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REPORT OF FIELD SAMPLING AND LABORATORY TESTING RESULTS

LAW Project No. 70241-8-0316.01

CAVE BUTTES FEASIBILITY MARICOPA COUNTY, ARIZONA

Prepared for:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PHOENIX, ARIZONA

Prepared by:

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
PHOENIX, ARIZONA

AUGUST 25, 1998

LAW

LAWGIBB Group Member

August 25, 1998

Mr. Tom Johnson, P.E.
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

Subject: **Field Sampling and Laboratory Testing Results**
Cave Buttes Feasibility
Maricopa County, Arizona
LAW Project No. 70241-8-0316.01

Dear Mr. Johnson:

Law Engineering and Environmental Services, Inc. (LAW) is pleased to submit the results of our field exploration and laboratory testing in support of the Flood Control District of Maricopa County's (FCDMC) evaluation of the former Cave Buttes Recreation Area in Maricopa County, Arizona. Our services were performed for FCDMC under our *On-Call Consultant Services for Construction Materials Testing, Environmental, Geotechnical Investigation, Testing and Evaluation Contract* FCD 98-01. This report presents the results of our field exploration and associated laboratory testing of the surface and subsurface soils.

PROJECT INFORMATION

We received project information from Mr. Tom Johnson, P.E. of FCDMC during a meeting on June 24, 1998 and through telephone conversations with Mr. Don Ross, of Ross Consultants on June 26, 1998. The FCDMC is conducting a feasibility study near the Cave Buttes Dam for site suitability as a candidate borrow source or groundwater recharge area. We understand the area under consideration reportedly contains sand, gravel, and cobble deposits to varying depths below ground surface.

LAW Engineering and Environmental Services, Inc.
4634 South 36th Place
Phoenix, AZ 85040
602-437-0250 • Fax 602-437-3675

PURPOSE AND SCOPE

The purpose of our work was to provide field sampling and laboratory testing data that will be used by FCDMC to evaluate the subject site's feasibility for use as a candidate borrow source or as a groundwater recharge area. Our scope of services included a field subsurface exploration and laboratory testing of on-site materials. The following information is provided in our report:

- A summary of the information provided to us;
- The soil boring records including the observed thicknesses of the subsurface soil, and groundwater conditions encountered in the test borings;
- The laboratory test data; and,
- A brief summary of our test procedures and the results of the testing conducted.

The scope of services did not include the development of technical recommendations, specifications, drawings, the assessment of site environmental conditions, or evaluation of the potential presence of pollutants in the soil or groundwater.

FIELD EXPLORATION AND LABORATORY TESTING PROCEDURES

Field Exploration

The soil conditions beneath the site were explored between July 15 and July 20, 1998 by drilling six soil borings at locations designated by Mr. Ross. The approximate locations of the test borings are shown on Figure 1 - *Test Boring Location Plan.* As requested by Don Ross, the test borings were advanced to a depth of 100 feet. The test borings are designated CBDH1 through CBDH6.

Our drilling and sampling was performed in general accordance with applicable American Society for Testing and Materials (ASTM) standards. The soil borings were advanced using a truck-mounted AP-1000 dual-wall down-hole percussion hammer, and the hole was cased using steel pipes. Bulk soil samples were obtained from the soil cuttings removed from the hole by compressed air. Soil

samples were obtained at intervals determined by LAW field personnel. A field engineer or geologist monitored the drilling operations, logged the borings and obtained samples for laboratory testing.

The subgrade soils were visually classified in the field in accordance with the Unified Soil Classification System (USCS). The logs of the borings are presented in the *Test Boring Records* along with the USCS in the Appendix. These records represent our interpretations of the subsurface conditions based on our field observations, a visual examination of samples by an engineer, and the indicated laboratory tests performed on selected samples. The lines designating the interface between various strata on the test boring records represent the approximate positions of the interface. The transitions between strata may be gradual. Groundwater conditions indicated in our report represent conditions only at the time of our exploration. After drilling, the boreholes were backfilled with the spoils.

Laboratory Testing

Laboratory tests were performed on selected samples obtained from the test borings to aid in the classification of the soils using the USCS. The following tests were performed:

- Moisture Content
- Particle Size Analysis
- Atterberg Limits
- Soil Corrosivity Testing

Five additional samples were selected for laboratory testing and the following tests performed:

- Moisture-Density Relationship (Proctor)
- Soil Hydraulic Conductivity (Permeability)

The testing was performed in accordance with applicable ASTM standards. We will store the collected samples for a period of 60 days, after which time they will be discarded unless we are notified otherwise. The results of the laboratory tests are presented in the following section.

FIELD EXPLORATION AND LABORATORY TESTING RESULTS

Subsurface Conditions

The subsurface soils encountered during our field exploration are described in the attached *Test Boring Records*. The *Test Boring Records* represent our interpretation of the subsurface conditions based on the field logs, visual examination of the field samples by an engineer, and tests of the collected field samples.

Subsurface conditions at the subject site were explored between July 15 and July 20, 1998 by advancing six borings to a depth of 100 feet. The soils encountered at borings CBDH 1, 2, and 6 consisted generally of moderately dense to dense sandy clays with gravel within the upper 10 feet. These soils overlay dense to hard clayey sands and silty sands with varying percentages of gravel, interbedded with layers of silty gravel, clayey gravel, and sandy gravel. Weathered bedrock was indicated at a depth of 53 feet and hard bedrock at a depth of 65 feet at boring CBDH 1. Borings CBDH 3, 4, and 5 generally consisted of near surface silty sands and sandy silts with varying percentages of gravel to approximately 15 feet. These soils were observed to overlay sandy gravel and silty gravel layers to a depth of between 30 and 50 feet. Silty sands, sandy silts, and clayey sands with varying amounts of gravel were encountered below the sandy gravel and silty gravel soils. Layers of cobble and boulders were also encountered throughout the borings in varying percentages. The soils encountered were generally low to medium in moisture content and plasticity, and the test borings did not encounter groundwater or deleterious fill materials.

Laboratory Testing

The subsurface samples obtained from our field exploration were selected for laboratory testing after examination by our geotechnical engineer. To determine the particle size distribution of the site soils and to aid in classification, mechanical analyses were performed. Twenty-four sieve analyses, 24 Atterberg Limits tests, and 31 moisture content tests were performed on selected soil samples collected from various depths below the surface. The results of the testing are presented on the attached *Sample Summary* sheets and are tabulated in the attached Table I - *Summary of Laboratory Testing*.

Five hydraulic conductivity (permeability) tests were performed on soil test samples selected by Mr. Ross. The samples were tested in general accordance with ASTM D2434 *Standard Test Method for Permeability of Granular Samples (Constant Head)*. The results of the testing are presented on the attached *Sample Summary* sheets and are tabulated in the attached Table I - *Summary of Laboratory Testing*.

One reactivity test was performed on a soil test sample selected by Mr. Ross. This sample was tested in general accordance with ASTM C289 *Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)*. The results of the test are attached.

CLOSING

We appreciate your choosing LAW for these services and are looking forward to working as your geotechnical consultant on future projects. Please contact us with questions you may have regarding this report.

Sincerely,

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

Patrick Cook
Staff Geologist

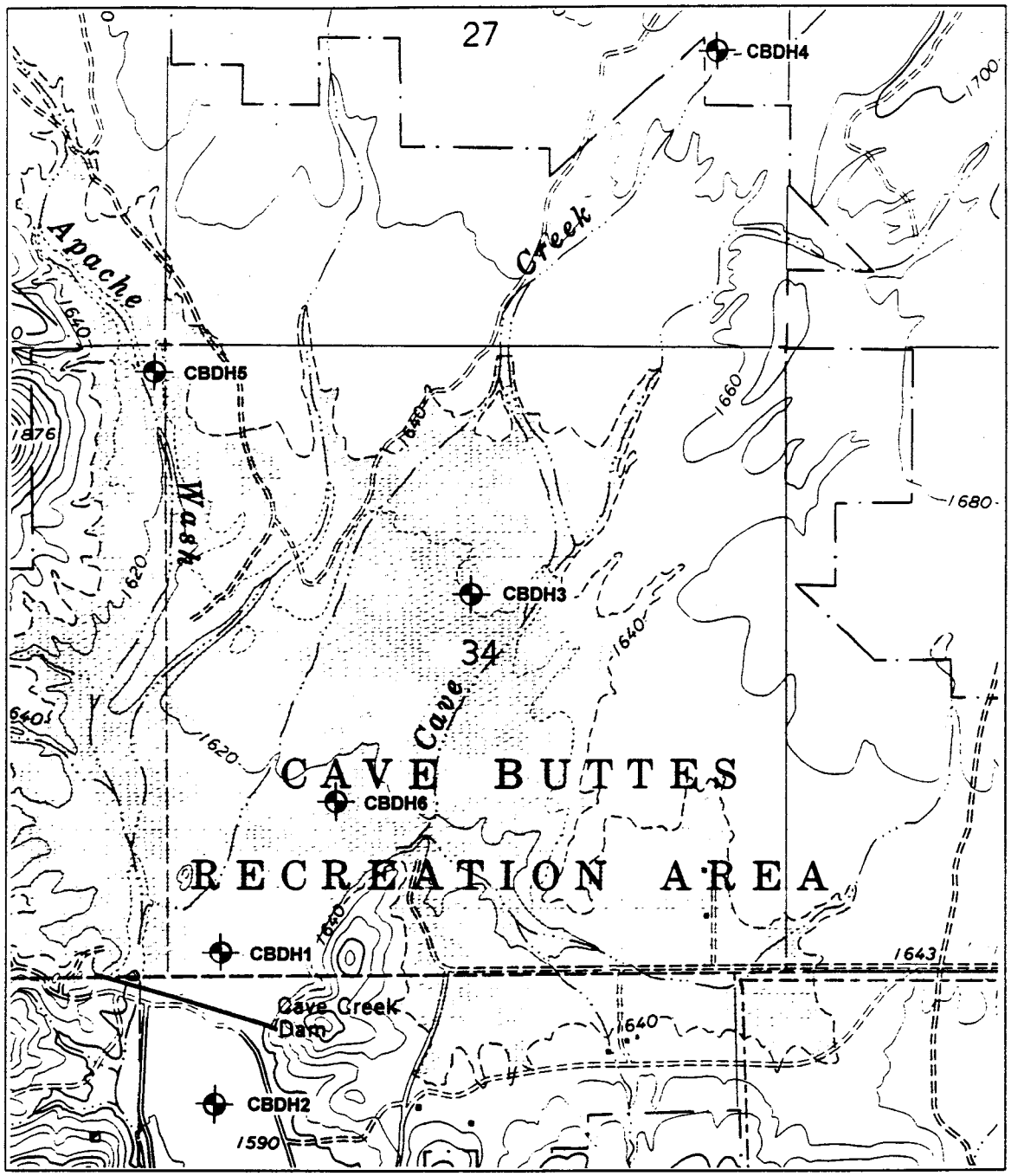
Bruce A. Wolle, M.S.E., P.E.
Project Engineer

PJC:BAW:kjw

Attachments

(ec\cmt\project\80316\01\report)

FIGURES



SOURCE: U.S.G.S. TOPOGRAPHIC MAPS 7.5 MINUTE SERIES, "UNION HILLS, ARIZONA" QUADRANGLE DATED 1981

APPROXIMATE SCALE: 1 : 16,850

0 1400 2800 FEET

- INDICATES APPROXIMATE LOCATION OF SOIL TEST BORING

N

TEST BORING LOCATION PLAN	FIGURE 1
LAW PROJECT NAME:	CAVE BUTTES FEASIBILITY
LAW PROJECT NO:	70241-8-0316.01
DRAWN BY:	BAW
DATE:	8/98

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LAWGIBB Group Member

CHECKED: P.M. _____ PRINCIPAL _____

TABLES

TABLE I
Summary of Laboratory Testing
Cave Buttes Feasibility
Cave Creek, Arizona
LAW Project No. 70241-8-0316.01

Sample Location Boring/Depth	LAW Lab No.	Sieve Analysis			In-Situ Moisture (%)	Reactivity R_c/S_c mMol/L	Permeability per SF ft/yr	Atterberg Limits, %		Moisture-Density Relationship ASTM D698-78 Method C		Soil Type[1]
		Gravel (%)	Sand (%)	Fines (%)				Liquid Limit	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	
DH1(11-13)	83143	NT	NT	NT	18.5	NT	NT	NT	NT	NT	NT	
DH1(13-15)	83144	NT	NT	NT	22.5	NT	NT	NT	NT	NT	NT	
DH1(15-20)	83145	47	39	14	NT	NT	NT	NV	NP	NT	NT	GM
DH1(20-30)	83146	NT	NT	NT	3.4	NT	NT	NT	NT	NT	NT	
DH1(30-35)	83147	61	31	8	NT	276/29.4	0.514	22	4	137.8	7.1	GW-GC
DH1(45-50)	83149	NT	NT	NT	9.3	NT	NT	NT	NT	NT	NT	
DH1(60-70)	83151	44	42	14	NT	NT	0.593	38	18	132.6	8.8	GC
DH1(80-90)	83152	NT	NT	NT	8.0	NT	NT	NT	NT	NT	NT	
DH1(90-100)	83153	42	41	17	NT	NT	NT	35	14	NT	NT	GC
DH2(0-10)	83154	38	39	23	NT	NT	NT	28	8	NT	NT	SC
DH2(20-30)	83157	52	30	18	NT	NT	0.105	42	18	130.4	10.6	GC
DH2(30-40)	83158	34	36	30	NT	NT	NT	45	26	NT	NT	SC
DH2(40-45)	83159	NT	NT	NT	13.1	NT	NT	NT	NT	NT	NT	
DH2(45-55)	83160	41	46	13	NT	NT	NT	24	8	NT	NT	SC

NP = Non-Plastic
NT = Not Tested
NV = No Value obtained
[1]USCS = Unified Soil Classification System
[2]Bulk Sample from Auger Cuttings

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		Gravel (%)	Sand (%)	Fines (%)				Liquid Limit	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	
DH3(0-10)	83163	0	66	34	NT	NT	NT	NV	NP	NT	NT	SM
DH3(20-30)	83165	62	32	6	NT	NT	NT	NV	NP	NT	NT	GP-GM
DH3(40-50)	83167	25	38	37	NT	NT	0.692	47	21	111.4	16.9	SC
DH3(60-70)	83169	NT	NT	NT	17.0	NT	NT	NT	NT	NT	NT	
DH3(80-90)	83171	35	50	15	NT	NT	NT	37	14	NT	NT	SC
DH3(90-100)	83172	NT	NT	NT	19.2	NT	NT	NT	NT	NT	NT	
DH4(0-10)	83173	61	31	8	NT	NT	NT	NV	NP	NT	NT	GW-GM
DH4(10-20)	83174	NT	NT	NT	4.5	NT	NT	NT	NT	NT	NT	
DH4(30-40)	83175	NT	NT	NT	6.0	NT	NT	NT	NT	NT	NT	
DH4(40-50)	83176	44	32	24	NT	NT	NT	36	12	NT	NT	GC
DH4(50-60)	83177	14	52	34	NT	NT	NT	45	18	NT	NT	SM
DH4(60-70)	83178	46	43	11	NT	NT	NT	NV	NP	NT	NT	GP-GM
DH4(70-80)	83179	NT	NT	NT	7.0	NT	NT	NT	NT	NT	NT	
DH4(80-90)	83180	NT	NT	NT	7.1	NT	NT	NT	NT	NT	NT	

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		Gravel (%)	Sand (%)	Fines (%)				Liquid Limit	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	
DH4(90-100)	83181	NT	NT	NT	18.8	NT	NT	NT	NT	NT	NT	
DH5(0-10)	83182	25	50	25	NT	NT	NT	32	12	NT	NT	SC
DH5(30-40)	83183	71	22	7	NT	NT	NT	NV	NP	NT	NT	GP-GM
DH5(40-50)	83184	11	34	55	NT	NT	NT	39	17	NT	NT	CL
DH5(50-60)	83185	NT	NT	NT	26.2	NT	NT	NT	NT	NT	NT	
DH5(70-80)	83186	NT	NT	NT	13.2	NT	NT	NT	NT	NT	NT	
DH5(80-90)	83187	NT	NT	NT	17.8	NT	NT	NT	NT	NT	NT	
DH5(90-100)	83188	NT	NT	NT	3.6	NT	NT	NT	NT	NT	NT	
DH6(0-10)	83189	NT	NT	NT	3.8	NT	NT	NT	NT	NT	NT	
DH6(10-20)	83190	43	49	8	NT	NT	NT	NV	NP	NT	NT	SP-SM
DH6(20-30)	83191	47	45	8	NT	NT	NT	25	11	NT	NT	GW-GC
DH6(30-40)	83192	15	47	38	NT	NT	0.534	34	16	120.1	12.6	SC
DH6(60-70)	83195	21	52	27	NT	NT	NT	33	13	NT	NT	SC
DH6(80-90)	83197	31	49	20	NT	NT	NT	40	18	NT	NT	SC

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APPENDIX

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
0	Dark Brown sandy CLAY with silt, moist, low plasticity		1620.0				
5			1615.0	BK			5
10	Black silty CLAY with sand, wet, medium high plasticity		1610.0	BK			19
	Black silty GRAVEL with sand, contains 14 percent cobble, non-plastic, moist			BK			23
15			1605.0	BK			
20	Orange sandy GRAVEL with cobble, dry, low plasticity		1600.0				
25			1595.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-1
COORD N: 1,575.0
COORD E: 1,050.0
EXCAVATED: July 15, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 1 OF 5**

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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
25	Orange sandy GRAVEL with cobble, dry, low plasticity		1595.0	BK			3
	Orange well graded GRAVEL with silty clay and sand, moist, low plasticity						
30			1590.0	BK			
35	Orange-brown clayey GRAVEL with sand, moist, low plasticity		1585.0	BK			
40			1580.0				
45			1575.0	BK			9
50			1570.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
50	Orange-brown clayey GRAVEL with sand, moist, low plasticity		1570.0				
55	Light brown clayey GRAVEL with sand, moist, moderate plasticity		1565.0	BK			
60			1560.0				
65			1555.0				
	Light brown sandy GRAVEL, dry, low plasticity						
70			1550.0	BK			
75			1545.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

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LAW
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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
75	Light brown sandy GRAVEL, dry, low plasticity		1545.0				
80			1540.0				
	Dark Brown clayey GRAVEL with sand, moist, moderate plasticity						
85			1535.0	BK			8
90			1530.0				
95			1525.0	BK			
100			1520.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

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PROJ. NO.: 70241-8-0316.01 **PAGE 4 OF 5**

LAW
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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
100	FIELD ENGINEERING NOTES:		1520.0				
	Approximate ground surface elevation = 1620 feet.						
	Soil boring terminated at approximately 1000 feet below ground surface.						
	Groundwater not encountered.						
	Borehole observed open to termination depth.						
	Borehole backfilled wih spoils.						
105			1515.0				
110			1510.0				
115			1505.0				
120			1500.0				
125			1495.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
0	Dark brown clayey SAND with gravel, contains 2 percent cobbles, dry, low plasticity		1580.0				
5			1575.0	BK			
10	Purple boulders and cobble		1570.0	BK			
	Dark brown-green sandy GRAVEL with cobble, moist, low plasticity						
15			1565.0	BK			
	Orange-brown clayey GRAVEL with sand, wet, moderate to high plasticity						
20			1560.0				
25			1555.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-2
COORD N: 280.0
COORD E: 1,008.0
EXCAVATED: July 15, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 1 OF 5**

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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
25			1555.0	BK			
30	Orange-brown clayey SAND with gravel, wet, moderate to high plasticity		1550.0				
35			1545.0	BK			
40			1540.0				
				BK			13
	Dark brown clayey SAND with gravel, moist, low plasticity						
45			1535.0				
	Gray clayey SAND with gravel, moist, low plasticity						
50			1530.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
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50	Gray clayey SAND with gravel, moist, low plasticity		1530.0	BK			
	Weathered bedrock						
55			1525.0	BK			
60			1520.0				
65	BEDROCK		1515.0				
70			1510.0				
75			1505.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

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EXCAVATED: July 15, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 3 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
75	BEDROCK		1505.0				
80			1500.0	BK			
85			1495.0				
90			1490.0				
95			1485.0				
100			1480.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-2
COORD N: 280.0
COORD E: 1,008.0
EXCAVATED: July 15, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 4 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
100	FIELD ENGINEERING NOTES:		1480.0				
	Approximate ground surface elevation = 1580 feet.						
	Soil boring terminated at approximately 100 feet below ground surface.						
	Groundwater not encountered.						
	Borehole observed open to termination depth.						
	Borehole backfilled with spoils.						
105			1475.0				
110			1470.0				
115			1465.0				
120			1460.0				
125			1455.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-2
COORD N: 280.0
COORD E: 1,008.0
EXCAVATED: July 15, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 5 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
0	Brown silty SANDwith gravel, loose to dense, dry, non-plastic		1630.0				
5			1625.0	BK			
	Brown silty SAND, dense, dry, non-plastic						
10			1620.0				
15	Brown silty GRAVEL with sand, dry, non-plastic		1615.0	BK			
20	Brown poorly graded GRAVEL with silt and sand, contains 15 percent cobble, dry, non-plastic		1610.0				
25			1605.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-3
COORD N: 4,550.0
COORD E: 3,150.0
EXCAVATED: July 17, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 1 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
25	Brown poorly graded GRAVEL with silt and sand, contains 15 percent cobble, dry, non-plastic		1605.0	BK			
30	Brown silty SAND, dry, low plasticity		1600.0				
35			1595.0	BK			
40	Light brown sandy SILT with gravel, moist, low plasticity		1590.0				
45	Brown silty SAND with gravel, moist, low plasticity		1585.0	BK			
50			1580.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-3
COORD N: 4,550.0
COORD E: 3,150.0
EXCAVATED: July 17, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 2 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
50	Brown silty SAND with gravel, moist, low plasticity		1580.0				
55			1575.0	BK			
60	Brown sandy SILT with gravel, moist, moderate plasticity		1570.0				
65			1565.0	BK			17
70	Brown sandy SILT with gravel, dry, low to moderate plasticity		1560.0				
75			1555.0				

TEST PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-3
COORD N: 4,550.0
COORD E: 3,150.0
EXCAVATED: July 17, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
75	Brown clayey SAND with gravel, dry, moderate plasticity		1555.0	BK			
80			1550.0				
85			1545.0	BK			
90			1540.0				
95			1535.0	BK			19
100			1530.0				

TEST_PIT_CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-3
COORD N: 4,550.0
COORD E: 3,150.0
EXCAVATED: July 17, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
100	FIELD ENGINEERING NOTES:		1530.0				
	Approximate ground surface elevation = 1630 feet.						
	Soil boring terminated at approximately 100 feet below ground surface.						
	Groundwater not encountered.						
	Borehole observed open to termination depth.						
	Borehole backfilled with spoils.						
105			1525.0				
110			1520.0				
115			1515.0				
120			1510.0				
125			1505.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-3
COORD N: 4,550.0
COORD E: 3,150.0
EXCAVATED: July 17, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 5 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
0	Brown well graded GRAVEL with silt and sand, dry to moist, non-plastic		1670.0				
5			1665.0	BK			
10			1660.0				
15			1655.0	BK			
	Brown sandy gravel, dry, low plasticity						
20	Brown sandy gravel, dry, low plasticity		1650.0				
25			1645.0				

TEST PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-4
COORD N: 9,108.0
COORD E: 5,418.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 1 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
25	Brown sandy gravel, dry, low plasticity		1645.0	BK			
30			1640.0				
	Brown sandy gravel, dry, low plasticity						
35			1635.0	BK			6
40	Brown clayey GRAVEL with sand, moist, moderate plasticity		1630.0				
45			1625.0	BK			
50			1620.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-4
COORD N: 9,108.0
COORD E: 5,418.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
50	Brown clayey GRAVEL with sand, moist, moderate plasticity		1620.0				
	Brown silty SAND with gravel, moist, moderate to high plasticity						
55			1615.0	BK			
60			1610.0				
	Brown poorly graded GRAVEL with silt and sand, dense to hard, dry, non-plastic, contains 7 percent cobble						
65			1605.0	BK			
	Brown silty SAND with gravel, moist, low plasticity						
70			1600.0				
75			1595.0				

TEST PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-4
COORD N: 9,108.0
COORD E: 5,418.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
75	Brown silty SAND with gravel, moist, low plasticity		1595.0	BK			7
80			1590.0				
85			1585.0	BK			7
90	Brown silty SAND with gravel, moist, low plasticity		1580.0				
95			1575.0	BK			19
100			1570.0				

TEST PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-4
COORD N: 9,108.0
COORD E: 5,418.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
100	FIELD ENGINEERING NOTES:		1570.0				
	Approximate ground surface elevation = 1670 feet.						
	Soil boring terminated at approximately 100 feet below ground surface.						
	Groundwater not encountered.						
	Borehole observed open to termination depth.						
	Borehole backfilled with spoils.						
105			1565.0				
110			1560.0				
115			1555.0				
120			1550.0				
125			1545.0				

TEST_PIT_CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-4
COORD N: 9,108.0
COORD E: 5,418.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 5 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
0	Brown clayey SAND with gravel, dry, moderate plasticity, weak to moderate cementation		1630.0				
5	Brown sandy SILT with gravel, dry, low plasticity		1625.0				
10			1620.0				
15			1615.0	BK			
	Brown silty GRAVEL with sand, dry, low to moderate plasticity						
20			1610.0				
25			1605.0				

TEST PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-5
COORD N: 6,552.0
COORD E: 280.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 1 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
25	Brown silty GRAVEL with sand, dense to hard, dry, low to moderate plasticity		1605.0				
30	Brown-gray poorly graded GRAVEL with silt and sand, contains 17 percent cobble, dense to hard, dry, non-plastic		1600.0				
	Brown-gray poorly graded GRAVEL with silt and sand, contains 17 percent cobble, dense to hard, dry, non-plastic						
35			1595.0	BK			
40	Brown sandy lean CLAY, sample contains 26 percent cobble, moist, moderate plasticity		1590.0				
45			1585.0	BK			
50			1580.0				

TEST PIT CAVEBUTS.GPJ LAW GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-5
COORD N: 6,552.0
COORD E: 280.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 2 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
50	Brown clayey SAND, dry to moist, low plasticity		1580.0				
55			1575.0				
60			1570.0	BK			26
	Brown silty SAND, dense, dry, low plasticity						
65			1565.0				
70			1560.0				
75			1555.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-5
COORD N: 6,552.0
COORD E: 280.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 3 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
75	Brown silty SAND, dense, dry, low plasticity		1555.0	BK			13
	Brown sandy SILT, dry, low to moderate plasticity						
80	Brown sandy SILT, dense to hard, dry, low to moderate plasticity		1550.0				
85			1545.0	BK			18
90	Brown sandy SILT with trace gravel, dense, dry, low to moderate plasticity		1540.0				
95			1535.0	BK			4
100			1530.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-5
COORD N: 6,552.0
COORD E: 280.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
100	FIELD ENGINEERING NOTES:		1530.0				
	Approximate ground surface elevation = 1630 feet.						
	Soil boring terminated at approximately 100 feet below ground surface.						
	Groundwater not encountered.						
	Borehole observed open to termination depth.						
	Borehole backfilled with spoils.						
105			1525.0				
110			1520.0				
115			1515.0				
120			1510.0				
125			1505.0				

TEST PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-5
COORD N: 6,552.0
COORD E: 280.0
EXCAVATED: July 20, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 5 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
0	Brown sandy CLAY, weak to moderate cementation, dry, low plasticity		1620.0				
5			1615.0	BK			4
10	Brown poorly graded SAND with silt and gravel, dry, non-plastic		1610.0				
15			1605.0	BK			
	Brown poorly graded SAND with silt and gravel, moist, non-plastic						
20	Brown well graded GRAVEL with clay and sand, moist, low to moderate plasticity		1600.0				
25			1595.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

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SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-6
COORD N: 2,800.0
COORD E: 2,100.0
EXCAVATED: July 16, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE** 1 **OF** 5

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
25	Brown well graded GRAVEL with clay and sand, moist, low to moderate plasticity		1595.0	BK			
30			1590.0				
	Orange-Brown clayey SAND with gravel, moist, moderate plasticity						
35			1585.0	BK			
40			1580.0				
	Orange-Brown clayey SAND with gravel, moist, moderate plasticity						
45			1575.0	BK			
50			1570.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-6
COORD N: 2,800.0
COORD E: 2,100.0
EXCAVATED: July 16, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 2 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	Dry Density (pcf)	Moisture Content %
50	Orange-Brown clayey SAND with gravel, moist, moderate plasticity		1570.0				
55			1565.0	BK			
60	Light brown clayey SAND with gravel, moist, moderate plasticity		1560.0				
65			1555.0	BK			
70			1550.0				
75			1545.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-6
COORD N: 2,800.0
COORD E: 2,100.0
EXCAVATED: July 16, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 3 OF 5**

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES Dry Density (pcf)	SAMPLES Moisture Content %
75	Light brown clayey SAND with gravel, moist, moderate plasticity		1545.0	BK			
80			1540.0				
	Tan-Brown clayey SAND with gravel, dry, moderate plasticity						
85			1535.0	BK			
90			1530.0				
95	Tan-brown clayey SAND with gravel and cobble, dry, low plasticity		1525.0	BK			
100			1520.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-6
COORD N: 2,800.0
COORD E: 2,100.0
EXCAVATED: July 16, 1998
PROJ. NO.: 70241-8-0316.01

LAW
LAWGIBB Group Member

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES: IDENT	SAMPLES: TYPE	SAMPLES: Dry Density (pcf)	SAMPLES: Moisture Content %
100	FIELD ENGINEERING NOTES:		1520.0				
	Approximate ground surface elevation ≐ 1620 feet.						
	Soil boring terminated at approximately 100 feet below ground surface.						
	Groundwater not encountered.						
	Borehole observed open to termination depth.						
	Borehole backfilled with spoils.						
105			1515.0				
110			1510.0				
115			1505.0				
120			1500.0				
125			1495.0				

TEST_PIT CAVEBUTS.GPJ LAW_GIBB.GDT 8/25/98

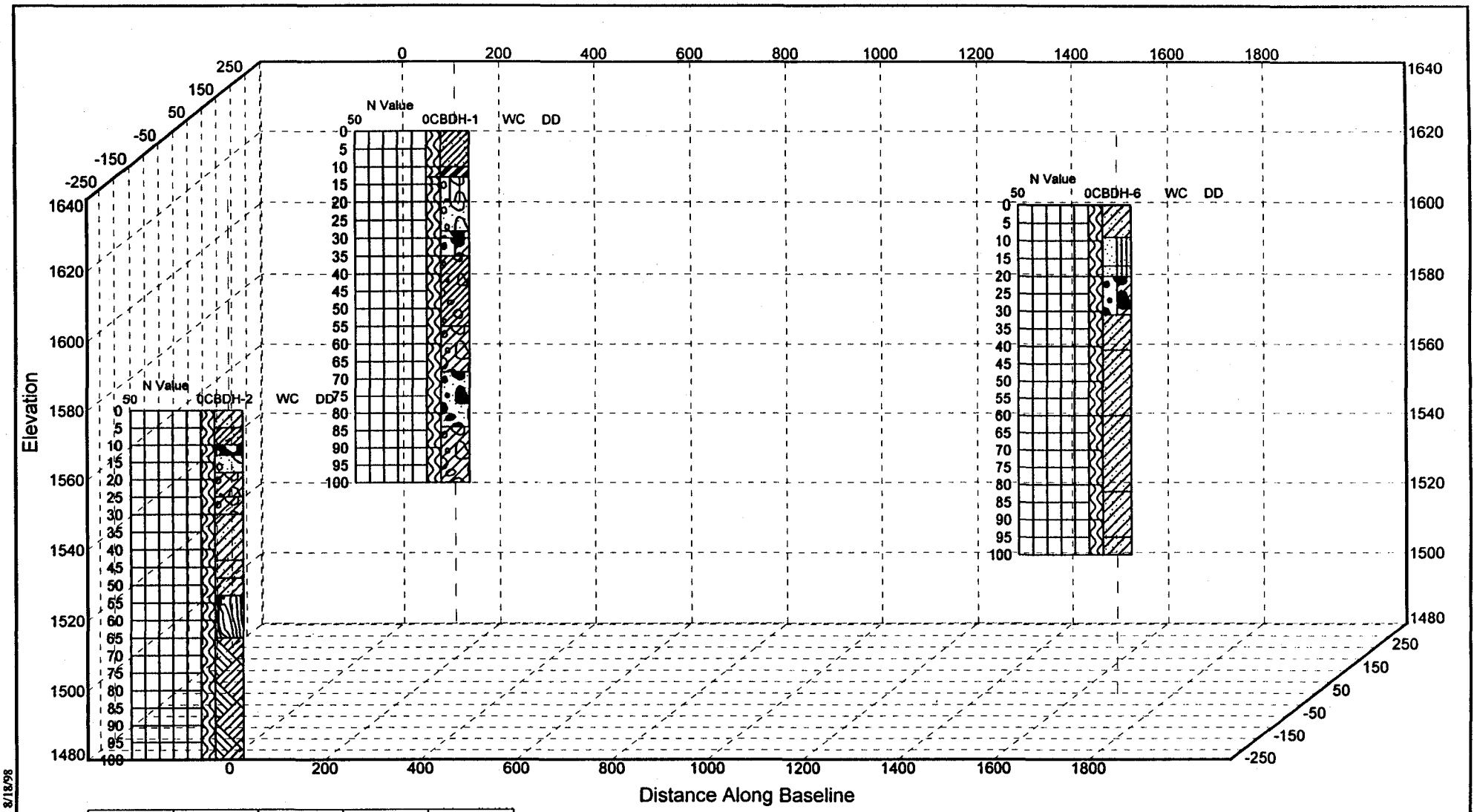
DRILLER: Layne Environmental Services
EQUIPMENT: AP-1000/Becker
HOLE DIM.: 9
REMARKS: Dual Wall Down-Hole Percussion Hammer with Tubex Attachment

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

PROJECT: Cave Buttes **TEST PIT NO.:** CBDH-6
COORD N: 2,800.0
COORD E: 2,100.0
EXCAVATED: July 16, 1998
PROJ. NO.: 70241-8-0316.01 **PAGE 5 OF 5**

LAW
LAWGIBB Group Member



Borehole	North	East	Elev.	Depth
CBDH-1	1575	1050	1620.0	100.0
CBDH-2	280	1008	1580.0	100.0
CBDH-6	2800	2100	1620.0	100.0

DISTANCES:

Beginning 0

Ending 1800

VIEWING ANGLES (degrees):

Horizontal 30.0

Vertical 20.0

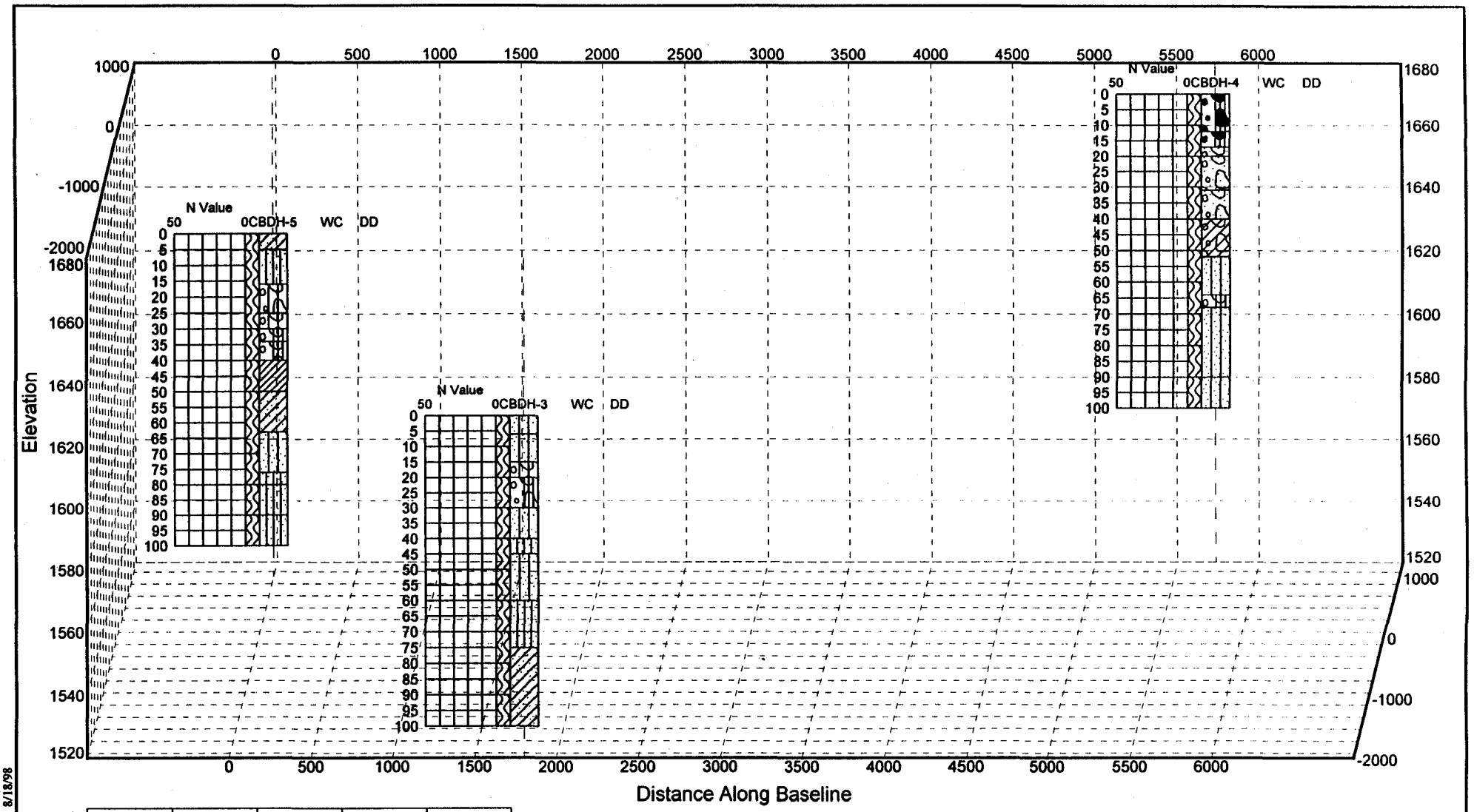
Position	North	East
Left, Front	1190	1519
Right, Front	2759	2399
Left, Back	1476	1008
Right, Back	3046	1889

SUBSURFACE FENCE DIAGRAM A-A'

Cave Buttes

PROJECT #	DATE	PLATE
70241-8-0316.01	Aug 98	1

FAGWGN01 CAVEBUTS.GPJ FAGWGN01.GDT 8/18/98



Borehole	North	East	Elev.	Depth
CBDH-3	4550	3150	1630.0	100.0
CBDH-4	9108	5418	1670.0	100.0
CBDH-5	6552	280	1630.0	100.0

DISTANCES:

Beginning	0
Ending	6000

VIEWING ANGLES (degrees):

Horizontal	5.0
Vertical	20.0

Position	North	East
Left, Front	3815	1500
Right, Front	6257	6980
Left, Back	7613	-193
Right, Back	10055	5288

SUBSURFACE FENCE DIAGRAM B-B'

Cave Buttes

PROJECT #	DATE	PLATE
70241-8-0316.01	Aug 98	1

FAGWGN01 CAVEBUTS.GPJ FAGWGN01.GDT 8/18/98

August 17, 1998

Law Engineering and Environmental Services, Inc.
4634 South 36th Place
Phoenix, AZ 85040

Attention: Mr. Troy Peck

Samples: Aggregate plus soil, Project: Cave Buttes Dam, Job No: 70241-8-0316.01

Lab No: 35656 - Screened sample B1 (30'-35')

ANALYSIS

	35656
R_c (Reduction in alkalinity, millimoles per liter of 1 N NaOH solution)	276
S_c (Silica dissolved from No. 50 to 100 mesh aggregate, millimoles per liter)	29.4

NOTE: When Potential Reactivity was determined, according to ASTM C289, the sample was found to be innocuous.

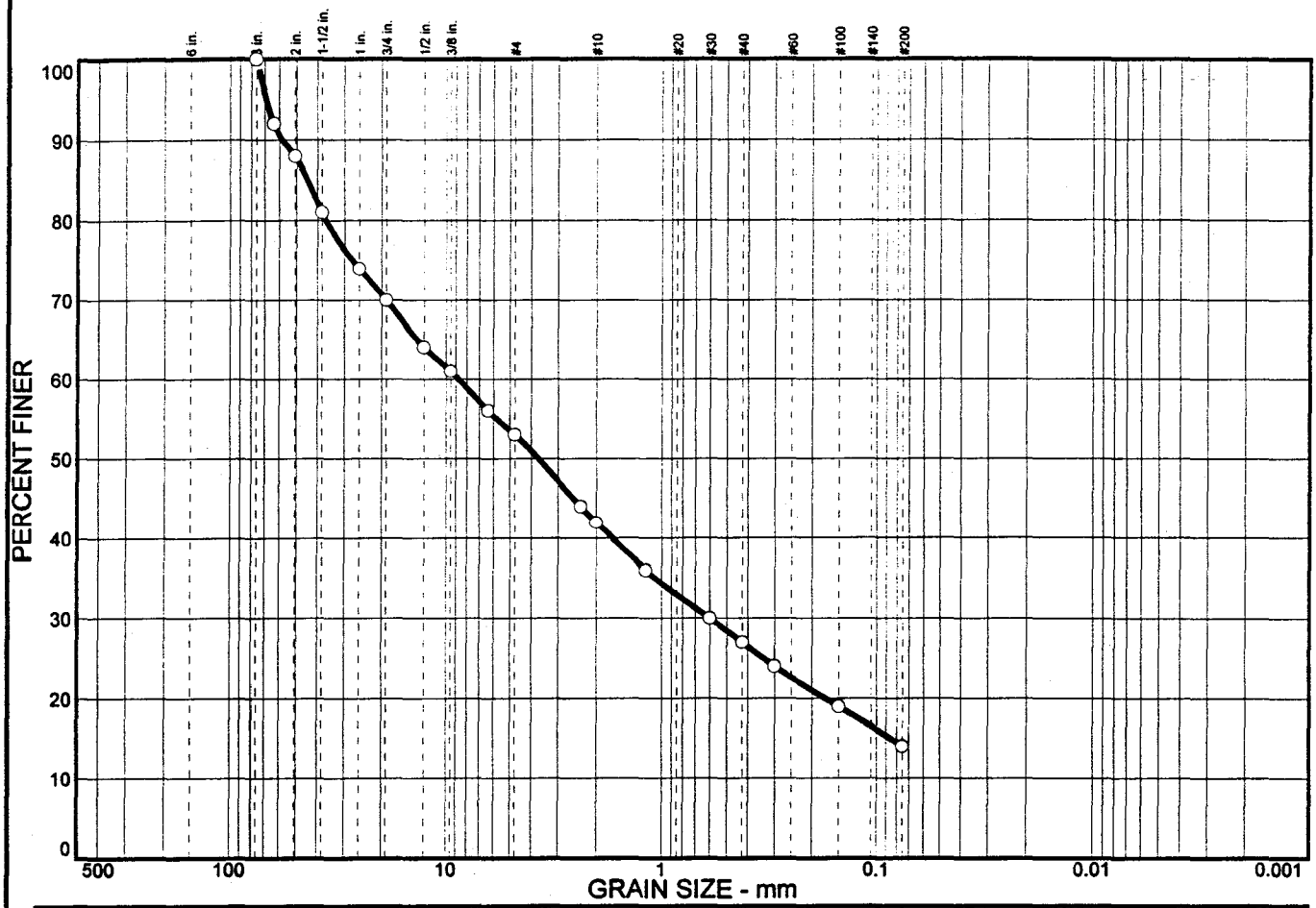
METHOD: ASTM C289 - 87

Respectfully submitted,

ANALYTICAL & RESEARCH LABORATORIES, INC.

M. L. Givens, President

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	47	39	14	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	92		
2 in.	88		
1-1/2 in.	81		
1 in.	74		
3/4 in.	70		
1/2 in.	64		
3/8 in.	61		
1/4 in.	56		
#4	53		
#8	44		
#10	42		
#16	36		
#30	30		
#40	27		
#50	24		
#100	19		
#200	14		

* (no specification provided)

Soil Description

Silty gravel with sand
Sample contains 14% cobbles

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 44.4 D_{60}= 8.74 D_{50}= 3.71
D_{30}= 0.600 D_{15}= 0.0860 D_{10}=
C_u= C_c=

Classification

USCS= GM AASHTO= A-1-a

Remarks

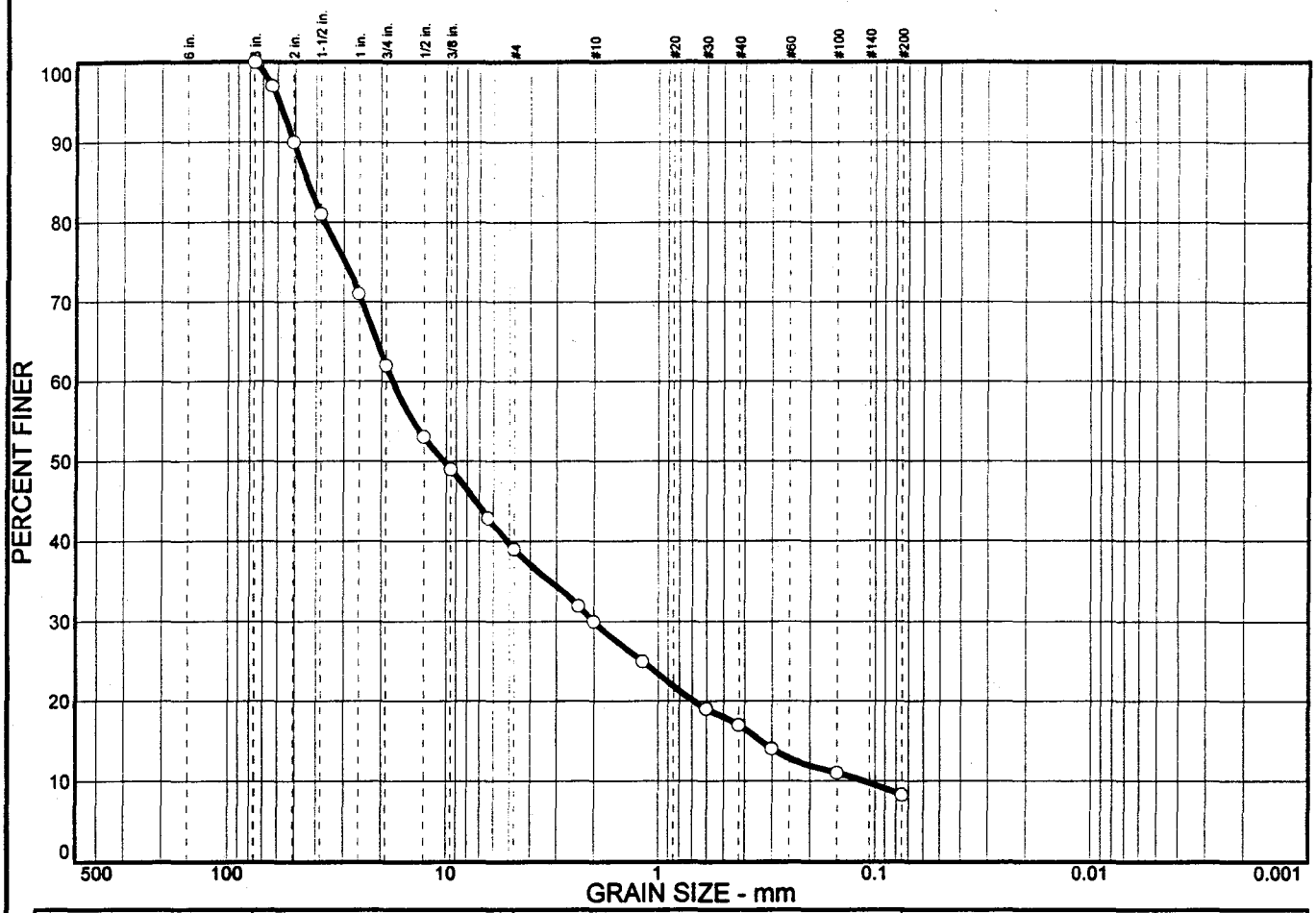
F.M.=4.82

Sample No.: 83145 **Source of Sample:** Boring 1 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 15'-20

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TN

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	61	31	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	97		
2 in.	90		
1-1/2 in.	81		
1 in.	71		
3/4 in.	62		
1/2 in.	53		
3/8 in.	49		
1/4 in.	43		
#4	39		
#8	32		
#10	30		
#16	25		
#30	19		
#40	17		
#50	14		
#100	11		
#200	8.3		

* (no specification provided)

Soil Description

Well-graded gravel with silty clay and sand

Atterberg Limits

PL= 18 LL= 22 PI= 4

Coefficients

D_{85}= 43.7 D_{60}= 17.7 D_{50}= 10.3
D_{30}= 2.00 D_{15}= 0.337 D_{10}= 0.113
C_u= 156.90 C_c= 1.99

Classification

USCS= GW-GC AASHTO= A-1-a

Remarks

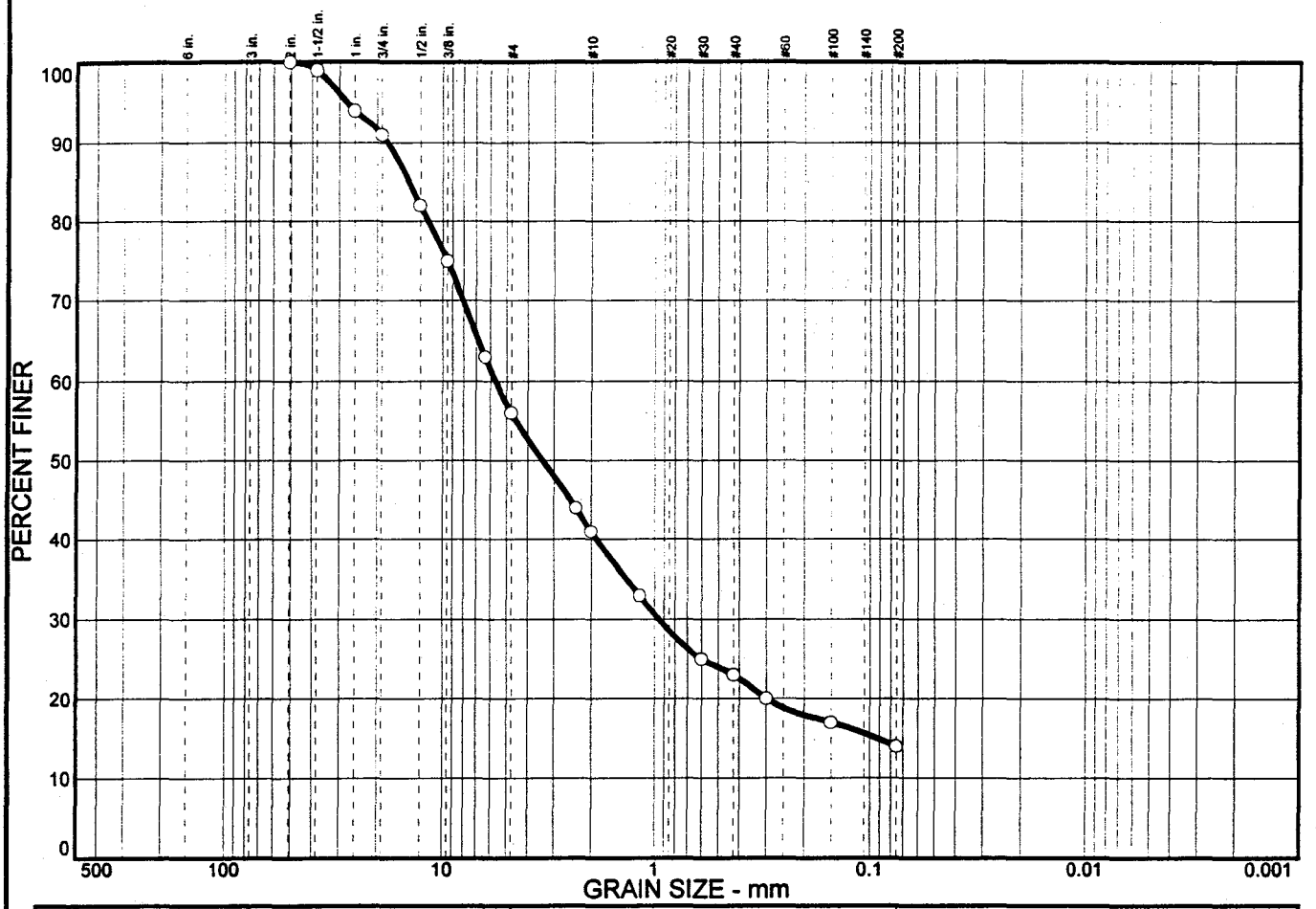
F.M.=5.68

Sample No.: 83147 **Source of Sample:** Boring 1 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 30'-35'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TD

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	44	42	14	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	99		
1 in.	94		
3/4 in.	91		
1/2 in.	82		
3/8 in.	75		
1/4 in.	63		
#4	56		
#8	44		
#10	41		
#16	33		
#30	25		
#40	23		
#50	20		
#100	17		
#200	14		

* (no specification provided)

Soil Description

Clayey gravel with sand

Atterberg Limits

PL= 20 LL= 38 PI= 18

Coefficients

D_{85}= 14.3 D_{60}= 5.67 D_{50}= 3.40
D_{30}= 0.951 D_{15}= 0.0924 D_{10}=
C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

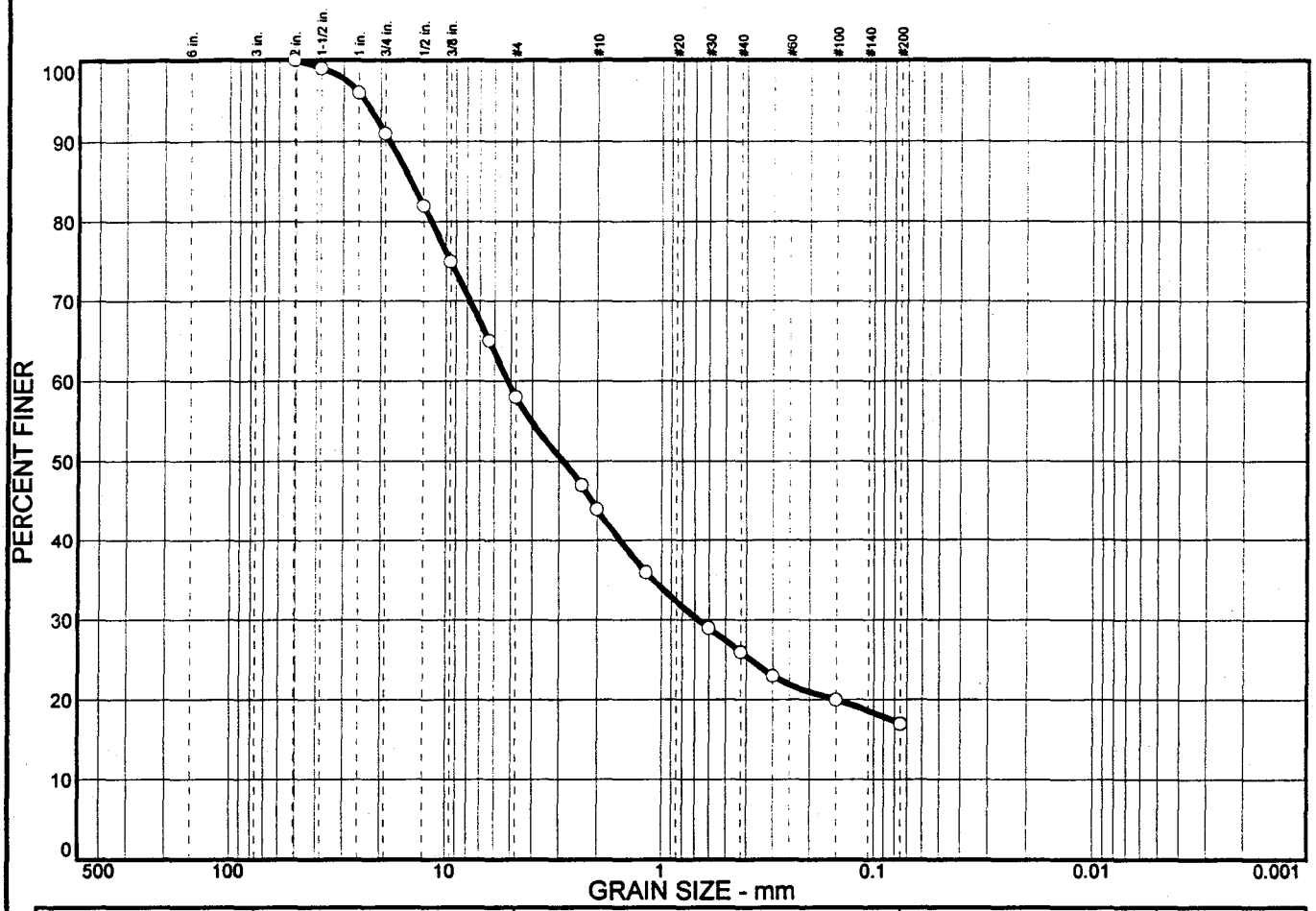
F.M.=4.40

Sample No.: 83151 **Source of Sample:** Boring 1 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 60'-70'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	42	41	17	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	99		
1 in.	96		
3/4 in.	91		
1/2 in.	82		
3/8 in.	75		
1/4 in.	65		
#4	58		
#8	47		
#10	44		
#16	36		
#30	29		
#40	26		
#50	23		
#100	20		
#200	17		

* (no specification provided)

Soil Description

Clayey gravel with sand

Atterberg Limits

PL= 21 LL= 35 PI= 14

Coefficients

D_{85}= 14.4 D_{60}= 5.19 D_{50}= 2.87
D_{30}= 0.671 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

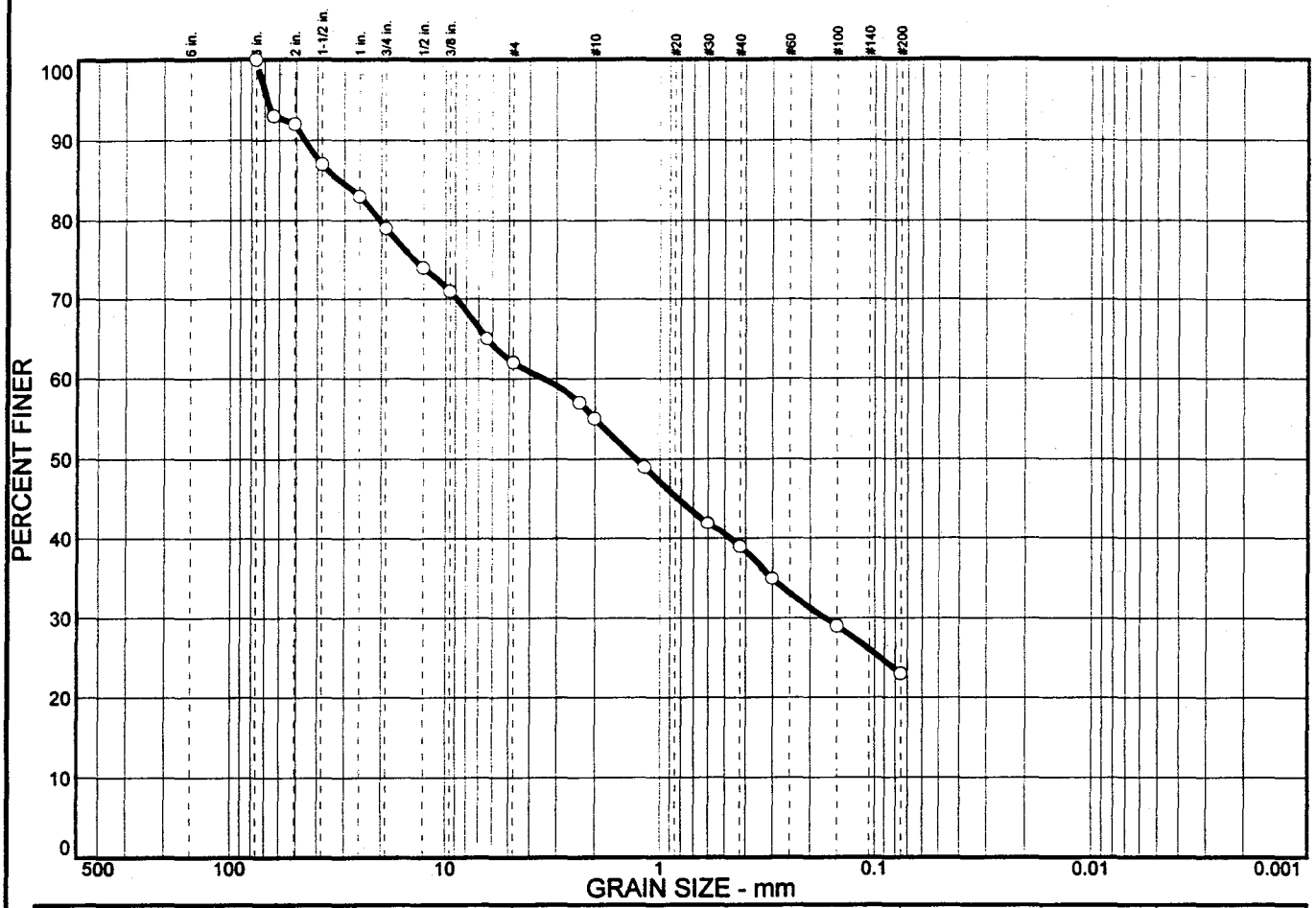
F.M.=4.22

Sample No.: 83153 **Source of Sample:** Boring 1 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 90'-100'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	38	39	23	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	93		
2 in.	92		
1-1/2 in.	87		
1 in.	83		
3/4 in.	79		
1/2 in.	74		
3/8 in.	71		
1/4 in.	65		
#4	62		
#8	57		
#10	55		
#16	49		
#30	42		
#40	39		
#50	35		
#100	29		
#200	23		

* (no specification provided)

Soil Description

Clayey sand with gravel
Sample contains 2% cobbles

Atterberg Limits

PL= 20 LL= 28 PI= 8

Coefficients

D_{85}= 31.5 D_{60}= 3.47 D_{50}= 1.29
D_{30}= 0.170 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-4(0)

Remarks

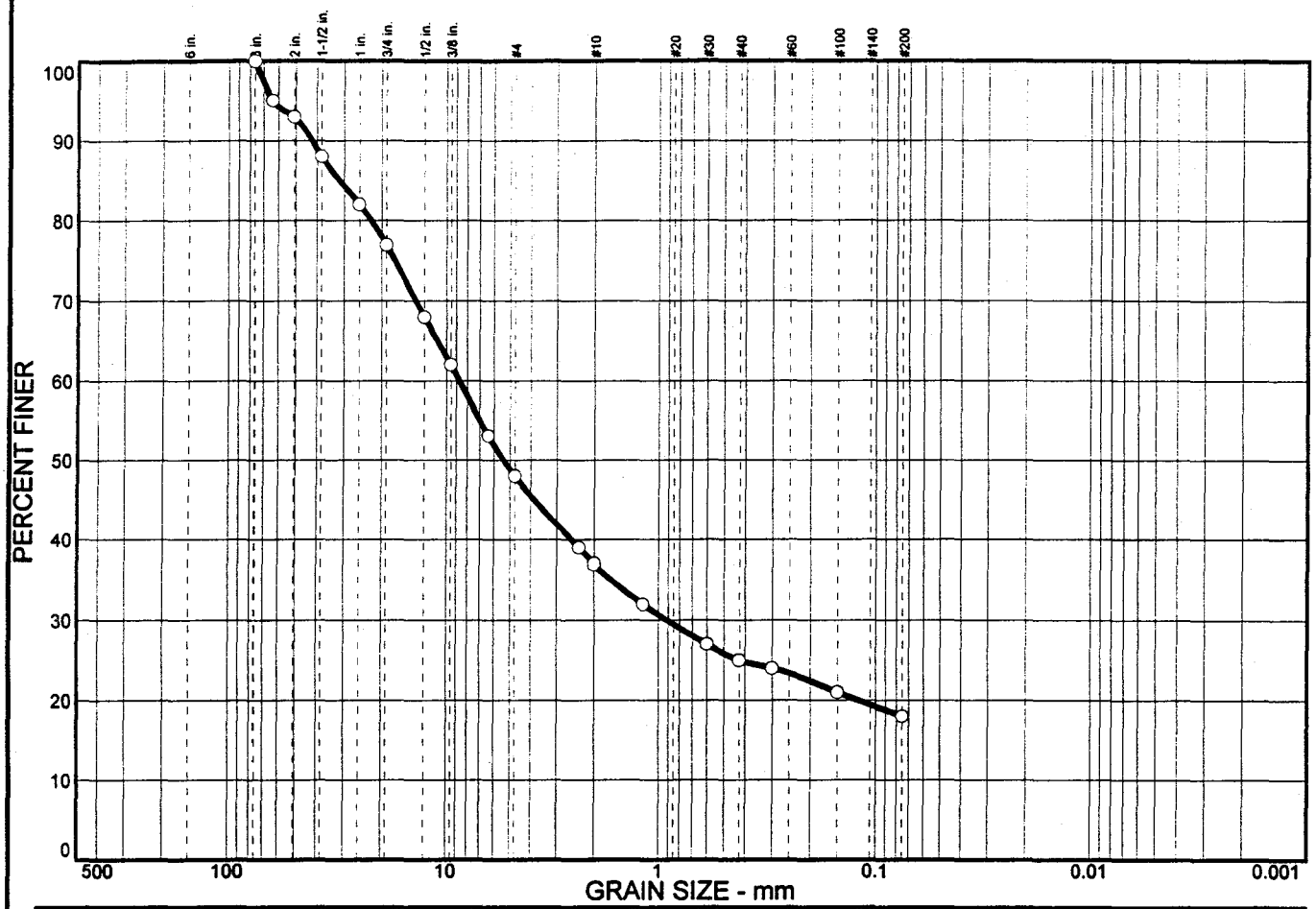
F.M.=3.89

Sample No.: 83154 **Source of Sample:** Boring 2 **Date:** 7-15-98
Location: Cave Buttes Dam **Elev./Depth:** 0'-10'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	52	30	18	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	95		
2 in.	93		
1-1/2 in.	88		
1 in.	82		
3/4 in.	77		
1/2 in.	68		
3/8 in.	62		
1/4 in.	53		
#4	48		
#8	39		
#10	37		
#16	32		
#30	27		
#40	25		
#50	24		
#100	21		
#200	18		

* (no specification provided)

Soil Description

Clayey gravel with sand

Atterberg Limits

PL= 18 LL= 42 PI= 24

Coefficients

D_{85}= 31.5 D_{60}= 8.71 D_{50}= 5.39
D_{30}= 0.914 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(0)

Remarks

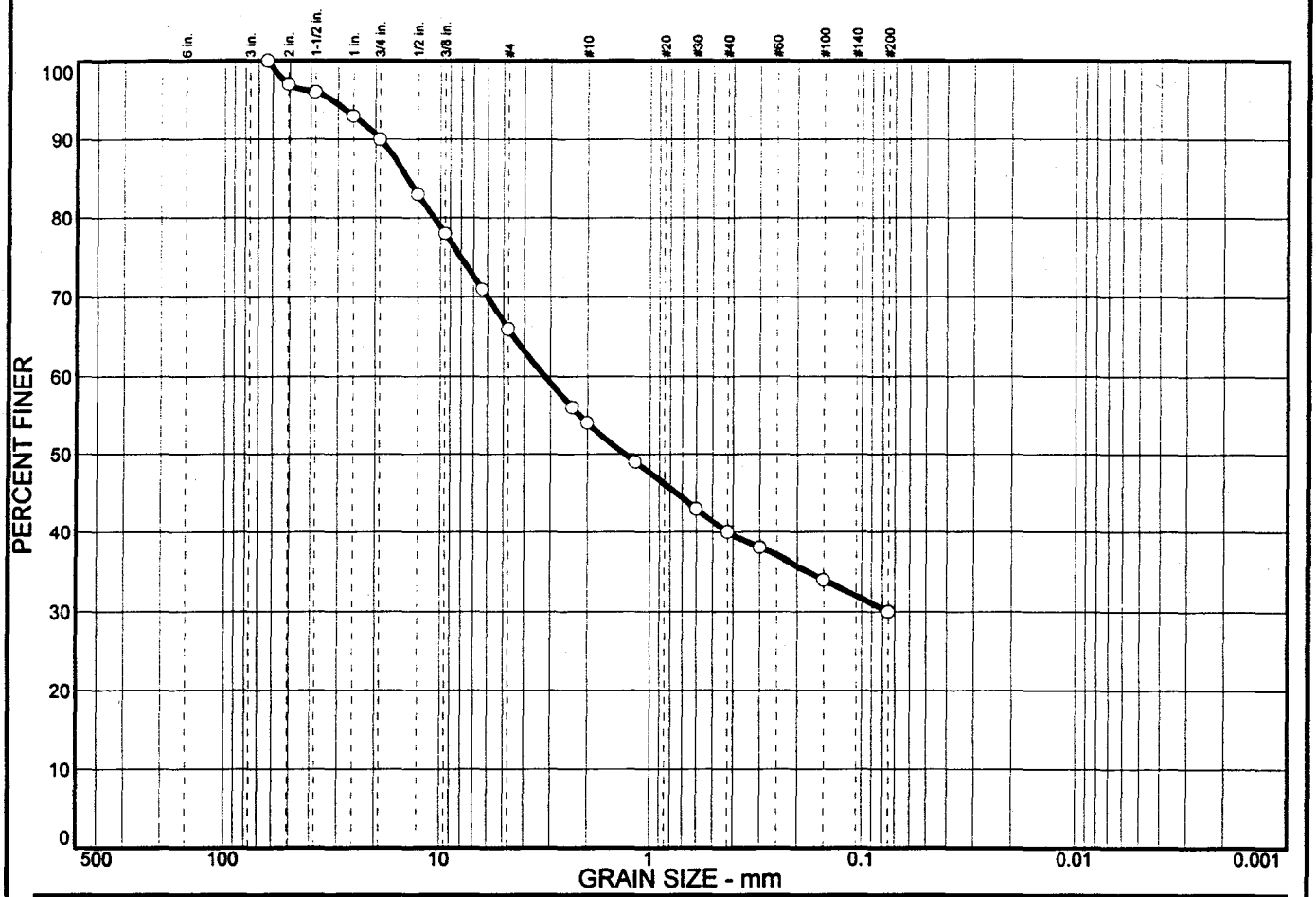
F.M.=4.82

Sample No.: 83157 **Source of Sample:** Boring 2 **Date:** 7-15-98
Location: Cave Butes Dam **Elev./Depth:** 20'-30'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TP

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	34	36	30	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2-1/2 in.	100		
2 in.	97		
1-1/2 in.	96		
1 in.	93		
3/4 in.	90		
1/2 in.	83		
3/8 in.	78		
1/4 in.	71		
#4	66		
#8	56		
#10	54		
#16	49		
#30	43		
#40	40		
#50	38		
#100	34		
#200	30		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 19 LL= 45 PI= 26

Coefficients

D_{85}= 14.1 D_{60}= 3.20 D_{50}= 1.33
D_{30}= 0.0750 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(2)

Remarks

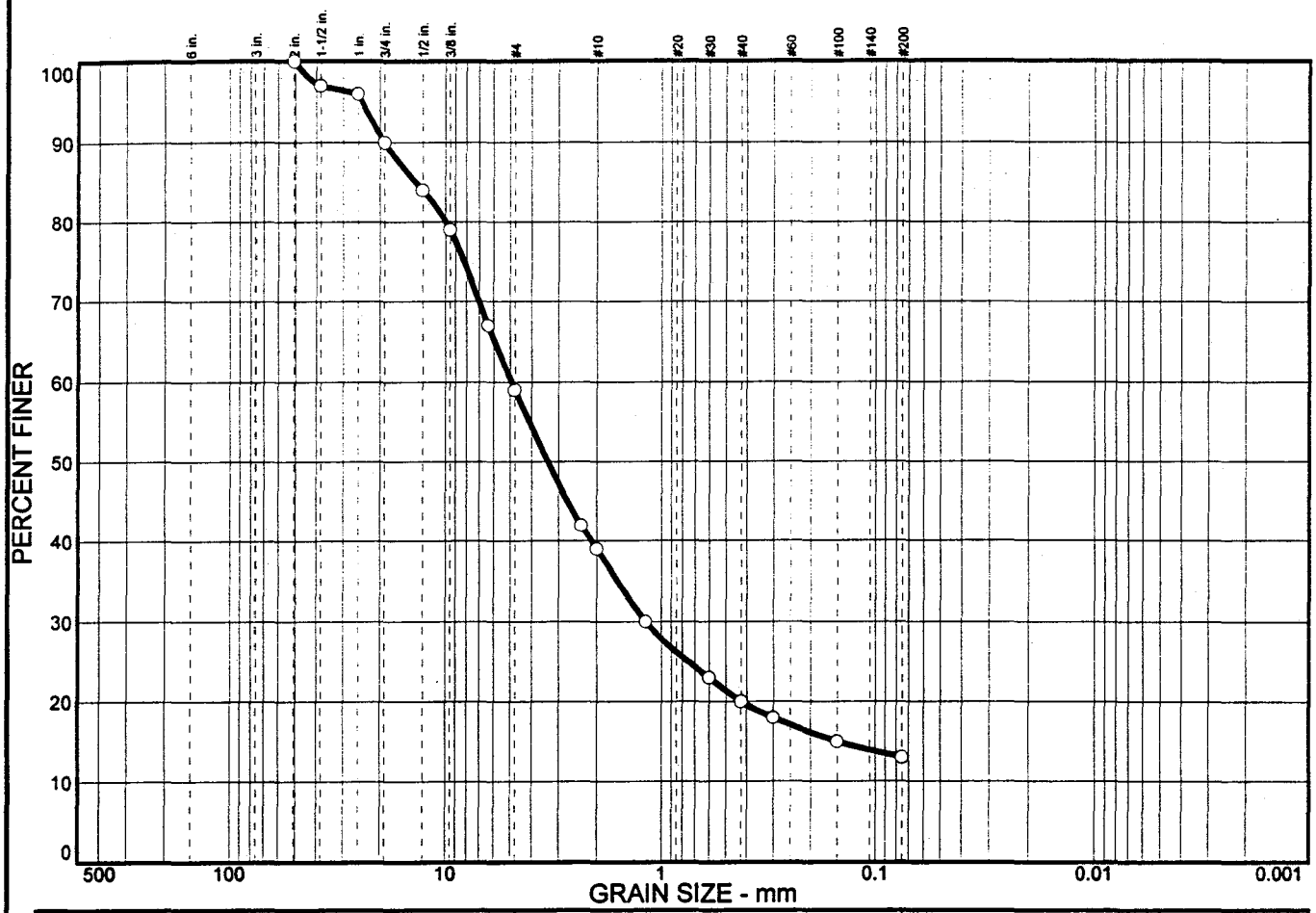
F.M.=3.50

Sample No.: 83158 **Source of Sample:** Boring 2 **Date:** 7-15-98
Location: Cave Buttes Dam **Elev./Depth:** 30'-40'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	41	46	13	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	97		
1 in.	96		
3/4 in.	90		
1/2 in.	84		
3/8 in.	79		
1/4 in.	67		
#4	59		
#8	42		
#10	39		
#16	30		
#30	23		
#40	20		
#50	18		
#100	15		
#200	13		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 16 LL= 24 PI= 8

Coefficients

D_{85}= 13.7 D_{60}= 4.93 D_{50}= 3.37
D_{30}= 1.18 D_{15}= 0.150 D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-4(0)

Remarks

F.M.=4.47

Sample No.: 83160 **Source of Sample:** Boring 2 **Date:** 7-15-98
Location: Cave Buttes Dam **Elev./Depth:** 45'-55'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	0	66	34	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#8	94		
#10	93		
#16	89		
#30	80		
#40	74		
#50	66		
#100	48		
#200	34		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.843 D_{60}= 0.239 D_{50}= 0.163
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

F.M.=1.23

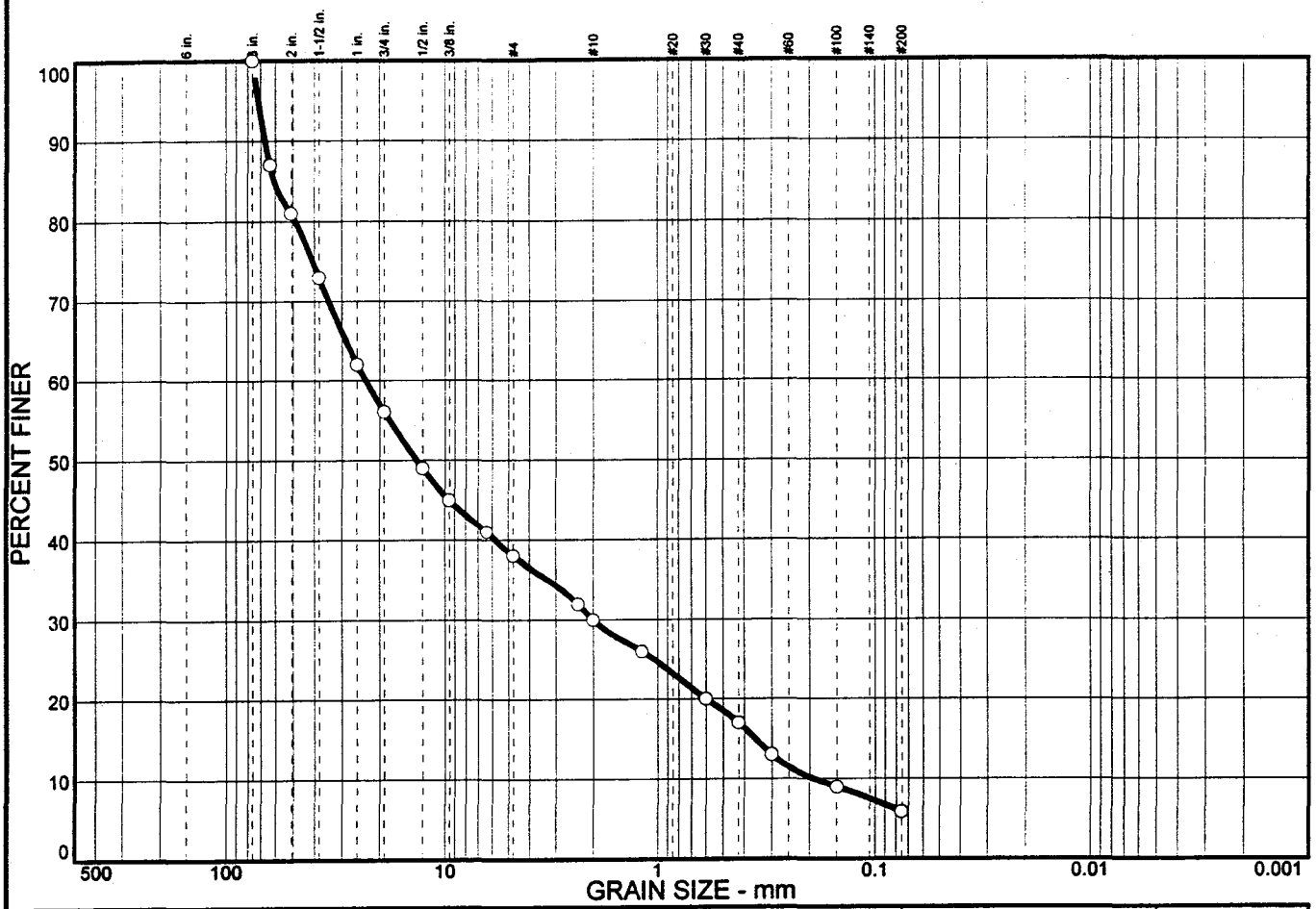
Sample No.: 83163 **Source of Sample:** Boring 3 **Date:** 7-17-98
Location: Cave Buttes Dam **Elev./Depth:** 0'-10'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	62	32	6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	87		
2 in.	81		
1-1/2 in.	73		
1 in.	62		
3/4 in.	56		
1/2 in.	49		
3/8 in.	45		
1/4 in.	41		
#4	38		
#8	32		
#10	30		
#16	26		
#30	20		
#40	17		
#50	13		
#100	9		
#200	5.9		

* (no specification provided)

Soil Description

Poorly graded gravel with silt and sand
Sample contains 15% cobbles.

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 60.6 D_{60}= 23.2 D_{50}= 13.5
D_{30}= 2.00 D_{15}= 0.357 D_{10}= 0.193
C_u= 120.61 C_c= 0.89

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

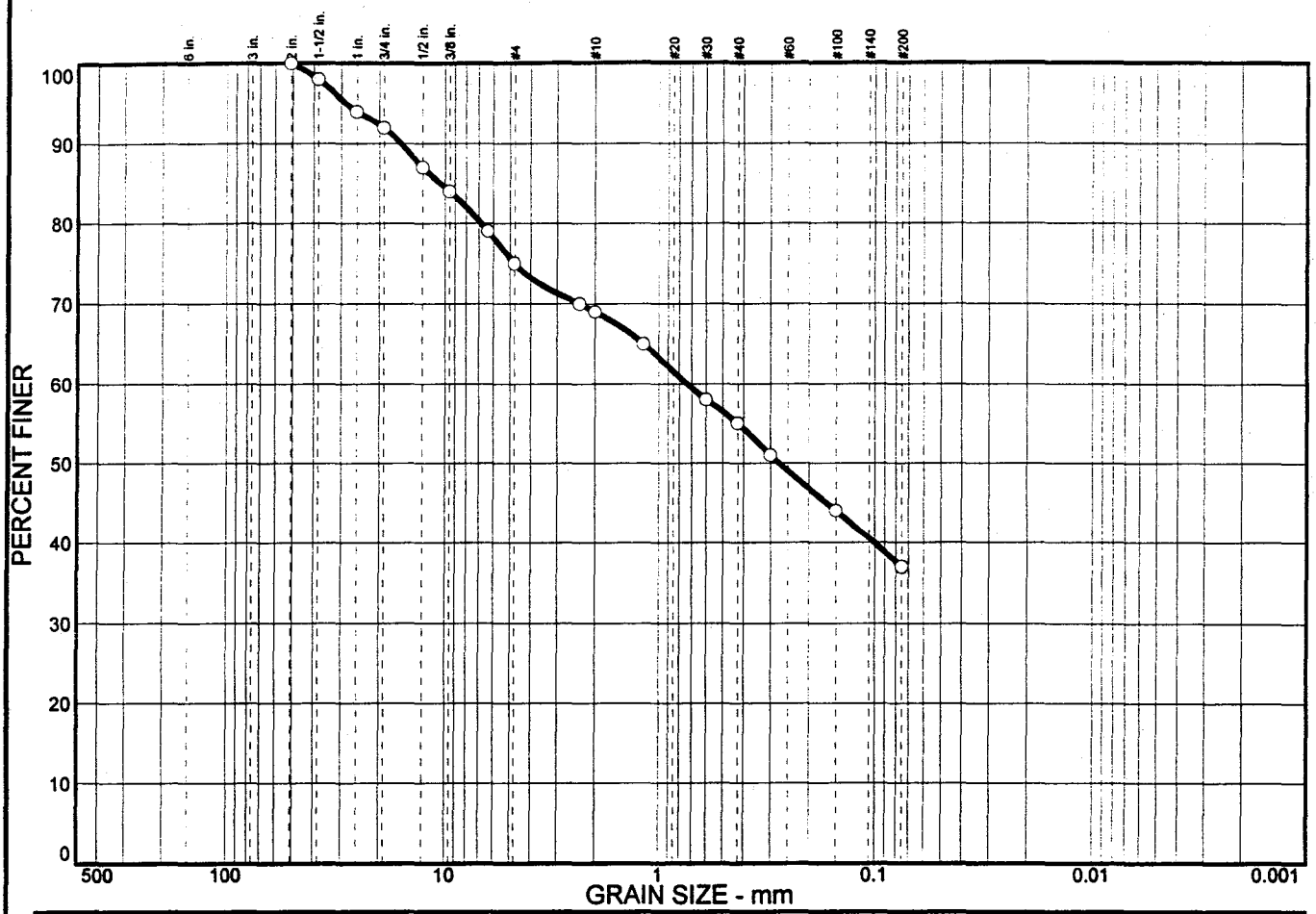
F.M.=5.88

Sample No.: 83165 **Source of Sample:** Boring 3 **Date:** 7-17-98
Location: Cave Buttes Dam **Elev./Depth:** 20'-30'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	25	38	37	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	98		
1 in.	94		
3/4 in.	92		
1/2 in.	87		
3/8 in.	84		
1/4 in.	79		
#4	75		
#8	70		
#10	69		
#16	65		
#30	58		
#40	55		
#50	51		
#100	44		
#200	37		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 26 LL= 47 PI= 21

Coefficients

D_{85}= 10.5 D_{60}= 0.735 D_{50}= 0.275
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(3)

Remarks

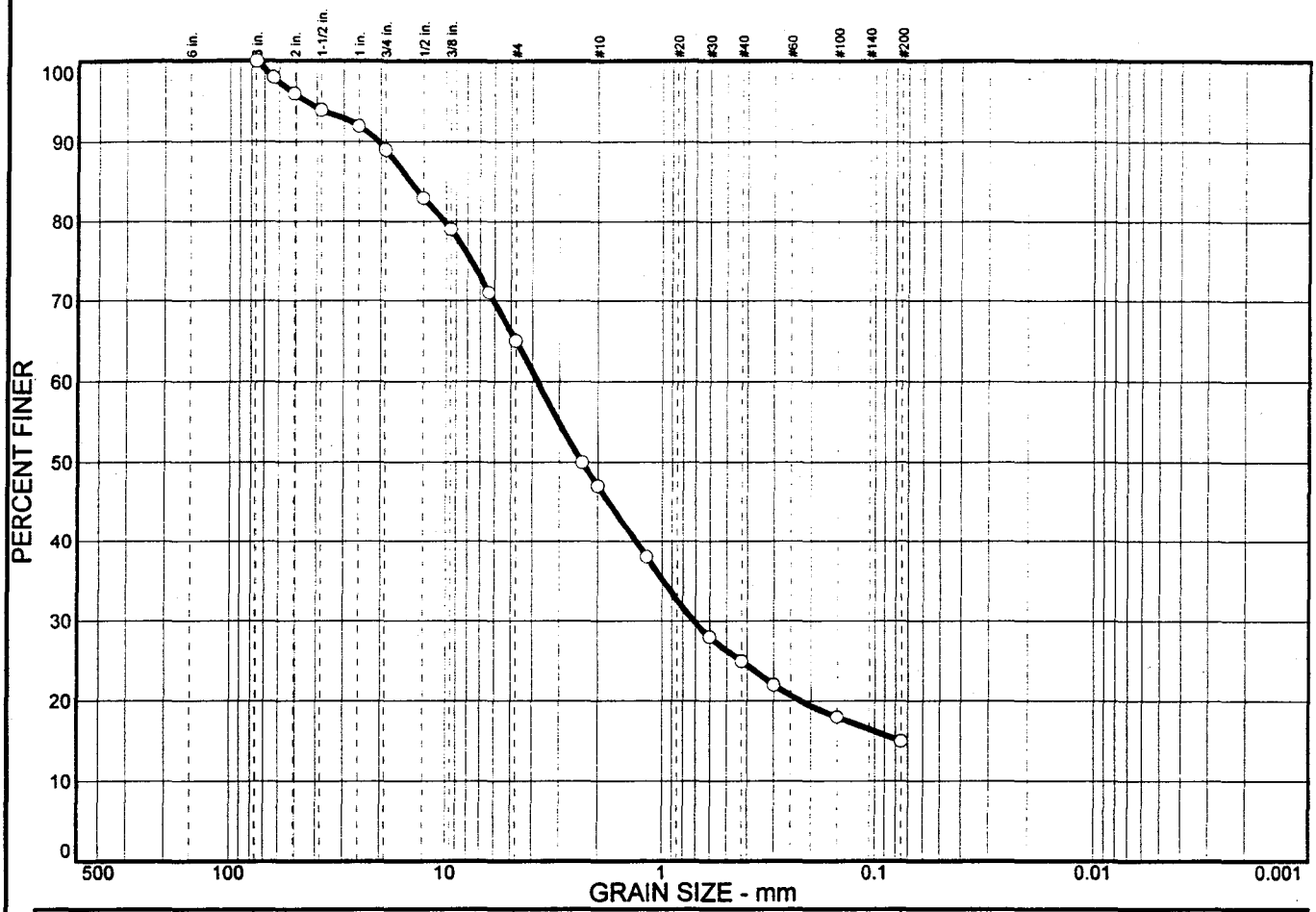
F.M.=2.63

Sample No.: 83167 **Source of Sample:** Boring 3 **Date:** 7-17-98
Location: Cave Buttes Dam **Elev./Depth:** 40'-50'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	35	50	15	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	98		
2 in.	96		
1-1/2 in.	94		
1 in.	92		
3/4 in.	89		
1/2 in.	83		
3/8 in.	79		
1/4 in.	71		
#4	65		
#8	50		
#10	47		
#16	38		
#30	28		
#40	25		
#50	22		
#100	18		
#200	15		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 23 LL= 37 PI= 14

Coefficients

D_{85}= 14.5 D_{60}= 3.78 D_{50}= 2.36
D_{30}= 0.709 D_{15}= 0.0750 D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

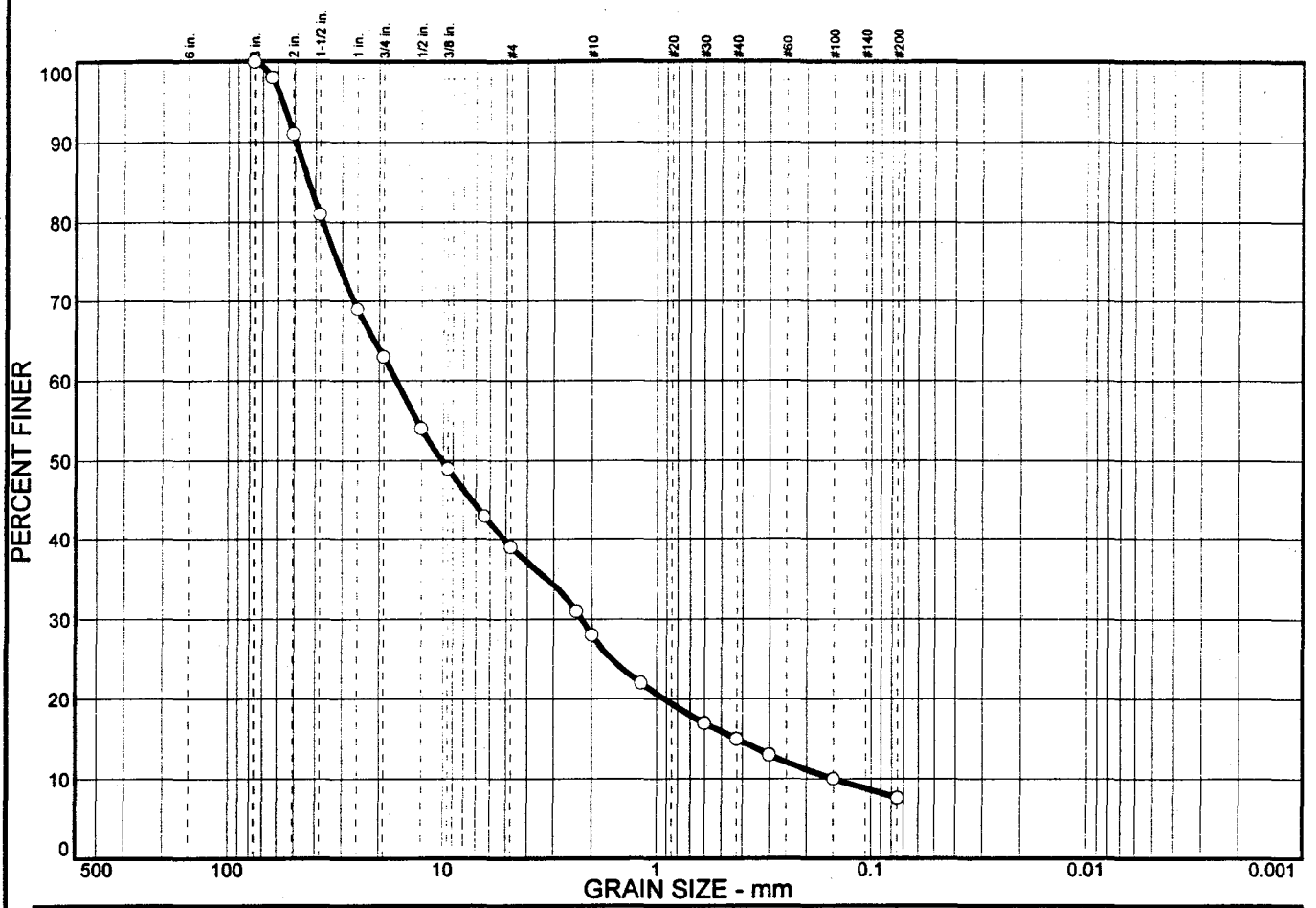
F.M.=4.17

Sample No.: 83171 **Source of Sample:** Boring 3 **Date:** 7-17-98
Location: Cave Buttes Dam **Elev./Depth:** 80'-90'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TP

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	61	31	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	98		
2 in.	91		
1-1/2 in.	81		
1 in.	69		
3/4 in.	63		
1/2 in.	54		
3/8 in.	49		
1/4 in.	43		
#4	39		
#8	31		
#10	28		
#16	22		
#30	17		
#40	15		
#50	13		
#100	10		
#200	7.6		

* (no specification provided)

Soil Description

Well-graded gravel with silt and sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 42.9 D_{60}= 16.6 D_{50}= 10.1
D_{30}= 2.23 D_{15}= 0.425 D_{10}= 0.150
C_u= 110.90 C_c= 2.00

Classification

USCS= GW-GM AASHTO= A-1-a

Remarks

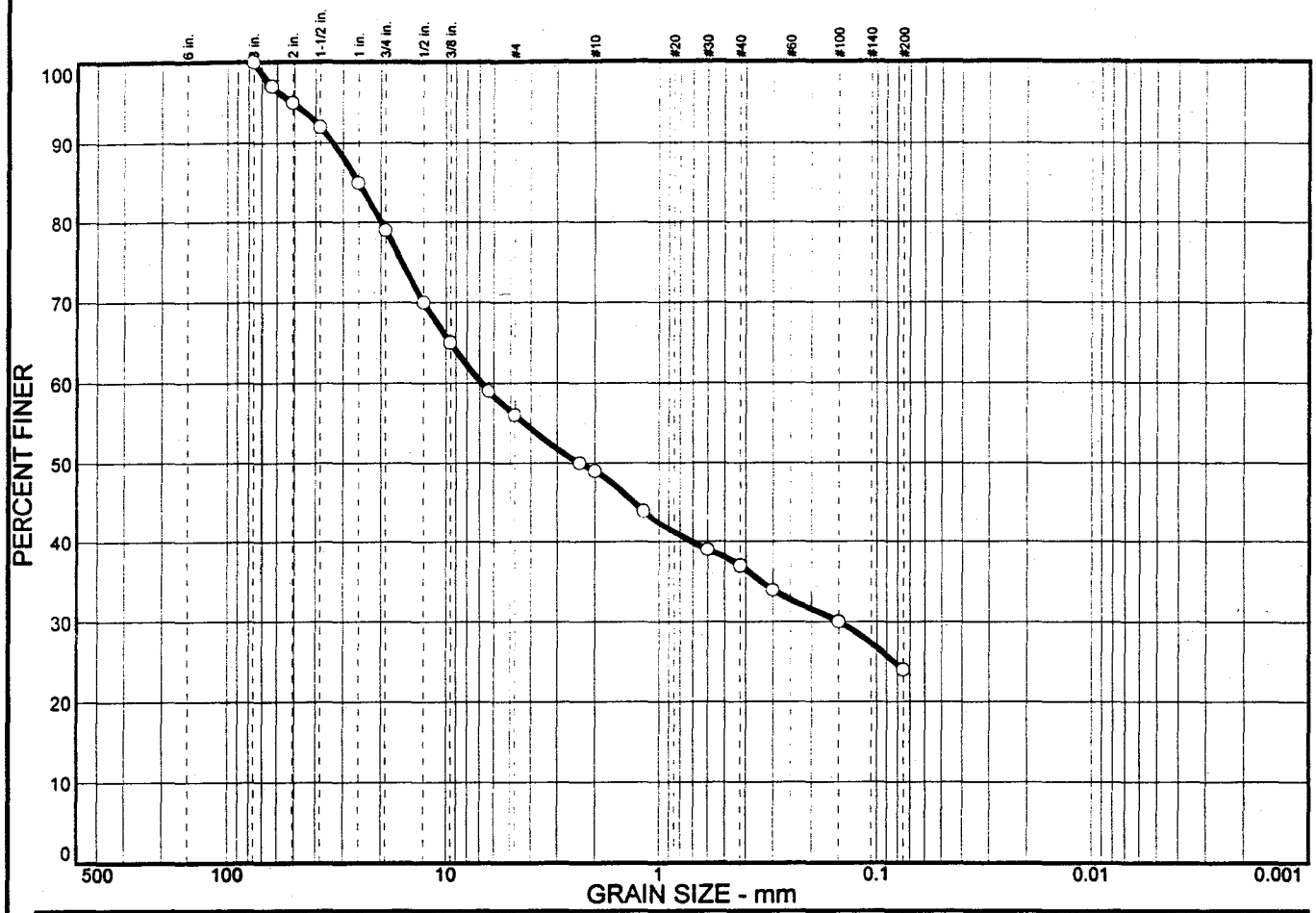
F.M.=5.75

Sample No.: 83173 **Source of Sample:** Boring 4 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 0'-10'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TB

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	44	32	24	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	97		
2 in.	95		
1-1/2 in.	92		
1 in.	85		
3/4 in.	79		
1/2 in.	70		
3/8 in.	65		
1/4 in.	59		
#4	56		
#8	50		
#10	49		
#16	44		
#30	39		
#40	37		
#50	34		
#100	30		
#200	24		

* (no specification provided)

Soil Description

Clayey gravel with sand

Atterberg Limits

PL= 24 LL= 36 PI= 12

Coefficients

D_{85}= 25.4 D_{60}= 6.86 D_{50}= 2.36
D_{30}= 0.150 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

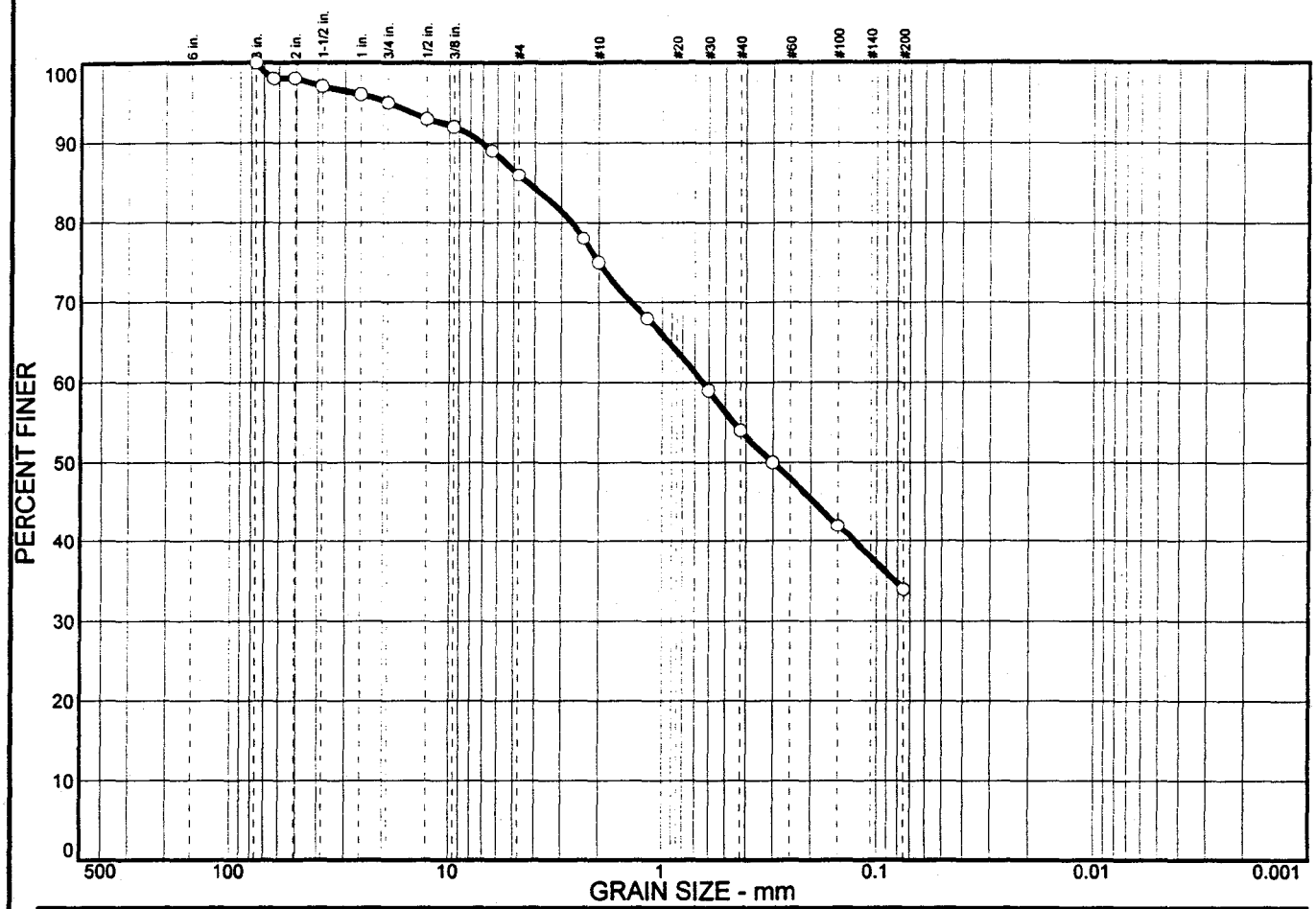
F.M.=4.11

Sample No.: 83176 **Source of Sample:** Boring 4 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 40'-50'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	14	52	34	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	98		
2 in.	98		
1-1/2 in.	97		
1 in.	96		
3/4 in.	95		
1/2 in.	93		
3/8 in.	92		
1/4 in.	89		
#4	86		
#8	78		
#10	75		
#16	68		
#30	59		
#40	54		
#50	50		
#100	42		
#200	34		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= 27 LL= 45 PI= 18

Coefficients

D_{85}= 4.28 D_{60}= 0.642 D_{50}= 0.300
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-7(2)

Remarks

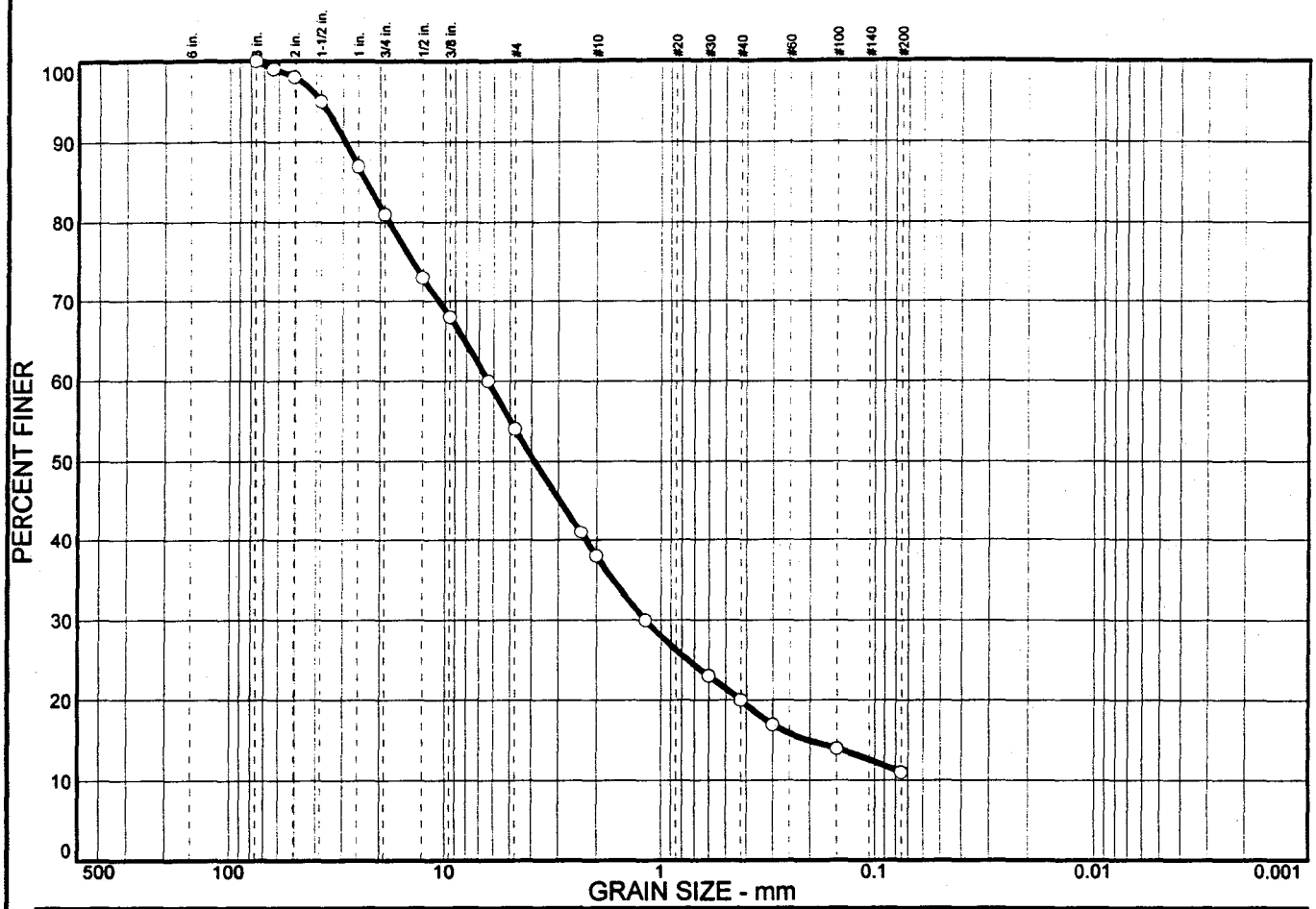
F.M.=2.33

Sample No.: 83177 **Source of Sample:** Boring 4 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 50'-60'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TP

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	46	43	11	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	99		
2 in.	98		
1-1/2 in.	95		
1 in.	87		
3/4 in.	81		
1/2 in.	73		
3/8 in.	68		
1/4 in.	60		
#4	54		
#8	41		
#10	38		
#16	30		
#30	23		
#40	20		
#50	17		
#100	14		
#200	11		

* (no specification provided)

Soil Description

Poorly graded gravel with silt and sand
Sample contains 7% cobbles

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 23.1 D_{60}= 6.35 D_{50}= 3.86
D_{30}= 1.18 D_{15}= 0.202 D_{10}=
C_u= C_c=

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

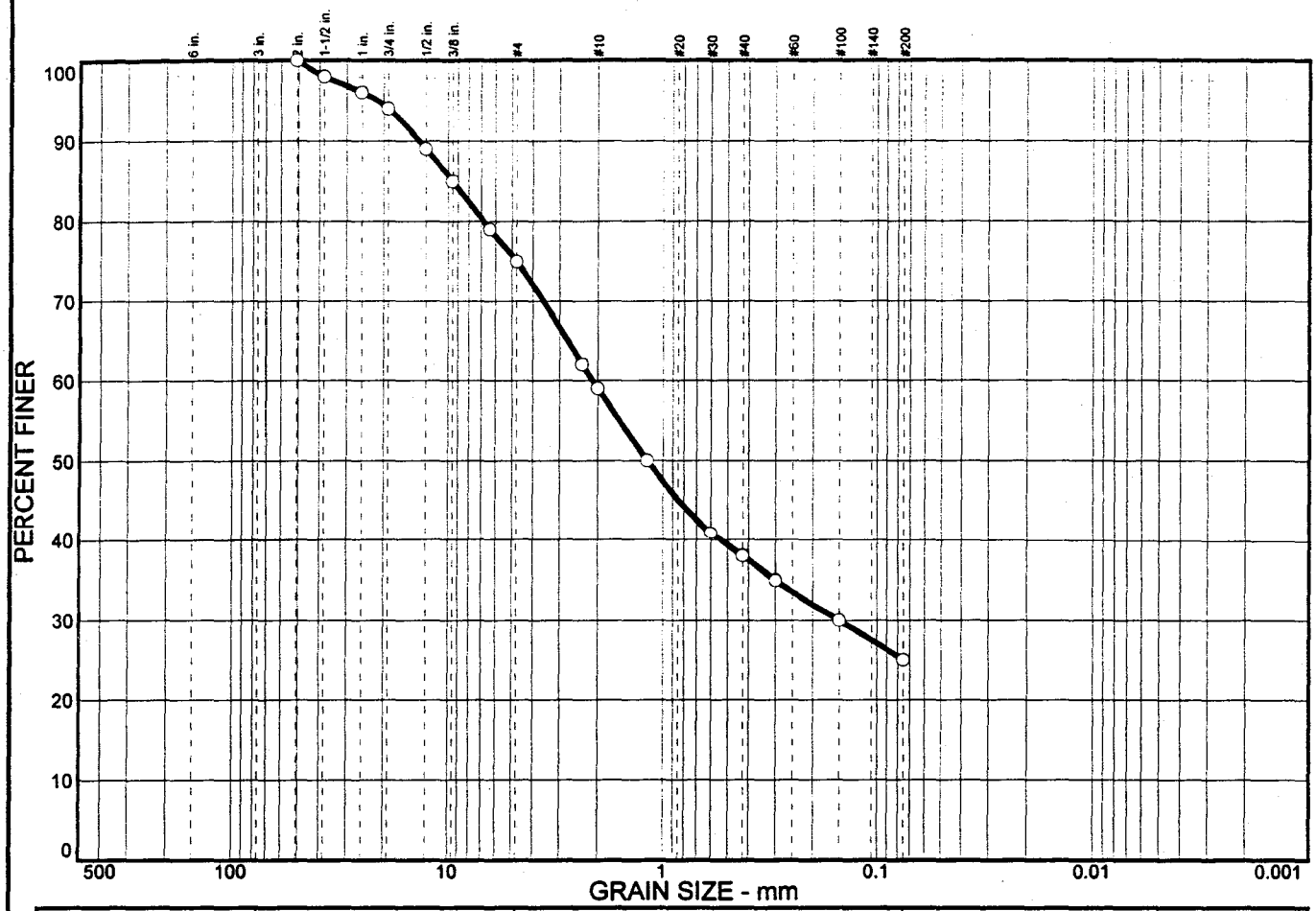
F.M.=4.77

Sample No.: 83178 **Source of Sample:** Boring 4 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 60'-70'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	25	50	25	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	98		
1 in.	96		
3/4 in.	94		
1/2 in.	89		
3/8 in.	85		
1/4 in.	79		
#4	75		
#8	62		
#10	59		
#16	50		
#30	41		
#40	38		
#50	35		
#100	30		
#200	25		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 20 LL= 32 PI= 12

Coefficients

D_{85}= 9.52 D_{60}= 2.12 D_{50}= 1.18
D_{30}= 0.150 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

F.M.=3.30

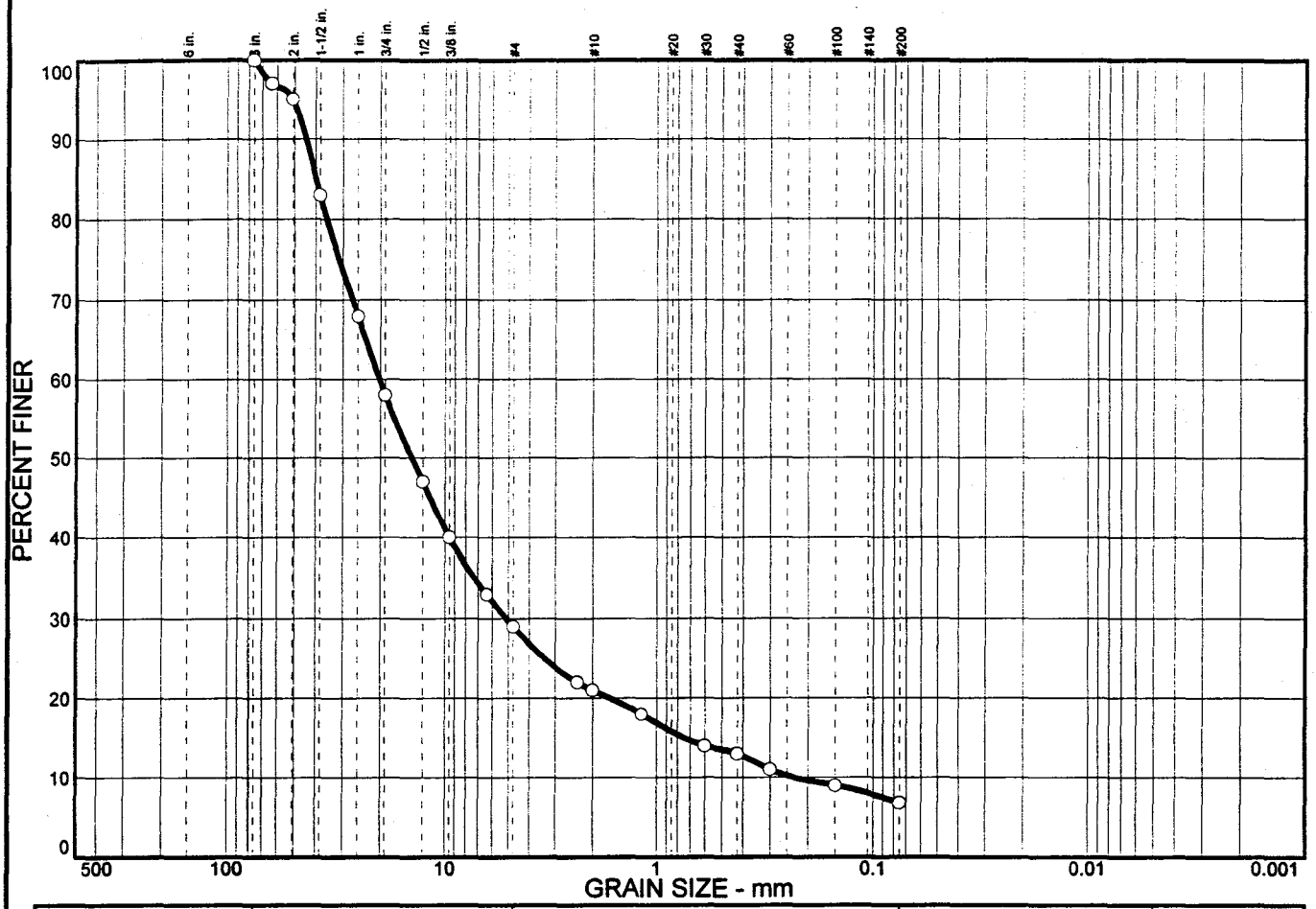
Sample No.: 83182 **Source of Sample:** Boring 5 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 0'-10

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	71	22	7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	97		
2 in.	95		
1-1/2 in.	83		
1 in.	68		
3/4 in.	58		
1/2 in.	47		
3/8 in.	40		
1/4 in.	33		
#4	29		
#8	22		
#10	21		
#16	18		
#30	14		
#40	13		
#50	11		
#100	9		
#200	6.8		

* (no specification provided)

Soil Description

Poorly graded gravel with silt and sand
Sample contains 17% cobbles

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 39.7 D_{60}= 20.2 D_{50}= 14.3
D_{30}= 5.13 D_{15}= 0.744 D_{10}= 0.234
C_u= 86.36 C_c= 5.54

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

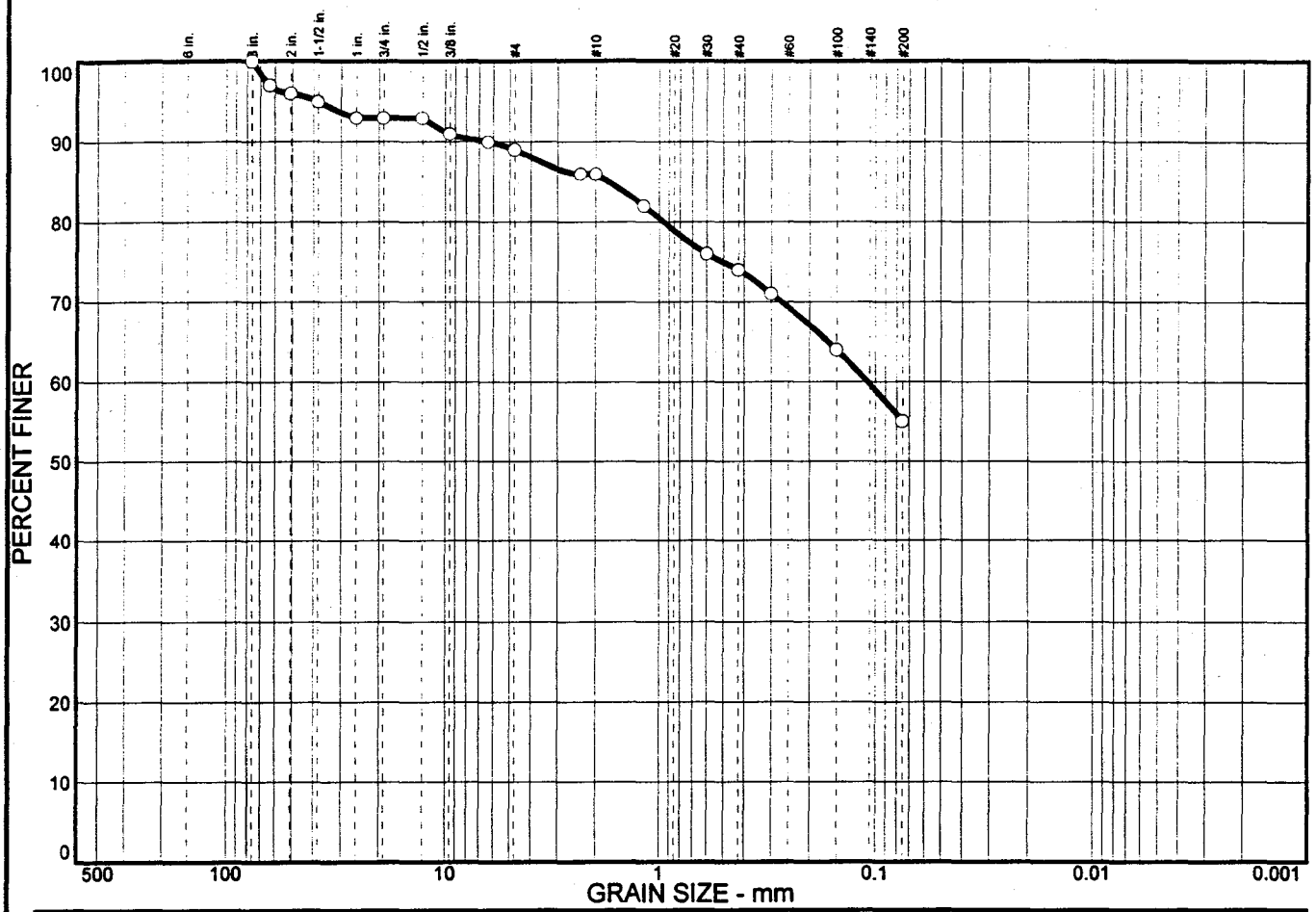
F.M.=6.16

Sample No.: 83183 **Source of Sample:** Boring 5 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 30'-40'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	11	34	55	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	97		
2 in.	96		
1-1/2 in.	95		
1 in.	93		
3/4 in.	93		
1/2 in.	93		
3/8 in.	91		
1/4 in.	90		
#4	89		
#8	86		
#10	86		
#16	82		
#30	76		
#40	74		
#50	71		
#100	64		
#200	55		

* (no specification provided)

Soil Description

Sandy lean clay
Sample contains 26% cobbles

Atterberg Limits

PL= 22 LL= 39 PI= 17

Coefficients

D_{85}= 1.73 D_{60}= 0.109 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(7)

Remarks

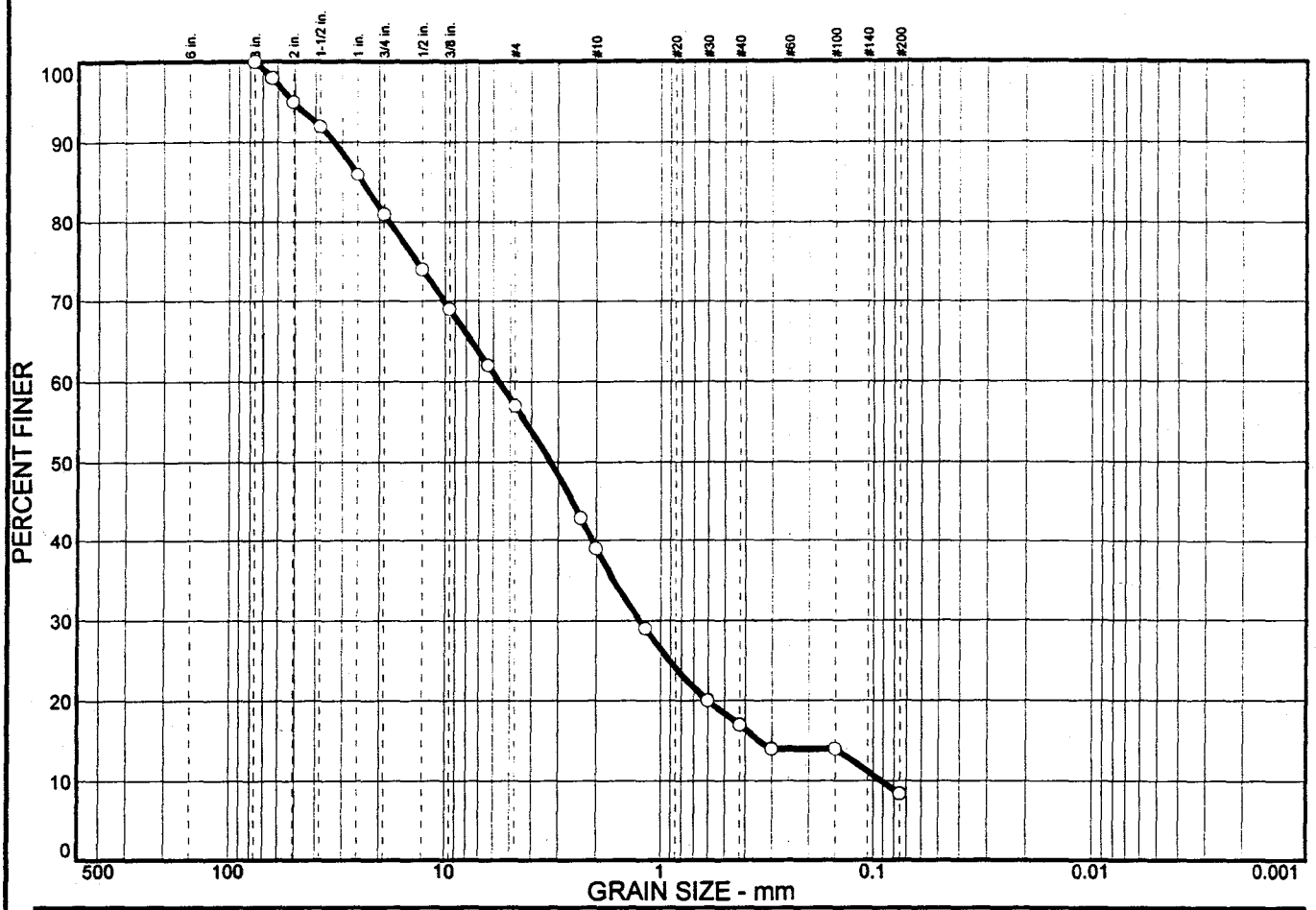
F.M.=1.53

Sample No.: 83184 **Source of Sample:** Boring 5 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 40'-50'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	43	49	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	98		
2 in.	95		
1-1/2 in.	92		
1 in.	86		
3/4 in.	81		
1/2 in.	74		
3/8 in.	69		
1/4 in.	62		
#4	57		
#8	43		
#10	39		
#16	29		
#30	20		
#40	17		
#50	14		
#100	14		
#200	8.4		

* (no specification provided)

Soil Description

Poorly graded sand with silt and gravel

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 24.0 D_{60}= 5.65 D_{50}= 3.25
D_{30}= 1.25 D_{15}= 0.345 D_{10}= 0.0914
C_u= 61.80 C_c= 3.05

Classification

USCS= SP-SM AASHTO= A-1-a

Remarks

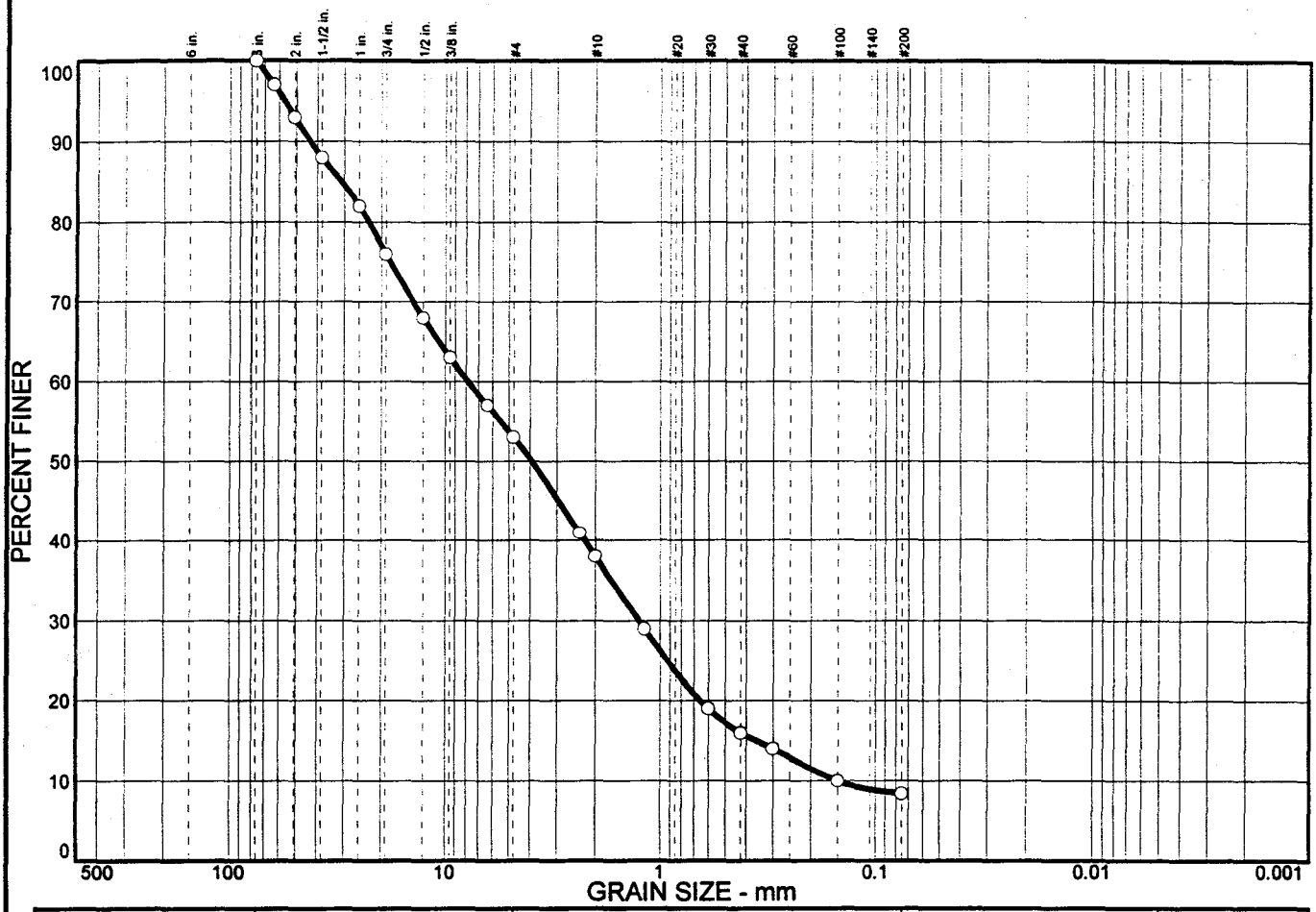
F.M.=4.81

Sample No.: 83190 **Source of Sample:** Boring 6 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 10'-20'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TP

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	47	45	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100		
2-1/2 in.	97		
2 in.	93		
1-1/2 in.	88		
1 in.	82		
3/4 in.	76		
1/2 in.	68		
3/8 in.	63		
1/4 in.	57		
#4	53		
#8	41		
#10	38		
#16	29		
#30	19		
#40	16		
#50	14		
#100	10		
#200	8.4		

* (no specification provided)

Soil Description

Well-graded gravel with clay and sand

Atterberg Limits

PL= 14 LL= 25 PI= 11

Coefficients

D_{85}= 30.8 D_{60}= 7.85 D_{50}= 3.92
D_{30}= 1.25 D_{15}= 0.360 D_{10}= 0.150
C_u= 52.32 C_c= 1.33

Classification

USCS= GW-GC AASHTO= A-2-6(0)

Remarks

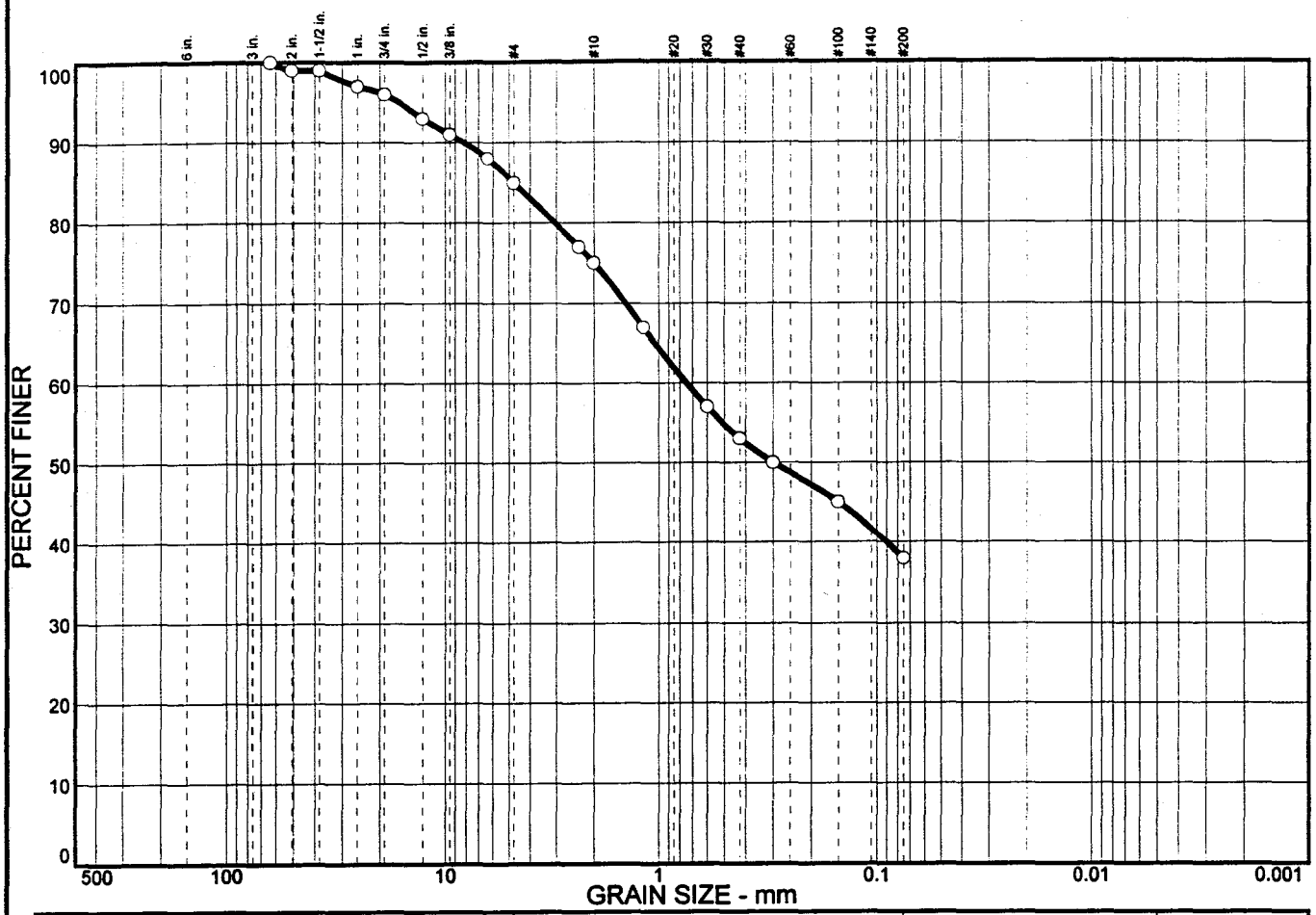
F.M.=5.07

Sample No.: 83191 **Source of Sample:** Boring 6 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 20'-30'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:** TB

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	15	47	38	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2-1/2 in.	100		
2 in.	99		
1-1/2 in.	99		
1 in.	97		
3/4 in.	96		
1/2 in.	93		
3/8 in.	91		
1/4 in.	88		
#4	85		
#8	77		
#10	75		
#16	67		
#30	57		
#40	53		
#50	50		
#100	45		
#200	38		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 18 LL= 34 PI= 16

Coefficients

D_{85}= 4.75 D_{60}= 0.747 D_{50}= 0.300
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-6(2)

Remarks

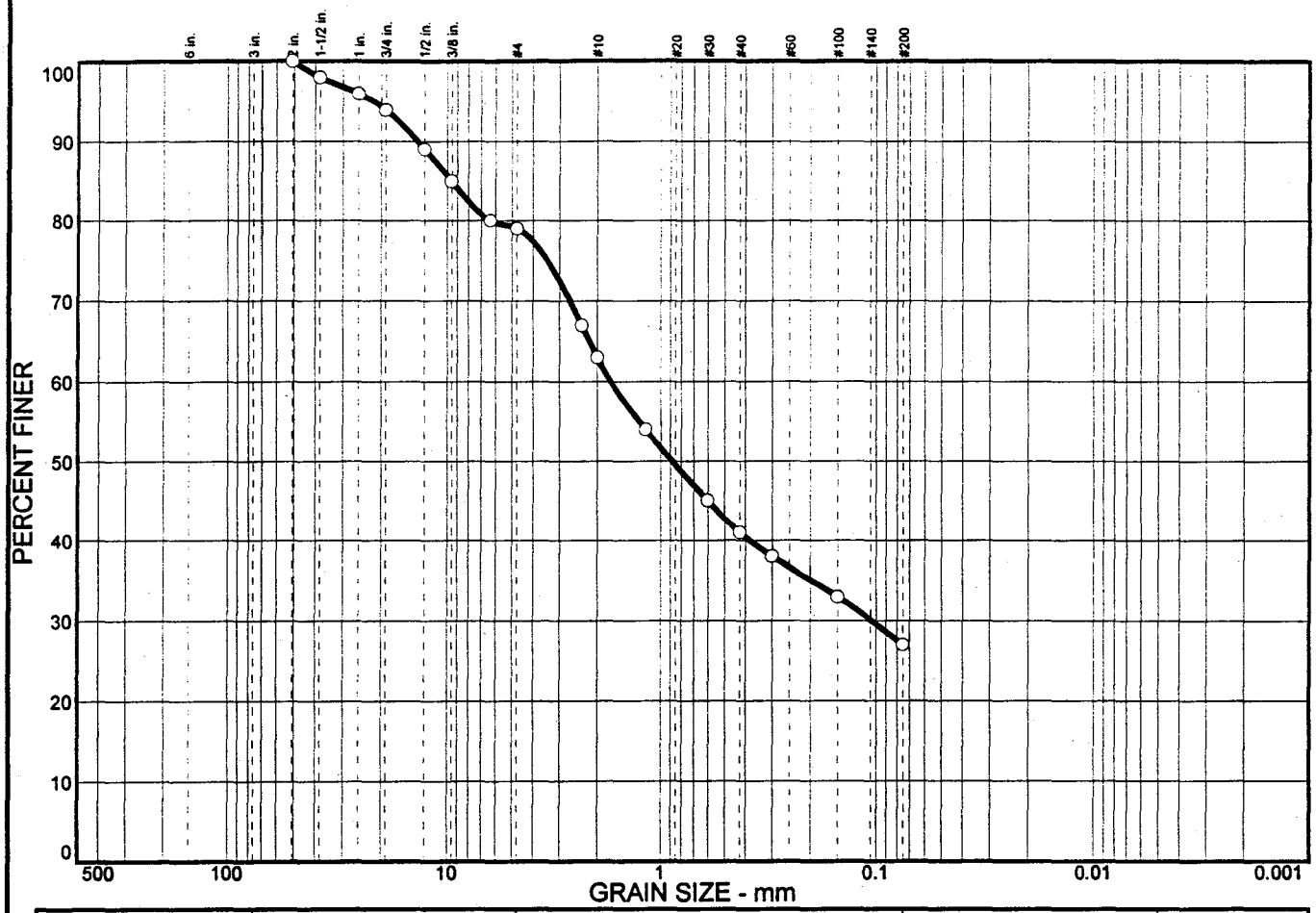
F.M.=2.33

Sample No.: 83192 **Source of Sample:** Boring 6 **Date:** 7-20-98
Location: Cave Butes Dam **Elev./Depth:** 30'-40'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	21	52	27	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	98		
1 in.	96		
3/4 in.	94		
1/2 in.	89		
3/8 in.	85		
1/4 in.	80		
#4	79		
#8	67		
#10	63		
#16	54		
#30	45		
#40	41		
#50	38		
#100	33		
#200	27		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 20 LL= 33 PI= 13

Coefficients

D_{85}= 9.52 D_{60}= 1.73 D_{50}= 0.882
D_{30}= 0.105 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

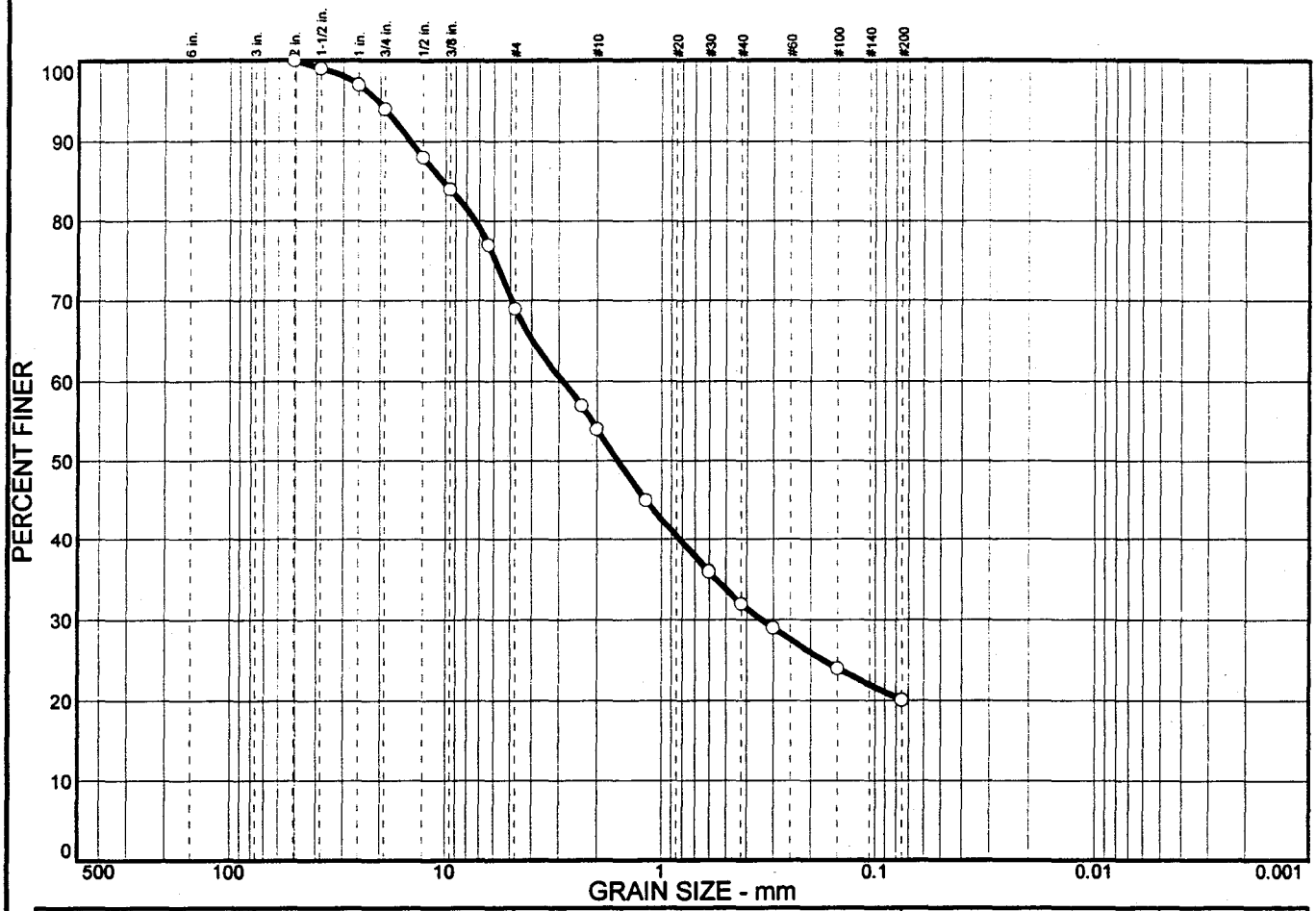
F.M.=3.07

Sample No.: 83195 **Source of Sample:** Boring 6 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 60'-70'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0	31	49	20	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
1-1/2 in.	99		
1 in.	97		
3/4 in.	94		
1/2 in.	88		
3/8 in.	84		
1/4 in.	77		
#4	69		
#8	57		
#10	54		
#16	45		
#30	36		
#40	32		
#50	29		
#100	24		
#200	20		

* (no specification provided)

Soil Description

Clayey sand with gravel

Atterberg Limits

PL= 22 LL= 40 PI= 18

Coefficients

D_{85}= 10.3 D_{60}= 2.87 D_{50}= 1.60
D_{30}= 0.340 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

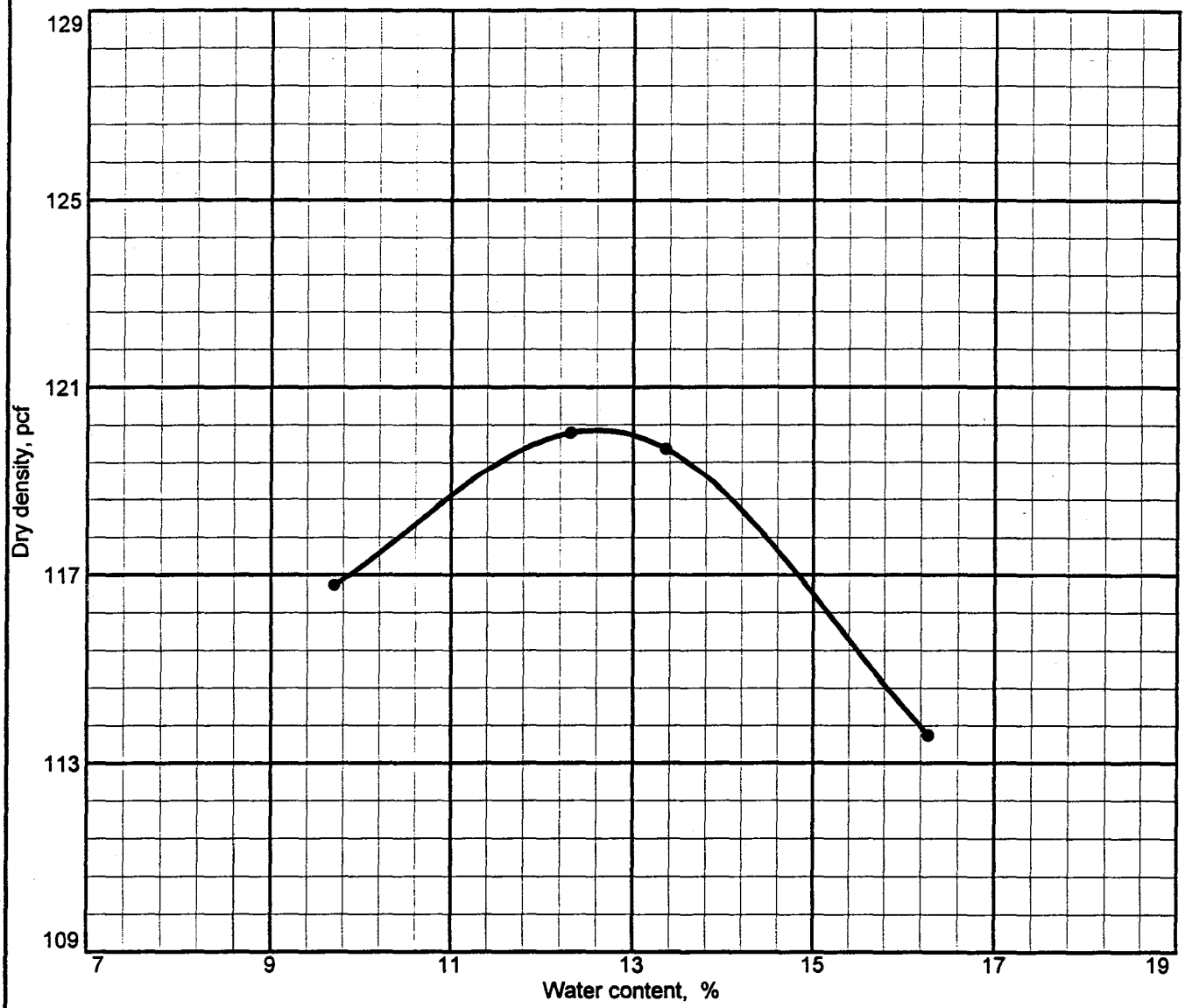
F.M.=3.63

Sample No.: 83197 **Source of Sample:** Boring 6 **Date:** 7-20-98
Location: Cave Buttes Dam **Elev./Depth:** 80'-90'

LAW
LAWGIBB Group Member

Client: Flood Control District of Maricopa County
Project: Cave Buttes Feasibility
Project No: 70241-8-0316.01 **Reviewed By:**

COMPACTION TEST REPORT



Test specification:

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
30'-40'	SC	A-6(2)			34	16	15	38

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 120.1 pcf Optimum moisture = 12.6 %	Clayey sand with gravel

Project No. 80316.01 **Client:** Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

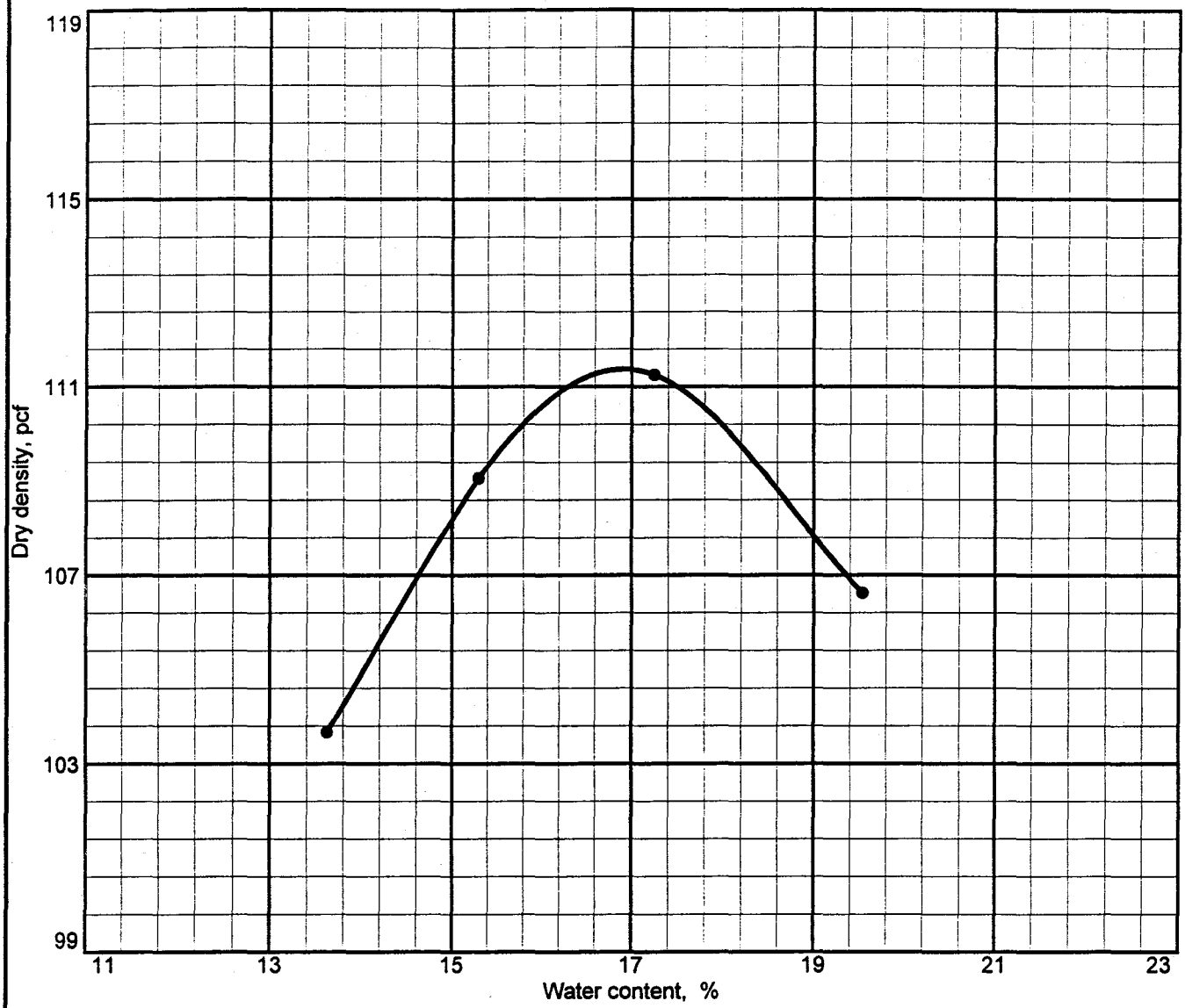
● **Source:** Boring 6 **Sample No.:** 83192 **Elev./Depth:** 30'-40'

LAW
LAWGIBB Group Member

Remarks:

Reviewed By:

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
40'-50'	SC	A-7-6(3)			47	21	8	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 111.4 pcf Optimum moisture = 16.9 %	Clayey sand with gravel

Project No. 80316.01 **Client:** Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

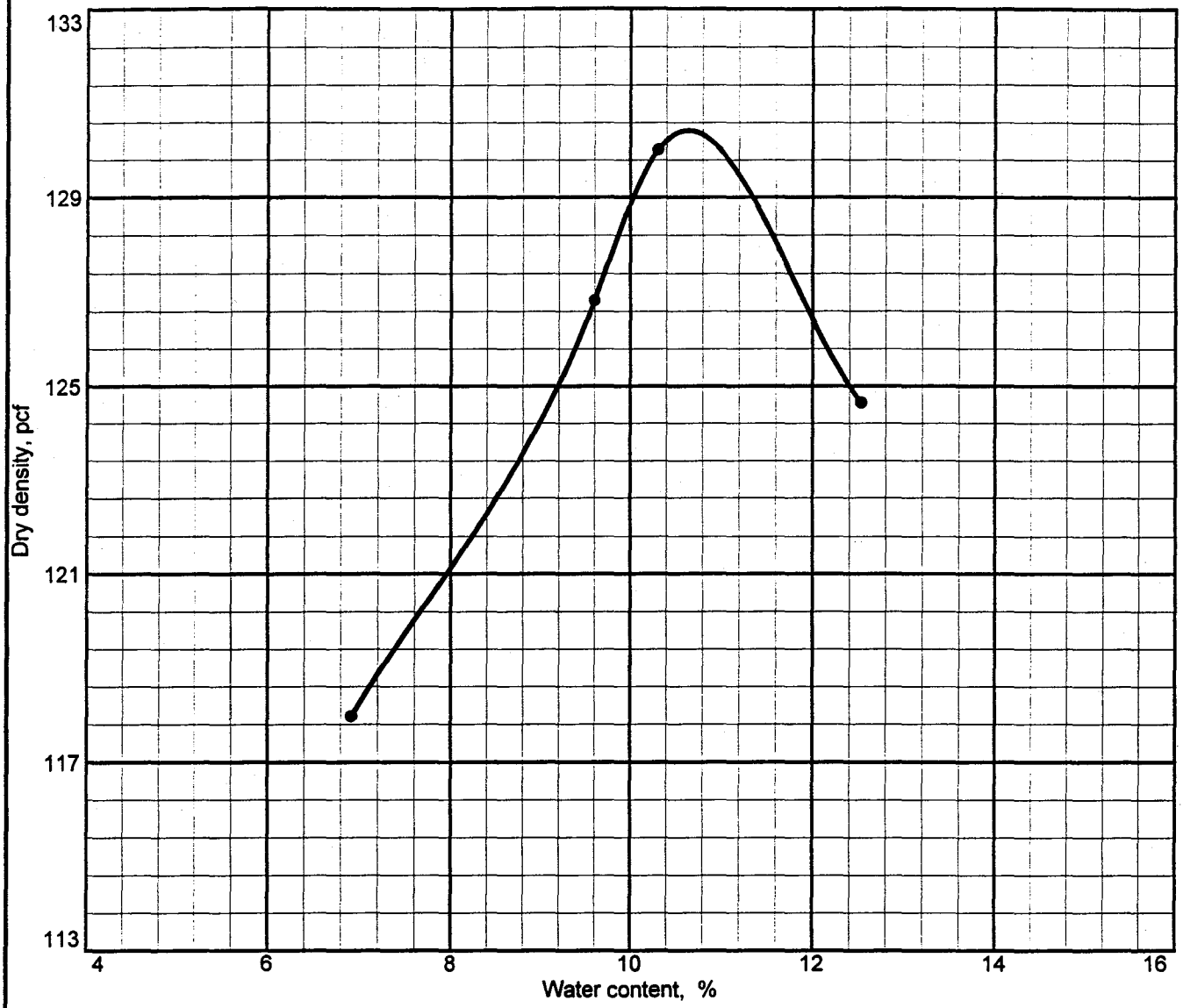
● **Source:** Boring 3 **Sample No.:** 83167 **Elev./Depth:** 40'-50'

LAW
LAWGIBB Group Member

Remarks:

Reviewed By:

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method C Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
20'-30'	GC	A-2-7(0)			42	24	23	18

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 130.4 pcf Optimum moisture = 10.6 %	Clayey gravel with sand

Project No. 80316.01 **Client:** Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

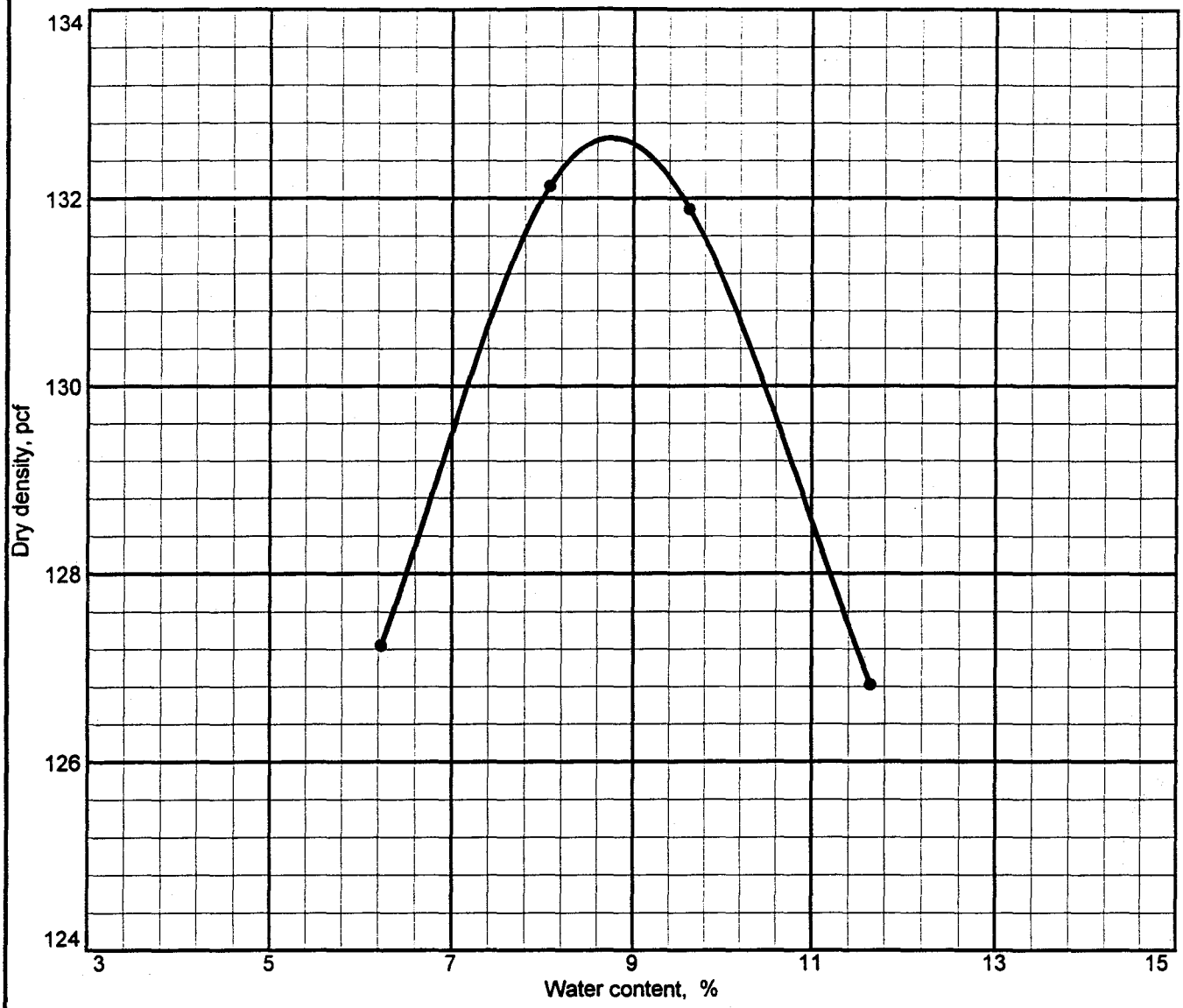
● **Source:** Boring 2 **Sample No.:** 83157 **Elev./Depth:** 20'-30'

LAW
LAWGIBB Group Member

Remarks:

Reviewed By:

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method C Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
60'-70'	GC	A-2-6(0)			38	18	9	14

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 132.6 pcf Optimum moisture = 8.8 %	Clayey gravel with sand

Project No. 80316.01 **Client:** Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

● **Source:** Boring 1 **Sample No.:** 83151 **Elev./Depth:** 60'-70'

LAW
LAWGIBB Group Member

Remarks:

Reviewed By:

COMPACTION TEST REPORT

Test specification: ASTM D 698-78 Method C Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
30'-35'	GW-GC	A-1-a			22	4	61	8.3

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 137.8 pcf Optimum moisture = 7.1 %	Well-graded gravel with silty clay and sand

Project No. 80316.01 **Client:** Flood Control District of Maricopa County
Project: Cave Buttes Feasibility

● **Source:** Boring 1 **Sample No.:** 83147 **Elev./Depth:** 30'-35'

Remarks:

LAW
LAWGIBB Group Member

Reviewed By: