de</li></ul>						
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199-C-55 Brown - Pry

Pu= 134,000 165

99C-55 #4

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(		/		2-		3	
0510520533540459556000	-00 14 031 048 062 076 0093 111 130 149 168 186 0206	. 019 * 049 073 093 110 125 .0139 152 164 175 .0197	0019 033 050 069 087 02 0112 132 147 162 177 192 0207	,0019 048 072 092 110 125 .0139 152 166 177 188 ,0198	,00/9 033 051 070 089 104 .0120 135 149 164 178 193 .0207	.0018 046 071 091 108 124 .0139 153 165 176 187 .0198	

#6 -19/24 Brown-Wet 996-59  $\phi = 5.942$ Pu= 93500 Sent by running to 25E165 Tral 3 Tral 1 Trial 2 Lateral Gage 1.5 5 0 5 - 1,8 0.5 5,2 1.8 1.0 5 1,2 1.8 • 5 2.0 1,2 5 4.4 1.6 >  $\mathcal{D}$ 1,2 97 99.Z 2 98 93:5 96 5 94.6 90.2 92.6 ) 86 89.6 91.Z > 81.8 85, Z 87.2 C 88 82.5 85.8 5 84,5 87,6 89.6 2 91.2 5 86 89.2 91,8 92.8 ) 87,4 95 89.8 92.8 > 97.Z 95.6 92 94,8 97.8 0,4 96.8 3.2 1 99.4 3.2 Latoral Gage set 5,2 5 perpedicator to Belly 1 6.6 Plane Belly

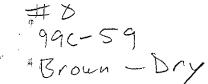
Vertical Gage

995-59 #6

	[
,0009	.0010
043	064
075	· /00
100	126
,0124	.0149
147	168
166	184
185	200
203	215
221	·0228
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45 ,0208 ,0221 ,0217 ,0225 221 ,0228	40	#,	/ ,	#2	2	#3		
	5000 (0 15 20 25 30	.0030 58 29 .0(00 120 142 164 185 .0208	.0664 097 123 .0144 163 179 .194 ,0208	.0040 071 096 0119 141 161 180 198 .0217	DO 63 098 124 0146 165 182 197 212	043 075 100 ,0124 147 166 185 203 221	064 100 126 10149 168 184 200 215	

-1-7-1-1



Load

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Pu = 128,500 165 \$=5.938 ₩Z-Lateral Gage Trial #1 Trial #3 Triel 99 99.6 0,2 99 99.4 0,2 99 924 99.6 98.6 98.2 18.6 97.6 97.Z 97 96.8 95.6 96,Z 24 95 94 92,4 92.4 93 91.8 90,Z 96.6 90 89 88.8 87.8 87 87.Z 84.8. 84.8 84,8 82.8 82.6 82 83 82.6 83 84.2 84.5 84.6 86 85.8 85,6 87 87.Z 87 88,Z 88.2 88 89.4 89,2 89.2 Fractural into lots at 91 longitudinal preces 90.6 U 92:8 92.6 92.4 Bedding 94.6 94,2 94,4 96.4 95.8 Plane 96.2 97.4 97.8 982 99.4 99  $\mathcal{O}$ 

990-99 #8

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٥	Ð	.0018	2018	,0017	.0017	,0017
5	.0015	049	032	048	033	047
10	033	074	052	.073	052	073-
15	052	095	070	094	070	. 095
20	070	115	089	.114	090	114
25	0.89	[33	108	[32	109	(33
<i>30</i>	.0/09	,0149	.0/27	,0149.	.0128	.0150
35	132	163	145	164	147	165
40	149	176	162	177	165	178
45	167	187	177	188	179	189
50	184	198	[9]	260	193	201
55	202	.0209	206	,0211	207	.0213
60,000	.0221		.0222		.0223	
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We	$\pm 16$	$\phi = 5.9$		1,98	atoral Wal Keading
	Seating	Trial #1	Trial #2	Trial #3	Boddy Pino
$\bigcirc$	0	0	97.5	96	
5	0.1	0	97,7	96.4	
10	0,2	99.5	97.	95.5	2-
15	0	98	95.5	94	
ZØ	92	95	92.5	90	
25	97	92.5		87	$P_{u} = 96000^{165}$
30	95	90	87	83	
35	93	87	83	802	
40	91	84,9	80	77.5	
45	88	82.5	77.4	74.5	A list
50	84.8	80	74.5	71.5	
55	81	76.5	76.5	68	
60	75,5	73	67.5	64	
65	69	68.5	63	59.8	
70	55	59,5	53.5	53	
65	53,5	51,8	56	53	
60	54,8	60,4	56-5	54	
55	56	61,5	58	55	
50	58	63.5	59.5	57	
45	60,3	66	61.7	59.5	
40	63	61	65	63	
35	65.5	71,5	68-5	66.5	
30	68	74,2	71	69.5	
25	71	77,5	74:4	73	
20	74	80.8	78,2	77	
15	77	84.5	82.5	81.5	
10	81	88.8	87	86	Brown - Wet
5	84	93	91.3	91	
4	Ince	ane	ac	19551	

#10 #10

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99C - 61

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(1000#) Seating Trial 5 :0035 .0090 ,0130 10 0064 .0161 15 10089 .0185 20 .0121 25 Z/00140 30 231 .0(63 250 35 -0183 40 ,026 10202 45 281 10221 50 294 ,0244 .0268 3/0 55 .0290 320 CeO 65 .0313 .0328 ,0346 70 75

FF 10 #Z\_ 73 .0013-0006 1.0007  $\Diamond$ ,00 *40* .0070 .0048 .0078 .005 ,0078 5 13 ,0085 ,0121 93 (0 @ ,0073 ·CIZ (2) ,0000 0114 1510 .0153 150 123 167 20 95 .0172 180 · Q.134 144 1A 183 196. 010 ,0203 25 20 170 .0/78 209 184 Z18 195 ,0203 ,0230 30 0 223 243 248 235 224 35 00 217 205 ZZI 237 266 40 35 252 240 242 238 45 40 Ż82 ,0268 251 277 258 D 45 281 0268 297 255 ,0291 276 55 B 274 295 .\$296 304 244 311 60 99 291 317 ,0312 321 307,0303 6560 ,0320 ,319 ,0334 30B .0328 328 70/05 .0346 ,0331 ,0340 Ð

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°99C-6Z

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Brown-Dry

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Trial #1 Trial #2 Trial #3

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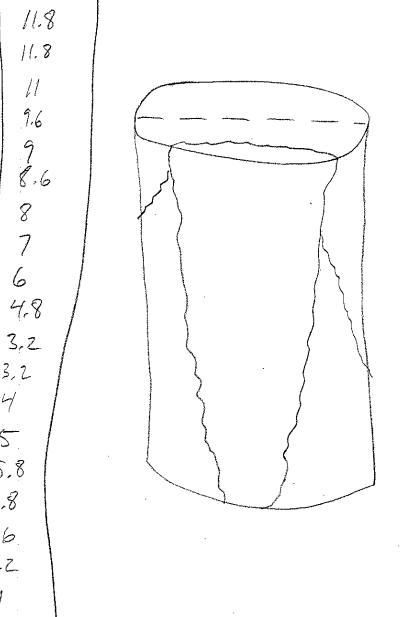
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Bedding 45" 9

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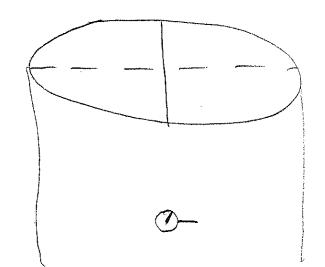
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وبارد	19										
990	2-61	6	±/			ø	= 5.937		Puis =	249,000 16	
Se-	Iston	Fres	4 D	Y	17	L	= 11.67				
Load	Trial	#/	Trin	1#z	Tri	-1#	Pre load	to	set gage	5 fo 75k	105
0~	17,8	18	18.6	18,6	19	18.4	11				
10	16.4	11.8	18	11.6	18	11.4				· /	
20	15	7,6	15.8	6.8	15.4	6.2					
30	14,6	3	17.6	1.6	1Z.4	1.2					
40	13.4	97.6	9.4	96.9	8,6	96					
50		93	6	11.8	5.2	91.2					
60	3	89	2,6	88.4	1.6	87.4					
70	98	85	99.2	84	98	83					
80	93	81	95.6	80.4	94	79.4					
70	88,8	77	13.2	76	91.4	74.6					
100	85	71,6	90.6	70,4	88.6	69					
110	80.6	66	88	63.4	86	62					
120	76,4		82	59	82	28					
130	73	60	736	57.Z	73-6	56.Z					
140	68.4	58.6	66	55,8	65	55					
150	64	57.4	60	54.4	58	53.4					
160	58		54.8		53						
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99C-66 DRY

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10	.00 35		65	.0/02	73	.01:02	
20	68	.0140	.0100	146	.0110	147	
30	96	173	133	180	140	183	
40	.0122	207	165	213	173	216	1
50	146	237	193	243	201	244	
60	172	261	223	. 267	231	270	
70	194	283	248	Z90	2576	292	
80	219	303	273	3/1	281	3/3	
90	246	322	295	330	303	332	
100	. 273	341	315	348	324	351	
110	300	359	337	367	344	369	
120	327		358	383	364	385	and the second s
130	353	390	378	398	384	400	A
140	379	403	-398	413	404	415	
(50	403	.0418	417	. 0428	424	,0429	
160	.0 427		.0439		.0444	ile comme cita e fi	a dalaha na ina dala
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180						Agentine dan be C. P Agen	A DECEMBER OF STREET
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99C-69	#4
Sandstono	F

Load

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\$= 5.933 L= 12.08

Fresh Dry Trial #/ Trial #2 Trial #3 83 87 84.4 84.8 86.6 0 85.6 78 83 77 80.4 97,6 80 95 74.4 21 82.6 72.4 67 77 66 92.2 79.6 70 62 62.8 74 76.4 20 65.4 70 87.4 62 73 58.4 57.8 53,2 54.6 69,4 66.4 84.4 57.6

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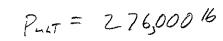
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99C-69 DRY

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5/12/99

5/12/99 #8 996-73 Sandstone Fresh Dry

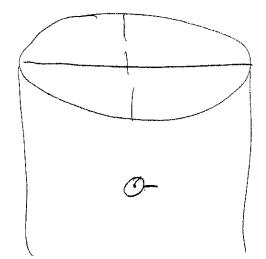
q = 5.934L = 11,93

Part = 269,000 #

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Load	Ter	×/ #/	Triel	#2	Tri-1	#3
D	0	86	86	84	84.Z	83
10	99	80,6	96	78.6	84	77
20	97	75,4	84	73	81.6	7Z
30	94,8	70,8	8/	68	78.6	66
40	92	65.4	78	62.8	75,2	6/
50	89.4	61	74.8	28	71,8	56.Z
60	86.6	57	71.4	54	68,4	52,8
70	83.8	53.8	68	50.4	64.8	49
80	80, Z	50,4	63.8	46.8	60,6	46
90	76	47, z	60	43.6	56.4	42,2
100	71,2	44.6	55.6	40,8	52.4	39.Z
110	66	42	51.4	38	48.4	36.2
120	60	39.2	47.4	35,Z	44	33.8
130	54	37	43	33	39.8	31.4
140	48	34.8	38.6	30,6	35.2	29
150	40.6	33	33-8	28.8	30.8	27
160	33.6		28		26	

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990-	73 DRY					
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0	-0-	,0035	.0035	~0040	.0040	,0042
(0	,0037	.0/0B	74	,0110	79	.0/10
20	74	/54	.0110	157	116	157
30	.0107	1,91	143	196	/50	197
40	141	227	175	231	183	233
50	167	258	205	261	ZII	262
Q	196	284	253	187	240	288
76	221	308	-260	-3(1	265	311
80	249	33/	287	335	293	336
70	278	353	3(3	356	319	357
100	307	372	338	375	344	376
110	337	391	363	394	368	395
'20	364	409	386	411	390	413
'30	391	425	407	427	413	428
140	418	441	429	444	434	445
50	445	.0456	452	.0459	456	,0458
160	445 10467		,0473		D475	
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an () Pult = 200,000 lbs \$ = 5.936 #9 996-74 L=12.00 Sandstone Fresh Wet Load to 75 kins to seaf Tr. 1#2 Tria/#3 Lood (kys) Tr.) #1 21.4 19.2 0 30.4 30.2 21,4 10 19.2 28.6 20 20 17.4 28.4 17 14 30 27.8 13.4 40 10 9.8 50 26 6 2 6 60 25 4 ZZ.4 .91 70 18 1.4 97 80 13 97 98 90 90.4 6.6 95.Z 100 87 91 0.6 110 864 82 93-8 120 80 85,6 77 130 80 85.4 77.2 120 81.4 87 110 79 89 84 81.4 100 91,4 84 81.Z 90 29 87 94 80 91, Z 89 96.Z 70 99 91.2 94 60 1,2 97 50 94.6 5.4 99.4 1 40 9.4 4 6 30 8,4 13 20 10 13 17.6 10 14.4 18 19 21,4 0

99C-74 WET

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$\odot$	-0-		,0013	.0017	.0017	,0019	
10	.0062	.0106	80	,0113	84	.0113	
20	.010	162	.0132	165	,0134	170	
30	145	202	169	208	178	212	
40	175	238	207	246	216	246	
50	204	Z70	239	275	248	278	
60	229	292	270	301	277	304	
70	253	315	293	323	302	327	
EO,	279	336	317	344	326	348	
90	307	355	342	365	349	368	
100	335	372	363	381	371	385	
110	364	389	385	398	392	402	
120	392	,0405	406	.0414	4.13	.0418	
130	0419		.0430		.0435		
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99C-72 #7 Palt = 188,50016 \$=5.933 Fresh Sandstre Wet H=11.71 Load to 75% to sont gasas Lateral Gage Reading Tr=1 #2 Tr-1#3 Tral #1 Load (kips) 3/ 31,6 28.6 ZY 26.2 20,4 19.6 11.6 15.6 5.4 93.6 84.6 Z 65.6 65.6 11 0 79.6 78.2 82,4 73.6 81,Z 85.4 80.4 88. ŶΖ 93,Z Ð Ó

Vertical Gage

5/12/99

792 - 72 WET

	5		2	-	کر ا	
0	2	,0017	,0017	.0020	,0020	1002/
10	.00.45	98	66	,0/03	70	,0/02
20	Ho	.0147	.01.10	152	.0117	156
30	,0/22	182	148	190	155	192
40	150	216	184	222	190	225
50	175	243	213	251	221	255
60	200	269	241	275	249	280
70	222	292	268	299	276	303
80	248	311	292	318	300	324
90	276	330	315	338	323	344
100	304	3:47	337	356	344	361
110	333	363	359	37Z	366	378
120	363	.0380	380	,0389	- 387	.0394
130	.0389		,0403		.0409	
	9 10 10 10 10 10 10 10 10 10 10 10 10 10					
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Ø=5.935 H= 12,07 #5 99C-70 Pult = 191,000 165 Fresh Sandstre Wet Lateral Gase Realize Lord to Sotias to seat gages Tri-1#2 Trial#3 # 1 Trial Load (kips) 86 88.6 99.6 0 88.6 98,8 86 10 83.4 86 96.8 20 83 79.8 94 30 80 92.2 76.4 40 89.8 73 77 50 86.8 68.8 73 60 \$0.6 66 70 61.6 59 73 54.2 80 90 46 63.6 50.4 55,2 100 42,8 37.6 35.4 30 46,4 110 28 120 23 36 130 19 15 25 19.6 15,2 120 27 21.4 [10 17 30,4 24 20 100 26.8 23.4 33 90 80 29.6 38 33 45,4 40 37 70 45 47.4 53.6 60 54.8 60 50 52 59 40 \* 65.4 61.6 65 30 67 70.6 20 75,4 72 70 81.6 10 77 78.6 86 85 88 0

5/12/99

	l		Z	-	3		
0	0	.0020	,0020	,0026	,0026		
10,000	,0048	,0102		.0110	* 79	,0110	
20	93	155	,0118	164	.0126	167	
30	,0/30	193	198	200	167	204	
40	163	225	192	232	202	238	
50	190	253	,0220	262	231	268	
$\omega$	217	277	248	287	258	292	
70	242	300	273	309	282	313	
80	2:08	320	298	331	308	336	
90	295	341	323	351	333	356	
100	32Z	358	347	370	356	377	
110	320	,0377	370	387	379	- 394	
120	378	•	393	.0403	402	•	
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1990-70 Wer Vertical Gase

ASTM D 3967 - SPRITTING TENSILE STRENGTH - JE

		BZ	DWN		}								
	#							: j	s z z				
3#	FIELD	 U		AVER				ERAGE	difter up		1-6	LOAD	J+
	ШĂ		THICKN	) 555 (	inches)	TOP	MID	BOTT	Moistu Conditiu duruga	LOAD ORIGINTATION	RATIC	(Lbs),	(Psi)
-54	3A	3.077	3,018	3.065	3.672	5,934	5.93L	(5.935)	Wet	along bedding	,52	5200	570"
	В	3.040	3.041		(3.039)	5,933	5,935	5,932	Wet	Perpendicular to bedding	,51	7700	ţ.
	0	3,03	3.041	3,069	3,643)	5.935	5.934	5.934	Dry	along bedding	.51	8400	
	D	3,090	31077	3.111	3.100	5,932		(5,933)	Dry	Perpendicular	.52	13000	
				•					1				
-56	БA	3.007	2.999	2,971	2,990	5.932	5,935	5.935 1/1937	Wet	along bedding	.50	4800	540
	В	3.094	3,075	3,077	3.084		5.935	(5.935)	Wlet	Perpendicular to bedding	.52	8000	
	C	2.998	3,000	3,025	3.011)	5,937	5,935	5,936	Dry	along bedding	.51	6600	740
	D	3,079	3,093		3.074	5,933	5.934	5.933	Dry	Perpendicular to bedding	.52	11900	
		•		,					,				
58	74	3,000	3,070	3,075	3.076	5934	F1936	5.935	Wet	along bedding	152	5000	550
	в	3,091	3.049	· · •	3.041	5.933		5935	Wet	Perpendicular to bedding	,51	8000	890
	C	3.047	3,035	3.021	3,034	5,934	1	(5,935)	Dry	along bedding	51.	7900	880
	ע	3,134	3.120	( 3.103	3.117	-		5.932	Dry	Perpendicular	,53	13400	1450
				. ,									
-60	94	2.867	2.880	1.892	2.87B) 2.8108	6.93(1	5.937	5,937	Wet	along bedding	.48	3900	460
	B	2.817	2.820	2,813	2.816	5,934	(	5,934)		Perpendicular to bedding		7900	
	C	3.020	3,026	31030	2.825	5.934	5.9361	5.935		along bedding	.48	8000	950
	0		3.065	3,025	3.036	5,932	5.934	5,934	Dry	Permiticular		13300	1480
		• ``	. /	,			1	· · · · · · · · · · · · · · · · · · ·	!	1	1		

used:

Timus OLSEN test machine - replaced top platen w/ 3" used Medium Load - 100 lbs graduation (LOW RANGE goes up to only 8000 lbs) each cored cylinders were saw-cut to 3"± designated as A, E, C & D

ASTM D 3967 - SPUTTING TENSILE STRENGTH - OF

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		·	· · · · · ·						+	- n I			
		THIC	KNESS		IZAGE es)	Di	AVE A, (In		Moisture Condition	LOAD	40 RATIO		(psi)
-67	2Д	2,817	2,800	2.842	2.827 2.916 2.807		5,93	9 5.937 (5.932)	Wet	along hedding Perpendicular	·48	10,400	1240
	B	2.910	21910	2,907	2901	5.934	5.93	0 6.932	Wet	to bedding	.47	15,100	1810
	C	2.749	2,819	2,820	2.784)	5.931	5,93	( <u>5,930</u> ) 2. 5,927	Dry	along bedding	.47	16,000	1940
	D	2.864	2.868	2.943	2.610	5,931	5,933	( <u>5,930</u> ) 2 5,928	Dry	perpendicular to bedding	.49	20,600	2400
71	4A	2,84	2,810	2:774	(2.823) 2826 (2.788)	5,938			Wet	along bedding perpendicular	48	11,400	1360
	B	2.796	2,783	2:780	2,792	5.932		(5,933) 4-5,933	Wet	to bedding	.47	15,900	1920
	C	2.925	2.906	2.899	2.913	5,937	5,929	(5,931) 3 5,928	Dry	along bedding	, 49	15,200	1760
	D	2,899	2.909	2,924	(2.907) 2.895	5,930	5.930	(5,931) 7 5,933	Dry	perpendicular to bedding	,49	21,600	2510
75	10 A	3,012	3,008	3,005	3,011	5.936	6,939		Wet	along bedding	.51	9,600	1070
	B	3.025	3.012	3.007		5.928		5,930	Wlet	perpendicular to bedding	.51	10,300	1150
	C	3,086	3,043	3,048	3.068	5.932		5.932)	Dry	along bedding	,52	17,900	1970
	D	3.001	3.037	3,040	3.021) 3.006	5,924	5,927	(5,9 <u>27)</u> 5,930	Dry	perspendicular to bedding	,51	17,700	1980
78	13A B	3.040 3.118	3,060 3,134	3.089 3.109	(3.113) 3.091	5,935 6,923	5.924	5.922	Wet Wet	along bedding perpendicular to bedding	,52 ,53	9,100	1000 1590
	C	3,058	3.012		3,028)	5.930	5,930	5.929)	11	along bedding	,51	15,200	690
	D	2,732	2.733	2,840	2,777	5.930	5925	5.926)	ary	perpendicular to bedding	, 47	19,500	2370

### APPENDIX I

#### ROCKFILL MATERIALS PHYSICAL PROPERTIES AND ROCK STRENGTH (PUBLISHED DATA)

UC Berkeley Report by Becker, et. al., 1972

		• • • • • • • • • • • • • • • • • • •				
Test	Moisture	Oroville*	Pyramid**	Sandstone		
Unconfined	Dry.	45,500 psi		8,845 psi		
Compressive Strength Average	Sat.	28,000 psi	15,500 psi	4,797 psi		
Young's Modulus Compression	Dry and Sat.	6.2x10 <sup>6</sup> psi	4.2x10 <sup>6</sup> psi	1.8x10 <sup>6</sup> psi		
Brazilian Tension	Dry	1,870 psi	1,896 psi	1,133 psi		

TABLE 2-4COMPARISON OF AVERAGE MECHANICAL PROPERTIES OF<br/>OROVILLE, PYRAMID AND SANDSTONE ROCK CORES

\*Amphibolite only

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\*\*Not reported if dry or saturated

Deere and Miller (1966) proposed an engineering classification based on strength and deformation. They tested a large variety of rock cores in unconfined compression and plotted the average values of the uniaxial compressive strength versus the modulus of elasticity (tangent modulus at 50% ultimate strength) as an arithmetic plot. The plot indicated that the data could be fitted approximately by a straight line with the equation:

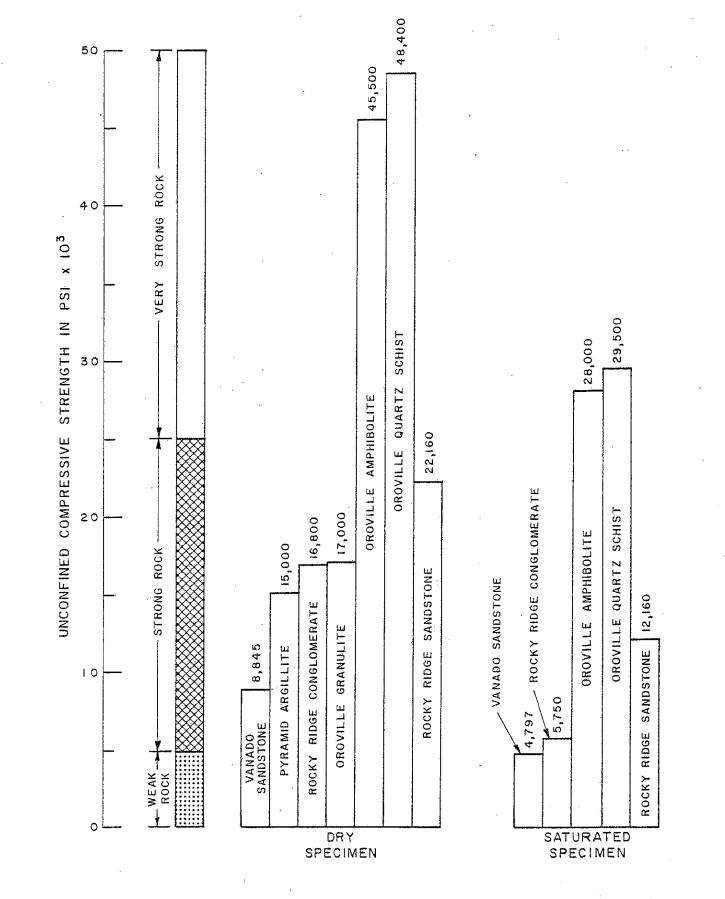
 $E_t = 300 \sigma_a (ult)$ 

where  $E_t$  is the tangent modulus at 50% of ultimate strength and  $\sigma_a$  is the ultimate uniaxial compressive stress. The ratio  $E_t/\sigma_a$  (ult) was called the modulus ratio and its average value was about 300. They proposed a classification chart as shown on Figure 2-4. The average results of unconfined compressive strength and Young's modulus in compression for the Pyramid Dam, Oroville Dam and Venato Sandstone materials have been plotted on this figure. According to this classification the saturated Venato

DWR Report on Rockfill Materials for Newville Dam, 1980

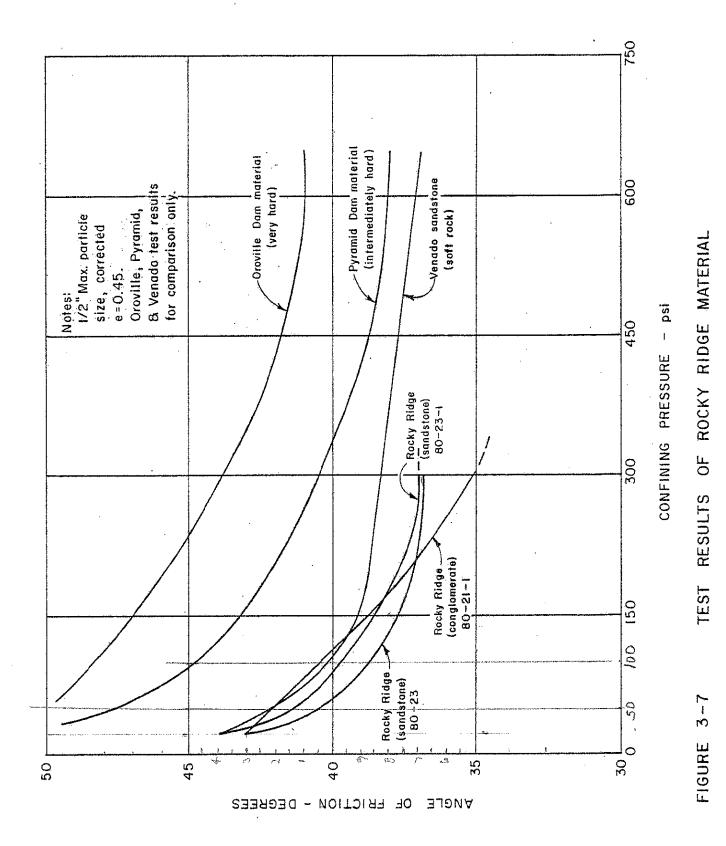
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COMPARISON FIGURE 3-1 AVERAGE OF UNCONFINED STRENGTH OF COMPRESSIVE ROCK CORES

-8-



-26-

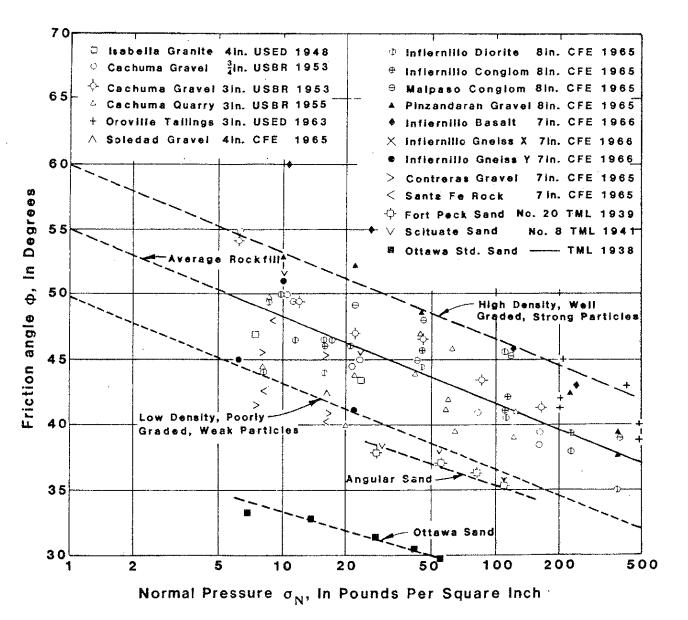
#### **APPENDIX J**

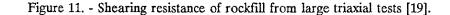
ROCKFILL MATERIALS SHEAR STRENGTH (PUBLISHED DATA) "Review of Shearing Strength of Rockfill," Leps 1970

Chapter 2 - Embankment Design

EMBANKMENT DAMS







DS-13(2)-9 - 6/1/92

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SECTION II - ROCKFILL DAMS

## USBR's Earth Manual, 1998

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#### EARTH MANUAL

 Table 1-3.—Average engineering properties of compacted soils from the 17 Western United States. Data from reports published between June 1960 and December 1985.

 Data from 2005 tests on 1110 samples. Table compiled January 1988

		I	· · · · · · · · · · · · · · · · · · ·	1			000 18513 0	T	pies. Table	a compiled						
				Compaction				Shear Strength Consolidated-drained and consolidated- Unconsolidated-undrained triaxial shear								
		Specific	c gravity	Labo	ratory	Index	density	undrained triaxial shear tests			tests					
			T	(			1	Av. placement		T		Av, pia	cement	1		
	Total				Optimum	i .	•		itions	Effectiv	e stress	r ·	lilions	Effectiv	e stress	. •
USCS	No. of			Max. dry	moisture		ĺ	Dıy	Moisture	Friction	1	Dry	Moisture	Friction		
soil type	samples tested	No. 4 minus	No. 4 plus	density kg/m³	content %	Max. kg/m³	Min. kg/m³	density kg/m <sup>3</sup>	content %	angle degrees	Cohesion kPa	density kg/m³	content %	angle degrees	Cohesion kPa	Values listed
		2.69	2.58	1989	11.4	2167	1746				1	<u> </u>		<u> </u>		Average
		0.03	0.08	51	1.2	139	128									Std. dev.
GW	22	2.63	2.39	1907	9,9	1810	1417		1					-		Minimum
		2.75	2.67	2042	13.3	2332	1896			[	<u> </u>					Maximum
		17 2.68 .	10 2.52	1907	12.2	2 2212	1808	1933	7.5	40.0	0.1				1	# of tests
		0.04	0.21	153	4,3	113	124	238	4.1	42.2 2.1	8.1 16.3					Average Std. dev.
GP	62	2.54	1.76	1436	9.1	1826	1375	1489	3.3	38.0	0.0					Minimum
	·	2.77	2.65	2045	26.5	2383	. 1986	2144	15,1	43.8	40.7					Maximum
		37	15	1		. 5	0		<u> </u>	5	·		,			# of tests
		2.73	2.43	1819	15.7										1	Average
GM	37	0.07 2.65	0.18 2.19	189- 1393	5.9 5.8					· .	[					Std. dev. Minimum
GM	31	2.00	2.92	2130	29.5											Maximum
		35	17	3			<u> </u>		L	L	I <u></u>		<u>.                                    </u>		1	# of tests
		2.73	2.50	1854	14.2											Average
		0.09	0.15	126	3.9											Std, dev.
GC	32	2.67	2.38	1537	6.0											Minimum
		3.11 30	2.78	2066 3	23.6		I				<u> </u>					Maximum_
		2.67	5 2.57	2019	2 9,1	1987	1576				1		I			# of tests Average
		0.03	0.03	96	1.7	128	142									Std. dev.
sw	20	2.64	2.54	1896	7.4	1683	1278									Minimum
		2.72	2.59	2162	11.2	2207	1758									Maximum
		13	2	4		1										# of tests
	81	2.66	2.62	1,827	10.5	1890	1542									Average
SP		0,04 2.60	0.08 2,52	160 1649	2.1 7.8	120 1621	144 1252									Std. dev. Minimum
9.		2.86	2.75	2159	13,4	2199	1960									Maximum
		50	5	Ę		4										# of tests
		2.68	2.50	1877	12,3	1803	1379	1760	13.2	34.0	20.7	1821	12.6	33.5	59.3	Average
		Ó.06	0.12	140	3,3	147	136	145	5.2	4.9	25,5	201	5.5	6.1	42.1	Std. dev.
SM	174	2.51	2.24 2.69	1488 2114	6.8 05 F	1417 1968	1034	1459	4.6 .	23.7	0,0	1488	7.6	23.3	0.0	Minimum
		3.11 162	10	13	25.5	1906 20	1555 n	2019	23.0 1(	40.7 ว	90.3	2122	25.0 8	45.0	146.2	# of tests
		2.69	2.47	1906	12.4		<u> </u>	1773	15.4	32.7	19.3	1967	11.1	35.1	53.8	Average
		0.04	0.18	99	2.4			225	5.2	3.8	14.5	88	2.1	0,7	4.1	Std. dev.
SC	112	2.56	2.17	1547	6.7			1459	7.5	25.5	0.0	1843	9.7	34.2	49.0	Minimum
		2.84	2.59	2109	22.1	I		2111	22.7	38.3	42.1	2035	14.0	35.8	58.6	Maximum
		110	4	9				1500	1.			1070	3	*****	64.4	# of tests
		2.70 0.09		1645 168	20.1 5.7	. ]		1528 179	25.2 9.5	35.2 2.5	4.8 3.4	1678. 161	17.4 5.7	31.8 4.3	61.4 24.1	Average Std. dev.
	63	2.52		1355	10.6			1292	13.5	31.4	0,0	1512	11.1	25.2	21.4	Minimum
ML		3.10		2018	34.6			1778	40.3	38.3	10.3	1909	25.8	37.2	82.0	Maximum
		60		3					1	1			4			# of tests
		2,79		1372	33.1					ĺ			1			Average
мн	11	0.27		35 1327	1.5 31.5											Std. dev. Minimum
IVII")		2.47 3.50		1327	31.5											Maximum
-		9		4									1			# of tests
		2.70	2.48	1768	16.4			1665	18.3	28.1	15.2	1760	15.3	24.4	91.0	Average
		0.05	0.13	97	3.1			174	5.7	5.0	18.6	86	2.4	7.0	49.0	Std. dev.
CL	395	2.56	2.34	1398	10.7			1297	10.2	10.8	0.0	1622	11.6	8.0	0.0	Minimum
	1	2.87	2.75	2002	30.9			1922	35.0	36.8	104.1	1986	20.2	33.8	164.1	Maximum
		361 2.73	8	28 1531	24.8			1406	30.6	20.5	32.4	1574	24 22.7		124.1	# of tests Average
		0.06		102	52			107	30.6 5.7	6.3	32.4 31.0	1574 92	4.6	15.1 6.7	25.5	Std. dev.
СН	101	2.51		1318	16.6	l		1249	22.4	10.8	0.0	1438	17.9	5.1	85.5	Minimum
		2.89		1720	41.8			1555 .	42.0	30.9	108.2	1680	29.1	26.1	148.2	Maximum
		93		36	ŝ					1	1		5			# of tests

Conversion factors: 1 kg/m<sup>3</sup> = 0.06243 lb/ft<sup>3</sup>; 1 kPa = 0.145 lb/in<sup>2</sup>

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UC Berkeley Report by Marachi et. al., 1969

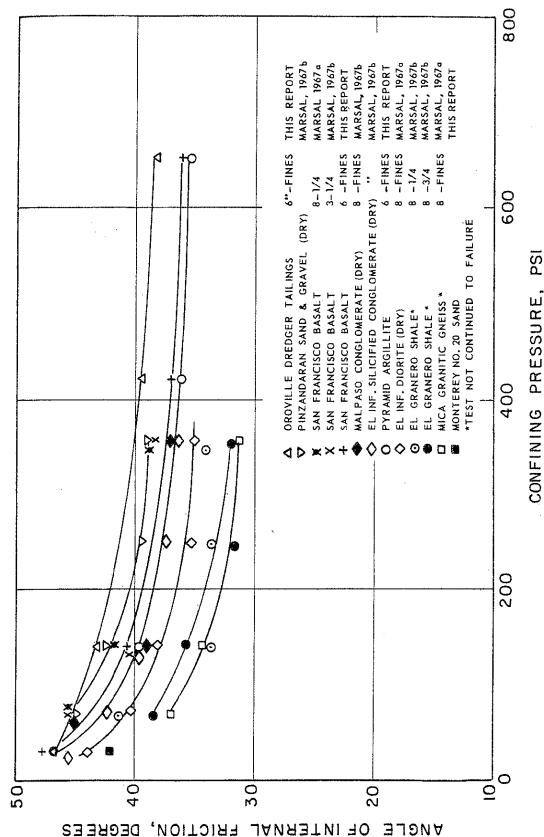
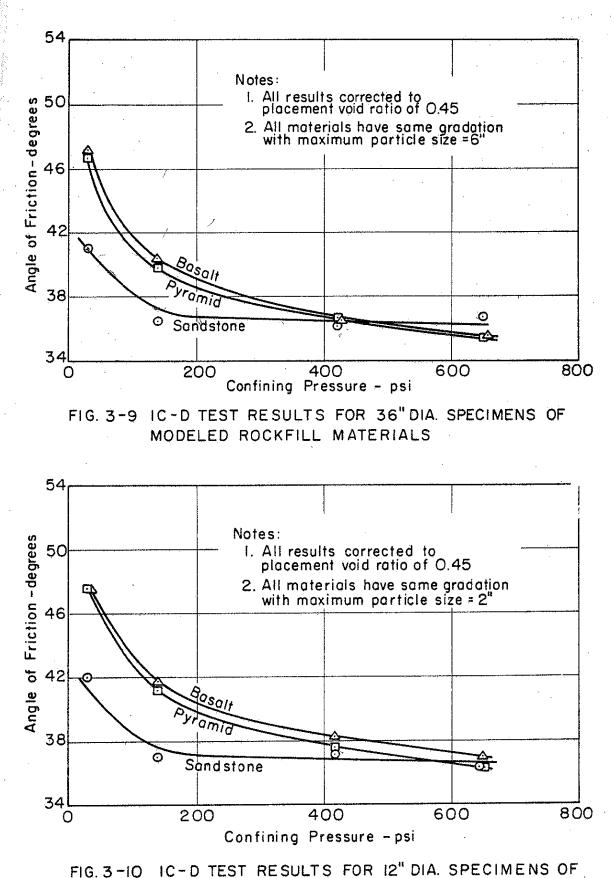


FIG. 51 ANGLES OF INTERNAL FRICTION FOR LARGE SIZE ROCKFILL SPECIMENS

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UC Berkeley Report by Becker et. al., 1972

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MODELED ROCKFILL MATERIALS

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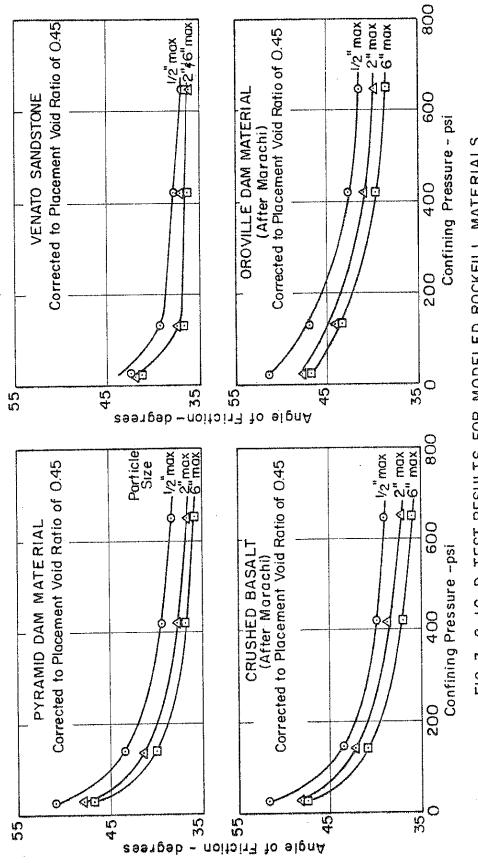
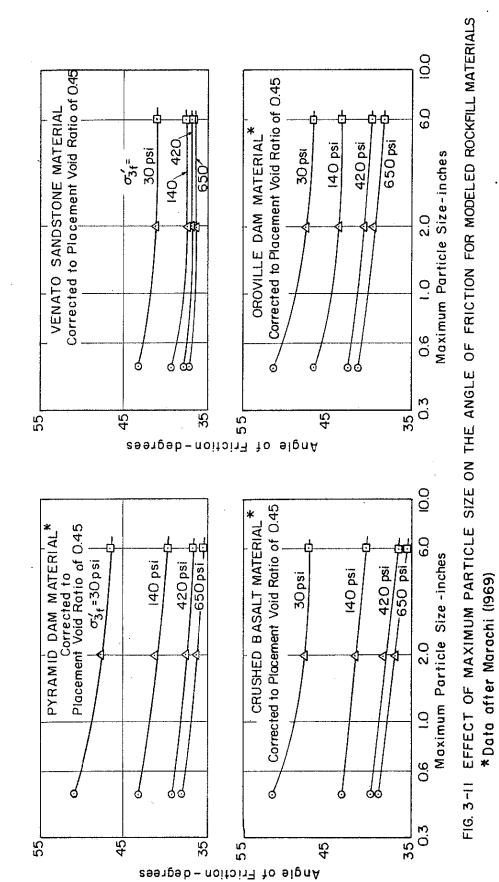


FIG. 3-8 IC-D TEST RESULTS FOR MODELED ROCKFILL MATERIALS



"The Quality and Suitability of Rockfill Used in Dam Construction," by Penman and Charles, 1976 high at confining pressures up to 2.5  $MN/m^2$ . The loading frame was designed with a capacity of 15 MN. Drained triaxial tests on rockfill from Infiernillo showed  $\Phi'$  decreasing from 46° to 36° as the confining pressure was raised from 0.1  $MN/m^2$  to 2.5  $MN/m^2$ . Marsal *et al.* describe the rockfill as a mixture of sound fragments of silicified conglomerate and diorite and add that this may be considered among the best materials possible for rockfill.

A triaxial machine built at Imperial College to test samples of rockfill 0.3 m in diameter has been described by Tombs (1969). Tests on heavily compacted samples of Carboniferous sandstone rockfill from Scammonden dam showed a  $\Phi' = 49^{\circ}$  at a confining pressure of 0.1 MN/m<sup>2</sup> decreasing to  $\Phi' = 37^{\circ}$  at a confining pressure of 1.7 MN/m<sup>2</sup> (Charles, 1973), i.e. comparable with the strength parameters found for the Infiernillo fill.

If the Scammonden rockfill is regarded as an average quality rockfill, then the material used at Balderhead must stand on the borderline of what can be usefully described as rockfill. Consolidated undrained tests on the Balderhead shale (Kennard *et al.*, 1967) show  $\Phi'$  reducing from 39° at an effective confining pressure of 0.08 MN/m<sup>2</sup> to 35° at an effective confining pressure of 0.17 MN/m<sup>2</sup>.

In making comparisons between these results several factors must be considered. Firstly, the tests were made on rockfill samples with different maximum particle sizes. In the large-scale rockfill testing equipment built at the University of California samples 0.91 m diameter  $\times$  2.3 m high can be tested and drained triaxial tests on rockfills with parallel grading but different maximum particle size have that gradings with a maximum particle size of 150 mm have an angle of shearing resistance about 4° smaller than samples of the same material with a maximum particle size of 12 mm (Marachi *et al.*, 1969). This may account for the Scammonden sandstone, tested with a maximum particle size of 76 mm giving slightly greater angles of shearing resistance than the Infiernillo conglomerate rockfill with a maximum particle size of 200 mm.

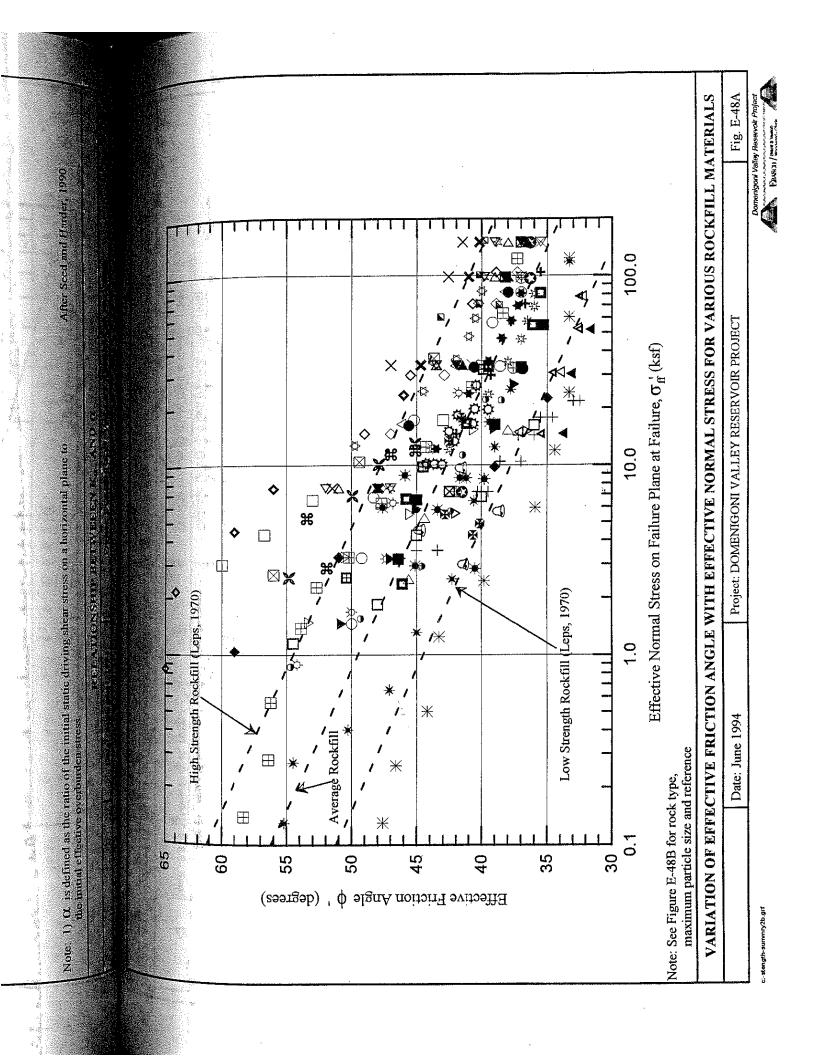
Marsal has carried out tests on a granitic gneiss rockfill from the site of Mica dam and also used different gradings of the rockfill (Marsal, 1973). When results were compared at the same confining pressure, a well graded sample showed an angle of shearing resistance typically about 4° greater than a uniformly graded sample.

The shear strength of rockfill measured in triaxial compression also depends on the initial porosity of the sample. Small-scale triaxial tests on the Scammonden rockfill indicated that the angle of shearing resistance reduced by about 1° per 1 % increase in porosity at low confining pressures. With increase in confining pressure the dependence on initial porosity was less marked.

The angle of shearing resistance measured in the triaxial tests on these three widely different types of rockfill do illustrate the relatively small

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Domenigoni Valley Reservoir Project, 1994



+	Greywacke - 1.5 inch (Indraratna et. al, 1993)	♥	Basalt - 12 inch (Marachi et. al, 1972)	
+	Greywacke - 1.0 inch (Indraratna et al. 1993)	$\times$	Basalt - 36 inch (Marachi et. al, 1972)	
- •		×	Amphibolite (Oroville Dam) - 2.8 inch (Marachi et al. 1072).	
┝ <		X	Ambibolite (Oroville Dam) - 13 inch (Marschi et al. 1973)	
>	Basaft - 1.0 mch (Al-Hussaini, 1983)		r where $r$ and $r$	
\$	Basalt - 3.0 inch (Al-Hussaini, 1983)	\\ 2	Amphibolite (Oroville Dam) 36 inch (Marachi et. al, 1972)	
٥	Basalt (Charles & Watts, 1980)		Venato Sandstone - 2.8 inch (Becker et al. 1972)	
٠	Sandstone (Charles & Watts, 1980)	$\oplus$	Venato Sandstone - 12 inches (Becker et al. 1972)	
	High Grade Slate (Chries & Watts, 1980)	0	Venato Sandstone - 36 inches (Becker et al. 1972)	
	Low Grade Slate (Charles & Watts, 1980)	*	Quartzite, Test Fill No. 1 (U.S. Army Corps of Engineers, 1976)	
۵	Silicified Conglomerate - El Infiemillo Dam (Marsal, 1973)	×	Argillite and Phyllite, Test Fill No. 2 (U.S. Anny Corps of Engineers, 1976)	
	Diorite - El Infiernillo Dam (Marsal, 1973)	ø	Quartzite, Argillite and Phyllite, Test Fill No. 5 (U.S. Army Corns of Envirement 1926)	
0	Conglomerate - Malposa (Marsal, 1973)	æ	Gueiss - Scalbed Gradation (11 S. Army Corns of Environment toon)	
۲	Basalt - 3.0 inch (Marsal, 1973)	Ċ	Conside Damitsi Construction Corps of Languages, 1992)	
$\triangleleft$	Basalt - 8.0 inch (Marsal, 1973)	0 ¥	Curciss - r tutatici Oracantori (U.S. Army Corps of Engineers, 1992) Quartrite and Quartz - 1.5 inch (Skenner & Hillis, 1970)	
4	Granitic Gneiss - 8.0 inch (Marsal, 1973)	☆	Quartzite and Ouartz - 1.5 inch (Skenner & Hillis 1070)	
•	Granitic Gneiss - 8.0 inch (Marsal, 1973)	*	Quartzite and Quartz - 0.2 inch (Skermer & Hillis 1070)	
٩	Gramitic Gneiss plus 30% Schist (Marsal, 1973)	*	Granulated Chalk (Billam, 1971)	
$\triangleright$	Slate - 8.0 inch dense (Marsal, 1973)	Ж	Crushed Anthracite (Billam, 1971)	
⊳	Slate - 8.0 inch loose (Marsal, 1973)	⊞	Limestone Sand (Billaur, 1971)	
	Slate - 8.0 inch dense (Marsal, 1973)	⊞	Silurian Mudstone (Tombs, 1969)	
	Slate - 8.0 inch loose (Marsal, 1973)	$\boxtimes$	Granitic Gneiss (Tombs, 1969)	
Δ	Argillite (Pyramid Dam) - 2.8 inch (Marachi et. al, 1972)	0	Cachuma Gravel - 0.75 inch (Holtz & Gibbs, 1956)	
<b>ل</b>	Argillite (Pyramid Dam) - 12 inch (Marachi et. al. 1972)	¢	Cachuma Gravel - 3.0 inch (Holtz & Gibbs, 1956)	
₽.	Argillite (Pyramid Dam) - 36 inch (Marachi et. al. 1972)	*	Cachuma Quarty - 3.0 inch (Holtz & Gibba, 1956)	
▽	Basalt - 2.8 inch (Marachi et. al., 1972)	8	Oroville Tailings - 3.0 inch (Hall & Gordon, 1963)	Alexandra Alexandra Alexandra Alexandra
A TO CANK	TONIOF SUPER-THE BUILD STOP SWEET WITH STUDY	CLUME IN	DRAVAG STRESS FOR VARIANS DACEMIN 1 4111111	
	机复数 医外侧侧 机压线 经规则性 化化学化学 化丁烯基 计计算 化丁烯基 医外外 化化学 化化学学 化化学学 化化学学 化化学学 化化学学 化化学学 化		COMPACT AND A CONTRACT OF A CONT	
		a tanja na mangan Satabarta na Managan Managarta na Managan		
		DARD C	RISE EINE FILL CONTRACT SIEVE 31ZE	
	- 50 - 60 - 1000	01	2, 11\5, 2\4, 3\4, 	
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# APPENDIX K

ROCKFILL MATERIALS DENSITY (PUBLISHED DATA) UC Berkeley Report by Becker et. al., 1972

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Pyramid gradation. The change in relative density of specimens having the same void ratio, but different maximum particle size for the modeled gradations can readily be seen in Table 4-2. The Venato Sandstone material has the least variation in relative density for change in maximum particle size of the modeled gradation, which corresponds to the nearly flat curves for this material on Figure 4-3.

TABLE 4-1	MAXIMUM-MINIMUM DRY DENSITIES AND VOID RATIOS FOR MODELED ROCKFILL MATERIALS	
	ROCKFILL MATERIALS	

	MAXIMUM PARTICLE SIZE (IN)	SPECIFIC GRAVITY	MAXIMUM DRY DENSITY (PCF)	MINIMUM VOID RATIO	MINIMUM DRY DENSITY (PCF)	MAXIMUM VOID RATIO
Pyramid Dam at Pyramid Gradation	6 2 1 2	2.62 2.62 2.62	120.2 118.6 116.5	.360 .378 .403	95.5 94.2 92.5	.712 .735 .767
Crushed Basalt at Pyramid Gradation	6 2 <u>1</u> 2	2.87 2.87 2.87 2.87	136.0 131.2 125.0	.317 .365 .433	108.2 103.3 96.7	.655 .733 .852
Venato Sandstone at Pyramid Gradation	6 2 <u>1</u> 2	2.74 2.74 2.74	119.7 119.1 118.3	.428 .435 .445	91.0 91.0 91.0	.879 .879 .879
Oroville Dam at Oroville Gradation	$\begin{array}{c} 6\\ 2\\ \frac{1}{2} \end{array}$	2.93 2.91 2.88	157.0 153.5 146.1	.165 .187 .230	128.5 124.2 115.9	.423 .467 .550
Oroville Dam at Pyramid Gradation	2	2.93	139.0	.314	117.3	.557

## Angle of Friction and Relative Density

In order to determine the effect of maximum particle size on the angle of friction for tests performed at constant placement relative density, it was necessary to prepare curves showing the relationship of the angle of friction at different placement relative densities. These relationships, for samples with  $\frac{1}{2}$ " maximum particle size are shown in Figures 4-5 through 4-7.

41

# APPENDIX L

# USACE INSPECTION REPORTS OF SITES QUARRY AND SITES QUARRY (SOUTH) FOR SANDSTONE USED AS RIVERBANK SLOPE PROTECTION

#### RJA/sjf 14Mar72 Revised 21 Mar 72

SPKED-F

MEMO FOR RECORD

SUBJECT: Inspection of the Welch and Cton Quarries near Sites, California

1. The subject quarries were inspected on 13 March and 20 March 1972, by the following District personnel:

Chester R. Ziebarth Ervin L. Olen	C-O Division Valley Resident Ofc Msvl Project Office Engineering Division
Reed J. Anderson	Engineering Division

Mr. Olen was not present on the 20 March inspection.

The two quarries are located about 0.3 miles spart in the lower foothills of the Coast Range. They are 8.7 to 9.0 miles northwest of Maxwell (freeway exit) and about 0.8 mile to 1.1 miles east of Sites in Coluse County (see attached location map). Both quarries are in T17N, R4W. The Welch Quarry is in Section 29 and the Cron Quarry is almost due north in Sections 20 and 21. They are accessible from Interstate 5 via the Sites-. Road, a paved two-lane highway. The srea is shown on the Sites Quadrangle, USGS 7.5 minute series.

2. The purpose of the inspection was to make a preliminary evaluation of the Welch Quarry and to obtain a rock sample for testing by the Division Laboratory. Meichert Construction Company intends to use the rock. If acceptable, for bank protection on the Sacramento River for a Corps Of Engineers contract (722-0057, Julit 22, Sacramento River Bank Protection, Colusa and Sutter Counties). The Cron Quarry was visited and will be described briefly to eliminate some confusion that has existed between the two quarries. Previous reports refer to both quarries as the Sites Quarry. The inspection of the Welch Quarry was made with Mr. Wayne Russell of Teichert Construction.

3. The history of the quarries is not available in detail. Samples from the Welch Quarry were tested by the SPD Laboratory in March and June of 1962 and by a private laboratory in February 1962. In July 1962 the quarry was approved by the Sacramento District as a source of rock for bank protection providing only the fresh, dark grayish green graywacke (sandstone) is used. As far as is known the rock had not been used on a Sacramento River job until about one yest ago, when it was used OB a Sacramento River job near Princeton by W. Davi Parker. Rock from the Cron Quarry has not been tested by the Sacramento District and has not been used on any District job. Rock from one or both quarries is reported to have been used for building construction in San Francisco and in the old Post Office Building at 7th and K Spreets in Sacramento. The south face of the Cron Quarry has been line drilled on 2 to 2.5 foot centers, probably for the purpose of taking out huilding stone. Present owners of the quarries are Harry Cron, Williams, and Eleanor Welch, Colusa. The Cron Quarry is leased by James L. Farry and Son, Sacramento, and the Welch Quarry is presently leased by Teichert Construction, Sacramento.

Except for slight color variations, rock from the two quarries is 4. similar. It is a grayish green to bluish gray graywacke (sandstone) containing a few thin beds of shale. It probably belongs to the Creteceous Chico or Shasta Formation. It is distinctly bedded, strikes about northsouth and dips to the east at 40 to 45 degrees. Thickness of the sandstone bads ranges from a few inches up to about 5 feet. Beds appear to be getting thicker with depth. Where this bedded, the rock tends to be weathered, at least near the surface. Breakage will be controlled partly by bedding, especially in the thinner bodded sequences. At the Welch Quarry the present face is a bedding plane surface at least 100 feet high and about 150 feet wide. The rock in the face is massive appearing and has no apparent structural weaknesses except for scattered joints. Where broken by previous blasting operations, the rock has some cendency to break into irregular slabby pieces that are not related to bedding plane weaknesses. The Gron Quarry has been opened at the south and of a north-south ridge, and the face developed is about perpendicular to the strike of the bedding. A thick section of east dipping graywacks beds is exposed. The rock is essentially the same as at the Welch Quarry.

5. In detail the rock is a fairly uniform fine-grained graywacke that is moderately hard and very slightly friable (a few grains can be broken off by herd rubbing). It appears to be heavy enough to meet minimum specific gravity requirements, although some of the samples tested by SPD in 1962 were just under the minimum required. The fresh rock is fairly tough and appears able to withstand such treatment as blasting, loading, dumping, and spreading without excessive breakdown. A definite statement regarding durability cannot be made prior to laboratory testing, however, as the rock is not extremely well cemented.

2

5. In the rock exposed in the Welch Quarry, weathering is not a problem except in the upper 5 to 10 feet, in the thin, highly fissile shale beds and on the extreme left side of the quarry where there is a sharp break between good quality fresh rock and rotten rock. Mr. Russell said that the Contractor does not intend to work the left side where the weathered rock occurs.

7. <u>Conclusions.- Welch Quarry</u>. Although the rock appears to be of acceptable quality, the specific gravity and durability characteristics have to be considered questionable until proven adequate by laboratory tests. The rock in the main part of the quarry appears to be uniform in quality, and if the sample submitted to the SPD Laboratory proves to be acceptable there should be little need for extensive inspection or control at the quarry site. The contractor should understand, however, that the rotten rock near the surface and on the left (south) side of the quarry face will have to be avoided or wasted.

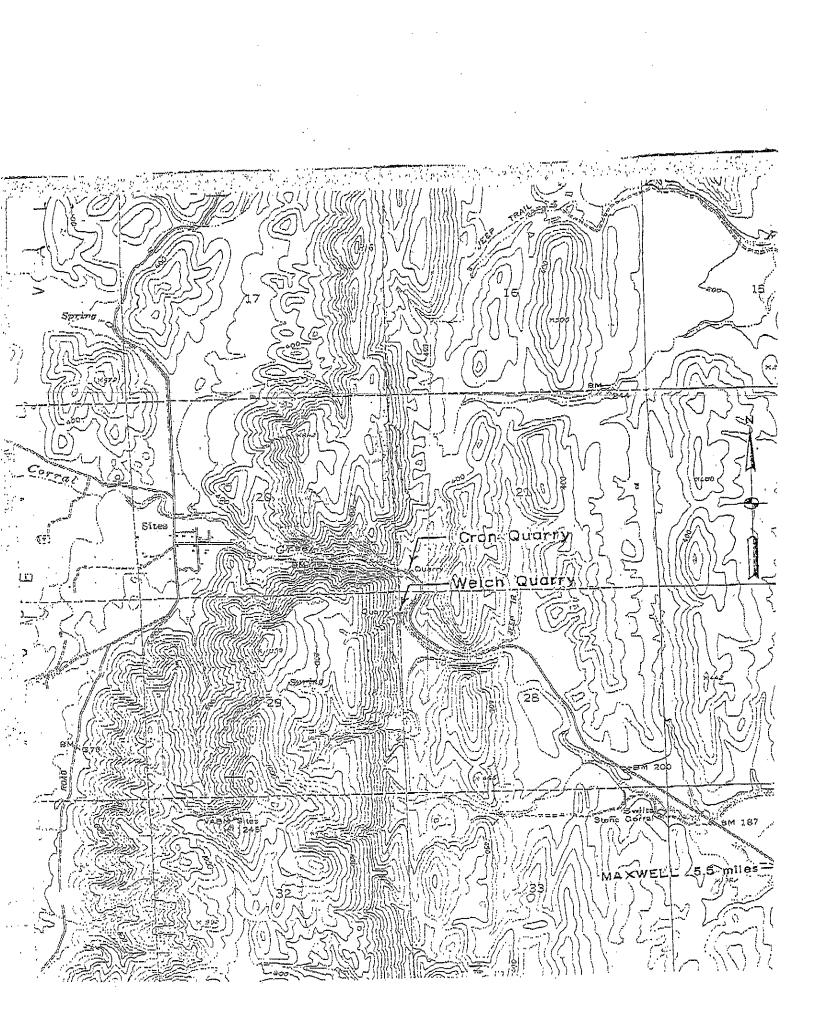
Keed & auterion REED J. ANDERSON

Geologist

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cc:

Engr Div (2) C-O Div Valley Res Ofc F&M Branch Emb Des Sec Geol & Conc Sec



P.JA/sjf 5July72

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29 June 1972

SPKED-T

MENO FOR RECORD

SUBJECT: Inspection of Quarrying Operation at Welch (Sites) Quarry

1. References:

ر میں مستقلم معرب

a. Memo for Record by R. J. Anderson, 21-March 1972, "Inspection of the Walch and Cron Quarries near Sites, California."

b. Memo for Record by P. J. Guthrie, 21 April 1972, "Inspection of Rock from Welch (Sites) Quarry."

2. The subject quarry was visited on 29 June 1972, by E. M. Hashimoto, C-O Division. R. J. Anderson, Foundations and Materials Branch and D. L. Mauck, Valley Resident Office. Purpose of the trip was to observe the shooting of an area of the main quarry face and to inspect the rock produced by the blast. The Contractor (Teichert Construction) had reported that the main face would be shot at 2:00 p.m. on 29 June. The area is of particular interest because, on the surface, it appears to contain better rock than any produced from the quarry thus far.

3. On arrival at the site the drilling and blasting methods being used were discussed with B. Lundgren of Mid State Contractors, Sonora, California, who has subcontracted with Teichert to operate the quarry. Methods being used seem appropriate for the rock type and condition of the quarry. According to Mr. Lundgren an average 8-foot hole spacing is being used, but the holes might be in an 8 x 8 foot square or staggered pattern of in a 7 x 9 foot staggered pattern depending on the size and shape of the area being drilled out. Maximum hole depth in production areas was said to be 20 feet. Annonium nitrate (fertilizer) with fuel oil is used with 55 percent gel primers. Miliscond delay caps are used for each succeeding row of holes. Powder factors are reported to be between 0.6 and 0.8 pound per yard.

4. The area which was drilled out and loaded at the time of the visit was not the area of the main face as anticipated. It was a small area (perhaps 25 by 40 feet) to the left (south) of the main face where the rock is highly jointed, weathered and seamy. The area could not be inspected closely before the blast because the shot was already wired. The blast lifted the area only enough to open up joints and lossen the rock sufficiently so it could be pushed down the slope with dosers. It did not open up a face on the back or side that could be inspected for rock quality. The rock in the shot that could be seen was brown, blockily jointed. weathered and it seemed to contain a lot of soil. 5. Three rows of holes in the upper central part of the main face had been drilled but they were not loaded. According to the foreman from Mid State Contractors, drilling will be finished in this area about 6 July and the blast will probably be made at 5:00 p.m. on that date.

6. The overall condition of the quarry did not seem to be improved over its condition on the last visit of the undersigned (6 June). On the pouth side at about the elevation of the crusher and above the material exposed contains more soil than rock. It was being excavated and wasted with front end loaders. The crusher was not operating, and there was no material in sight that appeared to be suitable for processing. Stripping at the top of the main face and above has produced two benches about 20-30 feet wide. Rock exposures are spotty in the areas being stripped.

Reed & anderson REED J. ANDERSON

Geologist

ce: Engr Div (Z) C-O Div John Crove Valley Res Ofc Design Branch F&M Branch (Orig) Geol & Conc Sec Emb Des Sec

RJA/sjf 17Ju172

14 July 1972

#### SPKED-F

MEMO FOR RECORD

SUBJECT: Inspection of Rock at Welch (Sites) Quarry

1. References:

a. Nemo for Record by T. R. Smith, 13 July 1972, "Meeting with A. Teichert Personnel to Discuss Sites Quarry, Contract 72-C-0057, Unit 22, Sacramento River Bank Protection Project."

b. Nemo for Record by R. J. Anderson, 29 June 1972, "Inspection of Quarrying Operation at Welch (Sites) Quarry" and references a and B.

2. The subject quarry was visited on 14 July 1972, by E. M. Hashimoto, C-O Division and R. J. Anderson, Foundations and Materials Branch. The trip was made specifically to inspect the 5,000 ton stockpile of good quality rock that personnel of Teichert Construction had said was at the quarry site (ref. a.) and incidentally to observe the overall quarry operation and the quality of rock exposed.

3. There is no separate stockpile of better quality rock at the quarry. The rock being produced at the quarry at the present time is being dumped on the west side and around the south end of the existing stockpile. The dumping has been done in such a way that it is impossible to separate the more recently processed rock from the older rock. Thus, there is no distinction between the newer, "better quality" rock and the older rock which has been inspected, sampled and tested previously.

4. The rock that was being hauled from the crusher during the inspection of the stockpile was better than most of the rock seen at the quarry before. It contained an estimated 10 to 15 percent brown rock of which a large portion was the softer brown. However, inspection of the stockpile where (according to an equipment operator) recently processed rock had been dumped indicated that overall it is similar to that produced previously. Some is better quality, most appeared to be about average for the quarry, some is considerably worse than average. One area contained more than 50 percent brown rock. It appears that the contractor is deliberately mixing poor quality brown rock at the crusher with the better quality rock. During the visit the equipment operators were observed taking 4 or 5 buckets of recently shot rock to the crusher followed by 1 or 2 buckets from an area near the crusher which consists of soil and soft brown rock.

14 July 1972

SPKED-F SUBJECT: Inspection of Rock at Welch (Sites) Quarry

5. The quarry itself has not improved much in appearance since the visit of 29 June. One area in the upper central part has fresh blue rock exposed in the back face. A bench in front of this face contains relatively fresh shale which is too soft and platy to be acceptable. An area on the upper right side is being drilled out, but rock exposed downslope from the work area is of poor quality. Therefore, it appears that the overall quality of rock produced from the quarry will not improve in the immediate future. The contractor is not concentrating his efforts in the part of the quarry that contains the better quality rock.

. .... R. J. auderson

R. J. ANDERSON Geologist

cc: Engr Div (2) C-O Div John Crowe Valley Res Ofc Design Branch F&M Branch (Orig) Geol & Conc Sec Emb Des Sec

# Teichert Construction

September 28, 1972

Department of the Army Corps of Engineers Sacramento District 650 Capitol Mall Sacramento, California 95814 Attention: James C. Donovan Colonel, CE Contractiny Officer

Subject: Quarry Stone at Sites Quarry

Gentlemen:

At this time we wish to inquire what the Corps of Engineers' position will be on suitability of quarry stone produced at the Sites Quarry for slope protection rock on future contracts.

As you are aware, this quarry has been on the Corps of Engineers approved list for some time. We are currently using it on our Unit 22 contract and it has been used on other past contracts in recent years.

At the present time, we have developed the quarry to the extent that we are producing almost entirely a hard, durable graywacke sandstone, dark gray or gray-green in color. The quantity of rock of this quality is extensive. The specific gravity is over 2.5 and the absorption is less than four percent according to tests you have run.

There is some question as to the rock meeting the specification requirements that have appeared in your most recent bid invitations. The most critical test for this rock appears to be the sodium sulfate requirement (ASTM-C 88) that has appeared in recent specifications. Although we have not received any test results from you on sodium sulfate, we have some tentative results on magnesium sulfate soundness (CRD-C 137) that would require further clarification.

As you are aware, economical sources of rock are scarce in the upper Sacramento River area (Knights Landing North). It appeared to us that the Sites location would fulfill the needs for future contracts in this area because of its proximity to the river and the suitability of the rock.

Corps of Engineers September 28, 1972 Page Two

On this basis, we entered into a long term lease with Mrs. Welch, the owner of the quarry, and have made considerable investment in plant equipment and pit development, not only to fulfill the requirements of our Unit 22 contract, but in order to supply rock for future work.

At this time we are negotiating the extension of our lease

with the owner and, as a result, the future of this pit needs to be determined at this time, both by ourselves and for the owner.

We will appreciate an early reply to this inquiry. If you have any questions in this regard, please contact us.

Very truly yours,

TEICHERT CONSTRUCTION

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Carl F. Bauer Manager Heavy Engineering

CFB:dw

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RJA/øjf 130ct72

12 October 1972

SPKED-F

MEMO FOR RECORD

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SUBJECT: Inspection of Welch (Sices) Quarry

1. The subject quarry was visited on 11 October 1972, by J. Growe, C-O Division, W. L. Goecker and R. J. Anderson, Foundations and Materials Branch. The trip was made to observe the condition of the quarry, the quality of rock being produced and the potential of the quarry in terms of rock quality and quantity.

Description of quarty. At the present time a face about 200 feet long and 75 feet high is exposed in the central part of the quarry. It is a bedding plane face that slopes to the east at about 45 degrees and is 50 to 60 feet farther into the hill than the original face that had been developed. A small plug of rock between these two faces remains to be blasted, and the south side of this section exposes the type of rock that has been excavared recently. It consists of about equal amounts of bluish gray to dark gray mostly fresh sandstone (graywacke) and interbedded shale. The quality of the sandetone appears to be as good as the quarry da capable of producing, which is to say that it is borderline for use as bank protection (ref. SPD Laboratory report dated July 1972, "Petrographic Report, Sites Quarry, Unit 22, Sacramento River Project, Colusa and Sutter Counties, California"). The shale, which is fissile and soft is completely unsuitable for riprap, and it must be separated from the harder and more durable sandstone in order to produce rock that comes close to meeting Sacramerico District specifications. ' Sandstone exposed in the main face is bluish gray and fresh from the bottom upward about 30 to 40 feet and is discolored tan to brown by weathering in the upper 30 to 40 fest. The uppermost 5 to 10 fest is highly weathered tock and soll.

3. Upslope from the quarry face is a series of sandstone faces that are separated by relatively flat benches. The sandstone outcrops are dip faces; the benches are interpreted to be shale layers, and it appears that the percentages of sandstone and shale are roughly equal.

13 Occober 1972

SPKED-F SUBJECT: Inspection of Welch (Sites) Quarry

4. A muck pile in the quarry consists of fresh to slightly weathered sandstone with a large percentage of dark gray fines that are apparently produced from shale layers breaking down from blasting and equipment operation. Much of the sandstone is in blocks that are too large to be run through the crusher. They will require plugging and shooting or will have to be wasted. The need to separate fines and redrill and shoot boulders would seem to create a very inefficient operation.

5. At both ends of the quarry in front of the present face are large banks of moderately to highly weathered conditions and shale with large amounts of brown clay. This material should have been stripped before quarrying operations were begun. In the past much of this type of material has been processed through the plant, and some of it ends up in the stockpiles mixed with the better rock.

6. Evaluation of quarry. Considering the overall quarry it is estimated that only 25 to 40 percent of the material available will be usable, and the best of it is only considered to be marginal under the specification currently in use. Any upgrading of the specifications would probably eliminate all of the rock from consideration. The low yield of usable rock cuts production, increases the time factor considerably and causes delays, and it appears that this situation is not going to change in the forseeable future. The problem will continue as it has throughout the operation of the quarty of separating the poor to medium quality rock from the acceptable rock. In the central part of the quarty where excavation is underway at the present time, the soft platy shale must be separated from sandscone. This is being accomplished with a grizzly, and the operation is generally successful, but a few large flat blocks of shale are getting through the grizzly and into the stockpile. On the levee slope they would break down rapidly and leave a void in the rock facing. When a new face is started in back of the present one, there will be two problems; separating shale from sandstone and separating softer, weathered sandstone from harder fresh sandstone. In the upper part of the quarry (from ground surface to a depth of 30 to 40 feet), an estimated 50 percent shale and 25 percent weathered sandstone will cut the volume of acceptable (marginal) rock to about 25 percent of the total production. Below the weathered zone the ratio of good rock to waste will increase to about 40 to 50 percent. Past experience has shown that it is not possible to separate weathered sandstone from fresh sandstone, and the resulting product is a mixture in varying proportions of suitable and unsuitable rock.

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SPKED-F SUBJECT: Inspection of Welch (Sites) Quarry 13 October 1972

7. <u>Conclusions</u>. The inspection trip and the past record of the quarry lead to the following conclusions.

a. The best rock available from the quarry is still marginal under present specifications.

b. Any rock furnished from the quarry will contain a certain amount of soft shale and weathered sandstone mixed . with the bluich gray sandstone.

c. Because of the large amount of waste, the quarrying operation is inefficient and it is doubtful that large amounts of riprap can be furnished in a timely manner.

d. There is no data such as core samples available to indicate the type of material behind the present face; however, surface evidence indicates that it will be similar to that produced in the past. Therefore, there is no reason to expect improvement in the rock quality or operating conditions.

e. The quarry should be considered as a source of riprap only for emergency situations.

EED J. ANDERSON Ceologist

cc: Engr Div (2) C-O'Div John Crowe Valley Res Ofc Design Branch F&M Branch (Orig) Geol & Cone Sec Emb Des Sec]

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## **APPENDIX M**

# MUDSTONE COMPRESSIVE STRENGTH AND BRAZILIAN TENSILE STRENGTH TEST RESULTS (2.5-INCH DIAMETER DRILL CORES FROM GEOLOGIC EXPLORATION)

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

PROJECT: SITES RESERVOIR

FEATURE: 2.5" DIAMETER ROCK CORES

ASTM C: 97 SPG % (ssd) ABS	0.2	3.7	3.5 3.4	1.	3.7	5.4			· · ·	- - -	
ASTN SPG (ssd)	2.74	2.47	2.50	2.66	2.52	2.41	· 				
REMARKS	Good Test	Good Test	Good Test Good Test	Good Test	Good Test Good Test	Good Test	Good Test	Good Test		The second second second second second second second second second second second second second second second se	
ASTMD-2938 COMPRESSIVE STRENGTH (DS)	17,910	13,080	7, <u>23</u> 0 13,120	16,850	4, <u>620</u> 11,270	7,290	5,390	1,180	:		•
MOISTURE	Wet	Dıy	Wet Dry	Dıy	Wet Dry	Dry	Dıγ	Diy			
LOAD (abplied to failure) (bs))	78,700	58,800	32,500 59,000	75,600	21,200 50,150	32,550	24,200	5,250			
RATIO RATIO	2.0	2.1	1.9	2.1	1.7	2.1	2.1	6.1			
	2.365	2.392	2.392	2.390	2.377 2.380	2.385	2.390	2.385			
LENGTH DIAM	4.733	5.010	<u>4.521</u> 5.009	5.018	4.010	5.013	5.038	4.555			l   
SSI SSI NO NO NO NO NO NO NO NO NO NO NO NO NO	Fresh, 45° per-bed, representative of sandstone	Fresh	Fresh	Slightly weathered, representative of pitting	Slightly weathered	Moderately weathered	Fresh	Moderately weathered		fer Managahanana an anana	
КОСК ТУРЕ	Ss	Ss	Ss	Ss	Ss	Ss	Ms	Ms			
DEPTH (feet)	51.3-52.0	51.0-52.3	53.4-54.2	35.6-36.3	27.8-28.4	16.2-17.2	199.5-200.3	23.2-23.8			
户 NO S			, m	" <i>"</i>	<2iΩ			1			1 6
SHE HOLE F. S NO	LC-2	RA-1	RA-1	LC-1	LA-1	RA-1	- - -	LC-1	*	!	
鼍	Sites	99	99	99	09	99	99	66			,
NOR SOUTH AND AND AND AND AND AND AND AND AND AND	99C-110	99C-91	99C-92	99C-88	99C-84	06-266	99C-89	99 <u>C-87</u>			

REMARKS: Rock Types - Ms=Mudstone, Ss=Sandstone, I = Interbedded Mudstone/Siltstone

INITIAL: RGJ/TEC REQUEST NO.: 99-19 DATE

SHEET 1 of 1

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STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

CIVIL ENGINEERING CANALS AND LEVEES SECTION

DIVISION OF ENGINEERING

FEATURE: 2.5" DIAMETER ROCK CORES

SITES RESERVOIR

**PROJECT:** 

2-97 % ABS	2.9 2.8	4.6	2.9 2.8	3.6	46	3.1	3.0
ASTM C-97 SPG %	2.56 2.56 2.57	2.51 <sup>A</sup>	2.49 2.50	2.56 <sup>A</sup>	2.53 <sup>A</sup>	2.53	2.55
			;	ferragi an	· · · ·		
\$ g <sub>11</sub>							
ASTM D-3967 SPLITTING TENSILE (ps)							
					,		
MOISTURE COMPRESSIVE COMPRESSIVE CONDITION STRENGTH (psi)	5703 10125		4693 9791		3980		
MOISTURE C CONDITION	WET DRY		WET DRY				
		;   			DRY		
LOAD (applied (0 failure) (lbs))	25650 45500		22800 47600		19350		
ENTO BATO	2.04 2.03	0.78	2.01	2.03	1.98 2.01 1.42	2.01 0.62	
BIAM.	2.392 2.393 2.392	2.387	2.487 2.488	2.492 2.493	2.488 2.487 2.487	2.494 2.493 2.493	
(Inch)	4.884 4.883 4.861	1.866	5.007 5.020	5.047 1.556	4.919 4.990 3.535	5.024 5.027 1.545	
ROCKTYPE	S S S S	Ws	SS SS	Ms Ms	Ms Ms Ms	Ss Ss	
DEPTH (feet)	75.8-77.3	163.3-164.4	56.0-57.0	146.7-147.7	140.1-141.3	70.8-71.9	
о о Ц	, ∧, , , , , , , , , , , , , , , , , ,		B	N N		C B A	
HOIE NO	GGC-LA1	GGC-LA1	GGC-RC1	GGC-RC1	GGC-RC2	GGC-RC2	
Rev of	2001-28 G	2001-29 6	2001-30 G	2001-31 G		2001-33 G	

Rock TypesMs=MudstoneSs=SandstoneI = Interbedded Mudstone/SiltstoneA - broken and/or end pieces used for specific gravity and absorption REMARKS:

0. 2001-08

DATE: INITIAL: REQUEST NO.

SHEET 1 of 5

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES SITES RESERVOIR

PROJECT:

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

FEATURE: 2.5" DIAMETER ROCK CORES

ASTM C.97 AG	2.6 2.6 2.8 2.8	3.9	2.3	4.8	8.3 6.7	6.8	
ASTIV ASTIV SPG (ssub)	2.53 2.55 2.56 2.56	2.52 <sup>A</sup>	2.48 2.48	2.40 <sup>A</sup>	2.28 2.39	2.41 <sup>A</sup>	<b>1</b>
						-	
-3967 -3967 -11NG -11E							
ASTMD 3960 SPLITTING TENSILE (pSI)		1		i i			
VSTM:D:2936 ASTM:D:3967 OMPRESSIVE SPLITTINC STRENCTH TENSILE (psi) (psi)	4810 9997	2184	: •			! 1	2338
	4.92	5	, * 4 ~ - 3=	: 	- I		
ASTMD-2936 MOISTURE COMPRESSIVE CONDITION STRENGTH STRENGTH	WET DRY	DRY	an ter a transmission and the second se				DRY
LGAD (applied failure) ((bs.)	21650 45000	9800		1	··· ! • · · · ·   • · · · ·   • · · · · · · ·	. <u></u> 4. 1 1	
10 FINATIO	0.62 2.10 0.58	2.09	2.02		0.60 1.45 0.51 0.60		0.51 0.54 0.50 0.50
DIAM.	2.394 2.394 2.394 2.394 2.394	2.390	2.491 2.491		2.478 2.480 2.488 2.488 2.488		2.493 2.493 2.493 2.493
ENGTH	1.495 5.019 5.019 1.398	4.996	5.024 5.018		1.480 3.588 1.258 1.505		1.283 1.347 4.193 1.238
воскалле	လို လို လို လို	Ms	S S	Ms.	* * * S	Ms	As As
	59.9-61.0	146.3-147.5	45.0-46.0	140.1-140.0	97.1-99.0	63.0-64.0 Ms	120.4-121.4, Mis
S S S		×					
<u> </u>	GGC-RA1	GGC-RA1	GO-DHS-3	SSD3-4	SSD5-3	SSD8-5	SSD9-1
<u>Hanna an an an an an an an an an an an an</u>	2001-34	2001-35	2001-36	2001-37	2001-38	2001-39	2001-40

SHEET 2 of 5

Ss=Sandstone | = Interbedded Mudstone/Siltstone

REMARKS: Rock Types Ms=Mudstone Ss=Sandstone I = In A - broken and/or end pieces used for specific gravity and absorption

> rgj 2001-08

INITIAL: REQUEST NO.

DATE

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DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA THE RESOURCES AGENCY

CIVIL ENGINEERING CANALS AND LEVEES SECTION DIVISION OF FNGINEERING

> SITES RESERVOIR PROJECT:

2.5" DIAMETER ROCK CORES FEATURE:

ASIM 2-97 FG %	3.3 3.3 3.3	0 0 0 0 0 0 0	3.7			0.8				SHEET 3 of 5
ASTA ASTA ASTA ASTA SPG (ssd)	2.48 2.43 2.42	2.57 <sup>A</sup> 2.57 <sup>A</sup>	2.45 2.44	2.44 2.43		2.66				SH
				2	and the second sec					stone
				d 1	₫ 1 ± 4 1		1 - 1	1 <u>.</u> 	a in	dstone/Silt
ASTM P 3967 SPLITTING (83)	1776					2480		• - •		I = Interbedded Mudstone/Siltstone
		- !		<u>     </u>		Ň				I = Inter
MOISTURE COMPRESSIVE SONDITION STRENGTH (ps)	5226					6861			99	ss Ms=Mudstone Ss=Sandstone I = I I and/or end bieces used for specific gravity and absorption
MOISTURE	WET					DRY WET				ne
LOAD (applied to failure) (lbs)	3630 25450			1 1 1		4910 33750	sketch)			Ms≓Mudstone Dieces used for
	0.66 2.02 0.58	1.51	2.01	0.56	,	0.64 1.84	cimen- see	0.61		nd/or end i
BIAM ((nich)	2.491 2.490 2.490	2.490 2.491	2.492 2.492	2.492	(did not receive sample)	2.486 2.490	(can not obtain test specimen- see sketch)	2.491	÷	REMARKS: Rock Types A - broken a
LENGTH (Inch)	1.641 5.033 1.448	<u>3.762</u> 4.980	5.020 5.021	1.398	(did not rec	1.593 4.593	(can not ob	1.523	i   (	REMARKS.
BOCK TYPE	S S S S	S Ms		သိ လိ	s S	0 Ss	Ms	Ms I		
DEPTH (feet)	71.0-72.2	206.5-207.6	272.0-273.0		45.0-46.0	56.0-57.0	57.0-57.7	<u>26.5-27.0 Ms</u>	A Anna A Anna Anna Anna Anna Anna Anna	rgi rgi
T S S S	< B O	< '@ ·			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		+++++++++++++++++++++++++++++++++++++++			
Ę Ę	GO-DHT3	GO-DHT3	GO-DHT3		2001-51 GGO-DHS3	2001-52 GGO-DHS4	2001-53 GGO-DHS4	2001-54 GGO-DHS4	1	
RA No	2001-41	2001-42	2001-43	, , , , , , , , , , , , , , , , , , ,	2001-51	2001-52	2001-53	2001-54		DATE: INITIAL:

A - broken and/or end pieces used for specific gravity and absorption

rgj 2001-08 ----: INITIAL: REQUEST NO.

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DEPARTMENT OF WATER RESOURCES THE RESOURCES AGENCY STATE OF CALIFORNIA

CANALS AND LEVEES SECTION DIVISION OF ENGINEERING CIVIL ENGINEERING

FEATURE:	2.5" DIAMETER ROCK CORES	An original and the second of the second secon
1	FEATURE:	

SITES RESERVOIR

**PROJECT:** 

REMARKS: Rock Types rgj 2001-08

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į. ł ł REQUEST NO INITIAL: DATE:

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

SITES RESERVOIR

**PROJECT:** 

FEATURE: 2.5" DIAMETER ROCK CORES

CANALS AND LEVEES SECTION

DIVISION OF ENGINEERING CIVIL ENGINEERING

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						Ī									
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р В 8	- 	:	· ·		1				: •	:		r	: 1		
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ASTM D-2936 OMPRESSIV STRENGTH (psi)	5745 8803		3856	1									:	I	
						-				1	-	•+ 	1	ļ	-
ASTM D-2938 MOISTURE CONDITION STRENGTH (ps)	WET WET DRY		DRY DRY												
LOAD (applied to failure) (lbs))	3200 42900 42900		18900 2700								1				
	32 28( 42(	÷	27		,	:			! +-	i 		· · ·	i *	- ,	
L(B) RATIO	0.61 2.02 2.01 2.02	1.92	1.92 0.62							l					
	····· · · · · · · · · · · · · · · · ·	10			:			1 :	•		,		I	ţ	
DIAM. ((nich)	2.491 2.491 2.491 2.491	2.495	2.492 2.493			Ļ	-								
ENGTH (Inch)	1.512 5.028 5.028 5.023	4.786	4.788											 	
	2100	., 1				1	· ·			-	-		- 4		
ROCK TYPE	S.	4 Ms	3 W S			<b></b>				-	; ; 	 		3	
DEPTH (feet)	430.5-432.0	535.4-536.4	556.3-557.3						1	1	:		:		
	430.5	535.	256				 			-	 		 		
S C		P P										   			
HOLE NO	2001-61 GGÓ-DHT5	2001-62 GGO-DHT6	2001-63 GGÖ- <u>DHT6</u>	1							an search			-	
una de la destructura de la definitación Manufación de la definitación Manufación de la definitación Manufación de la definitación de la Manufación de la definitación de la		2 66(	3,66(					ļ i	÷	I		i			
BAB No C	2001-6	2001-6;	2001-6:												

SHEET 5 of 5

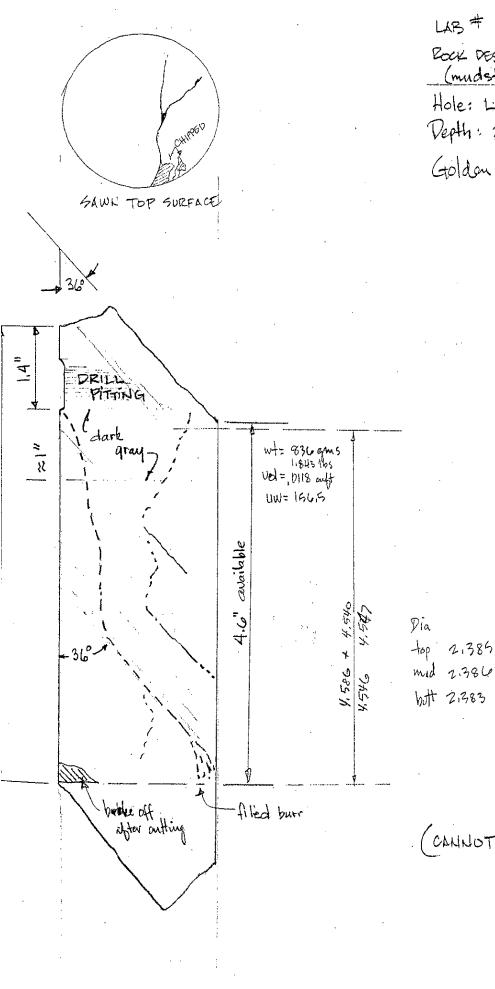
REMARKS: Rock Types Ms=Mudstone Ss=Sandstone I = Interbedded Mudstone/Sittstone A - broken and/or end pieces used for specific gravity and absorption

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<u>rgj</u> 2<u>001-08</u>

REQUEST NO.

DATE: INITIAL.



LAB # 99C-87 ROCK DESCRIPTION: Weathered shale (mudstone Hole: L:C-1

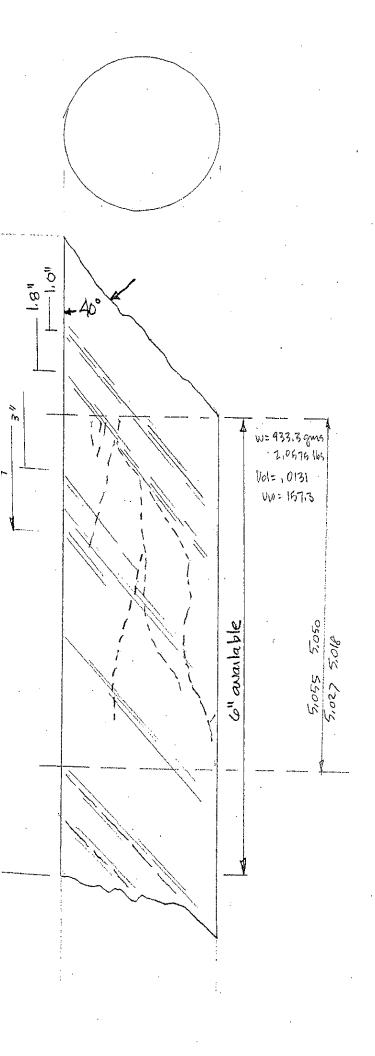
Depth: 23.2~23.8

Goldon Gate

5250 lbs

aug L = 4,555 " aug D = 2,385 " Area = 4,468# 4/17= 1.91

(CANNOT GOAK)



LAB # 99C - 89 Rock DESCRIPTION ; Shale (mudistone)

Hole: LC-1 Depth: 199.5~200.3

Golden Grate

24200 lbs

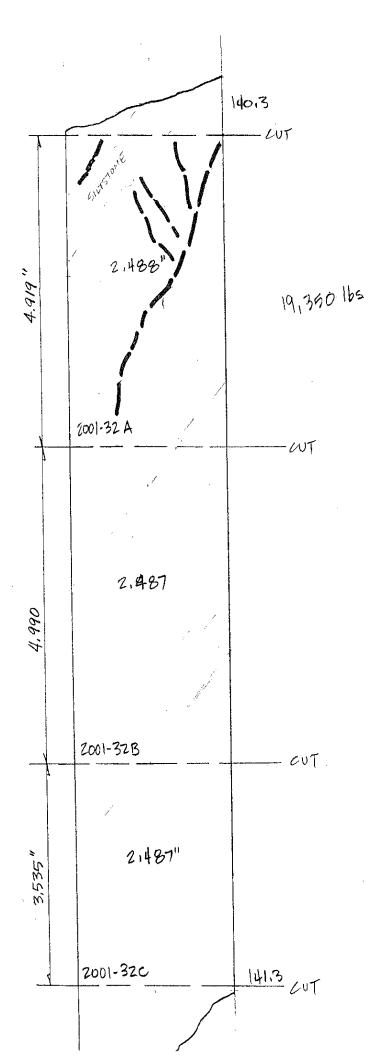
avg L = 5.038avg D = 2.390top 2,390 Area = 4.486 mid 2:389

Dia

bott 2.392

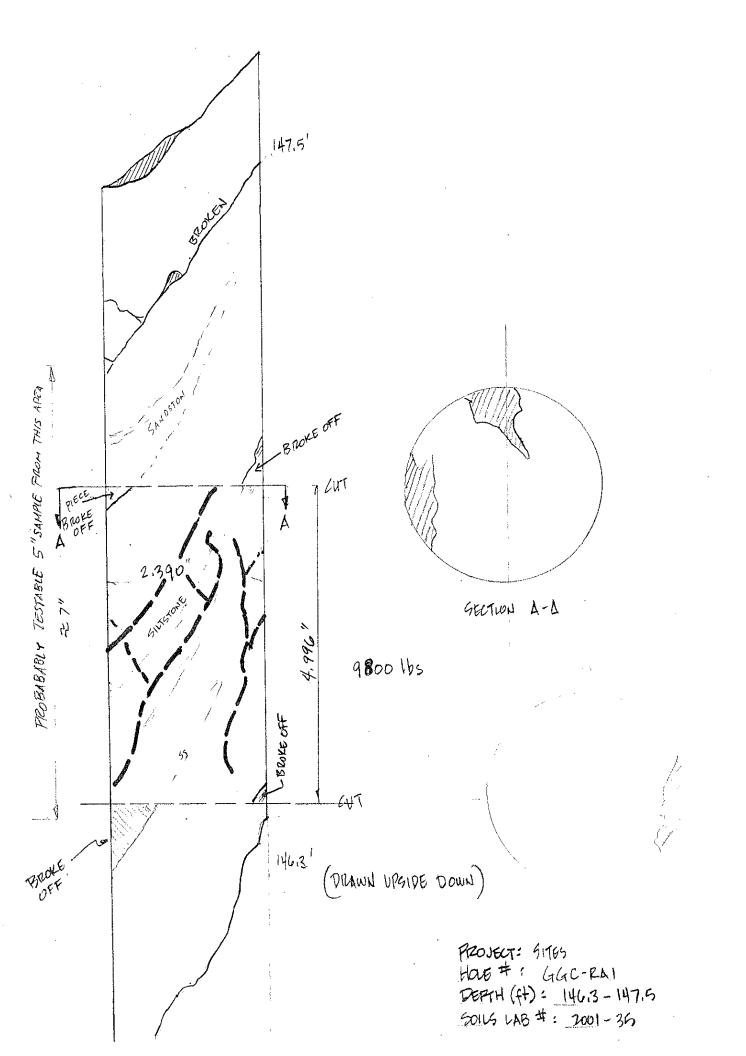
40-2.11

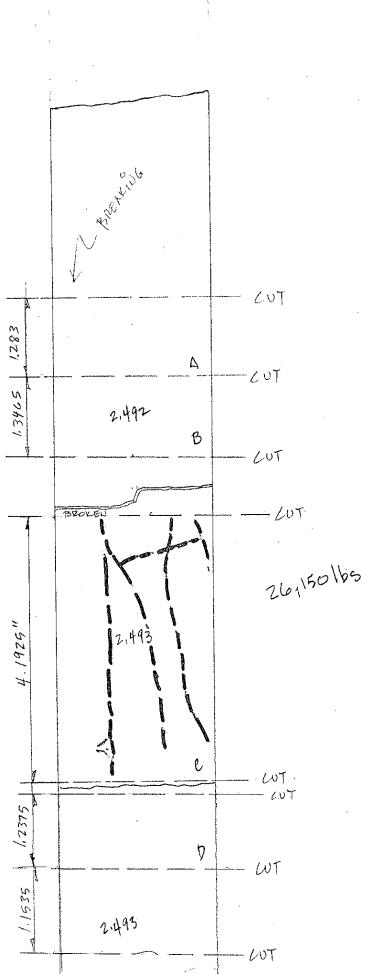
(CANNOT GOAK)



PIZOJECT: SITE HOUE #: GGC-RCZ DEPTH (ft): 140,1-141,3 50115 LAB #: 2001-32

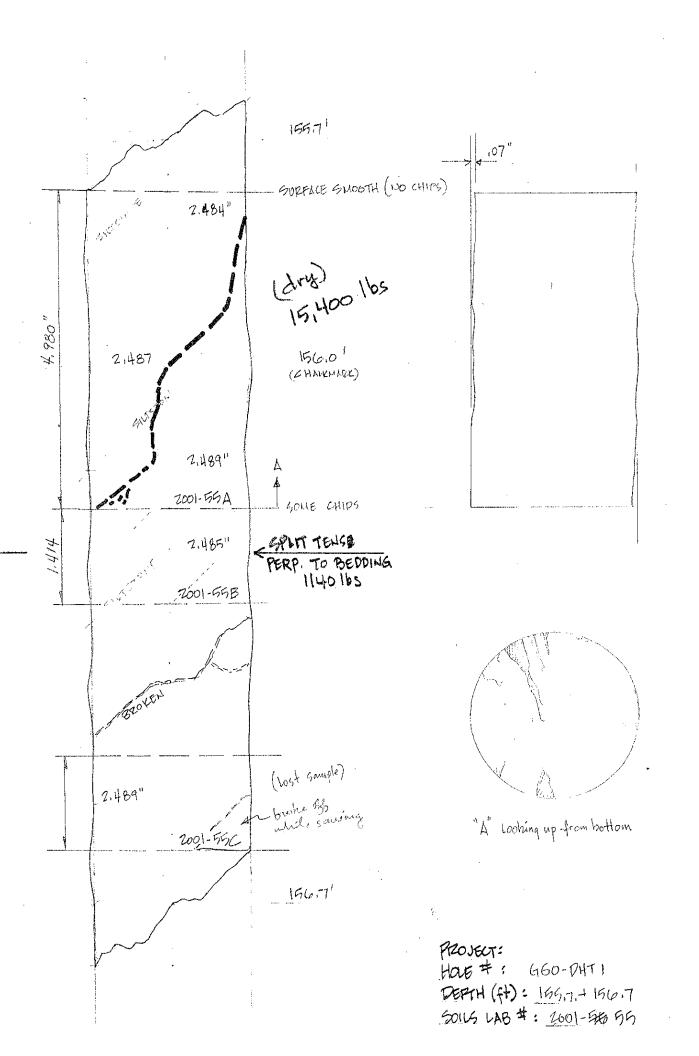
OJECT: SITE UE # : GGC-RCZ

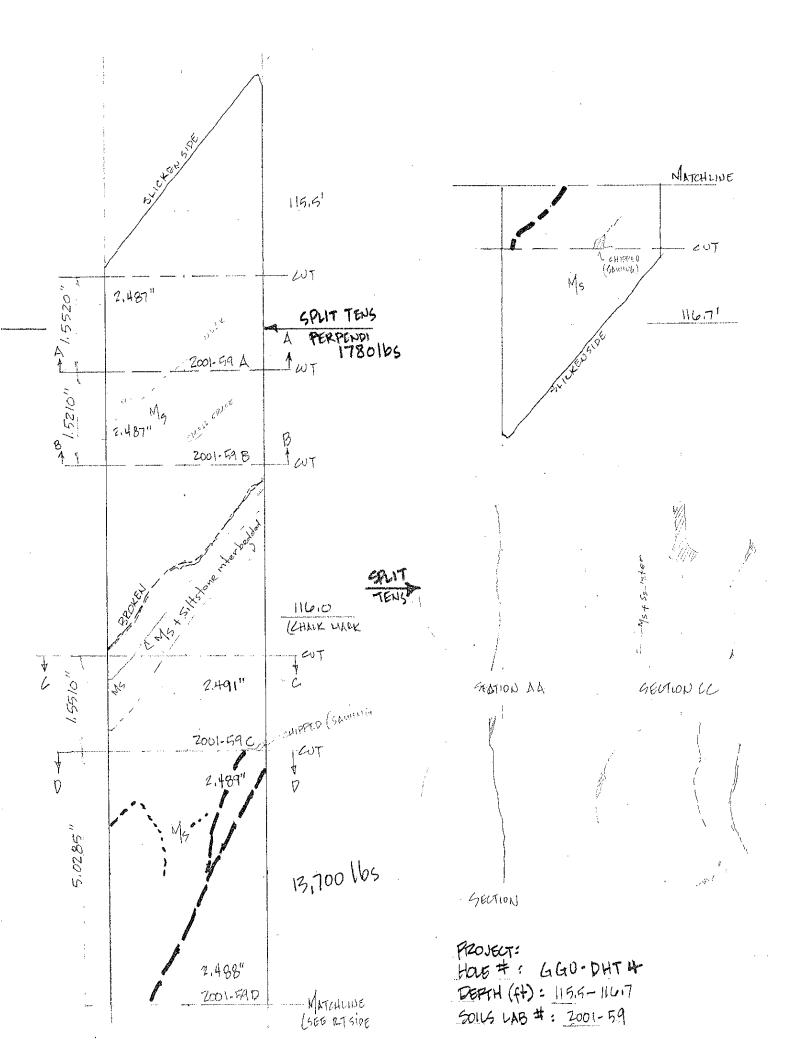


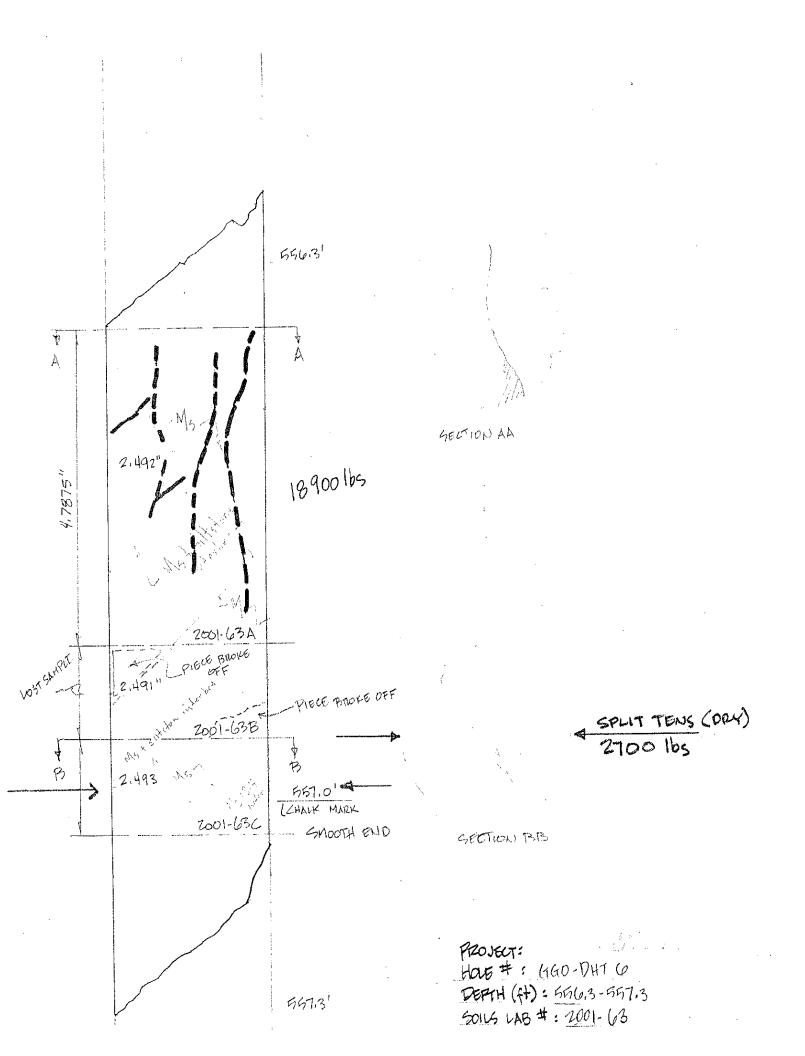


"Somple dry cut" did not use water blade wobbling-getting hot

PIZOJECT: HOLE #: 55D9-1 DEPTH (ft): 120,4'-121,4 50145 LAB #: 2001-40







# **APPENDIX N**

MUDSTONE SHEAR STRENGTH (DWR PUBLISHED DATA)

,		~	RESS 512 FESS FESS			•	TC STY	1;7 R	І.Т. н	1.7 н	ж 0.	4 0	N D	°¥. Ө	H E•I	143 E 1	1•3 H	1.5 ×	1+5 K
			TOTAL STRE Ratio-eff	•			1Hd1	22	22	22	0	0	0	е	21	12	51	20	20
		P-PLATEY	FAILURE Stress-total Stress ratio Ss				E E	•			0	©	o	0	G	0	6	c	C.
	<b>-</b> 1976		0 F 2 10R 5 1R		SYSTEM)		ЕРНІ	4 E	34	34	0	Э	9£	39	6E	68.	6E	. 37	7 <b>C</b> -
		WR-YELL ROUNDED	DEFINITION (Max devia (Max eff p) Max shear	•	CLASSFICATION		8-VALUE	<b>+6</b>	• <del>8</del> •	<b>.</b> 88	16.	0	C	<b>C</b>	.90	• 60	. 50	.1.00	1 • 00
					CLASSF		SAT	c	• <b>0</b>	Ľ	c	100	47	99	¢	¢	. : •	c	e .
		-ALLUVIAL R-ROUNDED			SOIL (UNIFIED		W/C	11.1	11.0	11.1	10+3	9 <b>*</b> 9	10+0	6"6	10.4	10.9	10.9	11.2	
		FT A-ALL			SOIL (U	WS	сомя	<b>6°</b> 46∶	94.9	94.9	95.2	94 5 .	94.5	5 <b>*</b> 46	95,2	95.2	ۍ 25 ° 5	95,2	95°2
	57UDY 2	EDIMENTARY A SH-SUBROUNDED IPS PER CU FT ER CU FT ER CU FT ER CU FT CENT CENT CENT	C C C C C C C C C C C C C C C C C C C	SQ CM SQ CM	TYPE OF		TDN	611	113	113	119	121	122	123	121	122	122	120	121
		S-SEDIMEN FT-KIPS PE FT-KIPS PE LB PER CU LB PER CU LB PER CU PER CENT PER CENT PER CENT	KGMS PER KGMS PER KGMS PER KGMS PER KGMS PER KGMS PER	IS PER S IS PER S IS PER S PER MIN	ΤY	_	NQ1	211	112	112	611	121	121	121	119	119	611	119	119
1	88 1 1		KGMS KGMS KGMS KGMS KGMS KGMS KGMS KGMS	N D A D A D A D A D A D A D A D A D A D		(dMp)	NOM	118	118	118	125	128	128	128	125	125	125	125	125
	AR SIRENGTH CO Soil test data	-SUBANGUL,	URE URE SFS	м м м м м м м м м м м м		-MEASURE	EN	50	20	20	20	20	20	20	20	20 <sup>.</sup>	20	20	. 20
	SHEAR SIR Soil Ti	M I M I M I M I M I M I M I M I M I M I	RESS AT FAILURE RESS AT FAILURE AT FAILURE Ective Stresses	LI C SSES SSES SES SES SES SES SES SES SES	TEST	(TRIAX-CONS UNDRAINED	sp.G.	2,71	2+73	2,71	2.72	2°13	2.73	2ª73	2.69	2,69	2+69	2,69	643
	HS.	ISIVE ANGUL	STRESS / ESS / STRESS / SS AT FA) JRE	0PE-EFFCTI 10PE-EFFCTI 0PE-TOTAL 8-REWOLUED 8-REWOLUED	TYPE OF. TEST	าร ประ	2 10 1	Ð	0	0	e	11	11	11	10	<b>1</b> 0	10	10	10
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	N	ANIC I-INTRU: HD-GRAVEL) A-, ry ry consolidation dn fent	IER B AAL SI VIATC VIATC VIATC VIATC VIATC			(18[/	, DE-	11	11	11	78	9	٤١	19	65	65	<b>5</b> 9.	65	ыr Д
	DEFINITION	IIN V-VOLCANIC I-INTRUSIVE M SHAPE (SAND-GRAVEL) A-ANGULAR IN ENERGY BRY DENSITY BRY DENSITY COMPACTION COMPACTION COMPACTION COMPACTION COMPACTION COMPACTION	ARAME ARAME ARANORI THE DR SSURE SSURE STH EN	STRENGTH ENVEL NGTH ENVELOPE STRENGTH ENVEL U-UNDISTURBED		CUE	4	100	100	0 U ľ	100	100	100	100	100	100	100	100	
J	DEF	GIN VH SHAPE DN ENEL DRY DER DRY DER DRY DER COMPA( MATER (	CT SUPE I (X-AVER, CT SHE, CT SHE, X-HALF CT SHE ER PHE	PT OF STRENC			LL PI	dN dN	NP NP	AP NP	NP NP		dN JN	dN dN	NP NP	dN dN	AP .	NP NP	an no
	Ĵ	SOLL ORIGIN V-VOLCAN PARTICLE SHAPE (SAND-C COMPACTION ENERGY MAALWM DRY DENSITY I.ITTAL DRY DENSITY I.ITTAL DRY DENSITY BRY DENSITY AFTER CON PER CENT COMPACTION INITAL WATER CONTEN' SATUPATION	PURE PRESSURE PARAMETER B FUH TRIAX-AVERAGE PRINCIPAL STRE FUH DIRECT SHEAR-NORMAL STRESS FUH THIAX-HALE THE DE VIATOR STRE FUH THIAX-HALE THE DE VIATOR STRE FUHE WITER PHESSURE AT FAILURE AHGLE OF STRENGTH FNVFLOPE-EFEED	Luter Asser Asser Saver Saver Saver Saver			0Ŗ Þ <sub>S</sub>		•		,	м.:	۰.						÷
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SAT	<b>с</b> ~	¢	Ð	C,	c	C	c	C	c	Ū.	c	Ċ	Ľ	0	c	c	C	C	c	C	0	ė	Ð	Đ	¢	c	c
¥/C	10.7	11.0	12,1	12.1	11.8	10.0	10.0	6°6	9 <b>*</b> 5	11.4	11.2	10.7	10.8	10.7	10.6	10.7	11,3	14.8	E+1	14.5	12.1	12+3	11.7	12.2	12.6	11.9	8 9
сомр	95,2	95.2	95,2	95 <b>*</b> 2	¢5,2	94.46	4 • 46	94°4	95,2	94.4	95.2	95 <b>°</b> 5	95,2	95.2	95.2	95 <b>°</b> 2	94.4	6°£6	9.4.8	94.8	<b>I</b> ‡ 56.	95.1	1.39	95 <b>°</b> 1	54,2	0 55 .	∳5 <b>.</b> 4
TDN	123	122	119.	120	123	119	121	121	121	118	120	120	122	119	120	122	123	108	109	110	118	117	119	123	116	117	126
NGI	119	611	118	8 L I	118	119	119	119	120	117	118	118	118	θtι	118	118	117	108	109	109	116	9.11	116	116	114	115	125
MDM	125	125	124	124	124	126	126	126	126	124	124	124	124	124	124	124	124	115	1.15	115	122	i 22	122	122	121	121	131
E	5,0	50	20	20.	50	20	20	20	2 Û	20	20	20	20	20	50	20	20	20	20	20	20	502	20	20	20	20	50
SP.G.	2.63	2,69	2,68	2.68	2.68	2.65	2,65.	2+65	2,65	2.70	2.70	2.70	2.70	2.70	2.70	2.10	2,70	2,65	2,65	2.65	2.70	2.70	2.70	2.70	2,65	2.65	. 2.70
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1.0	16	Ņ	33	1.00	C	12.9	95.1	118	116	122	20-	2.72	14	6) 4	θĥ	100	NP NP		964	54094
1.0	16	∿ •	C E	1 • 00	c	12,8	95 <b>.</b> 1	117	116	122	20	2,72	14	e *	86	100	dN dN			56062
<b>1</b> •0	15	ŝ	30	1.00	10	11.5	94.9	115	112	118	02	2*70	14	₽ 4	06	100	dN dN			
1.0	រះ	េ	. D.E.	1.00	¢	11.8	64,9	113	112	118	20	2.70	14	11) 12	96	100	dil dN		7247	ն ող է ն
с. •	12		33	ε9 <b>*</b>	c	10.4	95 <b>°</b> 3	126	122	128	20	2,70	17	4 N	L L.	100	29 5		4197	n6134
6•	12	:		•80	0	10.4	95 • 3	125	122	128	20	2.76	17	42	11	100	5 52		4197	
5	12	•1	EE 33	06*	C	10.3	95 <b>°</b> 3	124	122	128	20	2,76	17	42	11	100	2 <del>3</del> 5		4197	65134
	<b>E</b> E	,	9E	• 65	c	9 <b>°</b> 7	95°2	120	119	125	20	2,71	18	41	92	100	dN dN		5472	5H04A
- <mark>1</mark>	ЕĘ	1.	36	60	¢	6 <b>°</b> 6	95 <b>°</b> 5	120	119	125	20	2,71	18	<b>[</b> 4	92 26	100	dN dN		5872 1	6404A
1.3	E E	:	9E	€₽*	C	10+2	65+2	119	119	125	20	2.71	8	[*	92	100	dN dN		5972	6A043
 O	0	C	31	52	÷C	8 <b>.</b> 9	<b>∳°</b> 56	128	125	161	20	2.76	2	40	4 2	001	dn dn	-	66l+	56134
0	0	0	37	.78	c	9°0	94°7	127	124	131	20	2.76	12	40	74	100	NP NP		4199	<b>66134</b>
TC STY	IHdT	ЕC	ІндЭ	B-VALUE	SAT	H/C	Сомр	TON	NOI	NOM	EN F	SP.G.	10 11	<b>*</b> 30 <b>*</b> 200 <b>*</b> 5H	00-	<b>†</b>	Id TT	ខ្ល	0H	I•D•
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· ·	I- 1-1976	WR-WELL ROUNDED P⊷PLATEY		· .	DEFINITION OF FAILURE	(MAX DEVIA - (MAX EFF P	SHEAR STRESS	•		ASSFICATION SYSTEM		T B-VALUE EPHI EC TPHI IC SIY	r r			6.8° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5° 5		• <sup>9</sup> 0 36 0 13 •	а о о о о о о о о о о о о о о о о о о о	0 30 0 15 .**	.87 38 0 14 1.0 H	1 • • 87 38 0 1 <b>1</b> 4 1 • 0	87 3A 0 14 1.0 W	
	ON STUDY LE 2	YENTARY A-ALLUVIAL SUBR∩UNDED R-ROUNDED PER CU FT 'U FT	222	CENT CENT Cent	H SQ CM	CM	ck ou ch tratettette cR SQ ch	R SO CH	. NIW	TYPE OF SOIL (UNIFIED CL	SC	TDN COMP W/C SA	122 96,1 9,6	123 94.5 9.7	125 95.3 9.6	101 94.3 19.5 0	105 96.2 17.2 0	103 95•2 19•0 0 114 94.2 13.1 105	115 95,0 13,1 1	116 95.0 13.0 100	127 95.4 8.9 n	129 95.4 8.9 0	131 95.4 8.7 n	·
	SHEAR STRENGTH CORRELATION SOIL TEST DATA TABLE	M-METAMORPHIC S- LAR SA-SUBANGULAR FI-		$r n \alpha$	AT FAILURE KGMS PE	ILURE KGMS KGMS	KGMS KGMS FS	ESSES NGMS P ESSES NGMS P ES NGMS P	JN PER	TEST	JRAINED-MEASURE PWP)	SP.G. EN MDN IDN	2.06 20 127 122	2.66 20 127 120	127 12	2.69 20 105 99	20 10	2.65 20 120 13 200 2.65 20 120 133	0	2.65 20 120 114	2.73 20 130 124	2.73 20 130 124	2.73 20 130 124	a im imme men and a second and a Vander af an Andre San
زلي	SHE NAME · DEFINITION	SOIL ORIGIN V-VOLCANIC I-IN PARTICLE SHAPE(SAND-GRAVEL) CUMPACTION ENERGY MAXIMUM DRY DENSITY	;  z z z	WC INITIAL MATER CONFENT SAT SATURATION	PROFESSURE PARANETER B DR FUR PLAN-VENAGE PAINCIPAL STRESS DR FUN DIFFOT COLORDON DAL	FUR THIAX-HALF THE DEVIATOR STRESS FUR THIAX-HALF THE DEVIATOR STRESS FUR DIRECT SHEAR-SHEAR STRESS AT FA		EC INTERCEPT OF STRENGTH ENVELOPE-EFFCTIVE STR TPHI ANGLE OF STRENGTH ENVELOPE-TOTAL STRESSES TC INTERCEPT OF STRENGTH ENVELOPE-TOTAL STRESSES STY SAMPLE TYPE - U-UNDISTURRED H-REMOLDED	STHAIN HATP	TYPE OF TEST	CUE ITRIAX-CONS UNDRAINED-	1*0* 0H PS LL PI *4 *30 -200 -5M SF	1441 - 20 3 100 74 31 13	691,71 1401 20 3 100 74 31 13 2	100 74 31 13	20 100 75 39 0	41 20 100 75 39 0 41 20 100 75 30 2	9 33 13 100 70 40 20	3759 33 13 100 76 40 20	3759 33 13 100 70 40 20	1 10 81 40 17 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	7401 26 8 100 81 40 17	11 0 8 100 8 100 8 40 17 2	annana ann ad the coinnet tha 19. In ann annan athread an annan achair ann ann ann ann ann ann ann a

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<b>B</b> <sup>uis</sup>		IHdi	4	13	.Ŧ	15	5	12	12	12	12	. <b>*</b>	. <b>4</b> 	14		•						-	
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		B-VALUE	06"	5 26.	. 83	*6*		<b>*</b> 8 <b>*</b>	56.	<b>.</b> 84	58°	16.	-82	[9•			•						· · · · · · · · · · · · · · · · · · ·
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· .		H/C	£"61	19 . 4	19,3	14.0	14.1	14•2	20.1	20+0	19,8	11.3	10.7	10.9									
	r	COMP	95.2	95.2	95,2	54°7	94 <b>.</b> 7	94.7	£*56	6°56	95,3	94.4	95,2	94 a 4								۰ ۲ ۲	•
		TDN	103	105	106	106	108	109	103	105	107	123	124	125								2	
		IDN	100	100	100	108	108	108	101	101	101	119	120	119			,					*	
		NOH	105	105	105	114	114	114	106	106	901	126	126	126								· ,	
	۰	EN	50	20	20	20	20	20	20	20	20	20	. 0Z	20	-	·							
		SP.G.	2.67	2.67	2.67	2.70	2,70	2.70	2,73	2.73	2,73	2.17	2,77	2.77								• .	
		#2#	Ð	0	0	29	53	59	0	0	0	20	02	20								· ·	
		-200	4	24	4	£ ₽	45	u ∳	47	47	47	8 *	84	4		'n							
		En -	80	មិ	80	11	77	77	76	76	76	85	ង	85									
		4 1	100	100	100	100	100	100	100	100	100	100	100	100			•						
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1		1.D. 0R	h714416830	0689187179	h714416830	6A048 5859 '	<i></i> Ак <sub>0</sub> 48 5859	6883 876	47141634	458419el/u	4E83144114	1136 A969	51135 8969 ,	67136 H969		•		<del>.</del>	·			• • • •	· .

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# APPENDIX O

## VENADO SANDSTONE (CRUSHED) CONCRETE AGGREGATE QUALITY TEST RESULTS

THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

SANDSTONE TEST SUMMARY

CIVIL ENGINEERING CANALS AND LEVEES SECTION DIVISION OF ENGINEERING

> Sites and Golden Gate Dams PROJECT:

FEATURE: Sandstone Quality for Rip-Rap and RCC Aggregate

							PERCEI	PERCENT FINER	R					3-inch:C	3-inch:CUBE SAMPLES	PLES			
		<u> </u>				MEC	HANICA	MECHANICAL ANALYSIS	YSIS.					compressive.	specific	percent		CLASSIFICATION	
LAB	HOLE	ц Ч		U	GRAVEL					SAND	D			strength	gravity	absorption	GROUP		
QU	NO	ΟN	'n	1 <sup>1</sup> / <sub>2</sub> *	314"	3 <sub>/8</sub> "	4	ø	16	30	50	100	200	(isi)	(pss)	%	SYMBOL	GROUP NAME	
4					1							·		:					
98-182	SSQ-9	A	•••••••		1	- 1			i					-11250	2.49	2.8			
:	=	ф												11040	2.49	2.6		`   `	
=	= =	0	!				I		:	ŀ	i	ļ		11360	2.48	2.6			1
98-183	SSQ-10	A	· ···	1	1	,				i		-  	 	11240	2.45	2.8		1	i
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=	÷	ະ ບ	- <u>f</u>	1			. h		i		4	·!		11490	2.46	2.7			1
	   	<u> </u>	1	1			1. :				4	+	<u> </u>	57		;. 			
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in l			·		RE.	SULT	RESULTS OF QUAL		IY TE.	STS OI	I CRUS	SHED :	SAND	ITY TESTS ON CRUSHED SANDSTONE		: : ;			
		1	1. AS	LM C-	- 131 Lc		M C-131 Los Angeles Rattler	ittler To	Test ( Grading A	÷ adine ∕	· ···- <u>-</u>	× 3/8	الله Size fra	/, x 3/8 size fraction) :	,	:			ļ
-	4		}		- 100 re	volutic	= SU(	100 revolutions = 11.4 percent loss	cent lo:	S	ļ		) 						
	÷ 4	;	÷	÷	<u>500 re</u>	volutic	nns = 4	500 revolutions = 43.4 percent loss	cent lo:	 SX		.ļ	4					107 mm m	
		-				L	1								,	i 4		ł	
. ~.	· ····		I	Specifi	ic Grav	/ity and	d Abso	rption	lests be	fore pe	Specific Gravity and Absorption tests before performing	g LAR	ļ. Fi	1	1	:		i	
:	ŧ	<b>F</b>	<b></b>		Spec. Grav. = 2.48	Grav. =	= 2.48		5.	()   	ŀ	ļ				:			
				· · · · ·	Absor	ption	= 4.2 ]	Absorption $= 4.2$ percent			<b> </b> -	·	<del>  .</del> 	} I	i i	 		-	
		 					1		••••••		·····				1	; 			
7	·· •	. <u></u> ;	2. AS	LM C-	Dun	rabilitl	ASTM C Durabilitly Index (3/4	x (3/4 x	x #4 size fration)	: fratio		ļ		i					
			·		Durab	ility In	Durability Index, Dc = 42	ic = 42		- I	·····		····	1-				-	-
	4	. ‡		Crecifi Liner		ity and	4 Aben	rotion	- ed of o		Specific Grouter and Abcorntion tests hefore nerforminer			Coree Durchility Index		:			
1	· 	÷			Snec J	Snec Grav = $2.50$	= 2, 50	uond i		4			n r r			:			
	i	ŋ <u></u>			Absorption	ption	= 4.11	= 4.1 percent			J		1	1					
																			Sheet 2 of 2
DATE:		5/25/	5/25/1998		REM.	REMARKS:	In dete	mining	the abs	orption,	the stren	igth sarr	tples (ct	In determining the absorption, the strength samples (cubes) were oven dried	an dried			IM - INSUFFICIENT MATERIAL	
INITIAL:			RGJ				at 160 °F. TI	°F. The	crushed	l sample	he crushed samples were oven dried at 230 °F.	ven drie	ed at 23	0 °F. All samples	oles			NP - NON-PLASTIC	
REQUEST NO.:	:	~	99-19				were soaked	oaked fc	for 24 hours.	IFS.								NG - NO GOOD	
	1																		

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THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

# SANDSTONE TEST SUMMARY

DIVISION OF ENGINEERING CIVIL ENGINEERING CANAI S AND I FVFFS SECTION

Sites and Golden Gate Dams **PROJECT:** 

FEATURE: Venado Sandstone Quality for Rip-Rap and RCC Aggregate

					Ц.	PERCENT FINER	FINER					ASTM		ASTM C-40	0		AS	ASTM C-127 & 128	& 128			ASTM-C-131	C-131	A	ASTM C-142	2
					MECH	MECHANICAL ANALYSIS	ANALY	SIS				C-29	ç,	was	washed.	3/4" × 3/8		3/8: X#4	4	.#4 × #200	200	100	100 500	3/4× 3/8 3/8× #4 #4×#8	3/8×#4	#4,2#8
LAB	HOLE FS		Ō	GRAVEL					SAND			DRUW		as fin	fines	spg: 5/0	% abs	5¢3	%		%0	rev	¢.	% c	% clay lumps and	and
NO.	NO.	۶.	1 <sup>1</sup> /2"	314"	з/е	4	ß	16	30 51	50 100	200	) [ (pci)		rec'd removed		(ssd) a	abs. (s	(ssd)	abs. (	(ssd)	abs	% loss	% loss	μi.	friable particles.	les.
99C-113	<	   	100	96	32	12	- 6	~	7 6		5	88.3		clear cle	clear 2.	2.48 4	4.9 2	2.48	6.3 2	2.57	2.40	11.4	50.8	1.0	2.1	6.5
=	8   	   	100	35	57	35	28	23	20 1	11 81	9	88		clear cle	clear 2.		5.0 2	2.48	6.3	:	2.30	15	36.9	0.2	0.1	1.7
=	C		100	97	65	44	36	30	27 24	4 16	6	88.6		clear cle	clear 2.	2.48 5	5.4 2	2.48	6.2	•	2.50	11.5	49.5	0.2	0.1	13
99C-114	A		100	67	51	22	17	14	12 1	1 7	4	86.2			clear 2.		6.2 2.	47	6.6	2.56	2.70	13.7	56.0	1.7		8.6
=	B	· · · · · · · · ·	100	76	Ĵ.	27	16	15	[] []	1 2	4	86.4		3 Cle	clear 2.	2.46 6		2.47	. 9.9	ł	2.70	9.2	43.5	0.2	0.4	ເ <b>ດ</b> 
÷	0		100	95	47	22	10	13	12 1	0 6	ς Γ	87.5	<u> </u>	·	clear 2.	,	6.0 2.	46	6.6	de e	2.70	12.5	54.5	0.4	0.9	3.7
L					I		-		i	·· -	:	<u>.</u>		÷	= 	-					<u>.</u>		у			
				4.001	ERCE	NT CO	ARSE	AGGR	100 PERCENT COARSE AGGREGATE					ŀ	 	÷	:			<del> .</del>	<b> </b>	!	1			
		÷	112	3/.4	з/в	4	10	16	30	50 100	200		<u>i.                                    </u>	ł	 	;	,				:  					1
99C-113	<		100	95	22	0						<u>+</u>		-	 	· i					4	· [· · · ·			1	
=	B	: <u>}</u>	100	92	34 14				i.,	þ			 	;	ļ	.i	,				<del> </del>					
=	0 	; ;	100	95	38	; 0	:		÷	· • •	4.		<u>.i=</u>		 -	<u>і</u>				·•	<del>.</del>			<u>.</u>	1	
99C-114		! 	100	96	37				.i	···· -		1 ****	÷	-		ŀ				i	<del>.</del>	-				
2	B	۱۰ <u>۱</u> ۰ – ۱	100	96	39	0			ļ.	- <b> </b>		-		•	. <u> </u>	- 	•								;	
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				-00	PERC	ENT F	INE A	100 PERCENT FINE AGGREGATE	jA.TE	-1		-		-		r I	~				-  i			- <b>i</b>		
		5	1/2	$^{3}I_{4}^{*}$	5 10 10	4	ω	16	30 50	0.100	200				= ::	-÷ -	A	ŀ			1		-r	- j	1	
99C-113	4					100	73	61	56 51		18		<del></del>	-						· {· · · · ·		1	.i	- <u>.</u>		
; ; ≠	B	· 	}i			100	78	65	58 51	1 32	i i		<u> </u>			i	j						1			1
±	c			i	ļ	100	18	. 89	61 54	4 36	51		ŧ==:	r		;	 1	1				· • · · · · ·		- <b>.</b>		1
99C-114	A					100	76	62	54 7 47	7 30	16	; 	ļ		 		.j.					1				
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=	C	<u>+</u>	· ·· ·	·ļ	I	100	74	60	53 45	5 29	16	+	· <b> </b> :		• • •	-				1	:				1	
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																									очо U	Shoot 1 of 1
DATE:	6/1	6/12/1000		REMAR	3KS: 9	9c-113 =	= fresh (	crushed	REMARKS: 99c-113 = fresh crushed sandstone.	ţ														ai ISNI - MI	INSTERICENT MATERIAL	
INITIAL:		RGJ			ð	9c-114 =	= weath	ered cri	99c-114 = weathered crushed sandsto	dstone.														NP - NON-PLASTIC	PLASTIC	
REQUEST NO		99-19																						NG - NO GOOD	000	

 Project:
 Sites and Golden Gate Damsites

 Feature:
 Sandstone quality for aggregate (Rip-rap and RCC use)

 Request No:
 98-18

Hote number	1.5 c 3/8 ft	1.5 c 3/8 fraction graded for	led for	3/4 x #4 fr	3/4 x #4 fraction graded for	ed for
laboratory number	LA. Rattler			Coarse Du	Coarse Durability Index	ъ б
			A			A
Wt. Saturated surface dry sample			5249			2556
Wt. Oven Dry sample			5037			2455
Wt. water absorbed			212			101
% water absorbed			4.2			4.1
Wt. S.S.D. sample suspended in water			3136			1532
Wt. Water Displaced by S.S.D. sample	-		2113			1024
Wt. Water Displaced by Solid sample			1901			923
Bulk Specific Gravity (Dry Basis)			2.38			2.40
Bulk Specific Gravity (S.S.D. Basis)			2.48			2.50
Apparent Specific Gravity			2.65			2.66

LA. Rattler Test Results ASTM C-131 grading A

r			<u> </u>
Percent	of Wear	11.4	43.4
Loss	(grams)	5695	2176
Final WT.	(grams)	4440	2833
Original Wt.	(grams)	5009	5003
No. of	Revolutions	100	500

### I ECHNICAL SERVICES OFFICE CONCRETE SECTION

### TEST FOR "ABRASION OF COARSE AGGREGATE" ASTMC-131-76 -535-76

PROJECT			LABORATORY	( NO,	·····	
FEATURE Sand stone	for Kip Kap	ST KCC	FIELD SAMPL	E NO		
SOURCE OF MATERIAL						
SIZE FRACTION TESTED	•	/			and the second se	
WORK ORDER NO.	utting cubes	for comp. Str. )	compressive	str speci	neus were	also coushed
VISUAL DESCRIPTION	ty Gieve	· · · ·	······································			

TABLE 1 - GRADING OF TEST SAMPLES

SIE	E SIZE	<u>.</u>	Weight	& Grodi	ng of T	est Samp	les ~ g	
PASSING	RETAINED	<u> </u>	в	с	D	I	II	III
3 111.	25 114.	<u> </u>	<u> </u>			2500*		
214 IN.	2 IN.	· .	<u> </u>			2500		
2 IN.	115 IN.					5000*	5000*	
115 IN.	1 IN. ±29	1250					5000+	5000*
1 IN.	NIN25/	1250						5000*
NIN,	BIN. 510	1250	2500					1
15 IN.	3/8 IN. 10	1250	2500					
3 8 111,	NO. 3			2500				
110.3	NO. 4			2500				
HO. 4	NO.8				5000			

	RASIVE CHA	
Grading	No. of Spheres	Weight of Chorge — g
$\overline{\mathbf{A}}$	12	5000± 25
B	11	4584 25
с	8	3330 + 20
D	6	2500-15
E	12	5000±25
F	12	5000 ± 25
G	. 12	5000 ± 25

\* Toleronce of 25 permitted 5000±10

TEST RESULTS

NO. OF REV.	ORIGINAL WT-g	FINAL WT. g	LOSS OF WT, g	PERCENT OF WEAR
100	5009	4440	569	11.4
500	5009	2833	2176	43,4

.

$$1/2 - 1$$
 1252  
 $1 - 3/4$  1257  
 $3/4 - 1/2$  1257  
 $1/2 - 3/8$  1251  
 $5009$ 

TESTED BY <u>Roland</u> DATE TESTED <u>3/20/98</u> COMPUTED BY \_\_\_\_\_ CHECKED BY \_\_\_\_\_

ţ,

State of Californi The Resources Agen Department of Wate Division of Design	cy r Resources			
Durability Index Test	Californ	ia Test Met	hod 229	
PROJECT		LABORATORY	NO. Soil R	iteq (
FEATURE		.I.C. or FI		
VISUAL DESCRIPTION Crugbed Souston	<u>e</u> :			
		<b>.</b>		
Manufacture			•	
TRIAL NO.	#2	#3		
DATE TESTED	5/19	5/19		
TESTED BY	Roland	Roland		
COMPUTED BY				
CHECKED BY				
SIZE FRACTION	m/4 × #4			
PROCESSING				
A TIME STARTED SOAKING				
B TIME STARTED SHAKING				
C TIME STARTED SETTLING	0:00	02:30		
D TIME READINGS TAKEN	20:00	22:30	÷	-
E LEVEL AT TOP OF SEDIMENT	5.1"	5.5"		
F DURABILITY FACTOR De	4.2	40		_
G AVERAGE				
H REPORTED VALUE			3	
$\frac{\text{REMARKS}}{\frac{1}{2}} = \frac{\frac{3}{4} \times \frac{1}{2}}{\frac{1}{2} \times \frac{3}{8}} = 1000000000000000000000000000000000000$	Proposed (cum. u 1080 + 10 1660 + 2	) 0	· · · · · · · · · · · · · · · · · · ·	
3/8× #4 910=5	2574 2490 aft	ur initial prep	4 0, d.	

# SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

TEST METHOD: ASTM C 127-

State of California THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES TECHNICAL SERVICES OFFICE CONCRETE LABORATORY

Project		Laboratory No. Soil Reg. 98-18	
Feature :		Field Sample No	
Hole No.	Elev. Top of Hole	Depth of Sample	
Visual Description			
			_

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DE	TERMINATION NO.	······				
D٨	TE TESTED					
ΤE	STED BY					
сç	MPUTED BY		LART	COARSE DC		
C۲	IECKED BY		Greenm			
S1Z	ZE FRACTION		1/hx 3/92	7/4 x #4		
PR	OCESSING					
A	WT. SATURATED SURFACE DRY SAMPLE		5249	25560		
В	WT. OVEN DRY SAMPLE		5037	2455-		
С	WT. WATER ABSORBED	A <sub>₹</sub> B	212	101		
D	% WATER ABSORBED	C/B \$ × 100	A.2	4.1		
Ε	WT. S.S.D. SAMPLE SUSPENDED IN WATER		3134	1532		
,F	WT. WATER DISPLACED BY S.S.D. SAMPLE	AE	2113	1024		
Ģ	WT. WATER DISPLACED BY SOLID SAMPLE	F-C	1901	923		
н	BULK SPECIFIC GRAVITY (DRY BASIS)	<u>8</u> F	2:38	2.40		·····
	BULK SPECIFIC GRAVITY (S.S.D. BASIS)	<u></u>	Z:48 ·	2,50		
J	APPARENT SPECIFIC GRAVITY	B G	2.65	2.66	·	

REMARKS:

			C DI #3	42
1/2 × 3/4	3/4 × 3/2	Dur Index	73	
2624 55d	2625	2550	0 min = 7:7	
1567 in water	1569	1532	Duin	20 min
2520 od	2517	2455	s.H.=5.5" D= 40	s.H.= 5.\$" D= 42

1057	1056	1024
2.48 ssd	2,49	2,50
104		
4.1%	4,3%	4,1%

.

L.A Rattler 5005 - I blew it. 100 REV DID NOT PROPERTY GET - TIMER DIRTY <u>3193</u> did not get to 100 May NEED TO REDO 1812

$$\frac{1}{2} - \frac{1}{12}$$
  
 $1 - \frac{3}{4}$   
 $\frac{1258}{1262}$   
 $\frac{1}{2} - \frac{3}{4}$   
 $\frac{1258}{1268}$   
 $\frac{1}{4} - \frac{1}{2}$   
 $\frac{1258}{1249}$   
 $\frac{14440 = 100 \text{ ReV} = 11,4\%}{1268}$   
 $\frac{1251}{12833} = 500 \text{ ReV} = 43.4\%$   
 $\frac{1251}{1269}$ 

	## -# 	L L		<u>- 1</u>	9 00	0 m	3.7		* n.e.								,					
C-142	3/1 v 3/6 3/6 . 4.1	1	<u>i</u>	5 5	r v	o t	0.9							·								
	31. 236		••••••••••••••••••••••••••••••••••••••		Ę	Ч 0	0				-		<u>, 9</u>	- <u>&gt;</u>	0		- <i>c</i> .	· · · · ·				
		52. 8	1 2 2	62 9	° H	<u>,</u> Д	5, 73	······ •	ļ 	je o s		H V	2.19	2110	2:00	י קון 	7.63	2.29		:		
121-7157	Cors OA)	日十 50.8	02 676 81	11.5 49.5 123	(3.7 Exero . 24)	9.2 43.5 ,21	12.5 44.5 ,23					A A	20	2	12	. :	<u>e</u> <u>e</u>	n Di			ł	
- G21	A state	167 2.4	168 2.3	512 842	Sc 2.7	12 19	1-2 14			- 		#50 # [00 # m	6 18 14	7 19 16	7 18 15	2 1 1 1 1 1	1 12 1	<u>,  </u>				
- 127	The the		2,48 6.3 2.48 2.3	<b>L</b> -1	2.47 6.10 2.56 2.7	1.2 1.412 Dig LAIZ	2.46 6.6 2.67 2.7	Ð	2		els Each	# 10 # 20 #		7-	5 7	ь Г	E 2			•		
121-JU124	596	crear crear 2,48 4,9	2,49 5,0	OLEN CARE ZURS 6.4 ZURS	C100 2:42 7.2	atal 2. ye Lo	cutal Zitle C.D	RR. U. WGL	88 i K3	18:00	ntiaa	44	120		0	市 0		01 Q		80 F	015	
2	OBHSYM Orbergo	CLEAR CLEAR	CLEAR CLEAR 2,49	OLEN CAR	2 CLEAR	1	3 cuar	Û.R	;		<b></b>	• 	•	·						÷		
	m # 200	2	'S		+	4	3	2 #4	22 8	34		4 7 00 7 00 7 00 7 00 7	6	2.	7	2	91	14	#1	57 39	<b>U</b> 0 33	
	1/2 3/4 3/5 #4 #8 #10 #30 #60 #100 #200	100 dr 25 15 9 8 1 C + 5	0 11 81 02 22 82 52 14 54 001	97 US 444 360 30 27 24 16 9	+ L 11 21 11 L1 12 14 Lb 001	4 L 11 EI 51 11 12 15 10 1001	100 45 47 22 16 13 12 10 6 3	1/12 3/4 1/2 #M	0 5 73 1	6 50 34 5 50 34	in la	# 12 # 30 # 50 # 100 # 100	73 61 56 50 32 18	76 15 25 10 10 00	1% the 17 cm 10 mm	00 Jr 65 24 11 30 10	12 of	NO 14 10 63 45 29	1/2 3/4 3/8 #L	オキ	J r	
	(0 # 30 (1)	7	5 20	12 0	12	5	2	2/11	0	00	OLO PAGGING	r#20. ₩	2	60 - 21 - 21	5		7	5	271	0 0	0	
	# 20	6	2 8	9 %	7 19	<u>7</u> .	<u>ب</u> ح				1/0	# 0 #	2	2 6	2 5	r (67	6 6	200				
	林山	<u>1</u>	35 2	44- 3	1 72	1 12	121	 #	0	<i>o</i> c		+	8	000	0 00	76 00	69 69 00	2 00	1	0 0	0	
	2/4	28	15	E.	2	22	41	9/0	0 22 66			, r		:				-	218 4	39	23	
	1 3/4	n or	51 00	100 97	0 97	1-10 0	5 0	1 # 8/c 1/c 2/	100 95	100 96 29						-	v	-	1 + 8/2 1/2 2/1	0 62 11 001	100 93 33 0	
		0	- 10	0	1	101	0	S S	0	<u>0</u> 0		، انت انت انتخار		a c	<b>)</b>		~ .		5 <u>1</u>		C 10C	
		AC-113A	- 113.6	-1130	AC-14A	9 hill		11×11×11×11×11×11×11×11×11×11×11×11×11×	-490C115A		)	Sand only	సి	6 119D		114 A	いすい		Gac-11-LA	8	)	

	,	99C	-113				,
,	A		B	1			
Pry Wt	3608 Wt gms	do	2838				
	Wt gas	10 Vars	wf	Clo Pags	wf	% Pass	
1/2	0	100	0	100	0	100	
3/4	163	95,5	150	94.7	90	97.1	•
3/8	2472	31.5	1215	57.2	1140	69.4	•
#4	3168	12.2	1835	353	1862	44,0	
: 	1 6.9	i I I	221,4		260.60		
#8	3285 37	9.0	2056	2716	2133		
#16	53,17 <b>33339</b> 35,0		128.4 <b>Z185</b> 74.4	23.0	2310		
#30 <sup>2</sup>	3364- 1514	6,8	2259 70:1	10:4	98.9		
2 Com	2200	61	2329	17.9	2521	23.8	;
#100	2701+ 18,0 3467- 14,2	3,9	2515	11.4	2.790		:
77300	- 353	21	2680	5.6	3002	1	:
	3608		2838		3309	: ; ; ;	•
	1						
FINEAC	:					* • • • •	•
# 4	1 <b>1</b> 0	100	<i>50</i> ;	100	-0	100	
#8	1 117	73.4	221	78.0	281	80.7	
#16	1 17]	61.1	350	65.1	467	6.0	
# 30	1 196	55,5	424	57.7	570	60.9	
#40		49.8	494	50.8	449	54.1	
#100	299	3211	680	32.2	938	35,10	
#200	363	17,5	846	19.8	1150	211	
Pan	, 440		1003	I	457	I	
COARSE AGE	ANG R						ang
1/2	;	100		100		100	(00)
3/4		94.9		91.8		94.8	93.8
3/8		22.0		73.8		38.1	31.3
#4		0,0	-	0.0		0,0	0

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446-114

A	B	$\sim$
11/2 0 100 3/4 105 97.2 3/8 1822 51.2 4 2898 22.4	0 100 101 97.2 1617 55.3 2635 27.1	0 100 173 94.7 1708 47.4 2937 21.8
$= \frac{10}{2004}$ $= \frac{10}{3102}$ $= \frac{10}{3212}$ $= \frac{10}{3212}$ $= \frac{14.0}{3281}$ $= \frac{10}{3281}$ $= \frac{12.1}{3343}$ $= \frac{10.5}{3482}$ $= \frac{100}{3482}$	$   \begin{array}{ccccccccccccccccccccccccccccccccccc$	$     \begin{array}{ccccccccccccccccccccccccccccccccc$
Fine Aqq $\pm 4$ . 0 100 $\pm 8$ . 201 204 75.60 $\pm 16$ . 314 62.14 $\pm 30$ 69 383 54.1 $\pm 50$ 24 75.6 $\pm 16$ 314 62.14 $\pm 50$ 69 383 54.1 $\pm 50$ 62 445 46.7 $\pm 100$ 584 30.1 $\pm 200$ 705 15.60 7am 835 Coarse Aqq 11/2 0 100 $\pm 11/2$ 0 100 $\pm 11/2$ 0 100 $\pm 11/2$ 0 100 $\pm 11/2$ 0 0 100 $\pm 11/2$ 0 0 0	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

	99	C-113A	I	B	I	C			990	-114 A		B		<u>_</u>
	140	win	Olas	WH						1	-			2
井中	0	0	0	0	0	0			0	0	O	0	0	0
#8	27	27	12	22	19	19	19	15	24	24	32	32	26	26
# 16	12	39	13	35	13	32	15	30	14	38	13	45	14	40
# 372	5	44	7	42	7	39	25,	(ستا دیم	B	46	G	53	7	47
\$60	6	50	7	49	7	46	25	80	7	53	7	60	8	55:
# 100	18	68	19	68	lB	64	0	10	17	70	13	73	16	71
# 200	14		16		15		ή		14		11		13	- 
PAIL	18	2.28	16	2.16	21	2.00	3		16	2.31	16	2.63	10	2.39
		-			1					:	:			<u>.</u> :
											\$			
		4												

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		4	7	F	>	2	-	· · ·	Ą	17	5	· <	-
mövert mple kilt (gms) ven Dry Wt (gm D. after Washing	ns)	<b>36</b> 36	1.1	290 280 268	2 55 38	33	10 3.1 09 9.3 02	37	04	37-36	3.0 14:	32 31	329 2.46 136
1/2	·	bul O	cuum D'					129 =	3.5 be	, 164 -	- 43	110=	· ~ , <del>`</del> X
3/4		163	113	150	150	96	94	105	105	101	101	173	173
3/8		2309	2472			1060		1717	1822	1514	1617	1535	1709
#4		1963 363	3168 3531	1,20 845	1835 2180	2060 1150	862 3002			1018 829		829 599	2537 31360
#B	,	305 422.5	32,2	43010	26.2	424.1	24,4	461,0	28.9	492.9	37.7	459.0	31,0
# 14		476.65	14.8	602.(p	15.2	403,3	4.2	629,9	历。他	571.5	15.8	539.3	14.2
# 30	c	601.5	6.9	51hl.4	8,8	647,0	9.0	679.4	9.8	618.2	9,4	584.6	9.1
#ific		in1.0	7.0	F84.1	8,3	H891.0	8,6	623,9	8.8	657.4	7,9	Muit	8,4
#19		logile	21.5	699.0	27.0	W3.0	23.4	123,0	19.6	735.0	历心	725.5	199
#20		610.0 670.2 365.2	15.14 - 2.3 100.1	762.0 (1)	4.2	178.62 192.6 195.8	15.5 2.9 100	794,0 809.4	14.12 <u>3.1</u> 6 99.9	304.0	11.8 2.0 100.2	802.3	13,6
CHO WASHER AS REZ	20	CLE	私兄	CREA CLEA 100	R	CUEDO CUEDO CUEDO 10	R	100	AR.	CLG1 3		CV67 3	
3/			5,5	94		9-		97		97		94	
		•	1.5	57.		6		51		54		47	
十 十		i	2.12	35			.0	22.		27	.)	21	,
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#11	Le l	A BANK A LOUGH A						·	:				r t
# 34	D						÷	l	ļ				ł
45	Ŀ	and a second sec											
¥10	סי				1								
* 20	>0			2.1.		۵ م		26		ل حر		<i>(</i> e 11	

C-142	社父		*v
		990-113	5 A
	3/4×3/8	3/8×#4	MINUS
0, 7, (qui)	2332	1566	170
O.D wit after Processing	2310	1633	159
with loss	22	33	
% 1055	1.0.	2.1	6.5
		000	<b>+</b> 5

·	. (	190-113	Б
0.0	2600	1488	172
0.17 after	2600 2596	1487	169
wt 6645	4	١	ろ
020 Logis	12	0,1	17

99C-114A 1/4×3/8 3/0×#+ 41005 2200 1632 128 2162 1578 117 38 54 11 17 33 8,6

990-114B 2528 1139 169 2524 1135 164 4 4 5

.2 .4 3.0

99C-114C 2709 1392 274 2697 1379 264 12 13 10 0.4 0.9 3.7

# GPG & ABS

	- Bertan		99-	113	1	i a		1	99-1	14	1	ź
	A 1/4 x 3/8	A 3/8×#4		B 3/8#4	C 5/1 × 3/8	C 3/8/ #4	27 A 14 74 x 3/8		B 10	32 13 31		C <sup>+23</sup> Z,2 3/8 x#4
tin Air 55	p 2382	713	1087	625	1174	705	1744	1068	1510	1055	1583	853
fin Air O.	0 2270	671	1035	58B	1114	664	1642	1002	1424	990	1494	800
f of H20 abs	a 112	42	52	37	60	41	102	66	86	65	89	53
s absorpti	on 4.9	6.3	5,0	6.3	5.4	6.2	62	6.6	6.0	6.6	6.0	6.4
t ssd in wat	ur 1423	426	650	373	701	421	1033	635	895	627	940	506
H2D Displace by SSD Sam	Ne 464	287	437	252	473	284	711	433	615	428	ويهل	347
H20 PI4Pla My solid Sou	ple 847	245	385	215	413	243						
JUK OPT B	Nii) 2,37	2,34	2:37	2 33	236	2,34	2,45	2147	2,44	2.47	2,40	2,46
ILK SPG (SGD BASI IPPARENT SPG	15 2,48	2,48	2,49	2,48	2148	2,48						
- Sact Surf	A	MC Aeter	Ы	MC deter	С	MC Leter		MC determi	B		C	
ry sample	500.6	536,8	501.6	430.6	500.4	STON	506.1	583.7	500.7	560,4	500.6	577.2
t over dry crowpl	e 488.9	624.3	490.3	616.7	488.2	556, Le	492.8	568.2	487.5	5455	487.4	562.3
t water absor	bed 11.7	12,5	113	13,9	12.12	13.8	13:3	15.5	13.2	4.9	13.2	14.9.
6 water abox 5 ml Vol flask:	P17	214	2.3 F	2.3 1,42.8 1,91.2	2.6 G	2.5	2.7 F	2.7 (a1.1 105.4	217 Gt	2.7 6.6.5 169.8	2.7 F	Z.7 691.8 191.2
Alled w/	13° 1076,25		78° 1199.14		n° 664.0		74.5	689.1	n° 664.0		17° 689.7	
t 550.+ t flask "/ wa	ter 1176.86	103.0	1191.2	189.3	1164.4		1196,0	673.6	1164.7	721,0	190.3	
t flask aft Vacuum	480.9	(18.7)	997.1	172.6	9707	106.W	998.5		969.9	160.6 H 98	995.5	163.0
by SSD	194.95		194.1		193.7		197.5		194.8		194.8	
H danpleid by solid ILIK SPG	183.25	i	182.8		181.5		184.2		181.6		181.6	
Dry BAGIS	2.61	1	2,63		2.62		260		2.50		2,50	
LSSP BASIS	2.67		2.58		2.58		2.50	e	2.57		2.57	
sparent Spa	2,117		2.68		2.19		2.68		2,68		2.68	

 $\frac{1}{2} = \sum_{i=1}^{N} \frac{\partial f_{i}}{\partial x_{i}}$ 

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C-131	GP&DIA	0G B		500±10		Charge 11 sph		
	990 A	2-113 B	С		A	990-114 TS	C	
3/4 x 1/2 total wt 2/fer 100 rev 2/fer 700 rev 2/fer 700 rev 2055 100 rev	2503 5001 4433 2460 11.4	B 2502 5003 4036 3174 7.3	4002	4432	2607 5003 4317 2202 13.7			
6055 1500 rev 00/1500 logs ratio	50.B 123	36:7 ,20 198	1	49,5 ,23	56,0 .25	43,5	54.5 ,23	
C-29	Unit W	REV-lot	oids A	, aqq				
Kotding Ht of Rodded agg + Measure (1) wt of Measure(1) wt of Measure(1) wt of Measure(1) wt of Measure(1) wt of Measure(1)	60,41 60,41 16.3 44.0	10-113 0 60.40 5 6			69.35 16.35 43.0	990-1 59.45 43.1	14 60,00	1 1 1
D.R.U.W. (pof)	88 B		88.7		86.2	8614	87.5	

# APPENDIX P

CONGLOMERATE Compressive Strength Test Results for DWR Samples SUMMARY SHEET

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES

DIVISION OF ENGINEERING CIVIL ENGINEERING CANALS AND LEVEES SECTION

2.5" DIAMETER ROCK CORES	
2.5" DIAMETER ROCK	

FEATURE:

SITES RESERVOIR

**PROJECT:** 

C:97	% ABS	*0 0	0 0 0 0 0 0	r T	+. + + +	1.2	1.2*	1.4	1.0	0.9*	0.6							
ASTM C-97	SPG (ssd)	rc c	2.35		2.60	2.59	2.59	2.57	2.62	2.63	2.65							
a a nandari na ta kati na na	under nach sonn der der der der der der der der der der		,									 		 				
N									 		hadra da	 		 	 			
ASTM D-3967	SPLITTING TENSILE (psi)																	
ASTM D-2938	COMPRESSIVE STRENGTH (psi)	FOLO	6417		2512	3632	2659	2859	5618	6077	5589							
	MOISTURE C CONDITION	1 X (to 1.	DRY		WET	DRΥ	WET	DRY	 DRΥ	WET	ряγ			 			•	
LOAD	to failure) (Ibs.)		31500	00041	12300	17800	13000	14000	27600	29900	27500							
	L/D RATIO		2.11	ц С	2.05	2.06	2.09	2.08	 2.10	2.10	2.10							
	DIAM. (inch)	0,100	2.500	007	2.497	2.498	2.495	2.497	2.501	2.503	2.503							
	LENGTH (Inch)	100 1	5.274		5.128	5.146	5.225	5.185	5.264	5.266	5.257			 				
кые	воскт		8 8		Ond	Cng	Chg	Ong .	 Cng	Cng	Cng			 	 			
	DEPTH (feet)		31.6 - 32.0		72.0 - 72.4	72.4 - 72.9 (	72.9 -73.3	73.3 - 73.7 Cng	111.8 - 112.2	112.2 - 112.7 Cng	12.7 - 113.2							
	s o L Z		< @	<		0	۵	ш	 A 1	ш Т				 	 			
	HOLE NO		1-0 000	1 0 COO			-		SSD 6-1				1441 M 1 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201 M 201					
	LAB NO		7002-114		21-3003				2001-31					 		 		

SHEET 1 of 1 Cng = Conglomerate (3/4 inch nominal max. size aggregate) REMARKS: Rock Types Ss=Sandstone Cng = Conglomerate (3/4 inch nominal m. \* Did not oven dry - values were estimated Test Machine = Tinius Olsen set at middle range ( 80,000 lbs. capacity, 100 lbs. division) rgj 2002-09 4/16/02 INITIAL: REQUEST NO. DATE:

SITES RESERVOIR

DEPTH	31.0-32.0	72.0-73.0	112.0-113.0
HOLE NO.	SSD 6-1	SSD 6-1	SSD 6-1
LAB. NO.	02-114	02-115	02-116

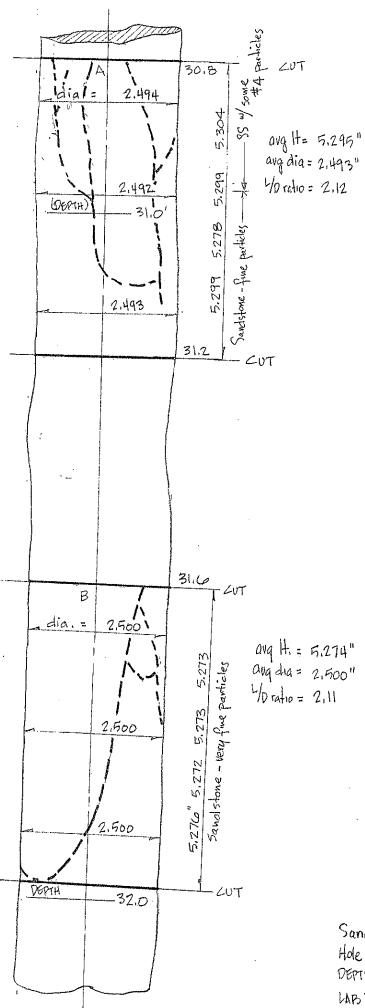
Sandstone - 2.5 × 16.5 inches Conglomerate - 2.5 inch × 26.5 inches Conglomerate - 2.5 inch × 16.0 inches

.

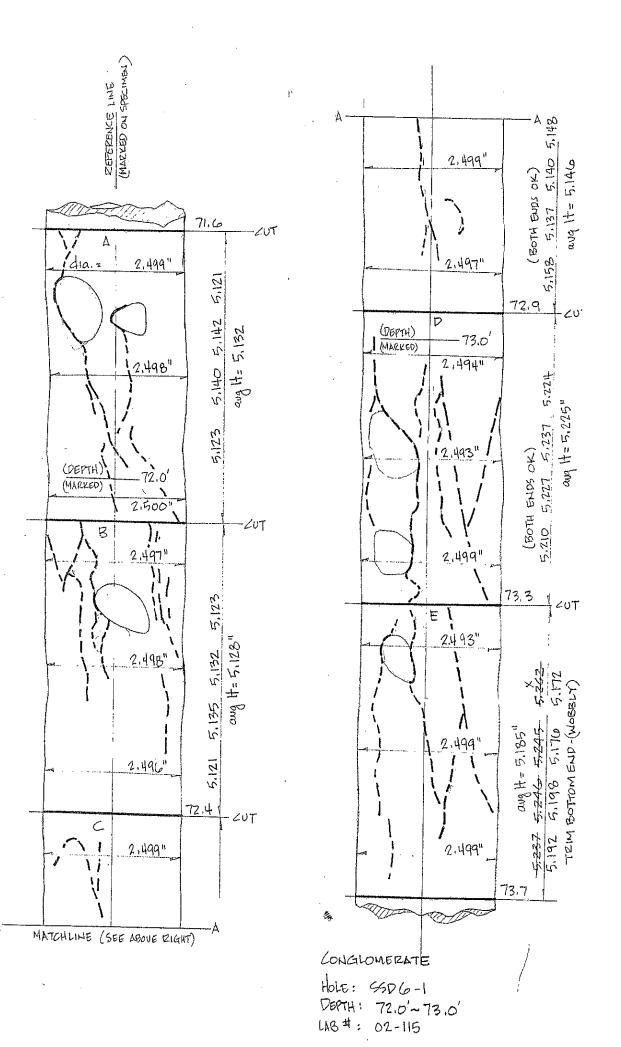
# SPECIFIC GRAVITY AND ABSORPTION

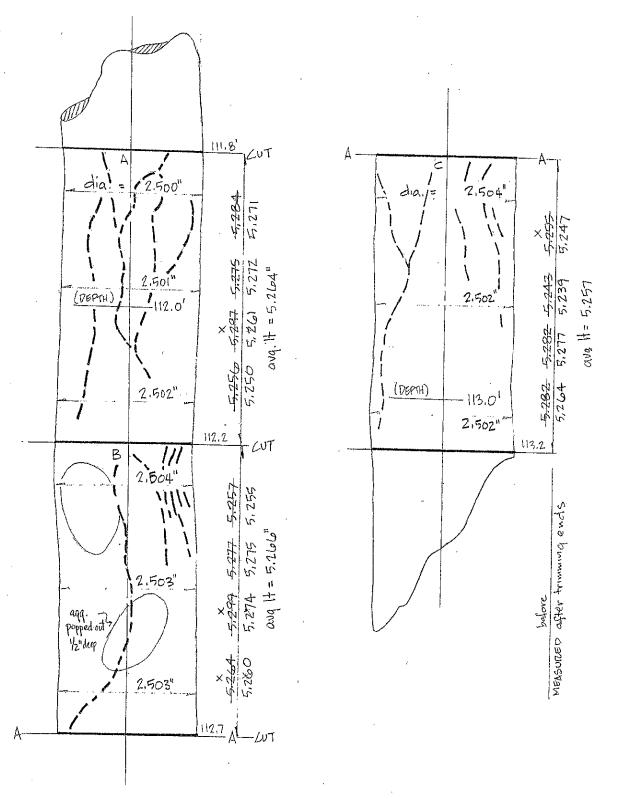
LENGTH (inches)         5.296         5.274         5.132         5.132         5.132         5.132         5.128         4           DIAMETER (inches)         2.493         2.500         2.493         2.491         106           A         WT.OVEN DRY SAMPLE         982.9         992.5         992.5         956.2         956.2         1068.4         1068.4         106         106           C         WT. WATER DRY SAMPLE         A-B         37         36.3         36.3         36.3         31.4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4         1<4	LAB. NO.		02-114A	02-114B	02-115A	02-115B	02-115C	02-115D	02-115E
2.493       2.500       2.493       2.497         strength       WET       DRY       WET       D         wET       DRY       WET       D       NET       D         strength       WET       DRY       WET       D         strength       WET       DRY       WET       D         962.9       956.2       956.2       1068.4       1063.9       10         A-B       37       36.3       1053.4       1048.9       10         A-B       37       36.3       1053.4       1048.9       10         A-B       37       36.3       1653.4       1048.9       10         A-B       37       36.3       1.4       1.4       1.4       1.4         A-E       421.3       422       657.8       654.6       65       657.8       654.6       65         A-E       421.3       422       385.7       395.6       394.3       31         F-C       384.3       385.7       2.56       2.56       2       34.3       34         F-C       384.3       385.7       2.56       2.56       2       34.3       34       34.3       34.3	LENGTH (inches)		5.295	5.274	5.132	5.128	5.146	5.225	5.185
e strength         WET         DRY         WET           e strength         WET         DRY         WET           999.9         992.5         1068.4         1063.9           999.9         992.5         1053.4         1063.9           A-B         37         36.3         956.2         1053.4         1048.9           A-B         37         36.3         1053.4         1048.9         1           C/B × 100         3.8         3.8         1.6.0         15.0         15.0           C/B × 100         3.8         3.8         3.8         1.4         1.4           F         421.3         422         657.8         654.6         14           A-E         421.3         422         410.6         409.3         14           B/F         2.29         2.27         2.35         2.56         394.3         14           A/F         2.37         2.35         2.60         2.60         2.60         2.60         2.60         2.60	DIAMETER (inches)		2.493	2.500	2.499	2.497	2.498	2.495	2.497
999.9         992.5         1068.4         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.9         1063.4         1063.4         1063.4         1063.3         1063.4         1063.3         1063.4         1063.9         1063.4         1063.9         1063.4         1063.3         105.0         15.0         15.0         15.0         15.0         15.0         15.0         15.0         15.0         15.0         16.4         1.4	moisture condition for unconfined compressive str	rength	WET	DRY	DRY	WET	DRΥ	WET	DRΥ
962.9         956.2         1053.4         1048.9         -           A-B         37         36.3         15.0         15	A WT.SATURATED SURFACE DRY SAMPLE		999.9	992.5	1068.4	1063.9	1062.3	1079.8	1064.8
A-B         37         36.3         36.3         15.0         15	B WT.OVEN DRY SAMPLE		962.9	956.2	1053.4	1048.9	1049.4	1066.9	1049.6
C/B × 100         3.8         3.8         3.8         1.4         1.4         1.4           578.6         570.5         657.8         654.6         654.5         654.3         654.3         654.3         654.3         656.6         294.3         656.6         294.3         656.6         294.3         656.6         256.6         256.6         256.6         256.6         256.6         256.6         256.6         256.6         256.6	C WT. WATER ABSORBED	A-B	37	36.3	15.0	15.0	12.9	12.9	15.2
578.6         570.5         657.8         654.6         654.3         654.3         654.3         654.3         654.3         654.3         654.3         654.3         654.3         656.6         756.6 <th< td=""><td></td><td>C/B x 100</td><td>3.8</td><td>3.8</td><td>1.4</td><td>1.4</td><td>1.2</td><td>1.2</td><td>1.4</td></th<>		C/B x 100	3.8	3.8	1.4	1.4	1.2	1.2	1.4
A-E         421.3         422         410.6         409.3         409.3         410.6         410.6         410	E WT. S.S.D. SAMPLE SUSPENDED IN WATER		578.6	570.5	657.8	654.6	651.4	662.9	650.3
F-C         384.3         385.7         395.6         394.3         394.3         394.3         395.6         394.3         304.3         304.3         304.3         305.6         304.3         304.3         305.6         304.3         304.3         305.6         304.3         304.3         305.6         304.3         305.6         304.3         305.6         304.3         305.6         304.3         305.6         304.3         305.6         304.3         305.6         3	F WT. WATER DISPLACED BY S.S.D. SAMPLE	A-E	421.3	422	410.6	409.3	410.9	416.9	414.5
B/F         2.29         2.27         2.57         2.56         2.56         2.56         2.60	G WT. WATER DISPLACED BY SOLID SAMPLE	Ч	384.3	385.7	395.6	394.3	398	404	399.3
A/F 2.37 2.35 2.60 2.60	H BULK SPECIFIC GRAVITY (DRY BASIS)	B/F	2.29	2.27	2.57	2.56	2.55	2.56	2.53
	I BULK SPECIFIC GRAVITY (S.S.D. BASIS)	A/F	2.37	2.35	2.60	2.60	2.59	2.59	2.57
J APPARENT SPECIFIC GRAVITY B/G 2.51 2.48 2.66 2.66 2.66 2.	J APPARENT SPECIFIC GRAVITY	B/G	2.51	2.48	2.66	2.66	2.64	2.64	2.63

LAB. NO.	02-116A	02-116B	02-116C	-114	-114	-116	
LENGTH (inches)	5.264	5.266	5.257	mid	bottom	top &	
DIAMETER (inches)	2.501	2.503	2.503	section	section	bottom	
moisture condition for unconfined compressive strength	DRY	WET	DRY			section	
A WT SATURATED SURFACE DRY SAMPLE	1105.1	1112.9	1117.5	708.9	320.9	611.7	
B WT.OVEN DRY SAMPLE	1094.7	1102.5	1111.2	678.9	307.1	603.8	
C WT. WATER ABSORBED A-B	10.4	10.4	6.3	 30	13.8	7.9	
D % WATER ABSORBED C/B x 100	1.0	0.9	0.6	4.4	4.5	1.3	
E WT. S.S.D. SAMPLE SUSPENDED IN WATER	683.3	690.5	696.2	409.4	185.7	377	
F WT. WATER DISPLACED BY S.S.D. SAMPLE A-E	421.8	422.4	421.3	299.5	135.2	234.7	
G WT. WATER DISPLACED BY SOLID SAMPLE F-C	411.4	412	415	269.5	121.4	226.8	
H BULK SPECIFIC GRAVITY (DRY BASIS) B/F	2.60	2.61	2.64	 2.27	2.27	2.57	
I BULK SPECIFIC GRAVITY (S.S.D. BASIS) AF	2.62	2.63	2.65	 2.37	2.37	2.61	
J APPARENT SPECIFIC GRAVITY B/G	2.66	2.68	2.68	2.52	2.53	2.66	



Sandstone Hole: 550 6-1 DEPTH: 31.0'~ 32.0' LAB# 02-114





LONGLOMERATE Hole: 5506-1 DEPTH: 112.0'~113.0' LAB #: 02-116

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# APPENDIX Q

MUDSTONE After Compaction Classification Test Results for DWR Samples

IGINEERING EERING ALS SECTION	Page 1 of 1									A DATE IN CALL OF A DATE A DATE OF A		
DIVISION OF ENGINEERING CIVIL ENGINEERING DAMS AND CANALS SECTION				CLASSIFICATION			GROUP NAME			A MARKAN A MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA MANAGANA M	Clayey sand with gravel	M - INSUFFICIENT MATERIAL NP - NON-PLASTIC MG - NO GOOD
						GROUP	WINDOL			÷	sc	
	Mudstone from Drill Holes SSD 5-3 (16.0' to 16.9'), SSD 8-1 (7.3' to 8.5' & 10.2' to 11.0'), & SSD 8-3 (9.0' to 11.0')				ioisture:	·  - · ·	% ORGANICS SYMBOL					
	(16.0' to "), & SSE				ATTERBERG MOISTURE	LIMITS		4			19	
	SD 5-3 ( to 11.0				ATTE	panarb		45			43	
IARY	l Holes S & 10.2'		ETER	i.AV	1 M	2 0.001	шш					
NMUS	om Drill 10 8.5		HYDROMETER	SILT & CLAY	2M	5 0.002	шш					machir
CLASSIFICATION TEST SUMMARY	stone fr <u>8-1 (7.3</u> '				22	5 0.005	шш					02-110, sample insitu 02-110, sample 2X through compaction machine 02-111, sample hydrated @ 10%. JX through compaction machine
IN TE					200	5 0.075	uu uu	× *	35	l í		lachine lagh con
CATIC	FEATURE:				100	0.15	uuu L	6	36	÷	49	LX thron n
SIFIC	FEA	NER		j O	23	0.3	uu u	6	36	+	49	h comps
CLAS		PERCENT FINER			30	8 0.6	u u u	6	3 37	÷;-	20	situ throug drated (
Ŭ		ЪĘВ	JALYSIS		16	36 1.18	u u u		0 38	++	202	02-110, sample insitu 02-110, sample X through compaction machine 02-111, sample hydrated @ 10%. J X through com
			NCAL AN		00	75 2.36	um mm	1 10	43. 40		54 52	109, sar 110, sar 111, sar
			MECHANICAL ANALYSIS		3/8" 4	9.5 4.75	E E	53	65 4	-	70 5	REMARKS: 02-109, sample insitu 02-111, sample bydrat
						19 9	u u	48 2	90 06	÷	66	REMAR
			والمراجع المراجع	GRAVEL	1.5° 3	37.5 1	u E	91	100		9 9 1 0	
			والراجار الراج		3.0"	75 3	u mu	100		-	***	
JRCES	E					DEPTH	(feet)					3/27/2002 djn 2002-09
ORNIA AGENCY R RESOL	Sites Dam					ю Ц	Ň					
STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES						HOLE	ŇQ	i				
STA THE R DEPARTMEI	PROJECT:			al of the second	fra logi y	LAB,	NO	02-109	02-110		02-111	DATE: INITIAL: REQUEST NO::