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In cooperation with CALFED Ecosystem Restoration Program, California Bay–Delta Authority, and California Resources Agency

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U.S. Department of the Interior
U.S. Geological Survey

Photo on front cover:

South Yuba River, looking upstream from old Highway 49 bridge, Nevada County, California; February 25, 2004, discharge approximately 1,500 cubic feet per second, on rising limb of hydrograph. Photograph by C.N. Alpers.

Use of Sediment Rating Curves and Optical Backscatter Data to Characterize Sediment Transport in the Upper Yuba River Watershed, California, 2001–03

By Jennifer A. Curtis¹, Lorraine E. Flint¹, Charles N. Alpers¹, Scott A. Wright², and Noah P. Snyder³

U.S. Geological Survey Scientific Investigations Report 2005–5246

Prepared in cooperation with CALFED Ecosystem Restoration Program,
California Bay–Delta Authority, and California Resources Agency

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
centimeter (cm)	0.3937	inch
cubic meter (m ³)	0.0008107	acre-foot
cubic meter per second (m ³ /s)	35.31	cubic foot per second
cubic meter per second (m ³ /s)	70.07	acre-foot per day
meter (m)	3.281	foot (ft)
millimeter (mm)	0.03937	inch
square centimeter (cm ²)	0.1550	square inch
square centimeter (cm ²)	0.001076	square foot
square kilometer (km ²)	0.3861	square mile (mi ²)
square meter (m ²)	0.0002471	acre
square meter per second (m ² /s)	10.76	square foot per second

Inch/Pound to SI

Multiply	By	To obtain
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)
cubic yard (yd ³)	0.7646	cubic meter
foot (ft)	0.3048	meter
inch (in.)	2.54	centimeter
gallon (gal)	3.785	liter
square inch (in ²)	6.452	square centimeter
ton per day (ton/day)	0.9072	metric ton per day (tonne/d)

Dual units are used in this report. English units are used throughout with the exception of suspended-sediment concentration, grain size, and optical backscatter data, which are presented in milligrams per liter, millimeters, and millivolts.

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$$

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27). Elevation refers to distance above the National Geodetic Vertical Datum of 1929 (NGVD 29)

Abbreviations

ft, foot
 ft³/s, cubic foot per second
 ft²/s, square foot per second
 g/ft/s, gram per foot per second
 in., inch
 m, meter
 μm, micrometer
 mi, mile
 mm, millimeter
 m², square meter
 mi², square mile
 Mya, million years ago
 phi, unit of measure used in grain size analysis
 r², coefficient of determination
 tons/day, tons per day
 tons/mi², tons per square mile
 yd³, cubic yard

Acronyms and Symbols

CBDA, California Bay–Delta Authority
 CBDA-ERP, California Bay–Delta Authority-Ecosystem Restoration Program
 D₈₄, the grain size representing 84 percent of the bed-surface material
 EDI, equal discharge interval
 EWI, equal-width increment
 ERP, Ecosystem Restoration Program
 g, gravitational acceleration
 GCLAS, Graphical Constituent Loading Analysis System
 h¹, the portion of the flow depth attributed solely to skin friction
 H₂O₂, hydrogen peroxide
 ID, identification number
 OBS, optical backscatter sensor
 p value, the probability of error associated with accepting the predicted results as true
 PI_{np}, nonparametric prediction interval
 Q, streamflow
 RMS, root mean square
 SSC, suspended-sediment concentration
 SSC/V, suspended-sediment concentration/voltage
 SDSZ, unpublished software documentation
 U, mean velocity
 U*, bed-shear velocity
 USGS, U.S. Geological Survey
 UYRSP, Upper Yuba River Studies Program
 WY, water year

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By Jennifer A. Curtis, Lorraine E. Flint, Charles N. Alpers, Scott A. Wright, and Noah P. Snyder

Abstract

Sediment transport in the upper Yuba River watershed, California, was evaluated from October 2001 through September 2003. This report presents results of a three-year study by the U.S. Geological Survey, in cooperation with the California Ecosystem Restoration Program of the California Bay–Delta Authority and the California Resources Agency. Streamflow and suspended-sediment concentration (SSC) samples were collected at four gaging stations; however, this report focuses on sediment transport at the Middle Yuba River (11410000) and the South Yuba River (11417500) gaging stations. Seasonal suspended-sediment rating curves were developed using a group-average method and non-linear least-squares regression. Bed-load transport relations were used to develop bed-load rating curves, and bed-load measurements were collected to assess the accuracy of these curves. Annual suspended-sediment loads estimated using seasonal SSC rating curves were compared with previously published annual loads estimated using the Graphical Constituent Loading Analysis System (GCLAS). The percent difference ranged from –85 percent to +54 percent and averaged –7.5 percent. During water year 2003, optical backscatter sensors (OBS) were installed to assess event-based suspended-sediment transport. Event-based suspended-sediment loads calculated using seasonal SSC rating curves were compared with loads calculated using calibrated OBS output. The percent difference ranged from +50 percent to –369 percent and averaged –79 percent.

The estimated average annual sediment yield at the Middle Yuba River (11410000) gage (5 tons/mi²) was significantly lower than that estimated at the South Yuba River (11417500) gage (14 tons/mi²). In both rivers, bed load represented 1 percent or less of the total annual load throughout the project period. Suspended sediment at the Middle Yuba River (11410000) and South Yuba River (11417500) gages was typically greater than

85 percent silt and clay during water year 2003, and sand concentrations at the South Yuba River (11417500) gage were typically higher than those at the Middle Yuba River (11410000) gage for a given streamflow throughout the three year project period. Factors contributing to differences in sediment loads and grain-size distributions at the Middle Yuba River (11410000) and South Yuba River (11417500) gages include contributing drainage area, flow diversions, and deposition of bed-material-sized sediment in reservoirs upstream of the Middle Yuba River (11410000) gage. Owing to its larger drainage area, higher flows, and absence of man-made structures that restrict sediment movement in the lower basin, the South Yuba River transports a greater and coarser sediment load.

Introduction

The upper Yuba River watershed is a heavily managed basin recovering from hydraulic gold mining that occurred in the mid 1800s to early 1900s. The Upper Yuba River Studies Program (UYRSP), a component of the California Bay–Delta Authority (CBDA) Ecosystem Restoration Program (ERP), is evaluating options for introducing spring-run Chinook salmon and steelhead trout upstream of Englebright Dam, which is located in the foothills of the northwestern Sierra Nevada, California (*fig. 1*). This report is one product of on-going studies by the U.S. Geological Survey (USGS) (Childs and others, 2003; Flint and others, 2004; Snyder and others, 2004a, 2004b, 2004c; Curtis and others, 2005), which provide a comprehensive analysis of sediment sources, transport, and storage in the upper Yuba River watershed. The USGS is also investigating water quality in the Yuba River watershed and sediment quality in Englebright Lake, with an emphasis on mercury contamination and bioaccumulation (Alpers and others, 2004; Slotten, 2004).

Figure 1. Location of sediment and streamflow gaging stations, study area of the Upper Yuba River Studies Program (UYRSP), and the upper Yuba River watershed, California. See table 1 for station names.

Purpose and Scope

This study assesses sediment transport in the upper Yuba River watershed, using sediment rating curves and optical backscatter data, and along with the USGS Annual Water-Data Reports (Rockwell and others, 2001; Smithson and others, 2002; Friebe and others, 2003), provides baseline daily, annual, and event-based sediment-transport data for the upper Yuba River watershed. The sediment rating curves and OBS time-series data were used to calibrate a watershed-scale sediment transport model (Flint and others, 2004) and to assess the magnitude and duration of sediment loads that may impact the viability of long-term fish-introduction strategies (Curtis and others, 2004). The rating curves provided a means to estimate annual sediment loads by using simulated historic streamflow from 1940 to 2000 (Flint and others, 2004). The estimated historic annual sediment loads were compared to downstream annual sedimentation rates in Englebright reservoir (Snyder and others, 2004c). In addition, the rating curves were used to estimate event-based sediment transport using 15-minute streamflow data, and these estimates were compared with estimates made using optical backscatter data. Sediment loads estimated using rating curves were compared with loads estimated using GCLAS (Rockwell and others, 2001; Smithson and others, 2002; Friebe and others, 2003), but are not intended to replace the previously published daily and annual loads.

Acknowledgments

Terry Mills and Rebecca Fris (CBDA-ERP) and the California Resources Agency assisted with project funding and contract management. Denis O'Halloran (USGS-Carnelian Bay, California) and Ned Andrews (USGS-Denver, Colorado) provided insightful discussions regarding sediment transport. Alan Mlodnosky (USGS-Marina, California), Carlin Dare (USGS-Menlo Park, California), Gary Schneider (USGS-Menlo Park, California), and Ryan Wooley (USGS-Menlo Park, California) completed the suspended-sediment-concentration and grain-size analyses. Sarah Yarnell (University of California, Davis), Michael Hunerlach (USGS-Sacramento, California), Donna Knifong (USGS-Sacramento, California), Michael Judd, and David Sparks assisted with the Shady Creek bed-load measurements.

Study Area

The Yuba River, a tributary to the Feather River in northern California, drains approximately 1,344 mi² along the western slope of the Sierra Nevada (*fig. 1*). The study area is within the upper Yuba River watershed, which encompasses the area upstream of Englebright Lake and includes three tributaries: the North Yuba River, the Middle Yuba River, and the South Yuba River. A significant part of the Yuba River sediment load is deposited in New Bullards Bar Reservoir (Brown and Thorpe, 1947; Dendy and Champion, 1978), in Englebright Lake (Childs and others, 2003; Snyder and others, 2004b; Snyder and others, 2004c), and behind Log Cabin Dam and Our House Dam (Yuba County Water Agency, 1989). Because only wash-load-sized material (the finer part of the sediment load carried by streamflow) bypasses New Bullards Bar Reservoir on the North Yuba River, the focus of this study was on sediment transport solely within the Middle Yuba and South Yuba Rivers.

The upper Yuba River tributaries (North Yuba, Middle Yuba, and South Yuba Rivers) are steep, mountain drainages that flow through narrow, deeply incised canyons alternating between bedrock and alluvial reaches. Alluvial reaches store considerable volumes of sediment in the channel bed, active bars, and infrequent well-vegetated floodplains and terraces (Curtis and others, 2005). Bedrock reaches have minimal channel storage, although patchy alluvium may be found in deep pools or behind bedrock constrictions or large boulders. Large volumes of sediment, derived from upstream hydraulic-mining activities, are currently stored in several upland tributaries that flow into the Middle Yuba and South Yuba Rivers.

Climate, Precipitation, and Runoff

The study area has a mediterranean climate with hot, dry summers and cool, wet winters. Beginning in November, Pacific frontal systems bring winter precipitation into northern California, and approximately 85 percent of the annual precipitation falls between November and April. Mean annual precipitation ranges from 20 in. at Marysville at the western downstream end of the watershed (*fig. 1*) to more than 59 in. at the eastern margin of the watershed along the Sierra Nevada crest (Western Regional Climate Center, accessed November 8, 2004). Total precipitation at Englebright Lake was 24 in., 32 in., and 37 in. (California Data Exchange Center, accessed November 8, 2004) during water years 2001, 2002, and 2003, respectively. Average annual precipitation at Englebright Lake is 33 in.; therefore, water year 2001 was a dry year, 2002 was below average, and 2003 was above average.

Figure 2. Annual peak streamflows measured from 1942 to 2003 for the gaging station on the Yuba River below Englebright Dam (YRE, 11418000) in the upper Yuba River watershed, California. See table 1 for station name and location. Data source: <http://nwis.waterdata.usgs.gov/>, accessed November 8, 2004.

Runoff in the study area is produced by winter storms from the Pacific, spring snowmelt, and occasional convective storms generated in the late summer or early autumn by subtropical air masses from the Gulf of Mexico (Kattleman, 1996). Peak flows can be as much as three orders of magnitude greater than base flows and annual runoff volumes can be as much as seven times greater in extremely wet years than those in critically dry years. Elevations between 4,000 to 6,000 ft in the study basin are susceptible to rain-on-snow events (California Department of Water Resources, 1966); these events have the greatest magnitude, duration, and ability to mobilize sediment. Notable runoff events (peak streamflows greater than 100,000 ft³/s) at the Yuba River below Englebright Dam (11418000) occurred during water years (WY) 1951, 1956, 1963, 1965, 1986, and 1997 (*fig. 2*). The timing of runoff throughout the study area is controlled to a considerable extent by a system of reservoirs and diversions (*fig. 3*).

Geologic Setting

Bedrock in the study area is composed primarily of Paleozoic metasediments and metavolcanics (ShooFly and

Calaveras Formations), Paleozoic and Mesozoic plutonic rocks (Bowman Lake batholith, Sierra Nevada batholith, and Yuba River pluton), and a Mesozoic ophiolite (Smartville Complex). Ridge tops typically are capped by Eocene auriferous sediments deposited by the ancestral Yuba River, Miocene-Pliocene rhyolites, rhyolitic sediments (Valley Springs Formation), and andesitic lahars (Mehrten Formation) (Saucedo and Wagner, 1992).

Cenozoic geologic history includes uplift and tilting of the Sierra Nevada and at least two Late Quaternary glaciations (Lindgren, 1911; Bateman and Wahrhaftig, 1966; Christensen, 1966; James and others, 2002). Uplift and tilting reorganized drainage networks and initiated a period of sustained channel incision. The modern Yuba River system began incising approximately 5 Mya (million years ago) (Wakabayashi and Sawyer, 2001). The easternmost portion of the basin was glaciated during the Quaternary, and the Middle Yuba River and South Yuba River drainages are mantled by till and glacial outwash deposited by Late Quaternary valley glaciers (James and others, 2002).

EXPLANATION

▲ 4,160	Gaging station and abbreviated number (Complete number as given in the station description is 11416000)	←	Stream, open flume, or canal showing direction of flow
□	Powerplant	← - - - -	Penstock, tunnel, closed flume, or pipe showing direction of flow

Figure 3. Stream diversions and reservoir storage in the upper Yuba River watershed, California. Source: Rockwell and others, 2001 <http://water.usgs.gov/pubs/wdr/WDR-CA-01-4/>.

EXPLANATION

- ▲ 4160 Gaging station and abbreviated number
 (Complete number as given in the station
 description is 11416000)
- Powerplant
- Stream, open flume, or canal
 showing direction of flow
- - - Penstock, tunnel, closed flume,
 or pipe showing direction of flow

Figure 3. Continued.

Figure 4. Hydraulic mining at Malakoff Diggings (circa 1876), located in the South Yuba River watershed, California. Historic photograph taken by Carleton E. Watkins, Hearst Mining Collection, Bancroft Library, University of California at Berkeley.

Hydraulic Mining History

Gold-bearing sediments, deposited by the ancestral Yuba River (Whitney, 1880; Lindgren, 1911; Yeend, 1974), were hydraulically mined during the California Gold Rush of the mid-to-late 1800s and again during a protracted period of licensed mining in the early 1900s. Hydraulic-mining involved directing high-pressure water cannons at exposures of Eocene gravel (*fig. 4*) and washing the excavated sediment slurry through mercury-laden sluice boxes (Bowie, 1905; May, 1970; Averill, 1976; Alpers and others, 2005). Hydraulic mine tailings were conveyed into adjacent watercourses (Alpers and Hunerlach, 2000; Alpers and others, 2005), leading to dramatic increases in sediment loads and severe aggradation (Hall, 1880; Turner, 1891; Gilbert, 1917). Gilbert (1917) estimated that hydraulic-mining contributed approximately 682 million yd³ of sediment to Yuba River channels. In 1884, owing to downstream environmental effects, large-scale hydraulic-mining was ended by court injunction (Sawyer Decision). Licensed hydraulic-mining began in 1893 (Camenetti Act) and continued in the Yuba River basin

until the 1930s. Presently, the abandoned hydraulic mine pits experience chronic hillslope erosion (Yuan, 1979) and, therefore, are considered a significant sediment source to upper Yuba River channels (Curtis and others, 2005).

Extensive remobilization of stored hydraulic-mining sediment began as early as 1861 when severe winter storms delivered substantial volumes of sediment to the Central Valley. In 1941, the California Debris Commission built Englebright Dam to trap hydraulic-mining sediment mobilized within the upper Yuba River watershed. The majority of Middle Yuba River and South Yuba River mainstem channels have since recovered their pre-mining bed elevations, but significant volumes of hydraulic mining sediment remain stored in wide mainstem reaches and in smaller upland tributaries of these two rivers. Previous studies of the Yuba River and adjacent watersheds (Wildman, 1981; James, 1993; Curtis, 1999) indicate that these smaller tributaries are asymptotically incising toward pre-mining channel-bed elevations; therefore, remobilization of hydraulic-mining sediment continues to affect sediment yields from impacted basins.

Methods of Data Collection and Analysis

Streamflow measurements and suspended-sediment samples were collected at four upper Yuba River gaging stations (*fig. 1*; *table 1*): Middle Yuba River near North San Juan (USGS station ID 11410000), South Yuba River at Jones Bar near Grass Valley (USGS station ID 11417500), Yuba River below New Colgate Powerplant near French Corral (USGS station ID 11413700), and Yuba River below Englebright Dam near Smartville (USGS station ID 11418000). The Middle Yuba River (11410000) gage operated from 1911 to 1941 and from 2001 to present. The South Yuba River (11417500) gage operated from 1940 to 1948 and from 1959 to present. The Yuba River below New Colgate Powerplant (11413700) gage was established in 2001 but was abandoned in 2003 owing to a poor gaging record. The Yuba River below Englebright Dam (11418000) gage operated continually from 1941 to present. Daily records of streamflow and suspended-sediment loads for water years 2001, 2002, and 2003 are published in USGS Annual Water-Data Reports (Rockwell and others, 2001; Smithson and others, 2002; Friebel and others, 2003). Annual streamflow peaks as well as daily and 15-minute streamflow data are available at <http://waterdata.usgs.gov/nwis/>.

Suspended Sediment

Sampling and Concentration Analysis

Depth-integrated, single vertical and multi-vertical suspended-sediment samples were collected at upper Yuba River gaging stations following standard USGS procedures (Edwards and Glysson, 1999). Samples were collected at four gaging stations (Middle Yuba River, 11410000; South Yuba River, 11417500; Yuba River below New Colgate Powerplant, 11413700; and Yuba River below Englebright, 11418000) during water years 2001 and 2002 and at three gaging stations (11410000, 11417500, 11418000) during water year 2003. Suspended-sediment concentrations for all samples were measured at the USGS sediment laboratory in Marina, California, using methods described by Guy (1969). During water years 2001 through 2003, single vertical samples were collected 1 to 7 days per week, depending on hydrologic conditions, with increased frequency of sampling during periods of higher streamflow. Beginning in water year 2002, two sequential single vertical samples were collected during each visit and analyzed separately for concentration. Multi-vertical cross-section samples, collected approximately monthly, were used to determine a coefficient to account for discrepancies between the mean suspended-sediment concentration of the single vertical samples and that of the entire cross section. Multi-vertical sampling consisted of collecting a single vertical sample, a set of 12 equal-discharge-increment (EDI) samples across the channel,

followed by another single vertical sample. The concentrations of these 14 samples were analyzed separately. Comparisons of the single vertical samples with the cross-section samples indicate that flows generally were well-mixed with respect to sediment at all four gaging stations. The average difference between concurrent single vertical and EDI samples was 13 percent. Although streamflow samples for suspended-sediment analysis were collected primarily during low and moderate flows, we infer the mean discharge-weighted suspended-sediment concentration of all single vertical samples are representative of the channel cross section, thus making use of a coefficient unnecessary.

Storm Sampling

Storm sampling at the Middle Yuba River (11410000) and South Yuba River (11417500) gages enabled characterization of changes in suspended-sediment concentrations and grain-size distributions over the duration of four discrete storm hydrographs during water year 2003. Storms were chosen to represent four different times during the wet season (November, December, February, and March). The November storm was the first runoff event of the wet season and the other three runoff events were typical winter storms. The protocol for storm sampling included collection of single vertical suspended-sediment samples at 1- to 2-hour intervals during daylight hours and collection of at least one sequential pair of grain-size samples per day, which enabled characterization of the rising limb, peak, and falling limb of each storm hydrograph.

Grain-Size Analysis of Suspended Sediment

Replicate sets of suspended-sediment samples were collected from three of the upper Yuba River gaging stations (Middle Yuba River, 11410000; South Yuba River, 11417500; and Yuba River below Englebright Dam, 11418000) during storm sampling for detailed grain-size analyses. Two sequential sets of depth integrated, multi-vertical, equal-discharge-interval (EDI) suspended-sediment samples were collected at five centroids across the channel cross section. One set of samples was analyzed at the USGS sediment laboratory in Marina, California. A second set of samples was analyzed at the USGS Coastal and Marine Geology laboratory in Menlo Park, California. Both laboratories used standard sieve methods described by Guy (1969) for grain size analysis of the sand-sized fraction and results were similar. However, sample preparation and the results for sediment smaller than 0.063 mm differed between the two laboratories. The Marina Laboratory removed organic material (using H₂O₂ [hydrogen peroxide]) only from the sand-sized fraction, and the less than 0.63-mm sized fraction is reported. The Menlo Park Laboratory removed the organic material from the full sample and completed detailed analyses of the less than 0.063-mm fraction. Both laboratories used hexametaphosphate to disperse sediment smaller than 0.063 mm, but the Menlo

Table 1. Summary of streamflow and suspended-sediment measurements for four sites in the Upper Yuba River watershed, California, during water years 2001, 2002, and 2003.

[See figure 1 for station locations. Latitude and longitude are referenced to the North American Datum of 1927 (NAD 27). Elevation is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). EDI, equal-discharge interval; N, number of samples. mi², square miles; ft, feet; ft³/s, cubic feet per second. —, gage discontinued because of poor rating]

Map identifier	Station identifier	Gage name	Location		Drainage area (mi ²)	Elevation (ft)	Water year 2001		
			Latitude	Longitude			Suspended-sediment EDI samples (N) ¹	Minimum daily streamflow (ft ³ /s)	Maximum daily streamflow (ft ³ /s)
MYG	11410000	Middle Yuba River near North San Juan, CA	39°23'39"	121°05'02"	198	1,450	196	27	150
SYG	11417500	South Yuba River at Jones Bar near Grass Valley, CA	39°17'32"	121°06'13"	308	1,600	194	29	1,020
YRC	11413700	Yuba River below New Colgate Powerplant near French Corral, CA	39°19'50"	121°11'34"	717	550	98	41	3,080
YRE	11418000	Yuba River below Englebright Dam near Smartville, CA	39°14'07"	121°16'23"	1,108	279	62	598	2,280

Map identifier	Station identifier	Water year 2002			Water year 2003		
		Suspended-sediment EDI samples (N) ²	Minimum daily streamflow (ft ³ /s)	Maximum daily streamflow (ft ³ /s)	Suspended-sediment EDI samples (N) ³	Minimum daily streamflow (ft ³ /s)	Maximum daily streamflow (ft ³ /s)
MYG	11410000	150	28	906	152	29	1,390
SYG	11417500	154	30	1,750	143	41	2,990
YRC	11413700	106	43	3,050	—	—	—
YRE	11418000	36	573	4,170	33	629	6,940

¹Sediment sample collection period for MYG and SYG, November 3, 2000, to September 30, 2001; for YRC, January 10, 2002, to September 30, 2001; and for YRE, January 13, 2001, to September 30, 2001. ²Sediment sample collection period October 1, 2001, to June 30, 2001. ³Sediment sample collection period November 1, 2002, to May 31, 2003.

Park Laboratory used ultrasound dispersal techniques also to further disperse the less than 0.063-mm sized fraction.

At the Menlo Park Laboratory, sediment smaller than 0.063 mm was analyzed using a Coulter LS 100Q laser-diffraction particle-size analyzer. Each sample was run through the Coulter instrument three times; the reported size distribution is the average of the three runs. Grain-size statistics were calculated using software (SDSZ; McHendrie and Madison, 1989, unpublished software documentation) that interpolates the size distribution at 0.5 phi increments.

Suspended-Sediment Rating Curves

Suspended-sediment transport is governed by sediment supply and the capacity of a stream to transport the available sediment. In some cases, such as alluvial rivers, streamflow and sediment supply tend to vary together such that the suspended-sediment concentration at a given location can be characterized using sediment rating curves, which relate transport of suspended sediment to streamflow. For cases when streamflow and sediment supply do not vary together, suspended-sediment concentration cannot be characterized by streamflow alone. In these cases, separate sediment rating curves must be developed for different supply conditions. Varying supply conditions occur primarily as a function of season in the Middle Yuba and South Yuba Rivers and justify development of separate suspended-sediment rating curves, as described below.

The relation between suspended-sediment concentration and streamflow at the four upper Yuba River gaging stations is shown in *figure 5 A-D* (also see *Appendix 1* for complete data set shown in *figure 5 A-D*). Significant scatter in the concentration–streamflow relations indicates differences in sediment supply conditions attributable to seasonal and natural variability. Lack of precipitation during summer and fall months results in low base streamflow (for example, 25 ft³/s), which allows fine sediment to settle and accumulate in deep pools. During the first significant fall runoff event, called the first flush, significant amounts of easily transportable fine sediment are scoured from pools and eroded from hillslopes. Although hillslope erosion rates throughout the upper Yuba River watershed are relatively low compared with erosion rates for rapidly eroding hillslopes such as those in the Pacific Northwest, rilling, gullying, and mass wasting occur throughout the study area (Curtis and others, 2005).

Seasonal variability in the supply of suspended sediment is clearly evident when peak streamflow and associated suspended-sediment concentrations for first flush and snow melt conditions are compared. Samples collected from the upper Yuba River during the first flush generally have high suspended-sediment concentrations with low associated streamflow. For example, peak suspended-sediment concentrations in November 2002, and associated streamflow (shown in parentheses), were 134 mg/L (280 ft³/s) at the South Yuba River (11417500) gage and 100 mg/L (58 ft³/s) at the Middle Yuba River (11410000)

gage (concentrations are averages for duplicate samples listed in *Appendix 1a,b*). Conversely, significant runoff from snowmelt occurs during the spring, resulting in high baseflows. Samples collected during snowmelt conditions have low suspended-sediment concentrations but high associated streamflow, indicating supply-limited conditions. For example, suspended-sediment concentrations during peak snowmelt conditions in May 2003, and associated streamflow, were 22 mg/L (1,930 ft³/s) at the South Yuba River (11417500) gage and 7 mg/L (260 ft³/s) at the Middle Yuba River (11410000) gage (concentrations are averages for duplicate samples listed in *Appendix 1a,b*).

Natural variability also influences the concentration–streamflow relation owing to processes such as depletion or rejuvenation of suspendable-sized sediment or to spatial variations in precipitation intensity and runoff throughout tributary and mainstem channel networks. Variability in the concentration–streamflow relation may also be caused by errors during sample collection and by corruption of samples during shipping or laboratory analyses.

Although there are numerous methods for developing rating curves, the most commonly used function for sediment rating curves is a power function,

$$SSC = a Q^b, \quad (1)$$

where SSC is suspended-sediment concentration (mg/L), Q is streamflow (ft³/s), and a and b are regression coefficients (Walling, 1977; Asselman, 2000; Horowitz, 2002). Power functions were defined and regression coefficients were fit using non-linear, least-squares regression. Suspended-sediment concentrations at the Yuba River below New Colgate Powerplant (11413700) (*fig. 5C*) and Yuba River below Englebright Dam (11418000) (*fig. 5D*) gaging stations are influenced by management of New Bullards Bar Reservoir and Englebright Lake. Because there are no systematic relations between suspended-sediment concentrations and streamflow at the Yuba River below New Colgate Powerplant (11413700) and Yuba River below Englebright Dam (11418000) gaging stations, regression analyses were completed only on samples collected at the Middle Yuba River (11410000) (*fig. 5A*) and South Yuba River (11417500) (*fig. 5B*) gages, which have significant scatter but show a general increase in suspended-sediment concentration with increasing streamflow.

Most of the suspended-sediment samples were collected under low to moderate streamflow conditions (*fig. 5(5)*); thus, regression analyses on these data are strongly influenced by the large number of measurements made during low streamflow conditions. The low-streamflow bias was removed from these data using a group average method, which results in a better defined slope for the upper end of the rating curve (Glysson, 1987). Removal of bias is an extremely important consideration because a slight error in the slope of the upper end of a sediment rating curve can generate significant error in predictions of suspended-sediment concentration, and may result in considerable error in calculations of sediment load.

Figure 5. Relation of suspended-sediment concentration to instantaneous streamflow by season for the four gaging stations in the upper Yuba River watershed, California. A, Middle Yuba River (11410000). B, South Yuba River (11417500). C, Yuba River below New Colgate Powerplant (11413700). D, Yuba River below Englebright Dam (11418000).

Figure 5. Continued.

Seasonal variability dramatically influences sediment supply and transport in the upper Yuba River watershed. A single suspended-sediment concentration rating curve that represents average conditions cannot represent these varying conditions. Therefore, a series of group-average sediment rating curves were established for the Middle Yuba River (11410000) and South Yuba River (11417500) gages that describe average (all data), summer/fall, first flush, winter, and spring snowmelt conditions. Prior to regression analysis, the arithmetic mean of suspended-sediment concentration was determined for several small ranges of Q , and an outlier threshold was established whereby suspended-sediment concentration values outside two standard deviations were excluded from the analysis. This improved the skewness of the data set and resulted in an approximate normal distribution. The average suspended-sediment concentration was plotted against the associated average streamflow value for each streamflow bin. Both variables were transformed to log 10 and a power function was fit through the group average data using non-linear least squares regression. The accuracy of the suspended-sediment rating curves was assessed using summary statistics and 95-percent confidence bounds.

Optical Backscatter

Schoellhamer and Wright (2003) demonstrated that optical backscatter sensors (OBS) can be used to predict suspended-sediment concentration in rivers if particle size and sediment color remain fairly constant. The sensors, developed and tested by Downing and others (1981), emit infrared light that is reflected by suspended particles in the water column. A series of photodiodes positioned around the emitter of the OBS detects any backscatter, and then an empirical calibration is used to convert the output voltage of the sensor into a suspended-sediment concentration. Calibration of the output voltage to suspended-sediment concentration can vary significantly with particle size and color (Conner and De Visser, 1992; Levesque and Schoellhamer, 1995; Sutherland and others, 2000) and bio-fouling can result in significant loss of data. Therefore, optical sensors must be cleaned regularly and calibrated using field data on a site-specific basis to determine if the effects of particle size and color influence sensor calibration for a given location.

Continuously recording OBSs were installed at the Middle Yuba River (11410000) and South Yuba River (11417500) gages to provide a 15-minute time series record of suspended-sediment concentration. The sensors were calibrated using depth-integrated, single vertical suspended-sediment samples that were analyzed for suspended-sediment concentration and percent fine-grained sediment (less than 0.063 mm) to assess the effects of grain size on the OBS output voltages. Because the OBS data can display non-constant variance, a linear calibration equation was determined using a robust, nonparametric, repeated median method originally developed for OBSs deployed in San Francisco Bay (Buchanan and Ruhl, 2000, 2001, 2002; Buchanan and Ganju, 2003, 2004). In addition, a prediction

interval and a 95-percent confidence interval were calculated for each calibration equation to assess the goodness-of-fit.

The repeated median method (Siegel, 1982) calculates slope in a two-part process. First, for each point (X, Y) , the median of all possible "point i " to "point j " slopes is calculated

$$\beta_i = \text{median} \left(\frac{Y_j - Y_i}{X_j - X_i} \right) \text{ (for all } j \neq i) \quad (2)$$

The calibration slope is calculated as the median of β_i

$$\text{slope} = \hat{\beta}_1 = \text{median}(\beta_i) \quad (3)$$

The calibration intercept is calculated as the median of all possible intercepts using the calibration slope

$$\text{intercept} = \hat{\beta}_0 = \text{median}(Y_i - \hat{\beta}_1 X_i) \quad (4)$$

The final linear calibration equation is

$$Y = \hat{\beta}_1 X + \hat{\beta}_0 \quad (5)$$

The nonparametric prediction interval (PI_{np}) (Helsel and Hirsch, 1992, p. 76) contains one standard deviation (68.26 percent) of the calibration data set and represents essentially the same error prediction limits as the root mean square (RMS) error of prediction in ordinary least-squared regression. However, the PI_{np} , unlike the RMS error of prediction, frequently is not symmetrical about the regression line. Asymmetry about the regression line is a result of the distribution of the data set; thus, the PI_{np} may be reported as +9 to -16 mg/L. The PI_{np} is calculated by computing and sorting, from least to greatest, the residuals for each point. Then, based on the sorted list of residuals,

$$PI_{np} = \hat{Y}_{(\alpha/2)(n+1)} \text{ to } \hat{Y}_{(1-\alpha/2)(n+1)} \quad (6)$$

$\hat{Y}$ is the residual value, n is the number of data points, and α is the confidence level of 0.6826.

To calculate the confidence interval, all possible point-to-point slopes are sorted in ascending order. On the basis of the confidence interval desired, 95 percent for the purposes of this report, the ranks of the upper and lower bounds are calculated as follows:

$$Ru = \frac{\frac{n(n-1)}{2} + 1.96\sqrt{\frac{n(n-1)(2n+5)}{18}}}{2} + 1 \quad (7)$$

$$Rl = \frac{\frac{n(n-1)}{2} - 1.96\sqrt{\frac{n(n-1)(2n+5)}{18}}}{2} \quad (8)$$

where Ru is the rank of the upper bound slope, Rl is the rank of the lower bound slope, and n is the number of samples. To establish the 95-percent confidence interval, the ranks calculated above are rounded to the nearest integer and the slope associated with each rank in the sorted list is identified.

Bed Load

Bed Material Grain-Size Analysis

For the purpose of developing bed-load rating curves, bed-surface samples were collected at Middle Yuba River (11410000) and South Yuba River (11417500) gages and at three locations along Shady Creek (figs. 1, 6). Pebble counts, made using the method described by Wolman (1954), were used to determine the surface grain-size distribution at the Shady Creek sites, whereas volumetric bed-material samples, collected using methods outlined by Milhous (1973), were used to determine the surface grain-size distribution at Middle Yuba River (11410000) and South Yuba River (11417500) gages.

Volumetric bed-material samples required excavation of the largest particle exposed on the channel bed. Although there were boulder-sized particles (greater than 256 mm) on the channel bed, only particles less than or equal to 128 mm were collected because particles larger than this could not easily be

measured. Bed material was sampled volumetrically from a 0.25-m² area to a level corresponding roughly to the bottom of the hole that was created when the largest particle was removed. Because small samples are systematically biased toward fine-grained sediment (Ferguson and Paola, 1997), we used a technique that increased the total sample volume, thus improving the sampling of particles larger than 64 mm. As sediment was shoveled into four 5-gallon buckets, all the particles greater than 64 mm were removed and hand sieved using a hand-held size analyzer and the less-than-64-mm sediment deposited in the buckets. We assumed that the particle-size distribution of the less-than-64-mm sediment in the four buckets was equal and completed further grain-size analyses of the less-than-64-mm fraction using sediment from a single bucket, which is an important consideration when sediment must be transported to a laboratory facility for sieving of the less-than-11-mm particles. The less-than-64-mm sediment from one bucket was sun-dried and field sieved at 0.5 phi intervals that ranged from 64 to 11 mm. Particles smaller than 11 mm were transported to a USGS sediment lab located in Sacramento, California, where

Figure 6. Location of bed-load sampling sites and cross-section bed-load transport locations along Shady Creek in the upper Yuba River watershed, California.

they were oven-dried and laboratory sieved at 0.5 phi intervals ranging from 11 to 0.063 mm. Church and others (1987) recommend much larger sample sizes than were collected in this study. The suggested sample size would have required earth-moving equipment. For this study, the added time and expense were not justifiable.

Bed-Load Rating Curves

To compute total sediment transport at the Middle Yuba River (11410000) and the South Yuba River (11417500) gages, bed-load transport had to be estimated. Regression relations between measured bed-load transport and streamflow could not be developed because logistics and expense precluded collection of bed-load measurements on the Middle Yuba and South Yuba Rivers. Therefore, bed-load transport rates were predicted using an empirical relation that relates sediment transport to the hydraulic conditions of the channel and to the sediment available for transport on the bed.

A single representative grain size was used in early studies (Meyer-Peter and Müller, 1948) to determine bed-load rating relations; consequently, these relations cannot account for different grain sizes moving at different rates. More recent bed-load relations can be used to predict transport rates for many individual grain sizes (Parker and others, 1982; Parker, 1990) but are limited to grain sizes larger than 2.0 mm. Using a series of flume experiments Wilcock and others (2001) concluded that small proportions of sand can cause nonlinear increases in bed-load transport, thereby causing predictions of greater bed-load transport rates. These flume data were used to develop an empirical mixed-size bed-load transport relation (Hopkins model; Wilcock and Crowe, 2003).

Bed-load transport rates were calculated for a range of streamflow values using the Hopkins model, which was developed from 48 observations of flow, transport, and bed-surface grain size (Wilcock and others, 2001). The 48 experimental runs spanned a four-fold range in streamflow (volumetric water discharge per unit width = 0.32 ft²/s to 1.39 ft²/s) and a 6 order-of-magnitude range in total sediment transport (0.0007 to 2,977 g/ft/s). Sediment used in the flume experiments were sand and gravel mixtures with gravel sizes ranging from 2.0 to 64 mm and sand sizes ranging from 0.2 to 2.0 mm. The proportion of sand in the sediment mixtures ranged from 6.2 to 34.3 percent, and the proportion of surface sand was measured following each experimental flume run and varied from 0.1 to 48 percent.

It is commonly advised that sediment transport models be applied only under conditions similar to those for which the model was developed. At the Middle Yuba River (11410000) gage, South Yuba River (11417500) gage, and Shady Creek sites, the streamflows of interest ranged from 18 to 4,800 ft³/s, which equates to unit streamflows of 2.2 ft²/s to 28.0 ft²/s. Although application of the Hopkins model for the upper Yuba River sites requires significant extrapolation beyond the maximum measured unit streamflow (1.39 ft²/s) in the

empirical data set of the model, the mean daily unit streamflow at the Middle Yuba River (11410000) and South Yuba River (11417500) gages exceeded this value (1.39 ft²/s) only about 5 percent of the time. Granted the percentage of the annual bed load transported at these higher flows was likely much greater than 5 percent; however, bed load was not measured and therefore the percentage of bed-load transport represented by the empirical dataset could not be determined. However, the percentage of sand in surface samples of bed material collected at the Middle Yuba River (11410000) gage, South Yuba River (11417500) gage, and at the Shady Creek sites ranged from 1.7 to 3.4 percent, which is within the range of the surface sand proportions in the empirical data set of the model.

The Hopkins model requires estimates of the surface grain-size distribution, water-surface slope, and shear velocities associated with the streamflow of interest. Laboratory analyses of bed material from the Middle Yuba River (11410000) and South Yuba River (11417500) gage sites and pebble counts (Wolman, 1954) at the Shady Creek sites were used to define surface grain-size distributions (*fig. 7*). Water-surface slopes were determined from longitudinal surveys of water-surface elevations measured using a surveyor's transit level and a stadia rod along 500 ft of channel distance. Water-surface slope and surface grain-size distributions were assumed to be stationary for the range of streamflow analyzed.

Methods used to estimate bed-shear velocities warrant a detailed explanation. Bed-shear stress can be partitioned into skin friction, the portion of stress that is exerted on individual grains and thus responsible for transport, and form drag attributable to large roughness elements, such as bedforms, boulders, bedrock outcrops, or large trees within the active channel. When applying a transport predictor such as the Hopkins model, only the skin-friction portion of bed-shear stress should be used to compute bed-shear velocities. Because bed-shear stresses in the upper Yuba River include a significant component of form drag, this term was removed before computing the shear velocities used in the Hopkins model. Skin friction was estimated using a form of the Einstein-Keulegan relation defined for a mixture of bed particles (Andrews, 1983)

$$U/U^* = 2.5 \ln(3.7 h^1 / D_{84}) \quad (9)$$

$$U^* = (g h^1 S)^{1/2} \quad (10)$$

where U is mean velocity, U^* is bed-shear velocity, h^1 is the portion of the flow depth attributed solely to skin friction, D_{84} is the grain size representing 84 percent of the bed-surface material, g is gravitational acceleration, and S is water-surface slope. Estimates of skin friction (bed-shear velocity minus the form-drag component) for a range of streamflows (0 to 5,000 ft³/s) were calculated by solving both sides of equation 9 for h^1 iteratively using EXCEL Solver. In the absence of form drag, $h^1 = h$; thus, h^1 represents a hypothetical flow depth that can be used to estimate bed-shear velocities attributable solely to skin friction. Calculation of h^1 required estimates of U , S , and D_{84} for a range of streamflows (0 to 5,000 ft³/s). Mean velocities (U) for the

Figure 7. Cumulative percentage of the grain-size distribution of bed-surface material for two bed-load sampling sites located in Shady Creek and gaging stations on the Middle Yuba River (11410000) and South Yuba River (11417500) in the upper Yuba River watershed, California.

range of streamflows were estimated using mean velocity and streamflow relations (*fig. 8*), whereas slope (S) and D_{84} were estimated using field data. At the Middle Yuba River (11410000) gage, channel geometry changes between the low (wading site) and high (bridge site) streamflow measurement sites necessitated development of two separate velocity-streamflow relations (*fig. 8*). The high-flow relation was used to develop the Middle Yuba River (11410000) gage bed-load rating curve.

Shady Creek Bed-Load Measurements

Bed-load samples collected on Shady Creek (a tributary to the South Yuba River) were used to assess the accuracy of the bed-load rating curves developed using the Hopkins model. Concurrent streamflow and bed-load measurements were collected at two locations along Shady Creek (*fig. 6*) using standard sampling techniques (Edwards and Glysson, 1999).

Single equal-width increment (EWI) samples were collected using a BL-84 cable-operated bed-load sampler at the Old Hwy 49 Bridge site and a BLH-84 hand-held sampler at the Rust Pit wading site (*fig. 6*). Both samplers have a 3-square-inch entrance nozzle and an area expansion ratio (ratio of nozzle exit area to entrance area) of 1.40. Samples were collected at the midpoints of evenly spaced verticals and sampling times at each vertical were equal. This allowed composite samples to be prepared for laboratory analyses. The bed-load samples were oven dried, weighed, and sieved at 0.5 phi intervals that ranged from 0.063 to 180 mm. Bed-load discharge (tons/day) was calculated as

$$q_{bi} = k (M / T) \quad (11)$$

where q_{bi} is the bed-load transport rate (tons/day); k is a conversion factor, based on the width of the sampler nozzle (0.381 for 3-in. nozzles used here) used to convert grams/second into tons/day; M is total mass of the bed-load sample (grams); and T is the total time the sampler was on the channel bed (seconds).

EXPLANATION

- Middle Yuba River low flows
- ▲ Middle Yuba River high flows
- ◆ South Yuba River

Figure 8. Mean velocity and streamflow relations for gaging stations on the Middle Yuba River (11410000) and South Yuba River (11417500) in the upper Yuba River watershed, California. Note that streamflow measurements were collected at two sites near the Middle Yuba River gaging station: a wading site during low flows and at a bridge site during higher flows.

Results

Suspended Sediment

Storm Sampling

Storm sampling provided information regarding the timing of suspended-sediment concentration and streamflow peaks as well as information about varying grain-size distributions during storm events. Storm hydrographs, suspended-sediment concentrations, and percent sand are shown in *figure 9A-D*. Sediment sampling missed the November 2002 streamflow peak (*fig. 9A*); however, several sediment peaks that arrived prior to the storm peak were sampled and are characteristic of abundant sediment supply during first flush conditions. During the December 2002 storm event, the peak in suspended-sediment concentration coincided with the peak in streamflow (*fig. 9B*). We inferred that this was indicative of an abundant sediment supply during transport-limited winter storm conditions. During the February 2003 storm, the peaks in suspended-sediment concentration and streamflow coincided at the South Yuba River gage, again inferred to represent winter storm conditions, but the peak in suspended-sediment concentration was delayed at the Middle Yuba River (11410000) gage (*fig. 9C*). During the March 2003 storm, the peak in suspended-sediment concentrations arrived approximately 3 hours earlier than the peak in streamflow at the Middle Yuba River (11410000) gage and 6 hours earlier than the streamflow peak at the South Yuba River (11417500) gage (*fig. 9D*). The early arrival of sediment peaks indicated a limited supply of sediment. For the most part, concentrations of sand change systematically over the storm hydrographs with the lowest percentage of sand on the rising limb, greater percentages on the falling limb, and the highest percentages at the peak, indicating some hysteresis in sand concentrations.

Another observation made during storm sampling was of anomalously high suspended-sediment concentrations at the Middle Yuba River (11410000) gage on December 16, 2002 (see inset *figure 9B*). Significant volumes of sediment are stored behind Log Cabin Dam and Our House Dam (*fig. 1*), which require periodic dredging (Yuba County Water Agency, 1989). During large runoff events, these facilities discharge water over their spillways, and previously impounded sediment may be scoured and conveyed downstream resulting in elevated suspended-sediment concentrations at the Middle Yuba River (11410000) gage. Log Cabin Dam spilled again during the March 2003 storm sampling, but the impact of the spill was less dramatic in the March 2003 data set. During the March 2003 event, the peak in suspended-sediment concentration coincided with the peak of the spill, but the peak in streamflow at the Middle Yuba River (11410000) gage did not occur until several hours later. The magnitude of the December 2002 and March 2003 streamflows were similar, which may indicate that the first spill event of the water year flushed most of the finer impounded sediment available for transport over the spillway.

Grain-Size Analysis of Suspended Sediment

Suspended-sediment concentrations and grain sizes of sand-size material measured at the U.S. Geological Survey laboratory in Marina, California, are presented in *table 2*. Samples processed at the Marina laboratory did not meet the minimum sample mass requirement for pipet analyses of the less-than-0.063-mm sized sediment. However, the less-than-0.063-mm grain-size fraction of replicate samples sent to the USGS sediment laboratory in Menlo Park, California, was analyzed using a laser-diffraction particle-size analyzer. Suspended-sediment concentration, median and mean grain sizes (in μm), and percentages of clay (less than 0.004 mm), silt (0.004 to 0.063 mm), and sand (0.063 mm to 2.0 mm) measured at the Menlo Park laboratory are presented in *table 3*; full grain-size distributions are presented in *Appendix 2*.

A

EXPLANATION

— Streamflow   X Percent sand in suspended sediment   ■ Suspended-sediment concentration

Figure 9. Instantaneous streamflow, suspended-sediment concentrations, and percent sand of suspended sediment during storm events at the Middle Yuba River (11410000) and South Yuba River (11417500) gaging stations in the upper Yuba River watershed, California. A, November 2002; B, December 2002; C, February 2003; and D, March 2003. X's denote the date and time of samples analyzed for percent sand, and there are no grain-size data from the February 2003 event at Middle Yuba River gage.

Figure 9. Continued.

C

EXPLANATION

- Streamflow
- × Percent sand
- Suspended-sediment concentration

Figure 9. Continued.

D

EXPLANATION

- Streamflow
- × Percent sand
- Suspended-sediment concentration

Figure 9. Continued.

Table 2. Summary of streamflow, suspended-sediment concentrations, and grain sizes of sand-sized suspended sediment at gaging stations in the upper Yuba River watershed, California.

[See figure 1 for station locations. Sand-size material measured by the U.S. Geological Survey in Marina, California. ft³/s, cubic foot per second; mg/L, milligram per liter; mm, millimeter]

Map identifier	Station identifier	Date	Time	Streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)	Grain size percent finer than 2.0 mm	Grain size percent finer than 1.0 mm	Grain size percent finer than 0.5 mm	Grain size percent finer than 0.25 mm	Grain size percent finer than 0.125 mm	Grain size percent finer than 0.063 mm
MYG	11410000	11/08/02	15:15	88	55		100	99	98	98	96
		11/09/02	08:15	66	96		100	98	98	97	97
		12/14/02	10:00	1,250	79		100	99	97	92	86
		12/15/02	07:30	883	48		100	98	96	92	88
		12/16/02	11:50	1,950	374		100	98	95	93	90
		12/16/02	11:50	1,950	375	100	97	96	95	93	90
		12/16/02	11:50	1,950	360		100	99	97	95	94
		12/17/02	13:25	170	35			100	99	98	95
		12/18/02	10:00	95	10			100	97	93	92
		12/30/02	12:00	150	5						¹ 94
		03/14/03	15:00	63	7						¹ 94
		03/15/03	15:45	1,230	218		100	99	98	96	88
		03/16/03	15:30	100	6						¹ 90
SYG	11417500	11/08/02	10:15	279	116		100	100	99	97	94
		12/13/02	14:22	123	12		100	100	76	72	65
		12/14/02	08:00	1,970	145		100	100	90	87	83
		12/15/02	14:15	1,270	50		100	100	96	93	89
		12/16/02	14:35	3,060	223		100	100	89	84	79
		12/17/02	09:52	1,240	30		100	100	93	87	79
		12/17/02	10:11	1,220	29				92	86	78
		12/17/02	10:11	1,220	31		100	100	89	82	73
		12/18/02	09:40	605	13				95	88	79
		12/30/02	16:00	750	14				93	87	79
		12/31/02	11:31	1,190	199		100	100	99	99	98
		02/16/03	07:00	661	39		100	100	95	91	87
		02/16/03	07:00	661	36		100	100	95	93	88
		02/17/03	13:00	419	7						¹ 91
		02/17/03	13:00	419	8						¹ 86
		03/14/03	16:00	409	89				99	99	98
		03/15/03	11:30	2,790	404	100	97	97	80	76	70
		03/16/03	12:30	974	18				92	85	75
YRE	11418000	03/15/03	14:10	5,400	10						¹ 89
		03/16/03	10:45	2,980	3						¹ 95

¹Insufficient samples; therefore, percent finer than 0.063 mm only.

Table 3. Summary of streamflow, suspended-sediment concentrations, and grain sizes of suspended sediment collected at gaging stations in the upper Yuba River watershed, California.

[See figure 1 for station locations. Grain-size material measured at the U.S. Geological Survey in Menlo Park, California. ft³/s, cubic foot per second; mg/L, milligram per liter; mm, millimeter; μ m, micrometer]

Map identifier	Station identifier	Date	Time	Streamflow (ft ³ /s)	Suspended sediment concentration (mg/L)	Sand (greater than 0.063 mm) (%)	Silt (0.004 to 0.063 mm) (%)	Clay (less than 0.004 to 0.063 mm) (%)	Grain size, median (μ m)	Grain size, mean (μ m)
MYG	11410000	11/08/02	15:20	88	48	2	30	68	3	3
		11/09/02	08:17	66	82	0	31	69	3	2
		12/14/02	10:00	1,250	69	7	70	23	11	11
		12/15/02	07:30	889	37	0	62	38	6	5
		12/17/02	13:25	170	39	2	65	33	6	6
		12/18/02	10:00	100	9	0	58	42	5	4
		12/30/02	12:00	153	4	0	61	39	5	5
		02/06/03	08:00	158	13	1	54	45	5	4
		02/16/03	08:00	158	12	0	58	42	5	5
		02/17/03	14:00	83	5	0	48	52	4	4
		02/17/03	14:00	83	10	0	65	35	6	6
		02/17/03	14:00	83	13	0	41	59	3	3
		03/14/03	15:00	70	12	0	55	45	5	5
		03/15/03	15:45	1,240	223	8	66	26	10	9
		03/15/03	15:45	1,240	219	7	65	28	9	9
		03/16/03	15:30	105	8	0	54	46	5	4
SYG	11417500	11/08/02	10:22	279	105	0	59	41	5	5
		12/13/02	14:22	123	18	0	48	52	4	4
		12/14/02	08:00	1,970	128	9	56	35	6	8
		12/15/02	14:15	1,270	49	6	62	32	7	7
		12/16/02	14:35	3,060	87	18	60	22	10	15
		12/18/02	09:40	605	9	17	56	27	9	11
		12/30/02	16:00	750	11	10	57	33	7	8
		12/31/02	11:30	1,190	208	1	58	41	5	5
		02/16/03	07:00	661	36	7	59	34	7	7
		02/17/03	13:00	419	5	9	58	33	7	7
		03/14/03	16:00	409	90	1	54	45	4	4
		03/14/03	16:00	409	83	0	52	48	4	4
		03/15/03	11:30	2,790	411	22	50	28	9	15
		03/15/03	11:30	2,790	415	24	49	27	9	15
		03/16/03	12:30	974	11	2	63	35	7	6
YRE	11418000	03/15/03	14:10	5,400	10	0	54	46	4	4
		03/16/03	10:45	2,980	10	0	56	44	5	5

Normalized by the mean of the two measurements, the concentrations measured in the Marina laboratory were on average 4.9 percent higher than those measured in the Menlo Park laboratory. Generally higher concentrations measured at the Marina laboratory may reflect the different sample-processing techniques used in the two laboratories (removal of organic material from the full sample and ultrasonication at Menlo Park). The Marina laboratory measurements of sand content averaged 7.0 percent higher than the measurements at the Menlo Park laboratory. This difference may reflect the removal of organic material, perhaps because the H_2O_2 reaction not only dissolves free-floating organic material but also the thin organic films on the surfaces of sediment grains. In addition, ultrasound dispersal techniques used at the Menlo Park laboratory may break up particle aggregates thereby reducing grain size relative to the undispersed samples. Concentration and percent sand were measured in the Menlo Park laboratory both before and after removal of organics for a subset of 12 samples from February and March 2003. On average, suspended-sediment concentrations were 28.0 percent higher prior to removal of organic material (reflecting 3–26 mg/L of material removed during the reaction with H_2O_2) and sand contents were 1.4 percent greater.

Suspended sediment in the upper Yuba River watershed was dominantly silt and clay (typically greater than 85 percent) during water year 2003, and sand concentrations were higher at the South Yuba River (11417500) gage than at the Middle Yuba River (11410000) gage for similar streamflow rates (*fig. 10*). Small-volume (5 to 10 pints) samples collected for grain-size analyses resulted in high variability among processed replicate

samples. These differences underscore the importance of using large-volume samples to obtain more precise grain-size analyses, especially during low-concentration conditions.

Suspended-Sediment Rating Curves

Group-average suspended-sediment rating curves for the Middle Yuba River (11410000) and South Yuba River (11417500) gages describe average, summer/fall, first flush, winter, and spring snowmelt conditions (*fig. 11*). The form and goodness-of-fit of regressions are shown in *table 4*. Suspended-sediment concentrations generally increase with increasing streamflow indicating an associated increase in stream power (the ability of the river to transport sediment); however, the slopes of the seasonal rating curves differ significantly. Variations in the slopes of the rating curves indicate changes in sediment supply throughout the water year. Under average and below-average precipitation conditions, such as occurred during the study period, sediment supply is greatest during the first flush of the water year; therefore, the first flush curves for the Middle Yuba and South Yuba Rivers have the greatest slopes. Sediment supplies decreased following the first flush; thus, the slopes of the winter rating curves are lower than those of the first flush curves. The spring and summer/fall rating curves had the lowest slopes, indicating lower sediment supplies during spring snowmelt conditions and throughout the dry summer and fall months.

EXPLANATION

Samples analyzed at USGS laboratory located in

- Marina, California
- Menlo Park, California

Figure 10. Relation between percent sand (the proportion of suspended-sediment larger than 0.063 millimeter) and instantaneous streamflow for two gaging stations in the upper Yuba River watershed, California. A, Middle Yuba River (11410000). B, South Yuba River (11417500).

A

Figure 11. Non-linear regression relations between suspended-sediment concentration and instantaneous streamflow for the Middle Yuba River (11410000) and South Yuba River (11417500) gaging stations in the upper Yuba River watershed, California. A, Average; B, Summer/Fall; C, Fall first flush; D, Winter; and E, Spring. See table 4 for regression equation form and summary statistics.

B

Figure 11. Continued.

C

Figure 11. Continued.

D

Figure 11. Continued.

E

Figure 11. Continued.

Table 4. Regression equation form and statistics for gaging stations in the Middle Yuba and South Yuba Rivers in the upper Yuba River watershed, California.

[Note: Regression variables, which include suspended-sediment concentration and streamflow, were converted to base-10 logarithms. r^2 , coefficient of determination. a is the Y intercept and b is the regression coefficient in equation 1. N, number of data points: Data points were used to determine group-averaged dataset; group-averaged data points were used in the regression analysis]

	a	b	r^2	Standard error	P value	F statistic	Critical F statistic	⁶ N	⁷ N (group-averaged)
Middle Yuba River (MYG, Station ID 11410000)									
Average ¹	-1.776	1.278	0.95	0.165	0.000	326	1.4	675	19
Summer/fall ²	-0.602	0.516	0.28	0.125	0.050	5	1.5	135	14
First flush ³	-4.377	2.987	0.60	0.423	0.001	18	1.5	154	14
Winter ⁴	-1.838	1.317	0.91	0.207	0.000	178	1.4	371	19
Spring snowmelt ⁵	-0.736	0.602	0.65	0.145	0.008	13	1.6	174	9
South Yuba River (SYG, Station ID 11417500)									
Average ¹	-2.066	1.221	0.87	0.310	0.000	120	1.4	698	20
Summer/fall ²	-1.548	1.024	0.57	0.209	0.002	16	1.5	127	14
First flush ³	-3.127	1.945	0.79	0.383	0.000	40	1.5	145	12
Winter ⁴	-2.750	1.460	0.91	0.273	0.000	184	1.4	380	20
Spring snowmelt ⁵	-0.798	0.538	0.67	0.186	0.007	20	1.6	165	9

¹Used all data except outliers. ²Used all data collected from June through November except outliers and first flush event data. ³Used all data collected from June through November except outliers. ⁴Used all data collected from December through March except outliers. ⁵Used all data collected from April through May except outliers.

⁶Number of data points used to determine group-averaged dataset. ⁷Number of group-averaged data points used in regression analysis.

The accuracy of seasonal suspended-sediment rating curves was assessed based on 95-percent confidence intervals for predicted values (*fig. 11A–E*) and summary statistics (*table 4*). Confidence intervals denote a range around the predicted value where the “true” value can be expected with a given level of certainty, which is 95 percent in this case, and the confidence interval width indicates uncertainty. The first flush regressions display the widest confidence intervals, and therefore the predicted suspended-sediment concentrations have the greatest associated uncertainty. The confidence intervals for the summer/fall and spring snowmelt rating curves are greater than those for the winter and average curves indicating greater accuracy for the winter and average curves.

The following is a synopsis of the summary statistics presented in *table 4*. The p value represents the probability of error associated in accepting the predicted results as true. Higher p values indicate less confidence in the regression as a reliable indicator of the relation between suspended-sediment concentration and streamflow. Typically, p values less than or equal to 0.05 are considered borderline statistically significant, p values less than or equal to 0.01 commonly are considered statistically significant, and p values less than or equal to 0.001 often are considered highly significant. The total variation in predicted suspended-sediment concentrations accounted for by the regression equations is given by r^2 , which can also be used as a measure of the strength of the regression relation. The standard error is an overall indication of the accuracy with which the regression predicts the dependence of suspended-sediment concentration on streamflow; however, the magnitude of the standard error is proportional to the magnitude of the dependent variable. Thus this statistic cannot be used to compare the accuracies of several of the regressions. The p values of all the regressions listed in *table 4* were 0.05 or less, indicating statistical significance. In addition, the F statistic was greater than the critical F ($\alpha = 5$ percent) for all regressions in *table 4*, providing further evidence of statistical significance. The r^2 values for the first flush and spring snowmelt regressions for the Middle Yuba and South Yuba Rivers generally were lower than those for the average and winter regressions; the r^2 values for the summer/fall regressions were extremely low. Consequently,

the average and winter regressions have a greater likelihood for predicting suspended-sediment concentrations closest to the true value.

Bed Load

Bed-Load Rating Curves

Bed-load rating curves (*fig. 12*) indicate that the Middle Yuba River has greater transport capacity (the ability to transport bed load) than the South Yuba River for a given instantaneous streamflow, even though bed material at the Middle Yuba River (11410000) gage site (*fig. 7*) is coarser because of deposition of fine-grained bed material in upstream reservoirs. The greater transport capacity at the Middle Yuba River (11410000) gage, compared with that at the South Yuba River (11410000) gage, can be attributed to a narrower and deeper channel that results in higher streamflow velocities (*fig. 8*) and to a smaller component of form drag that affects bed-shear stresses. The high slopes of the velocity-streamflow relations (*fig. 8*) further demonstrate that the Middle Yuba and South Yuba Rivers experience a rapid increase in capacity and competence (the size of the largest particle a stream can entrain under any given set of hydraulic conditions) with increasing streamflow.

Shady Creek Bed-Load Measurements

The accuracy of predicted bed-load rating curves was assessed using bed-load measurements collected in Shady Creek, a tributary to the South Yuba River that has been severely impacted by hydraulic mining (*fig. 13*). Shady Creek bed-load rating curves, a comparison of bed-load measurements and predicted bed-load transport rates, and grain-size distributions of bed-load samples are presented in *figure 14*, *table 5*, and *figure 15* respectively.

Figure 12. Relation of bed-load transport to instantaneous streamflow for the Middle Yuba River (11410000) and South Yuba River (11417500) gaging stations in the upper Yuba River watershed, California. Bed-load rating curves were developed using an empirical transport model for mixed-size sediment (Wilcock and Crowe, 2003). Note that the bed-load transport was developed only for the range of flows observed during the study period from 2001 to 2003.

Figure 13. Extensive volumes of historical hydraulic-mining sediment are located in Shady Creek, a tributary to the South Yuba River in the upper Yuba River watershed, California. View is looking upstream along the left bank.

Figure 14. Relation of bed-load transport and instantaneous streamflow, and bed-load measurements for bed-load sampling sites on Shady Creek, a tributary to the South Yuba River in the upper Yuba River watershed, California. See figure 6 for site locations.

Table 5. Measured bed load and predicted bed-load transport rates for two sites along Shady Creek in the upper Yuba River watershed, California.

[See figure 6 for location of sampling sites. ft³/s, cubic feet per second; tons/day, tons per day]

Sampling location	Sample number	Date	Time	Streamflow (ft ³ /s)	Measured bed-load transport (tons/day)	Predicted bed-load transport rates (tons/day)		Ratio (predicted/measured) ¹
						Rust Pit rating curve	Shady Road rating curve	
Rust Pit	RP-1a	02/17/02	09:00	10	0.7	0.2		29
	RP-1b	02/17/02	09:10	13	0.8	0.5		63
	RP-2a	04/28/03	11:20	22	14.3	2.3		16
	RP-2b	04/28/03	11:30	28	16.8	4.6		27
Above Old Hwy 49 Bridge	H49-1a	02/25/04	11:15	191	289.9		817.3	282
	H49-1b	02/25/04	11:50	196	480.5		817.3	170
	H49-2a	02/25/04	14:40	201	487.9		980.2	201
	H49-2b	02/25/04	15:09	207	267.7		980.2	366
	H49-3a	02/26/04	15:40	66	94.2		134.4	143
	H49-3b	02/26/04	16:16	72	214.4		134.4	63
	H49-4a	02/26/04	10:01	77	126.3		224.5	178
	H49-4b	02/26/04	10:19	80	89.2		224.5	252

¹Bed-load transport rates at the Above Old Hwy 49 Bridge site were predicted using the Shady Road rating curve

Figure 15. Cumulative grain-size distributions for bed-load samples collected on Shady Creek, a tributary to the South Yuba River in the upper Yuba River watershed, California. The fraction of the bed-load sample from Rust Pit consisting of grains less than 1.4 millimeter was not sieved. Paired samples are indicated by matching colors. The order of collection of the pairs is indicated by "a" and "b" labels. See figure 6 for site locations and table 5 for information about paired samples.

Shady Creek bed-load rating curves were developed for two locations (Rust Pit and Shady Road, *fig. 6*). Subsequent to developing the rating curves, sites were chosen for bed-load measurements. Low streamflow conditions were measured at the Rust Pit wading site and higher streamflow conditions were measured at the Old Hwy 49 Bridge site (*fig. 6*). Predicted bed-load transport at the Shady Road site was inferred to be representative of bed-load transport at the Old Hwy 49 Bridge site; therefore, the Shady Road rating curve was used to estimate bed-load transport at the Old Hwy 49 Bridge site. Use of the Shady Road rating curve to estimate bed-load transport at the Old Hwy 49 Bridge site was justified based on the equation of continuity and the character of the channel between the two sites. Downstream of the Shady Road site, the channel transitions into a narrower, steeper, bedrock channel with negligible channel storage; therefore following the laws of conservation, bed-load transported past the Shady Road site subsequently passes the Old Hwy 49 Bridge.

Overall, the bed-load measurements agreed well with predicted curves; bed-load measurements were generally within the bounds of the bed-load rating curves (*fig. 14*). Grain-size distributions for paired bed-load samples agreed well; sediment values were generally within 10 percent of each other (*fig. 15*). However, transport rates at the Old Hwy 49 site were generally overpredicted and transport rates were generally underpredicted for the Rust Pit site (*table 5*).

Sediment Transport

There are three ways of defining total sediment discharge, the sum of all sediment passing a gaging station per unit time. (1) Total sediment discharge may be divided into fine-grained

material and bed-material fractions. Fine-material discharge consists of particles finer than those normally found in the streambed. Bed-material discharge is composed of particles typically found in considerable quantity in the streambed. (2) Total sediment discharge may be divided into suspended-sediment, whose weight is entirely supported by the surrounding fluid, and into bed load, whose weight is supported primarily by the streambed. (3) Total sediment discharge may also be divided into sampled and unsampled sediment discharge. Owing to physical limitations of depth-integrating suspended-sediment samplers, samples are only collected from the water surface to within 0.3 ft of the streambed. Sampled sediment discharge consists of both fine material and bed material transported in suspension greater than 0.3 ft above the streambed. Unsampled sediment discharge (unsampled by the bed-load sampler) consists of both fine material and bed material transported in suspension less than 0.3 ft above the streambed and bed material transported as bed load. In this report, total sediment discharge equates to the sum of sampled suspended-sediment discharge and estimated bed-load discharge.

Annual Sediment Discharge

Annual sediment discharge was calculated at the Middle Yuba River (11410000) gage and South Yuba River (11417500) gage for water years 2001, 2002 and 2003 (*table 6*). Suspended-sediment discharge was calculated using seasonal suspended-sediment rating curves and mean daily streamflow, whereas bed-load discharge was calculated using the flow-duration sediment transport method (Glysson, 1987), which employed bed-load rating curves and 15-minute streamflow data.

Table 6. Annual sediment discharge and bed-load estimates for gaging stations on the Middle Yuba and South Yuba Rivers in the upper Yuba River watershed, California.

[Annual suspended-sediment discharge estimated using seasonal suspended-sediment rating curves. Annual bed-load discharge estimated using mixed-sediment model (Wilcock and Crowe, 2003). Total annual sediment discharge equals annual suspended-sediment discharge plus annual bed-load discharge. tons/mi², tons per square mile; mi², square mile]

Year	Annual suspended-sediment discharge (tons)	Annual bed-load discharge (tons)	Total annual sediment discharge (tons)	Annual sediment yield (tons/mi ²)
South Yuba River (SYG, Station ID 11417500 [drainage area 308 mi ²])				
2001	730	1	731	2
2002	4,700	16	4,716	15
2003	7,600	89	7,689	25
Average annual (sediment discharge)			4,379	14
Middle Yuba River (MYG, Station ID 11410000 [drainage area 198 mi ²])				
2001	150	0	150	1
2002	910	3	913	5
2003	2,000	19	2,019	10
Average annual (sediment discharge)			1,027	5

Estimated annual sediment discharges at the Middle Yuba River (11410000) gage were significantly lower than those at the South Yuba River (11417500) gage even when compared by drainage area. The main contributing factor to the difference in sediment loads is that 88 percent of the Middle Yuba River watershed lies upstream of Log Cabin and Our House Reservoirs. This effect is compounded by significant flow diversions above the Middle Yuba River (11410000) gage, which resulted in a median daily flow for the project period of 57 ft³/s at the Middle Yuba River (11410000) gage compared with 98 ft³/s at the South Yuba River (11417500) gage. Because the South Yuba River has higher flows and no man-made restrictions to sediment movement in the lower basin, it is able to transport a greater and coarser sediment load.

In water years 2001, 2002, and 2003, the Middle Yuba River transported only 9, 14, and 31 percent, respectively, of the load transported by the South Yuba River at the gaging stations. The increase of sediment discharge in water year 2003 at the Middle Yuba River (11410000) gage, relative to that at the South Yuba River (11417500) gage, may reflect the influence of spill events at Log Cabin and Our House Dam reservoirs. Our House Reservoir, the larger of the two facilities, spilled only 1 day in 2001, 11 days in 2002, and 21 days in 2003. Because anomalously high suspended-sediment concentrations (*fig. 9B* inset) can occur during spill events, annual suspended-sediment discharge may be elevated during years in which these reservoirs spill. Storm sampling in December 2002 and March 2003 indicates that the first spill event in December 2002 flushed a fraction of suspendable-sized reservoir sediment impounded within Log Cabin and Our House Dam reservoirs. As the volume of suspendable-sized reservoir sediment was depleted, subsequent spills, such as occurred in March 2003, contributed smaller amounts of sediment.

The percentage of annual sediment discharge transported as bed load was less than 1 percent throughout the study period, which was quite low and unexpected given the abundance of bed material available for transport. Significant volumes of hydraulic-mining sediment remain stored in smaller upland tributary channels. The mining sediment tends to be finer grained and therefore more transportable than bed material derived from non-mining sources (James, 2005). Consequently, stored sediment from hydraulic mining represents a significant sediment source in the Middle Yuba and the South Yuba Rivers (Curtis and others, 2005).

It is important to note that 88 percent of the Middle Yuba River watershed lies upstream of Log Cabin and Our House Reservoirs; therefore most of the source area for coarser sediment in the Middle Yuba River was cutoff by the reservoirs, which subsequently resulted in decreased bed-load transport and coarsening of the channel bed at the Middle Yuba River (11410000) gage (*fig. 7*). However, the low bed-load transport rates at the South Yuba River (11417500) gage remain an anomaly (*table 6*). Below-average to average precipitation conditions occurred throughout the project period, which likely influenced the low percentage of annual sediment discharge transported as bed load. During above-average water years, the percentage of bed load may change as greater streamflows mobilize larger volumes of bed material.

A better representation of the long-term average bed-load transport can be made using estimates of bed load transported by the Feather River (*fig. 1*). The Feather River is adjacent to the Yuba River and has a similar land-use history including hydraulic mining and timber harvesting. On the basis of deposition in Lake Oroville, long-term average sediment discharge for the Feather River from 1902 to 1962 consisted of approximately 13 percent bed load (Porterfield and others, 1978).

Annual suspended-sediment discharges reported here are compared with those published in the USGS annual data reports (*table 7*). Annual suspended-sediment discharges published in USGS annual data reports were estimated using a software package called Graphical Constituent Loading Analysis System (GCLAS; <http://oh.water.usgs.gov/gclas/>). GCLAS is designed to compute mean daily suspended-sediment concentrations and mean daily sediment loads. Using suspended-sediment concentrations and mean daily streamflow, GCLAS implements a user-defined interpolation between suspended-sediment concentration data points to predict a continuous trace of mean daily suspended-sediment concentrations. A typical time series of concentration data includes one concentration data point every 1 to 3 days. Load computations are made by applying a mid-interval method to the concentration time series data, which involves interpolating concentrations during periods between data points. Options for interpolation are user-defined and include linear (preferred) or log-linear equations.

Table 7. Annual suspended-sediment discharge for gaging stations on the Middle Yuba (MYG) and South Yuba (SYG) Rivers in the upper Yuba River watershed, California. [GCLAS, Graphical Constituent Loading Analysis System, used for U.S. Geological Survey annual data reports (Rockwell and others, 2001; Smithson and others, 2002; Friebe and others, 2003). Percent difference is the difference between the GCLAS and rating curve estimates divided by the GCLAS estimate. Rating curve regression equations listed in table 4 for sample periods]

Water year	Sampling period	Annual suspended-sediment discharge		Percent difference
		Estimated using GCLAS (tons)	Estimated using rating curves (tons)	
South Yuba River (SYG, Station ID 11417500)				
2001	11/08/00–09/30/01	1,500	690	54
2002	10/01/01–06/30/02	3,400	4,700	-38
2003	11/01/02–05/31/02	7,700	7,500	3
Middle Yuba River (MYG, Station ID 11410000)				
2001	11/08/00–09/30/01	140	140	0
2002	10/01/01–06/30/02	480	890	-85
2003	11/01/02–05/31/02	2,400	1,900	21

The two methods for estimating annual suspended-sediment discharge produced substantially different results (*table 7*). The difference in annual suspended-sediment discharge estimated using the seasonal rating curves and that estimated using GCLAS ranged from -85 to +21 percent for the Middle Yuba River and from -38 to +54 percent for the South Yuba River. The percent difference was generally greatest for water years that had below average precipitation (WY2001 and 2002); however, there was 0 percent difference for the Middle Yuba River in WY2001. Wetter conditions prevailed during WY2003, and the number of samples increased. The time series dataset for suspended-sediment concentrations in WY2003 included four storm sampling events. The increased number of samples collected during WY2003 likely improved the GCLAS estimates of sediment loads.

Event-Based Suspended-Sediment Discharge

A continuous time series of calibrated OBS data and seasonal suspended-sediment rating curves were used to evaluate event-based suspended-sediment transport. Calibration of the optical backscatter data required a relatively stable particle-size distribution. Over the range of flows represented in the calibration data sets (50 to 2,000 ft³/s), the fraction of fine-grained sediment (percent less than 0.063 mm) remained quite high, varying from 73 to 99 percent, which indicates that fine-grained sediment dominates the suspended load. A plot of the ratio of suspended-sediment concentration to sensor output voltage as a function of suspended particles finer than 0.063 mm (*fig. 16*) has an essentially constant slope, illustrating the minimal effects of particle size on sensor calibration (*fig. 17*). At higher flows, as more sand goes into suspension, the effects of particle size likely increase; therefore, sensor calibrations indicate an increase in uncertainty with increasing streamflow, indicated by the large deviation outside the prediction interval by the confidence bounds at higher suspended-sediment concentrations (*fig. 17*).

The accuracy of the calibrated OBS data was assessed using nonparametric prediction intervals and 95-percent confidence intervals. The nonparametric prediction interval (Helsel and Hirsch, 1992, p. 76) contains one standard deviation (68.26 percent) of the calibration dataset and represents essentially the same error prediction limits as the root mean square (RMS) error of prediction in ordinary least-squared regression, and the confidence intervals represent a range of predicted values where the true value can be expected to fall with 95 percent certainty. The smaller width of the prediction and confidence intervals for the Middle Yuba River calibration equation indicates greater accuracy than that for the South Yuba River calibration equation. In addition, confidence bounds increase with increasing concentration and sensor output voltage, indicating greater accuracy at low to moderate concentrations.

Figure 16. Ratio of suspended-sediment concentration to optical backscatter sensor output voltage as a function of suspended particles finer than 0.063 millimeter for two gaging stations: Middle Yuba River (11410000) and South Yuba River (11417500). OBS, optical backscatter sensor; SSC, suspended-sediment concentration.

Figure 17. Relation of suspended-sediment concentration and optical backscatter sensor (OBS) output for two gaging stations in the upper Yuba River watershed, California. A, Middle Yuba River (11410000); B, South Yuba River (11417500). OBS, optical backscatter sensor.

Calibrated OBS data and winter suspended-sediment rating curves were used to evaluate suspended-sediment transport for two moderate discharge events occurring during December 2002 at the Middle Yuba River (11410000) and South Yuba River (11417500) gages (*table 8*). *Figure 18* shows streamflow and predicted suspended-sediment concentrations based on calibrated OBS output and winter rating curves. During the December 20–23, 2002 storm, the OBS registered delayed sediment peaks at both the Middle Yuba River (11410000) and South Yuba River (11417500) gages. The OBS sediment peaks occurred 5 hours after the streamflow peak at the Middle Yuba River (11410000) gage (*fig. 18A*) and almost 24 hours after the streamflow peak at the South Yuba River (11417500) gage (*fig. 18B*). Suspended-sediment transport estimated using the winter rating curve during the December 20–23, 2002, storm was 86 percent of that estimated using the calibrated OBS data at the Middle Yuba River (11410000) gage and only 50 percent of that estimated using the OBS data at the South Yuba River (11417500) gage (*table 8*). During the December 27–30, 2002 storm, the OBS registered early sediment peaks at both the Middle Yuba River (11410000) and South Yuba River (11417500) gages. The OBS sediment peaks occurred 2 hours before the streamflow peak at the Middle Yuba River (11410000) gage (*fig. 18C*) and 5 hours before the streamflow peak at the South Yuba River (11417500) gage (*fig. 18D*). Suspended-sediment transport during the December 27–30, 2002, storm, estimated using the winter rating curve, was nearly five times higher than that estimated using the OBS data

for the Middle Yuba River (11417500) gage, whereas the two methods gave estimates within 13 percent for the South Yuba River (11410000) gage (*table 8*).

The percent difference ranged from 50 to –369 percent and an average of the four percent-difference values in *table 8* is –79 percent. OBS is preferred over rating curves when event-based suspended-sediment transport is assessed because the OBS data provide an independent, continuous time-series dataset with detailed information about the timing of sediment peaks and the duration of sediment loads, whereas the rating curve is dependent on the streamflow dataset. As a result, rating curves may misrepresent sediment transport in situations where the sediment transport does not mimic streamflow. In these situations, calibrated OBS data can provide a more accurate estimate of suspended-sediment transport.

Compared to the OBS data, the rating curves underestimated suspended-sediment discharge during the December 20–23, 2002, storm characterized by lower streamflows and overestimated suspended-sediment discharge during the December 27–30, 2002, storm characterized by higher streamflows (*table 8*). This could indicate that the slope of the winter rating curves is too steep such that suspended-sediment concentrations are underpredicted at lower streamflows and overpredicted at higher streamflows (*table 8*). Alternatively, this may indicate a depletion of suspended sediment resulting in lower concentrations during the December 27–30, 2002, storm that were measured using the OBS but could have been misrepresented by the rating curves, which rely on the streamflow dataset.

Table 8. Event-based suspended-sediment discharge at gaging stations on the Middle Yuba and South Yuba Rivers in the upper Yuba River watershed, California.

[Percent difference is the difference between the OBS (optical backscatter sensor) and rating curve estimates divided by the OBS estimate. ft³/s, cubic feet per second]

Storm events	Peak streamflow (ft ³ /s)	Event-based suspended-sediment discharge		Percent difference (%)
		Estimated using OBS data ¹ (tons)	Estimated using rating curves ² (tons)	
Middle Yuba River (MYG, USGS Station ID 11410000)				
December 20–23, 2002	346	21	18	14
December 27–30, 2002	995	64	300	–369
South Yuba River (SYG, USGS Station ID 11417500)				
December 20–23, 2002	984	200	100	50
December 27–30, 2002	1,980	520	590	–13

¹Estimated using calibrated OBS data.

²Estimated using winter rating curves shown in *table 4*.

Figure 18. Instantaneous streamflow and suspended-sediment concentrations (SSC) during storm events at the Middle Yuba River (11410000) and South Yuba River (11417500) in the upper Yuba River watershed, California, (A,B) December 20 to 23, 2002, and (C,D) December 27 to 30, 2002. OBS, optical backscatter sensor.

Figure 18. Continued.

Summary

The purpose of this study was to characterize annual and event-based sediment transport in the upper Yuba River watershed during water years 2001, 2002, and 2003. Data collection included gaging streamflow and sampling suspended-sediment concentration at four upper Yuba River gaging stations: Middle Yuba River (11410000), South Yuba River (11417500), Yuba River below New Colgate Powerplant (11413700), and Yuba River below Englebright Dam (11418000). Suspended-sediment samples were collected 1 to 7 days per week at all gaging stations, depending on hydrologic conditions, and samples were collected at the Middle Yuba River (11410000) gage and South Yuba River (11417500) gage during four storms in water year 2003. Additional suspended-sediment samples were collected at the Middle Yuba River (11410000), South Yuba River (11417500), and Yuba River below Englebright Dam (11418000) gages for detailed grain-size analyses. Continuously recording optical backscatter sensors (OBS) were installed at the Middle Yuba River (11410000) gage and South Yuba River (11417500) gage to provide 15-minute time-series records of suspended-sediment concentration. Bed-load rating curves were developed for the Middle Yuba River (11410000) and South Yuba River (11417500) gage sites, and two sites on Shady Creek (Rust Pit and Shady Road) using an empirical bed-load transport relation (the Hopkins model); the accuracy of bed-load rating curves was assessed using bed-load measurements from Shady Creek, which agreed well with predicted curves. Finally, methods for estimating annual and event-based suspended-sediment discharge were compared.

Group-average suspended-sediment rating curves for the Middle Yuba River (11410000) and South Yuba River (11417500) gages describe average, summer/fall, first flush, winter, and spring snowmelt conditions. Variations in the slopes of the rating curves indicate changes in sediment supply throughout the water year. Under below-average and average precipitation conditions, such as occurred during the study period, sediment supply is greatest during the first flush of the water year; the rating curves for the first flush have the greatest slopes. Sediment supplies decreased following the first flush; thus, the slopes of the winter rating curves are lower than those of the first flush curves. The spring and summer/fall rating curves had the lowest slopes, indicating low supply conditions.

Although summary statistics and confidence bounds indicate that the accuracy of individual rating curves varies considerably, p values (less than 0.05) and F statistics (greater than the critical F for $\alpha = 5$ percent) indicate statistical significance for all the suspended-sediment regressions. The r^2 values for the first flush and spring snowmelt regressions generally were lower than those for the average and winter regressions; the r^2 values for the summer/fall regressions were extremely low. The first flush regressions display the widest confidence intervals, and therefore the predicted suspended-sediment concentrations have the greatest associated uncertainty. The confidence intervals for the summer/fall and spring

snowmelt rating curves are greater than those for the winter and average curves indicating greater accuracy for the winter and average curves. Thus, the winter and average regressions have the greatest likelihood for predicting suspended-sediment concentrations closest to the true value.

Seasonal suspended-sediment rating curves were developed to aid in the calibration of a watershed-scale sediment transport model and to assess the magnitude and duration of sediment loads that may impact the viability of long-term fish-introduction strategies. The seasonal rating curves were used to estimate annual suspended-sediment loads during water years 2001, 2002, and 2003. These estimates were compared with previously published annual suspended-sediment loads estimated using an interpolation software package (GCLAS). The percent difference ranged from -85 to $+54$ percent and averaged -7.5 percent.

Event-based suspended-sediment loads were estimated using calibrated OBS data and seasonal rating curves for two storms during December 2002. The percent difference ranged from 50 to -369 percent and averaged -79 percent. Compared to the OBS data, the rating curves underestimated suspended-sediment transport during the December 20–23, 2002, storm characterized by lower streamflows and overestimated suspended-sediment transport during the December 27–30, 2002, storm characterized by higher streamflows. This may indicate that the slopes of the winter rating curves are too steep such that suspended-sediment concentrations are underpredicted at lower streamflows and overpredicted at higher streamflows. Alternatively, this may indicate a depletion of suspended-sediment resulting in lower concentrations during the December 27–30, 2002, storm that were measured using the OBS and misrepresented by the rating curves, which rely on the streamflow dataset. The OBS data provided an independent continuous time-series dataset containing detailed information about the timing of sediment peaks and the duration of sediment loads; therefore the calibrated OBS estimates of suspended sediment transport is preferred over the rating curve estimates.

For 2001–2003, the estimated average annual sediment yield at the Middle Yuba River (11410000) gage (5 tons/mi^2) was significantly lower than that for the South Yuba River (11417500) gage (14 tons/mi^2); in both rivers, bed load represented less than 1 percent of the total annual load throughout the project period. Suspended sediment at both the Middle Yuba River (11410000) and South Yuba River (11417500) gages was typically greater than 85 percent silt and clay during water year 2003, and sand concentrations at the South Yuba River (11417500) gage were typically higher than those at the Middle Yuba River (11410000) gage for a given streamflow. Factors contributing to differences in sediment loads and grain-size distributions on the Middle Yuba and South Yuba Rivers include drainage area, flow diversions, and deposition of bed-material-sized sediment in Middle Yuba River reservoirs. Owing to its larger drainage area, higher flows, and absence of man-made structures that restrict sediment movement in the lower basin, the South Yuba River transports a greater and coarser sediment load.

Rainfall-runoff conditions were below average during the first two years of this study and average during the last year. Because sediment transport is heavily influenced by extreme rainfall-runoff events, the results of this study are somewhat limited. Additional data collected during wetter years and at higher streamflows would greatly improve the value of the rating curves as tools to estimate long term transport.

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Appendix 1.

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous stream-flow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	11/07/00	1020	49	0.25
	11410000	11/08/00	1115	49	0.25
	11410000	11/13/00	1010	51	0.25
	11410000	11/14/00	0955	53	2
	11410000	11/15/00	0935	52	1
	11410000	11/16/00	0940	51	0.25
	11410000	11/17/00	1330	49	1
	11410000	11/20/00	1205	49	1
	11410000	11/21/00	1150	49	1
	11410000	11/22/00	1030	49	1
	11410000	11/24/00	1100	49	1
	11410000	11/27/00	1100	49	2
	11410000	11/29/00	1130	68	2
	11410000	11/29/00	1130	68	2
	11410000	11/30/00	1100	53	2
	11410000	12/01/00	1125	51	1
	11410000	12/04/00	1100	49	3
	11410000	12/05/00	1120	49	1
	11410000	12/06/00	1115	49	2
	11410000	12/07/00	1100	48	2
	11410000	12/11/00	1100	51	3
	11410000	12/12/00	1100	66	2
	11410000	12/13/00	1115	53	3
	11410000	12/14/00	1100	86	30
	11410000	12/15/00	1045	86	15
	11410000	12/18/00	1100	56	6
	11410000	12/19/00	1050	55	1
	11410000	12/20/00	1045	53	4
	11410000	12/21/00	1045	53	1
	11410000	12/22/00	1050	55	6
	11410000	12/26/00	1100	51	5
	11410000	12/27/00	1055	51	2
	11410000	12/27/00	1055	51	1
	11410000	12/28/00	1030	51	1
	11410000	12/29/00	1045	51	1
	11410000	01/03/01	1050	49	1
	11410000	01/03/01	1050	49	2
	11410000	01/04/01	1100	51	1
	11410000	01/05/01	1300	49	2
	11410000	01/08/01	1115	58	2
	11410000	01/09/01	1100	52	1

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous stream-flow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	01/10/01	1115	55	1
	11410000	01/12/01	1115	66	4
	11410000	01/17/01	1100	53	0.25
	11410000	01/18/01	1035	52	1
	11410000	01/19/01	1030	52	1
	11410000	01/22/01	1210	51	1
	11410000	01/23/01	1030	52	2
	11410000	01/24/01	1045	68	11
	11410000	01/24/01	1045	68	9
	11410000	01/25/01	1040	61	5
	11410000	01/26/01	1030	65	5
	11410000	01/29/01	1028	65	2
	11410000	01/30/01	1030	58	5
	11410000	01/31/01	1035	55	1
	11410000	01/31/01	1035	55	2
	11410000	02/02/01	1020	53	1
	11410000	02/05/01	1035	55	3
	11410000	02/06/01	1055	53	1
	11410000	02/07/01	1020	53	1
	11410000	02/07/01	1020	53	1
	11410000	02/08/01	1025	52	0.25
	11410000	02/09/01	1020	52	1
	11410000	02/10/01	1240	68	1
	11410000	02/11/01	1105	84	2
	11410000	02/13/01	1030	63	2
	11410000	02/15/01	1020	60	1
	11410000	02/15/01	1020	60	1
	11410000	02/16/01	1025	58	1
	11410000	02/20/01	1045	105	18
	11410000	02/22/01	1025	153	11
	11410000	02/23/01	1030	113	3
	11410000	02/26/01	1040	84	2
	11410000	02/27/01	1035	74	1
	11410000	02/27/01	1300	74	5
	11410000	02/28/01	1040	70	0.25
	11410000	03/02/01	1040	82	3
	11410000	03/05/01	1045	140	7
	11410000	03/06/01	1100	105	3
	11410000	03/07/01	1105	88	2
	11410000	03/08/01	1105	84	1
	11410000	03/09/01	1045	84	2
	11410000	03/09/01	1045	84	2
	11410000	03/12/01	1040	70	2
	11410000	03/13/01	1045	68	2
	11410000	03/13/01	1415	68	0.25

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	03/14/01	1050	66	2
	11410000	03/14/01	1050	66	3
	11410000	03/15/01	1045	66	2
	11410000	03/16/01	1045	65	1
	11410000	03/19/01	1050	65	2
	11410000	03/20/01	1045	66	3
	11410000	03/22/01	1015	66	4
	11410000	03/23/01	1205	66	4
	11410000	03/26/01	1040	74	8
	11410000	03/27/01	1055	66	4
	11410000	03/28/01	1055	66	4
	11410000	03/29/01	1045	66	2
	11410000	03/30/01	1055	65	4
	11410000	03/30/01	1055	65	2
	11410000	04/02/01	1040	63	1
	11410000	04/04/01	1045	60	3
	11410000	04/04/01	1050	60	2
	11410000	04/05/01	1100	60	1
	11410000	04/06/01	1055	60	1
	11410000	04/06/01	1055	60	1
	11410000	04/09/01	1050	61	1
	11410000	04/09/01	1050	61	1
	11410000	04/10/01	1100	61	1
	11410000	04/11/01	1055	60	1
	11410000	04/13/01	1040	60	2
	11410000	04/16/01	1045	78	3
	11410000	04/16/01	1050	78	3
	11410000	04/18/01	1100	80	1
	11410000	04/20/01	1105	93	2
	11410000	04/23/01	1050	82	1
	11410000	04/23/01	1100	84	1
	11410000	04/23/01	1100	84	1
	11410000	04/25/01	1050	84	2
	11410000	04/26/01	1055	84	1
	11410000	04/26/01	1055	84	2
	11410000	04/30/01	1045	78	3
	11410000	05/01/01	1050	78	4
	11410000	05/03/01	1045	78	4
	11410000	05/04/01	1040	76	3
	11410000	05/07/01	1045	76	4
	11410000	05/08/01	1045	76	5
	11410000	05/09/01	1030	78	4
	11410000	05/10/01	1030	78	3
	11410000	05/11/01	1030	76	3
	11410000	05/14/01	1030	74	2

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	05/15/01	1050	74	3
	11410000	05/17/01	1045	72	2
	11410000	05/18/01	1030	70	2
	11410000	05/21/01	1025	66	2
	11410000	05/22/01	1020	68	4
	11410000	05/23/01	1045	68	2
	11410000	05/24/01	1050	68	4
	11410000	05/25/01	1030	68	2
	11410000	05/29/01	1040	68	3
	11410000	05/30/01	1030	68	3
	11410000	05/31/01	1040	66	2
	11410000	06/01/01	1035	66	3
	11410000	06/04/01	1030	66	3
	11410000	06/05/01	1045	66	4
	11410000	06/06/01	1040	66	3
	11410000	06/07/01	1040	66	2
	11410000	06/08/01	1035	66	1
	11410000	06/11/01	1045	78	2
	11410000	06/12/01	1145	76	3
	11410000	06/13/01	1050	76	1
	11410000	06/14/01	1050	74	2
	11410000	06/18/01	1055	60	3
	11410000	06/19/01	1050	58	2
	11410000	06/20/01	1045	58	2
	11410000	06/21/01	1040	47	1
	11410000	06/22/01	1010	47	1
	11410000	06/25/01	1045	44	1
	11410000	06/26/01	1030	48	3
	11410000	06/27/01	1035	48	2
	11410000	06/28/01	1030	49	1
	11410000	06/29/01	1045	49	1
	11410000	07/02/01	1030	45	2
	11410000	07/03/01	1030	44	3
	11410000	07/05/01	0930	43	1
	11410000	07/06/01	1045	42	1
	11410000	07/09/01	1030	39	1
	11410000	07/10/01	1055	39	1
	11410000	07/11/01	1045	39	2
	11410000	07/12/01	1035	38	2
	11410000	07/13/01	1045	38	1
	11410000	07/16/01	1050	36	1
	11410000	07/17/01	1055	36	3
	11410000	07/18/01	1040	37	2
	11410000	07/19/01	1050	38	3
	11410000	07/20/01	1030	37	1

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	07/23/01	1145	37	1
	11410000	07/24/01	1115	37	1
	11410000	07/25/01	1030	36	1
	11410000	07/26/01	1030	36	0.25
	11410000	07/27/01	1100	35	1
	11410000	07/30/01	1055	33	1
	11410000	07/31/01	1030	34	2
	11410000	08/01/01	1045	36	2
	11410000	08/02/01	1030	35	3
	11410000	08/03/01	0905	34	1
	11410000	08/06/01	1100	32	2
	11410000	08/07/01	0950	32	2
	11410000	08/15/01	1015	30	0.25
	11410000	08/21/01	0955	29	1
	11410000	09/05/01	1000	28	4
	11410000	09/11/01	0920	27	2
	11410000	09/21/01	1055	28	1
	11410000	09/27/01	1100	28	3
	11410000	09/30/01	1400	28	0.25
	11410000	10/03/01	1130	30	2
	11410000	10/10/01	1115	31	1
	11410000	10/17/01	1045	31	2
	11410000	10/24/01	1110	31	2
	11410000	10/30/01	1105	42	3
	11410000	11/01/01	0850	45	3
	11410000	11/02/01	1115	42	1
	11410000	11/07/01	1100	36	0.25
	11410000	11/13/01	1030	65	5
	11410000	11/14/01	1005	53	2
	11410000	11/26/01	1040	56	2
	11410000	11/27/01	1100	49	1
	11410000	11/28/01	1100	48	1
	11410000	11/29/01	1025	53	1
	11410000	11/30/01	1125	58	4
	11410000	12/03/01	1045	102	18
	11410000	12/04/01	1115	63	6
	11410000	12/05/01	1045	78	3
	11410000	12/06/01	1030	140	7
	11410000	12/07/01	1045	78	3
	11410000	12/11/01	1030	52	2
	11410000	12/12/01	1050	51	1
	11410000	12/13/01	1030	48	2
	11410000	12/14/01	1115	110	15

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	12/15/01	1010	63	4
	11410000	12/18/01	1035	108	4
	11410000	12/19/01	1050	70	3
	11410000	12/20/01	1030	97	3
	11410000	12/21/01	1005	110	7
	11410000	12/26/01	0	60	3
	11410000	12/27/01	1105	60	2
	11410000	12/28/01	1020	58	1
	11410000	12/29/01	0945	90	3
	11410000	12/31/01	1530	701	28
	11410000	01/03/02	1105	423	6
	11410000	01/04/02	1010	110	6
	11410000	01/08/02	1025	108	0.25
	11410000	01/09/02	1020	95	0.25
	11410000	01/09/02	1020	95	1
	11410000	01/10/02	1105	88	1
	11410000	01/11/02	1040	82	0.25
	11410000	01/14/02	1030	74	0.25
	11410000	01/14/02	1030	74	0.25
	11410000	01/15/02	1035	70	0.25
	11410000	01/16/02	1055	68	0.25
	11410000	01/17/02	1050	66	1
	11410000	01/17/02	1050	66	0.25
	11410000	01/18/02	1105	65	0.25
	11410000	01/22/02	1045	66	0.25
	11410000	01/23/02	1025	65	1
	11410000	01/23/02	1025	65	3
	11410000	01/24/02	1035	63	0.25
	11410000	01/25/02	1030	63	1
	11410000	01/28/02	1025	80	2
	11410000	01/28/02	1025	80	1
	11410000	01/29/02	1100	74	1
	11410000	01/30/02	1040	70	2
	11410000	01/31/02	1100	68	1
	11410000	01/31/02	1100	68	2
	11410000	02/04/02	1045	63	1
	11410000	02/11/02	1020	65	2
	11410000	02/13/02	1100	65	2
	11410000	02/14/02	1045	65	1
	11410000	02/14/02	1045	65	2
	11410000	02/15/02	1030	65	1
	11410000	02/19/02	1020	82	2
	11410000	02/20/02	1020	1250	83
	11410000	02/20/02	1020	1250	84
	11410000	02/21/02	1020	326	7

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	02/22/02	1025	110	5
	11410000	02/25/02	1025	86	2
	11410000	02/25/02	1025	86	2
	11410000	02/26/02	1020	82	2
	11410000	02/27/02	1025	82	1
	11410000	02/27/02	1025	82	1
	11410000	02/28/02	1035	80	4
	11410000	03/01/02	1020	76	2
	11410000	03/04/02	1010	70	1
	11410000	03/04/02	1010	70	0.25
	11410000	03/05/02	1010	70	2
	11410000	03/06/02	1040	137	12
	11410000	03/06/02	1040	137	8
	11410000	03/06/02	1200	158	11
	11410000	03/07/02	1015	399	13
	11410000	03/07/02	1305	359	10
	11410000	03/07/02	1305	359	7
	11410000	03/08/02	1000	204	8
	11410000	03/08/02	1000	204	14
	11410000	03/08/02	1305	153	5
	11410000	03/08/02	1305	153	6
	11410000	03/11/02	1020	113	4
	11410000	03/11/02	1020	113	3
	11410000	03/12/02	1035	102	3
	11410000	03/12/02	1035	102	4
	11410000	03/14/02	1010	90	2
	11410000	03/14/02	1010	90	2
	11410000	03/15/02	1020	86	3
	11410000	03/15/02	1020	86	2
	11410000	03/18/02	1015	70	2
	11410000	03/18/02	1015	70	2
	11410000	03/19/02	1015	68	1
	11410000	03/19/02	1015	68	2
	11410000	03/20/02	1010	68	1
	11410000	03/20/02	1010	68	2
	11410000	03/21/02	1010	66	1
	11410000	03/21/02	1010	66	2
	11410000	03/22/02	1025	65	2
	11410000	03/22/02	1025	65	1
	11410000	03/24/02	1010	228	21
	11410000	03/24/02	1010	228	22
	11410000	03/25/02	0845	127	5
	11410000	03/25/02	0845	127	5
	11410000	03/26/02	1025	102	5
	11410000	03/26/02	1025	102	3

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	03/27/02	1025	90	3
	11410000	03/27/02	1025	90	3
	11410000	03/28/02	1025	84	5
	11410000	03/28/02	1025	84	4
	11410000	03/29/02	1025	82	2
	11410000	03/29/02	1025	82	3
	11410000	04/02/02	1100	70	3
	11410000	04/02/02	1100	70	2
	11410000	04/03/02	1025	70	2
	11410000	04/03/02	1025	70	2
	11410000	04/04/02	1020	70	2
	11410000	04/04/02	1020	70	1
	11410000	04/05/02	1025	68	2
	11410000	04/05/02	1025	68	2
	11410000	04/08/02	1025	61	1
	11410000	04/08/02	1025	61	2
	11410000	04/09/02	1035	61	3
	11410000	04/09/02	1035	61	2
	11410000	04/10/02	1010	61	2
	11410000	04/10/02	1010	61	3
	11410000	04/11/02	1010	61	2
	11410000	04/11/02	1010	61	3
	11410000	04/15/02	1015	88	3
	11410000	04/15/02	1015	88	4
	11410000	04/16/02	1005	82	3
	11410000	04/16/02	1005	82	1
	11410000	04/17/02	1015	86	2
	11410000	04/17/02	1015	86	3
	11410000	04/18/02	1010	84	2
	11410000	04/18/02	1010	84	1
	11410000	04/19/02	1015	82	1
	11410000	04/19/02	1015	82	1
	11410000	04/22/02	1000	82	2
	11410000	04/22/02	1000	82	2
	11410000	04/23/02	1020	82	2
	11410000	04/23/02	1020	82	3
	11410000	04/24/02	1000	82	2
	11410000	04/24/02	1000	82	3
	11410000	04/25/02	1010	80	2
	11410000	04/25/02	1010	80	2
	11410000	04/26/02	1005	84	3
	11410000	04/26/02	1005	84	1
	11410000	04/30/02	1025	82	3
	11410000	04/30/02	1025	82	2
	11410000	05/01/02	0955	82	6

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	05/01/02	0955	82	1
	11410000	05/02/02	1005	82	1
	11410000	05/02/02	1005	82	2
	11410000	05/03/02	0955	80	2
	11410000	05/03/02	0955	80	2
	11410000	05/06/02	1015	82	2
	11410000	05/06/02	1015	82	3
	11410000	05/07/02	1020	82	2
	11410000	05/07/02	1020	82	2
	11410000	05/08/02	1025	82	2
	11410000	05/08/02	1025	82	2
	11410000	05/09/02	1020	82	1
	11410000	05/09/02	1020	82	1
	11410000	05/10/02	1005	80	2
	11410000	05/10/02	1005	80	1
	11410000	05/13/02	1010	78	1
	11410000	05/13/02	1010	78	1
	11410000	05/14/02	1025	78	3
	11410000	05/14/02	1025	78	2
	11410000	05/15/02	1020	80	1
	11410000	05/15/02	1020	80	2
	11410000	05/16/02	1035	80	2
	11410000	05/16/02	1035	80	4
	11410000	05/17/02	1020	80	2
	11410000	05/17/02	1020	80	3
	11410000	05/20/02	1020	90	4
	11410000	05/20/02	1020	90	4
	11410000	05/21/02	1030	86	4
	11410000	05/21/02	1030	86	2
	11410000	05/22/02	1015	82	2
	11410000	05/22/02	1015	82	3
	11410000	05/23/02	1035	80	2
	11410000	05/23/02	1035	80	2
	11410000	05/24/02	1010	78	3
	11410000	05/24/02	1010	78	4
	11410000	05/28/02	1015	80	4
	11410000	05/28/02	1015	80	2
	11410000	05/29/02	1020	80	1
	11410000	05/29/02	1020	80	1
	11410000	05/30/02	1000	82	2
	11410000	05/30/02	1000	82	1
	11410000	05/31/02	1015	82	1
	11410000	05/31/02	1015	82	2
	11410000	06/04/02	1530	74	1
	11410000	06/04/02	1530	74	1

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	06/06/02	1350	74	4
	11410000	06/06/02	1350	74	3
	11410000	06/10/02	1025	76	2
	11410000	06/10/02	1025	76	1
	11410000	06/11/02	1025	76	3
	11410000	06/11/02	1025	76	3
	11410000	06/12/02	1015	74	3
	11410000	06/12/02	1015	74	3
	11410000	06/13/02	1030	72	1
	11410000	06/13/02	1030	72	2
	11410000	06/14/02	1020	72	2
	11410000	06/14/02	1020	72	1
	11410000	06/17/02	1025	53	2
	11410000	06/17/02	1025	53	2
	11410000	06/18/02	1025	53	1
	11410000	06/18/02	1025	53	1
	11410000	06/19/02	1000	53	5
	11410000	06/19/02	1000	53	2
	11410000	06/20/02	1005	53	2
	11410000	06/20/02	1005	53	1
	11410000	06/21/02	0930	52	3
	11410000	06/21/02	0930	52	3
	11410000	06/24/02	1020	52	2
	11410000	06/24/02	1020	52	4
	11410000	06/25/02	1015	51	4
	11410000	06/25/02	1015	51	3
	11410000	06/27/02	1010	51	1
	11410000	06/27/02	1010	51	2
	11410000	06/28/02	1020	49	2
	11410000	06/28/02	1020	49	2
	11410000	11/05/02	1220	33	0.25
	11410000	11/05/02	1220	33	0.25
	11410000	11/07/02	1030	43	1
	11410000	11/07/02	1030	43	0.25
	11410000	11/07/02	1230	42	1
	11410000	11/07/02	1230	42	2
	11410000	11/07/02	1430	40	2
	11410000	11/07/02	1430	40	8
	11410000	11/07/02	1600	43	2
	11410000	11/07/02	1600	43	3
	11410000	11/08/02	0800	51	6
	11410000	11/08/02	0800	51	5
	11410000	11/08/02	1000	56	4
	11410000	11/08/02	1000	56	5
	11410000	11/08/02	1200	74	26

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	11/08/02	1200	74	25
	11410000	11/08/02	1400	82	84
	11410000	11/08/02	1400	82	91
	11410000	11/08/02	1600	76	45
	11410000	11/08/02	1600	76	47
	11410000	11/09/02	0831	58	94
	11410000	11/09/02	0831	58	96
	11410000	11/09/02	1000	58	95
	11410000	11/09/02	1000	58	105
	11410000	11/09/02	1200	56	39
	11410000	11/09/02	1200	56	46
	11410000	11/12/02	1405	53	5
	11410000	11/12/02	1405	53	4
	11410000	11/13/02	1045	52	2
	11410000	11/13/02	1045	52	2
	11410000	11/15/02	1040	47	3
	11410000	11/15/02	1040	47	2
	11410000	11/18/02	1028	51	1
	11410000	11/18/02	1028	51	1
	11410000	11/20/02	1100	51	0.25
	11410000	11/20/02	1100	51	1
	11410000	11/22/02	1050	49	1
	11410000	11/22/02	1050	49	1
	11410000	11/25/02	1030	49	0.25
	11410000	11/25/02	1030	49	1
	11410000	11/27/02	1045	45	0.25
	11410000	11/27/02	1045	45	0.25
	11410000	12/02/02	1040	47	5
	11410000	12/02/02	1040	47	4
	11410000	12/04/02	1020	47	2
	11410000	12/04/02	1020	47	0.25
	11410000	12/06/02	1030	47	1
	11410000	12/06/02	1030	47	0.25
	11410000	12/09/02	1025	47	1
	11410000	12/09/02	1025	47	0.25
	11410000	12/11/02	1030	49	0.25
	11410000	12/11/02	1030	49	1
	11410000	12/12/02	0900	47	1
	11410000	12/12/02	0900	47	1
	11410000	12/13/02	0800	80	4
	11410000	12/13/02	0800	80	5
	11410000	12/13/02	1000	84	6
	11410000	12/13/02	1000	84	6
	11410000	12/13/02	1200	84	5
	11410000	12/13/02	1200	84	8

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	12/13/02	1400	90	5
	11410000	12/13/02	1400	90	4
	11410000	12/13/02	1530	110	9
	11410000	12/13/02	1530	110	14
	11410000	12/13/02	1630	137	7
	11410000	12/13/02	1630	137	8
	11410000	12/14/02	1000	1250	85
	11410000	12/14/02	1000	1250	85
	11410000	12/14/02	1325	1090	57
	11410000	12/14/02	1325	1090	63
	11410000	12/14/02	1632	706	181
	11410000	12/14/02	1632	706	159
	11410000	12/15/02	0730	883	47
	11410000	12/15/02	0730	883	52
	11410000	12/15/02	0830	778	41
	11410000	12/15/02	0830	778	42
	11410000	12/15/02	0941	680	11
	11410000	12/15/02	1036	602	33
	11410000	12/15/02	1036	602	33
	11410000	12/15/02	1130	528	30
	11410000	12/15/02	1130	528	32
	11410000	12/15/02	1233	464	32
	11410000	12/15/02	1233	464	28
	11410000	12/15/02	1328	423	24
	11410000	12/15/02	1328	423	26
	11410000	12/15/02	1328	423	27
	11410000	12/15/02	1434	346	26
	11410000	12/15/02	1434	346	23
	11410000	12/15/02	1536	297	22
	11410000	12/15/02	1536	297	20
	11410000	12/15/02	1630	255	19
	11410000	12/15/02	1630	255	22
	11410000	12/16/02	0900	2100	309
	11410000	12/16/02	0900	2100	329
	11410000	12/16/02	1100	1900	389
	11410000	12/16/02	1100	1900	406
	11410000	12/16/02	1300	1990	269
	11410000	12/16/02	1300	1990	275
	11410000	12/16/02	1500	2260	1870
	11410000	12/16/02	1500	2260	1857
	11410000	12/16/02	1600	2160	1054
	11410000	12/16/02	1600	2160	1057
	11410000	12/17/02	0815	359	61
	11410000	12/17/02	0815	359	59
	11410000	12/17/02	1000	280	50

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	12/17/02	1000	280	54
	11410000	12/17/02	1200	204	39
	11410000	12/17/02	1200	204	47
	11410000	12/17/02	1300	177	38
	11410000	12/17/02	1300	177	36
	11410000	12/17/02	1515	147	25
	11410000	12/17/02	1515	147	28
	11410000	12/17/02	1600	142	25
	11410000	12/17/02	1600	142	26
	11410000	12/18/02	0900	97	11
	11410000	12/18/02	0900	97	9
	11410000	12/20/02	1030	82	5
	11410000	12/20/02	1030	82	5
	11410000	12/23/02	1020	86	3
	11410000	12/27/02	1021	142	5
	11410000	12/27/02	1021	142	5
	11410000	12/31/02	0900	232	44
	11410000	12/31/02	0900	232	42
	11410000	01/03/03	1050	88	2
	11410000	01/03/03	1050	88	1
	11410000	01/06/03	1050	76	2
	11410000	01/06/03	1050	76	2
	11410000	01/08/03	0950	72	2
	11410000	01/08/03	0950	72	1
	11410000	01/10/03	1050	88	6
	11410000	01/10/03	1050	88	6
	11410000	01/13/03	1100	88	2
	11410000	01/13/03	1105	88	1
	11410000	01/15/03	0915	78	2
	11410000	01/15/03	0915	78	1
	11410000	01/17/03	1230	74	1
	11410000	01/17/03	1230	74	2
	11410000	01/21/03	1040	78	0.25
	11410000	01/21/03	1040	78	1
	11410000	01/23/03	1015	342	28
	11410000	01/23/03	1015	342	28
	11410000	01/27/03	1055	88	2
	11410000	01/27/03	1055	88	3
	11410000	01/31/03	1105	76	2
	11410000	01/31/03	1105	76	2
	11410000	02/03/03	1125	72	0.25
	11410000	02/03/03	1125	72	0.25
	11410000	02/05/03	0850	68	3
	11410000	02/05/03	0850	68	2
	11410000	02/07/03	1050	65	1

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	02/07/03	1050	65	2
	11410000	02/10/03	0915	63	1
	11410000	02/10/03	0915	63	1
	11410000	02/12/03	0920	61	2
	11410000	02/12/03	0920	61	1
	11410000	02/14/03	0830	74	4
	11410000	02/14/03	0830	74	3
	11410000	02/15/03	1215	68	2
	11410000	02/15/03	1215	68	2
	11410000	02/15/03	1400	68	1
	11410000	02/15/03	1400	68	3
	11410000	02/15/03	1530	68	2
	11410000	02/15/03	1530	68	2
	11410000	02/16/03	0730	164	10
	11410000	02/16/03	0730	164	13
	11410000	02/16/03	0930	140	17
	11410000	02/16/03	0930	140	17
	11410000	02/16/03	1130	122	114
	11410000	02/16/03	1130	122	136
	11410000	02/16/03	1330	113	149
	11410000	02/16/03	1530	108	23
	11410000	02/16/03	1530	108	24
	11410000	02/17/03	0730	86	5
	11410000	02/17/03	0730	86	4
	11410000	02/17/03	0930	86	6
	11410000	02/17/03	0930	86	7
	11410000	02/17/03	1330	84	7
	11410000	02/17/03	1330	84	7
	11410000	02/18/03	0830	78	3
	11410000	02/18/03	0830	78	2
	11410000	02/18/03	1030	76	3
	11410000	02/18/03	1030	76	3
	11410000	02/19/03	1115	82	1
	11410000	02/19/03	1115	82	1
	11410000	02/21/03	1045	72	2
	11410000	02/21/03	1045	72	2
	11410000	02/24/03	1020	68	1
	11410000	02/24/03	1020	68	1
	11410000	02/26/03	1100	66	2
	11410000	02/26/03	1100	66	2
	11410000	02/28/03	1030	65	4
	11410000	02/28/03	1030	65	3
	11410000	03/05/03	1040	61	2
	11410000	03/05/03	1040	61	4
	11410000	03/07/03	1015	60	3

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	03/07/03	1015	60	7
	11410000	03/10/03	1115	58	2
	11410000	03/10/03	1115	58	3
	11410000	03/12/03	0930	56	2
	11410000	03/12/03	0930	56	1
	11410000	03/13/03	1430	56	3
	11410000	03/13/03	1430	56	2
	11410000	03/14/03	0700	66	4
	11410000	03/14/03	0700	66	4
	11410000	03/14/03	0900	68	4
	11410000	03/14/03	0900	68	4
	11410000	03/14/03	1100	70	4
	11410000	03/14/03	1100	70	3
	11410000	03/14/03	1300	72	2
	11410000	03/14/03	1300	72	5
	11410000	03/14/03	1500	70	6
	11410000	03/14/03	1500	70	3
	11410000	03/15/03	0740	187	57
	11410000	03/15/03	0740	187	59
	11410000	03/15/03	0930	675	180
	11410000	03/15/03	0930	675	178
	11410000	03/15/03	1130	1110	198
	11410000	03/15/03	1130	1110	224
	11410000	03/15/03	1330	1330	158
	11410000	03/15/03	1330	1330	157
	11410000	03/15/03	1530	1260	133
	11410000	03/15/03	1530	1260	109
	11410000	03/16/03	0730	236	10
	11410000	03/16/03	0730	236	10
	11410000	03/16/03	0930	183	9
	11410000	03/16/03	0930	183	8
	11410000	03/16/03	1130	145	6
	11410000	03/16/03	1130	145	7
	11410000	03/16/03	1330	120	15
	11410000	03/16/03	1330	120	5
	11410000	03/16/03	1530	105	5
	11410000	03/16/03	1530	105	5
	11410000	03/17/03	1015	88	5
	11410000	03/17/03	1015	88	4
	11410000	03/19/03	1100	70	0.25
	11410000	03/19/03	1100	70	1
	11410000	03/21/03	1100	70	2
	11410000	03/21/03	1100	70	1
	11410000	03/24/03	1110	70	2
	11410000	03/24/03	1110	70	1

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	03/26/03	1105	84	3
	11410000	03/26/03	1105	84	2
	11410000	03/28/03	1110	72	2
	11410000	03/28/03	1110	72	2
	11410000	03/31/03	0915	65	4
	11410000	03/31/03	0915	65	4
	11410000	04/03/03	1030	63	2
	11410000	04/03/03	1030	63	1
	11410000	04/04/03	1400	74	1
	11410000	04/04/03	1400	74	1
	11410000	04/09/03	1045	60	3
	11410000	04/09/03	1045	60	2
	11410000	04/11/03	1120	60	1
	11410000	04/11/03	1120	60	2
	11410000	04/14/03	1040	190	8
	11410000	04/14/03	1040	190	8
	11410000	04/16/03	1100	118	3
	11410000	04/16/03	1100	118	2
	11410000	04/18/03	1025	110	4
	11410000	04/18/03	1025	110	2
	11410000	04/21/03	1055	105	5
	11410000	04/21/03	1055	105	0.25
	11410000	04/23/03	1040	90	3
	11410000	04/23/03	1040	90	2
	11410000	04/28/03	1050	200	56
	11410000	04/28/03	1050	200	54
	11410000	04/30/03	1035	155	3
	11410000	04/30/03	1035	155	3
	11410000	05/02/03	1010	127	1
	11410000	05/02/03	1010	127	4
	11410000	05/05/03	1050	511	5
	11410000	05/05/03	1050	511	6
	11410000	05/06/03	1010	326	4
	11410000	05/06/03	1010	326	4
	11410000	05/07/03	1050	147	3
	11410000	05/07/03	1050	147	6
	11410000	05/08/03	1035	180	6
	11410000	05/08/03	1035	180	4
	11410000	05/09/03	1005	173	3
	11410000	05/09/03	1005	173	4
	11410000	05/14/03	1105	120	1
	11410000	05/14/03	1105	120	2
	11410000	05/16/03	1010	155	1
	11410000	05/16/03	1010	155	4
	11410000	05/19/03	1055	100	1

Table A1a. Suspended-sediment concentration samples and associated instantaneous streamflow for the Middle Yuba River near North San Juan (MYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous stream-flow (ft ³ /s)	Suspended-sediment concentration (mg/L)
MYG	11410000	05/19/03	1055	100	2
	11410000	05/21/03	1110	97	1
	11410000	05/21/03	1110	97	2
	11410000	05/22/03	1040	97	1
	11410000	05/22/03	1040	97	2
	11410000	05/23/03	1115	95	4
	11410000	05/23/03	1115	95	1
	11410000	05/27/03	1030	88	1
	11410000	05/27/03	1030	88	1
	11410000	05/29/03	1025	259	6
	11410000	05/29/03	1025	259	8

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	11/07/00	1235	66	0.25
	11417500	11/08/00	1220	65	0.25
	11417500	11/09/00	1205	63	1
	11417500	11/13/00	1145	59	1
	11417500	11/14/00	1115	67	0.25
	11417500	11/15/00	1050	70	0.25
	11417500	11/16/00	1055	63	0.25
	11417500	11/17/00	1445	62	0.25
	11417500	11/20/00	1015	61	0.25
	11417500	11/21/00	1015	61	0.25
	11417500	11/22/00	0910	61	1
	11417500	11/24/00	0910	61	1
	11417500	11/27/00	0930	61	2
	11417500	11/28/00	1000	61	0.25
	11417500	11/29/00	1000	73	2
	11417500	11/30/00	0945	144	9
	11417500	12/04/00	0940	67	1
	11417500	12/05/00	1000	65	0.25
	11417500	12/06/00	1045	63	1
	11417500	12/06/00	1045	63	2
	11417500	12/07/00	1040	63	1
	11417500	12/07/00	1310	65	2
	11417500	12/08/00	0930	63	1
	11417500	12/09/00	0945	63	1
	11417500	12/12/00	0935	119	2
	11417500	12/13/00	0945	102	5
	11417500	12/13/00	0945	102	4
	11417500	12/14/00	0930	158	7
	11417500	12/15/00	0920	262	28
	11417500	12/18/00	0945	107	2
	11417500	12/19/00	0930	95	2
	11417500	12/20/00	0920	89	2
	11417500	12/20/00	0920	89	2
	11417500	12/21/00	0920	84	4
	11417500	12/22/00	0930	89	1
	11417500	12/26/00	0930	74	0.25
	11417500	12/27/00	0930	73	3
	11417500	12/27/00	0930	73	2
	11417500	12/28/00	0910	71	4
	11417500	12/29/00	0920	70	0.25
	11417500	01/02/01	0920	67	1
	11417500	01/03/01	0925	66	3
	11417500	01/03/01	0925	66	1
	11417500	01/04/01	0920	63	0.25
	11417500	01/05/01	1130	65	4
	11417500	01/09/01	0930	75	1
	11417500	01/10/01	0940	81	1

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	01/10/01	0940	81	1
	11417500	01/11/01	1045	310	34
	11417500	01/11/01	1201	307	30
	11417500	01/12/01	0945	178	19
	11417500	01/16/01	0915	92	1
	11417500	01/17/01	0930	83	1
	11417500	01/17/01	0930	83	1
	11417500	01/18/01	0930	79	1
	11417500	01/19/01	0930	80	0.25
	11417500	01/22/01	1320	77	1
	11417500	01/23/01	0935	77	2
	11417500	01/24/01	0940	163	10
	11417500	01/24/01	0940	163	10
	11417500	01/25/01	0940	141	12
	11417500	01/26/01	0930	158	6
	11417500	01/29/01	0940	114	11
	11417500	01/30/01	0920	122	4
	11417500	01/31/01	0935	103	8
	11417500	01/31/01	0935	103	8
	11417500	02/01/01	0935	99.5	2
	11417500	02/02/01	0925	92	1
	11417500	02/03/01	0935	97	6
	11417500	02/05/01	0940	124	3
	11417500	02/06/01	1210	125	3
	11417500	02/07/01	0925	121	2
	11417500	02/07/01	0925	121	7
	11417500	02/08/01	0925	103	2
	11417500	02/09/01	0920	96	2
	11417500	02/10/01	1030	169	18
	11417500	02/11/01	0950	205	6
	11417500	02/12/01	0920	180	4
	11417500	02/13/01	0930	162	2
	11417500	02/15/01	0920	127	1
	11417500	02/15/01	0920	127	2
	11417500	02/16/01	0925	127	3
	11417500	02/20/01	0940	445	76
	11417500	02/22/01	0925	731	84
	11417500	02/23/01	0930	478	26
	11417500	02/26/01	0940	335	6
	11417500	02/27/01	0930	285	4
	11417500	02/27/01	1030	282	17
	11417500	02/27/01	1435	277	3
	11417500	02/28/01	0935	250	3
	11417500	03/01/01	0925	223	3
	11417500	03/05/01	0940	1290	168
	11417500	03/06/01	1000	676	17
	11417500	03/07/01	1015	514	10

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	03/08/01	1005	478	5
	11417500	03/09/01	0945	423	5
	11417500	03/09/01	0945	423	5
	11417500	03/12/01	0945	275	3
	11417500	03/13/01	0945	259	2
	11417500	03/14/01	1000	259	2
	11417500	03/14/01	1000	259	2
	11417500	03/15/01	0950	255	1
	11417500	03/16/01	0950	241	1
	11417500	03/20/01	0945	312	2
	11417500	03/21/01	0940	335	3
	11417500	03/21/01	0940	335	3
	11417500	03/22/01	0920	318	6
	11417500	03/23/01	1100	307	5
	11417500	03/27/01	1225	337	2
	11417500	03/28/01	0950	307	2
	11417500	03/29/01	0945	318	1
	11417500	03/30/01	0950	292	3
	11417500	03/30/01	0955	292	1
	11417500	04/02/01	0940	254	1
	11417500	04/03/01	0945	230	1
	11417500	04/04/01	0945	211	1
	11417500	04/04/01	0950	211	1
	11417500	04/05/01	0955	190	1
	11417500	04/06/01	0945	182	1
	11417500	04/09/01	0950	198	2
	11417500	04/10/01	0945	191	1
	11417500	04/11/01	0955	187	2
	11417500	04/12/01	0915	252	10
	11417500	04/13/01	0935	205	3
	11417500	04/16/01	0930	196	1
	11417500	04/17/01	0950	205	1
	11417500	04/18/01	1000	214	1
	11417500	04/19/01	0945	250	0.25
	11417500	04/20/01	1000	342	8
	11417500	04/23/01	0950	301	2
	11417500	04/24/01	0955	305	2
	11417500	04/24/01	0955	305	2
	11417500	04/25/01	0945	301	2
	11417500	04/26/01	0950	314	3
	11417500	04/26/01	0950	314	2
	11417500	04/30/01	0940	239	3
	11417500	05/01/01	0945	249	5
	11417500	05/02/01	0945	243	3
	11417500	05/03/01	0945	212	3
	11417500	05/04/01	0940	198	4
	11417500	05/07/01	0955	189	2

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	05/08/01	0950	187	4
	11417500	05/09/01	0935	189	4
	11417500	05/10/01	0930	177	4
	11417500	05/11/01	0930	168	2
	11417500	05/14/01	0930	145	1
	11417500	05/15/01	1000	140	1
	11417500	05/16/01	0950	150	2
	11417500	05/17/01	0945	139	1
	11417500	05/18/01	0930	128	1
	11417500	05/21/01	0930	102	2
	11417500	05/22/01	0925	92	3
	11417500	05/23/01	0945	92	3
	11417500	05/24/01	0945	85	1
	11417500	04/05/01	0935	82	3
	11417500	04/09/01	0945	71	3
	11417500	05/30/01	0940	69	3
	11417500	05/31/01	0950	64	2
	11417500	06/01/01	0940	62	4
	11417500	06/04/01	0930	64	2
	11417500	06/05/01	0935	59	2
	11417500	06/06/01	0945	58	2
	11417500	06/07/01	0940	59	1
	11417500	06/08/01	0935	55	0.25
	11417500	06/11/01	0950	51	1
	11417500	06/12/01	1000	49	2
	11417500	06/13/01	0955	52	0.25
	11417500	06/14/01	0950	48	1
	11417500	06/15/01	0930	49	3
	11417500	06/18/01	0955	46	3
	11417500	06/19/01	0950	46	1
	11417500	06/20/01	0940	46	1
	11417500	06/21/01	0930	47	1
	11417500	06/22/01	0915	46	2
	11417500	06/25/01	0945	43	3
	11417500	06/26/01	0930	47	2
	11417500	06/27/01	0930	51	1
	11417500	06/28/01	0930	55	2
	11417500	06/29/01	0950	52	1
	11417500	07/02/01	0935	43	2
	11417500	07/06/01	0930	38	2
	11417500	07/09/01	0930	46	3
	11417500	07/10/01	0940	44	1
	11417500	07/11/01	0930	42	1
	11417500	07/12/01	0915	41	1
	11417500	07/16/01	0940	43	1
	11417500	07/17/01	0950	40	3
	11417500	07/18/01	0935	38	1

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	07/19/01	0950	38	1
	11417500	07/20/01	0930	35	5
	11417500	07/21/01	1230	35	5
	11417500	07/23/01	1030	33	2
	11417500	07/24/01	1000	35	2
	11417500	07/25/01	0930	35	1
	11417500	07/26/01	0930	34	1
	11417500	07/27/01	0930	33	0.25
	11417500	07/30/01	0955	32	2
	11417500	07/31/01	0930	33	2
	11417500	08/01/01	0945	34	2
	11417500	08/03/01	0805	33	1
	11417500	08/06/01	1015	33	1
	11417500	08/07/01	0855	33	1
	11417500	08/15/01	0915	32	1
	11417500	08/21/01	0900	32	0.25
	11417500	08/29/01	0935	32	2
	11417500	09/05/01	0905	32	1
	11417500	09/05/01	0905	31	2
	11417500	09/11/01	0825	32	2
	11417500	09/21/01	0955	33	2
	11417500	09/27/01	1000	36	2
	11417500	09/30/01	2330	35	1
	11417500	10/03/01	1015	34	1
	11417500	10/10/01	1000	31	1
	11417500	10/24/01	1010	31	1
	11417500	10/30/01	1000	42	2
	11417500	10/31/01	0935	86	4
	11417500	11/01/01	1305	53	3
	11417500	11/02/01	1015	42	2
	11417500	11/07/01	0955	36	1
	11417500	11/13/01	1310	178	38
	11417500	11/14/01	0805	89	7
	11417500	11/26/01	0945	167	8
	11417500	11/27/01	1230	106	2
	11417500	11/28/01	1000	87	3
	11417500	11/29/01	0925	128	3
	11417500	11/30/01	1000	156	8
	11417500	12/03/01	0945	890	28
	11417500	12/04/01	1225	369	11
	11417500	12/05/01	0930	275	4
	11417500	12/06/01	1200	428	13
	11417500	12/07/01	1215	392	5
	11417500	12/11/01	1200	171	2
	11417500	12/12/01	0945	148	2
	11417500	12/13/01	0930	132	1
	11417500	12/14/01	0930	394	15

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	12/15/01	0905	257	10
	11417500	12/18/01	0935	593	15
	11417500	12/19/01	1230	337	3
	11417500	12/20/01	0930	415	8
	11417500	12/21/01	1135	439	19
	11417500	12/26/01	0920	259	4
	11417500	12/27/01	1220	262	1
	11417500	12/28/01	0915	294	2
	11417500	12/29/01	0840	709	29
	11417500	12/31/01	0910	1770	97
	11417500	12/31/01	1300	1580	51
	11417500	12/31/01	1400	1510	40
	11417500	12/31/01	1500	1450	35
	11417500	12/31/01	1600	1400	32
	11417500	01/03/02	1225	1300	14
	11417500	01/04/02	0910	794	8
	11417500	01/08/02	0915	665	5
	11417500	01/09/02	0915	552	5
	11417500	01/09/02	0915	552	4
	11417500	01/10/02	1220	460	2
	11417500	01/11/02	0940	406	6
	11417500	01/14/02	0920	307	2
	11417500	01/14/02	0920	307	3
	11417500	01/15/02	0930	285	1
	11417500	01/16/02	0945	262	2
	11417500	01/17/02	0940	246	2
	11417500	01/17/02	0940	246	1
	11417500	01/18/02	1210	227	1
	11417500	01/22/02	0950	227	1
	11417500	01/23/02	0920	189	1
	11417500	01/23/02	0920	189	2
	11417500	01/24/02	0930	189	1
	11417500	01/25/02	0930	181	2
	11417500	01/28/02	0920	267	5
	11417500	01/28/02	0920	267	3
	11417500	01/29/02	0930	233	3
	11417500	01/30/02	0935	215	2
	11417500	01/31/02	0940	208	3
	11417500	01/31/02	0940	208	2
	11417500	02/04/02	0935	169	1
	11417500	02/11/02	1020	233	2
	11417500	02/12/02	0920	226	2
	11417500	02/13/02	0940	224	1
	11417500	02/13/02	0940	224	2
	11417500	02/14/02	1045	233	2
	11417500	02/15/02	1030	229	1
	11417500	02/19/02	0920	285	5

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

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Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	02/19/02	0920	285	7
	11417500	02/20/02	0915	2000	213
	11417500	02/21/02	0920	1070	15
	11417500	02/22/02	0920	739	6
	11417500	02/22/02	0920	739	6
	11417500	02/25/02	0920	454	3
	11417500	02/26/02	0915	411	2
	11417500	02/27/02	0925	385	1
	11417500	02/28/02	0930	365	1
	11417500	02/28/02	0930	365	0.25
	11417500	03/01/02	0920	338	2
	11417500	03/04/02	0910	277	0.25
	11417500	03/05/02	0900	267	0.25
	11417500	03/06/02	1230	606	44
	11417500	03/06/02	1255	603	28
	11417500	03/06/02	1255	603	30
	11417500	03/07/02	0910	1280	50
	11417500	03/07/02	1200	1250	35
	11417500	03/08/02	0905	1070	23
	11417500	03/08/02	0905	1070	50
	11417500	03/08/02	1215	998	89
	11417500	03/11/02	0910	747	10
	11417500	03/11/02	0910	747	9
	11417500	03/12/02	0920	654	5
	11417500	03/12/02	0920	654	5
	11417500	03/13/02	0855	603	2
	11417500	03/13/02	0855	603	4
	11417500	03/14/02	0910	532	4
	11417500	03/14/02	0910	532	5
	11417500	03/15/02	0915	466	4
	11417500	03/15/02	0915	466	10
	11417500	03/18/02	0920	390	2
	11417500	03/18/02	0920	390	2
	11417500	03/19/02	0920	390	34
	11417500	03/19/02	0920	390	33
	11417500	03/20/02	0910	365	6
	11417500	03/20/02	0910	365	5
	11417500	03/21/02	0910	358	3
	11417500	03/21/02	0910	358	4
	11417500	03/22/02	0920	360	3
	11417500	03/22/02	0920	360	3
	11417500	03/24/02	0915	1260	64
	11417500	03/24/02	0915	1260	55
	11417500	03/25/02	1020	818	13
	11417500	03/25/02	1020	818	14
	11417500	03/26/02	0925	665	6
	11417500	03/26/02	0925	665	7

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

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Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	03/27/02	0920	580	5
	11417500	03/27/02	0920	580	4
	11417500	03/28/02	0910	532	7
	11417500	03/28/02	0910	532	5
	11417500	03/29/02	0910	541	3
	11417500	03/29/02	0910	541	3
	11417500	04/02/02	0925	532	2
	11417500	04/02/02	0925	532	3
	11417500	04/03/02	0915	546	3
	11417500	04/03/02	0915	546	4
	11417500	04/04/02	0920	559	2
	11417500	04/04/02	0920	559	3
	11417500	04/05/02	0920	543	2
	11417500	04/05/02	0920	543	2
	11417500	04/08/02	0915	439	2
	11417500	04/08/02	0915	439	3
	11417500	04/09/02	0925	418	5
	11417500	04/09/02	0925	418	3
	11417500	04/10/02	0910	448	3
	11417500	04/10/02	0910	448	3
	11417500	04/11/02	0910	428	2
	11417500	04/11/02	0910	428	2
	11417500	04/15/02	0920	448	3
	11417500	04/15/02	0920	448	3
	11417500	04/16/02	0905	352	2
	11417500	04/16/02	0905	352	2
	11417500	04/17/02	0920	356	2
	11417500	04/17/02	0920	356	2
	11417500	04/18/02	0910	346	5
	11417500	04/18/02	0910	346	0.25
	11417500	04/19/02	0920	312	3
	11417500	04/19/02	0920	312	10
	11417500	04/22/02	0855	280	1
	11417500	04/22/02	0855	280	1
	11417500	04/23/02	0920	282	3
	11417500	04/23/02	0920	282	2
	11417500	04/24/02	0905	280	1
	11417500	04/24/02	0905	280	3
	11417500	04/25/02	0915	279	2
	11417500	04/25/02	0915	279	3
	11417500	04/26/02	0905	279	3
	11417500	04/26/02	0905	279	3
	11417500	04/30/02	0925	265	2
	11417500	04/30/02	0925	265	0.25
	11417500	05/01/02	0900	232	0.25
	11417500	05/01/02	0900	232	1
	11417500	05/02/02	0915	229	0.25

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	05/02/02	0915	229	1
	11417500	05/03/02	0855	224	4
	11417500	05/03/02	0855	224	1
	11417500	05/06/02	0915	223	6
	11417500	05/06/02	0915	223	4
	11417500	05/07/02	0915	227	2
	11417500	05/07/02	0915	227	2
	11417500	05/08/02	0920	236	1
	11417500	05/08/02	0920	236	1
	11417500	05/09/02	0920	212	1
	11417500	05/09/02	9200	212	1
	11417500	05/10/02	0905	204	0.25
	11417500	05/10/02	0905	204	1
	11417500	05/13/02	0855	196	1
	11417500	05/13/02	0855	196	2
	11417500	05/14/02	0920	194	0.25
	11417500	05/14/02	0920	194	0.25
	11417500	05/15/02	0915	190	0.25
	11417500	05/15/02	0915	190	10
	11417500	05/16/02	0930	186	0.25
	11417500	05/16/02	0930	186	0.25
	11417500	05/17/02	0920	180	0.25
	11417500	05/17/02	0920	180	1
	11417500	05/20/02	0915	218	9
	11417500	05/20/02	0915	218	3
	11417500	05/21/02	0930	439	24
	11417500	05/21/02	0930	439	28
	11417500	05/22/02	0915	383	2
	11417500	05/22/02	0915	383	2
	11417500	05/23/02	0935	727	12
	11417500	05/23/02	0935	727	11
	11417500	05/24/02	0910	698	5
	11417500	05/24/02	0910	698	4
	11417500	05/28/02	0915	433	0.25
	11417500	05/28/02	0915	433	1
	11417500	05/29/02	0920	243	7
	11417500	05/29/02	0920	243	6
	11417500	05/30/02	0905	196	3
	11417500	05/30/02	0905	196	3
	11417500	05/31/02	0915	463	3
	11417500	05/31/02	0915	463	4
	11417500	06/04/02	1130	445	1
	11417500	06/04/02	1130	445	1
	11417500	06/06/02	1130	388	2
	11417500	06/06/02	1130	388	1
	11417500	06/10/02	0920	99	1
	11417500	06/10/02	0920	99	1

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	06/11/02	0925	98	2
	11417500	06/11/02	0925	98	0.25
	11417500	06/12/02	0910	92	2
	11417500	06/12/02	0910	92	2
	11417500	06/13/02	0930	87	1
	11417500	06/13/02	0930	87	1
	11417500	06/14/02	0920	80	1
	11417500	06/14/02	0920	80	2
	11417500	06/18/02	0930	79	3
	11417500	06/18/02	0930	79	2
	11417500	06/19/02	0830	79	0.25
	11417500	06/19/02	0830	79	1
	11417500	06/20/02	0830	78	1
	11417500	06/20/02	0830	78	2
	11417500	06/21/02	0810	74	1
	11417500	06/21/02	0810	74	2
	11417500	06/24/02	0920	72	2
	11417500	06/24/02	0920	72	3
	11417500	06/25/02	0920	70	2
	11417500	06/25/02	0920	70	3
	11417500	06/27/02	0910	67	1
	11417500	06/27/02	0910	67	1
	11417500	06/28/02	0900	67	1
	11417500	06/28/02	0900	67	4
	11417500	11/05/02	1018	43	1
	11417500	11/05/02	1018	43	1
	11417500	11/07/02	1110	54	0.25
	11417500	11/07/02	1110	54	1
	11417500	11/07/02	1300	56	0.25
	11417500	11/07/02	1300	56	2
	11417500	11/07/02	1500	60	4
	11417500	11/07/02	1500	60	2
	11417500	11/07/02	1630	64	1
	11417500	11/07/02	1630	64	1
	11417500	11/08/02	1040	280	133
	11417500	11/08/02	1040	280	134
	11417500	11/08/02	1150	338	125
	11417500	11/08/02	1150	338	121
	11417500	11/08/02	1400	409	78
	11417500	11/08/02	1400	409	85
	11417500	11/08/02	1530	397	69
	11417500	11/08/02	1530	397	70
	11417500	11/09/02	0845	463	39
	11417500	11/09/02	0845	463	32
	11417500	11/09/02	1045	417	32
	11417500	11/09/02	1045	417	31
	11417500	11/12/02	1335	163	9

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	11/12/02	1335	163	8
	11417500	11/13/02	0900	120	6
	11417500	11/13/02	0900	120	3
	11417500	11/15/02	0915	86	2
	11417500	11/15/02	0915	86	4
	11417500	11/18/02	0850	70	2
	11417500	11/18/02	0850	70	2
	11417500	11/20/02	0930	67	0.25
	11417500	11/20/02	0930	67	1
	11417500	11/22/02	0905	64	2
	11417500	11/22/02	0905	64	1
	11417500	11/25/02	0900	62	0.25
	11417500	11/25/02	0900	62	1
	11417500	11/27/02	0835	58	3
	11417500	11/27/02	0835	58	0.25
	11417500	12/02/02	0900	58	0.25
	11417500	12/02/02	0900	58	0.25
	11417500	12/04/02	0850	58	0.25
	11417500	12/04/02	0850	58	2
	11417500	12/06/02	0855	57	1
	11417500	12/06/02	0855	57	1
	11417500	12/09/02	0845	56	0.25
	11417500	12/09/02	0845	56	0.25
	11417500	12/11/02	0840	99	2
	11417500	12/11/02	0840	99	2
	11417500	12/13/02	0840	80	4
	11417500	12/13/02	0840	80	2
	11417500	12/13/02	1040	87	9
	11417500	12/13/02	1040	87	2
	11417500	12/13/02	1240	101	4
	11417500	12/13/02	1240	101	3
	11417500	12/13/02	1445	147	19
	11417500	12/13/02	1445	147	23
	11417500	12/13/02	1600	221	63
	11417500	12/13/02	1600	221	63
	11417500	12/14/02	0800	1790	44
	11417500	12/14/02	0800	1790	141
	11417500	12/14/02	1148	1620	96
	11417500	12/14/02	1148	1620	74
	11417500	12/14/02	1440	1490	92
	11417500	12/14/02	1440	1490	84
	11417500	12/15/02	0740	1790	188
	11417500	12/15/02	0740	1790	191
	11417500	12/15/02	0940	1620	138
	11417500	12/15/02	0940	1620	143
	11417500	12/15/02	1140	1500	110
	11417500	12/15/02	1140	1500	56

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	12/15/02	1340	1330	55
	11417500	12/15/02	1340	1330	56
	11417500	12/15/02	1615	1160	42
	11417500	12/15/02	1615	1160	42
	11417500	12/16/02	1000	4600	401
	11417500	12/16/02	1000	4600	374
	11417500	12/16/02	1215	3650	304
	11417500	12/16/02	1215	3650	360
	11417500	12/16/02	1415	3110	244
	11417500	12/16/02	1415	3110	237
	11417500	12/16/02	1500	3010	209
	11417500	12/16/02	1500	3010	198
	11417500	12/17/02	0930	1240	30
	11417500	12/17/02	0930	1240	31
	11417500	12/17/02	1100	1170	27
	11417500	12/17/02	1100	1170	28
	11417500	12/17/02	1300	1090	26
	11417500	12/17/02	1300	1090	24
	11417500	12/17/02	1500	1020	23
	11417500	12/17/02	1500	1020	24
	11417500	12/17/02	1630	956	25
	11417500	12/17/02	1630	956	23
	11417500	12/18/02	0830	615	13
	11417500	12/18/02	0830	615	9
	11417500	12/18/02	1030	595	10
	11417500	12/18/02	1030	595	12
	11417500	12/18/02	1230	560	10
	11417500	12/18/02	1230	560	11
	11417500	12/20/02	0900	390	4
	11417500	12/20/02	0900	390	3
	11417500	12/23/02	0900	331	8
	11417500	12/23/02	0900	331	7
	11417500	12/27/02	0930	305	4
	11417500	12/27/02	0930	305	3
	11417500	12/30/02	0910	834	18
	11417500	12/30/02	0910	834	16
	11417500	12/30/02	1500	765	11
	11417500	12/30/02	1500	765	11
	11417500	01/03/03	0920	493	2
	11417500	01/03/03	0920	493	2
	11417500	01/06/03	0910	432	2
	11417500	01/06/03	0910	432	3
	11417500	01/08/03	0900	366	1
	11417500	01/08/03	0900	366	2
	11417500	01/10/03	0900	482	5
	11417500	01/10/03	0900	482	5
	11417500	01/13/03	0930	544	7

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	01/13/03	0930	544	6
	11417500	01/15/03	1030	419	2
	11417500	01/15/03	1030	419	3
	11417500	01/17/03	1030	327	1
	11417500	01/17/03	1030	327	1
	11417500	01/21/03	0905	301	0.25
	11417500	01/21/03	0905	301	2
	11417500	01/23/03	0920	742	23
	11417500	01/23/03	0920	742	23
	11417500	01/27/03	0920	471	2
	11417500	01/27/03	0920	471	2
	11417500	01/31/03	0930	356	2
	11417500	01/31/03	0930	356	2
	11417500	02/03/03	0955	320	1
	11417500	02/03/03	0955	320	0.25
	11417500	02/05/03	1000	275	0.25
	11417500	02/05/03	1000	275	1
	11417500	02/07/03	0930	246	0.25
	11417500	02/07/03	0930	246	0.25
	11417500	02/10/03	1140	211	1
	11417500	02/10/03	1140	211	1
	11417500	02/12/03	1105	199	0.25
	11417500	02/12/03	1105	199	0.25
	11417500	02/14/03	1015	501	16
	11417500	02/14/03	1015	501	18
	11417500	02/15/03	1320	295	2
	11417500	02/15/03	1320	295	1
	11417500	02/15/03	1500	291	1
	11417500	02/15/03	1500	291	1
	11417500	02/15/03	1700	288	2
	11417500	02/15/03	1700	288	3
	11417500	02/16/03	0700	661	34
	11417500	02/16/03	0700	661	33
	11417500	02/16/03	0945	636	162
	11417500	02/16/03	0945	636	168
	11417500	02/16/03	1200	661	243
	11417500	02/16/03	1400	643	5
	11417500	02/16/03	1400	643	12
	11417500	02/16/03	1530	633	6
	11417500	02/16/03	1530	633	9
	11417500	02/17/03	0700	447	0.25
	11417500	02/17/03	0700	447	1
	11417500	02/17/03	0900	437	9
	11417500	02/17/03	0900	437	9
	11417500	02/17/03	1100	429	7
	11417500	02/17/03	1100	429	6
	11417500	02/17/03	1300	419	6

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	02/17/03	1300	419	7
	11417500	02/17/03	1500	407	2
	11417500	02/17/03	1500	407	2
	11417500	02/18/03	0900	352	3
	11417500	02/18/03	0900	352	2
	11417500	02/18/03	1100	345	1
	11417500	02/18/03	1100	345	2
	11417500	02/19/03	0915	312	1
	11417500	02/19/03	0915	312	3
	11417500	02/21/03	0915	288	2
	11417500	02/21/03	0915	288	3
	11417500	02/24/03	0900	233	3
	11417500	02/24/03	0900	233	4
	11417500	02/26/03	0900	214	2
	11417500	02/26/03	0900	214	2
	11417500	02/28/03	0900	208	2
	11417500	02/28/03	0900	208	2
	11417500	03/05/03	0850	170	2
	11417500	03/05/03	0850	170	1
	11417500	03/07/03	0845	159	2
	11417500	03/07/03	0845	159	4
	11417500	03/10/03	0940	146	6
	11417500	03/10/03	0940	146	3
	11417500	03/12/03	1100	146	2
	11417500	03/12/03	1100	146	2
	11417500	03/13/03	1300	150	1
	11417500	03/13/03	1300	150	13
	11417500	03/13/03	1500	153	2
	11417500	03/13/03	1500	153	3
	11417500	03/14/03	0730	218	3
	11417500	03/14/03	0730	218	3
	11417500	03/14/03	0930	263	5
	11417500	03/14/03	0930	263	3
	11417500	03/14/03	1210	303	9
	11417500	03/14/03	1210	303	12
	11417500	03/14/03	1400	340	10
	11417500	03/14/03	1400	340	7
	11417500	03/14/03	1530	395	44
	11417500	03/14/03	1530	395	40
	11417500	03/14/03	1530	395	112
	11417500	03/14/03	1530	395	120
	11417500	03/15/03	0730	2170	623
	11417500	03/15/03	0730	2170	577
	11417500	03/15/03	0930	2540	393
	11417500	03/15/03	0930	2540	330
	11417500	03/15/03	1130	2790	392
	11417500	03/15/03	1130	2790	385

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	03/15/03	1330	3160	334
	11417500	03/15/03	1330	3160	353
	11417500	03/15/03	1530	2810	191
	11417500	03/15/03	1530	2810	182
	11417500	03/16/03	0800	1110	19
	11417500	03/16/03	0800	1110	19
	11417500	03/16/03	1000	1050	20
	11417500	03/16/03	1000	1050	22
	11417500	03/16/03	1200	983	18
	11417500	03/16/03	1200	983	18
	11417500	03/16/03	1400	929	13
	11417500	03/16/03	1400	929	17
	11417500	03/16/03	1630	885	11
	11417500	03/16/03	1630	885	12
	11417500	03/17/03	0830	686	6
	11417500	03/17/03	0830	686	9
	11417500	03/19/03	0910	437	3
	11417500	03/19/03	0910	437	2
	11417500	03/21/03	1000	434	3
	11417500	03/21/03	1000	434	4
	11417500	03/24/03	0930	541	4
	11417500	03/24/03	0930	541	4
	11417500	03/26/03	0920	434	3
	11417500	03/26/03	0920	434	4
	11417500	03/28/03	0910	487	1
	11417500	03/28/03	0910	487	2
	11417500	04/03/03	1000	409	9
	11417500	04/03/03	1000	409	7
	11417500	04/09/03	0905	442	2
	11417500	04/09/03	0905	442	3
	11417500	04/11/03	0925	422	1
	11417500	04/11/03	0925	422	1
	11417500	04/14/03	0900	1190	23
	11417500	04/14/03	0900	1190	21
	11417500	04/16/03	0850	738	4
	11417500	04/16/03	0850	738	4
	11417500	04/18/03	0900	708	4
	11417500	04/18/03	0900	708	2
	11417500	04/21/03	0925	629	3
	11417500	04/21/03	0925	629	3
	11417500	04/23/03	0855	576	2
	11417500	04/23/03	0855	576	2
	11417500	04/28/03	0925	1190	12
	11417500	04/28/03	0925	1190	21
	11417500	04/30/03	0910	1020	11
	11417500	04/30/03	0910	1020	13
	11417500	05/02/03	0855	851	4

Table A1b. Suspended-sediment concentration samples and associated instantaneous streamflow for the South Yuba River at Jones Bar near Grass Valley (SYG) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
SYG	11417500	05/02/03	0855	851	4
	11417500	05/05/03	0930	1330	12
	11417500	05/05/03	0930	1330	10
	11417500	05/06/03	0850	1140	5
	11417500	05/06/03	0850	1140	6
	11417500	05/07/03	0930	965	5
	11417500	05/07/03	0930	965	3
	11417500	05/08/03	0910	1220	13
	11417500	05/08/03	0910	1220	10
	11417500	05/09/03	0850	1210	16
	11417500	05/09/03	0850	1210	15
	11417500	05/14/03	0930	1040	5
	11417500	05/14/03	0930	1040	4
	11417500	05/16/03	0855	1050	2
	11417500	05/16/03	0855	1050	2
	11417500	05/19/03	0925	872	3
	11417500	05/19/03	0925	872	2
	11417500	05/21/03	0925	1090	4
	11417500	05/21/03	0925	1090	5
	11417500	05/22/03	1155	1160	5
	11417500	05/22/03	1155	1160	6
	11417500	05/23/03	0940	1410	12
	11417500	05/23/03	0940	1410	10
	11417500	05/27/03	0910	1460	6
	11417500	05/27/03	0910	1460	5
	11417500	05/29/03	0855	1930	24
	11417500	05/29/03	0855	1930	21

Table A1c. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below New Colgate Powerplant near French Corral (YRC) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRC	11413700	01/09/01	1430	107	3
	11413700	01/11/01	1610	213	65
	11413700	01/12/01	1335	120	8
	11413700	01/19/01	1145	82	11
	11413700	01/22/01	1105	77	16
	11413700	01/23/01	1235	77	53
	11413700	01/24/01	1300	155	61
	11413700	01/25/01	1220	3400	8
	11413700	01/26/01	1220	143	4
	11413700	01/29/01	1230	107	2
	11413700	01/30/01	1225	102	106
	11413700	02/01/01	1225	125	2
	11413700	02/02/01	1215	134	1
	11413700	02/05/01	1225	86	14
	11413700	02/07/01	1215	86	4
	11413700	02/08/01	1225	84	2
	11413700	02/09/01	1220	86	8
	11413700	02/11/01	1250	257	303
	11413700	02/12/01	1210	175	19
	11413700	02/13/01	1215	134	7
	11413700	02/15/01	1210	112	2
	11413700	02/16/01	1205	104	1
	11413700	02/19/01	1205	125	2
	11413700	02/20/01	1225	281	28
	11413700	02/22/01	1215	402	16
	11413700	02/23/01	1215	239	7
	11413700	02/26/01	1230	165	6
	11413700	02/28/01	1220	2060	4
	11413700	02/28/01	1600	778	5
	11413700	03/02/01	1220	165	6
	11413700	03/05/01	1220	252	10
	11413700	03/07/01	1245	1030	7
	11413700	03/09/01	1230	152	2
	11413700	03/12/01	1215	120	6
	11413700	03/14/01	1230	128	1175
	11413700	03/15/01	1315	109	5
	11413700	03/16/01	1225	107	7
	11413700	03/19/01	1215	3380	2
	11413700	03/21/01	1235	104	4
	11413700	03/26/01	0915	469	313
	11413700	03/28/01	1225	1390	2
	11413700	03/30/01	1235	438	3
	11413700	04/02/01	1230	438	2
	11413700	04/04/01	1220	420	3
	11413700	04/06/01	1235	99.6	1
	11413700	04/06/01	1235	99.6	4
	11413700	04/09/01	1230	115	1
	11413700	04/09/01	1230	115	1

Table A1c. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below New Colgate Powerplant near French Corral (YRC) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRC	11413700	04/11/01	1230	125	2
	11413700	04/11/01	1230	125	2
	11413700	04/13/01	1215	851	1
	11413700	04/13/01	1215	851	1
	11413700	04/16/01	1220	2150	2
	11413700	04/16/01	1220	2150	5
	11413700	04/18/01	1230	134	2
	11413700	04/18/01	1230	134	1
	11413700	04/20/01	1230	1440	5
	11413700	04/20/01	1230	1440	1
	11413700	04/23/01	1225	718	2
	11413700	04/23/01	1225	718	1
	11413700	04/25/01	1220	2030	2
	11413700	04/25/01	1220	2030	20
	11413700	04/30/01	1215	2040	2
	11413700	05/02/01	1245	123	2
	11413700	05/04/01	1230	2000	2
	11413700	05/07/01	1230	1840	1
	11413700	05/09/01	1215	2530	1
	11413700	05/11/01	1200	3120	2
	11413700	05/14/01	1215	1660	1
	11413700	05/16/01	1225	943	19
	11413700	05/18/01	1200	2530	2
	11413700	05/21/01	1200	1780	1
	11413700	05/22/01	1205	2490	2
	11413700	05/23/01	1210	1320	1
	11413700	05/25/01	1215	887	4
	11413700	05/29/01	1215	2020	3
	11413700	05/31/01	1220	2750	2
	11413700	06/04/01	1200	1240	2
	11413700	06/06/01	1215	1490	2
	11413700	06/08/01	1210	2120	2
	11413700	06/11/01	1215	1260	1
	11413700	06/14/01	1220	1900	1
	11413700	06/18/01	1225	2770	3
	11413700	06/20/01	1220	860	3
	11413700	06/22/01	1050	2700	1
	11413700	06/25/01	1225	693	2
	11413700	06/27/01	1230	2630	0
	11413700	06/29/01	1215	1240	1
	11413700	07/02/01	1205	1890	8
	11413700	07/06/01	1230	2890	4
	11413700	07/09/01	1215	2470	1
	11413700	07/11/01	1200	3260	1
	11413700	07/13/01	1210	2800	5
	11413700	07/16/01	1235	2720	24
	11413700	07/18/01	1220	2300	1
	11413700	07/20/01	1210	2180	8

Table A1c. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below New Colgate Powerplant near French Corral (YRC) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRC	11413700	07/23/01	1315	2420	2
	11413700	07/25/01	1250	3340	1
	11413700	07/27/01	1215	1810	2
	11413700	07/30/01	1235	2820	2
	11413700	08/01/01	1220	1530	2
	11413700	08/02/01	1210	3170	1
	11413700	08/06/01	1245	3500	3
	11413700	08/15/01	1500	3300	8
	11413700	08/21/01	1120	3420	1
	11413700	08/29/01	1215	3130	12
	11413700	09/11/01	1035	2180	30
	11413700	09/21/01	1240	1600	3
	11413700	09/27/01	1220	701	3
	11413700	10/03/01	1300	1810	4
	11413700	10/10/01	1225	896	2
	11413700	10/17/01	1145	878	4
	11413700	10/24/01	1245	2420	3
	11413700	10/30/01	1240	1580	2
	11413700	10/31/01	1340	1240	4
	11413700	11/02/01	1220	420	113
	11413700	11/07/01	1235	963	2
	11413700	11/13/01	1030	1860	3
	11413700	11/16/01	1255	117	3
	11413700	11/26/01	1220	1030	4
	11413700	11/27/01	1000	1010	2
	11413700	11/28/01	1215	972	2
	11413700	11/29/01	1140	117	111
	11413700	12/03/01	1225	271	23
	11413700	12/05/01	1218	261	3
	11413700	12/06/01	0925	556	20
	11413700	12/07/01	0915	234	6
	11413700	12/11/01	0930	123	6
	11413700	12/12/01	1205	115	1
	11413700	12/14/01	1225	291	14
	11413700	12/15/01	1145	169	5
	11413700	12/18/01	1225	306	8
	11413700	12/19/01	0930	197	4
	11413700	12/20/01	1230	301	3
	11413700	12/26/01	1215	149	7
	11413700	12/28/01	1140	134	7
	11413700	12/31/01	1105	1170	105
	11413700	01/02/02	1330	508	5
	11413700	01/04/02	1135	301	4
	11413700	01/09/02	1145	243	0
	11413700	01/09/02	1145	243	13
	11413700	01/11/02	1220	194	2
	11413700	01/14/02	1155	2090	2
	11413700	01/16/02	1230	2550	14

Table A1c. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below New Colgate Powerplant near French Corral (YRC) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRC	11413700	01/16/02	1230	2550	1
	11413700	01/17/02	1245	2770	2
	11413700	01/22/02	1245	677	4
	11413700	01/24/02	1205	1110	1
	11413700	01/24/02	1205	1110	1
	11413700	01/28/02	1245	963	4
	11413700	01/30/02	1220	1640	2
	11413700	02/04/02	1250	953	1
	11413700	02/04/02	1250	953	2
	11413700	02/11/02	1210	1180	3
	11413700	02/13/02	1240	1060	5
	11413700	02/15/02	1230	1070	2
	11413700	02/15/02	1230	1070	3
	11413700	02/21/02	1215	542	2
	11413700	02/22/02	1205	281	4
	11413700	02/22/02	1205	281	22
	11413700	02/25/02	1210	1490	6
	11413700	02/26/02	1215	1040	17
	11413700	02/28/02	1210	607	3
	11413700	03/01/02	1205	585	6
	11413700	03/04/02	1150	1300	3
	11413700	03/05/02	1210	1240	3
	11413700	03/05/02	1210	1240	1
	11413700	03/11/02	1210	2800	2
	11413700	03/11/02	1210	2800	12
	11413700	03/12/02	1155	2340	4
	11413700	03/12/02	1155	2340	2
	11413700	03/14/02	1200	1060	6
	11413700	03/14/02	1200	1060	2
	11413700	03/15/02	1210	1390	3
	11413700	03/15/02	1210	1390	18
	11413700	03/18/02	1200	2370	3
	11413700	03/18/02	1200	2370	18
	11413700	03/19/02	1210	1950	2
	11413700	03/19/02	1210	1950	4
	11413700	03/22/02	1210	2180	3
	11413700	03/22/02	1210	2180	2
	11413700	03/24/02	1130	1580	8
	11413700	03/24/02	1130	1580	10
	11413700	03/25/02	1210	2730	3
	11413700	03/25/02	1210	2730	16
	11413700	03/26/02	1210	2340	2
	11413700	03/26/02	1210	2340	30
	11413700	03/28/02	1200	2190	1
	11413700	03/28/02	1200	2190	5
	11413700	03/29/02	1205	2900	3
	11413700	03/29/02	1205	2900	4
	11413700	04/03/02	1200	2720	155

Table A1c. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below New Colgate Powerplant near French Corral (YRC) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRC	11413700	04/03/02	1200	2720	2
	11413700	04/05/02	1205	2070	2
	11413700	04/05/02	1205	2070	2
	11413700	04/08/02	1215	3130	3
	11413700	04/08/02	1215	3130	10
	11413700	04/09/02	1220	3040	1
	11413700	04/09/02	1220	3040	1
	11413700	04/11/02	1155	2440	5
	11413700	04/11/02	1155	2440	0
	11413700	04/15/02	1200	2650	1
	11413700	04/15/02	1200	2650	1
	11413700	04/16/02	1155	3320	1
	11413700	04/16/02	1155	3320	2
	11413700	04/18/02	1155	2580	5
	11413700	04/18/02	1155	2580	2
	11413700	04/19/02	1225	3260	2
	11413700	04/19/02	1225	3260	2
	11413700	04/22/02	1145	2580	8
	11413700	04/22/02	1145	2580	3
	11413700	04/23/02	1205	3520	16
	11413700	04/23/02	1205	3520	1
	11413700	04/25/02	1210	3260	5
	11413700	04/25/02	1210	3260	1
	11413700	04/26/02	1155	2960	12
	11413700	04/26/02	1155	2960	1
	11413700	04/30/02	1240	2970	1
	11413700	04/30/02	1240	2970	3
	11413700	05/02/02	1150	3100	1
	11413700	05/02/02	1150	3100	4
	11413700	05/03/02	1155	3280	3
	11413700	05/03/02	1155	3280	2
	11413700	05/06/02	1145	3300	2
	11413700	05/06/02	1145	3300	4
	11413700	05/07/02	1205	3280	2
	11413700	05/07/02	1205	3280	3
	11413700	05/09/02	1210	3300	6
	11413700	05/09/02	1210	3300	3
	11413700	05/10/02	1150	3230	1
	11413700	05/10/02	1150	3230	2
	11413700	05/13/02	1145	no data	1
	11413700	05/13/02	1145	no data	4
	11413700	05/14/02	1210	no data	2
	11413700	05/14/02	1210	no data	1
	11413700	05/16/02	1150	1990	2
	11413700	05/16/02	1150	1990	2
	11413700	05/17/02	1200	1860	1
	11413700	05/17/02	1200	1860	2
	11413700	05/20/02	1205	2190	3

Table A1c. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below New Colgate Powerplant near French Corral (YRC) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRC	11413700	05/20/02	1205	2190	2
	11413700	05/21/02	1205	2580	5
	11413700	05/21/02	1205	2580	2
	11413700	05/23/02	1210	2390	1
	11413700	05/23/02	1210	2390	2
	11413700	05/24/02	1210	2780	2
	11413700	05/24/02	1210	2780	2
	11413700	05/28/02	1200	3130	2
	11413700	05/28/02	1200	3130	1
	11413700	05/30/02	1130	2520	2
	11413700	05/30/02	1130	2520	13
	11413700	05/31/02	1210	2620	0
	11413700	05/31/02	1210	2620	1
	11413700	06/04/02	1530	3190	2
	11413700	06/04/02	1530	3190	1
	11413700	06/06/02	1500	3400	2
	11413700	06/06/02	1500	3400	1
	11413700	06/10/02	1210	1740	1
	11413700	06/10/02	1210	1740	1
	11413700	06/11/02	1205	2600	5
	11413700	06/11/02	1205	2600	1
	11413700	06/13/02	1215	1130	2
	11413700	06/13/02	1215	1130	2
	11413700	06/14/02	1205	2920	2
	11413700	06/14/02	1205	2920	3
	11413700	06/17/02	1215	3240	2
	11413700	06/17/02	1215	3240	3
	11413700	06/18/02	1205	3620	11
	11413700	06/18/02	1205	3620	0
	11413700	06/20/02	1155	2520	2
	11413700	06/20/02	1155	2520	1
	11413700	06/21/02	1125	3440	1
	11413700	06/21/02	1125	3440	3
	11413700	06/24/02	1210	2530	2
	11413700	06/24/02	1210	2530	3
	11413700	06/28/02	1200	2970	1
	11413700	06/28/02	1200	2970	2

Table A1d. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below Englebright Dam near Smartville (YRE) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRE	11418000	01/12/01	1500	941	2
	11418000	02/02/01	1500	701	2
	11418000	02/06/01	0930	688	1
	11418000	02/10/01	1440	656	6
	11418000	02/12/01	1410	692	2
	11418000	02/13/01	1400	691	2
	11418000	02/15/01	1405	691	2
	11418000	02/16/01	1400	692	2
	11418000	02/20/01	1420	690	3
	11418000	02/22/01	1400	1240	1
	11418000	02/23/01	1405	1220	1
	11418000	02/27/01	1250	1040	1
	11418000	02/28/01	1130	946	4
	11418000	03/06/01	1310	738	6
	11418000	03/08/01	1255	745	3
	11418000	03/13/01	1245	734	3
	11418000	03/14/01	1335	731	3
	11418000	03/15/01	1250	728	2
	11418000	03/20/01	1245	721	10
	11418000	03/21/01	1130	721	7
	11418000	03/27/01	0925	725	4
	11418000	04/03/01	1250	1090	4
	11418000	04/05/01	1255	1085	2
	11418000	04/10/01	1300	1070	1
	11418000	04/10/01	1300	1070	1
	11418000	04/12/01	1250	1070	3
	11418000	04/12/01	1250	1070	3
	11418000	04/17/01	1310	no data	8
	11418000	04/17/01	1310	no data	2
	11418000	04/19/01	1250	no data	1
	11418000	04/19/01	1250	no data	1
	11418000	04/24/01	1305	880	1
	11418000	04/24/01	1305	880	1
	11418000	04/26/01	1255	885	1
	11418000	04/26/01	1255	885	1
	11418000	05/01/01	1250	875	3
	11418000	05/03/01	1245	994	3
	11418000	05/08/01	1255	1190	5
	11418000	05/10/01	1255	1130	2
	11418000	05/15/01	1255	900	3
	11418000	05/17/01	1250	850	2
	11418000	05/24/01	1245	880	1
	11418000	05/30/01	1000	972	2
	11418000	05/30/01	1245	978	3
	11418000	06/01/01	1240	946	1
	11418000	06/05/01	1245	972	2

Table A1d. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below Englebright Dam near Smartville (YRE) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRE	11418000	06/07/01	1250	972	4
	11418000	06/13/01	1255	946	2
	11418000	06/15/01	1245	972	3
	11418000	06/19/01	1215	1020	2
	11418000	06/21/01	1215	1040	1
	11418000	06/21/01	1230	1040	4
	11418000	06/26/01	1245	994	3
	11418000	06/28/01	1250	905	1
	11418000	07/03/01	1245	962	1
	11418000	07/05/01	1150	1920	5
	11418000	07/10/01	1320	2090	2
	11418000	07/12/01	1315	2120	1
	11418000	07/17/01	1300	2100	6
	11418000	07/19/01	1300	2130	1
	11418000	07/24/01	1315	2120	3
	11418000	07/26/01	1300	2120	2
	11418000	07/31/01	1235	2110	1
	11418000	08/03/01	1100	2000	1
	11418000	08/07/01	1200	1930	1
	11418000	08/15/01	1305	1900	2
	11418000	08/21/01	1245	1920	1
	11418000	08/29/01	1340	812	1
	11418000	08/30/01	1600	812	0.25
	11418000	09/05/01	1245	812	2
	11418000	09/11/01	1205	600	1
	11418000	09/27/01	1420	628	2
	11418000	09/30/01	2330	673	2
	11418000	10/03/01	1510	554	2
	11418000	10/10/01	1300	673	2
	11418000	10/17/01	1400	656	5
	11418000	10/24/01	1030	895	2
	11418000	10/25/01	1020	875	2
	11418000	11/06/01	1015	no data	3
	11418000	11/27/01	1500	no data	1
	11418000	11/29/01	1000	734	2
	11418000	12/04/01	0940	1275	4
	11418000	12/13/01	1000	624	5
	11418000	12/13/01	1300	624	9
	11418000	12/15/01	1115	628	4
	11418000	12/27/01	0920	826	4
	11418000	01/03/02	0925	1640	8
	11418000	01/04/02	1220	1570	9
	11418000	01/04/02	1220	1570	8
	11418000	01/08/02	1230	1960	8
	11418000	01/10/02	0930	1960	5
	11418000	01/15/02	1240	1970	3

Table A1d. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below Englebright Dam near Smartville (YRE) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRE	11418000	01/15/02	1240	1970	4
	11418000	01/18/02	0920	1985	3
	11418000	01/23/02	1230	1610	2
	11418000	01/25/02	1220	1610	3
	11418000	01/25/02	1220	1610	3
	11418000	01/29/02	1240	1610	3
	11418000	02/05/02	0930	1600	5
	11418000	02/14/02	1305	1570	2
	11418000	02/14/02	1305	1570	1
	11418000	02/20/02	1250	1590	2
	11418000	02/27/02	1255	1580	7
	11418000	03/05/02	1030	1570	9
	11418000	03/13/02	1235	no data	7
	11418000	03/13/02	1235	no data	8
	11418000	03/20/02	1230	2140	6
	11418000	03/20/02	1230	2140	4
	11418000	03/27/02	1245	2160	5
	11418000	03/27/02	1245	2160	6
	11418000	04/02/02	1000	2140	6
	11418000	04/10/02	1155	2140	3
	11418000	04/10/02	1155	2140	2
	11418000	04/12/02	1430	2150	3
	11418000	04/12/02	1430	2150	2
	11418000	04/12/02	1430	2150	2
	11418000	04/12/02	1430	2150	1
	11418000	04/12/02	1430	2150	2
	11418000	04/17/02	1235	2140	1
	11418000	04/24/02	1225	2140	1
	11418000	04/24/02	1225	2140	1
	11418000	05/01/02	1210	2270	2
	11418000	05/01/02	1210	2270	2
	11418000	05/03/02	1000	2280	1
	11418000	05/08/02	1245	2400	2
	11418000	05/08/02	1245	2400	3
	11418000	05/15/02	1245	2060	1
	11418000	05/15/02	1245	2060	1
	11418000	05/22/02	1240	2000	2
	11418000	05/22/02	1240	2000	2
	11418000	05/29/02	1240	1995	2
	11418000	05/29/02	1240	1995	3
	11418000	06/07/02	1045	2010	2
	11418000	06/07/02	1045	2010	0.25
	11418000	06/12/02	1030	2000	2
	11418000	06/12/02	1245	2000	2
	11418000	06/12/02	1245	2000	1
	11418000	06/19/02	1145	2010	0.25

Table A1d. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below Englebright Dam near Smartville (YRE) collected during water years 2001, 2002, and 2003.

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Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRE	11418000	06/19/02	1145	2010	2
	11418000	06/27/02	1230	2170	1
	11418000	06/27/02	1230	2170	1
	11418000	11/01/02	1257	951	1
	11418000	11/01/02	1257	951	1
	11418000	11/01/02	1300	951	1
	11418000	11/11/02	1010	no data	0.25
	11418000	11/12/02	1225	no data	1
	11418000	11/12/02	1225	no data	0.25
	11418000	11/25/02	1230	no data	2
	11418000	11/25/02	1230	no data	2
	11418000	12/04/02	1220	no data	0.25
	11418000	12/04/02	1220	no data	1
	11418000	12/11/02	1235	no data	3
	11418000	12/11/02	1235	no data	2
	11418000	12/20/02	1215	1040	30
	11418000	12/20/02	1215	1040	33
	11418000	12/23/02	1300	1080	33
	11418000	12/23/02	1300	1080	34
	11418000	12/30/02	1350	2360	11
	11418000	12/30/02	1350	2360	11
	11418000	01/08/03	1145	1290	9
	11418000	01/08/03	1145	1290	8
	11418000	01/16/03	1245	1930	4
	11418000	01/16/03	1245	1930	4
	11418000	01/23/03	1200	no data	3
	11418000	01/23/03	1200	no data	3
	11418000	02/05/03	1215	2410	4
	11418000	02/05/03	1215	2410	3
	11418000	02/14/03	1230	2000	3
	11418000	02/14/03	1230	2000	2
	11418000	02/17/03	1150	2010	2
	11418000	02/17/03	1150	2010	2
	11418000	02/28/03	1220	2020	7
	11418000	02/28/03	1220	2020	3
	11418000	03/07/03	1215	2030	4
	11418000	03/07/03	1215	2030	4
	11418000	03/12/03	1230	2030	2
	11418000	03/12/03	1230	2030	2
	11418000	03/15/03	1120	4810	1
	11418000	03/15/03	1120	4810	0.25
	11418000	03/15/03	1330	5300	4
	11418000	03/15/03	1330	5300	2
	11418000	03/16/03	1000	2950	12
	11418000	03/16/03	1000	2950	2
	11418000	03/16/03	1300	3370	4

Table A1d. Suspended-sediment concentration samples and associated instantaneous streamflow for the Yuba River below Englebright Dam near Smartville (YRE) collected during water years 2001, 2002, and 2003.

[USGS Marina sediment laboratory uses 0.5 mg/L (milligram per liter) as the detection limit for reporting suspended-sediment concentration (SSC); therefore, samples with SSC of less than 0.5 mg/L are reported as 0.25 mg/L (Helsel and Hirsch, 1992). ft³/s, cubic feet per second]

Map identifier	Station identifier	Date	Time	Instantaneous streamflow (ft ³ /s)	Suspended-sediment concentration (mg/L)
YRE	11418000	03/16/03	1300	3370	3
	11418000	03/16/03	1615	3960	3
	11418000	03/16/03	1615	3960	2
	11418000	03/17/03	1045	4200	16
	11418000	03/17/03	1045	4200	15
	11418000	03/21/03	1145	no data	9
	11418000	03/21/03	1145	no data	9
	11418000	04/08/03	1400	no data	1
	11418000	04/08/03	1400	no data	2
	11418000	04/15/03	0930	3480	7
	11418000	04/15/03	0930	3480	5
	11418000	04/22/03	0955	1800	5
	11418000	04/22/03	0955	1800	4
	11418000	05/02/03	1155	no data	5
	11418000	05/02/03	1155	no data	6
	11418000	05/05/03	1155	no data	6
	11418000	05/05/03	1155	no data	6
	11418000	05/16/03	1220	no data	2
	11418000	05/16/03	1220	no data	1
	11418000	05/22/03	0948	no data	1
	11418000	05/22/03	0948	no data	1
	11418000	05/27/03	1430	4920	2
	11418000	05/27/03	1430	4920	2
	11418000	05/29/03	1230	5710	1
	11418000	05/29/03	1230	5710	2

Appendix 2.

Table A2 . Grain-size distributions of the less-than 0.063 size fraction for suspended sediment collected during water year 2003.
[Numbers in each column represent percentage of total suspended-sediment mass finer than indicated size, but coarser than size in next column to right. mm, millimeter; ø, unit of measure used in grain size analysis]

Map iden- tifier	Station identifier	Date	Time	Suspended-sediment grain-size distribution																	
				0.0625 mm (4 ø)	0.0441 mm (4.5 ø)	0.0313 mm (5 ø)	0.0221 mm (5.5 ø)	0.0156 mm (6 ø)	0.0110 mm (6.5 ø)	0.0078 mm (7 ø)	0.0055 mm (7.5 ø)	0.0039 mm (8 ø)	0.0028 mm (8.5 ø)	0.0020 mm (9 ø)	0.0014 mm (9.5 ø)	0.0008 mm (10 ø)	0.0069 mm (10.5 ø)	0.0049 mm (11 ø)	0.0035 mm (11.5 ø)		
MYG	11410000	11/08/02	15:20	1.39	0	0	0.03	1.16	2.75	4.21	8.71	13.41	15.58	14.3	11.73	9.96	8.97	6.02	1.77		
	11410000	11/09/02	08:17	0	0	0	0	0.29	2.17	4.66	9.68	14.5	16.3	14.6	11.7	9.9	8.7	5.8	1.7		
	11410000	12/14/02	10:00	6.8	5.84	8.41	9.63	10.01	10.01	9.64	8.97	7.82	6.48	5.05	3.91	3.05	2.48	1.53	0.38		
	11410000	12/15/02	07:30	0	0.83	4.14	5.73	7.4	9.4	11.1	12	11.8	10.5	8.3	6.4	5.1	4	2.6	0.7		
	11410000	12/17/02	13:25	2.22	0.97	2.77	4.57	7.21	10.47	12.91	13.5	12.52	10.28	7.53	5.39	4.01	3.13	1.96	0.59		
	11410000	12/18/02	10:00	0	0	0.02	2.03	5.92	8.13	12.3	14.7	14.9	13	9.9	7	5.1	3.9	2.4	0.7		
	11410000	12/30/02	12:00	0	0	0.65	7	10.05	9.3	10.5	11.6	11.7	10.9	9	6.9	5.3	4	2.4	0.7		
	11410000	02/16/03	08:00	0.98	0	0.85	4.59	6.24	8.22	10.2	11.59	11.98	11.09	9.21	7.62	6.73	5.74	3.86	1.09		
	11410000	02/16/03	08:00	0	0.34	4.96	5.2	4.4	6.9	10	12.6	13.9	12.8	10.1	7.1	5	3.7	2.4	0.6		
	11410000	02/17/03	14:00	0	0	0.04	3.24	6.2	5.82	7.9	11	13.5	13.7	11.8	9.2	7.2	5.7	3.7	1		
	11410000	02/17/03	14:00	0	0.92	5.31	5.57	8	9.9	10.9	12	12.2	11.1	8.8	6.3	4.2	2.8	1.6	0.4		
SYG	11410000	02/17/03	14:00	0	0	0.54	2.76	3.46	4.24	6.7	10.2	13.3	13.8	12	9.9	8.7	7.7	5.2	1.5		
	11410000	03/14/03	15:00	0	2.18	4.22	7.3	7.29	6.78	7.5	9.17	10.32	10.22	8.96	7.82	6.98	6.05	4.06	1.15		
	11410000	03/15/03	15:45	7.85	4.03	6.63	8.32	9.31	9.8	9.8	9.41	8.31	7.03	5.45	4.46	3.76	3.17	2.08	0.59		
	11410000	03/15/03	15:45	7.1	3.09	6.09	8.04	9.15	9.91	10.09	9.72	8.88	7.38	5.8	4.67	3.92	3.36	2.16	0.65		
	11410000	03/16/03	15:30	0	0.33	2.13	5.24	6.16	7.9	9.91	11.2	11.61	10.9	9.41	7.8	6.9	5.71	3.7	1.1		
	11417500	11/08/02	10:22	0.35	0.1	2.46	5.07	6.62	9.17	10.96	12.06	12.06	10.86	8.77	6.98	5.78	4.78	3.09	0.9		
	11417500	12/13/02	14:22	0	0	0.42	4.96	6.12	6.3	8.2	10.2	12.2	12.9	11.6	9.4	7.4	5.7	3.6	1		
	11417500	12/14/02	08:00	9.19	1.8	3.42	4.49	5.79	7.82	9.93	11.22	11.03	9.65	7.54	5.79	4.79	4.13	2.67	0.74		
	11417500	12/15/02	14:15	6.21	1.4	4.02	5.25	7.2	9.65	11.55	12.12	11.17	9.57	7.19	5.21	3.98	3.03	1.89	0.57		
	11417500	12/16/02	14:35	17.9	2.03	4.2	5.99	7.83	9.77	10.83	10.57	9.24	7.13	5.11	3.34	2.55	1.94	1.23	0.35		
	11417500	12/18/02	09:40	16.6	2.3	4.8	5.95	7.19	8.51	9.32	9.4	8.79	7.54	6.03	4.7	3.64	2.93	1.78	0.53		
11417500	12/30/02	16:00	10.64	0.19	1.98	6.03	8.42	8.58	9.92	10.81	10.72	9.65	7.69	5.72	4.2	3.13	1.79	0.54			
11417500	12/31/02	11:30	1.22	0	0.01	1.42	4.92	8.17	12.74	15.41	15.51	13.14	9.58	6.62	4.74	3.65	2.17	0.69			
11417500	02/16/03	07:00	6.57	1.06	4.57	6.9	8.08	9.02	9.77	9.97	9.59	8.55	6.95	5.92	5.07	4.33	2.81	0.85			
11417500	02/17/03	13:00	9.46	0.41	3.82	4.74	6.24	8.78	10.96	11.77	11.32	9.51	6.97	5.07	4.16	3.62	2.44	0.72			
11417500	03/14/03	16:00	0.79	0	0	0.47	5.47	8.16	11.71	14.09	14.58	13.2	10.42	7.44	5.26	4.37	3.17	0.89			
11417500	03/14/03	16:00	0	0	0.05	1.81	4.69	7.35	11	13.4	14	12.5	10.2	8	6.7	5.6	3.7	1			
11417500	03/15/03	11:30	22.25	1.17	2.49	3.83	5.48	7.7	9.49	10.24	9.58	8.03	5.97	4.51	3.69	3.02	1.97	0.58			
11417500	03/15/03	11:30	23.77	1.26	2.36	3.68	5.16	7.34	9.27	10.24	9.83	8.15	6.12	4.44	3.38	2.74	1.78	0.48			
11417500	03/16/03	12:30	2.57	1.48	5.28	6.76	7.99	9.45	10.62	10.82	10.33	8.96	7.11	5.86	4.97	4.29	2.73	0.78			
YRE	11418000	03/15/03	14:10	0	0.01	1.35	4.76	6.88	8.2	9.2	11	12.4	11.5	9.5	7.6	6.7	5.8	4	1.1		
	11418000	03/16/03	10:45	0	0.01	2.52	6.39	6.08	7.1	9.6	11.7	12.5	11.4	9	7.2	6.2	5.5	3.7	1.1		