Summary of Bed Material Sampling in the Ventura River Basin

Matilija Dam Ecosystem Restoration Project, Ventura CA

US DEPARTMENT OF THE INTERIOR

US BUREAU OF RECLAMATION

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- to carry out related scientific research and investigations in support of these objectives;
- and to carry out trust responsibilities of the U.S. Government with respect to American tribes and Alaska Natives.

APPROVAL SIGNATURES

This report was prepared by the following persons in the Technical Service Center (TSC) of the Bureau of Reclamation:

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Introduction

This report describes the sediment sampling and analysis that was performed as part of the study of Matilija Dam Ecosystem Restoration Study, Ventura, California. From October 1 – 4, 2001, Edmund Andrews of the US Geological Survey (USGS), and Mitch Delcau and Blair Greimann of the US Bureau of Reclamation (Reclamation) collected data of the bed material in the Ventura River from 1 mile upstream of Matilija Dam downstream to the ocean. The bed material data will be used for sediment transport calculations and monitoring changes in the river during the implementation of the chosen project alternative.

The Ventura River Basin is shown in Figure 1. North Fork Matilija Creek joins with Matilija Creek to form the Ventura River at river mile (RM) 15.6. San Antonio Creek joins the Ventura River at RM 7.83, Coyote Creek at 5.93, and Canada Larga at 4.54. The drainage area of the Ventura River is approximately 226 mi^2 at its mouth (Table 1). Matilija Creek is one of the largest tributaries to the Ventura River with a drainage area of about 55 mi^2. San Antonio Creek is another major contributor of flow with a drainage area of 51.2 mi^2. The drainage area of Coyote Creek is also large, but the flows in Coyote Creek downstream of Casitas Dam are significantly impaired.

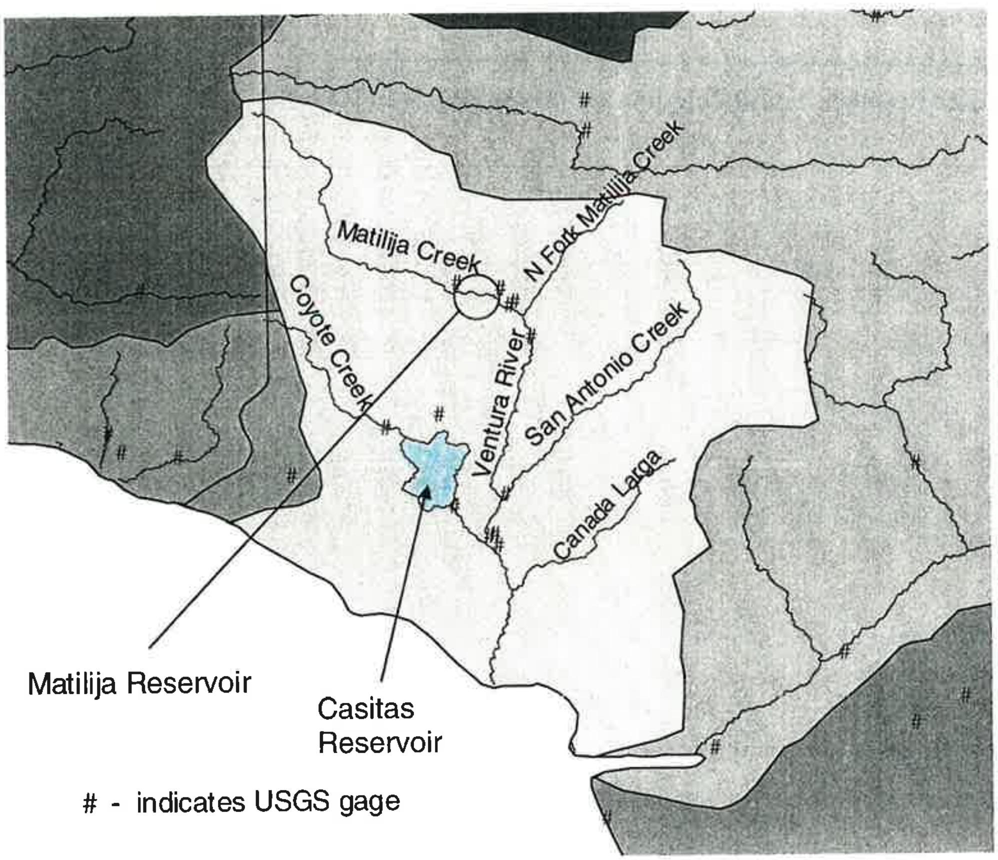


Figure 1. Location of sample area.

Table 1. Drainage Areas of Rivers in the Ventura River Basin.

River and Location	Drainage Area (mi^2)
North Fork Matilija Crk At Matilija Hot Sprs	15.6
Matilija Creek at confluence with N Fork	54.7
Coyote Creek Nr Ventura Ca	41.2
San Antonio Creek At Casitas Springs	51.2
Canada del Diablo at confluence with Ventura River	5
Canada Larga at confluence with Ventura River	19
Ventura River at Baldwin Rd	81
Ventura R below confluence with San Antonio Creek	143
Ventura R below confluence with Coyote Creek	184
Ventura R at mouth	226

Methods

A total of 18 bed material samples were collected in the Ventura River and Matilija Creek. They were spaced approximately every mile starting at the mouth and ending 1 mile upstream of Matilija Dam. Two additional samples of beach sand were collected along the shoreline near the mouth of the Ventura River.

The location of each sample was recorded in latitude and longitude coordinates with a portable Global Positioning Satellite (GPS) receiver and the locations are given in Appendix A Table A1 along with their approximate RM. The positions are also shown on a USGS map in Figures A1-A4 in the appendix. Two top view pictures of a representative area of the bed material were taken as well as pictures of the upstream and downstream reaches. The photographs are on file in the Sedimentation and River Hydraulics Group of Reclamation in Denver, CO.

Each bed material sample in the river consisted of a random pebble count of the sediment particles on the surface of the bed. Details on the sampling procedures can be found in Bunte and Abt (2001), but a short description follows. The random pebble count was performed by first delineating an area that was representative of the surface bed material of the river. The area chosen was usually a bar near the main channel of the river that was of similar elevation. The upper portion of the bar was chosen to provide consistency between samples and to be representative of the majority of the surface material in the river. In addition, the upper end of the point bar is where the largest particles entrained have been deposited and is of similar composition to the main channel. Once the area was chosen, two people randomly selected pebbles by averting the eyes from the bed, taking a step and reaching down with the forefinger. The intermediate axis of the pebble that was first touched was then measured with a metric ruler. No less than 100 pebbles were counted at each site. If the particle was less than 4 mm in diameter, it was noted. A bag sample of the material less than 4 mm in diameter was collected after the pebble count was completed. The bag samples were later dry sieved in the laboratory. The pebble counts and bag samples were combined by weighting each based on the surface area covered. At three of the sample sites, the three major axes of 25 pebbles were measured. Measuring all three axes gives an estimate of the asymmetry of the particles.

Results

The gradation results are given in Appendix B Table B1 in tabular form and also as graphs in Appendix B. Figure 3 contains the representative diameters of the bed material samples as a function of the river mile. Table 2 contains the approximate RM of various landmarks so that the sample site can be easily located. The representative diameters are defined as follows: d_{16} is the diameter that 16% of the particles are finer than, d_{50} is the diameter that 50% of the particles are finer than, etc…. The representative diameter can be used to characterize each sediment sample. The samples are numbered based on the time at which they were taken and not their location.

The bed is mostly dominated by cobbles, but there is a large range of sediment sizes. Throughout the entire reach there were sands interspersed between the larger rocks. In the upper reaches near the dam, particles larger than 3 m in diameter were recorded. A top view of typical bed material is shown in Figure 2. This photo is near sample site #8, at RM 2.5.

Figure 2. Typical surface bed material. Note large range of sizes.

The bed material generally becomes coarser with increasing RM. Near the ocean the d_{50} is approximately 70 – 80 mm, and near Matilija Dam it increases to over 300 mm. In the reach just downstream of the dam, the valley walls are steep and it is possible that some of the large material has its source from the hill slopes in the vicinity. Some of the bed material in this reach may not have been carried down by the stream but rather may have been sloughed from the valley walls. The bed material decreases in size upstream of the dam.

There are a few notable exceptions to the general trend of increasing particle size with RM. The exceptions are discussed below and can also be seen in Figure 3.

- Sample #3 (RM 0.6) had a significant amount of sands on the surface. Therefore, the d_{16} was much smaller than the other samples. The large amount of fine material could be due to the fact that it was nearer the ocean.
- Sample #7 (RM 5.1) is just downstream of the confluence with Coyote Creek and downstream of a more constricted part of the river. Bedrock outcrops control the bed elevation at this location (Figure 4 and Figure 5). There is only a thin covering of cobbles on top of the bedrock at this site.
- Sample #12 (RM14.4) is just upstream of Robles Diversion. The bed material is finer in this portion of the river because there is an observed decrease in the bed slope in this area (see Figure 6).
- Sample #15 is approximately 1.5 miles upstream of Matilija Dam (RM 17.9). The reservoir is approximately 2500 ft in length and the sample site was far enough upstream so that the dam did not affect the bed material size. Just downstream of the dam, the river enters a steep canyon and therefore the slope downstream of the dam is naturally steeper than upstream. Therefore, it is expected that the bed material just downstream of the dam is naturally coarser than upstream of the dam. However, because the dam has prevented gravel, cobbles and boulders from passing it, the dam has caused the bed material to be coarser than it would be without the dam. Removing the dam would increase the sediment supply to the reach and gradually add more fine particles to the bed material.

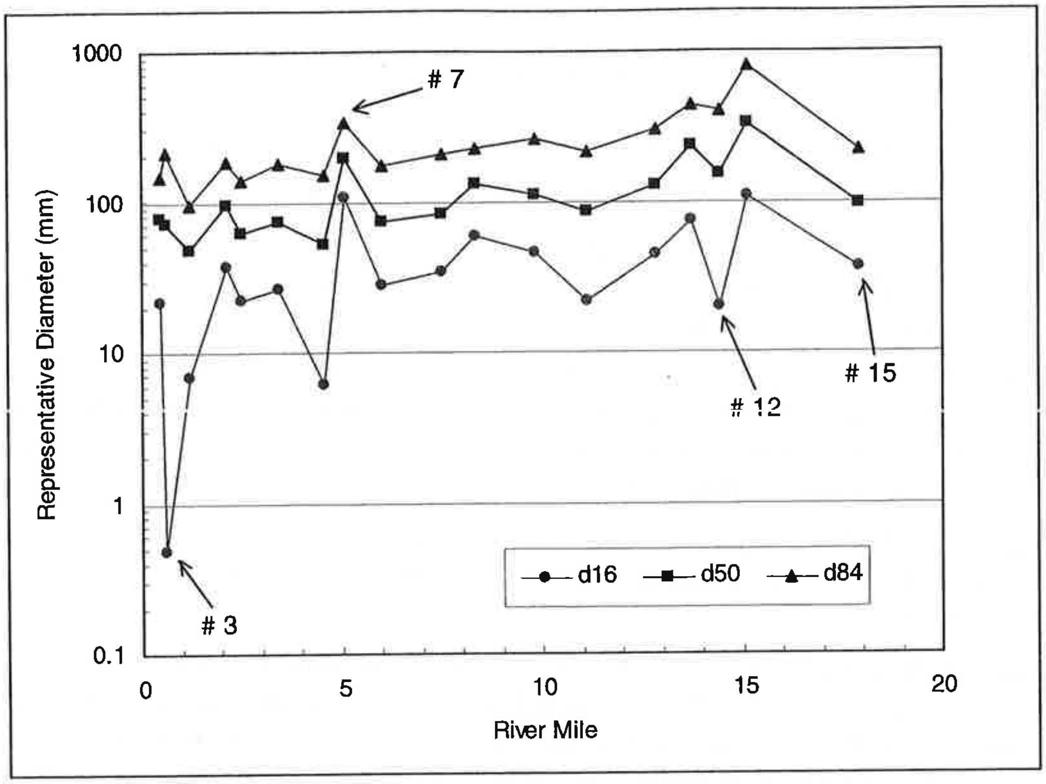


Figure 3. Measured representative diameters of surface bed material samples.

Table 2. Landmarks along river.

Landmark	River Mile (mi)	Elevation (ft)
Mouth	0.00	0
Southern Pacific Railroad	0.20	5
Ventura Freeway (Highway 101)	0.41	10
Main Street	0.55	15
Shell Road	3.10	80
Confluence of Ventura River and Canada Larga	4.54	120
Casitas Vistas Road (USGS stream gage)	5.86	150
Confluence of Ventura River and San Antonio Creek	7.83	250
Santa Ana Blvd	9.25	340
Baldwin Road	11.09	450
Los Robles Diversion	14.00	710
Matilija Creek confluence with N. Fork Matilija Creek	15.60	850
Matilija Dam	16.23	950

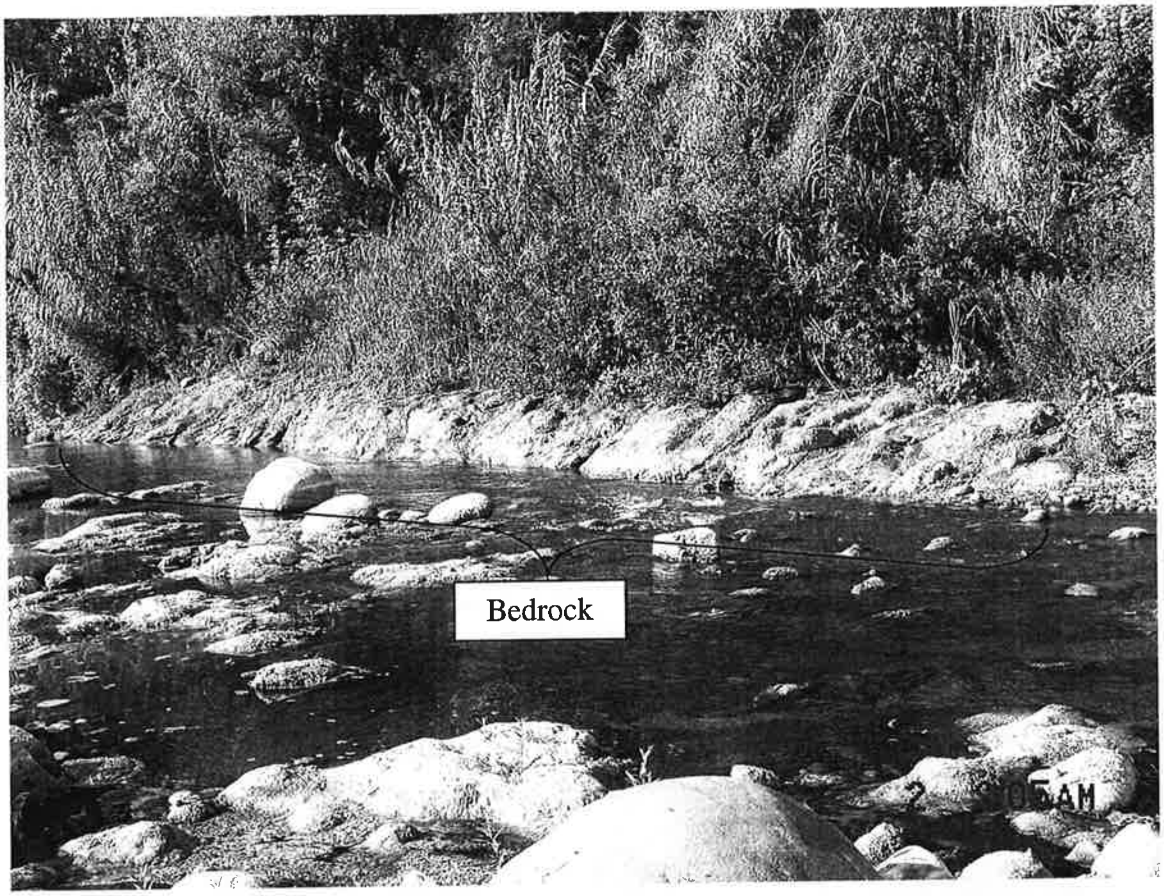


Figure 4. Bedrock outcrop at sample site #7.

Figure 5. Bedrock outcrop at sample site #7.

Downstream of Matilija dam, the average particle size is directly related to bed slope (Figure 6). The bed slopes were obtained using the 1997 Flood Insurance Study. As the bed slope increases in the upstream direction, so does the average particle size in the bed. The only major exceptions to this correlation between slope and particle size were stated previously.

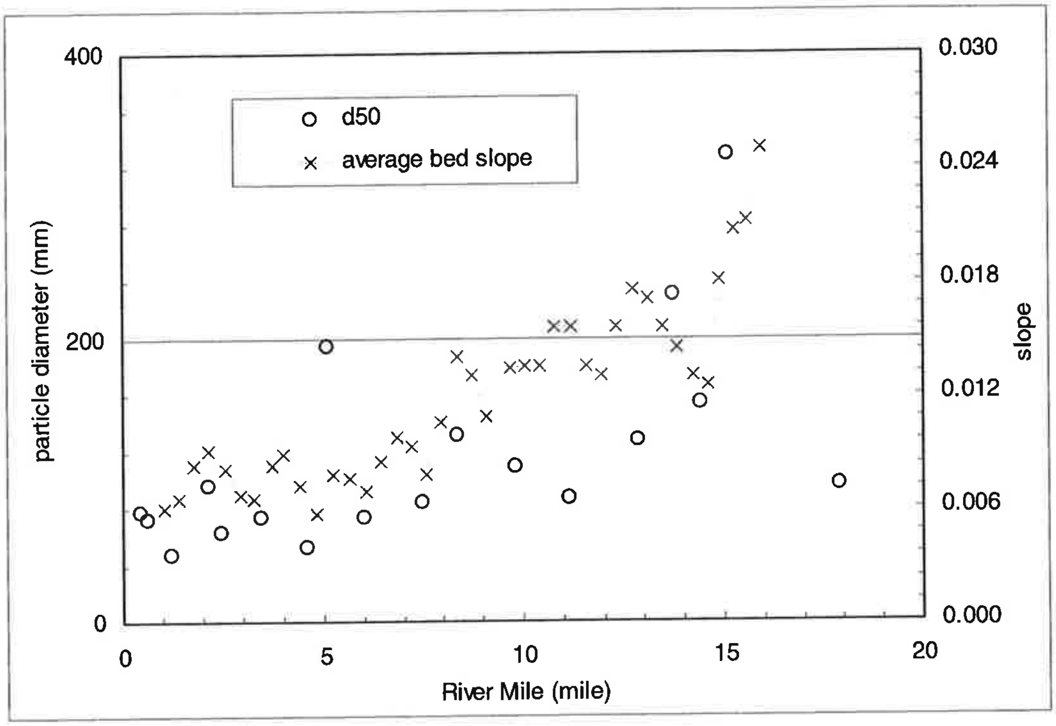


Figure 6. Average bed slope and d_{50} of bed material samples.

It is possible to compare the measured particle sizes against the predicted critical diameter. The critical diameter is the particle size that is just moved by a given flow. For an armored bed, it is assumed that the predicted critical diameter for large floods is similar to the dominant surface bed material size (an armored bed is one in which the surface layer is coarser than the subsurface layer). To test this assumption, the critical diameter was calculated for various floods using the Shield's criteria:

$$\theta_{cr} = \frac{\tau_b}{(\gamma_s - \gamma)d_{cr}}$$

where θ_{cr} is the non-dimensional critical shear stress, τ_b is the average bed shear stress, g is the acceleration of gravity, γ_s is the specific weight of sediment, γ is the specific weight of water and d_{cr} is the critical sediment diameter. For a given flowrate, particles larger than the critical diameter are not expected to move. It was assumed that $\theta_{cr} = 0.04$, which is a typical value assumed for gravel bed rivers (Buffington and Montgomery, 1997). To calculate the shear stress for various floods, the approximate river geometry was obtained from the 1997 Flood Insurance Study. Currently, new topography of the Ventura River is being developed, but the data will not be available until March 2002. The critical diameter was calculated for a flood with a recurrence interval of 2.33 years (also called the average annual flood), a flood with a recurrence interval of

5 years and a flood with a recurrence interval of 100 years. The results of the critical diameter calculation are shown in Figure 7.

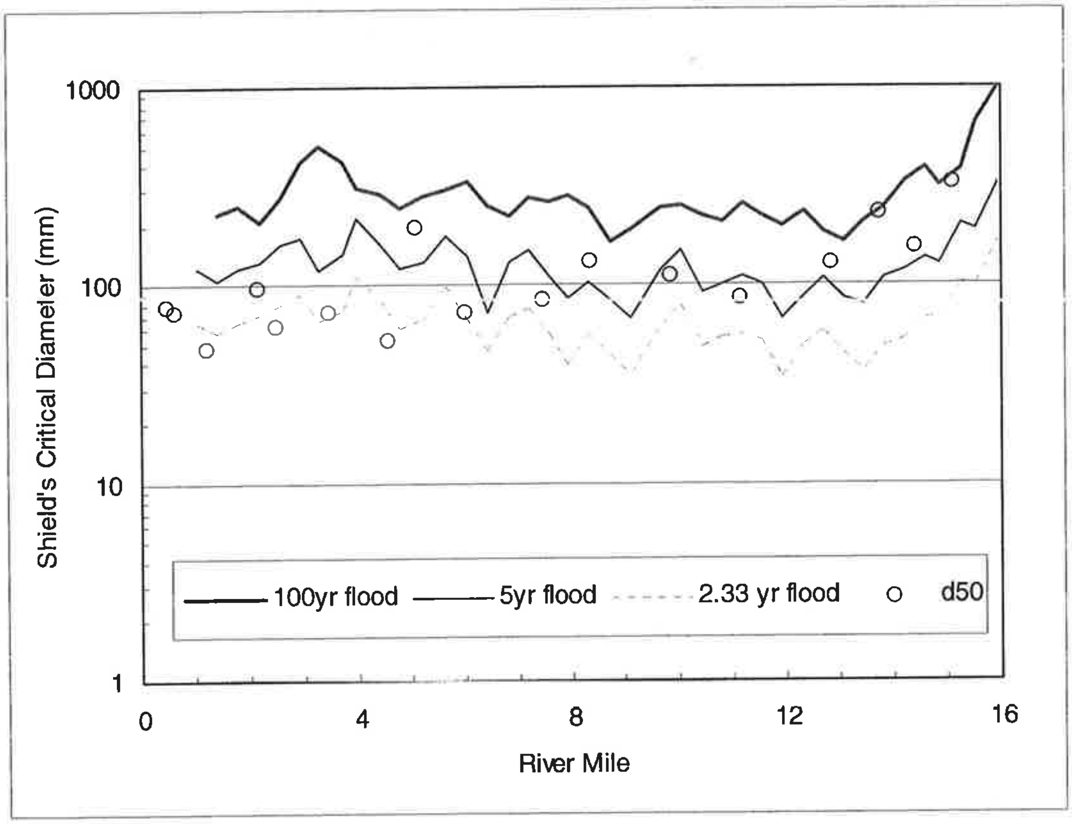


Figure 7. Critical diameter of various floods using Shields criteria. Particles larger than the critical diameter are not mobilized for the given flood. The measured d_{50} are shown as a circle.

The calculated critical diameter for the 2.33-year flood is a reasonably accurate predictor of the d_{50} of the surface bed material in the lower part of the river (RM 0 - 7). Further upstream, at RM 7- 12 the critical diameter for the 5-yr flood is a better predictor of the d_{50}. For RM 12-16, the critical diameter of a flood somewhere between a 5-yr and 100-yr return period is the best predictor. This indicates that the material in the lower part of the river is probably moved more frequently than the material in the upper portion of the river near the dam. There is, however, some uncertainty in the calculations of the critical diameter. For example, the assumed non-dimensional critical shear stress may not be a constant value for the entire river. For particles protruding into the flow, such as the large particles in the upper reaches, the non-dimensional critical shear stress may be lower than 0.04 because of the form drag of the protruding particles.

Summary

Surface bed material samples were taken throughout the Ventura River and Matilija Creek. The samples largely consisted of surface pebble counts and bag samples of the fine material. The particle size generally increased with RM. Initial calculations of critical diameter indicate that the average annual flood mobilizes the d_{50} in the lower portion of the river (RM 0 to 7). Upstream, the bed is mobilized less frequently. From RM 7 to 12 a 5-yr flood mobilizes the d_{50}

and from RM 12 to the dam, it takes a flood with a recurrence interval between 5-yr and 100-yr to mobilize the d_{50}.

The data obtained from this study will be used for sediment transport calculations and monitoring of changes in the river during the implementation of the chosen alternative.

References

Buffington, J.M, and Montgomery, D.R. “A systematic Analysis of Eight Decades of Incipient Motion Studies, with special Reference to Gravel-Bedded Rivers,” Water Resources Research, Vol. 33, No. 8, pp. 1993-2029, 1997.

Bunte, K., Abt, S.R., “Sampling Surface and Subsurface Particle-Size Distributions in Wadable Gravel and Cobble-Bed Streams for Analyses in sediment Transport, Hydraulics and Streambed Monitoring.” US Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-74, 2001.

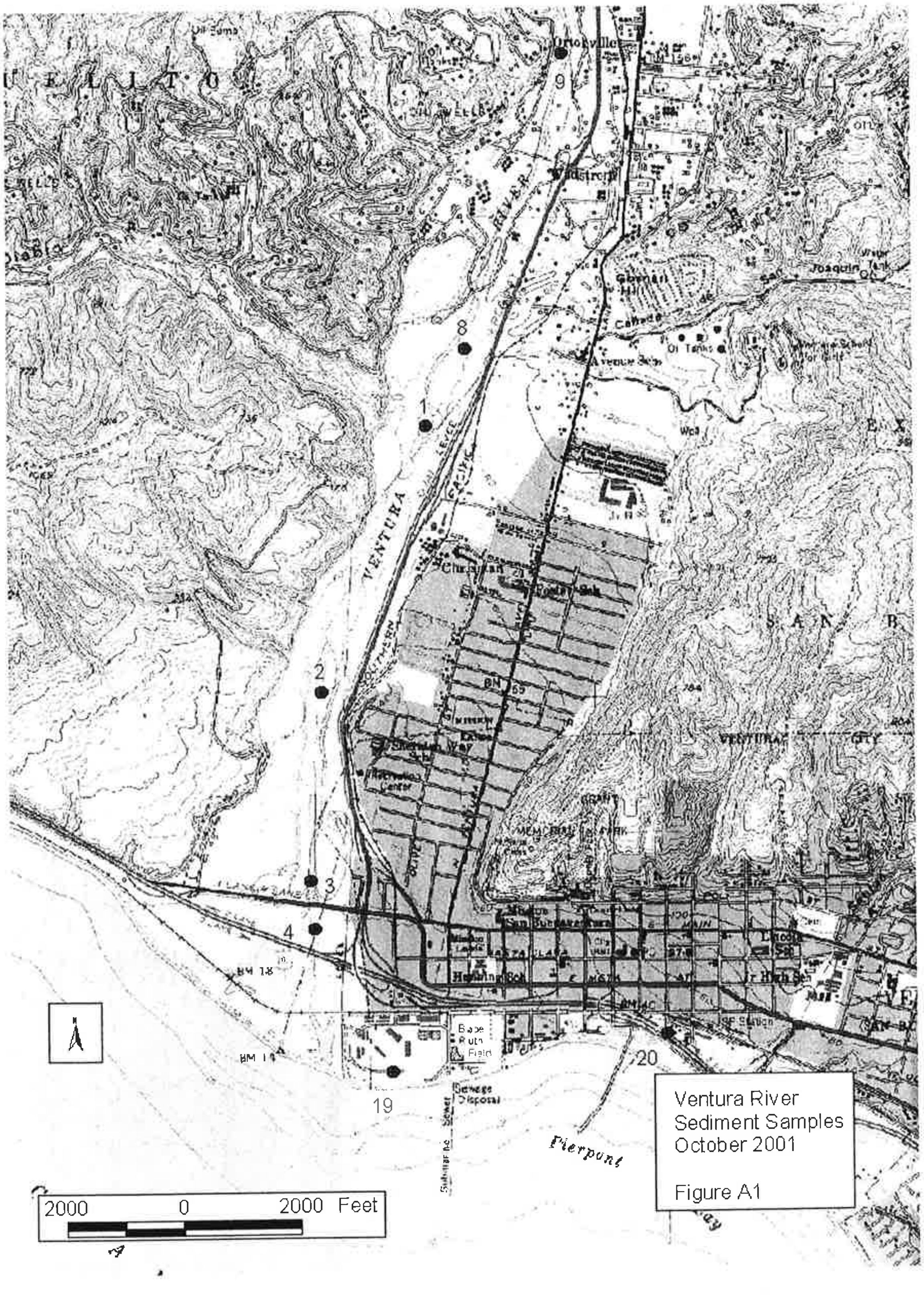
Flood Insurance Study, Ventura County, California, Federal Emergency Management Agency, Revised September 3 1997.

Flood Plain Information, Ventura River (Including Coyote Creek), Prepared for Ventura County California by Corps of Engineers, Los Angeles District, California, 1971.

Appendix A. Sample Locations

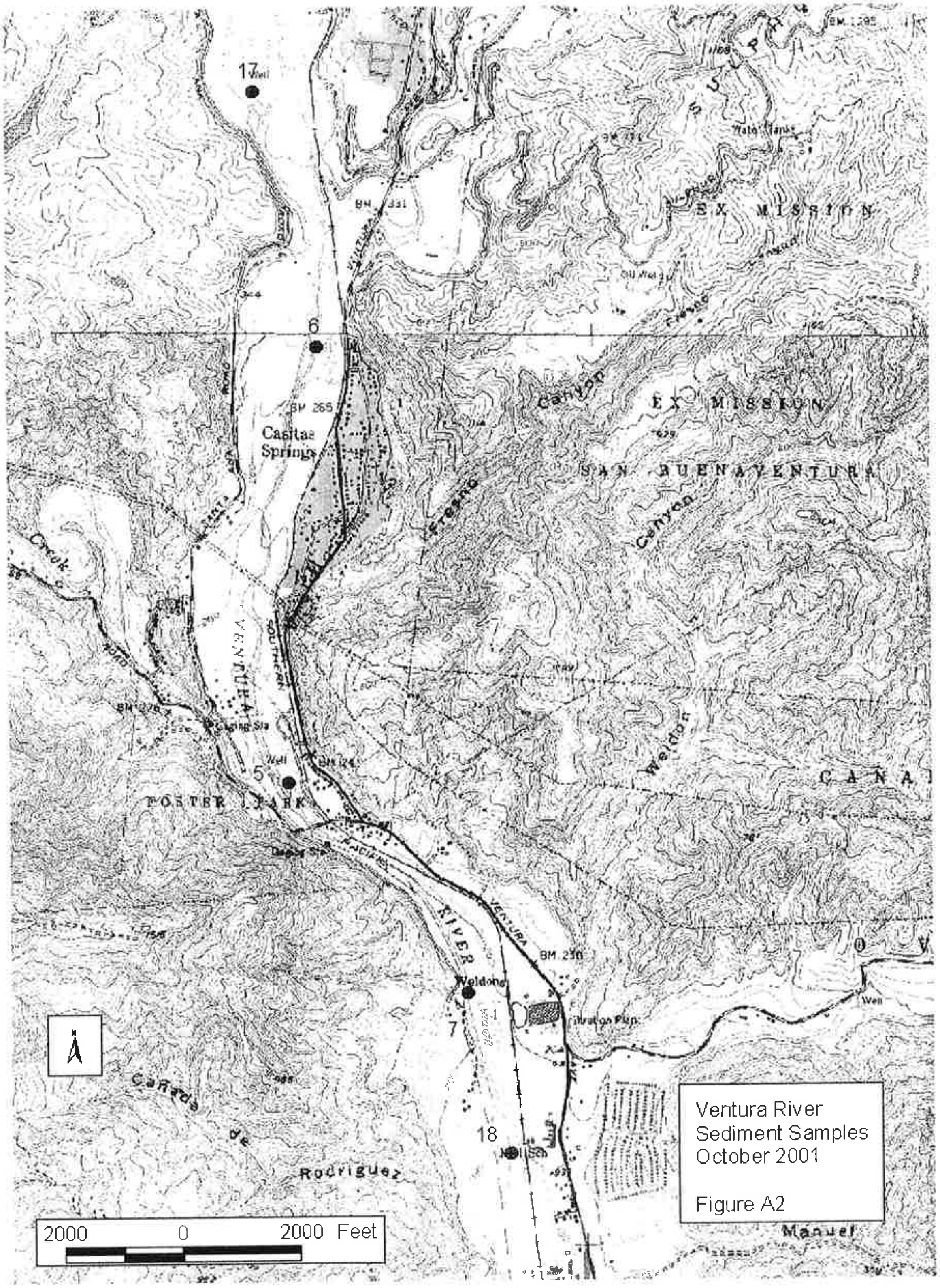
Table A1. Ventura River bed-material sample locations.

Sample #	River Mile	Latitude degrees	Latitude minutes	Latitude seconds	Longitude degrees	Longitude minutes	Longitude seconds
19	beach	34	16	26.73	119	18	14.05
20	beach	34	16	33.37	119	17	18.06
4	0.5	34	16	50.60	119	18	29.90
3	0.6	34	16	58.60	119	18	30.80
2	1.2	34	17	30.18	119	18	28.63
1	2.2	34	18	14.53	119	18	7.80
8	2.5	34	18	27.22	119	17	59.97
9	3.4	34	19	16.50	119	17	40.70
18	4.6	34	20	14.60	119	17	48.40
7	5.1	34	20	40.93	119	17	57.31
5	6.0	34	21	15.44	119	18	33.93
6	7.5	34	22	27.64	119	18	28.88
17	8.3	34	23	9.50	119	18	42.20
16	9.8	34	24	20.30	119	18	10.92
10	11.1	34	25	26.05	119	18	8.68
13	12.8	34	26	49.00	119	17	43.77
11	13.7	34	27	32.40	119	17	29.60
12	14.4	34	28	7.38	119	17	24.61
14	15.1	34	28	43.17	119	17	32.66
15	17.9	34	29	38.44	119	19	45.95



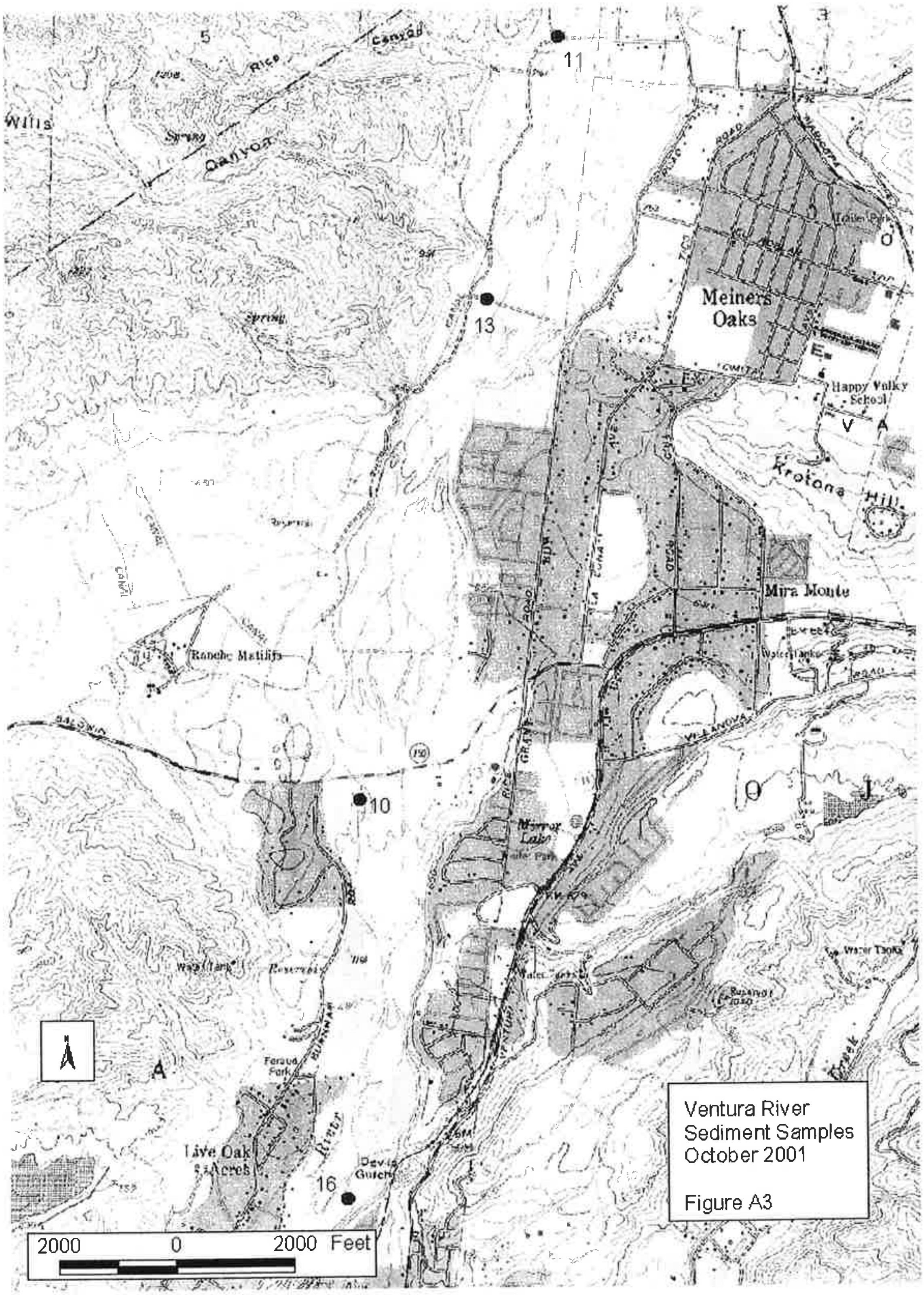
Ventura River
Sediment Samples
October 2001

Figure A1
2000 0 2000 Feet
1
2
3
4
8
9
19
20
VENTURA
Pierpont
Babe
Ruth
Field
Sewage
Disposal

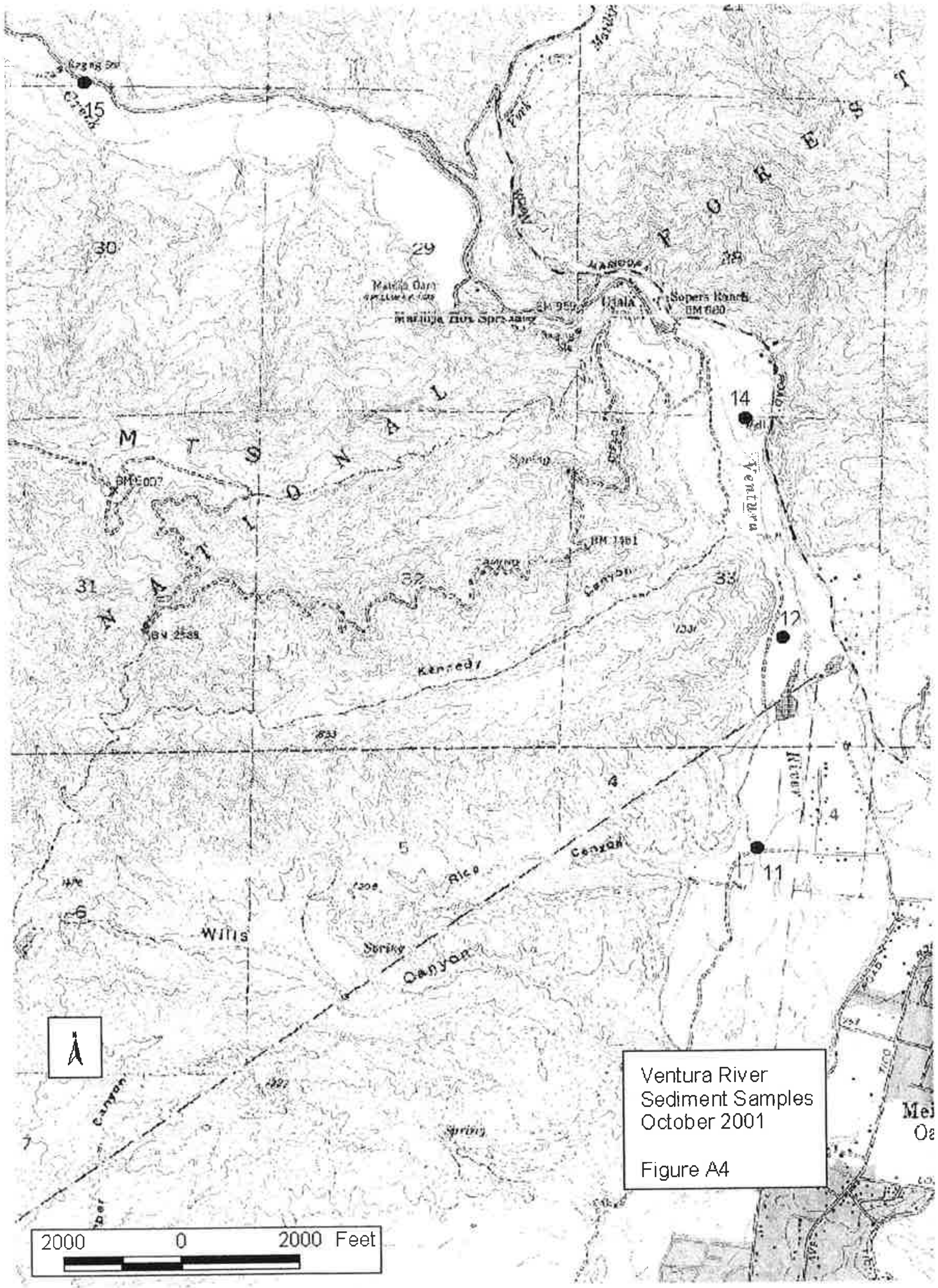


17
6
5
7
18
Casitas Springs
FOSTER PARK
VENTURA RIVER
Ventura River
Sediment Samples
October 2001

Figure A2
2000 0 2000 Feet



Ventura River
Sediment Samples
October 2001
Figure A3
2000
0
2000 Feet
11
13
10
16
Meiners Oaks
Happy Valley School
Krotona Hill
Mira Monte
Rancho Matilija
Mirror Lake
Live Oak Acres
Devils Gulch
River
Canyon
Rice
Wills
Water Tank
Reservoir
Spring
Villanova



Ventura River
Sediment Samples
October 2001

Figure A4

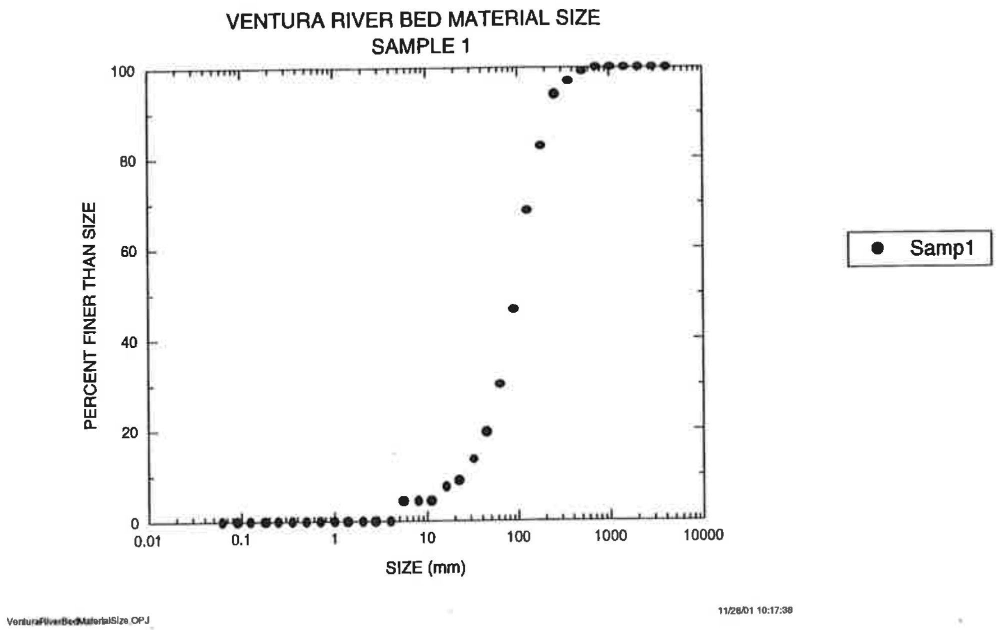
Appendix B. Gradation Results

Table B1. Sediment gradation results. (d_{16}, d_{50}, d_{84} = diameter which 16%, 50% and 84% of the material is finer than, respectively; $d_g = \sqrt{d_{84}/d_{16}}$).

Size	Samp1	Samp2	Samp3	Samp4	Samp5	Samp6	Samp7	Samp8	Samp9	Samp10
0.0625	0	0.23	0.3	0.9	0.1	0	0	0.6	0.0	0.03
0.09	0	0.5	0.9	1.6	0.1	0	0	1.2	0.2	0.04
0.125	0	1	1.3	2.3	0.1	0	0	2.2	0.3	0.06
0.18	0	2.2	3	3.5	0.2	0	0	3.7	0.6	0.1
0.25	0	4.3	6	4.9	0.4	0	0	4.9	1.3	0.2
0.35	0	8.5	11.4	7.2	0.8	0	0	5.8	2.3	0.3
0.5	0	12.7	16.5	9.2	1.7	0	0	6.4	3.7	0.7
0.7	0	14.5	18.3	9.9	2.4	0	0	6.8	5.2	1.4
1	0	15.2	18.8	10.2	3.7	0	0	7.2	5.3	2.5
1.4	0	15.3	18.9	10.3	4.4	0	0	7.4	5.3	4
2	0	15.4	19	10.3	4.8	0	0	7.6	5.3	5.4
2.8	0	15.5	19	10.4	5.0	0	0	7.8	5.3	6.2
4	0	15.5	19	10.4	5.1	0	0	7.9	5.3	6.7
5.6	4.5	15.6	19	10.4	5.2	1.6	0	8	5.3	7
8	4.5	16.3	19	11.1	5.2	1.6	0	8.8	6	7
11	4.5	19.3	20.4	11.9	5.2	1.6	0	10.4	6	8.6
16	7.5	23	21.8	12.6	7.1	3.1	0	12	6.7	11.7
22	9	27.4	23.2	16.3	11.7	8.6	0	16	12	16.4
32	13.5	36.3	27.5	19.3	18.2	14.8	0	24.8	20	21.1
45	19.5	46.7	35.9	26.7	29.9	20.3	2.7	35.2	33.3	28.1
64	30.1	65.9	44.4	41.5	42.9	35.2	5.4	51.2	44	39.8
90	46.6	82.2	59.9	56.3	61	53.9	9.8	65.6	59.3	51.6
128	68.4	93.3	67.6	78.5	74.7	70	22.3	81.6	75.3	67.2
180	82.7	97	78.9	91.9	85	80.5	44.6	91.2	84	78.1
256	94	98.5	88.7	96.3	97.4	89.8	70.5	97.6	97.3	91.4
360	97	99.3	96.5	100	100	98.4	86.6	100	100	97.7
512	99.2	100	99.3	100	100	100	92	100	100	99.2
720	100	100	99.3	100	100	100	99.1	100	100	99.2
1024	100	100	100	100	100	100	100	100	100	100
1440	100	100	100	100	100	100	100	100	100	100
2048	100	100	100	100	100	100	100	100	100	100
2880	100	100	100	100	100	100	100	100	100	100
4096	100	100	100	100	100	100	100	100	100	100
d_{16}	39.0	6.5	0.4	16.4	25.0	41.8	107.5	16.0	26.5	16.4
d_{50}	121.2	60.2	79.6	74.0	78.7	68.7	237.9	46.2	78.7	67.0
d_{84}	245.8	120.9	213.1	156.5	132.3	224.2	270.5	165.3	128.0	219.0
d_g	2.5	4.3	24.2	3.1	2.3	2.3	1.6	3.2	2.2	3.6

Table B1 (continued).

Size	Samp11	Samp12	Samp13	Samp14	Samp15	Samp16	Samp17	Samp18	Samp19	Samp20
0.0625	0	0.04	0	0	0	0	0	0.7	0	0
0.09	0	0.05	0	0	0	0	0	1.4	0.1	0.05
0.125	0	0.06	0	0	0	0	0	5.3	1.6	0.3
0.18	0	0.08	0	0	0	0	0	5.6	31.5	2.2
0.25	0	0.11	0	0	0	0	0	9.0	77	13.7
0.35	0	0.15	0	0	0	0	0	12.5	88.3	51.2
0.5	0	0.2	0	0	0	0	0	13.6	89.4	89.8
0.7	0	0.3	0	0	0	0	0	13.8	98.2	98.3
1	0	0.5	0	0	0	0	0	13.8	99.5	99.6
1.4	0	0.9	0	0	0	0	0	13.9	99.8	99.8
2	0	1.8	0	0	0	0	0	13.9	99.9	100
2.8	0	2.9	0	0	0	0	0	13.9	99.9	100
4	0	4.1	0	0	0	0	0	14.0	100	100
5.6	0	5.3	0	1.7	1.8	0	0	14.4	100	100
8	0	7.6	1.7	1.7	1.8	0	0	20.5	100	100
11	0.8	9.2	2.5	1.7	1.8	0	0	22	100	100
16	1.7	10.7	5	1.7	2.7	0	0.9	24.2	100	100
22	3.4	18.3	6.6	1.7	7.1	0.8	2.7	31	100	100
32	6.8	22.1	9.1	2.5	12.5	9.1	4.4	37.9	100	100
45	10.2	26.7	16.5	5	23.2	15.7	8	45.5	100	100
64	13.6	29	25.6	6.7	35.7	28.1	18.6	55.3	100	100
90	19.5	34.4	35.5	12.6	46.4	41.3	31	65.9	100	100
128	28.8	44.3	50.4	19.3	67.9	57	47.8	78.8	100	100
180	40.7	55	69.4	26.1	75.9	71.1	76.1	88.6	100	100
256	54.2	68.7	78.5	37.8	90.2	83.5	88.5	97	100	100
360	78.8	80.2	90	54.6	95.5	91.7	95.6	100	100	100
512	88.1	94.7	99.2	71.4	99.1	99.2	100	100	100	100
720	95.8	98.5	100	81.5	100	99.2	100	100	100	100
1024	98.3	100	100	90.8	100	100	100	100	100	100
1440	99.2	100	100	95	100	100	100	100	100	100
2048	99.2	100	100	98.3	100	100	100	100	100	100
2880	99.2	100	100	99.2	100	100	100	100	100	100
4096	100	100	100	100	100	100	100	100	100	100
d_{16}	78.3	17.6	32.7	107.0	40.3	63.5	49.1	7.3	0.15	0.34
d_{50}	200.8	150.1	90.9	281.0	120.7	105.3	175.3	54.4	0.22	0.25
d_{84}	420.5	466.9	305.8	931.5	209.7	352.6	204.5	150.2	0.28	0.37
d_g	2.3	5.1	3.1	2.9	2.3	2.4	2.0	4.5	1.4	1.0


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 1
PERCENT FINER THAN SIZE
SIZE (mm)
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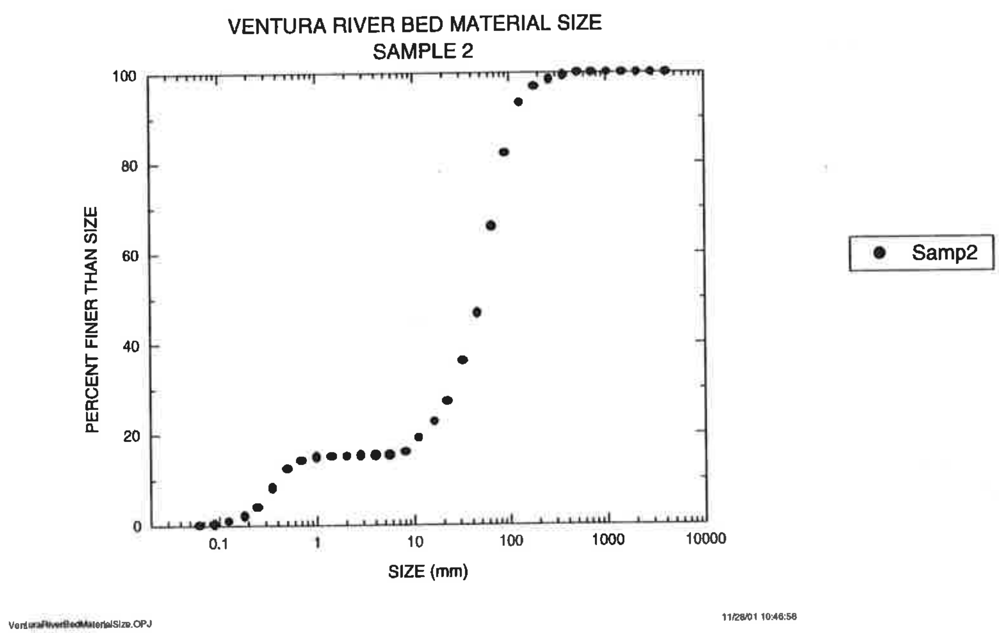
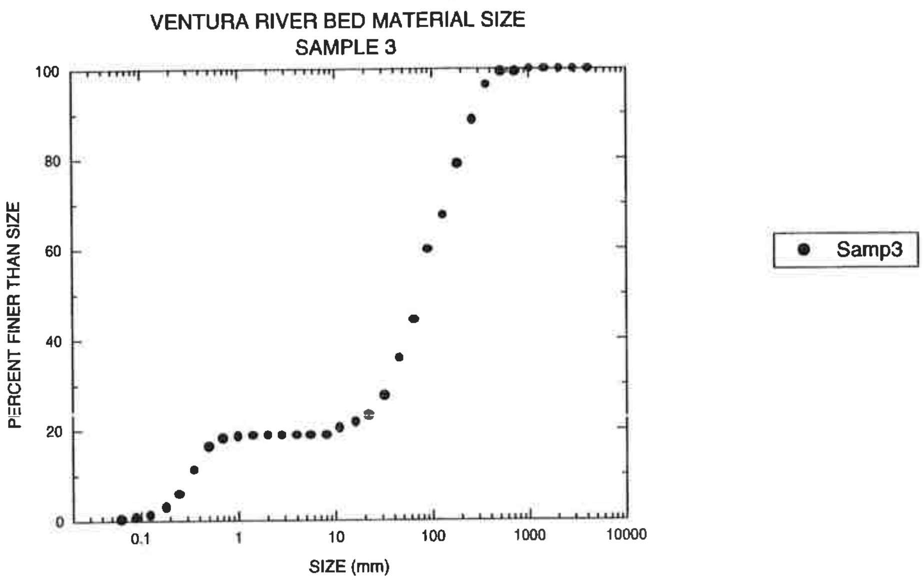
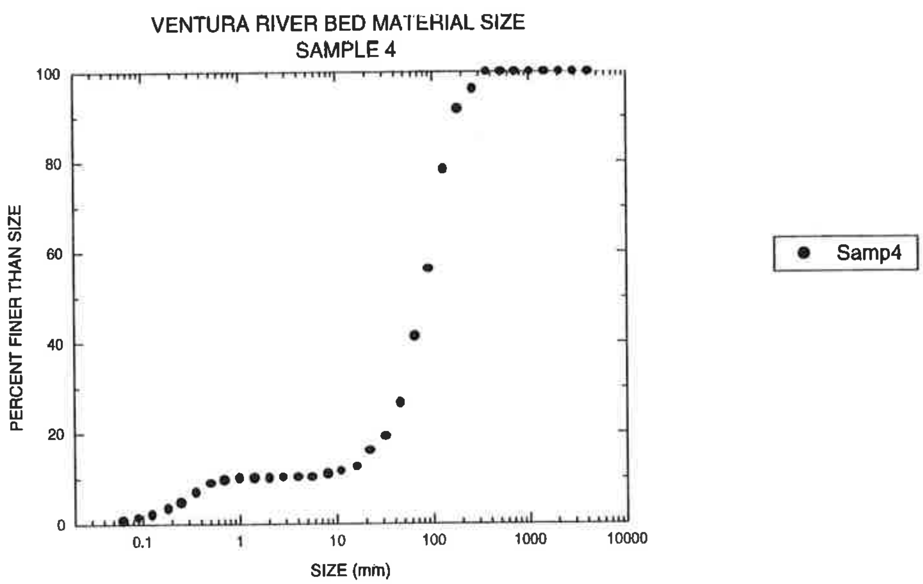
VenturaRiverBedMaterialSize.OPJ
11/28/01 10:17:38

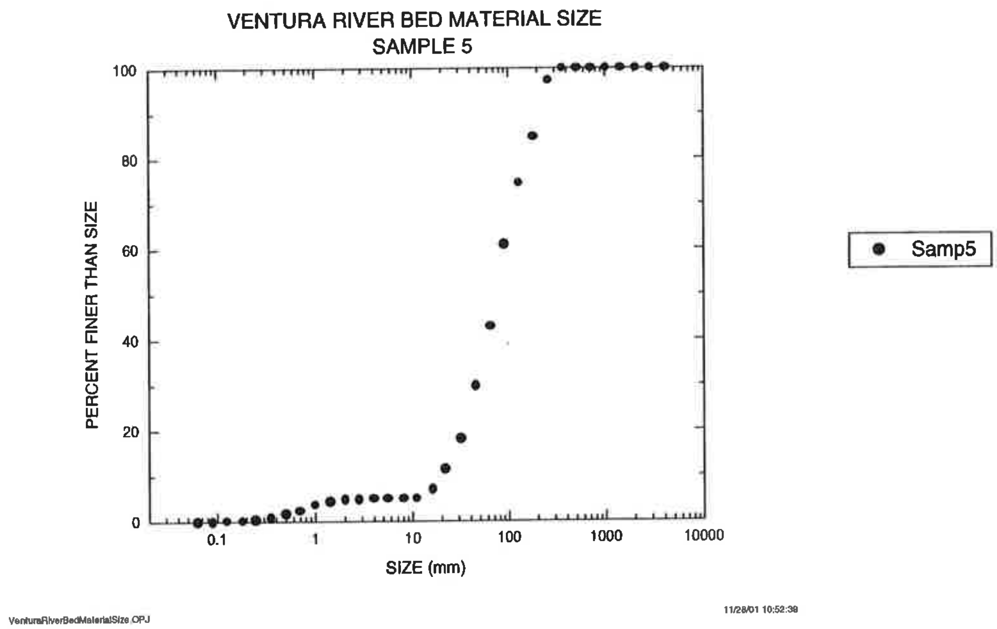

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 2
PERCENT FINER THAN SIZE
SIZE (mm)
Samp2
VenturaRiverBedMaterialSize.OPJ
11/28/01 10:46:58



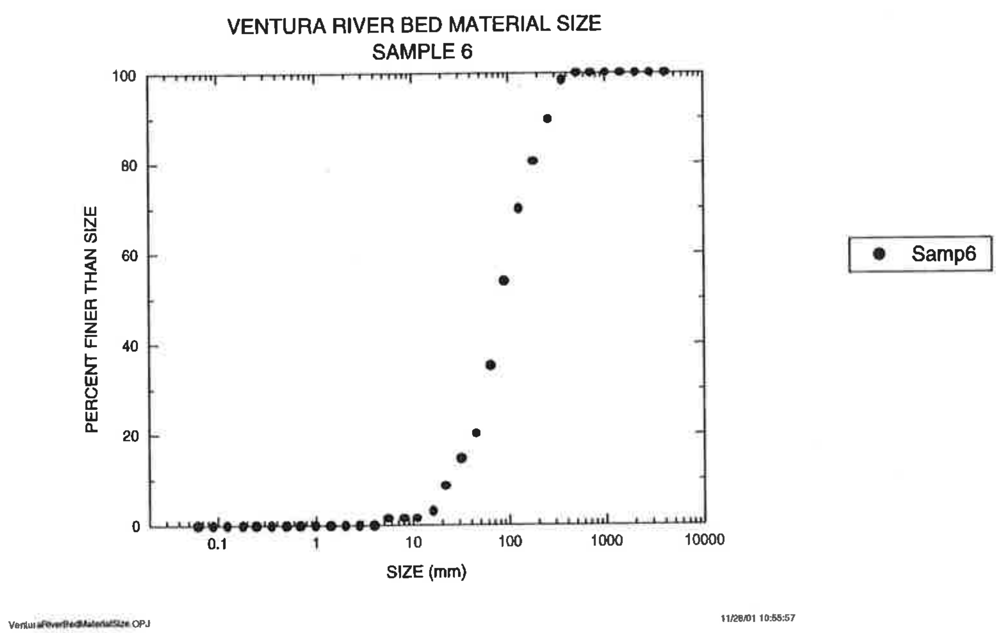
VenturaRiverBedMaterialSize.OPJ 11/28/01 10:49:19



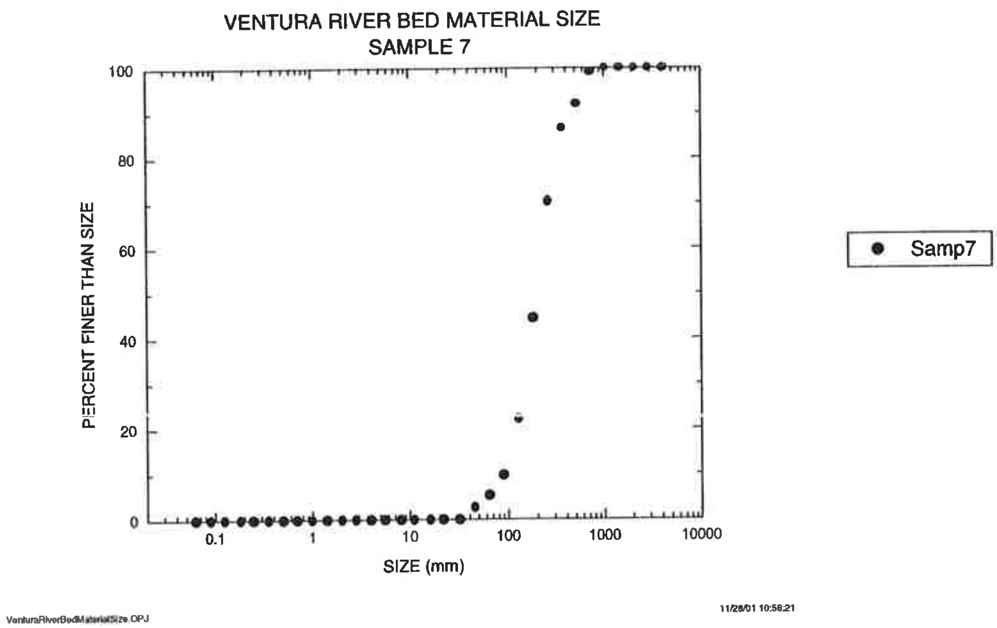
VenturaRiverBedMaterialSize.OPJ 11/28/01 10:51:24

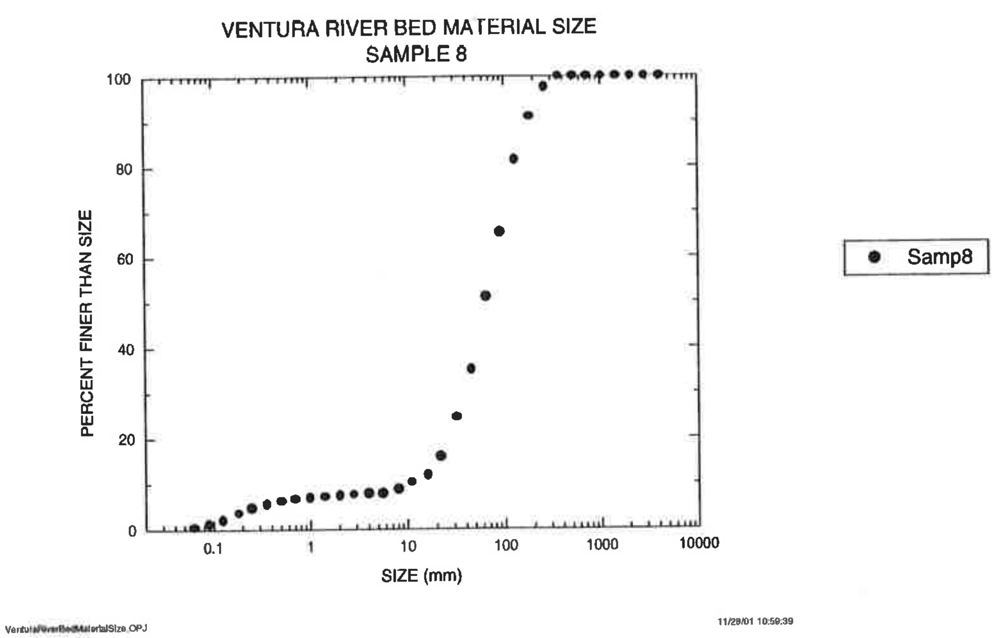


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 5
100
80
60
40
20
0
PERCENT FINER THAN SIZE
0.1
1
10
100
1000
10000
SIZE (mm)
Samp5
VenturaRiverBedMaterialSize.OPJ
11/28/01 10:52:39

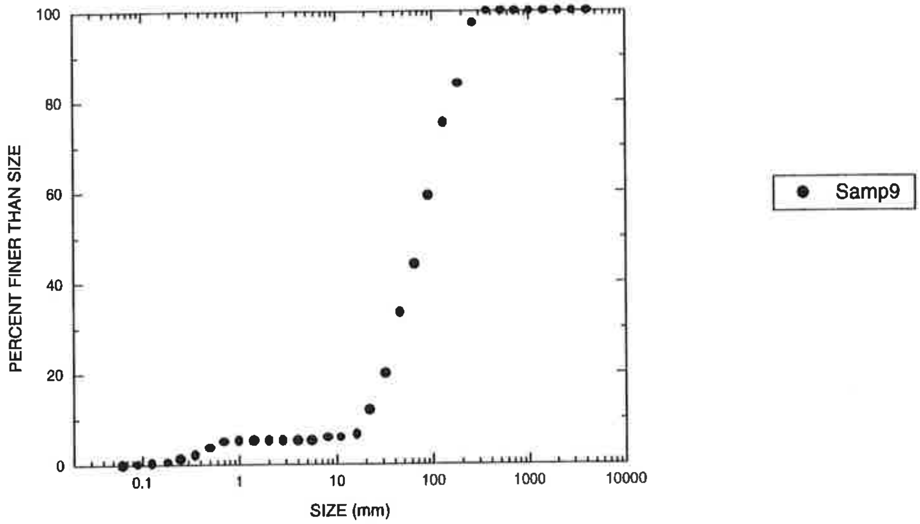


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 6
100
80
60
40
20
0
PERCENT FINER THAN SIZE
0.1
1
10
100
1000
10000
SIZE (mm)
Samp6
VenturaRiverBedMaterialSize.OPJ
11/28/01 10:55:57


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 7
PERCENT FINER THAN SIZE
0
20
40
60
80
100
0.1
1
10
100
1000
10000
SIZE (mm)
Samp7
VenturaRiverBedMaterialSize.OPJ
11/28/01 10:58:21

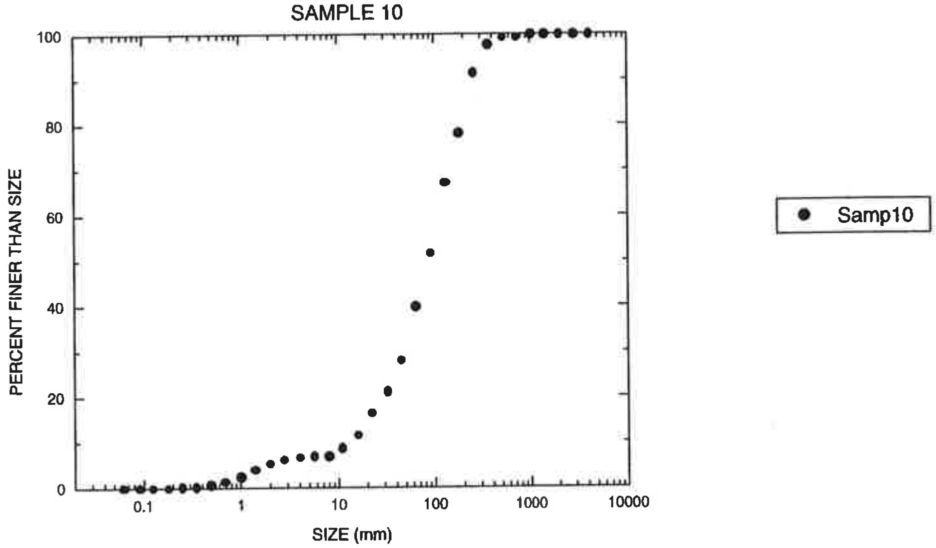

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 8
PERCENT FINER THAN SIZE
0
20
40
60
80
100
0.1
1
10
100
1000
10000
SIZE (mm)
Samp8
VenturaRiverBedMaterialSize.OPJ
11/28/01 10:59:39

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 9

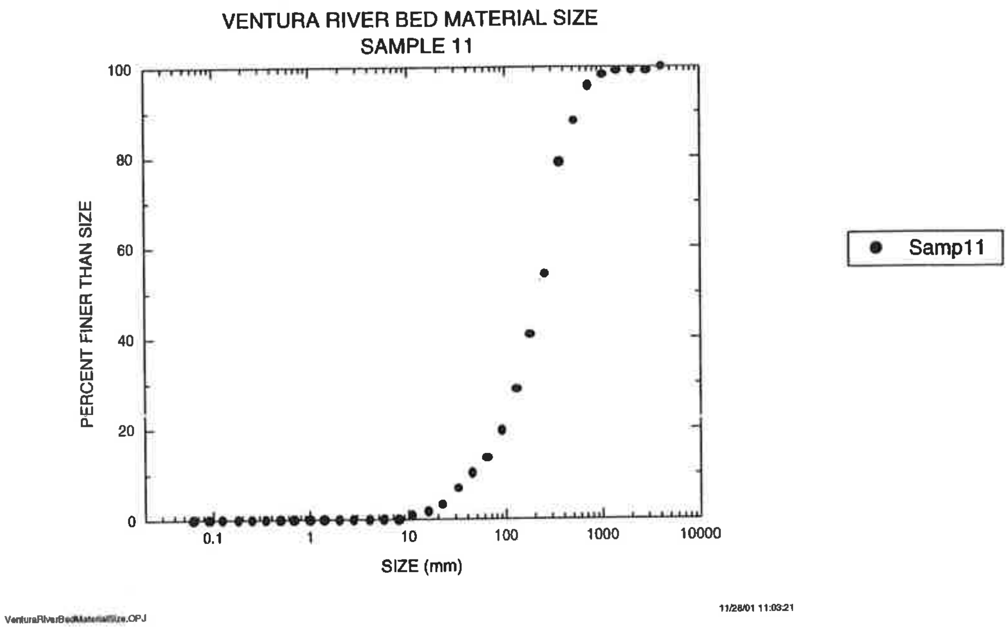


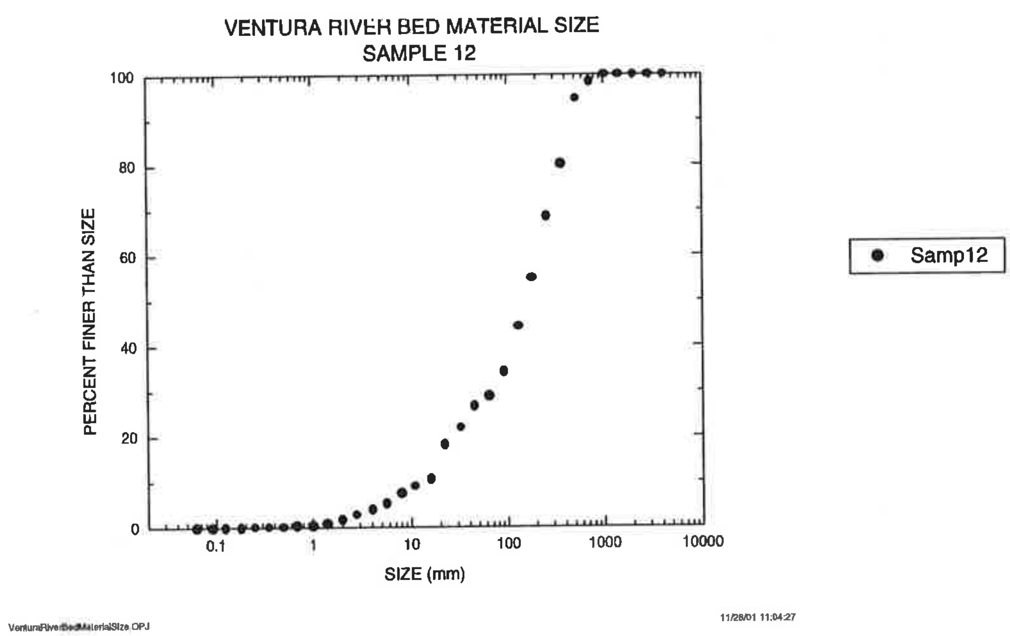
VenturaRiverBedMaterialSize.OPJ 11/28/01 11:00:41

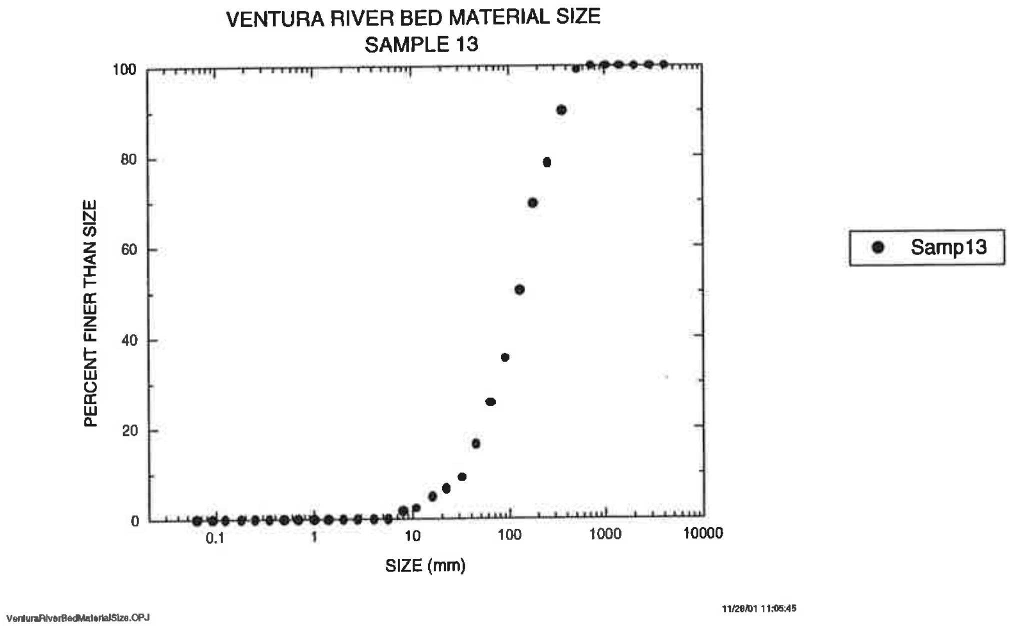
VENTURA RIVER BED MATERIAL SIZE
SAMPLE 10

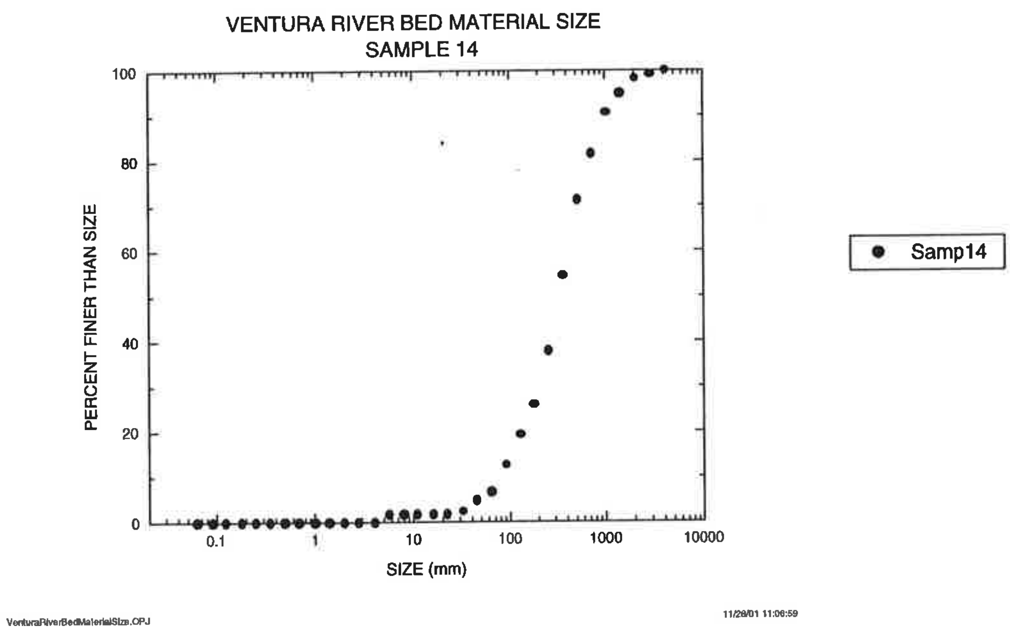


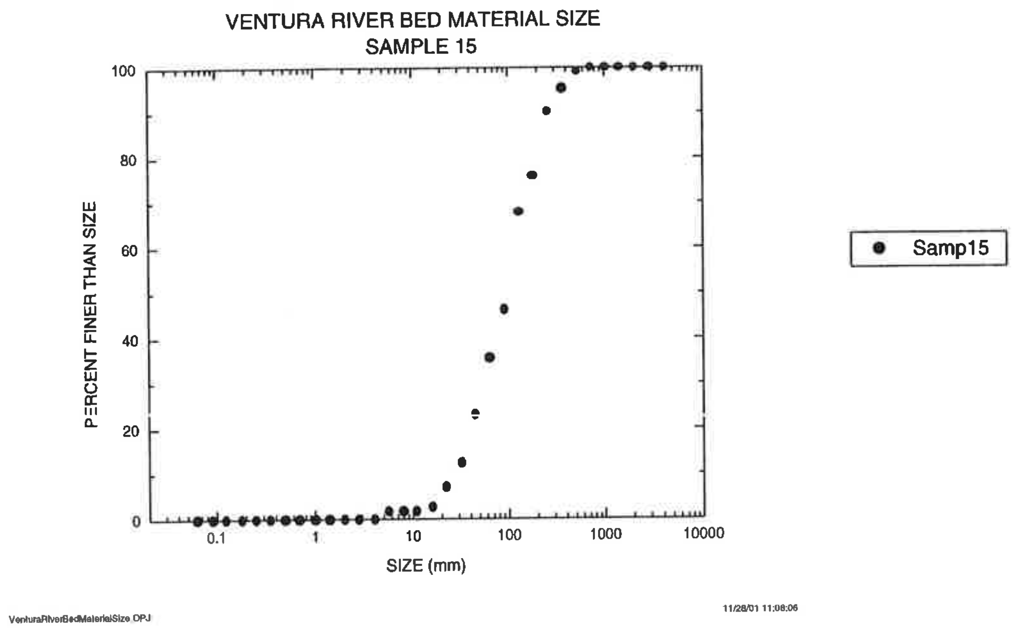
VenturaRiverBedMaterialSize.OPJ 11/28/01 11:02:18

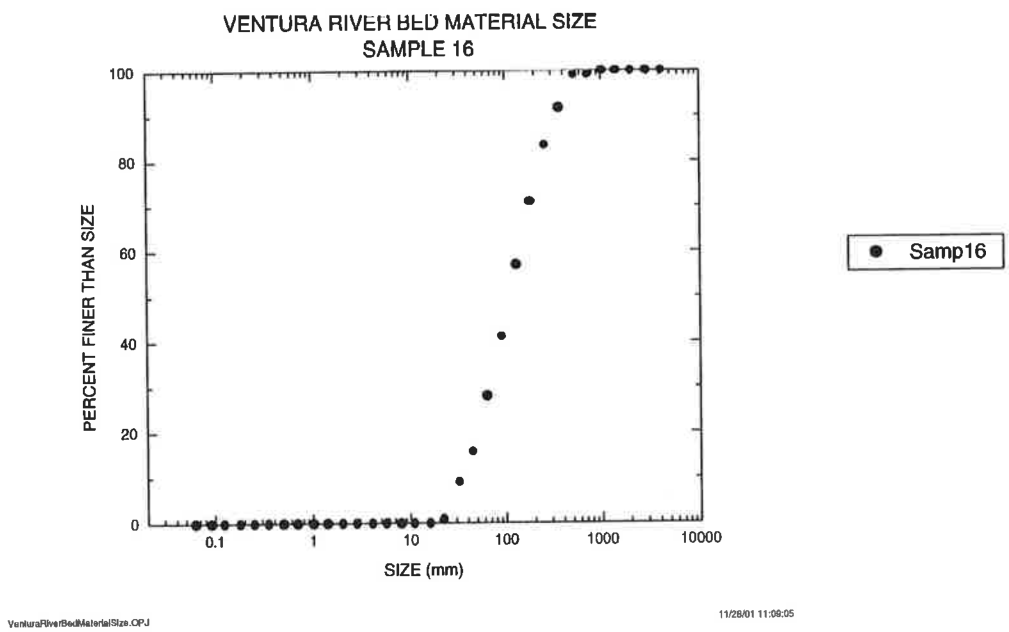

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 11
PERCENT FINER THAN SIZE
SIZE (mm)
Samp11
11/28/01 11:03:21

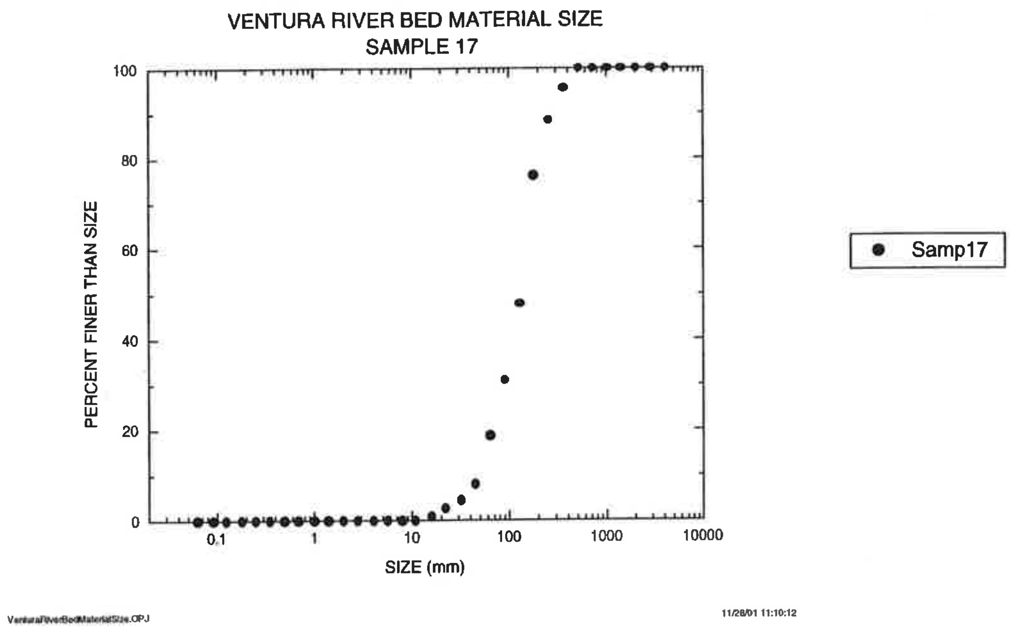

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 12
PERCENT FINER THAN SIZE
SIZE (mm)
Samp12
VenturaRiverBedMaterialSize.OPJ
11/28/01 11:04:27

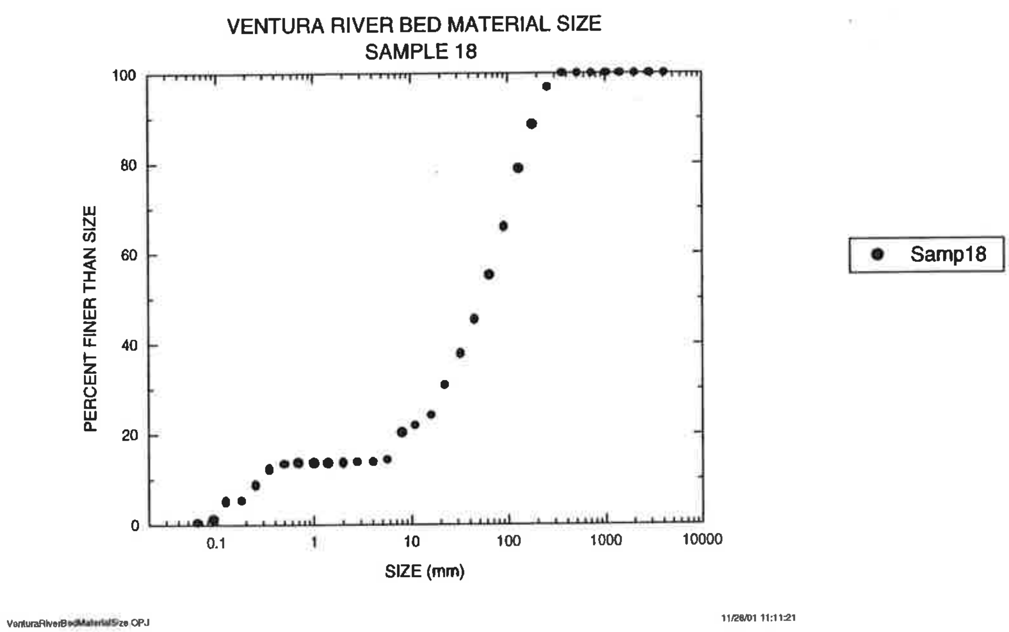

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 13
PERCENT FINER THAN SIZE
SIZE (mm)
Samp13
VenturaRiverBedMaterialSize.OPJ
11/28/01 11:05:45

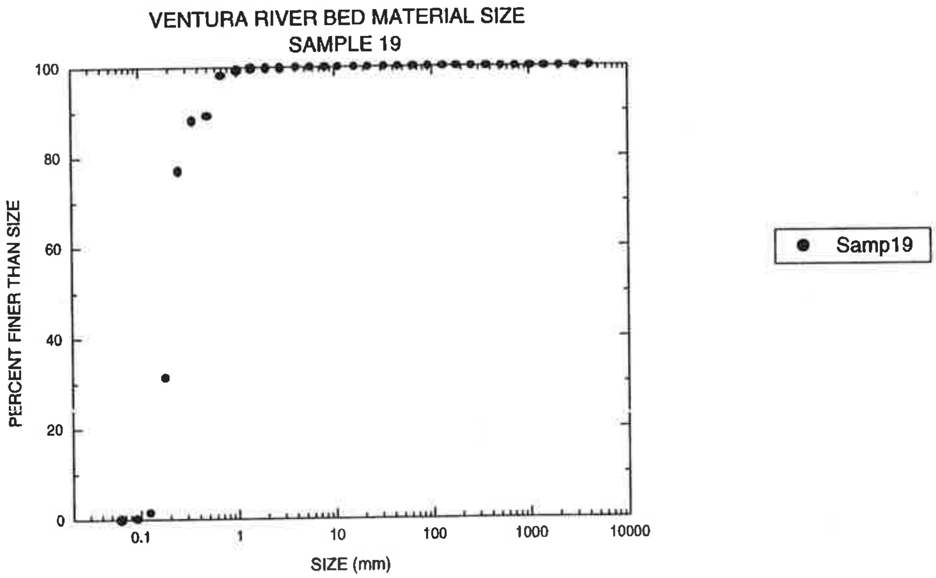

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 14
PERCENT FINER THAN SIZE
SIZE (mm)
Samp14
VenturaRiverBedMaterialSize.OPJ
11/28/01 11:06:59


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 15
PERCENT FINER THAN SIZE
100
80
60
40
20
0
0.1
1
10
100
1000
10000
SIZE (mm)
Samp15
VenturaRiverBedMaterialSize.OPJ
11/28/01 11:08:06

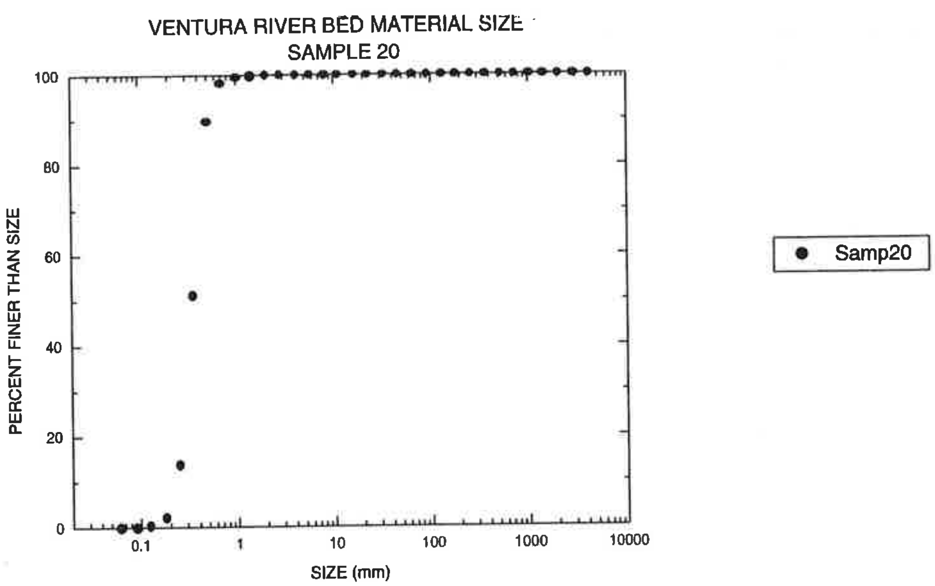

VENTURA RIVER BED MATERIAL SIZE
SAMPLE 16
PERCENT FINER THAN SIZE
100
80
60
40
20
0
0.1
1
10
100
1000
10000
SIZE (mm)
Samp16
VenturaRiverBedMaterialSize.OPJ
11/28/01 11:09:05


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 17
PERCENT FINER THAN SIZE
0
20
40
60
80
100
0.1
1
10
100
1000
10000
SIZE (mm)
Samp17
11/28/01 11:10:12


VENTURA RIVER BED MATERIAL SIZE
SAMPLE 18
PERCENT FINER THAN SIZE
0
20
40
60
80
100
0.1
1
10
100
1000
10000
SIZE (mm)
Samp18
11/28/01 11:11:21



VenturaRiverBedMaterialSize.OPJ 11/28/01 11:12:47



VenturaRiverBedMaterialSize.OPJ 11/28/01 11:13:53