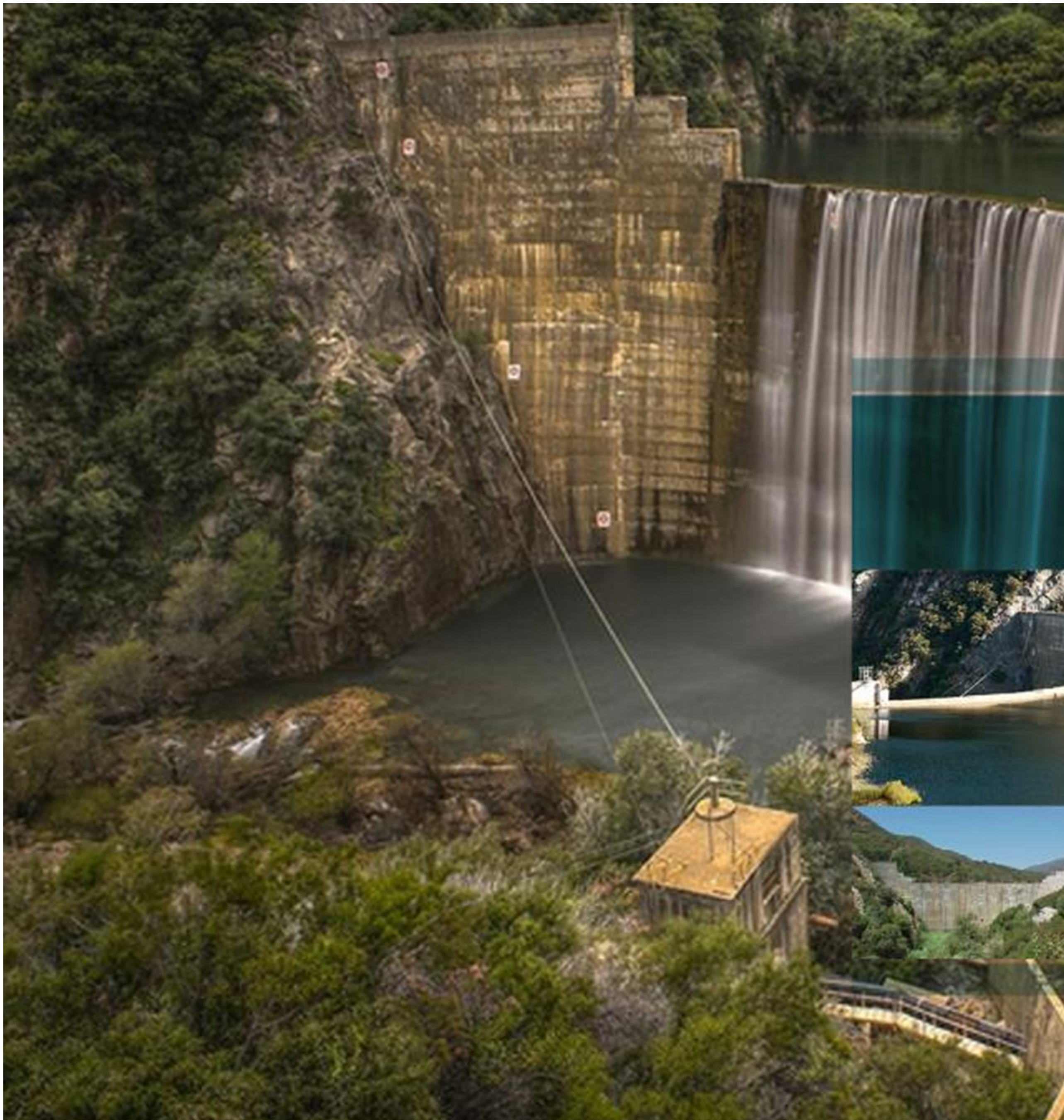


Tasks 2.1 and 2.2 : Hydrology & Sediment Characterization

May 28, 2014

PRESENTATION

MATILIJA DAM

DAM REMOVAL PLANS AND SEDIMENT TRANSPORT ANALYSIS AND ROBLES DIVERSION MITIGATION

URS with Stillwater Sciences

Topics

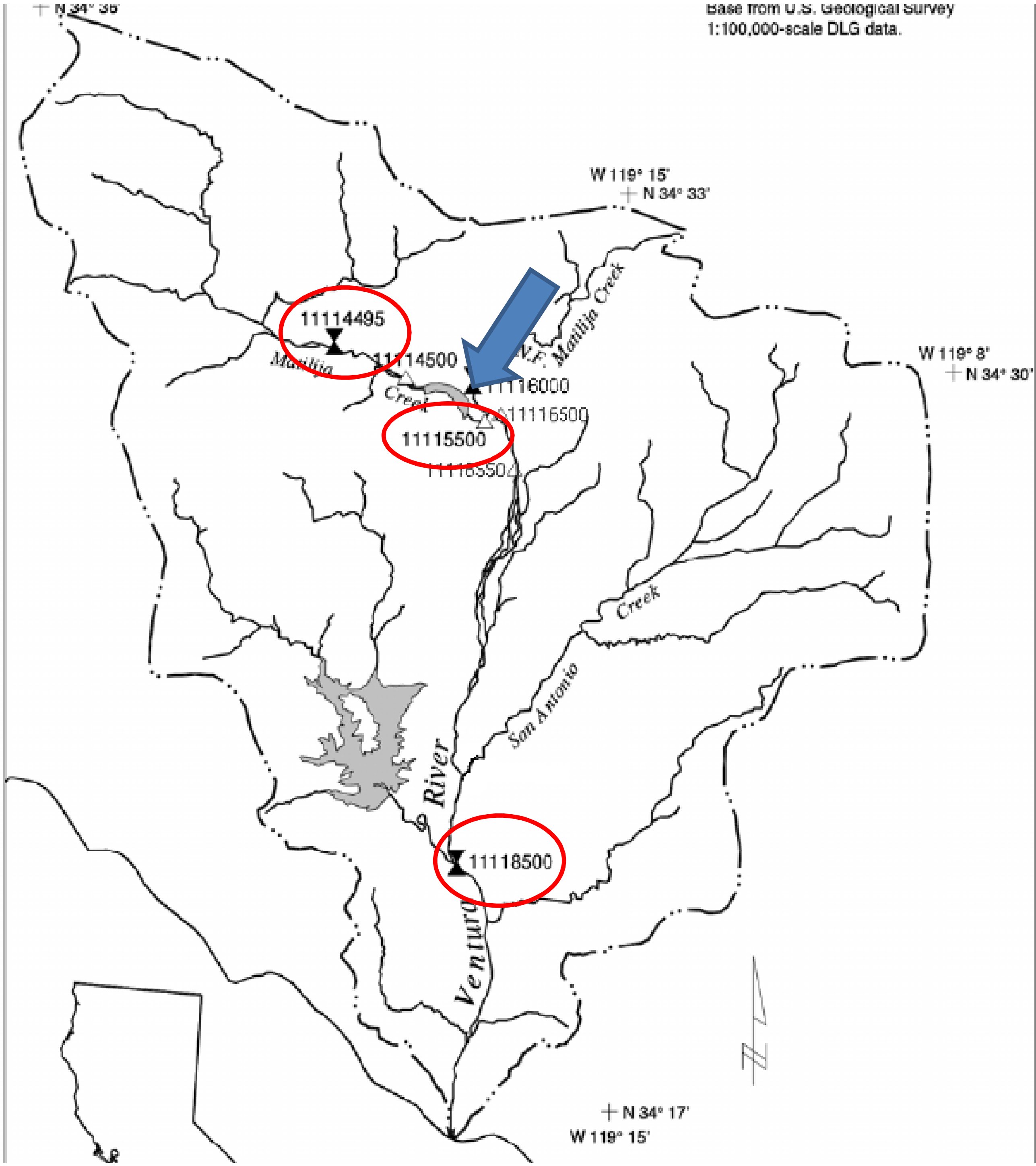
1. Watershed hydrology
2. Impoundment-area sediment
3. Watershed sediment
4. Questions

Topics

1. Watershed hydrology
2. Impoundment-area sediment
3. Watershed sediment
4. Questions

Table 1. USGS flow gages and dates of record in the Ventura River watershed.

Stream and Gage #	Lat.	Long.	Drainage area (mi²)	Begin date	End date	Decades covered by gage record									
						1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Matilija Ck:															
11114495	34°30'10"	119°21'23"	47.8	2/15/2002	present									■	■
11114500	34°29'41"	119°19'48"	50.7	6/1/1948	9/30/1969			■	■	■					
11115500	34°28'58"	119°18'03"	54.6	10/1/1927	9/30/1988	■	■	■	■	■	■	■			
North Fk Matilija:															
11116000	34°29'33"	119°18'20"	15.6	10/1/1928	9/30/1983	■	■	■	■	■	■	■			
Matilija + N Fk Matilija:															
11116500	34°29'06"	119°17'50"	70.7	10/1/1911	6/30/1924	■									
Ventura River:															
11116550	34°27'54"	119°17'20"	76.4	6/1/1959	9/30/1988					■	■	■			
11118500	34°21'08"	119°18'27"	188	10/1/1929	present		■	■	■	■	■	■	■	■	■



N 34° 36'
Base from U.S. Geological Survey
1:100,000-scale DLG data.
W 119° 15'
N 34° 33'
W 119° 8'
N 34° 30'
11114495
11114500
Matilija
Creek
N.F. Matilija Creek
11116000
11116500
11115500
11116550
Creek
San Antonio
River
Ventura
11118500
N 34° 17'
W 119° 15'

But first…a quick tour of the channel, from above Matilija Dam to Ventura River gage 11118500

Ventura River at Foster Park (gage 11118500)

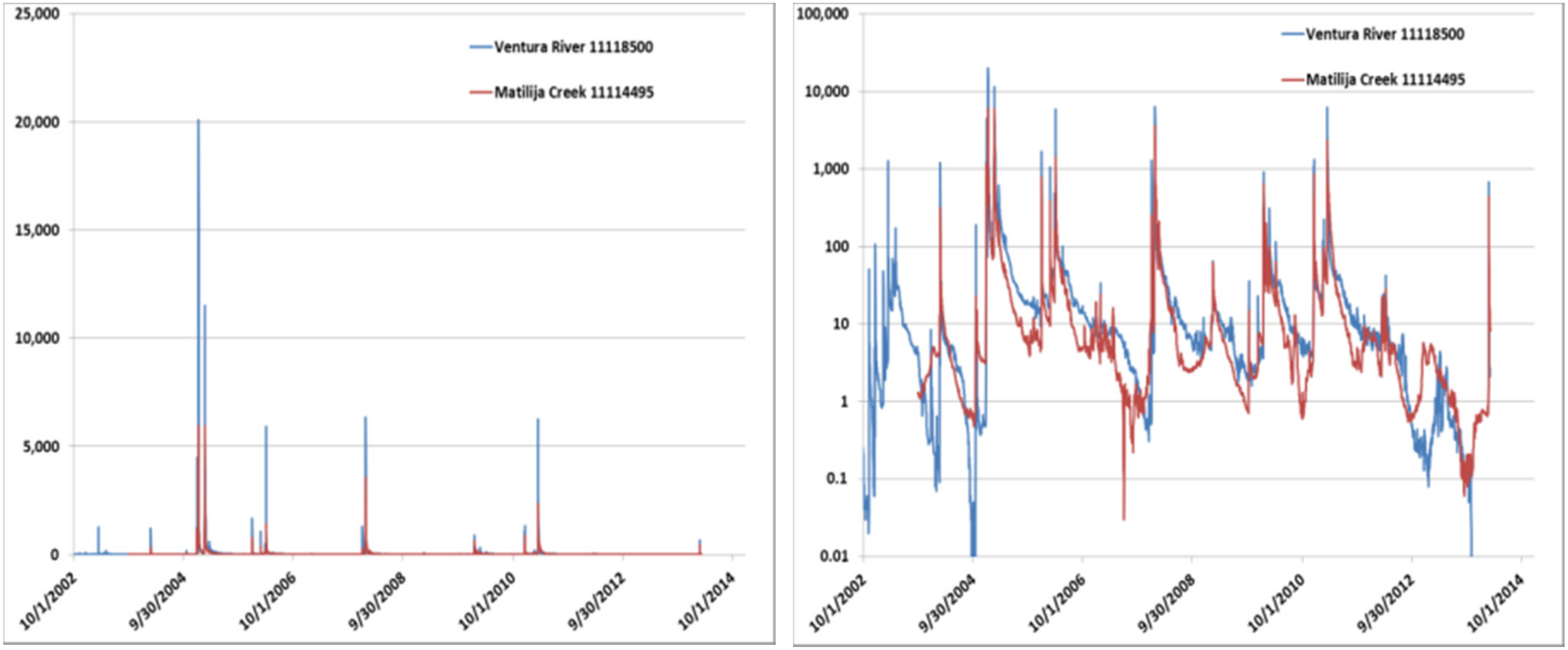
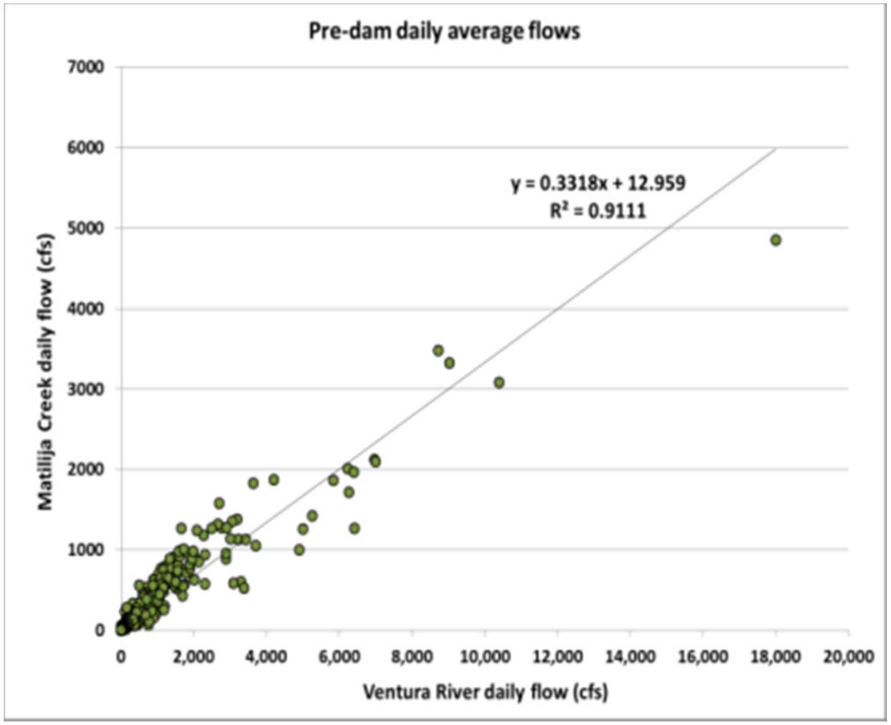


Figure 2. Hydrographs of the Ventura River and Matilija Creek for water years 2003 through mid-2014, expressed as cubic feet per second (cfs) on arithmetic (left) and log (right) scales. The former emphasizes the dramatic variability of this system, with individual flow events of typically a few days' to a few weeks' duration, separated by one to several years of very low flow; the latter shows that that flow is minimal but almost always non-zero in both channels at the gage locations. Both graphs also show the close correspondence of tributary (Matilija) and mainstem (Ventura) flows at the resolution of a daily time step.



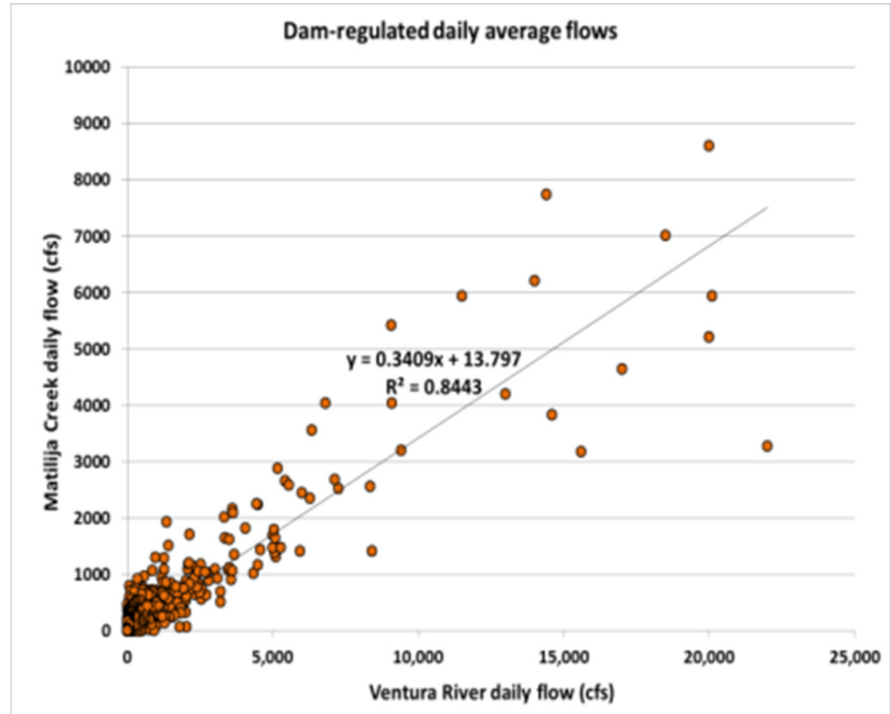
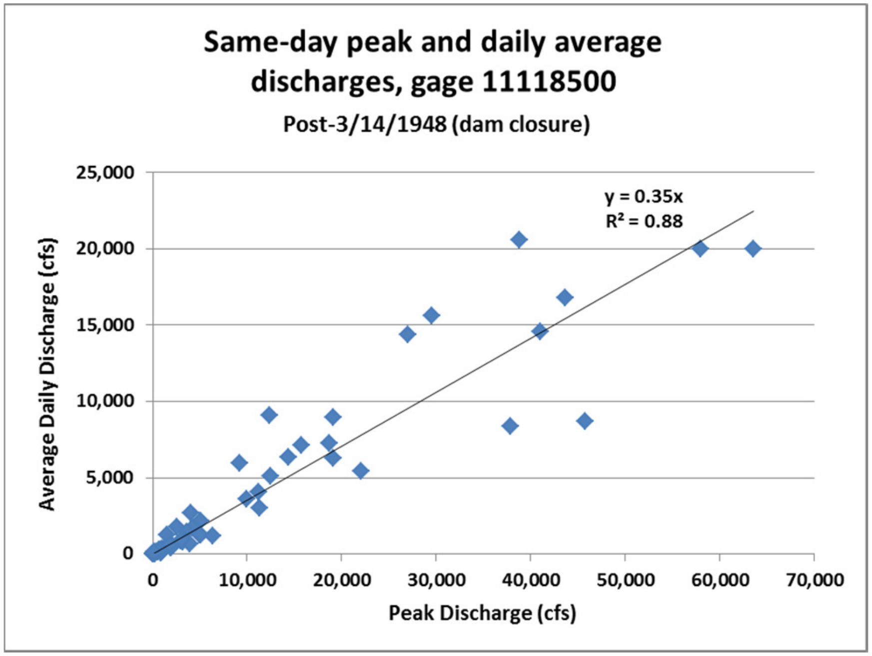


Figure 3. Same-day average flows for the Ventura River at gage 11118500 (x axis) and Matilija Creek (y axis) for the pre-dam (left) and dam-regulated (i.e., post- 4/14/1948) (right) periods. Correlations suggest:

1. a **3:1 ratio of flows** , and
2. **no significant systematic differences between the two periods.**



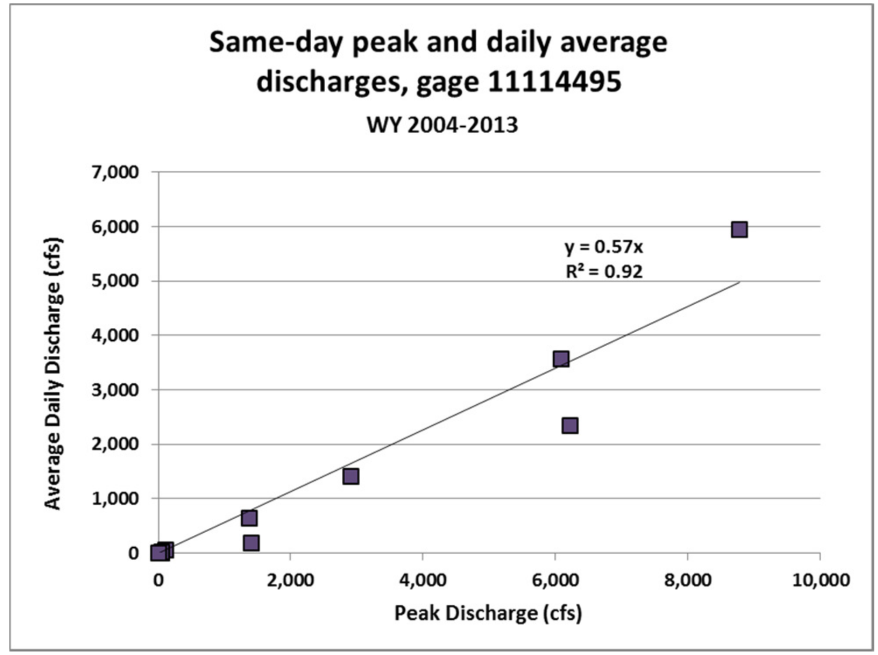


Figure 4. Same-day peak and daily average flows for the annual flood on the Ventura River (left, gage 11118500) and Matilija Creek (right, gage 11114495) for the dam-regulated period. **Correlations suggest an average daily flow of about <u>35%</u> of the same-day instantaneous peak flow on the Ventura River** (but with a range from 19-73% for individual events >10,000 cfs) **and <u>57%</u> on Matilija Creek**.

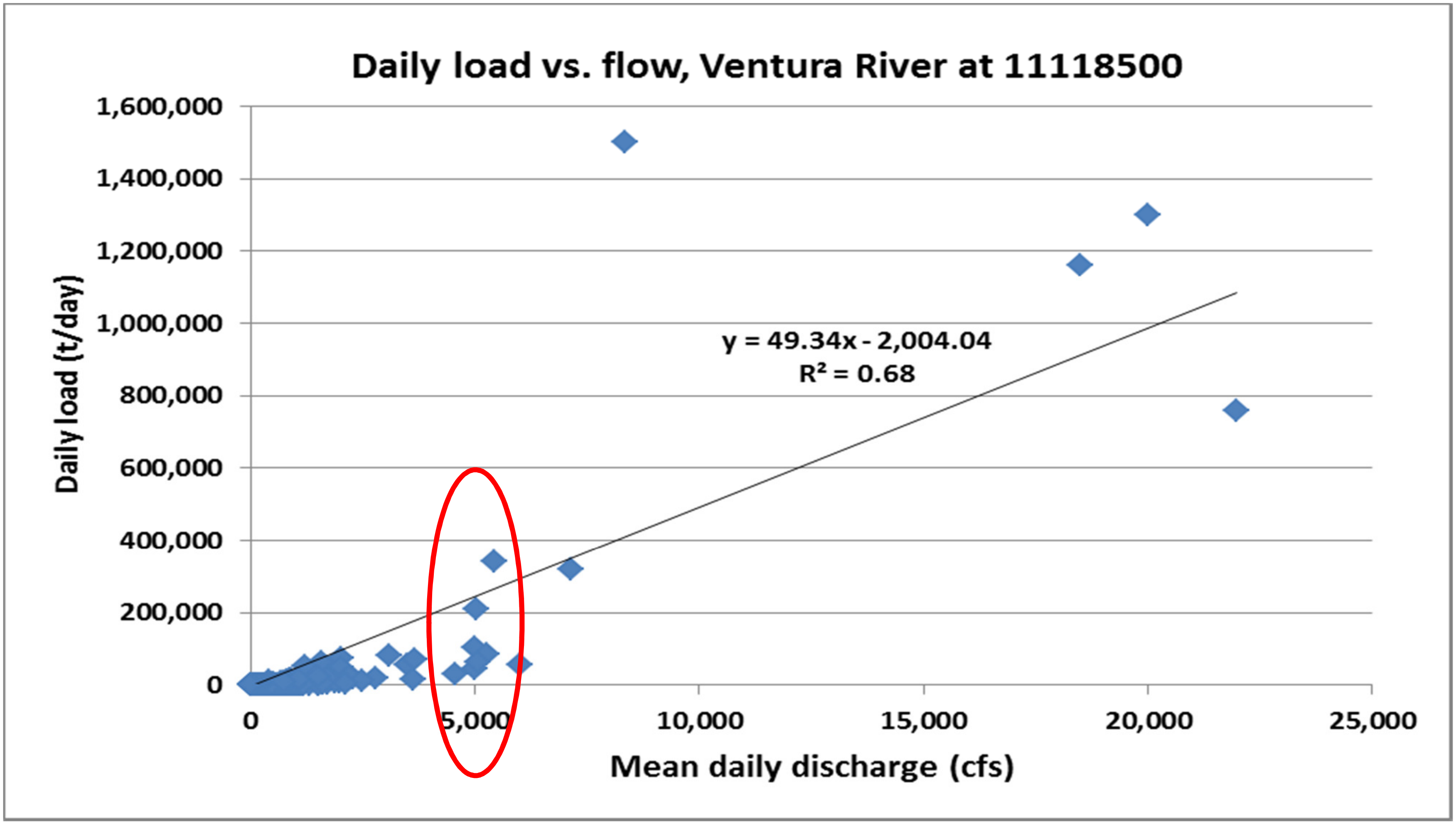
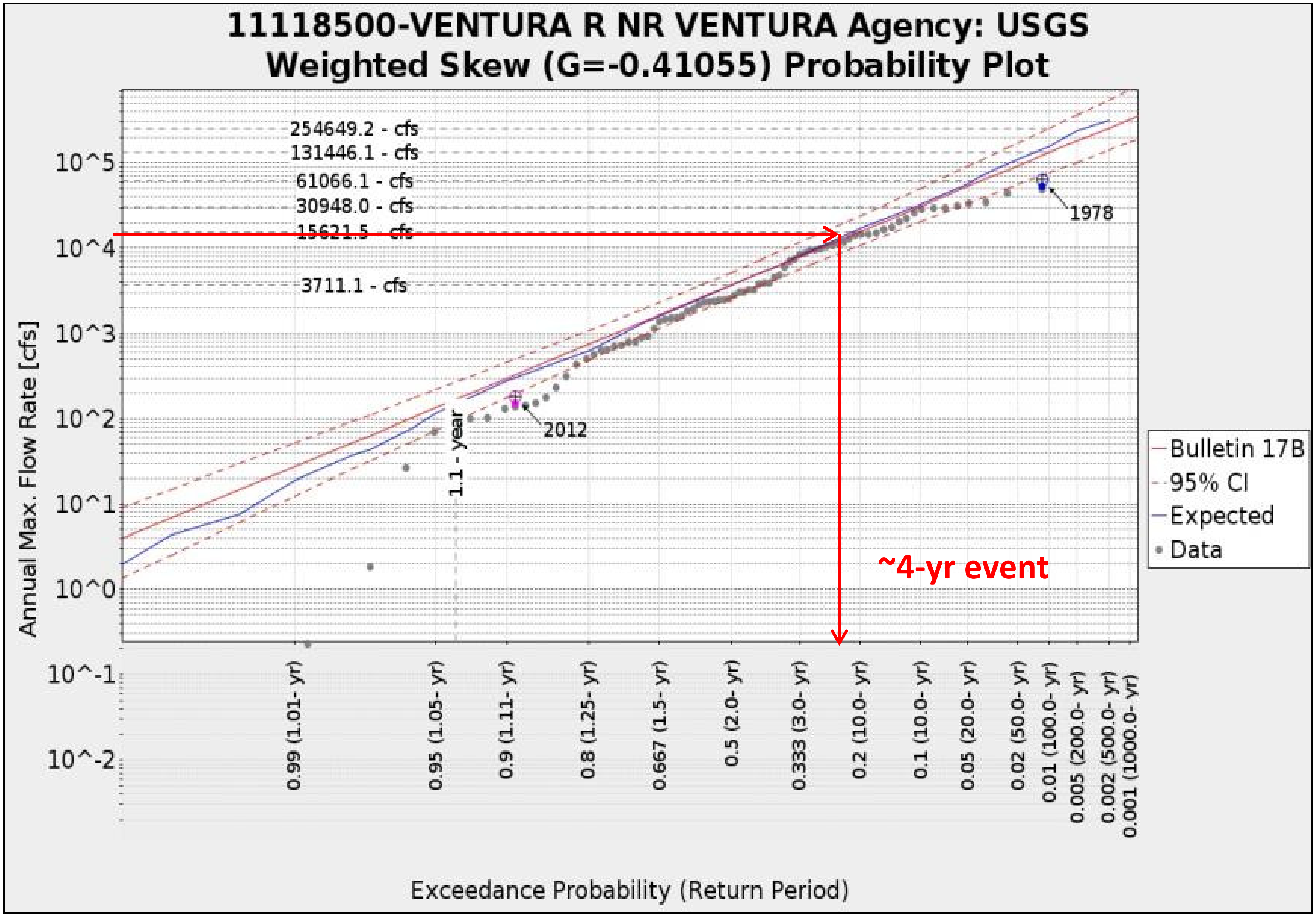


Figure 5. Comparison of mean daily (water) discharges and daily suspended sediment loads on the Ventura River at gage 11118500 for the period 1969-1989.


11118500-VENTURA R NR VENTURA Agency: USGS
Weighted Skew (G=-0.41055) Probability Plot
254649.2 - cfs
131446.1 - cfs
61066.1 - cfs
30948.0 - cfs
15621.5 - cfs
3711.1 - cfs
1978
2012
1.1 - year
~4-yr event
Annual Max. Flow Rate [cfs]
10^5
10^4
10^3
10^2
10^1
10^0
10^-1
10^-2
0.99 (1.01- yr)
0.95 (1.05- yr)
0.9 (1.11- yr)
0.8 (1.25- yr)
0.667 (1.5- yr)
0.5 (2.0- yr)
0.333 (3.0- yr)
0.2 (10.0- yr)
0.1 (10.0- yr)
0.05 (20.0- yr)
0.02 (50.0- yr)
0.01 (100.0- yr)
0.005 (200.0- yr)
0.002 (500.0- yr)
0.001 (1000.0- yr)
Exceedance Probability (Return Period)
Bulletin 17B
95% CI
Expected
Data

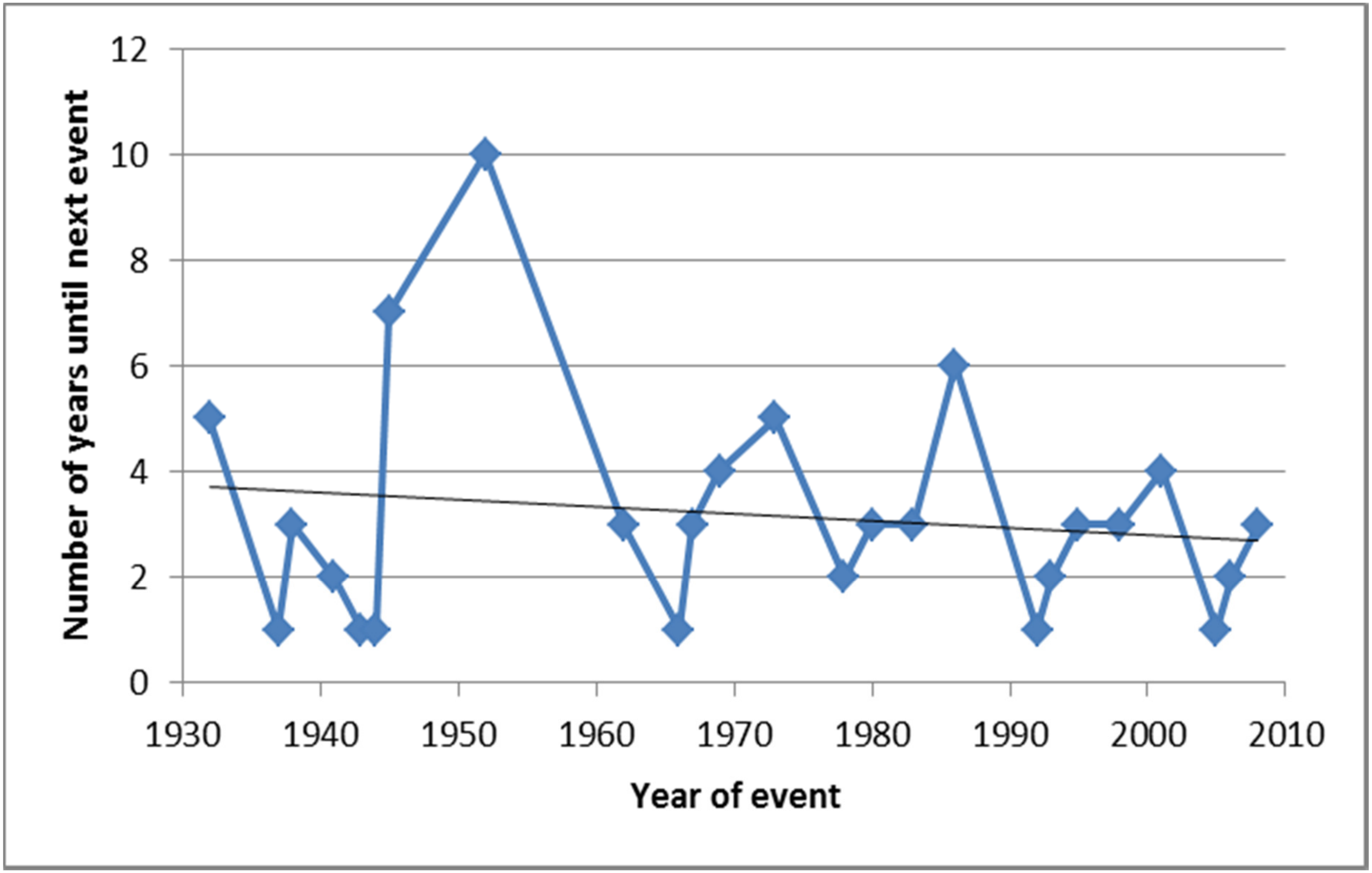


Figure 8. Time series of “events” (average daily flow of ≥5,000 cfs at 1118500 and/or ≥1,667 cfs in Matilija Creek) plotted on the y-axis as the number of years until the next year with at least one such event. Multiple events within the same water year are ignored.

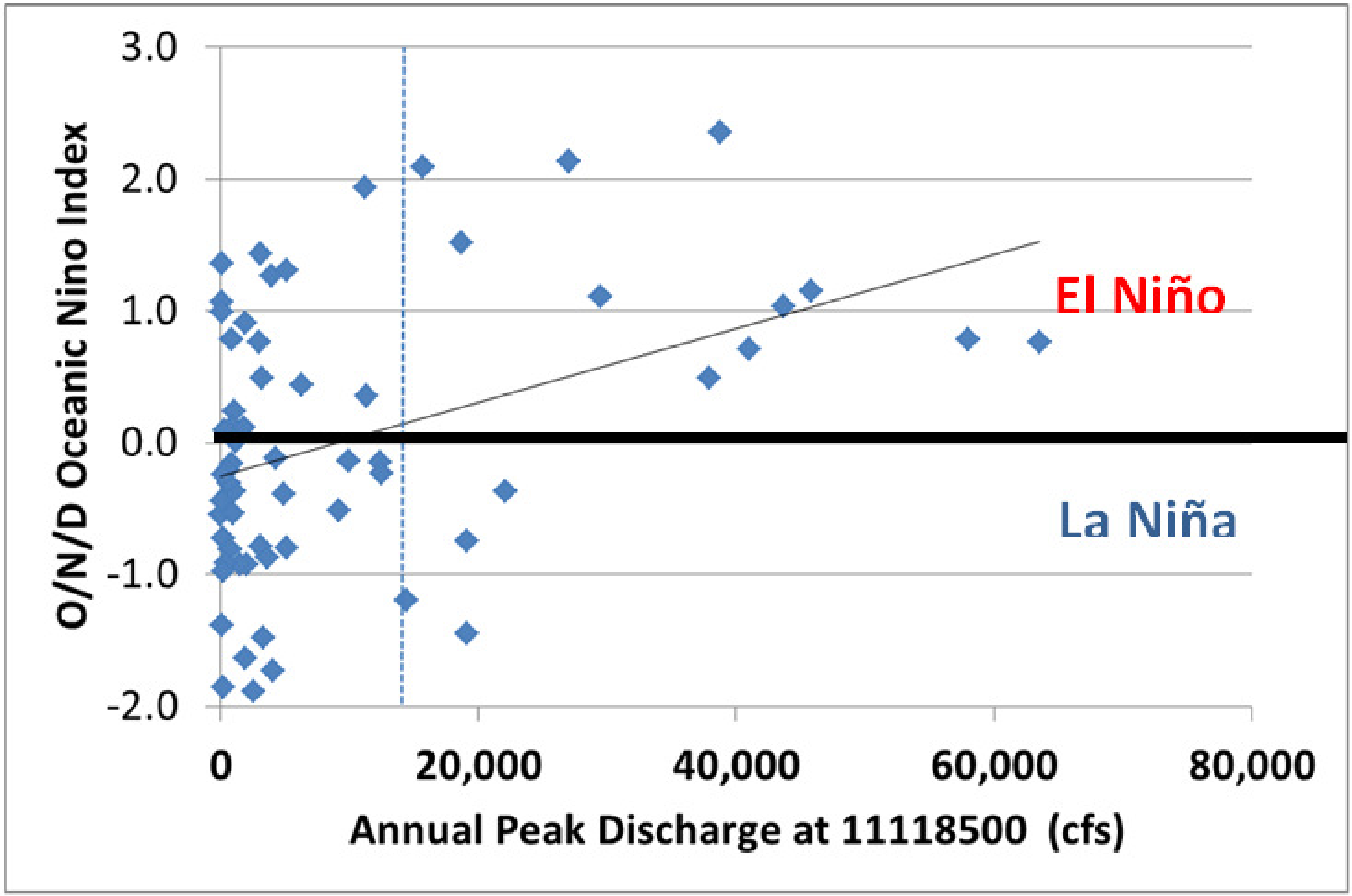


Figure 9. Annual peak discharge on the Ventura River at gage 11118500 plotted against the averaged value of the Oceanic Niño Index for the months of October, November, and December at the beginning of the corresponding water year (data range 1950–2011). The dashed vertical line marks 14,000 cfs, the presumptive peak discharge required for "significant" sediment transport (see text); the thin gray line marks the linear trend of the entire data set.

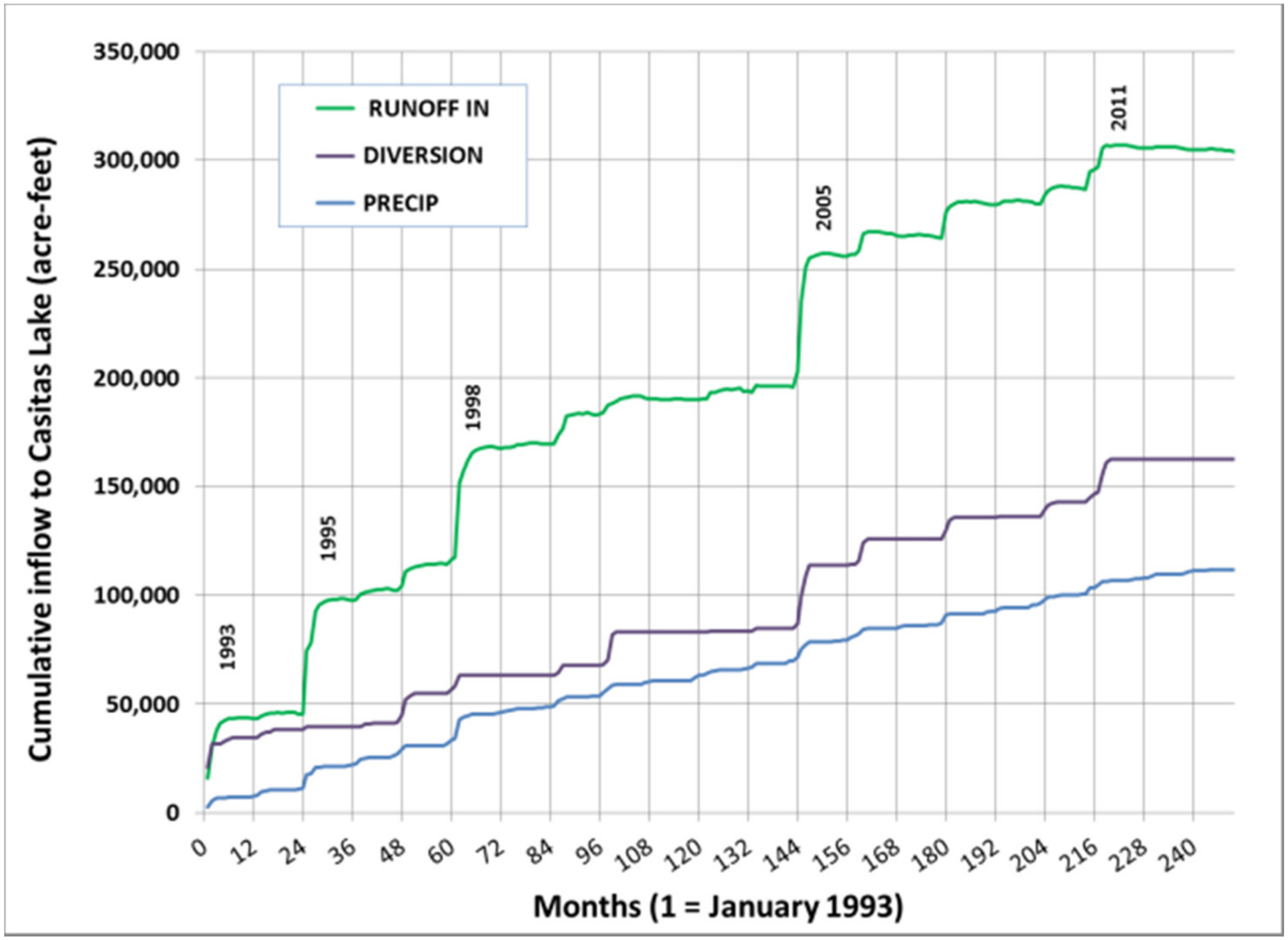


Figure 11. Cumulative volumes of water inputs to Lake Casitas, based on daily records from the Casitas Water District beginning in January 1993. "Runoff in" is derived from the watershed directly draining to the reservoir, and it includes some small negative values presumably resulting from seepage losses. Precipitation was calculated as the product of daily precipitation and lake surface area; the plotted diversion is the record of water inputs from Robles Diversion.

SOURCE	Acre-ft, 1993–2013	Percent of total
Runoff from the reservoir watershed	303,271	52.5%
Robles Diversion from the Ventura River	162,824	28.2%
Direct precipitation on the lake surface	111,867	19.4%
TOTAL	**577,962**	**100.0%**

Figure 11. Cumulative volumes of water inputs to Lake Casitas, based on daily records from the Casitas Water District beginning in January 1993. “Runoff in” is derived from the watershed directly draining to the reservoir, and it includes some small negative values presumably resulting from seepage losses. Precipitation was calculated as the product of daily precipitation and lake surface area; the plotted diversion is the record of water inputs from Robles Diversion.

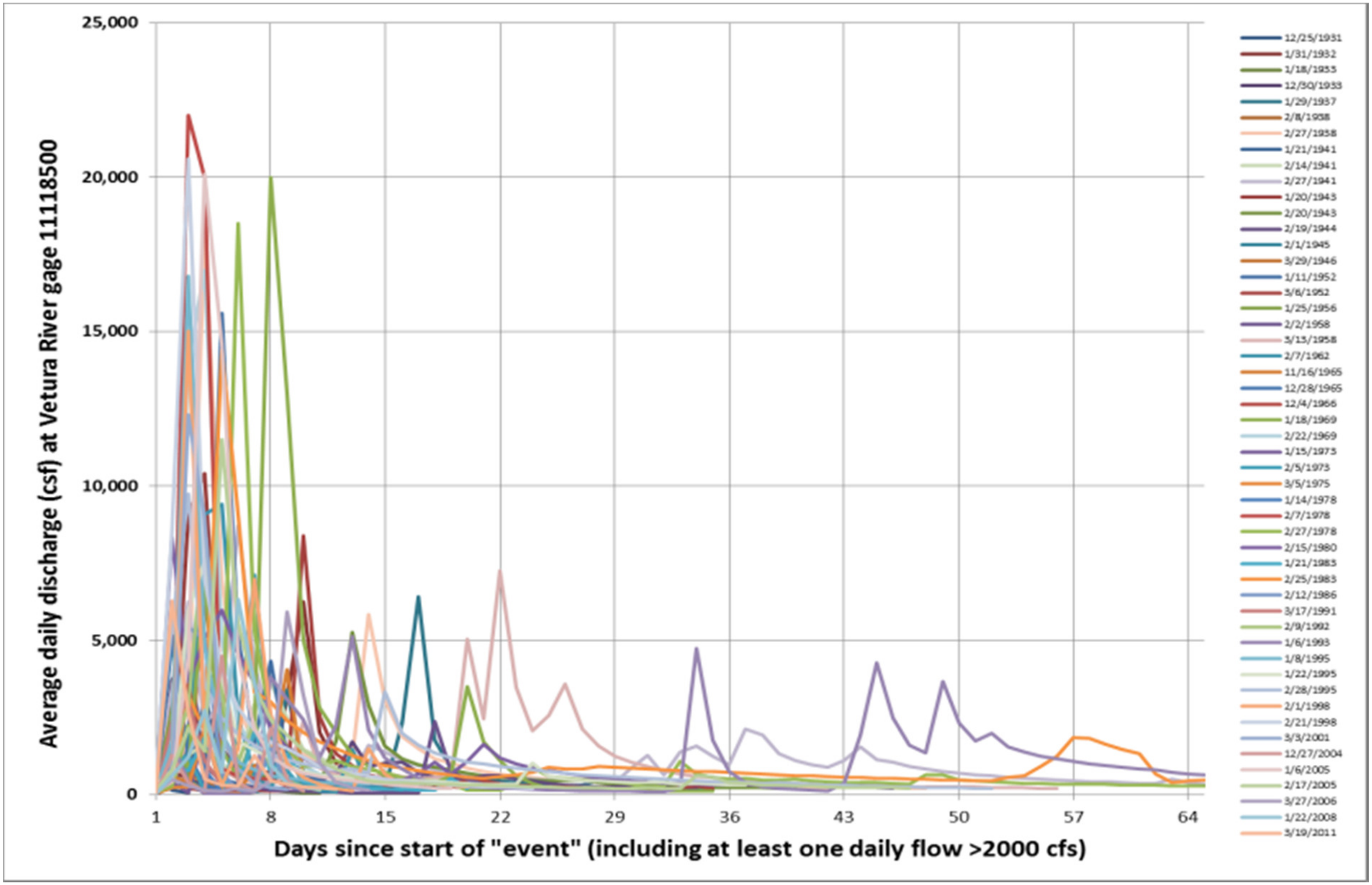


Figure 15. Hydrographs of all flow events on the Ventura River at gage 11118500 for the entire period of record. An “event” is defined as a continuous period of flows including at least one daily average flow >2,000 cfs; the graphed period is extended both prior to and following that >2,000 cfs discharge to include all “adjacent” days with flows above 200 cfs.

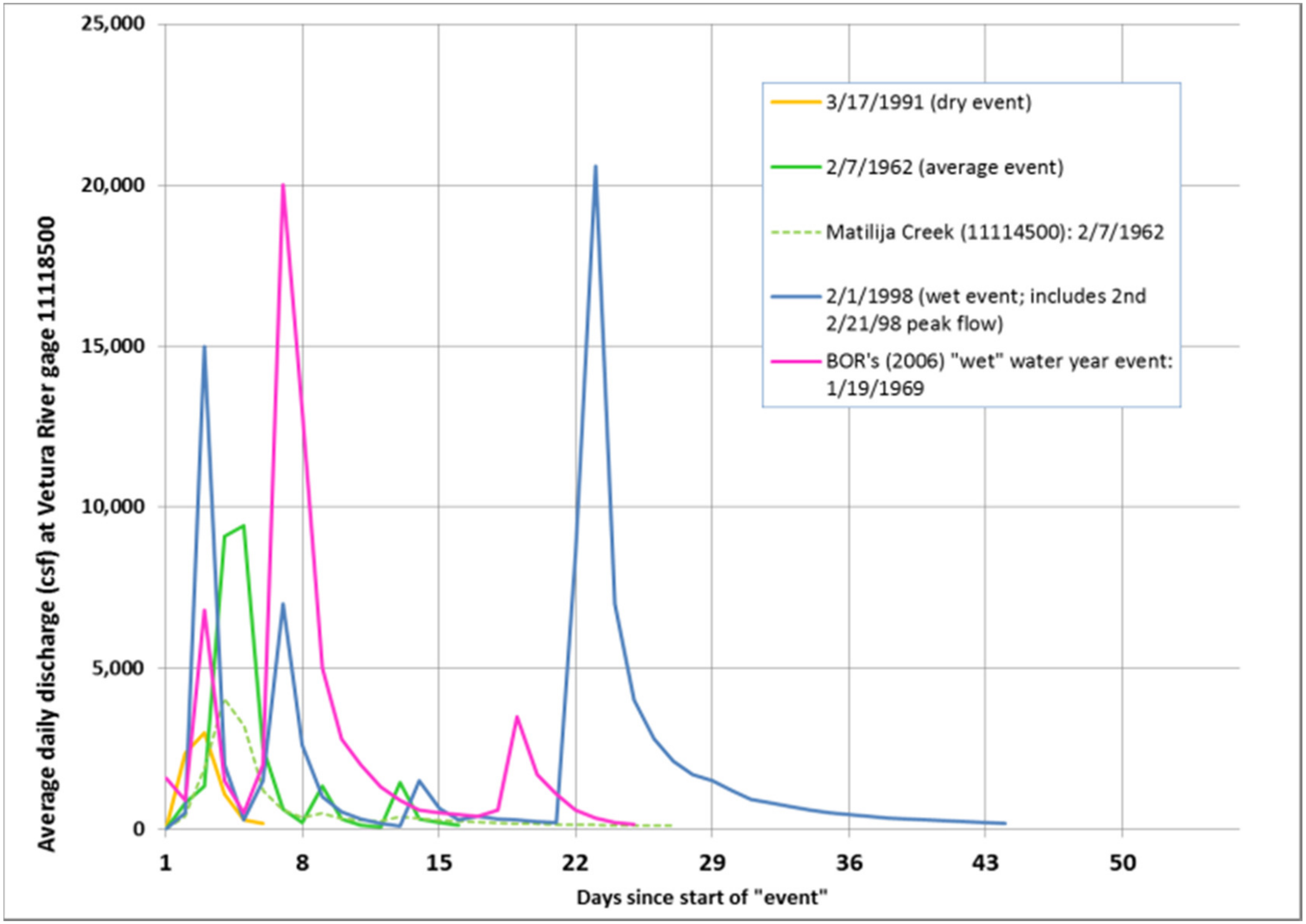
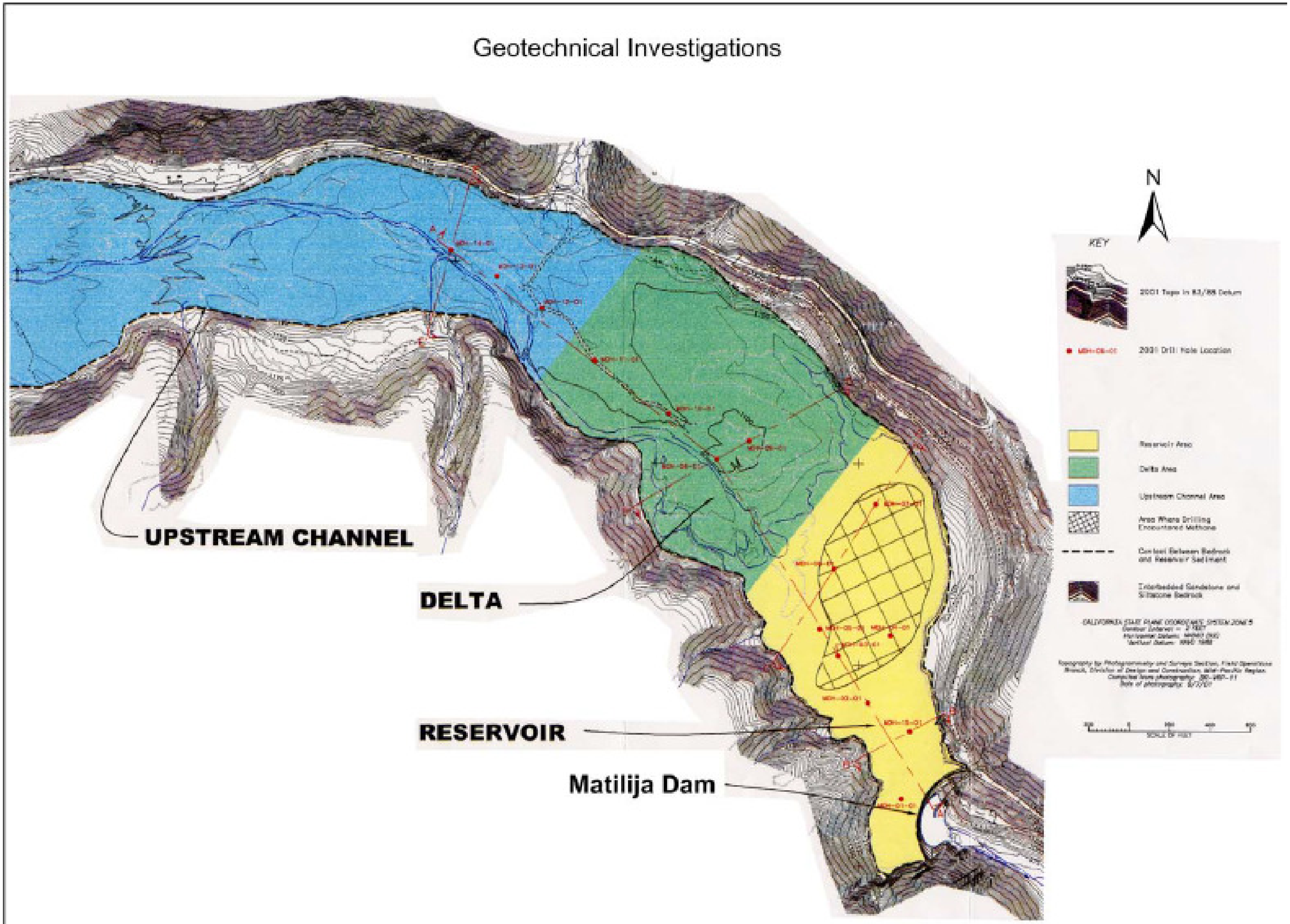


Figure 17. Hydrographs of the representative flow events identified in Figure 16. For comparison, the same-day flows for the "average" event on Matilija Creek (gage 11114500) are also plotted, showing the typical ~1:3 ratio with peak flows with the Ventura River and close correspondence in timing (Matilija gages were not operational during the "dry" and "wet" events).

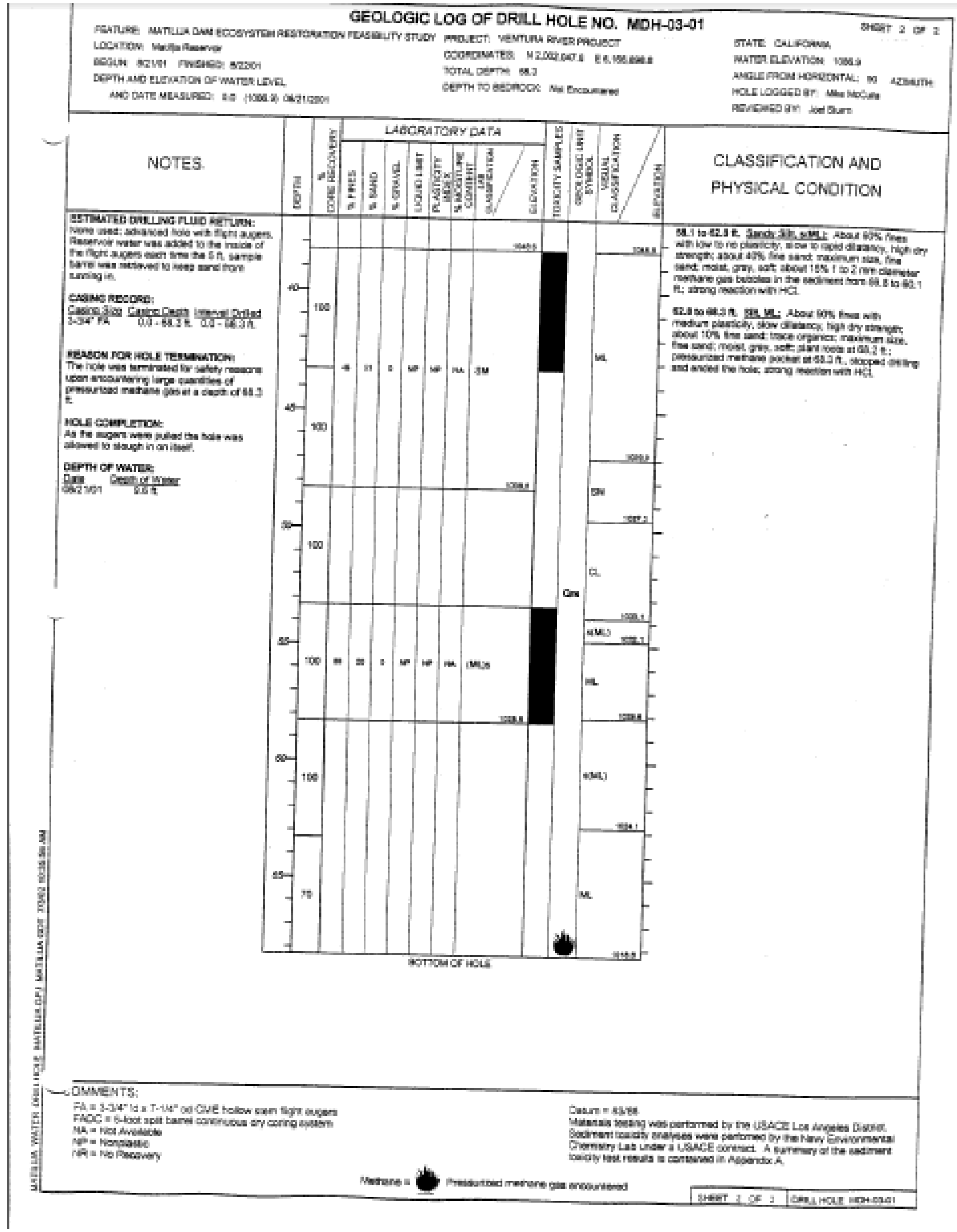
Topics

1. Watershed hydrology
2. Impoundment-area sediment
3. Watershed sediment
4. Questions



From Appendix C of Geotechnical Report

Example boring log from Appendix C (MDH-03-01)



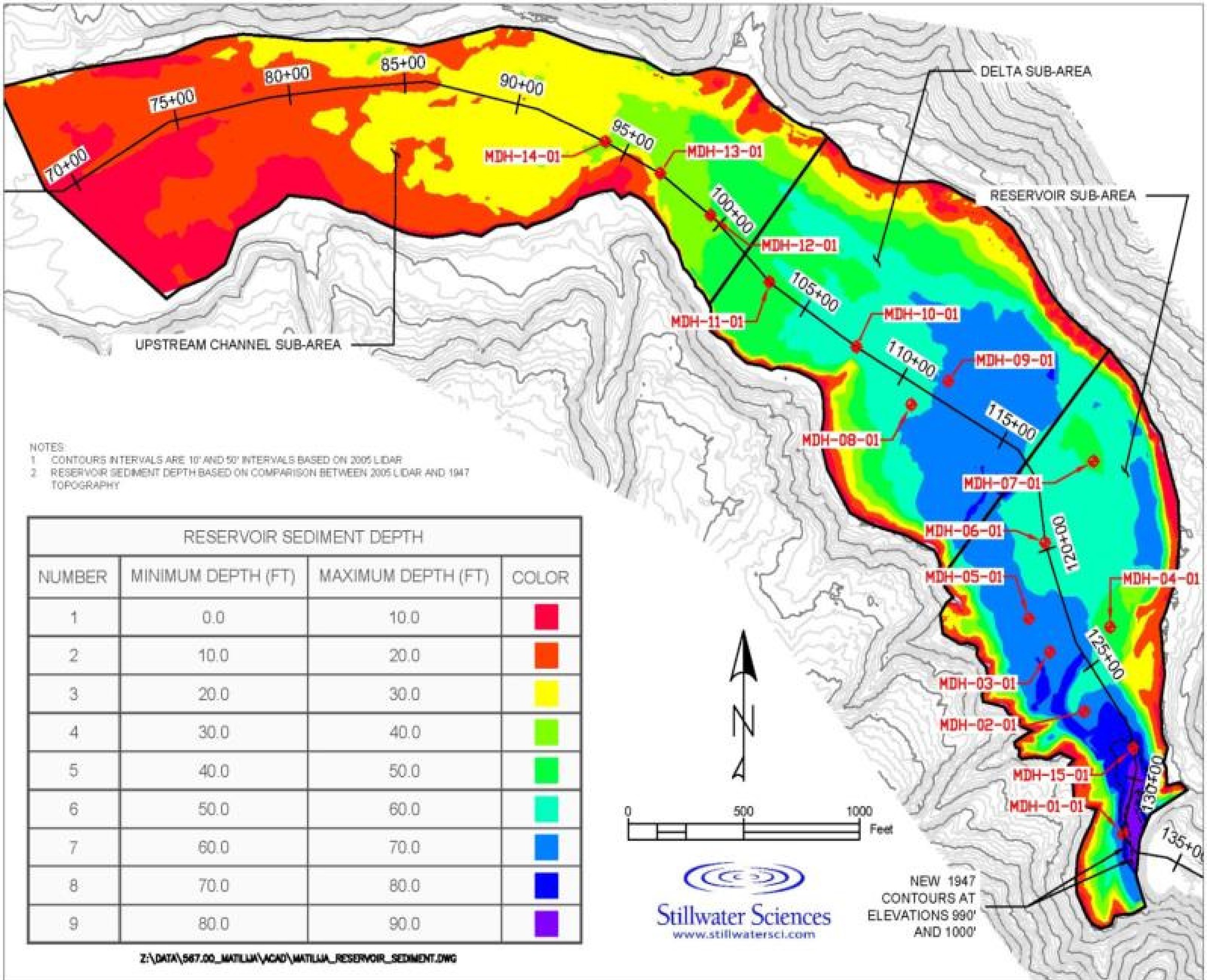


Figure 1. Plan view of Matilija Reservoir sediment deposits and borehole locations.

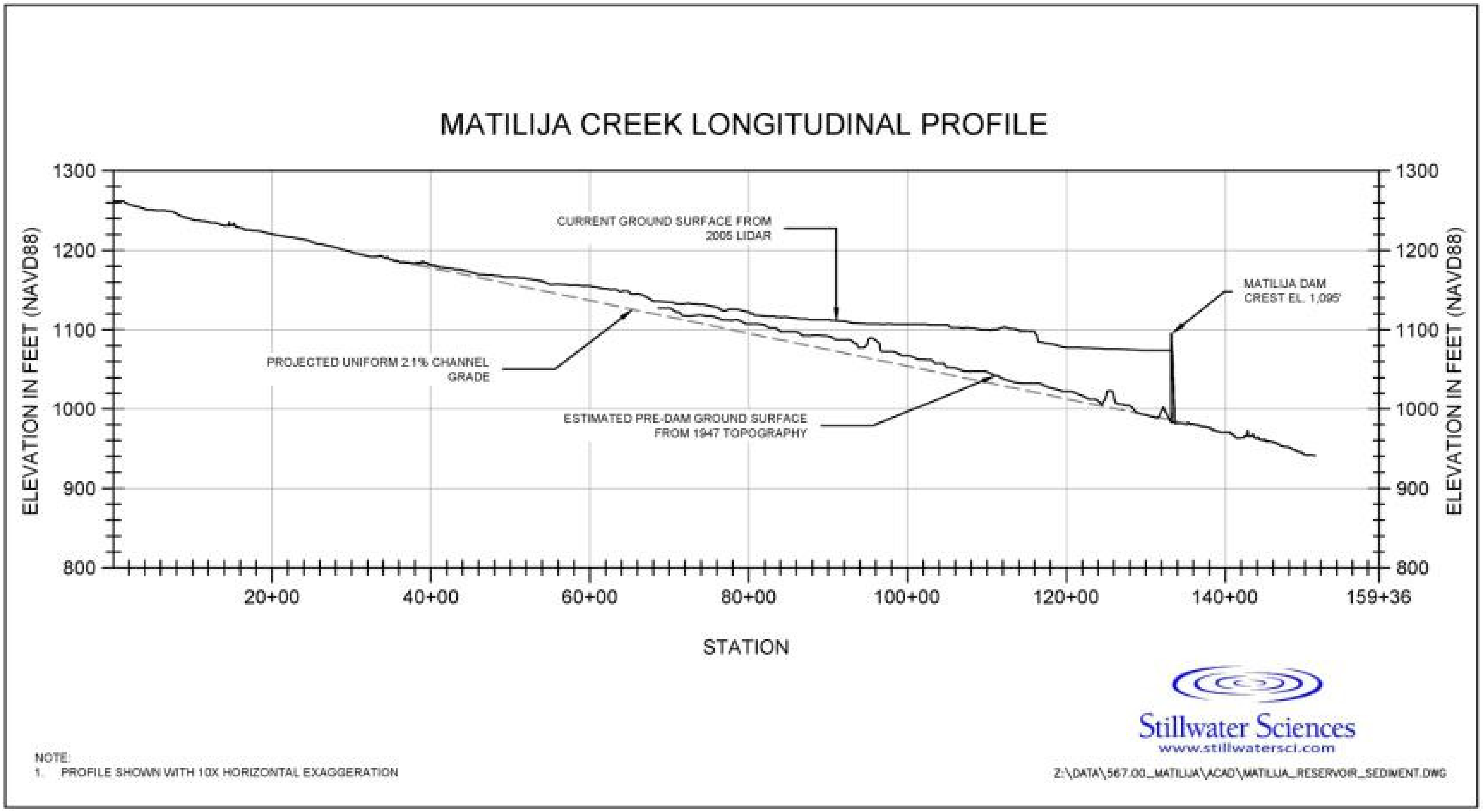


Figure 2. Matilija Creek longitudinal profile.

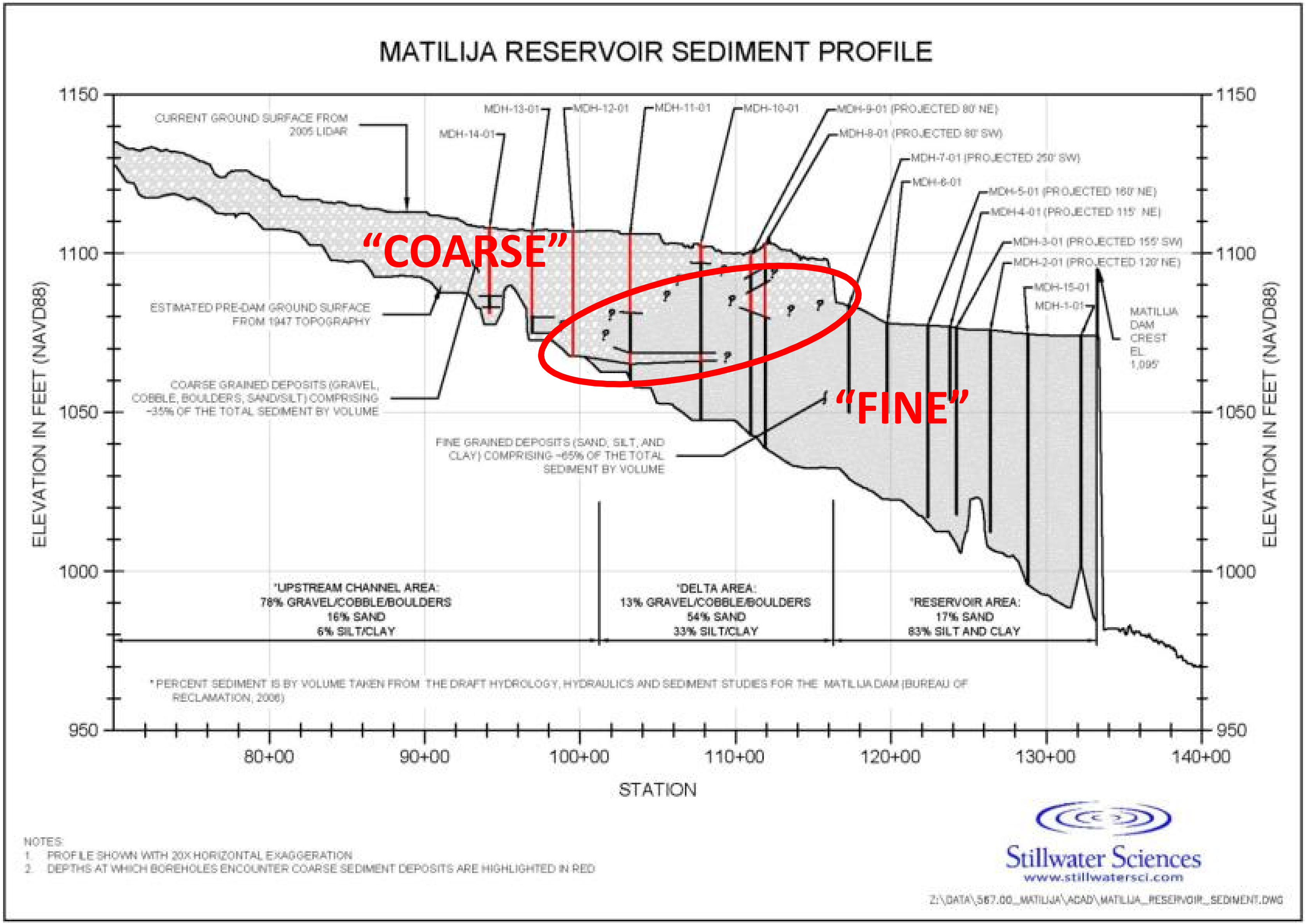


Figure 3. Matilija Reservoir sediment deposit profile.

Table 1. Sediment gradation percentages (determined from BOR 2006, Table 5.6).

Sediment Deposit Sub-Area:	% Gravel (>2 mm)	% Sand (0.0625–2 mm)	% Silt/Clay (<0.0625 mm)
Reservoir	0%	17%	83%
Delta	13%	54%	33%
Upstream Channel	78%	16%	6%

Table 2. Sediment gradation volumes.

Sediment Deposit Sub-Area	Total Volume Sediment (as of 2005)	Volume Gravel (>2 mm)	Volume Sand (0.0625 - 2 mm)	Volume Silt/Clay (<0.0625 mm)
	(all values in cubic yards)			
Reservoir	2,420,000*	0	410,000	2,010,000*
Delta	3,230,000	420,000	1,740,000	1,070,000
Upstream Channel	1,150,000	900,000	180,000	70,000
Total Volume	6,800,000*	1,320,000	2,330,000	3,150,000*
Total Percent	100%	19%	35%	46%

*Inferred deposition of silt/clay in the Reservoir sub-area during the period 2002–2005 but not "seen" by the LiDAR or 2001 boreholes should raise these amounts by ~160,000 yd^3 (see below).

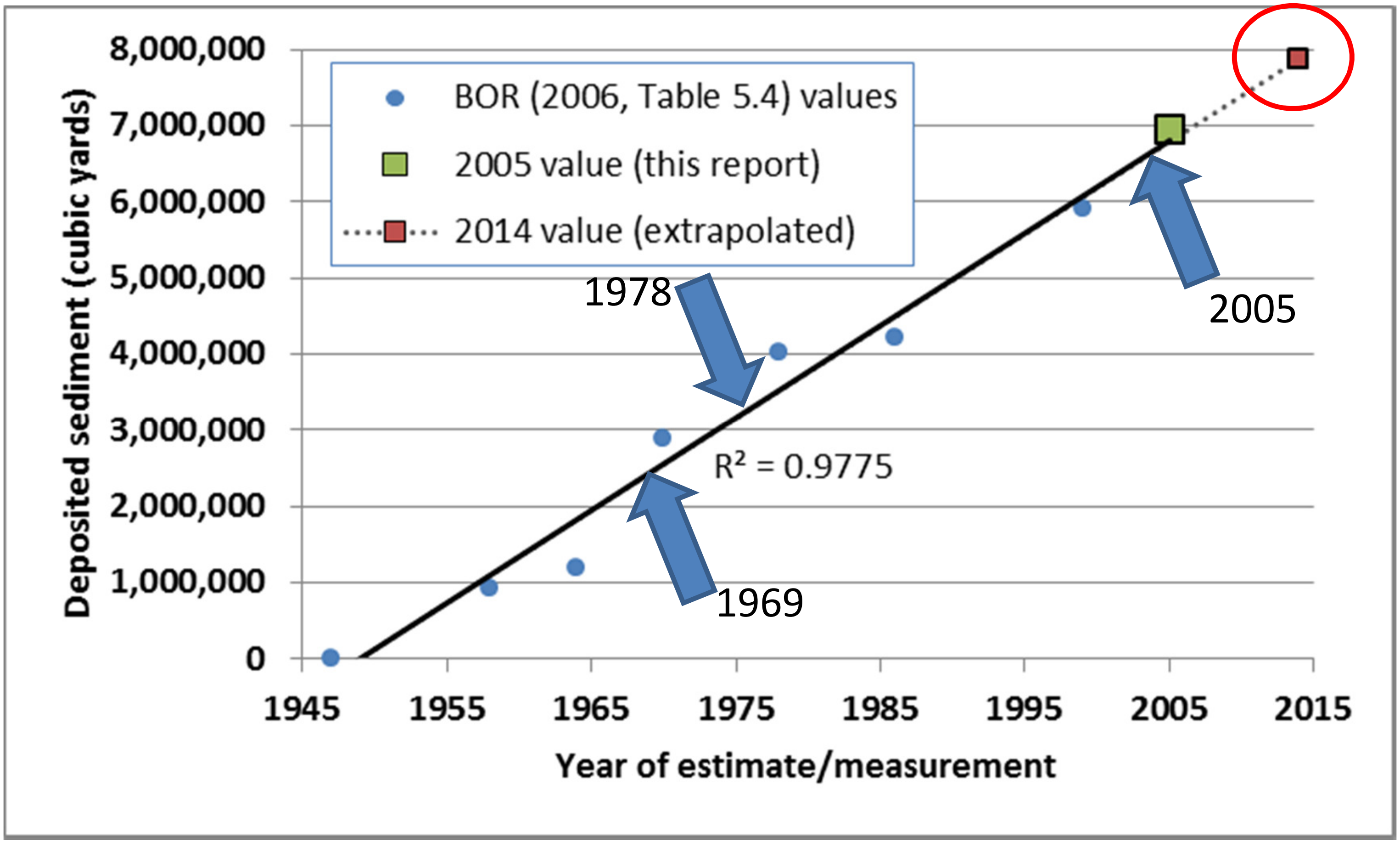


Figure 4. Historically inferred, measured, and extrapolated sediment volumes behind Matilija Dam (data sources as noted).

CONUNDRUM #1: Why so little effect from the really big flow events?

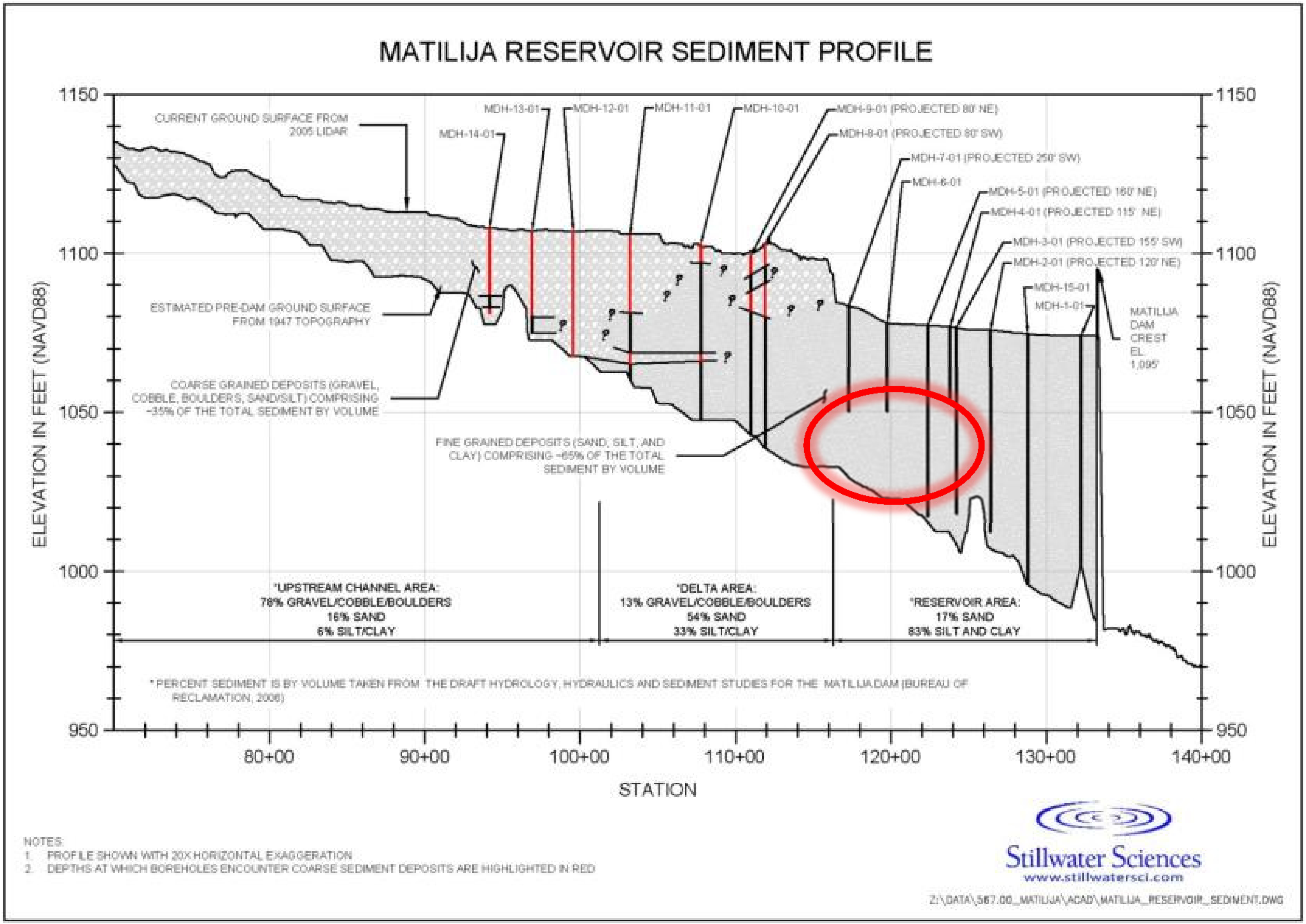
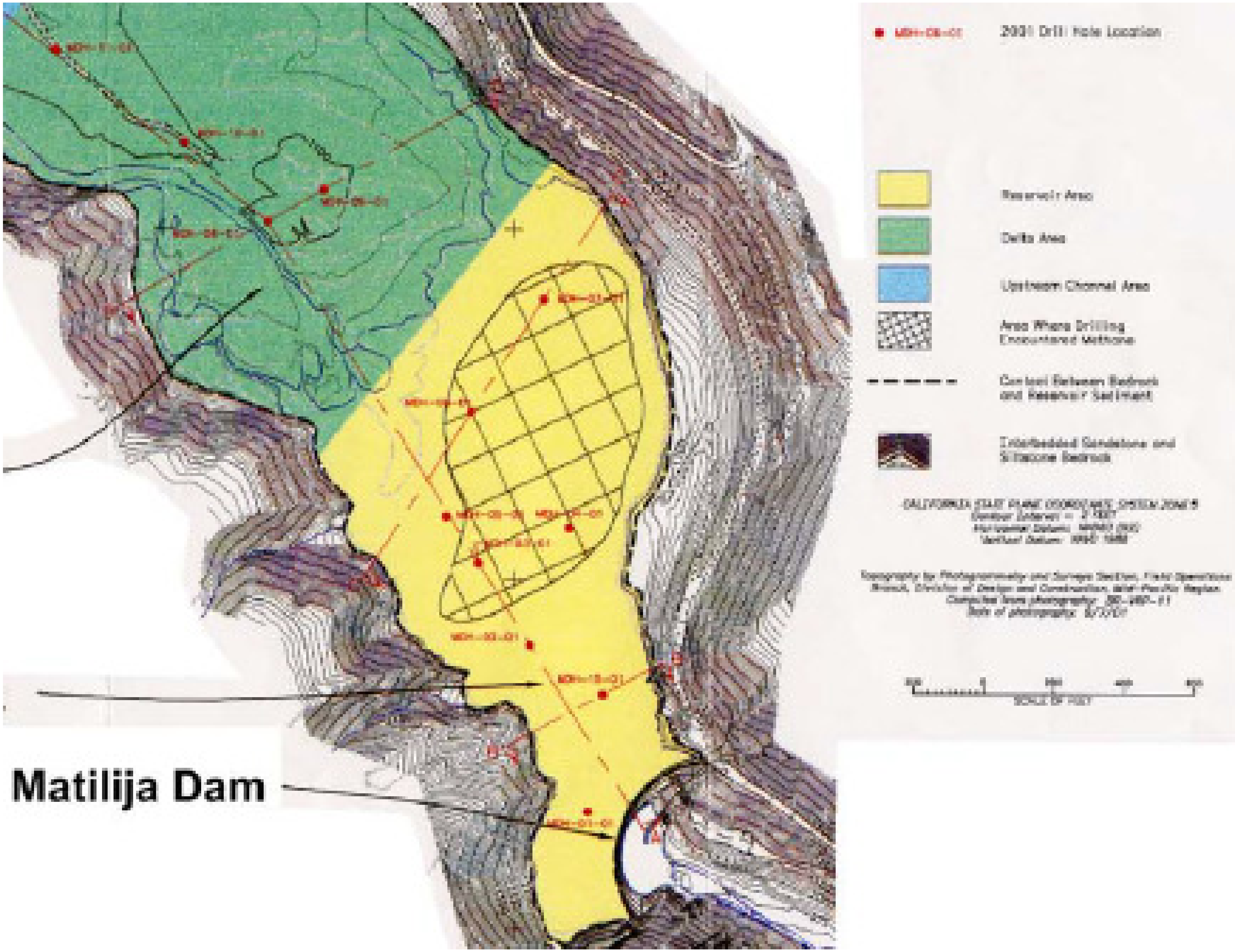
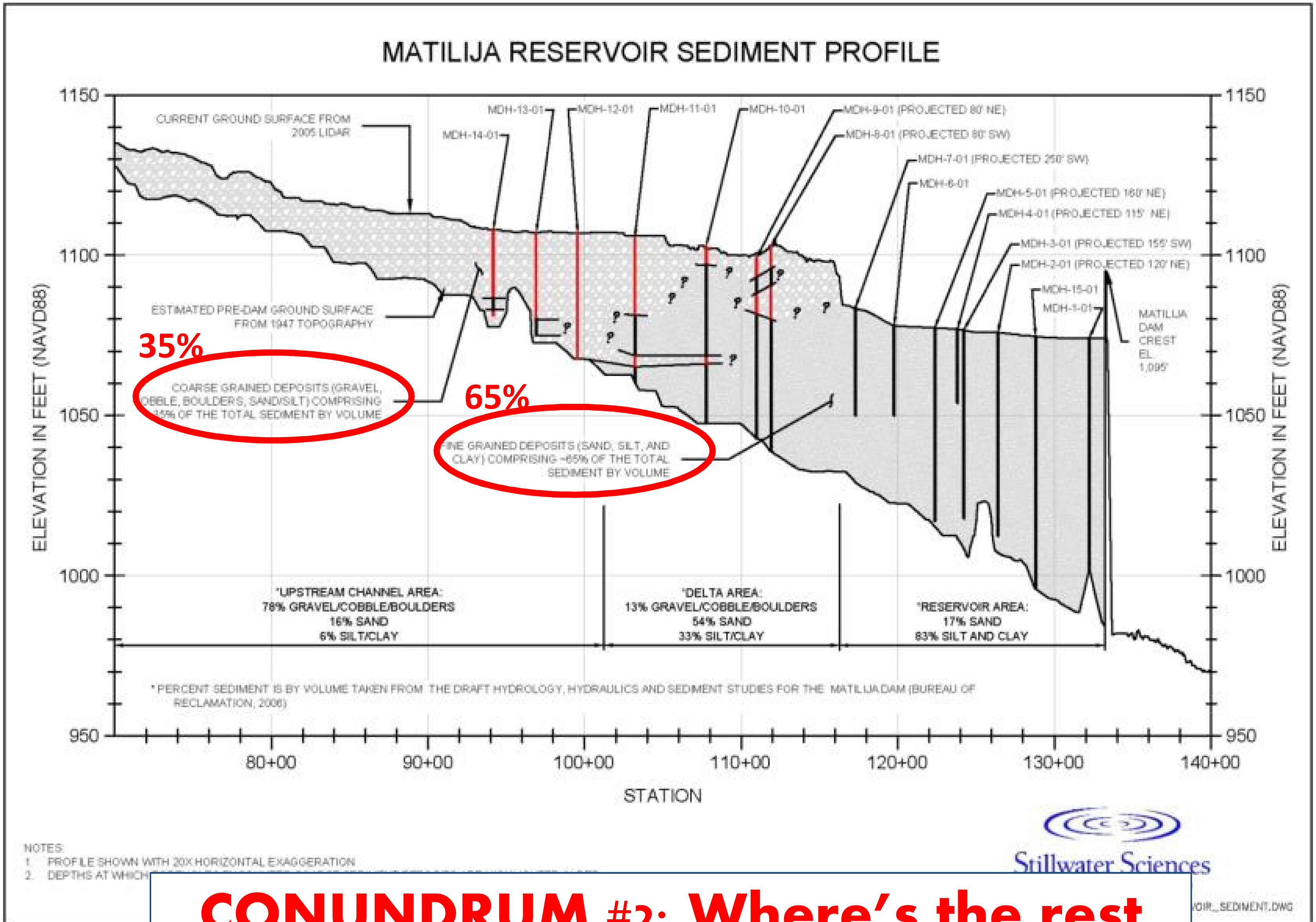


Figure 3. Matilija Reservoir sediment deposit profile.


2001 Drill Hole Location
Reservoir Area
Delta Area
Upstream Channel Area
Area Where Drilling Encountered Methane
Contact Between Bedrock and Reservoir Sediment
Interbedded Sandstone and Siltstone Bedrock
Matilija Dam



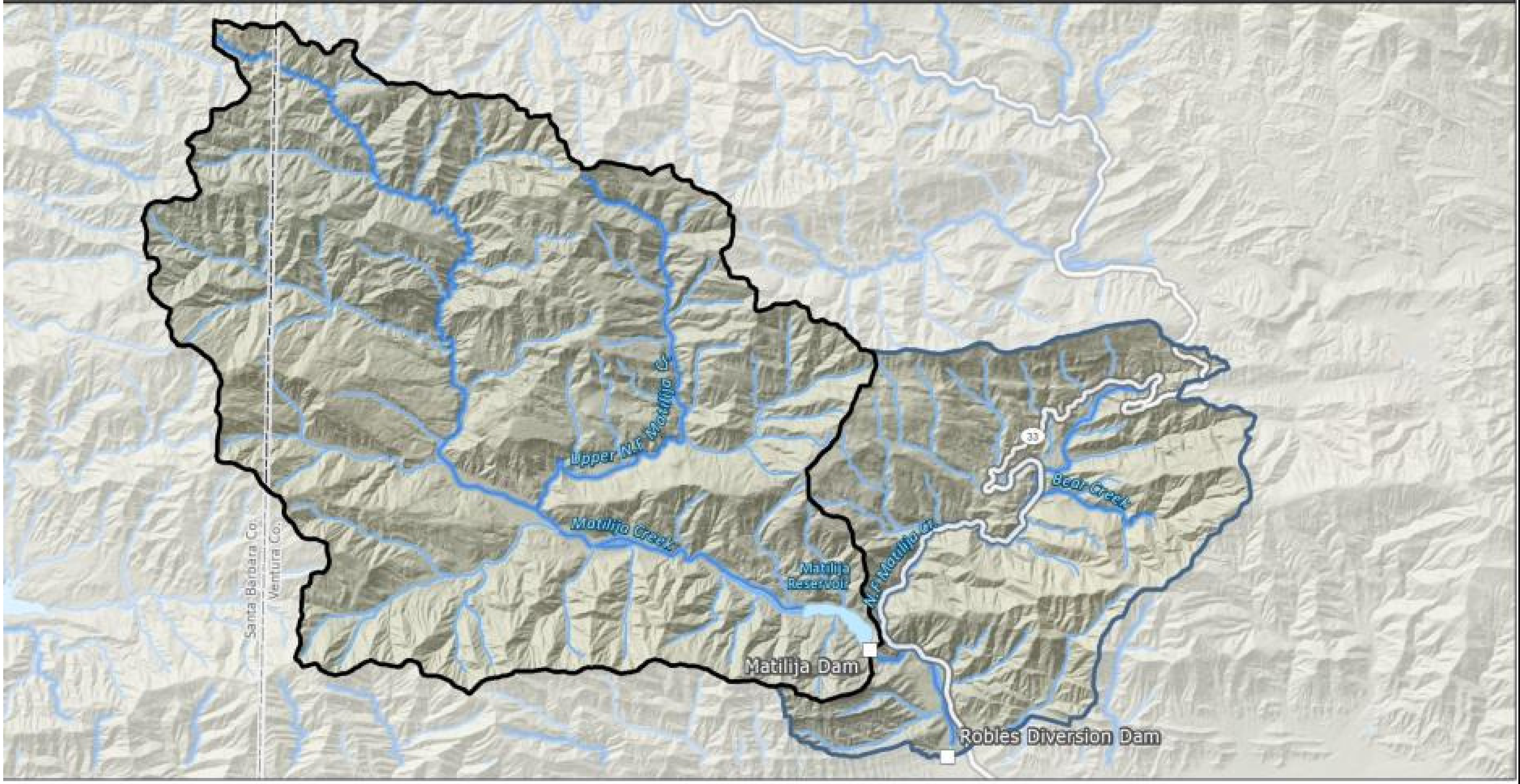
CONUNDRUM #2: Where's the rest of the fine sediment?

Figure 3.

Topics

1. Watershed hydrology
2. Impoundment-area sediment
3. Watershed sediment
4. Questions

TILIJA DAM REMOVAL ANALYSIS & MITIGATION



semap

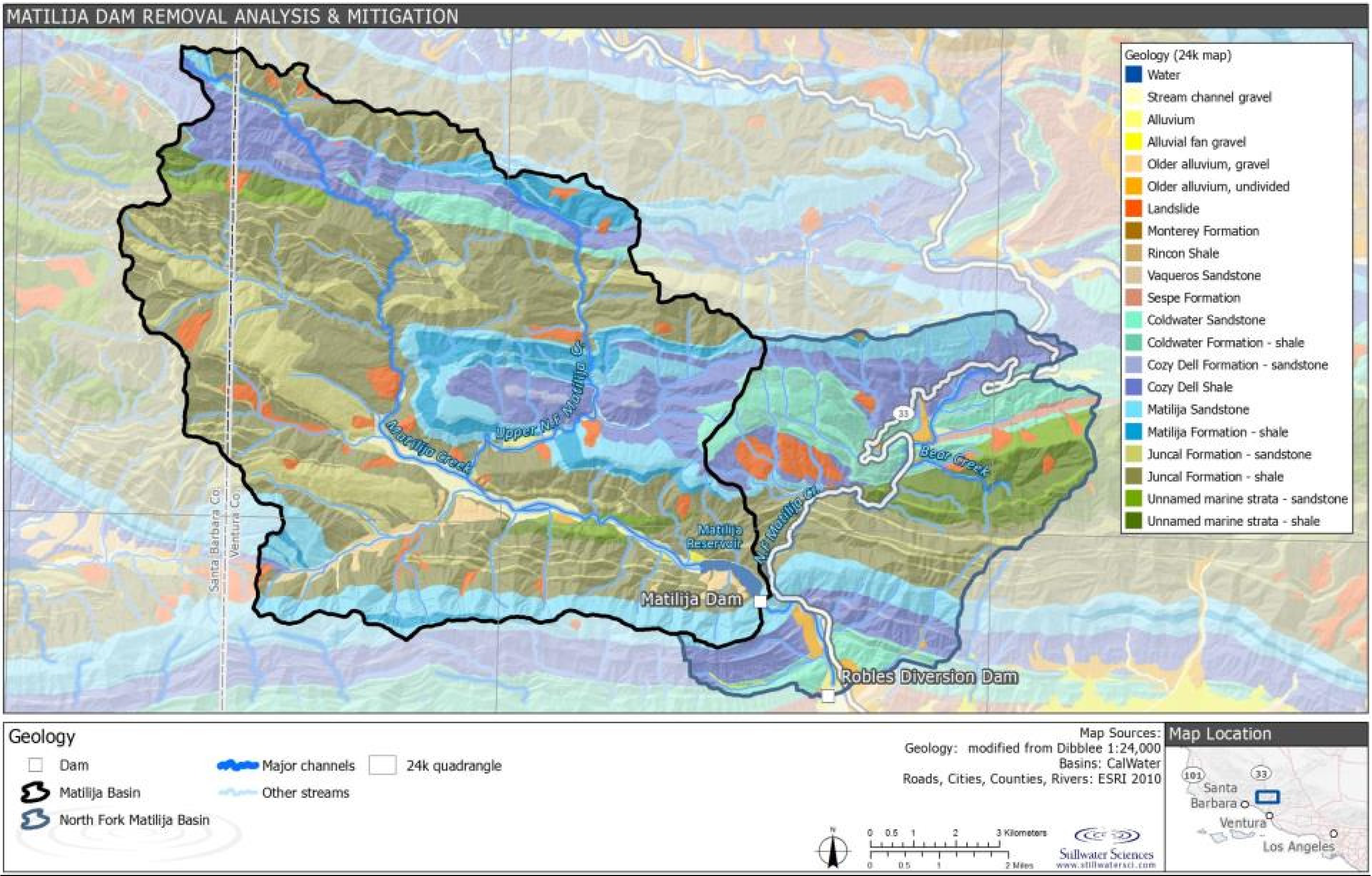
Dam — Matilija Basin — Major channels

North Fork Matilija Basin — Other streams

Map Sources:
Basins: CalWater
Roads, Cities, Counties, Rivers: ESRI 2010

Stillwater Sciences
www.stillwatersci.com

Map Location


MATILIJA DAM REMOVAL ANALYSIS & MITIGATION
Geology (24k map)
Water
Stream channel gravel
Alluvium
Alluvial fan gravel
Older alluvium, gravel
Older alluvium, undivided
Landslide
Monterey Formation
Rincon Shale
Vaqueros Sandstone
Sespe Formation
Coldwater Sandstone
Coldwater Formation - shale
Cozy Dell Formation - sandstone
Cozy Dell Shale
Matilija Sandstone
Matilija Formation - shale
Juncal Formation - sandstone
Juncal Formation - shale
Unnamed marine strata - sandstone
Unnamed marine strata - shale
Upper N.F. Matilija Cr.
Matilija Creek
Bear Creek
N.F. Matilija Cr.
33
Matilija Reservoir
Matilija Dam
Robles Diversion Dam
Santa Barbara Co.
Ventura Co.
Geology
Dam
Matilija Basin
North Fork Matilija Basin
Major channels
Other streams
24k quadrangle
Map Sources:
Geology: modified from Dibblee 1:24,000
Basins: CalWater
Roads, Cities, Counties, Rivers: ESRI 2010
0 0.5 1 2 3 Kilometers
0 0.5 1 2 Miles
Stillwater Sciences
www.stillwatersci.com
Map Location
101
33
Santa Barbara
Ventura
Los Angeles

TILIJA DAM REMOVAL ANALYSIS & MITIGATION

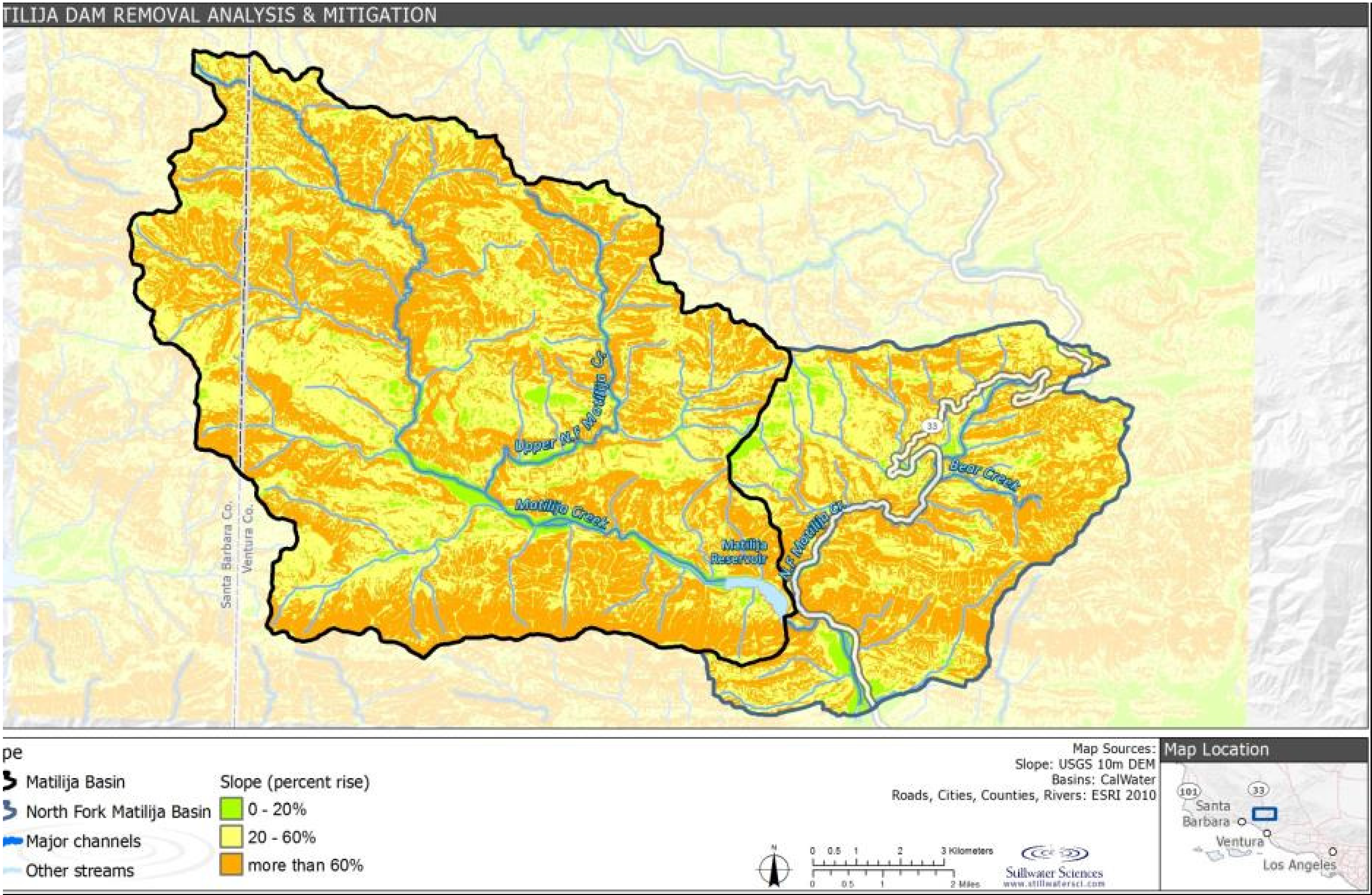


Table 5.14 of BOR (2006) reports the following estimates of watershed sediment yield:

Watershed	**Sediment Yield per mi^2 (acre-ft/mi^2/yr)**
Ventura Watershed without Casitas Dam and Matilija Dam	2.10
Ventura Watershed with Casitas Dam and Matilija Dam in place (current conditions)	1.36
Ventura Watershed with Casitas Dam in place	1.64
Matilija Creek Watershed	1.92

UNITS:

2.10 acre-ft/mi^2 /yr =

1 mm landscape lowering/yr =

2,600 tonnes/km^2/yr

A Method for Spatially Explicit Representation of Sub-watershed Sediment Yield, Southern California, USA

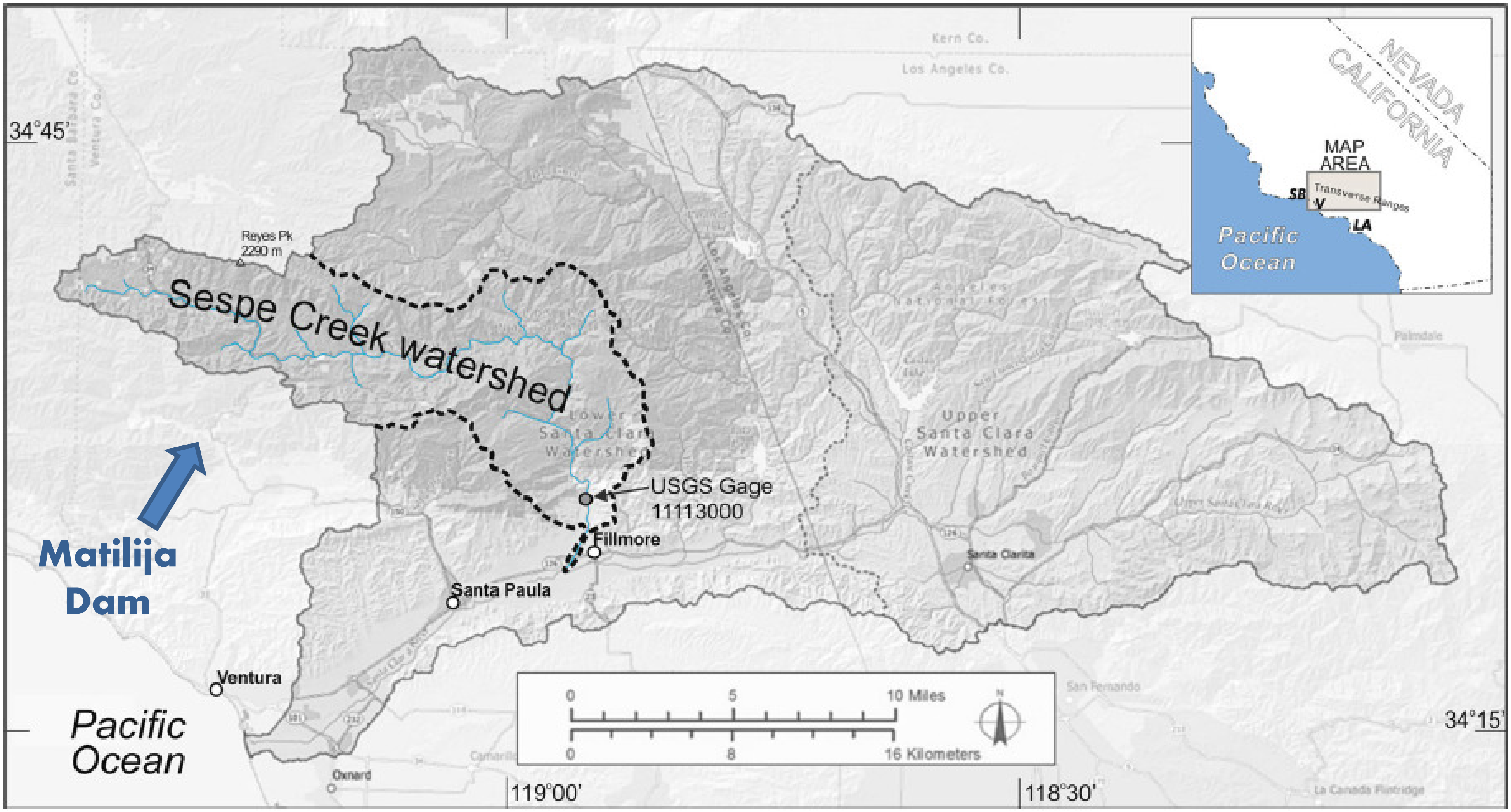
Derek B. Booth, Glen Leverich, Peter W. Downs, Scott Dusterhoff & Sebastian Araya

Environmental Management

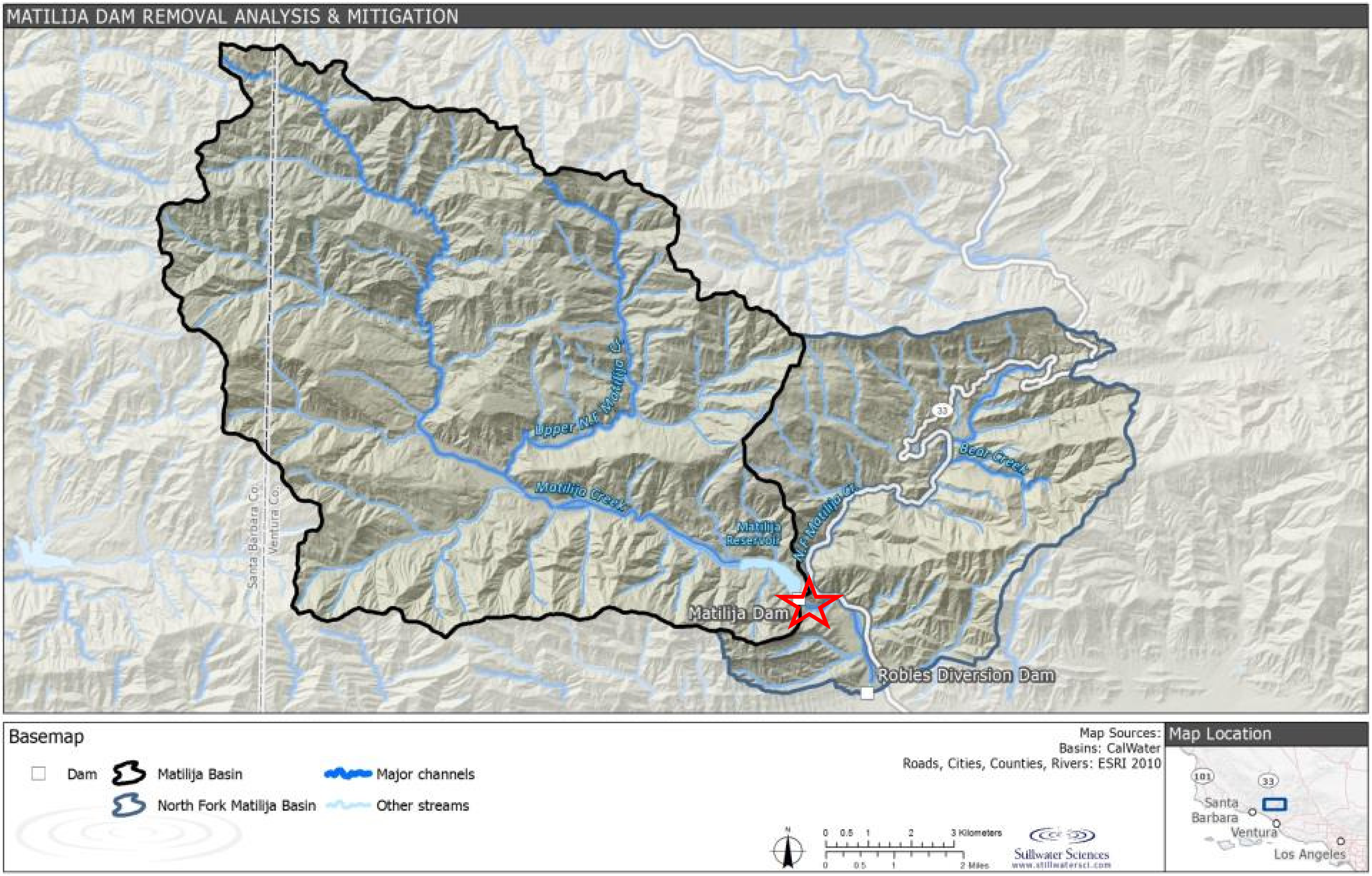
ISSN 0364-152X
Volume 53
Number 5

Environmental Management (2014)
53:968-984
DOI 10.1007/s00267-014-0251-9

Springer



Best estimate for Sespe Creek: 2,600 tonnes/km^2/yr



Best estimate for Matilija Creek: 3,000 tonnes/km^2/yr **= 400,000 tonnes/yr**

(Note: 1 tonne sediment ≈ 1 yd^3, given a density of 1.4 tonnes/m^3)

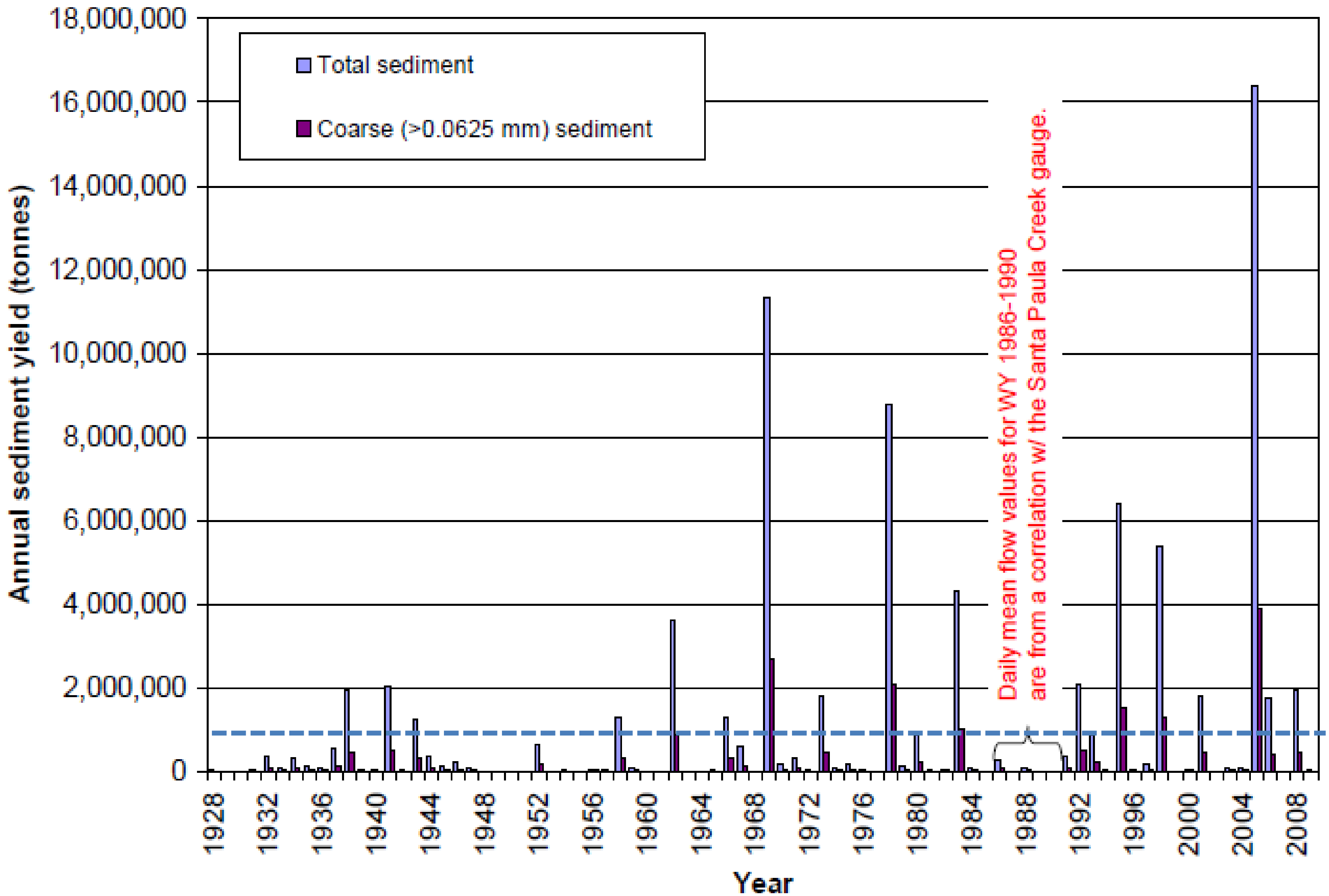
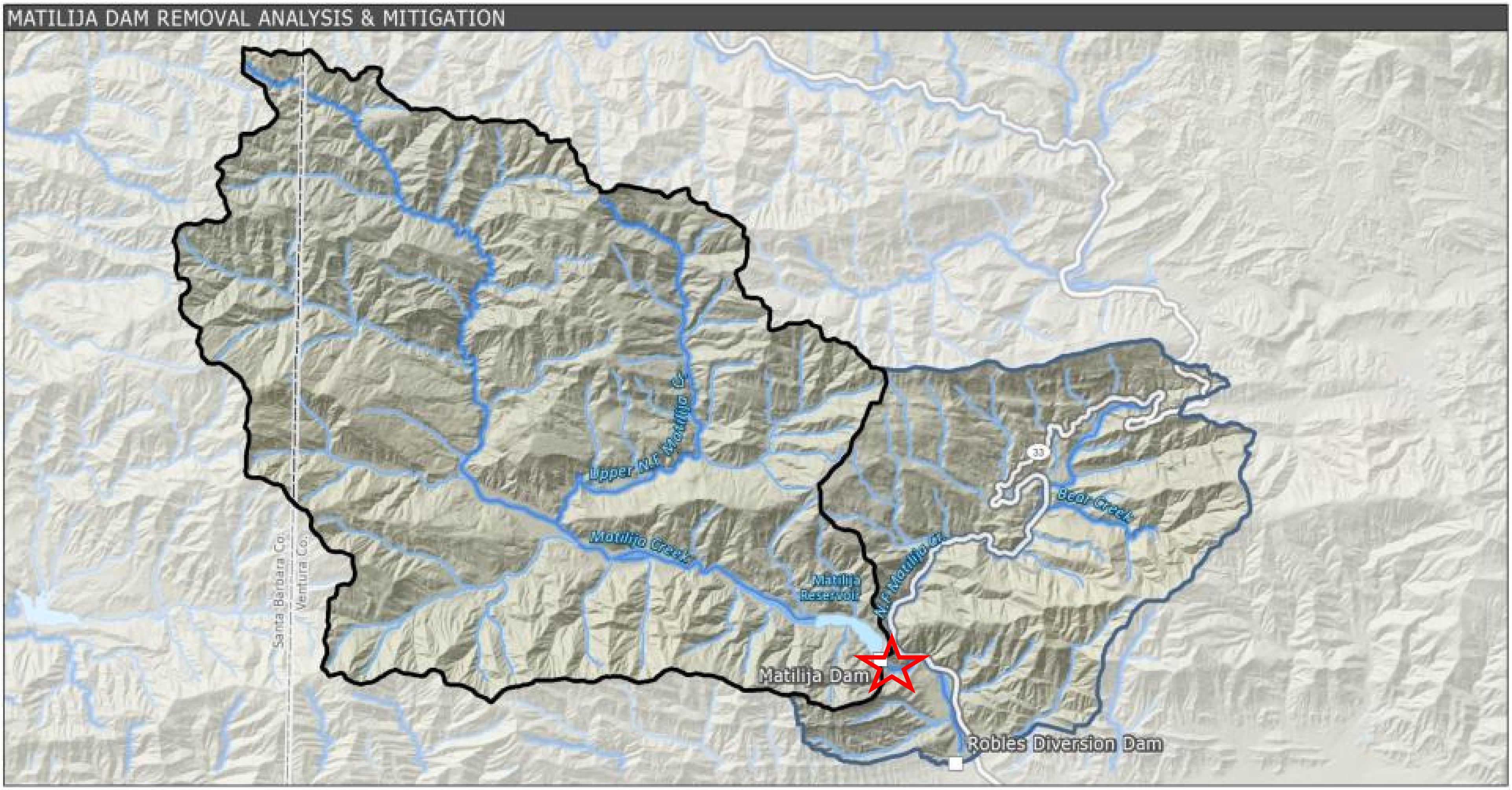


Figure 5. Calculated sediment load for Sespe Creek at Fillmore (USGS gage 11113000). Dashed blue line is the average annual sediment yield calculated from these data (990,000 tonnes/year). Major sediment-yielding years produce two to more than 16 times the long-term average value. From Stillwater Sciences (2010, their Figure 3.2).



- *Average* 400,000 tonnes/yr → 1 to >5M yd^3 for large events (of which >>50% will be silt/clay) (1-1.5M measured by USGS '69-'87).
- Compare this natural single-event transport volume to the ~4M yd^3 silt/clay now stored behind the dam.

Questions?