Water Quality and Streamflow Monitoring of San Francisquito and Los Trancos Creeks at Piers Lane, and Bear Creek at Sand Hill Road, Water Year 2005, Long-term Monitoring and Assessment Program San Mateo and Santa Clara Counties, California

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SUMMARY AND CONCLUSIONS

San Francisquito Creek is currently listed by the California State Water Resources Control Board as being impaired by sediment and by the organophosphate pesticide, diazinon. Water quality in the creek is of particular concern because the creek is habitat for steelhead trout, a federally-listed threatened species. This study reports results of water year 2005 stream gaging and water quality sampling conducted as part of the Long-Term Monitoring and Assessment Plan (LTMAP), a water-quality sampling program sponsored by Stanford University and the City of Palo Alto. Water year 2005 was the fourth year of monitoring at the Los Trancos Creek and San Francisquito Creek stations at Piers Lane, and the second year of monitoring at the Bear Creek at Sand Hill Road site. Measurements and observations continue during water year 2006.

Since fall 2001, Balance Hydrologics, Inc. has operated for LTMAP two automated water-quality sampling stations on San Francisquito Creek and Los Trancos Creek at Piers Lane, just above their confluence. In fall 2003, Kinnetic Labs (Santa Cruz) installed another automated sampling station, located on Bear Creek at Sand Hill Road, along the northern border of the Jasper Ridge Biological Preserve. The station, which is now also operated by Balance Hydrologics, is configured similarly to the other stations with a datalogger, several probes, and a programmable pumping unit. As in previous years, the electronic records were combined with manual measurements to create flow records for each stream. Measurements of temperature, specific conductance, dissolved oxygen and pH were made manually.

Five sets of comprehensive, composite water-quality samples were collected on each stream during the water year using time-paced sampling. The same storms were sampled at all three stations. Samples for particular constituents requiring special preservation methods (i.e., ammonia and mercury) were collected as grab samples during the composite sampling intervals. Suspended-sediment samples were collected during and between storms and used to estimate annual suspended-sediment yields. Results were compared to water quality objectives established by the San Francisco Bay office (Region 2) of the California Regional Water Quality Control Board ("Regional Board" or "RWQCB"). Our conclusions are presented below, together with citations to the relevant text subsections, tables and figures:

1. Rainfall and streamflow totals for water year 2005 were above average. Based on USGS provisional streamflow data for San Francisquito Creek, the peak flow for the year corresponds to about a 1.6-year recurrence-interval flood, equivalent to a 63 percent chance of being exceeded in any year. *(Sections 4.1 to 4.3; Table 4; Figures 2 to 5)*

2. Specific conductance values *(Section 6.2; Tables 1 to 3; Figures 8 to 10)* and pH values (*Section 6.7; Tables 1 to 3; Figure 14*) in all three streams were within the range of previous sampling results during water year 2005. Dissolved oxygen concentrations *(Section 6.8; Tables 1 to 3; Figures 15 to 17)* were occasionally low (less than 80 percent saturation) in late summer or fall, which may be limiting for biota.

3. Mean daily water temperatures at the Bear Creek and Los Trancos Creek sampling stations stayed below 21°C, although maximum temperatures in San Francisquito Creek exceeded the 21°C threshold for periods of up to six hours daily (average of three hours) during the three-week period from mid-July through early August 2005. Temperatures in San Francisquito Creek were slightly cooler than in Los Trancos Creek during the wet season, and slightly warmer during the dry season. Temperatures in Bear Creek were similar to Los Trancos Creek *(Section 6.6; Tables 1 to 3; Figures 11 to 13).*

4. Organophosphate pesticide concentrations were below detectable limits in all three streams on all dates sampled *(Section 6.4; Tables 5 and 6).* Given the small number of total samplings to-date, relative to the sample set required for consideration of de-listing *(Footnote 14)*, further sampling should be performed before concluding when or if these pesticides are present or absent in the three streams.

5. Ammonia-nitrogen was detected at low concentrations during water year 2005, below regulatory standards. Nitrate-nitrogen was detected at moderate concentrations in all samples from the three streams. Levels of both constituents were within the range of previous sampling results and typical of those observed in other streams in the Santa Cruz Mountains where urban and agricultural land uses occur *(Section 6.3; Tables 5 and 6).*

6. Total mercury concentrations in wet-season grab samples were high in all three streams in water year 2005 and often exceeded the chronic toxicity objective. Total mercury concentrations in dry-season grab samples, and dissolved mercury concentrations in all samples, were well below the regulatory standard *(Section 6.5.4; Tables 5 and 6).*

7. Dissolved copper concentrations were also high in all three streams in water year 2005, exceeding the chronic toxicity objective on one occasion and approaching the same objective in some other wet-season events *(Section 6.5.2; Tables 5 and 6).*

   Concentrations of all other total and dissolved metals were well below regulatory standards *(Section 6.5; Tables 5 and 6).*

8. Fluctuations in flow and specific conductance during baseflow periods were most noticeable at the Bear Creek station but propagated downstream to San Francisquito Creek at Piers Lane. Upstream diversions and other flow alterations may significantly and quickly affect summer baseflows and, therefore, aquatic habitat. Besides the volumetric changes to flow, water quality may also be altered by the apparent additions to creek flow *(Sections 4.4; Figures 3 and 6).*

9. Sediment-transport measurements and qualitative observations of bed conditions at all three stations indicate that sediment conditions in water year 2005 were typical of previous years and other Balance gaging stations in the San Francisquito watershed *(Section 6.9.3; Table 4; Figures 18 and 19).*

1. INTRODUCTION

This report presents the results of surface water monitoring in the San Francisquito Creek watershed by Balance Hydrologics, Inc. ("Balance"), on behalf of the Stanford University Utilities Division, Jasper Ridge Biological Preserve, Stanford Management Company, Stanford Linear Accelerator Center (all, "Stanford") and the City of Palo Alto. Stanford is a participant in the San Francisquito Watershed Council, which is managing the Long-Term Monitoring and Assessment Plan (LTMAP). The LTMAP was originally created by a subcommittee of the San Francisquito Creek Coordinated Resource Management and Planning (CRMP) Steering Committee, the group now known as the San Francisquito Watershed Council. The LTMAP was established primarily to monitor and assess current (i.e., baseline) conditions, analyze trends, and evaluate watershed management. Three LTMAP monitoring stations in the lower San Francisquito Creek watershed have been monitored since fall 2001 (water year 2002[1]); monitoring at a fourth station higher in the watershed began in fall 2003. Stanford and the San Francisquito Watershed Council have explored addition of one or more stations even further upstream if funding could be secured. Expanding the monitoring network to include stations higher in the watershed would provide greater understanding of longitudinal and temporal variation in water quality and stream flow conditions.

The San Francisquito Creek watershed is located on the San Francisco Peninsula, and includes the northwestern portion of Santa Clara County and the southeastern portion of San Mateo County (Figure 1). Los Trancos Creek and (below their confluence) San Francisquito Creek form the boundary between the two counties. The watershed encompasses approximately 45 square miles, of which about 37 square miles lies upstream from the two Piers Lane stations, and includes a wide diversity of urbanized, rural and natural habitats. The 11.7-square mile Bear Creek sub-watershed encompasses the northwestern headwaters of San Francisquito Creek, covering approximately 25 percent of its watershed. Los Trancos Creek has a sub-watershed area of 7.8 square miles.

[1] Most hydrologic and geomorphic monitoring occurs for a period defined as a water year, which begins on October 1 and ends on September 30 of the named year. For example, water year 2004 (WY2004) began on Oct. 1, 2003 and concluded on September 30, 2004.

The first three LTMAP automated sampling stations were installed in fall 2001. City of Palo Alto staff are operating the lowermost station on San Francisquito Creek at Newell Road, a short distance upstream of Highway 101 and near the head of tidewater. Balance staff are operating the other two stations, on San Francisquito Creek and Los Trancos Creek at Piers Lane, a short distance downstream (north) of Interstate 280 and immediately upstream of the confluence of the two creeks. A fourth LTMAP station was installed on Bear Creek at Sand Hill Road in fall 2003. This station, which is also operated by Balance, is about 2.5 miles upstream from Piers Lane and receives flows from about one-half of the San Francisquito Creek watershed.

Data and findings from the initial two years of monitoring the Piers Lane stations are presented in the prior annual monitoring reports (Owens and others, 2003; Owens and others, 2004). To better integrate findings from the three stations currently monitored by Balance staff, results from the third year of monitoring the two Piers Lane stations and the initial year of monitoring the Bear Creek at Sand Hill Road station were summarized in a single report (Owens and others, 2005). This report similarly presents results of water year 2005 monitoring at all three stations. Measurement and observations will continue during water year 2006 (WY2006).

2. BACKGROUND

Surface-water monitoring for this project is being implemented to assess known and potential pollutant concentrations as part of the Long-Term Monitoring and Assessment Plan (LTMAP). The LTMAP was originally created by a subcommittee of the San Francisquito Creek Coordinated Resource Management and Planning (CRMP) Steering Committee, the group now known as the San Francisquito Watershed Council. The goals of the LTMAP are to provide a comprehensive framework for organizing and coordinating monitoring and assessment activities in the San Francisquito Creek watershed.

As part of the LTMAP, surface water data are being collected for use in describing constituents which might adversely affect water quality in the watershed, under storm runoff and low-flow conditions, in major part as they affect the full range of steelhead life stages. To assist the LTMAP in one of its objectives, Balance was asked to:

1. Identify which contaminants or sets of contaminants are present in San Francisquito Creek, Los Trancos Creek and Bear Creek, and to prioritize analytes for more detailed study in future years;
2. assess if a relationship exists between the presence, absence or concentration of contaminants and streamflow; and
3. evaluate the amount of suspended sediment and bedload being transported by the three streams and compare them to results from other locations in the watershed also monitored during water year 2005 for other projects.

2.1 Local Influences on Water Quality

Restoration of habitat for steelhead -- a federally-listed threatened species greatly valued by the watershed community at large -- in the San Francisquito Creek drainage has been the focus of substantial efforts over the past ten years. Technical professionals and knowledgeable residents with experience in these streams suspect that water quality may be a significant constraint to the size and robustness of the steelhead population in San Francisquito Creek and its tributaries. Steelhead are anadromous[2] salmonids which spawn and rear throughout the free-flowing headwaters of the San Francisquito Creek

[2] Migrates to the ocean as a juvenile and returns to fresh water to spawn.

watershed. Water-quality impairment may likely affect other sensitive local species or possibly other beneficial uses as well.

The principal sources of potential concern include:

- horses and perhaps other livestock, particularly those boarded on land adjacent to the stream channels of San Francisquito Creek and its tributaries and/or using the stream or riparian buffer areas;
- septic systems;
- urban runoff, including road and highway surface runoff, which may contribute nutrients and other constituents, such as heavy metals;
- pulses of water which have been repeatedly observed and documented in the streams at low flow, that may originate from human-managed sources, perhaps from flushing of swimming pools and other chlorinated ponds; and
- common garden, orchard and lawn chemicals (i.e., fertilizers, pesticides).

Urban runoff and animal wastes from horses and other domesticated species, when washed into the creeks of the watershed, may be acutely toxic to steelhead and other fish or aquatic species. Chronic toxicity and/or indirect effects of these loadings may also counteract sustained regional efforts to improve and restore populations of steelhead. Each of the other sources listed above can also have chronic or acute toxicity.

The quantity of baseflow is also an important factor in maintaining habitat quality. Too little water in the creeks during the spring and summer can impede out-migration of year-old fish and affect summer survival of newly hatched "young-of-the-year". Insufficient baseflow also magnifies the effects of introduced pollutants by reducing the amount of dilution available to decrease pollutant concentrations, and at very low flows can lead to impaired conditions such as local increases in temperature or decreases in dissolved oxygen.

2.2 Related Water Quality Studies in the Watershed

We know of only one recent sub-watershed-scale investigation of water quality. As part of a grant from the Packard Foundation, the San Francisquito Watershed Council asked Balance to conduct a three-year water quality study in the Bear Creek portion of the larger watershed during water years 2000 through 2002. Balance has reported the results of the first two years of monitoring (Owens and others, 2001; 2002) and a draft report summarizing data from all three years of monitoring is currently undergoing final review. Both published and unpublished data from the Bear Creek study are used in this report as a basis for comparison. The Bear Creek watershed encompasses the northwestern headwaters of San Francisquito Creek, as shown in Figure 1. Thus, water-quality problems in the Bear Creek watershed can directly affect nearly all other spawning and rearing areas in the San Francisquito Creek watershed. Conversely, measures which control causes of toxicity to fish in the Bear Creek system will benefit nearly the entire local steelhead population, as well as other species in the San Francisquito Creek watershed. Knowledge of natural and anthropogenic factors affecting water quality in Bear Creek can help in planning and assessing water quality elsewhere in the watershed.

3. STATION LOCATIONS

3.1 Bear Creek Sub-watershed Station

The Bear Creek at Sand Hill Road station (designated as BCSH) is located on the northern border of the Jasper Ridge Biological Preserve (Figure 1), approximately 2.5 miles upstream of the San Francisquito Creek at Piers Lane station. Balance has periodically monitored streamflow and water-quality constituents at this site, which receives flows from almost one-half of the San Francisquito Creek watershed above Piers Lane, since the spring of 1997. Prior to the current study, the most complete sets of data were compiled during water years 2000 to 2002, when this station was one of eight stations in the watershed regularly monitored on behalf of the San Francisquito Watershed Council (see Section 2.2 above). Balance continued to operate the gaging station during water year 2003 but only minimal water quality measurements were made that year.

Through the combined efforts of Stanford Management Co., Stanford Linear Accelerator Center, and the Jasper Ridge Biological Preserve, this location recently became the fourth station in the LTMAP monitoring network. In fall 2003 (WY2004), Kinnetic Laboratories, Inc. (Santa Cruz) installed new monitoring equipment on the left bank of Bear Creek, about 200 feet downstream from Sand Hill Road and only a short distance from the previous gaging location. The station is equipped with a tipping-bucket rain gauge, a streamside staff plate, a datalogger and automated sampler pumping unit housed within an enclosure, and several water-quality probes. Water level, water temperature, specific conductance (an index of salinity), dissolved oxygen, and pH are continuously monitored. Water levels are measured using a pressure transducer, rather than the bridge-mounted sonar transponders used at the two Piers Lane stations described below. Manual measurements of water levels at a staff plate, streamflow and water quality parameters are made at regular intervals to calibrate the electronic record. The station is connected to a land-line telephone so that real-time data can be monitored over the Internet. The automated sampler is designed to collect aliquots over a specified period into a composite sample bottle kept chilled in an ice bath. Following sampled events, sub-samples of the mixed composite sample are poured into prepared sample bottles for laboratory analysis of individual constituents.

3.2 Piers Lane Stations

The other two LTMAP stations discussed in this report[3] are located on Los Trancos Creek and San Francisquito Creek, just upstream from their confluence, where Piers Lane crosses both creeks (Figure 1). The stations are within 100 yards of each other and only a short distance downstream (north) of Interstate 280. The stations were installed in fall 2001 by staff of Kinnetic Laboratories, Inc. and Larry Walker Associates (Davis) under contract to the City of Palo Alto. The station on San Francisquito Creek is equipped with a tipping-bucket rain gauge. Water levels are measured by an ultrasonic sonar transponder mounted on the bridge above the creek at each site. Otherwise, each station is equipped with the same instrumentation described above for the Bear Creek station and is monitored using the same protocols. Both stations are currently powered by batteries. Cell phone telemetry was attempted but found to drain the batteries too quickly to make the data available in real-time.[4]

Balance initiated operation of the newly-installed Piers Lane stations, designated as San Francisquito Creek at Piers Lane (SFPL) and Los Trancos Creek at Piers Lane (LTPL), at the start of water year 2002. For a number of reasons detailed in the first-year (WY2002) monitoring report (Owens and others, 2003), only a limited number of samples were collected during the first year of operation. Monitoring during water years 2003 to 2005 more closely followed the envisioned sampling sequence.

3.2 Other Stations in the Watershed

As part of a series of cooperating projects, Balance also monitored a number of locations in the San Francisquito Creek watershed upstream of Piers Lane during water year 2005 (Figure 1). The main focus was on monitoring streamflow and sediment discharge. Data from some of these other stations are used in this report for comparison to the data collected at the Piers Lane stations. Comparison of flow records among stations helps to verify the gaging data and describe and document differences in hydrologic responses to rainfall. These differences are proving larger than expected, such as very low baseflows on West Union Creek, or flashy storm peaks on Dry Creek, and may prove in

[3] The fourth LTMAP station, on San Francisquito Creek at Newell Road, a short distance upstream of Highway 101, has been operated by staff of the City of Palo Alto Regional Water Quality Control Plant since it was installed in fall 2001. Monitoring at this site is coordinated with activities at the upstream stations but results are interpreted by City staff and reported under separate cover.
[4] Connection to AC power or a land-line telephone would decrease obstacles to real-time data availability but is reportedly not feasible at this time.

and of themselves to be of significance to stream management, including steelhead restoration. Selected stations are described below.

3.2.1 Los Trancos Creek at Arastradero Road

Balance operates another station on Los Trancos Creek about 1.8 miles upstream of Piers Lane on behalf of Stanford University Utilities Division. This upstream station has been in operation since November 1994. Suspended-sediment and bedload discharge are also collected at this site.

3.2.2 Searsville sub-watershed stations

Balance operated gages at Sea rsville Dam and upstream from the dam on Corte Madera Creek at Westridge Drive during water year 2005. Data collection from the Searsville sub-watershed stations focuses on sediment transport. Searsville and Corte Madera Creek flow data were considered in this report where such comparisons were useful.

3.2.3 U.S. Geological Survey station on San Francisquito Creek

USGS stream gage #1164500 (San Francisquito Creek at Stanford University) is located approximately 0.5 miles downstream from Piers Lane. This station was originally established in 1931 and has maintained a continuous record of flow since 1954. USGS staff regularly collected suspended-sediment (but not bedload sediment) data at this station from the mid-1960s to early 1970s (Brown and Jackson, 1973).

4. HYDROLOGIC SUMMARY, WATER YEAR 2005

Observations and measurements from our water year 2005 site visits are documented in Table 1 (Bear Creek), Table 2 (Los Trancos Creek) and Table 3 (San Francisquito Creek). Annual hydrologic summaries for each of the three creeks are presented in Forms 1 to 3. Table 4 is a hydrologic summary for all three creeks over the period of record, which for Bear Creek, includes gaging results from the earlier three-year water quality study (water years 2000 to 2002).

Daily flow hydrographs are plotted together in Figure 2 and for individual creeks in Figures 3 to 5. Figure 6 shows the unit flow hydrograph for each of the three creeks. "Unit flow", calculated by dividing the mean daily flow by the watershed area, allows comparison of the response to rainfall among different watersheds. In general, the magnitude of streamflow is governed by the size of the watershed, so that a larger watershed produces higher flows. However, differences among streams in wet- and dry-season baseflows also reflect variations in the geology, topography and management of diversions within their watersheds.

4.1 Narrative Summary

In general, water year 2005 was a wet year in terms of total rainfall and flow, but the peak flow of the year was fairly small. Streamflows during water year 2005 are shown in Figure 2; Figure 7 presents the cumulative rainfall record for the year. Baseflows in the streams were low in October 2004, the beginning of water year 2005. Light rains commenced during mid-October. This year, as in water year 2004, many of the early rain events were small and similarly-sized making it difficult to define a distinct "first-flush"[5] in water year 2005. Following this tentative beginning, heavy rains commenced in early December and lasted through early April 2005.

[5] "First-flush" refers to a storm event that is strong enough to produce runoff and which occurs after a period of weeks or months of dry weather. The term is typically applied to the first major storm event of the wet-season but it may also be used to describe any significant storm occurring after a prolonged dry period. Since first-flush storms mobilize accumulated sediment, litter, nutrients and other pollutants, the resultant runoff often contains higher concentrations of these constituents than are observed in runoff from subsequent storms. Note that the first flush from impermeable surfaces, such as roads and roofs, often occurs earlier in the season than the first flush from open space lands, which must first become saturated.

The highest water level and flow rate on Bear Creek (Figure 3) occurred on December 30, 2004, with a calculated instantaneous peak flow rate of 487 cubic feet per second (cfs). San Francisquito Creek (Figure 4) had three large flows of almost identical magnitude this year. Calculated peak flow rates were 747 cfs on December 30, 2004, 749 cfs on February 15, 2005, and 741 cfs on March 22, 2005. The highest water level and flow rate on Los Trancos Creek (Figure 5) occurred on February 18, 2005, with a calculated peak flow rate of 357 cfs. The spring flow recession started in mid-April but was punctuated by several small rain events as late as mid-June. Baseflow levels declined through the summer but were above average, based on Balance's previous flow records for streams in these watersheds.

4.2 Precipitation

Water year 2005 rainfall recorded at the Piers Lane tipping-bucket rain gauge totaled approximately 21.9 inches, or about 118 percent of the USGS long-term mean annual precipitation of 18.5 inches (Rantz, 1971). Actual rainfall at Piers Lane was even higher but the rain gauge was inoperable from mid-March to mid-May 2005, probably due to clogging from bird droppings. Higher in the watershed, the tipping-bucket rain gauge at the Bear Creek at Sand Hill Road station recorded approximately 36.8 inches of rain in water year 2005, approximately 141 percent of the long-term mean annual precipitation of about 26 inches for the station location.

We obtained the rainfall records for two long-term index precipitation stations in the region, Mount Hamilton and the San Francisco Airport, from the California Data Exchange Center (CDEC). These data show that water year 2005 rainfall at Mount Hamilton was also above-normal at 134 percent of the long-term average values, while rainfall at the San Francisco Airport was 145 percent of the long-term average.

4.3 Return Period of Peak Flows

Even though we do not have a sufficient period of record to calculate the return period of peak flows at the stations that we monitor, we can characterize the peak flows at the USGS gaging station on San Francisquito Creek (USGS number 11164500). The estimated peak flow for this station for water year 2005 as reported by the USGS was 940 cfs, which corresponds to a 1.6-year return period (61 percent chance of being exceeded in any year), based on the annual-peak series. This is significantly lower than the median peak flow of 1,560 cfs, which is equivalent to the 2-year return period (50 percent chance of being exceeded in any year).

4.4 Unexplained Flow Surges

We did not note any major unexplained flow surges during water year 2005, although we continued to note significant abrupt changes in flow at the Bear Creek station that could be due to diversions such as the Bear Gulch intake facility. These changes are consistent with operation of upstream diversions by California Water Service Company;[6] other (unregulated) diversions are also likely to have occurred. During the fall of 2005 (early water year 2006), we have noted some small additions of water; these will be detailed in next year's report.

We have previously noted spikes of either high temperature, high salinity or both at all three of the monitoring stations but did not note any such spikes this year.

4.5 Creating a Record of Streamflow

We develop a record of streamflow in two steps. First, a record of water levels is compiled from the recorded electronic data and calibrated with field observations. Flow rates are then computed from the water levels using empirical equations developed specifically for each site from field measurements.

4.5.1 Developing a record of water levels

The monitoring equipment at the Bear Creek at Sand Hill Road station includes two pressure transducers, which measure water levels in the creek at 15-minute intervals, and a Campbell Scientific CR10X datalogger to record the water-level data. The two stations at Piers Lane are equipped with ultrasonic sonar transponders connected to an American Sigma 950 flow meter and datalogger. Field measurements and observations at each station are used to calibrate the electronic record. Observations during site visits include: water level (or gage height) at the staff plate, high water marks, the presence of twig and leaf dams which may temporarily raise or lower water levels, signs of sedimentation or scour, and the specific conductance and temperature of the water (Tables 1 to 3).

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[6] Personal communication from Darin Duncan, California Water Service Co. to Marty Laporte, Stanford University FACOPS, May 26, 2006.

During this year, as is typically done, we applied multiple stage shifts to the electronic water-level record to account for intermittent sedimentation, leaf dams and algae growth that affect the water-level elevation at the monitoring locations. We found that observed high-water marks corresponded well (usually within 0.2 to 0.3 feet) with the recorded water-level peaks, providing additional confidence in the stage record. As a check on the data, we compared the combined Los Trancos Creek-San Francisquito Creek flow record with the provisional record for the USGS stream gage approximately 0.5 miles downstream from Piers Lane. We also compared the Bear Creek record to the records from Corte Madera Creek and Searsville Dam. Because the timing and general magnitude of flow peaks at these stations were in agreement, we conclude that the monitoring equipment was working properly.

4.5.2 Computing flows

Based on our periodic site visits, staff plate readings, and flow measurements (Tables 1 to 3), we create an empirical stage-to-discharge relationship ("stage-discharge rating curve") for each gage. This rating curve is then applied to the electronic record of water levels measured by the pressure transducers (at BCSH) and sonar transponders (at SFPL and LTPL).

At low flows, the sonar transponder values have a large amount of variation, up to about 0.3 feet per day. We consider most of this variation to be "noise" in the instrument reading that does not reflect actual changes in water-levels, although a lower-amplitude (0.02-foot) diurnal pattern of water-level change is typically observed during low-flow periods. The flow record becomes particularly "noisy" at the 15-minute level of detail, which is why we present the data in daily form. Mean daily stream flow values appear to be fairly accurate because daily averaging removes most of the noise.

As with all other gaging of natural streams, some uncertainty remains (especially at high and low flows) in spite of efforts to be as precise as possible. We do not have manual measurements at the peak flow levels. Peak-flow estimates for this study are based on extension of the stage-discharge curve from our highest measured flow to the peak water level recorded by the automated monitoring equipment.

5. WATER QUALITY SAMPLING APPROACH

Larry Walker Associates developed the water quality monitoring plan for the two LTMAP stations at Piers Lane while under contract to the City of Palo Alto (LWA, 2001). Their Draft Surface Water Quality Monitoring Plan 2001/02, available from the City of Palo Alto, provides a complete description of the methods and protocols used in this study. Because the Bear Creek at Sand Hill Road stream gage is also part of the LTMAP study, the same protocols were used there as at the Piers Lane stations and results are comparable. Interested readers are referred to the water quality monitoring plan for additional detail.

5.1 Timing of Sampling Visits

The hydrologic conditions during which a sample is taken are an important factor influencing the analyzed or observed values. For example, sampling baseflow in late August can be expected to provide very different results from sampling a first-flush event in October, or a mid-winter storm. The LTMAP monitoring program is designed to measure field parameters on each sampling visit. Samples for ammonia, nitrate, phosphate, mercury, total and dissolved metals, and organophosphate pesticide analyses are collected approximately five times annually. Sediment sampling occurs from fall through spring, when flows are sufficiently elevated to transport sediment, but not in summer.

5.2 Field Measurements and Laboratory Analyses

The focus of the study is on characterizing water quality in the two streams during both baseflow and storm periods, particularly with regard to those constituents potentially affecting fisheries and aquatic habitat conditions. Thus, the sampling plan includes a broad range of chemical constituents, and both total and dissolved constituent analyses:

<u>Field Measurements</u>

- streamflow (cubic feet per second, or cfs)
- specific conductance (microsiemens, or μs @ 25°C)
- water temperature (°C)
- dissolved oxygen (mg/L)
- pH

- qualitative remarks, for example, odors, color, clarity, (if noticeable), and anomalies

Laboratory Analyses

- metals (aluminum, copper, lead, mercury, nickel, selenium, silver and zinc)
- organophosphate pesticides (diazinon and chlorpyrifos)
- nitrate-nitrogen and ammonia-nitrogen
- total phosphorus
- total hardness (needed to interpret metal toxicity)
- total suspended solids
- bedload sediment

5.3 Exceptions and Deviations from Proposed Methods

Deviations almost inevitably occur in hydrologic studies, usually at very high or low flows, such as the responses necessary when a tree falls or other changes in the channel at the sampling location are encountered.

During the second year of monitoring at the Bear Creek at Sand Hill Road station, we were unable to complete the following items as they were initially outlined in the project proposal:

- All five sets of composite water-quality samples were collected as time-paced samples, rather than flow-paced samples. We plan to continue using either time-paced or flow-paced sample collection as appropriate during water year 2006. [7]
- Sampling at this station occurred on the same dates and over roughly the same intervals as at the Piers Lane stations. The sole exception was the initial (first-flush) sampling, when the sampler was programmed but not fully activated. The situation was not discovered until the next afternoon during grab sample collection. We reprogrammed the station but sampling began approximately 13 hours later than at the two Piers Lane stations, ending at about the same time (see Appendix C: compare Figure C3 with Figures C1 and C2).

[7] While the *Monitoring Plan* specified flow–paced composite sampling to facilitate calculation of event-based concentrations, we have found that time-paced sampling is more practical for several reasons (see discussion in Section 7 of our WY2004 report). However, we will continue our attempts to perform flow-paced sampling in water year 2006, particularly for larger storms.

- The first year monitoring report identified the need to clean the three water quality probes more often to minimize fouling by algae and sediment. Since September 2004, when probe cleaning was integrated into the regular equipment maintenance schedule, the specific conductance probe has worked well, performance of the dissolved oxygen probe improved considerably but the pH probe has worked only intermittently. Until the probes are replaced with lower-maintenance, higher-reliability models, the record for these three parameters will consist mainly of manual measurements, such as were made regularly during water year 2005. [The probes were destroyed by the storm which began on Dec. 31, 2005 and have been replaced as part of the station repairs.]

During the fourth year of monitoring Los Trancos Creek and San Francisquito Creek at Piers Lane, we were unable to complete the following items as they were initially outlined in the project proposal:

- All five sets of composite water-quality samples were collected as time-paced samples, rather than flow-paced samples. We plan to continue using either time-paced or flow-paced sample collection as appropriate during water year 2006.

- Due to battery failure, the Los Trancos Creek datalogger did not record any data from April 16 to May 18, 2005. The flow record was reconstructed from Balance's record upstream at the Arastradero Road station, minus the record of diversions at the fish ladder.

- Following replacement of rodent-damaged cables during summer 2004, the tipping-bucket rain gauge at the San Francisquito Creek station operated well until spring 2005. From mid-March through mid-May 2005, the rain gauge was inoperable, probably due to clogging from bird droppings. This problem has been addressed by checking the data and condition of the gauge more frequently during water year 2006.

- The pH, dissolved oxygen and specific conductance probes at both stations require frequent maintenance to maintain functioning but probe maintenance and calibration is impeded by constriction of the cables in the conduit. Until the probes are replaced with lower-maintenance, higher-reliability models, the record for these three parameters will consist mainly of manual measurements, such as were made regularly during water year 2005. [This problem may be partially or fully alleviated by installation of a second conduit and new sampling tubing at each station in February 2006. This upgrade, largely funded by the RWQCP, followed the November 2005 failure of the sonar transponder at the San Francisquito Creek station. The transponder was replaced by a datalogger, pressure transducers and a different brand of specific conductance probe.]

Following water year 2004, we addressed a number of maintenance-related issues through development of checklists for staff to use in the field to confirm equipment functioning. These lists were amended after water year 2005 to include more frequent probe cleaning and inspection of the rain gauges. Recommendations for improving the monitoring program during water year 2006 and subsequent years are presented briefly in Chapter 7 below.

6. RESULTS AND DISCUSSION OF WATER QUALITY SAMPLING

This chapter includes a discussion of findings by individual constituent or constituent group. Results of manual measurements of specific conductance, temperature, pH, and dissolved oxygen are included in Tables 1 to 3. The specific dates when composite and/or grab water quality samples were collected, the laboratory reporting limits[8], and the analytical results are presented in Table 5 (Bear Creek) and Table 6 (San Francisquito Creek and Los Trancos Creek). Results of suspended-sediment sampling during and between storms, used to estimate annual suspended-sediment yields, are presented in Table 8 (Bear Creek) and Table 9 (San Francisquito Creek and Los Trancos Creek). All laboratory reports are collected in Appendix A (Piers Lane stations) and Appendix B (Bear Creek). Detailed hydrographs showing the timing of sample collection at each station for various constituents during each of the water-quality sampling visits are graphically presented in Appendix C.

During the fourth year of operating the two Piers Lane stations, and the second year of operating the Bear Creek at Sand Hill Road station, we collected time-paced composite water-quality samples on five occasions at all three stations: wet-season samples were collected on: October 18 to 19, 2004; Dec. 6 to 7, 2004; Dec. 29 to 31, 2004; and March 21 to 22, 2005. The dry-season baseflow sample was collected on Sept. 7 to 8, 2005.

6.1 Water Quality Objectives

The San Francisco Bay office (Region 2) of the Regional Board regulates water quality in the Bay area in accordance with the Water Quality Control Plan or 'Basin Plan' (RWQCB, 1995). The Basin Plan includes both numeric and narrative water quality objectives against which the LTMAP monitoring results in Tables 5 and 6 are evaluated. The water quality objectives for trace metals in the 1995 Basin Plan, for the South Bay below the Dumbarton Bridge and tributary streams which discharge into this portion of the Bay, were previously written as total recoverable concentrations, rather than the more bioavailable dissolved concentrations of the metals, because they were established in 1986 preceding the U.S. EPA directive on aquatic life criteria for metals. Furthermore, the U.S. EPA ambient water quality criteria for many metals have been updated since 1986 to incorporate more recent toxicity data and/or revisions to how the criteria were calculated.

[8] Laboratory reporting limits varied due to the methods used and the amount of sample dilution required.

To address these inconsistencies, the U.S. EPA criteria promulgated by the California Toxics Rule (CTR) included changes to the water quality objectives for arsenic, cadmium, chromium, copper (fresh water only), lead, nickel, silver and zinc. The updated water quality objectives were adopted by the Regional Board in 2004, approved by the U.S. EPA (Region 9) on January 5, 2005[9], and are now included in the Basin Plan. Tables 5 and 6 have been modified from previous years to incorporate the new water quality objectives for dissolved trace metal constituents into the Basin Plan objectives rather than showing them on separate lines. We note that the existing Basin Plan objective for mercury was retained pending development of new water quality objectives for this constituent, which will likely be based on fish-tissue concentrations.

6.1.1 Composite sampling effects on interpretation of acute-toxicity levels

When assessing the sample concentrations reported in this study, it is important to keep in mind that the composite samples are typically collected over periods of 12 to 36 hours, while the acute toxicity objective is a 1-hour average and the chronic toxicity objective is a 4-day or 96-hour average.

Particularly as regards the *acute* toxicity objective, concentrations in composite samples are likely to be significantly *lower* than the highest, short-term concentrations experienced by stream biota during the sampling period. One reason is simply that a high concentration in one aliquot is diluted by other aliquots of lower concentration, especially when the composite sampling interval includes a substantial period of baseflow prior to or following the storm (see Appendix C: sampling hydrographs). Additionally, exploratory sampling on Dry Creek during the previous Bear Creek study (Owens and others, 2001) indicated that concentrations of many constituents (including copper) increase as flows rise and decrease as flows decline, such that concentrations of dissolved metals could vary by at least a factor of two over the course of a storm event. Finally, the effect of metals toxicity would be magnified by changes in hardness, which typically decreases with increased stream flow. As a result, when metals concentrations are highest, the hardness values would be lowest (and much lower than reported from the composite sample), increasing the effective toxicity at a given metals concentration.

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[9] The Basin Plan amendment was previously approved by the State Water Resources Control Board on July 22, 2004, and by the California Office of Administrative Law on October 4, 2004.

Thus, a composite sample concentration equal to one-half the acute toxicity objective (1-hour period), such as occasionally occurred with dissolved copper in water year 2005 (see below), *may* indicate that the peak concentration actually exceeded that limit. For these constituents, synoptic grab sampling (multiple grab samples over the course of a single storm) and/or grab samples collected at the peak of multiple storms over a season, would be useful to better define the relationship between composite sample concentrations and acute water quality objectives.

6.2 Specific Conductance

Specific conductance was within the normal range during water year 2005 and is not considered to be a problem.

Specific conductance, a widely used index for salinity or total dissolved solids (TDS), was measured in the field and recorded at field temperatures, then later converted to an equivalent value at 25°C according to the accepted relationship between specific conductance and temperature. The expected range of specific conductance in the San Francisquito Creek watershed is from about 100 to 2000 µs (all values are normalized to 25°C). The lowest levels occur during storms, when flows are diluted with rain and fresh runoff. The highest levels are typically observed in early fall, when flows are lowest, prior to the onset of seasonal rains.

During water year 2005, specific conductance ranged from about 120 to 1,100 µs in Bear Creek (Table 1; Figure 9)[10]. Based solely on manual measurements, observed specific conductance ranged from about 260 to 2030 µs in Los Trancos Creek (Table 2), and from about 300 to 1,400 µs in San Francisquito Creek (Table 3). As was observed in water year 2004, specific conductance was typically lowest in Bear Creek and highest in Los Trancos Creek during water year 2005. Specific conductance levels in Los Trancos Creek were slightly lower this year in comparison to those observed in water year 2004, which were higher than in previous years (Figure 8).

6.3 Nitrogen

[10] The upstream station on Bear Creek was intermittently monitored during the year prior to installation of the new LTMAP gage and the specific conductance probe was partially-clogged with sediment. A different specific conductance probe, recently-calibrated, was installed on Nov. 25, 2003 as part of the new station approximately 40 feet downstream from the old gage.

As noted above, nitrogen has been identified as one of the potential pollutants affecting steelhead fisheries habitat in the San Francisquito Creek watershed, with possible sources including horse stables, fertilizers, yard waste, and failing residential septic systems. The most readily accessible forms of nitrogen in stream systems are typically nitrate ($NO3^-$) and ammonia (NH_3), although relatively large amounts of nitrogen can be stored in both living and dead biomass (i.e., leaf litter). Ammonia is the form produced during decomposition of organic matter and is also common in fertilizers. When mixed with water, the majority of ammonia quickly reacts to form the relatively harmless ammonium ion (NH_4^+) which, due to its positive charge, is rapidly taken up by plants or microbially converted to nitrate. However, a small amount remains as un-ionized ammonia, which can be toxic to fish and aquatic invertebrates. The concentration of un-ionized ammonia increases with increased pH and water temperature above certain thresholds. Nitrate, in contrast, persists much longer in the environment and is more mobile in soil.

6.3.1 Ammonia-nitrogen

Ammonia-nitrogen was detected at low concentrations during water year 2005, below levels of regulatory concern.

Ammonia concentrations in Bear Creek (Table 5) and Los Trancos Creek (Table 6) were above the detection limit (0.2 mg/L) on three of the five sampling dates in water year 2005, and concentrations in San Francisquito Creek (Table 6) were above the detection limit on two dates, with all detections occurring during the wet season. While the Regional Board has not established a specific acute toxicity objective for ammonia, the threshold for chronic (annual median) exposure to un-ionized ammonia cited in the Basin Plan (RWQCB, 1995) is 0.025 mg/L. At the water temperatures and pH values measured at the time the water year 2005 ammonia samples were collected, un-ionized ammonia represented approximately 0.5 to 2.0 percent (Goldman and Horne, 1983: p. 127) of the total ammonia concentration, and un-ionized ammonia concentrations ranged from less than 10 percent to approximately 50 percent of the 0.025 value.[11] These values are similar to those observed in previous years when ammonia was detected.

[11] We note that due to mis-labeled sample bottles, ammonia concentrations during the first-flush sampling on October 19, 2004 had to be analysed from the composite samples, rather than from grab samples. Thus,

The highest un-ionized ammonia concentration was observed in the sample collected from San Francisquito Creek on March 22, 2005 during the rising limb of a large spring storm (Table 6). At a pH of of 7.9 and a water temperature of 13˚C (Table 3), un-ionized ammonia in San Francisquito Creek would be about 1.8 percent (Goldman and Horne, 1983: p. 127) of the total ammonia concentration of 0.73 mg/L (Table 6), or 0.013 mg/L. Un-ionized ammonia concentrations in the three creeks at other times when ammonia was detected were more than 50 percent lower.

6.3.2 Nitrate-nitrogen

Nitrate-nitrogen concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

Nitrification is the process whereby ammonia-nitrogen (NH3) is microbially converted to nitrite (NO2-), and then nitrate (NO3-). The intermediate step occurs rapidly, so nitrite-nitrogen concentrations are usually very low or undetectable. Samples collected for nitrate analysis are preserved on ice and must be analyzed within 48 hours. However, timely delivery and processing of nitrate samples collected late in the work week and over weekends is problematic because laboratories are closed on weekends. To address this constraint, most of the water year 2005 samples were collected in acidified bottles, extending the hold time to 28 days, and submitted to the laboratory for "nitrite plus nitrate" analysis. The two analyses are listed separately in Tables 5 and 6 but, for practical purposes, virtually all of the nitrogen under the "nitrite plus nitrate" column is nitrate-nitrogen.

Nitrate-nitrogen concentrations were above the detection limit in all three creeks on all dates sampled in water year and similar to values observed in previous years. Nitrate concentrations ranged from 0.7 to 0.9 mg/L (as nitrogen) in Bear Creek in water year 2005, from 0.9 to 5.2 mg/L in Los Trancos Creek, and from 0.4 to 2.7 mg/L in San Francisquito Creek. Nitrate-nitrogen concentrations were higher in Los Trancos Creek than in the other two creeks on all five water year 2005 sampling dates. Wet-season nitrate-nitrogen concentrations are generally expected to be highest during first-flush events early in the season, when sufficient runoff is present to flush accumulated nitrate

the values for this sampling are not directly comparable to grab samples from prior or subsequent sampling dates.

into the stream but flows are below the threshold where nitrate concentrations become highly diluted by fresh runoff. Nitrate concentrations in both Los Trancos Creek and San Francisquito Creek tended to be highest during the first-flush and dry-season sampling events in water year 2005, as in previous years, and much lower during the large mid-winter and spring storms. No first-flush nitrate analysis is available for Bear Creek this year (WY2005) due to laboratory error.[12] Wet-season nitrate concentrations were relatively low and similar to those observed at this station during winter storms (0.6 to 1.0 mg/L) in a 3-year study encompassing water years 2000 through 2002 (Balance Hydrologics, unpublished data). The water year 2005 dry-season baseflow sample from Bear Creek had a nitrate concentration of 0.2 mg/L, similar to the dry–season values measured in water year 2004 and in the earlier 3-year study (0.14 to 0.63 mg/L).

On a total of nine occasions, samples were submitted to the laboratory for duplicate nitrate-nitrogen or nitrite plus nitrate nitrogen analysis, or for both analyses (Tables 5 and 6). Agreement was generally excellent, with the only significant difference being between the Dec. 6 to 7, 2004 samples for San Francisquito Creek, where the reported nitrate concentration of 1.50 mg/L was 50 percent higher than the nitrite plus nitrate analysis of 0.98 mg/L.

We note that the U.S. EPA has recommended a threshold of about 0.5 mg/L total nitrogen for ambient waters in sub-ecoregion 6, which includes a wide range of stream types in a diversity of settings from San Diego to northern California (U.S. EPA, 2000). The Pajaro River Watershed Water Quality Management Plan (Applied Science and Engineering, 1999) reported that nitrate-nitrogen concentrations of 0.05 to 2.0 mg/L would be expected in “uncompromised” streams draining the Santa Cruz Mountains.

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[12] The laboratory mislaid this sample bottle and did not locate it again until the sample had substantially exceeded the hold time for unpreserved nitrate, so the sample was discarded.

6.4 Organophosphate Pesticides

Diazinon and chlorpyrifos were not detected during water year 2005.

San Francisquito Creek is listed by the State Water Quality Control Board as being impaired by the common organophosphate pesticide, diazinon. As of December 31, 2004, the U.S. EPA banned sales of diazinon-containing outdoor, non-agricultural products in the United States in order to eliminate all residential uses of the insecticide. In the Bay Area, the Regional Board recently proposed a total maximum daily load (TMDL) that addresses diazinon (Johnson, 2004) in an effort to reduce pesticide-related toxicity in urban creeks. The TMDL process calls for development of numeric targets that translate the current Basin Plan's narrative toxicity objective.[13] Therefore, the Regional Board recently proposed diazinon concentration targets of 0.05 µg/L (four-day average) and 0.08 µg/L (one-hour average), not to be exceeded more than once every three years.[14] These objectives were originally identified by the California Department of Fish and Game and are consistent with the federal antidegradation policy promulgated in the Code of Federal Regulations (Title 40, §131.12).

Concentrations of diazinon, and another common organophosphate pesticide, chlorpyrifos, were below the detection limit in all three streams on all dates sampled in water year 2005 (Tables 5 and 6). Neither pesticide was detected in samples from Los Trancos Creek and San Francisquito Creek in water years 2002 to 2004 [15] or from Bear Creek during water year 2004. For comparison, during the Bear Creek water-quality study, diazinon was detected only once in three years, at 15.3 ug/L in October 2000, and chlorpyrifos was never detected in any sample.

[13] Waters should remain free of toxics at concentrations lethal to or adversely impacting aquatic organisms (RWQCB, 1995).

[14] The proposed numerical standard is intended to apply only to the Clean Water Act Section 303(d) listing process methodology and does not revise water quality objectives. As described in the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) list (California State Water Resources Control Board, 2004), the process by which a water segment is placed on or removed from the 303(d) list involves consideration of single or multiple lines of evidence and statistical evaluation of numeric water quality data. For example, a water segment can be listed if there are two or more exceedances in a set of up to 24 samples (for toxicants), or five or more exceedances in a set of up to 30 samples (for conventional pollutants). To be *delisted*, a water segment must have less than or equal to two exceedances in a set of 28 to 36 samples (for toxicants), or four or less exceedances in a set of 26 to 30 samples (for conventional pollutants).

[15] Samples collected for the Bear Creek water-quality study, and for the LTMAP study during water year 2002 and most of water year 2003, were analyzed for organophosphate pesticide content using a methodology with a detection limit of 0.5 ug/L. A more sensitive methodology, with a detection limit of 0.05 ug/L, was used beginning with the June 26, 2003 sampling.

6.5 Metals

Composite water quality samples collected from the three streams during water year 2005 were analyzed for total and dissolved concentrations of eight metals commonly associated with urban and suburban development in the San Francisquito Creek watershed: aluminum, copper, lead, mercury, nickel, selenium, silver, and zinc. Most metals were detected in either the dissolved or solid form in all three streams on every sampling date this year (Tables 5 and 6). The exceptions were aluminum, lead and silver. Neither aluminum nor lead were detected in any of the three creeks during the dry-season sampling on Sept. 7 to 8, 2004. Silver was not detected in San Francisquito Creek or Los Trancos Creek on any date in water year 2005. In Bear Creek, however, silver was detected on three dates, once in the total recoverable form and twice as dissolved silver (see Section 6.5.7 below).

Speciation is the term used to describe partitioning of the total load of a particular metal between the dissolved and particulate forms. Metals in the dissolved form are considered more readily available to aquatic organisms and therefore potentially more deleterious (see below). The proportion of the metal present in the dissolved form is dependent on the pH of the water, the chemical properties of the specific metal, and the nature of the suspended solids that are present (Sansalone and Buchberger, 1997a and 1997b):

- At typical San Francisquito watershed baseflow pH levels of 7.5 to 8.5 (Tables 1 to 3), metals are generally more likely to adsorb onto particles, while lower pH levels during storm events favor the dissolved form (Paulson and Amy, 1993).
- Copper and lead are more likely to form complexes with sediments in the system and thus have a greater particulate fraction, whereas the majority of the total zinc is often in the dissolved phase (Characklis and Wiesner, 1997; Flores-Rodriguez and others, 1994).
- Higher suspended sediment or turbidity concentrations will increase the particulate metal fraction due to the greater number of sites available for adsorption. It is important to note that many metals have been shown to be associated with the smallest of the suspended particles (Dempsey and others, 1993; Sansalone and Buchberger, 1997a).

As noted above, metals have been found to be less toxic to aquatic organisms when ambient hardness levels are higher. As a result, the U.S. EPA recently developed specific criteria for the dissolved form of selected trace metals. These criteria are hardness-dependent, since calcium and magnesium (the primary components of hardness[16]) act to buffer metal toxicity. The criteria were adopted in California through the California Toxics Rule (CTR) and have been incorporated into Basin Plan documents by the nine Regional Boards.

In general, hardness is lowest in Bear Creek, and slightly higher in Los Trancos Creek than in San Francisquito Creek (Tables 5 and 6). Hardness generally decreased as streamflow increased, reflecting reduced contributions of ground water relative to surface runoff during storms. Thus, hardness levels in water year 2005 were lowest, ranging from 94 to 255 mg/L as CaCO3, during the mid-winter (Dec. 29 to 31, 2004) and spring (March 21 to 22, 2005) storm samplings. Hardness levels were higher, ranging from 170 to 648 mg/L as CaCO3, during the first-flush, early winter and dry-season samplings. Hardness in Los Trancos Creek and San Francisquito Creek was similar in water year 2005 to values observed during WY2003 and WY2002, and higher than values from WY2004. Hardness in Bear Creek was similar in water year 2005 to values observed during WY2004.

Based upon these measurements, the regulatory values included for comparison in Tables 5 and 6 are calculated for the range of 100 to 500 mg/L as CaCO3. Table 7 presents water quality objectives at hardnesses of 100 to 500 mg/L as CaCO3 for the five hardness-dependent trace metals sampled as part of the LTMAP program. We note that the upper limit of hardness used by the Regional Board to assess the effects of metal concentrations is usually 400 mg/L. At the hardness levels typically observed in the three creeks during the dry season (>250 mg/L as CaCO3), the potential toxicity of trace metal ions is low.

6.5.1 Aluminum

Aluminum concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

In all three creeks, *total aluminum* concentrations were highest in composite samples collected during the storm event from Dec. 29 to 31, 2004 (Tables 5 and 6). This is not

[16] The convention is to express total hardness in terms of an equivalent concentration of calcium carbonate ($CaCO_3$).

unexpected since aluminum is a major naturally-occurring component of the silts and clays that largely comprise suspended sediment, and stream flows and suspended sediment concentrations were highest on these dates during one of the largest storms of water year 2005.[17] *Dissolved aluminum* concentrations were low or non-detectable during the wet season and below the detection limits during the dry-season. Concentrations of aluminum in both forms were similar to published values for aluminum concentrations in surface waters in natural streams of the United States (Hem, 1985), which include contributions from urban sources. Aluminum concentrations were not analyzed in the earlier Bear Creek study.

6.5.2 Copper

Dissolved copper concentrations were high in water year 2005. They may conceivably pose a problem.

Sources of copper in the San Francisquito Creek watershed include dust from vehicle brake pads, automotive fluids, wash waters, architectural building materials, and geologic sources. During the water year 2005 wet season, *total copper* concentrations in the three streams ranged from 7.1 to 60.0 μg/L (Tables 5 and 6) and were similar to values measured in previous years. The highest concentration in each stream occurred on different dates: the first flush event on Oct. 18 to 19, 2005 for San Francisquito Creek (58 μg/L); the late December 2004 event for Los Trancos Creek (28 μg/L), and the March 2005 storm for Bear Creek (60 μg/L). Total copper concentrations in all three streams were lowest in the dry-season samples collected September 7 to 8, 2005 and similar to values measured in these streams during prior dry-season samplings.

Concentrations of *dissolved copper* in wet-season samples from the three streams ranged from 3.8 to 10.9 ug/L during water year 2005 (Tables 5 and 6). Concentrations were similar to those measured at these sites during the past few years and at the Sand Hill Road station during the earlier Bear Creek study (1.8 μg/L to 9.9 μg/L). In all three streams, the highest values were measured in first-flush samples collected Oct. 18 to 19, 2004. Dissolved copper concentrations were only slightly lower in Los Trancos Creek and Bear Creek during the Dec. 29 to 31, 2004 sampling, however, hardness was much

[17] The acid digestion performed for total metal analysis also typically releases a much larger amount of the mineral than is naturally present in the stream.

lower on this date. As a result, the dissolved copper concentration in the sample from Bear Creek exceeded the chronic toxicity objective for dissolved copper (at a hardness level of 100 mg/L as CaCO3) established by the Regional Board (Table 7). The dissolved copper concentration in Los Trancos Creek was higher than in Bear Creek but the hardness value was also higher so the dissolved copper concentration did not exceed the chronic toxicity objective. Dry-season samples from all three streams had much lower dissolved copper concentrations and values were similar to those observed in previous years.

More than most streams draining to San Francisco Bay, geologic sources of copper may be contributing to the levels observed in the San Francisquito channels. Copper tends to be present at higher-than-usual concentrations in basic volcanic rocks (such as the Mindego or Franciscan volcanics which occur in the Los Trancos and San Francisquito sub-watersheds) or in sediments derived from them (such as the Purisima, and to a lesser extent, the Butano and Santa Clara formations found in all three sub-watersheds). Isolated exceedances have been reported in wells and streams drawing from most of these formations in other watersheds[18].

We note that while wet-season dissolved copper concentrations were below the acute and chronic toxicity objectives in all but one of the water year 2005 composite samples, actual dissolved copper concentrations in the streams may have exceeded the acute toxicity threshold during some portion of the sampling interval for the reasons discussed above in Section 6.1.1.

6.5.3 Lead

Lead concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

Total lead concentrations in water year 2005 samples ranged from 4.8 to 9.0 μg/L (Tables 5 and 6) and were generally similar in all three streams. The highest concentrations observed this year in Los Trancos Creek and San Francisquito Creek, from the Dec. 29 to 31, 2004 event, were lower than the peak values measured during the

[18] For more detail on geologic sources of trace metals in the San Francisquito watershed, see Appendix C of the WY2003 LTMAP monitoring report (Owens and others, 2004).

WY2004 and WY2003 wet seasons. On Bear Creek, the highest concentration of water year 2005 was found in the first-flush sample collected on October 19, 2004, although the sample concentration was likely elevated due to the truncated sampling interval at this station (see Section 5.3 above). Total lead was nondetectable in dry-season samples from all three streams, as has generally been found in previous years.

Dissolved lead was detected twice in each stream during the water year 2005 wet season, more frequently than in previous years. Concentrations of dissolved lead in wet-season samples ranged from 0.4 to 1.1 μg/L this year (Tables 5 and 6), similar to values observed in Los Trancos Creek and San Francisquito Creek in WY2003. The highest concentrations in San Francisquito Creek and Bear Creek occurred during the first-flush event. For Los Trancos Creek, dissolved lead concentrations were highest during the Dec. 29 to 31, 2004 storm. For comparison, in the earlier Bear Creek study, wet season concentrations of dissolved lead ranged from 2.6 to 8.4 μg/L in grab samples from stations in the Dry Creek watershed, which receives runoff from Highway 280. Dissolved lead was nondetectable in water year 2005 dry-season samples from all three streams. All detections were well below the acute and chronic toxicity objectives for dissolved lead established by the Regional Board.

The predominant source of lead in the watershed is probably residues from leaded gasoline, bound to organic matter or soil near roads and highways, and transported in urban runoff. Lead concentrations were nondetectable in samples from stations in other watersheds monitored during the same study. Lead is rarely reported from streams or wells in the region where human influences are minimal, and does not seem to have a significant or discernible geologic source, although likely present in trace quantities.

6.5.4 Mercury

All mercury data are from grab samples. Total mercury concentrations in water year 2005 samples regularly approached or exceeded the Regional Board chronic (4-day average) standard of 0.025 μg/L and may pose a problem. Total and dissolved mercury concentrations in samples collected through the LTMAP program have never approached the aquatic acute (1-hour average) standard of 2.4μg/L.

Mercury is of increasing concern locally, as studies document remobilization of mercury from natural ore bodies near New Almaden plus adjoining areas and from sediments deposited in San Francisco Bay during the hydraulic gold-mining era, followed by bioconcentration in fish and waterfowl once inorganic mercury is biomethylated by microbes.

Total mercury concentrations in water year 2005 samples ranged from 0.0017 to 0.066 µg/L in Bear Creek (Table 5), from 0.0014 to 0.043 µg/L in San Francisquito Creek, and from 0.0015 to 0.077 µg/L in Los Trancos Creek (Table 6). Wet-season concentrations in all three streams were similar to values observed in previous seasons. Total mercury concentrations in all three streams exceeded the Regional Board chronic (4-day average) standard of 0.025 µg/L in samples collected during the first-flush event on Oct. 19 to 20, 2004 and during the winter storm on Dec. 29 to 31, 2004. The chronic standard was also exceeded in the samples collected from Bear Creek and San Francisquito Creek on Dec. 7 to 8, 2004. Total mercury concentrations in other wet-season samples from these streams approached but did not exceed the chronic standard, while total mercury concentrations in dry-season samples from the three creeks were well below the chronic standard.

Dissolved mercury concentrations in samples from the three streams ranged from 0.0010 to 0.0080 µg/L during water year 2005, similar to values measured in previous years, and well below the regulatory standard. The highest concentrations in Bear Creek and Los Trancos Creek were found in samples collected during the December 29 to 31, 2004 storm event. The lowest dissolved mercury concentrations, from dry-season sampling on Sept. 7 to 8, 2004, were similar to levels in dry-season samples collected from these streams in WY2004 and WY2003.

6.5.5 Nickel

Nickel concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

Total nickel concentrations in wet-season samples from Los Trancos Creek and San Francisquito Creek ranged from 5 to 36 µg/L in water year 2005 (Table 6), similar to values measured in previous years. As observed for lead, total nickel concentrations in both streams were highest during the large storm of December 29 to 31, 2004, and lower in samples collected earlier and later in the season during periods of lower flows. Total nickel concentrations in Bear Creek followed the same pattern as in the other two streams, with the highest concentration in the sample collected during the same late December storm (Table 5). Dry-season samples from all three streams had low total nickel concentrations, similar to values measured in previous years.

Dissolved nickel concentrations ranged from 4.1 to 12.0 μg/L in Los Trancos Creek during water year 2005, from 4.2 to 7.0 μg/L San Francisquito Creek, and from 3.7 to 7.0 μg/L in Bear Creek. Concentrations in all three streams are similar to values measured in previous years. The highest concentrations were measured during the first-flush event on Oct 18 to 19, 2004. All values were far below acute and chronic toxicity objectives for dissolved nickel established by the Regional Board.

6.5.6 Selenium

Selenium concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

Total selenium concentrations in the three streams ranged from nondetectable to 0.5 μg/L in water year 2005, with slightly higher levels in San Francisquito Creek than in the other two streams (Tables 5 and 6). The highest concentrations in Los Trancos Creek and San Francisquito Creek, measured during the first-flush event on Oct 18 to 19, 2004, were higher than in WY2004 but lower than in WY2003. The highest total selenium concentrations in Bear Creek (0.3 μg/L) during water year 2005, from the first-flush sample and the sample collected on Dec. 29 to 31, 2004, were lower than the maximum concentration (0.6 μg/L) reported for Bear Creek in WY2004. Dry-season samples from Los Trancos Creek and San Francisquito Creek on September 7 to 8, 2005 had slightly higher total selenium concentrations than samples from the spring storm on March 21 to 22, 2004. The total selenium concentration was only 0.2 μg/L in the Bear Creek sample from the late March storm but total selenium was nondetectable in the dry-season sample. All concentrations were far below the U.S EPA (National Toxic Rule) aquatic acute toxicity objective of 20 μg/L and the chronic toxicity objective of 5 μg/L.

Concentrations of *dissolved selenium* in the three streams ranged from nondetectable to 0.4 μg/L in water year 2005 and generally followed a similar trend, with the highest values observed in the first-flush and dry-season samples, and the lowest value during the spring storm of March 21 to 22, 2005. Dissolved selenium concentrations in all three streams were similar to values measured in previous years. All values were far below acute and chronic toxicity objectives for dissolved selenium established by the U.S EPA. Selenium concentrations were not analyzed in the Bear Creek study but these concentrations are within the background range expected for this element, which is present in trace concentrations within rocks throughout the watershed.

6.5.7 Silver

When detected, silver concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

Silver, in either the total or dissolved form, was not reported above the 0.2 μg/L detection limit in any water year 2005 samples from Los Trancos Creek or San Francisquito Creek. For comparison, silver was detected once in Los Trancos Creek in WY2004, once in each stream in WY2003, and not at all in WY2002. Silver was detected on three occasions in Bear Creek in water year 2005: a *total silver* concentration of 1.3 μg/L in the sample from March 21 to 22, 2005, and *dissolved silver* concentrations of 0.3 μg/L in the sample from Dec. 29 to 31, 2004 and 0.2 μg/L in the dry-season sample from Sept. 7 to 8, 2005. The Regional Board has not established acute or chronic toxicity standards for silver. However, the Regional Board has established an aquatic instantaneous maximum value for dissolved silver. All of the dissolved silver concentrations detected this year are well below the standard.

For comparison, silver was detected once in Los Trancos Creek and once in San Francisquito Creek in WY2003, also at concentrations of 0.3 μg/L. In WY2002, concentrations of silver in samples from both streams were below the 0.2 μg/L detection limit during each of the two wet-season events sampled.

6.5.8 Zinc

Zinc concentrations were within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

Zinc tends to be substantially more abundant and more soluble than other trace metals. In general, as with other metals, one would expect higher *total zinc* concentrations at high flows, when streams are transporting elevated loads of suspended sediment, and this is the pattern which has been observed on Los Trancos Creek and San Francisquito Creek in previous years. In water year 2005, wet-season total zinc concentrations varied from 44 to 76 μg/L on San Francisquito Creek, from 33 to 65 μg/L on Los Trancos Creek, and from 50 to 86 μg/L on Bear Creek (Tables 5 and 6), with values generally similar to concentrations observed during past years. The highest concentration on San Francisquito Creek this year was in the first-flush sample collected on Oct. 19 to 20, 2004, while the highest concentrations measured on Los Trancos Creek and Bear Creek were in samples collected on Dec. 29 to 31, 2004. Total zinc concentrations in dry-season samples from Los Trancos Creek (39 μg/L) and Bear Creek (27 μg/L) were elevated as compared to the sample from San Francisquito Creek (8 μg/L), which was more typical of dry-season values from previous years.

In water year 2005, wet-season *dissolved zinc* concentrations in the three streams ranged from 15 to 50 μg/L, similar to levels measured in previous years. In each stream, the highest dissolved zinc concentration was measured in the first-flush sample collected October 19 to 20, 2004, and dissolved zinc concentrations did not show a trend of higher concentrations with increasing streamflows, as was observed during WY2003 and WY2004. Dissolved zinc concentrations in dry-season samples from San Francisquito Creek (34 μg/L) and Bear Creek (21 and 24 μg/L) were elevated as compared to the sample from Los Trancos Creek (5 μg/L), which was more typical of dry-season values from previous years. Dissolved zinc concentrations in all samples were well below the regulatory standard. Both local geologic formations[19] and anthropogenic sources, such as road runoff and galvanized architectural materials (e.g., roofs, fencing, gutters), likely contribute to observed dissolved zinc levels.

6.6 Temperature

Temperatures were within the range of previous sampling results during water year 2005 but may cause a slight stress to fish.

[19] Elsewhere in the Santa Cruz Mountains, zinc and cadmium are reported in elevated concentrations in both waters and sediment emanating from portions of the Monterey formation and the lower Purisima formation (c.f., Ricker and others, 2001; also, see Majmundar, 1980). Both units outcrop in portions of the San Francisquito and Los Trancos sub-watersheds (Balance Hydrologics, 1996). Both formations are also known geologic sources of phosphate.

Temperature strongly affects steelhead habitat. Although steelhead can withstand high water temperatures of 29˚C for a short period of time, and 25˚C for longer periods, they have progressively-increasing difficulty extracting dissolved oxygen from water at temperatures above 21˚C (Lang and others, 1998) and require a larger food source to sustain their elevated metabolism (Smith, pers. comm.). Therefore, water temperatures of 21˚C and below are considered to provide adequate summer habitat, and values chronically above 25˚C are likely not viable for the local steelhead population.

Balance staff made numerous manual measurements of water temperature in the three streams and, at each station, one or two instream probes continuously recorded water temperatures. Manual temperature readings measured during site visits followed the same seasonal pattern and values recorded by the instream probes (Figures 11 to 13). Water temperatures were within the acceptable range for steelhead habitat during most of the water year 2005 season. As observed in the three previous years (WY2002 to WY2004), water temperatures in San Francisquito Creek (Figure 11) appeared to be slightly cooler than in Los Trancos Creek (Figure 12) during the wet season, and slightly warmer during the dry season. Water temperatures in Bear Creek during the wet season were slightly cooler than in San Francisquito Creek (Figure 13), and markedly cooler than in Los Trancos Creek. During the dry season, temperatures in Bear Creek were similar to Los Trancos Creek and much cooler than in San Francisquito Creek.

Maximum daily temperatures in San Francisquito Creek exceeded the 21˚C threshold for periods of up to six hours daily (average of three hours) during the three-week period from mid-July through early August 2005 (Figure 11). Maximum daily temperatures in Los Trancos Creek (Figure 12) and in Bear Creek (Figure 13) did not exceed the 21˚C threshold during water year 2005.

6.7 pH

pH was within the range of previous sampling results during water year 2005. This constituent is not considered to be a problem.

As stated above in Section 5.3, the pH probes at all three stations were essentially non-functional in water year 2005, so this parameter was measured regularly using hand-held meters. Based on the manual sampling, pH varied from 7.3 to 8.1 in Bear Creek

(Table 1, Figure 14), from 7.7 to 8.4 in Los Trancos Creek (Table 2, Figure 14), and from 7.1 to 8.3 in San Francisquito Creek (Table 3, Figure 14). pH values were similar to measurements from previous years and pH was typically slightly higher in Los Trancos Creek than in the other two streams on both dry- and wet-season sampling dates.

We note that fisheries biologists familiar with the northern Santa Cruz Mountains and San Francisco Peninsula streams have found that pH is very rarely a limiting factor in regards to steelhead habitat, so long as there is flow moving from pool to pool.

6.8 Dissolved Oxygen

Dissolved oxygen concentrations were occasionally low during late summer and fall, which may be limiting for biota.

As stated above in Section 5.3, the dissolved oxygen probes at the Los Trancos and San Francisquito Creek stations were essentially non-functional in water year 2005. The dissolved oxygen probe at the Bear Creek station performed well during some periods and poorly during other periods, probably due to clogging with sediment and to probe positioning within the stilling well. Based on manual measurements during water year 2005, dissolved oxygen concentrations varied between 65 and 100 percent of saturation in Bear Creek (Table 1, Figure 15) and between 67 and 100 percent of saturation in Los Trancos Creek (Table 2, Figure 16). In San Francisquito Creek (Table 3, Figure 17), dissolved oxygen concentrations varied between 54 and 100 percent of saturation, with even lower values suggested by the electronic record. As reported in previous years, dissolved oxygen concentrations were typically highest in Los Trancos Creek, and higher in Bear Creek than in San Francisquito Creek. Concentrations decreased in all three streams during summer months, when water temperatures are high, streamflow is low, and there is little turbulence. Concentrations in San Francisquito Creek decreased even further during the early fall, when dead leaves blown into the creek have begun to rot but have not yet been flushed downstream by high flows from winter storms.

As noted in our WY2003 report (Owens and others, 2004), manual measurements of dissolved oxygen can vary considerably depending upon where in the creek the probe is placed, with values ranging from about 15 to 60 percent saturation at locations as little as one foot apart. This situation is particularly common in the fall, when the streams are full of dead leaves. Based on our monitoring data to date, we expect dissolved oxygen concentrations in the creeks to range from 10 to 14 mg/L (90 to 100 percent saturation) during the winter and especially at high flows, when turbulence and cold ambient water temperatures promote oxygen saturation. Dissolved oxygen concentrations become more limiting for fish as streamflows decrease and temperatures rise in spring and summer, with the lowest concentrations occurring in the fall, at the start of the next water year but before rains raise water levels and flush leaves from the creeks.

6.9 Sediment

Sediment concentrations were within the range of previous sampling results during water year 2005. Suspended sediment may be an impediment to fish in different ways at various life stages (c.f., Hecht, 1983).

San Francisquito Creek is listed by the State Water Resources Control Board as impaired due to sediment loading. All creeks carry some sediment; problems can arise when creeks carry too much sediment. Biologically, too much fine sediment can reduce oxygen circulation to buried eggs, abrade fish gills, fill hiding and resting niches and impede post-storm feeding. Too much coarse sediment affects bed conditions in a number of ways that can constrain steelhead habitat, including filling pools and undercut banks, creating 'soft' beds that are prone to scour, and forming mid-channel bars that divert flows into the banks, inducing bank erosion. Excess sediment can also settle-out at low-gradient locations, reducing pool depths and decreasing the flood capacity of the channel.

Monitoring sediment concentrations and rates of sediment transport is important as a way of evaluating the amount of sediment being carried by the creek, to assess the mobility of spawning gravels and document changes that may signal improving or worsening conditions. Previous Balance reports have documented rates of sediment transported in various watersheds upstream from Piers Lane (Balance Hydrologics, 1996; Owens and others, 2001; Owens and Hecht, 2002), as well as the role of Searsville Lake in trapping sediment and the contributions from different geologic formations. In this watershed, we have observed a number of sources, both natural (e.g., bank failure, landslides) and human-caused or human-exacerbated (e.g., failure of culvert outfalls, construction erosion control measures, bank protection). Detailing these sources, however, is beyond the scope of this report.

Following convention, we distinguish two types of sediment in transport, each of which is measured during storms using specific types of samplers and sampling methods. Suspended sediment is supported by the turbulence of the water and is transported at a velocity approaching the mean velocity of flow. In the San Francisquito Creek watershed, as elsewhere in the Santa Cruz Mountains, suspended sediment consists primarily of fine sands, silts, and clays. Bedload sediment is supported by the bed of the stream; it rolls and saltates along the bed, commonly within the lowermost 3 inches of the water column. Movement can be either continuous or intermittent, but is generally much slower than the mean velocity of the stream. At the Piers Lane sites and in the Bear Creek watershed, bedload consists primarily of coarse sands and gravels, but will also include cobbles at extreme high flows. Total sediment discharge is the sum of bedload-sediment and suspended-sediment discharges.

6.9.1 Suspended sediment

Suspended-sediment samples were collected from all three stations throughout the water year at various dates and levels of flow (Table 4) using standard methods and equipment adopted by the Federal Interagency Sedimentation Program (FISP: see Hecht, 1983). All grab samples were analyzed by Soil Control Laboratories of Watsonville, California, a state-certified laboratory. Composite samples were analyzed at the Regional Water Quality Control Plant in Palo Alto and these results are also shown in Tables 5 and 6 under the heading "Total Suspended Solids". No suspended-sediment samples were collected when stream waters were visibly clear. From past experience, we have found that samples collected when the streams are clear produce no useful information because they test below the analytical reporting limit of 5.0 mg/L.

By multiplying the reported suspended-sediment concentrations by the streamflow at the time the sample was taken, concentrations (mg/L) were converted into an instantaneous suspended-sediment "load" (tons/day), as shown in Tables 8 and 9. We then plotted sediment load as a function of streamflow to create suspended-sediment rating curves describing the general trend of the data points for each creek (Figures 18 and 19). We also applied the suspended-sediment rating curves to the records of streamflow (at 15-minute intervals) to calculate a total annual suspended-sediment load for each creek (Forms 4 to 6). Interpretation of suspended-sediment rates and total loads is discussed in Section 6.9.3 below.

6.9.2 Bedload sediment

The *Draft Surface Water Quality Monitoring Plan 2001/02* (LWA, 2001) does not include consideration or protocols for measurements of bedload-sediment transport. At all three LTMAP gaging stations discussed in this report, the threshold for significant bedload transport occurs at flow depths and velocities that border on being too deep to sample safely by wading. However, through the close of water year 2005, we have occasionally been successful in measuring bedload transport at the Bear Creek station and at the Los Trancos Creek station at Piers Lane. A greater emphasis on collecting bedload sediment transport data may develop as the LTMAP matures.

Although we have only a limited number of bedload-sediment measurements on Bear Creek and Los Trancos Creek at Piers Lane, as compared to the number of suspended-sediment samples, we have constructed bedload rating curves for each station (Figures 18 and 19). Bedload samples are converted to a discharge rate (in units of tons per day) and then plotted as a function of flow. As expected, sediment discharge increases as flow increases. We also applied the bedload rating curve to the record of streamflow (at 15-minute intervals) to calculate annual bedload totals for Bear Creek (Form 4 and Table 4) and Los Trancos Creek (Form 5 and Table 4). Interpretation of bedload-sediment rates and total loads for these two stations is discussed in Section 6.9.3 below.

6.9.3 Sediment discussion

Comparison of the suspended-sediment rating curves for the Los Trancos Creek and San Francisquito Creek at Piers Lane stations (Figure 19) with the rating curve for Bear Creek station (Figure 20) shows that both Bear Creek and Los Trancos Creek generally carry higher suspended-sediment loads at a given flow than San Francisquito Creek. Higher rates of transport in tributary streams is a typical condition and nearly universal throughout the Bay Area (c.f., Hecht, 1983), since tributary watersheds tend to be steeper and more subject to erosion due to higher flow velocities. In addition, suspended-sediment concentrations in San Francisquito Creek are diluted by outflows from Searsville Lake, which traps a large proportion of the sediment load from tributary streams higher in the watershed. We compared the sediment rating curve for Bear Creek to rating curves of other creeks that we monitor in the watershed and found that sediment-discharge rates (as a function of flow) for Bear Creek are lower than rates for Corte Madera or Los Trancos Creeks.

It is important to note that storm flow in San Francisquito Creek is typically twice as high as flow in Bear Creek[20], and usually three to five times greater than flow in Los Trancos Creek (Figure 2), so San Francisquito Creek still transports more sediment. This is evident in the annual sediment summaries (Forms 4 to 6), which show that the calculated total suspended-sediment load in San Francisquito Creek was about 9,500 tons in water year 2005, compared to about 2,500 tons in Bear Creek and 1,400 tons in Los Trancos Creek.

Sediment measurements at each of the stations also shows a strong dependence on flow at the time of the measurement; when flow is higher, the creeks carry more sediment. Therefore, sediment totals for each stream also vary from year to year depending on the amount of rainfall and the size of the largest flood peak (Table 4). This concept of "episodicity" is useful for interpreting the sediment measurements within the context of the inter-annual variability in climate conditions. Rather than trying to calculate an average sediment discharge per year, we acknowledge that there will be large year-to-year variability in sediment discharge. For example, on Bear Creek, where we have the longest record and have sampled both bedload sediment and suspended sediment, the sediment totals for water year 2000 are much higher than for the subsequent five water years (2001 to 2005) (Table 4). We attribute these higher totals to the higher peak flows and larger total volume of flow in water year 2000, rather than to any specific activities (or lack thereof) by inhabitants of the watershed.

6.9.4 Assessed bias of automated suspended-sediment sampling (excerpted from the WY2004 monitoring report)

[Note to Readers: the subsection below from the WY2004 report is included herein because the test and the results, even though preliminary and likely to be repeated, may inform readers who seek to interpret the suspended sediment data presented in this report .**]**

The standard method for sampling suspended sediment is to use an isokinetic sampler to collect a depth- and width-integrated sample (Porterfield, 1972; Edwards and Glysson, 1999). Depth integration is important because the concentration of suspended

[20] The relationship between flow at the Bear Creek at Sand Hill Road station and flow at San Francisquito Creek at Piers Lane varies seasonally with the amount of outflow from Searsville Lake. Typically, differences in flow between the two sites are smaller at the start of the wet season, when the water level in the lake is below the spillway. Later in the wet season, differences are greater once the lake begins to spill freely.

sediment increases from the stream surface downwards to the bed. We typically use a DH-48 hand-held sampler to collect equal-transit-rate[21] sub-samples at multiple verticals across the width of the creek. We wanted to assess the degree of bias associated with using an automated sampler to collect suspended sediment samples, because the automated sampler does not have an isokinetic intake, instead, it draws the sample from a fixed point, and creates a composite sample from which a sub-sample is decanted and analyzed. However, by subsampling from the stream at regular intervals (time-paced sampling) or from pre-set volumes of flow (flow-paced sampling), the automated sampler can theoretically produce a more accurate representation of suspended sediment transport during the entire course of a particular storm event than is possible from one or two manually-collected grab samples.

The initial tests[22] reported below were conducted in the early afternoon of February 18, 2004. Streamflow in Bear Creek, which had peaked at about 499 cfs at about 5 AM that morning, had decreased to approximately 185 cfs in early afternoon and was falling slowly while we collected the set of samples for this test. The four types of samples used in this analysis are:

- "composite" - We pumped about 8 liters of creek water into a bucket using the ISCO sampler; the sample was then swirled and mixed and a sub-sample was decanted into a bottle.

- "direct pump" – We used the ISCO sampler to pump water directly from the creek into a bottle.

- "at intake" – We plunged a DH-48 hand-held sampler from the surface to the approximate location of the sampler intake near the streambed and held it there for about 15 seconds, then quickly raised it out of the water and poured the sample into a bottle.

- "depth-integrated" – We used the DH-48 to collect depth-integrated sub-samples at three verticals across about half the width of the creek; the sample was then poured from the DH-48 into a bottle.

[21] Equal-transit-rate (ETR) means that the sampler is lowered and raised at a constant rate at a particular vertical point on a transect across the width of the creek, then moved to the next point where the process is repeated.

[22] We still intend to conduct at least two more tests of a similar nature when conditions are appropriate before drawing any firm conclusions.

The samples were collected in the order listed above, and all within a time span of ten minutes. The sample bottles used were identical 500-milliliter polyethylene bottles. All samples were sent to the same analytical laboratory (Soil Control Lab) and analyzed using identical methods. The results, detailed in Table 9 of the WY2004 report and discussed below, are consistent with our understanding of the limitations of different methods for sampling suspended sediment. For each type of sample, we present the suspended sediment concentration reported by the laboratory and the resulting suspended-sediment load for a 24-hour period:

- "composite" = 276 mg/l = 135 tons/day – This is the lowest value and probably reflects settling-out of the heaviest particles during the interval (a few seconds) between completion of mixing and decanting the sub-sample from the composite vessel into the sample bottle.

- "direct pump" = 350 mg/l = 171 tons/day – This is the highest value and probably reflects the high sediment concentrations near the bottom of the water column, where the intake is located. The shape of the intake port and the resulting intake velocities could also be influencing the results.

- "at intake" = 331 mg/l = 161 tons/day – This value is relatively high but slightly lower than the value from the "direct pump" test, perhaps due to an influx of water as the DH-48 sampler was being lowered and raised through the water column above the intake location.

- "depth-integrated" = 308 mg/l = 150 tons/day – Because this sample was manually collected using standard methods, it is the standard for comparison of the other types of samples collected.

Based on the results of this initial test, the sub-sample from the composite bottle under-represented suspended-sediment concentrations in the creek by about 9 percent, as compared to the depth-integrated sample, even though the sample collected through the automated sampler over-represented suspended-sediment concentrations by about 14 percent. While it appears that the two effects partially offset each other in this first test, additional test results will give us more confidence in our interpretation. Furthermore, we expect the results of the sampling techniques to differ depending on the flow level at which the test is conducted, since the relative fractions of the different sediment size classes mobilized will differ with stream flow.

7. FUTURE MONITORING AND RECOMMENDATIONS

The following recommendations for consideration by the LTMAP working group are based on our experience and observations since inception of monitoring:

1. We recommend that additional grab samples be collected and analyzed for dissolved copper and hardness concentrations to better define the relationship between composite sample concentrations of dissolved copper and the acute water quality objective. One approach would be synoptic grab sampling, wherein multiple grab samples (perhaps, four to five) are collected over the course of a single storm. Another approach would be to collect grab samples at the peak of the hydrograph during multiple storms (perhaps, four to five) over the course of a season.

2. We used time-paced sampling to collect all of the composite water quality samples this year. Under the conditions at these stations, it is more practical to program the monitoring equipment to collect time-paced samples, than flow-paced samples. However, we will continue our attempts to perform flow-paced sampling in water year 2006, particularly for larger storms, as the resulting composite samples can be used to calculate event mean concentrations, useful for examining pollutant mass loading.

3. We plan to sample water quality at all three sites on five occasions in water year 2006. Our focus will continue to be on monitoring first-flush storms in late fall and early winter, larger less-frequent mid-winter storms, a spring storm, and one non-storm (baseflow) sampling in late summer.

4. Stanford and the San Francisquito Watershed Council have explored addition of one or more stations further upstream if funding could be secured. Extending the monitoring network higher in the watershed would provide greater understanding of longitudinal variation in water quality and stream flows and more fully represent conditions throughout the watershed.

8. LIMITATIONS

Analyses and information included in this report are intended for use at the watershed scale and for the planning and long-term monitoring purposes described above. Analyses of channels and other water bodies, rocks, earth properties, topography and/or environmental processes are generalized to be useful at the scale of a watershed, both spatially and temporally. Information and interpretations presented in this report should not be applied to specific projects or sites without the expressed written permission of the authors, nor should they be used beyond the particular area to which we have applied them. Balance Hydrologics, Inc. should be consulted prior to applying the contents of this report to evaluating water supply or any out-of-stream uses not specifically cited in this report.

Readers who have additional pertinent information, who observed changed conditions, or who may note material errors should contact us with their findings at the earliest possible date, so that timely changes may be made.

9. ACKNOWLEDGEMENTS

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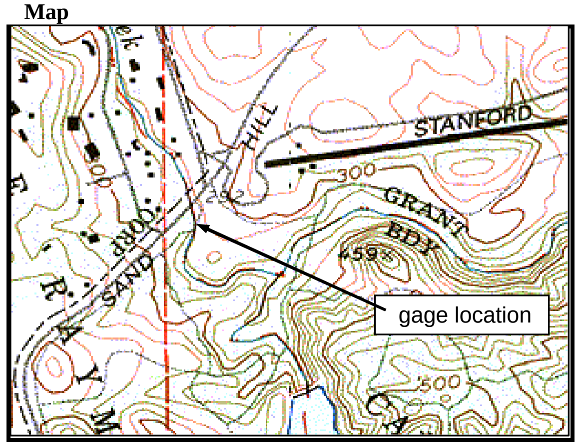
FORMS

Water Year:	**2005**
Stream:	Bear Creek
Station:	at Sand Hill Road
County:	San Mateo County, CA

Form 1. Annual Hydrologic Record

Map



Station Location / Watershed Descriptors

Latitude: 37 24' 40", Longitude: 122 14' 28" Jasper Ridge Biological Preserve, Stanford, CA. Gage is installed on left bank, about 200 feet downstream from Sand Hill Rd. Staff-plate pool is eroded into hard sandstone; underflow is thought to be minimal. Land use includes forested open space, and suburban uses in valleys. Drainage area above gage is 11.7 sq. miles.

Mean Annual Flow

Mean annual flow (MAF) for 2005 was 11.21 cfs.
MAF for WY 2004 was 5.87 cfs. WY 2002 was 5.12 cfs, WY 2001 was 3.71 cfs, WY 2000 was 10.65 cfs.

Peak Flows

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
12/8/04	6:30	4.56	324	2/15/05	19:45	4.31	306
12/30/04	**21:30**	**5.35**	**487**	3/22/05	16:15	5.27	463
12/31/04	19:45	3.90	243	3/23/05	8:30	5.18	445
1/8/05	20:15	4.40	319	3/27/05	22:15	4.70	358
1/10/05	20:45	3.59	206	4/8/05	11:45	3.64	202
1/11/05	7:15	3.76	228				

The peak for the period of record (Oct. 1999 to Sept. 2005) was 2,231 cfs on Dec. 16, 2002

Period of Record

Staff plate installed 5/12/97. New datalogger and probes installed Nov. 2003. Flow, sediment transport, water quality, and specific conductance measured periodically. Gaging sponsored by Jasper Ridge Biological Preserve.

WY 2005 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.05	0.05	0.44	79.02	6.74	18.57	12.12	1.47	2.27	0.85	0.36	0.29
2	0.05	0.06	0.41	85.98	6.08	58.66	12.87	1.42	2.19	0.81	0.77	0.29
3	0.02	0.15	0.40	71.08	5.56	26.90	24.14	1.36	2.03	0.77	0.26	0.11
4	0.10	0.48	0.37	22.45	5.09	44.35	20.40	1.57	2.02	0.78	0.23	0.08
5	0.10	0.16	0.40	12.37	4.83	26.36	8.57	2.08	1.92	0.69	0.32	0.07
6	0.03	0.12	0.44	8.50	4.61	18.07	9.17	1.48	1.91	0.69	0.19	0.09
7	0.03	0.11	32.77	66.62	4.79	13.77	14.63	1.37	1.92	0.65	0.16	0.24
8	0.01	0.10	120.21	190.49	4.38	11.18	52.38	1.46	1.94	0.62	0.31	0.15
9	0.02	0.13	13.86	89.33	4.13	8.69	31.71	2.73	2.32	0.60	0.23	0.14
10	0.01	0.19	3.71	57.31	3.92	6.83	21.72	1.55	2.02	0.58	0.18	0.05
11	0.05	1.88	2.05	119.39	3.88	6.18	14.59	1.37	1.87	0.54	0.27	0.06
12	0.05	0.73	1.58	36.03	3.66	4.97	8.95	1.32	1.75	0.50	0.18	0.04
13	0.01	0.32	1.34	21.27	3.53	3.84	6.58	1.29	1.63	0.47	0.22	0.02
14	0.02	0.23	1.18	15.26	7.28	3.44	7.02	1.31	1.50	0.45	0.21	0.03
15	0.01	0.20	1.07	11.93	139.96	2.81	5.47	1.29	1.31	0.41	0.25	0.06
16	0.14	0.17	1.00	9.77	82.83	2.03	4.88	1.24	1.40	0.37	0.54	0.06
17	0.51	0.17	0.94	8.43	20.57	1.95	3.56	1.19	1.71	0.40	0.26	0.10
18	0.39	0.18	0.90	7.41	90.35	2.16	2.74	1.59	1.40	0.41	0.24	0.10
19	9.18	0.21	0.88	6.75	69.15	13.24	2.25	8.05	1.39	0.32	0.33	0.07
20	7.18	0.23	0.94	6.32	89.85	16.31	2.01	3.34	1.27	0.34	0.25	0.11
21	0.38	0.25	0.86	5.84	45.60	9.73	1.79	2.16	1.22	0.33	0.17	0.29
22	0.18	0.24	0.83	5.88	27.18	208.06	1.67	1.93	1.20	0.46	0.14	0.12
24	0.33	0.22	0.77	5.97	10.74	83.72	1.63	1.76	1.11	0.32	0.29	0.11
25	0.14	0.22	0.75	5.74	8.76	34.94	1.63	1.83	1.10	0.29	0.33	0.21
26	5.93	0.20	0.84	15.77	7.53	21.97	1.60	1.75	1.09	0.29	0.27	0.09
27	0.61	7.71	16.63	11.58	24.54	63.05	1.49	1.70	1.04	0.33	0.21	0.02
28	0.30	0.93	13.19	33.33	25.24	123.32	3.75	1.57	1.02	0.35	0.19	0.02
29	0.21	0.55	16.27	15.34		102.94	1.74	1.57	1.01	0.33	0.18	0.06
30	0.22	0.46	176.09	10.43		55.06	1.53	1.57	0.92	0.37	0.15	0.12
31	0.10		170.32	8.01		21.54		1.65		0.34	0.20	
MEAN	0.88	0.57	19.38	34.79	26.33	33.82	9.74	1.87	1.57	0.49	0.26	0.11
MAX. DAY	9.18	7.71	176.09	190.49	139.96	208.06	52.38	8.05	2.32	0.85	0.77	0.29
MIN. DAY	0.01	0.05	0.37	5.74	3.53	1.95	1.49	1.19	0.92	0.29	0.14	0.02
cfs days	26.4	16.7	581.4	1043.6	710.8	1014.6	282.6	56.0	45.5	14.7	7.9	3.2
ac-ft	52.3	33.0	1153.3	2070.0	1409.8	2012.5	560.5	111.0	90.2	29.1	15.6	6.4

Monitor's Comments

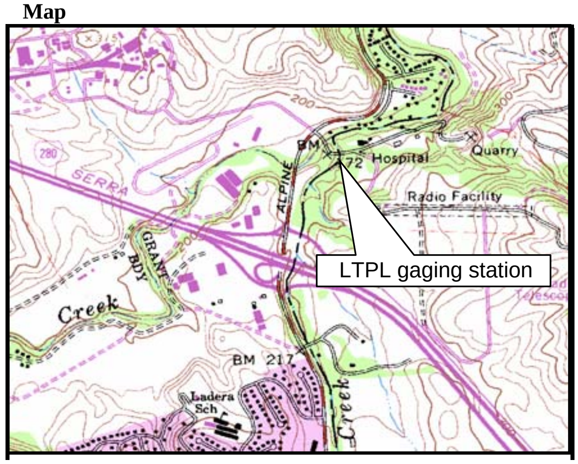
1. We collected a continuous water-level record for the water year.
2. Diversions upstream of the gaging location affect flow in the creek. Also, a small amount of water intermittantly flows into the creek from a ditch on the northwest side of Sand Hill Road (upstream of the gaging station).
3. Multiple stage shifts were applied to the rating equation. Stage shifts adjust for local scour and fill in addition to water-level changes due to algae growth or dams caused by dropped leaf accumulation.
4. Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.

Water Year 2005 Totals:		
Mean annual flow	**10.77**	(cfs)
Max. daily flow	**208**	(cfs)
Min. daily flow	**0.01**	(cfs)
Annual total	**3803**	(cfs-days)
Annual total	**7544**	(ac-ft)

Water Year:	2005	
Stream:	Los Trancos Creek	
Station:	Piers Lane	**LTPL**
County:	San Mateo County, CA	

Form 2. Annual Hydrologic Record

Map



Station Location / Watershed Descriptors

Latitude: 37° 24' 48" N, Longitude: 122° 11' 29" W, in San Mateo County, CA. The gaging station is located under Piers Lane bridge at Los Trancos Creek. Land use includes open space, sports fields, small commercial areas, and low-density residential. There is a water diversion about 1.8 miles upstream. Los Trancos Creek watershed area above gaging station = 7.8 square miles .

Mean Annual Flow

Mean annual flow (MAF) for WY 2005 was 3.56 cfs.
MAF for WY2004 was 2.70 cfs. MAF for WY2003 was 2.63 cfs.

Peak Flows

Date	Time[2] (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
12/30/04	23:30	3.13	146	3/4/05	12:45	2.32	42
1/2/05	21:15	2.68	81	3/22/05	16:00	3.45	189
1/11/05	8:15	3.53	226	3/23/05	9:30	2.67	72
2/15/05	20:00	3.91	278	3/27/05	22:30	2.84	91
2/18/05	**6:00**	**4.33**	**357**	3/29/05	9:15	2.26	39
3/2/05	1:00	2.31	42	4/8/05	12:45	2.26	39

The peak for the period of record (October 2002 to September 2005) was 649 cfs on 12/16/02.

Period of Record

Equipment installed October 2001. Periodic site visits to measure flow, make observations, and collect water quality samples have been made since Feburary 2002. Gaging sponsored by Stanford University Utilities Division.

WY 2005 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.02	0.13	0.25	10.08	2.36	7.98	8.35	*2.73*	1.16	0.51	0.19	0.21
2	0.02	0.12	0.24	22.85	2.33	17.94	7.73	*2.58*	1.10	0.49	0.17	0.19
3	0.02	0.15	0.20	17.92	2.40	9.94	10.22	*2.53*	1.00	0.54	0.18	0.20
4	0.02	0.18	0.23	6.01	2.03	21.66	10.57	*3.22*	1.05	0.51	0.18	0.22
5	0.02	0.12	0.21	4.92	1.56	11.34	7.43	*3.51*	1.08	0.47	0.19	0.23
6	0.02	0.10	0.24	4.38	1.49	8.40	6.73	*2.49*	0.97	0.45	0.19	0.21
7	0.02	0.13	4.00	10.65	1.62	7.55	7.63	*2.29*	0.97	0.43	0.20	0.21
8	0.02	0.13	6.40	16.38	1.49	6.73	13.01	*2.52*	1.06	0.42	0.22	0.21
9	0.02	0.12	0.52	7.78	1.34	6.27	8.83	*3.34*	1.55	0.41	0.21	0.18
10	0.02	0.15	0.28	9.05	1.34	5.86	6.89	*2.03*	1.04	0.48	0.21	0.17
11	0.02	0.63	0.24	47.82	1.51	5.42	6.41	*1.80*	0.93	0.41	0.20	0.16
12	0.02	0.34	0.25	6.13	1.36	5.71	6.00	*1.77*	0.89	0.38	0.18	0.17
13	0.02	0.24	0.27	4.33	1.42	5.20	5.60	*1.85*	0.77	0.33	0.16	0.17
14	0.02	0.21	0.30	3.64	2.81	4.94	4.60	*1.74*	0.78	0.32	0.17	0.16
15	0.02	0.22	0.26	3.43	67.14	4.69	3.74	*1.60*	0.70	0.32	0.23	0.18
16	0.02	0.22	0.21	3.10	28.86	4.64	*3.56*	*1.57*	0.79	0.32	0.20	0.17
17	0.06	0.19	0.22	2.89	6.40	4.36	*3.52*	*1.50*	1.10	0.31	0.18	0.17
18	0.03	0.21	0.23	2.66	66.38	4.45	*3.53*	*1.60*	0.84	0.28	0.17	0.16
19	0.85	0.22	0.21	2.56	14.00	6.39	*3.37*	*3.61*	0.83	0.26	0.17	0.15
20	0.49	0.29	0.18	2.40	13.41	7.60	*3.37*	2.42	0.74	0.27	0.16	0.20
21	0.09	0.45	0.20	2.31	16.60	7.16	*3.40*	2.04	0.74	0.26	0.16	0.20
22	0.08	0.34	0.23	2.30	9.13	55.63	*3.43*	1.82	0.66	0.28	0.17	0.18
23	0.09	0.33	0.20	2.15	5.44	45.61	*3.92*	1.69	0.69	0.26	0.18	0.15
24	0.08	0.34	0.19	2.17	5.35	16.76	*3.53*	1.52	0.64	0.23	0.18	0.16
25	0.07	0.38	0.20	2.15	6.97	10.50	*3.25*	1.36	0.65	0.22	0.18	0.15
26	1.14	0.40	0.24	3.31	7.55	8.97	*3.25*	1.33	0.67	0.22	0.21	0.15
27	0.16	1.85	10.13	2.94	10.38	16.97	*3.40*	1.29	0.65	0.21	0.23	0.15
28	0.15	0.43	3.86	7.80	9.12	25.21	*4.13*	1.22	0.64	0.21	0.21	0.14
29	0.14	0.28	2.79	3.93		20.70	*3.05*	1.22	0.64	0.22	0.21	0.14
30	0.12	0.26	42.52	3.17		12.24	*2.87*	1.25	0.57	0.21	0.20	0.14
31	0.13		32.15	2.76		9.22		1.23		0.19	0.20	
MEAN	0.13	0.30	3.47	7.23	10.42	12.45	5.51	2.02	0.86	0.34	0.19	0.18
MAX. DAY	1.14	1.85	42.52	47.82	67.14	55.63	13.01	3.61	1.55	0.54	0.23	0.23
MIN. DAY	0.02	0.10	0.18	2.15	1.34	4.36	2.87	1.22	0.57	0.19	0.16	0.14
cfs days	4.0	9.1	107.6	224.0	291.8	386.1	165.3	62.7	25.9	10.4	5.9	5.3
ac-ft	8.0	18.1	213.5	444.3	578.7	765.8	327.9	124.3	51.4	20.7	11.7	10.5

Monitor's Comments

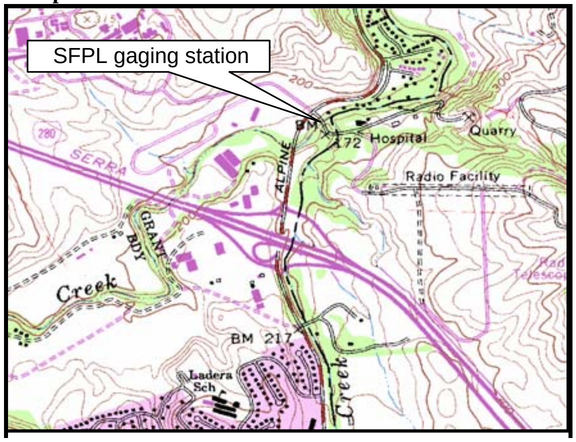
1. We collected a continuous record for the entire water year, except for Apr 16 to May 19.
2. The record shown in italics from April 16 to May 19 was created by correlation and is less reliable than the rest of the record.
3. Multiple stage shifts were applied to the rating equation; stage shifts adjust for local scour or fill and leaf debris build-up
4. The upper portion of the rating curve is based on several high-flow estimates.
5. Daily values with more than 2 to 3 significant figures result from electronic calculations; no additional precision is implied.
6. Stanford operates a surface water diversion and fish ladder, about 1.8 miles upstream of this station, which may divert water out of Los Trancos Creek from December 1 to April 30.

Water Year 2005 Totals to date:		
Mean annual flow	**3.56**	(cfs)
Max. daily flow	**67**	(cfs)
Min. daily flow	**0.02**	(cfs)
Annual total	**1298**	(cfs-days)
Annual total	**2575**	(ac-ft)

Water Year:	2005		
Stream:	San Francisquito Creek		
Station:	Piers Lane	**SFPL**	
County:	San Mateo County, CA		

Form 3. Annual Hydrologic Record

Map



Station Location / Watershed Descriptors

Latitude: 37° 24' 48" N, Longitude: 122° 11' 29" W in San Mateo County, CA. The gaging station is located directly under Piers Lane bridge at San Francisquito Creek, immediately upstream of its confluence with Los Trancos Creek. Land use includes open space, low-density residential, and some commercial uses. The watershed area above gaging station = 29.9 square miles.

Mean Annual Flow

Mean annual flow (MAF) for WY 2005 was 24.35 cfs.
MAF for WY2004 was 11.02 cfs; MAF for WY2003 was 15.40 cfs

Peak Flows

Date	Time[2] (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
12/8/04	8:30	6.56	375	1/11/05	9:15	7.07	547
12/30/04	**23:45**	**7.75**	**747**	**2/15/05**	**21:00**	**7.77**	**749**
12/31/04	21:30	6.53	393	2/18/05	7:15	6.67	375
1/3/05	1:00	6.64	422	**3/22/05**	**18:00**	**7.69**	**741**
1/8/05	22:15	6.78	462	3/27/05	23:00	7.03	532

The peak for the period of record (October 2002 to September 2005) was 2706 cfs, on 12/16/02.

Period of Record

Equipment installed October 2001. Periodic site visits to measure flow, make observations, and collect water quaility samples have been made since Feburary 2002. Gaging sponsored by Stanford University Utilities Division.

WY 2005 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.15	0.42	0.77	174.04	16.43	29.31	47.22	10.16	3.28	1.45	0.54	0.23
2	0.15	0.42	0.75	153.70	14.09	110.23	42.42	8.93	3.20	1.23	0.74	0.29
3	0.14	0.44	0.71	198.63	12.57	50.60	55.19	8.71	2.84	1.05	0.74	0.28
4	0.14	0.76	0.72	55.88	11.45	88.38	72.50	10.93	2.73	1.17	0.52	0.22
5	0.12	0.71	0.73	35.24	10.78	53.46	38.59	18.20	2.56	1.03	0.48	0.20
6	0.11	0.56	0.81	26.09	10.51	40.01	35.22	11.25	2.71	1.05	0.63	0.21
7	0.08	0.53	34.83	82.84	10.81	33.76	42.33	9.17	2.76	0.98	0.46	0.20
8	0.09	0.53	143.46	318.66	10.16	29.73	115.10	10.46	3.16	0.99	0.44	0.24
9	0.08	0.53	45.65	164.93	9.09	25.81	81.50	17.71	4.87	0.96	0.60	0.21
10	0.08	0.61	15.20	90.60	8.37	22.69	52.62	10.76	3.93	1.07	0.50	0.21
11	0.06	3.44	6.94	320.76	8.55	20.70	41.44	8.35	3.21	1.10	0.48	0.17
12	0.05	2.17	4.75	94.17	8.33	19.07	33.41	7.32	2.49	1.11	0.50	0.15
13	0.05	0.94	3.60	49.93	8.02	15.98	28.14	6.55	2.29	0.91	0.41	0.15
14	0.05	0.72	2.73	36.13	13.56	14.20	27.47	6.21	2.18	0.84	0.42	0.12
15	0.05	0.68	2.32	29.93	299.40	12.37	24.13	6.30	1.83	0.82	0.45	0.12
16	0.05	0.65	2.08	25.42	231.34	10.64	22.61	5.41	2.54	0.76	0.53	0.14
17	0.62	0.66	1.85	22.46	46.99	10.31	19.83	5.40	4.17	0.78	0.63	0.14
18	0.32	0.65	1.73	20.19	220.63	12.71	17.35	6.10	3.35	0.78	0.44	0.13
19	11.66	0.68	1.55	18.04	128.44	29.47	15.42	29.26	2.69	0.72	0.39	0.15
20	10.70	0.72	1.55	16.60	191.32	32.58	14.23	17.11	2.42	0.65	0.44	0.22
21	1.06	0.67	1.68	14.89	93.14	24.98	12.71	8.90	2.15	0.69	0.38	0.23
22	0.60	0.68	1.53	13.65	51.54	339.05	13.02	6.47	2.08	0.60	0.35	0.20
23	0.59	0.71	1.33	13.89	34.98	509.47	13.01	5.29	1.91	0.71	0.34	0.17
24	0.66	0.78	1.24	13.08	27.50	160.87	11.10	4.58	2.54	0.59	0.33	0.15
25	0.60	0.79	1.13	12.63	23.10	70.88	9.74	4.31	2.51	0.58	0.33	0.15
26	10.57	0.83	1.14	25.73	20.08	49.92	9.32	3.82	2.53	0.54	0.31	0.24
27	1.36	11.82	46.41	23.95	31.88	88.50	9.26	3.54	2.39	0.53	0.29	0.19
28	0.73	2.11	63.09	55.68	51.29	256.85	22.43	3.44	2.33	0.57	0.27	0.14
29	0.57	0.98	28.49	35.02		200.73	14.59	3.12	2.18	0.61	0.24	0.14
30	0.53	0.83	328.40	24.38		122.66	11.66	2.98	1.84	0.55	0.22	0.12
31	0.54		374.75	19.62		64.29		2.99		0.56	0.22	
MEAN	1.37	1.23	36.19	70.54	57.30	82.27	31.79	8.51	2.72	0.84	0.44	0.18
MAX. DAY	11.66	11.82	374.75	320.76	299.40	509.47	115.10	29.26	4.87	1.45	0.74	0.29
MIN. DAY	0.05	0.42	0.71	12.63	8.02	10.31	9.26	2.98	1.83	0.53	0.22	0.12
cfs days	42.6	37.0	1121.9	2186.8	1604.4	2550.2	953.6	263.7	81.7	25.9	13.6	5.5
ac-ft	84.4	73.5	2225.4	4337.4	3182.3	5058.4	1891.4	523.1	162.0	51.4	27.0	10.9

Monitor's Comments

1. We collected a continuous record for the entire water year.
2. Three peak flows are bolded above, signifying that three peaks occurred during the year that were of a very similar magnitude. Multiple other flow peaks occurred that were smaller than those specified above.
3. Multiple stage shifts were applied to the rating equation; stage shifts adjust for local scour or fill.
4. Daily values with more than 2 to 3 significant figures result from electronic calculations; no additional precision is implied.
5. Flow is regulated by multiple diversions and an upstream lake (Searsville Lake).

Water Year 2005 Totals to date:		
Mean annual flow	**24.35**	(cfs)
Max. daily flow	**509**	(cfs)
Min. daily flow	**0.05**	(cfs)
Annual total	**8887**	(cfs-days)
Annual total	**17627**	(ac-ft)

Form 4. Annual Sediment-Discharge Record, Bear Creek at Sand Hill Road, water year 2005

Water Year:	**2005**	
Stream:	Bear Creek	**BCSH**
Station:	at Sand Hill Road	
County:	San Mateo County, CA	

Total annual sediment discharge (suspended- plus bedload-sediment discharge)		
WY 2005:	**2,559**	***tons***

WY 2005 Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	37.5	0.2	2.8	0.7	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	54.6	0.2	22.7	0.9	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	31.0	0.2	4.1	4.9	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	2.6	0.1	10.5	2.5	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.8	0.1	3.5	0.4	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.4	0.1	1.7	0.4	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	14.1	38.1	0.1	1.0	1.2	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	101.7	200.1	0.1	0.6	26.6	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	1.3	46.7	0.1	0.4	5.1	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.1	29.5	0.1	0.2	2.4	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	81.6	0.1	0.2	1.1	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	6.8	0.1	0.1	0.4	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	2.3	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	1.2	0.5	0.1	0.2	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.7	154.5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.5	47.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.4	2.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.3	48.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	2.0	0.0	0.0	0.2	30.4	1.8	0.0	0.3	0.0	0.0	0.0	0.0	
20	1.2	0.0	0.0	0.2	43.8	3.1	0.0	0.1	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.2	10.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.2	3.8	299.7	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.2	1.5	365.3	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.2	0.6	38.8	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.2	0.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.7	0.0	0.0	1.7	0.3	2.4	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	1.2	2.0	0.8	10.6	62.5	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	1.1	6.0	3.9	87.1	0.1	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	6.6	1.2		58.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	214.4	0.6		16.3	0.0	0.0	0.0	0.0	0.0	0.0	**Qss**
31	0.0		164.8	0.3		2.4		0.0		0.0	0.0		**Annual**
TOTAL	4	1	506	547	361	993	48	1	0	0	0	0	**2,460**
Max.day	2	1	214	200	154	365	27	0	0	0	0	0	**365**

WY 2005 Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	1.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	2.2	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	1.2	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.1	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.6	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	4.1	8.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.1	1.9	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	1.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.1	0.0	0.0	0.0	1.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	1.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.0	0.2	12.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.0	0.1	14.6	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.1	0.0	0.4	2.5	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.2	0.2	3.5	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.3	0.0		2.3	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	8.6	0.0		0.7	0.0	0.0	0.0	0.0	0.0	0.0	**Qbed**
31	0.0		6.6	0.0		0.1		0.0		0.0	0.0		**Annual**
TOTAL	0	0	20	22	14	40	2	0	0	0	0	0	**98**
Max.day	0	0	9	8	6	15	1	0	0	0	0	0	**15**

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Multiple sediment-discharge rating curves were used for different periods of the year and ranges of flow.
Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.

Form 5. Annual Sediment-Discharge Record, Los Trancos Creek at Piers Lane, water year 2005

Water Year: **2005**
Stream: Los Trancos
Station: at Piers Lane **LTPL**
County: San Mateo County, CA

Total annual sediment discharge		
(suspended- plus bedload-sediment discharge)		
WY 2005:	**1,509**	***tons***

WY 2005 Daily Suspended-Sediment Discharge*(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	3.2	0.1	1.9	1.8	0.2	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	28.8	0.1	10.0	1.5	0.2	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	12.8	0.1	2.8	3.3	0.2	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.9	0.1	13.0	3.0	0.3	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.6	0.1	3.3	1.4	0.3	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.5	0.1	1.8	1.1	0.2	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.9	3.3	0.1	1.4	1.5	0.1	0.0	0.0	0.0	0.0	
8	0.0	0.0	1.3	7.2	0.1	1.2	5.8	0.2	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	1.6	0.0	1.0	2.0	0.3	0.1	0.0	0.0	0.0	
10	0.0	0.0	0.0	3.1	0.0	0.9	1.2	0.1	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	136.3	0.1	0.8	1.0	0.1	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	1.0	0.0	0.8	0.9	0.1	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.5	0.1	0.7	0.8	0.1	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.3	0.3	0.6	0.6	0.1	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.3	310.6	0.6	0.4	0.1	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.2	51.1	0.5	0.3	0.1	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.2	1.1	0.5	0.3	0.1	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.2	345.6	0.5	0.3	0.1	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.2	6.0	1.1	0.3	0.3	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.1	4.9	1.5	0.3	0.2	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.1	7.1	1.5	0.3	0.1	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.1	2.4	123.8	0.3	0.1	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.1	0.7	59.2	0.4	0.1	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.1	0.7	7.2	0.3	0.1	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.1	1.2	2.8	0.3	0.0	0.0	0.0	0.0	0.0	
26	0.1	0.0	0.0	0.3	1.4	2.0	0.3	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.2	4.4	0.2	4.3	16.5	0.3	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.4	1.6	2.2	19.7	0.4	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.4	0.4		12.0	0.2	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	87.4	0.3		3.9	0.2	0.0	0.0	0.0	0.0	0.0	**Qss**
31	0.0		52.1	0.2		2.2		0.0		0.0	0.0		**Annual**
TOTAL	0.1	0.2	146.9	204.9	740.7	295.6	30.7	3.6	0.6	0.1	0.0	0.0	**1,424**
Max.day	0.1	0.2	87.4	136.3	345.6	123.8	5.8	0.3	0.1	0.0	0.0	0.0	**346**

Daily Bedload-Sediment Discharge*(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	0.2	0.0	0.6	0.1	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	1.7	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.8	0.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.1	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.1	0.2	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.1	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	8.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	20.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.0	0.4	7.4	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.0	0.1	3.5	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.0	0.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.3	0.0	0.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.1	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	5.2	0.0		0.1	0.0	0.0	0.0	0.0	0.0	0.0	**Qbed**
31	0.0		3.1	0.0		0.1		0.0		0.0	0.0		**Annual**
TOTAL	0.0	0.0	8.8	12.3	44.6	17.7	1.7	0.2	0.0	0.0	0.0	0.0	**85**
Max.day	0.0	0.0	5.2	8.2	20.7	7.4	0.3	0.0	0.0	0.0	0.0	0.0	**21**

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Daily values with more than 2 significant figures result from electronic calculations. No additional precision is implied.

Form 6. Annual Sediment-Discharge Record, San Francisquito Creek at Piers Lane, water year 2005

Water Year: **2005**
Stream: San Francisquito Creek
Station: at Piers Lane **SFPL**
County: San Mateo County, CA

WY 2005 Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	172.3	1.4	4.5	11.3	0.5	0.1	0.0	0.0	0.0	
2	0.0	0.0	0.0	183.5	1.0	69.9	9.1	0.4	0.1	0.0	0.0	0.0	
3	0.0	0.0	0.0	247.7	0.8	13.0	18.9	0.4	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	16.2	0.7	39.8	28.7	0.7	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	6.3	0.6	14.6	7.5	1.7	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	3.4	0.6	8.1	6.2	0.7	0.0	0.0	0.0	0.0	
7	0.0	0.0	14.7	52.1	0.6	5.7	9.1	0.4	0.0	0.0	0.0	0.0	
8	0.0	0.0	141.1	540.1	0.5	4.4	97.9	0.6	0.1	0.0	0.0	0.0	
9	0.0	0.0	12.8	158.7	0.4	3.4	34.8	1.6	0.1	0.0	0.0	0.0	
10	0.0	0.0	1.2	65.0	0.4	2.6	14.1	0.6	0.1	0.0	0.0	0.0	
11	0.0	0.1	0.3	569.9	0.4	2.2	8.7	0.4	0.1	0.0	0.0	0.0	
12	0.0	0.0	0.1	47.4	0.4	1.8	5.7	0.3	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.1	12.7	0.3	1.3	4.0	0.2	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	6.6	1.3	1.0	3.8	0.2	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	4.5	768.7	0.8	2.9	0.2	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	3.2	418.6	0.6	2.6	0.2	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	2.5	11.2	0.5	2.0	0.1	0.1	0.0	0.0	0.0	
18	0.0	0.0	0.0	2.0	295.8	0.8	1.5	0.2	0.1	0.0	0.0	0.0	
19	1.7	0.0	0.0	1.6	93.8	5.3	1.2	4.5	0.0	0.0	0.0	0.0	
20	1.1	0.0	0.0	1.4	202.3	6.3	1.0	1.6	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	1.1	44.6	3.5	0.8	0.4	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.9	13.6	894.1	0.9	0.2	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	1.0	6.2	1379.8	0.9	0.1	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.9	3.8	143.5	0.6	0.1	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.8	2.7	25.9	0.5	0.1	0.0	0.0	0.0	0.0	
26	1.1	0.0	0.0	3.9	2.0	12.5	0.4	0.1	0.0	0.0	0.0	0.0	
27	0.0	1.6	19.1	2.9	11.3	100.9	0.4	0.1	0.0	0.0	0.0	0.0	
28	0.0	0.0	22.7	15.8	15.7	377.3	2.7	0.1	0.0	0.0	0.0	0.0	
29	0.0	0.0	4.2	6.3		222.0	1.1	0.1	0.0	0.0	0.0	0.0	
30	0.0	0.0	628.0	3.0		80.0	0.7	0.0	0.0	0.0	0.0	0.0	**Qss**
31	0.0		831.9	1.9		21.2		0.0		0.0	0.0		**Annual**
TOTAL	3.9	1.8	1676.4	2135.8	1899.6	3447.3	280.2	16.8	1.3	0.1	0.0	0.0	**9,463**
Max.day	1.7	1.6	831.9	569.9	768.7	1379.8	97.9	4.5	0.1	0.0	0.0	0.0	**1,380**

Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1													
2													
3													
4													
5	Daily Bedload Discharge was not measured or calculated												
6													
7													
8													
9													
10	Daily Bedload Discharge was not measured or calculated												
11													
12													
13													
14													
15	Daily Bedload Discharge was not measured or calculated												
16													
17													
18													
19													
20	Daily Bedload Discharge was not measured or calculated												
21													
22													
23													
24													
25	Daily Bedload Discharge was not measured or calculated												
26													
27													
28													
29													
30													**Qbed**
31	Daily Bedload Discharge was not measured or calculated												**Annual**
TOTAL	...	...	...	...	...	...	...	...	...	...	...	...	**...**
Max.day	...	...	...	...	...	...	...	...	...	...	...	...	**...**

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Daily values with more than 2 significant figures result from electronic calculations. No additional precision is implied.

TABLES

Table 1. Station Observer Log
Bear Creek at Sand Hill Road, water year 2005

Site Conditions				Streamflow				Water Quality Observations							High-Water Marks		Remarks
Date/Time	Observer	Stage	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	pH	Dissolved Oxygen	Dissolved Oxygen	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		(feet)	'R/F/S/B)	(cfs)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(pH)	(mg/L)	(% sat.)	(Qbed, etc.)	(feet)	(mm/dd/yr)	
10/5/04 11:11	jg	1.065	B	0.12	…	PY	g	14.3	530	678	7.8	7.3	72%	…	…	…	leaves on cobble bars above water line, smell of dead animal
10/17/04 14:15	cw, bjm, aa	1.16	B	…	0.09	visual	p	16.4	414	495	…	8.6	88%	…	…	…	program sampler to collect "first flush"; removed recently shot (dead) deer from channel upstream
10/18/04 19:20	cw, aa	1.06	F	…	…	…	…	14.5	454	567	…	…	…	…	…	…	discard original composite sample, reprogrammed sampler
10/19/04 12:14	cw, aa	2.52	F	…	…	…	…	14.2	226	283	7.5	9.3	91%	WQ	…	…	collected ammonia and mercury grab samples; start composite sampler (failed to start 10/18); rain earlier & rain started again while at site
10/20/04 15:55	cw	1.30	F	…	…	…	…	13.3	266	342	…	…	…		2.05	recent	composite bottle retrieved and partitioned
11/22/04 12:30	jg	1.09	B	0.26	…	PY	f	…	…	…	…	…	…	…	…		gate open, small tracked vehicle crossed stream at ford & plowed dirt on bank
12/6/04 13:47	jo	1.08	B	…	0.4	visual	p	6.8	466	730	7.9	11.0	90%	…	2	Nov. 2004	water clear, brown algae on rocks, cleaned WQ probes, programmed sampler for impending rain
12/7/04 6:55	jo, gg	2.45	F	…	43.5	visual	p	10.3	194	276	7.6	10.7	97%	WQ, Qss	3.25	this AM	collected ammonia and mercury grab samples; light rain, water turbid, Qss at 6:30, just a trace of bedload
12/7/04 12:01	jo, gg	1.71	F	…	…	…	…	10.1	274	392	7.8	11.0	98%		…	…	water down from AM levels, retrieved composite sample, bottle ~3/4 full
12/24/04 12:45	jo	1.13	B	0.80	…	PY	g,f	6.3	444	705	8.0	11.3	92%	…	3.1	12/8/2004	water clear, evidence of bedload movement from last storm
12/27/04 10:22	jo, cw	1.93	R	…	…	…	…	9.6	395	573	7.9	10.5	92%	Qss	…	…	raining, no bedload moving
12/29/04 18:30	cw, bjm	…		…	…	…	…	9.5	339	493	…	…	…	…	…	…	programmed automated sampler
12/30/04 10:06	bjm, aa	3.04	F	…	93.8	floats	p	10.0	177	254	…	…	…	WQ, Qss	4.04	today	collected ammonia and mercury grab samples;
12/31/04 16:20	cw	2.46	F, R	…	89.6	floats	p	10.2	197	281	…	11.9	100%	Qss	3.8	recent	retrieved composite sample; between showers at start, Qss at 16:35, downpour at end
1/6/05 14:10	jo	1.50	F, B	8.39	7.0	AA	g	9.5	354	515	7.9	10.9	96%	…	5.5	Dec.30,31	water slightly turbid, most leaves appear to have flushed-out
2/9/05 10:00	bkh	1.28	B	4.19	2.5	PY	g	9.6	456	662	…	…	…	…	1.51	January?	water clear, light showers on 2/7/05
2/15/05 15:50	jo	3.5	F	…	…	…	…	…	…	…	…	…	…	Qss	…	…	water brown and fully opaque, some floating debris
3/4/05 10:00	sb, bkh	2.33	F	52.8	…	AA	g	11.4	295	408	8.1	11.1		Qss	5.3, 3.3	12/30, 3/4	rain overnight and this morning, tested for bedload but found none moving
3/18/05 10:45	jo	1.24	R	…	2	visual	p	11.7	487	668	…	…	…	…	…	…	programmed automated sampler, light rain, creek is slightly turbid (1" visibility)
3/21/05 15:20	bjm	…		…	10	visual	p	…	…	…	…	…	…	…	…	…	water slightly turbid, discarded previous composite sample and reprogrammed sampler
3/22/05 11:50	cw, aa	2.6	R	…	…	…	…	12.4	225	303	7.7	10.8	100%	WQ, Qss, Qbed	…	…	collected ammonia and mercury grab samples;
3/22/05 16:55	cw, aa	5.15	R	…	…	…	…	11.6	126	173	7.3	10.7	99%	Qss	…	…	retrieved composite sample, woody debris downstream
4/1/05 10:30	sb, bkh	1.66	F, B	15.7	…	PY	g	10.9	310	434	8.0	11.4	100%	Qss	4.7, 3.6	3/22, 3/27	water slightly cloudy, cleaned WQ probes, removed old datalogger
5/17/05 10:00	jg	1.125	B	1.22	1.3	PY	e	14.0	407	525	8.0	8.2	80%	…	…	…	experiment blocks in creek, thin algae on sand bed of creek
5/19/05 12:10	jo, jg	1.58	F	…	4.0	visual	p	15	344	432	8.0	10.1	100%	Qss	…	…	creek turbid, rain overnight and this AM, cleaned probes and rain gauge
6/28/05 12:00	jg	1.125	B	1.08	…	PY	g	15.4	515	640	8.2	7.3	73%	…	…	…	filamentous algae growing at gate and riffle downstream of gage, water clear
8/18/05 18:45	jo	1.01	B	0.29	…	PY	f,g	18.8	603	688	8.0	6.8	75%	…	…	…	water clear; many 1-3-inch fish in pool d/s of gate, gate closed
9/7/05 11:44	jo, zr	1.09	B	0.32	…	PY	f,g	15.8	563	693	7.9	6.7	69%	…	…	…	water clear, brown tint from algae on bed, many 1" fish in shallows, cleaned DO probe in stilling well others looked clean, leaf dam 3' d/s of flow msmt. site - seemed to stay intact during measurement, programmed sampler
9/8/05 14:00	cw, zr	1.03	B		0.03	visual	p	16.2	554	675	8.0	6.4	65%	WQ	…	…	collected ammonia and mercury grab samples; creek clear- no TSS taken, retrieved composite sample
9/21/05 10:20	jg, zr	1.1	B					14.9	555	699	7.8	7.8	77%	…	…	…	installed new staff plate on stilling well near gate---d/s but in same pool as old staff plate---no change in reading; moved ph/do/sc container a few inches to make room for staff plate, removed old PVC by tree, left old staff plate in place
10/17/05 16:00	jg, zr	1.1	B	0.06		flume	p	14.4	575	734	7.9	…	…	…	…	…	cleaned dissolved oxygen probe at 15:45, gate still closed, flow taken with 8" Cutthroat flume

Notes:
Observer Key: aa is Anne Ardillo, jo is Jonathan Owens, jg is John Gartner, cw is Chris White, bkh is Brian Hastings, bjm is Bonnie Mallory, sb is Scott Brown, gg is Greg Guensch, zr is Zan Rubin
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B), or diversion underway (D)
Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (V).
Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy given
High-water mark (HWM): Measured or estimated at location of the staff plate
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25°C by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance
Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, WQ = collect ammonia and mercury grab samples while composite sampling for water quality suite; other symbols as appropriate

Table 2. Station observer log: Los Trancos Creek at Piers Lane, water year 2005

Site Conditions				*Streamflow*				*Water Quality Observations*							*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	pH	Dissolved Oxygen	Dissolved Oxygen	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(R/F/S/B)*	*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(°C)*	*(µmhos/cm)*	*(at 25 °C)*	*(pH)*	*(mg/L)*	*(% sat.)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
10/5/04 15:40	jg	0.84	B	0.017	…	PY	f	16.5	1676	2026	8.1	6.8	71%	…	…	…	small leaf dam downstream of staff plate
10/17/04 11:55	cw, bjm	0.085	B	…	0.03	visual	p	15.4	1624	2020	8.3	7.1	67%	…	…	…	programmed sampler
10/18/04 16:35	cw, aa	0.84	B	…	0.02	visual	p	15.1	1257	1575	…	…	…	WQ	1.03	…	water clear, discarded previous sample; reprogrammed sampler
10/19/04 14:37	cw	1.44	F	4.2	…	float	p	15.5	841	1043	7.8	9.6	96%	WQ, Qss	…	…	collected ammonia and mercury grab samples; stage rising & falling, rain earlier
10/20/04 11:45	cw	1.08	F	…	…	…	…	13.8	782	1014	…	…	…	…	…	…	water is tea-colored
10/20/04 14:25	cw	1.00	F	…	0.2	visual	p	14.6	845	1073	…	…	…		1.38	unsure	retrieved composite sample
11/12/04 9:23	bjm	0.97	F	0.38	…	PY	g	13.0	990	1311	8.1	…	…	…	2.15	11/11/05	download data
12/6/04 15:06	jo	0.90	R	…	0.19	visual	f	9.1	1078	1586	8.0	11.0	96%	…	…	…	cleaned leaves/debris from intake, collected data, programmed sampler
12/7/04 7:43	jo, gg	1.69	F	…	9.98	visual	f	10.4	383	544	7.9	10.7	96%	Qss	…	…	tested for Qbed, very few grains of bedload transport
12/7/04 13:54	jo, gg	1.14	F	…	2.4	visual	f	11.0	521	728	…	10.4	95%	WQ, Qss	…	…	water sl. turbid/brown but can see bottom; collected ammonia and mercury grab samples; retrieved composite sample
12/24/04 16:18	jo	0.90	B	0.181	…	AA	f	8.4	1000	1499	8.2	11.7	100%	…	…	…	water clear, additional rockfall on right bank downstream from bridge
12/27/04 8:55	jo, cw	1.57	R	…	…	…	…	10.4	379	538	…	…	…	Qss	…	…	raining, water turbid but translucent brown
12/27/04 12:31	jo, cw	1.85	R	…	20.2	visual	p	10.4	343	487	7.9	10.7	96%	Qss	…	…	tested for Qbed, just a few grains; more turbid than AM visit
12/29/04 19:40	cw, bjm	0.98	F	…	…	…	…	10.3	910	1296	…	…	…	…	…	…	programmed sampler
12/30/04 11:50	bjm, aa	1.97	F	29.21	…	AA	g	9.9	244	351	8.0	11.9	100%	WQ, Qss	…	…	collected ammonia and mercury grab samples; no bedload transport, water slightly brown and turbid
12/31/04 19:05	cw	1.35	R	…	…	…	…	10.7	602	848	7.7?	11.2	100%	Qss	4.29	…	retrieved composite sample, coarse sediment at bottom of bottle
1/13/05 17:00	jg	1.32	B	…	…	…	…	9.1	574	844	7.4	11.5	100%	…	4.0	…	download data, getting dark
2/9/05 14:30	bkh	1.075	B	1.3	…	PY	g	11.8	782	1070	…	…	…	…	5.5	12/30/04	water clear, channel clear of large woody debris
2/15/05 14:08	jg	1.92	R	…	29.8	visual	p	…	…	…	…	…	…	Qss, Qbed	…	…	water turbid, brown
2/17/05 13:27	bkh	1.42	F	6.05	…	PY	g	12.3	605	817	8.3	10.6	…	Qss	4.2	2/15/05	water only slightly turbid
2/21/05 10:30	bkh	1.74	F	…	12	visual	p	…	…	…	…	…	…	…	…	…	water turbid, download data
3/4/05 13:00	sb, bkh	2.31	F	39	…	AA	f	12.6	297	398	8.2	10.7	100%	Qbed, Qss	4.4	3/5/05	bedload measurement difficult due to cobbly bed
3/10/05 11:00	jg	1.45	B	6.32	…	PY	g	12.7	594	793	…	10.3	98%	…	…	…	water very slightly turbid, no bedload
3/18/05 11:27	jo	1.36	R	…	3.8	visual	p	12.4	598	805	…	…	…	…	…	…	light rain this morning, water slightly turbid, boulders on bed moved around by people, programmed sampler
3/21/05 18:55	cw	1.44	F	…	…	…	…	13.1	592	782	8.2	10.3	98%	…	…	…	light rain, discarded previous sample and reprogrammed sampler
3/22/05 13:30	cw, aa	2.21	R	…	…	…	…	13.0	377	499	8.1	10.2	97%	WQ, Qbed, Qss	…	…	water rising; collected ammonia and mercury grab samples
3/22/05 18:05	cw, aa	3	F	…	76.6	float	p	12.1	189	256	7.9	10.7	100%	Qss, WQ	…	…	retrieved composite sample
4/1/05 15:05	sb, bkh	1.53	R	8.88	…	AA	g	13.5	557	728	8.4	10.3	99%	Qss	5.6	3/22/05	water clear
5/17/05 15:00	jg	1.17	B	1.86	…	PY	g	14.1	686	883	8.4	10.3	98%	…	…	…	water clear, trees fully leafed out, download data
5/19/05 13:30	jo, jg	1.37	B	…	1.1	visual	f	15.5	618	767	8.3	10.2	100%	…	…	…	download data
6/28/05 18:15	jg	1.03	B	0.599	…	PY	g	17.5	926	1091	7.9	8.3	88%	…	…	…	water clear, some leaves in riffle may cause stage shift
8/18/05 17:28	jo	0.953	B	0.172	…	PY	g	19.5	1305	1462	8.4	8.8	96%	…	…	…	water clear, brown algae coating bed, many leaves and twigs on rock dam
9/7/05 13:46	jo, zr	1.02	B	0.19	…	PY	g	17.2	1189	1412	8.4	9.7	101%	…	…	…	programmed sampler; water clear, eucalyptus leaves in water, cleaned intake. Base of rod loose, so depth measurements may all be 0.01 too deep.
9/8/05 17:07	cw, zr	0.82	B	…	0.06	visual	p	17.4	1220	1441	8.2	7.8	82%	WQ	…	…	collected ammonia and mercury grab samples; retrieved composite sample, cleared leaf dam d/s staff plate at 15:50. Water clear.
9/14/05 10:55	jg, zr	0.85	B	…	0.18	visual	p	13.0	1160	1537	7.3	8.5	89%	…	…	…	changed battery, some leaves dammed in controlling riffle

Observer Key: aa is Anne Ardillo, jo is Jonathan Owens, jg is John Gartner, cw is Chris White, bkh is Brian Hastings, bjm is Bonnie Mallory, sb is Scott Brown, gg is Greg Guensch, zr is Zan Rubin

Stage: Water level observed at outside staff plate

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B), or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (vis. est.).

Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) = +/- > 9%

High-water mark (HWM): Measured or estimated at location of the staff plate

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25°C by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, WQ = collect ammonia and mercury grab samples while composite sampling for water quality suite; other symbols as appropriate

Table 3. Station observer log: San Francisquito Creek at Piers Lane, water year 2005

Site Conditions				Streamflow				Water Quality Observations							High-Water Marks		Remarks
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	pH	Dissolved Oxygen	Dissolved Oxygen	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		(feet)	(R/F/S/B)	(cfs)	(cfs)	(AA/PY)	(e/g/f/p)	(°C)	(μmhos/cm)	(us@25°C)	(pH)	(mg/L)	(% sat.)	(Qbed, etc.)	(feet)	(mm/dd/yr)	
10/5/04 16:32	jg	3.27	B	0.12	…	float	p	15.1	1107	1387	7.3	5.4	54%	…	…	…	difficult to measure flow through rocks
10/17/04 12:30	cw,	3.27	B	…	…	…	…	15.1	1025	1285	8.0	7.1	71%	…	…	…	programmed sampler to collect "first flush";
10/18/04 17:05	cw, aa	3.47	F	…	0.1	visual	p	15.3	904	1127	…	…	…		…	…	discard previous composite sample and reprogram sampler; tea-colored water
10/19/04 15:42	cw, aa	4.39	F	…	…	…	…	14.6	491	624	7.6	8.9	84%	WQ, Qss	…	…	collected ammonia and mercury grab samples;
10/20/04 11:30	cw	3.90	F	…	…	…	…	13.8	407	528	…	…	…	…	…	…	retrieve composite sample
11/12/04 11:00	bjm	3.58	F	1.88	…	PY	g	12.7	615	821	8.1	8.0	74%	…	…	…	download data, water turbid with orange tint
12/6/04 15:15	jo	3.44	R	…	…	…	…	7.1	654	1016	7.6	9.1	77%	…	…	…	water clear, impending rain, programmed sampler
12/7/04 8:05	jo, gg	5.13	F	…	…	…	…	10.1	211	302	7.5	10.2	91%	WQ, Qss	5.63	12/7/05	collected ammonia and mercury grab samples; water greyish-brown and opaque, some foam
12/7/05 13:05	jo, gg	4.24	F	…	18.75	visual	f	10.5	257	364	7.9	10.5	94%	Qss	…	…	water opaque, light brown, retrieved composite sample
12/24/04 15:52	jo	3.51	B	1.33	…	AA	f	6.9	574	896	8.0	10.7	91%	…	6.5	12/8/04	water clearer than usual; some white foam on surface
12/27/04 9:05	jo, cw	4.21	R	…	…	…	…	9.3	457	669	…	…	…	Qss	…	…	raining, water smells slightly of sewage or decay; water brown and opaque
12/27/04 12:45	jo, cw	4.75	R	…	…	…	…	9.4	439	641	8.0	10.4	91%	Qss	…	…	water brown and turbid but does not appear to be as muddy as Los Trancos Cr.
12/29/04 19:15	cw, bjm	4.24	F	…	…	…	…	9.1	406	597	…	…	…	…	…	…	programmed sampler
12/30/04 11:10	bjm, aa	6.35	F	…	…	…	…	9.6	321	466	7.7	11.7	100%	WQ, Qss	14.35	unsure	water slightly turbid and brown, too deep to wade, collected ammonia and mercury grab samples
12/31/04 18:00	cw	5.50	R	…	…	…	…	10.1	255	365	7.1	11.0	98%	Qss	…	…	retrieved composite sample, too deep to wade
1/13/05 17:30	jg	…	B	…	…	…	…	8.5	323	483	7.4	11.3	95%	…	…	…	download data, dark and difficult to see staff plate
2/9/04 15:00	bkh	3.84	B	8.44	…	…	g	10.2	563	804	…	…	…	…	6.7	12/?/04	water clear to slightly cloudy
2/15/05 14:17	jo	5.85	R	…	…	…	…	…	…	…	…	…	…	Qss	…	…	water brown and murky, too deep to wade
2/17/05 14:17	bkh	4.75	F	41.5	…	…	g	12.0	341	464	8.1	10.2	94%	Qss	7	2/15/05	water v. turbid, difficult to determine HWM at staff plate under bridge, easier upstream
2/21/05 10:35	bkh	5.32	F	…	45	visual	p	…	…	…	…	…	…	…	…	…	download data, rain previous night
3/4/05 13:20	bkh, sb	5.25	F	…	120	visual	f	12.0	385	524	8.1	10.5	97%	Qss	…	…	water just barely too deep to wade
3/10/05 10:15	jg	4.27	B	…	…	…	…	13.4	510	668	…	9.4	92%	…	…	….	water clear, no bedload transport
3/18/05 11:40	jo	4.10	R	…	12.8	visual	p	12.8	730	972	…	…	…	…	…	…	light rain earlier this morning, programmed sampler
3/21/05 19:07	cw	4.21	F	…	…	…	…	13.2	557	734	8.1	9.2	87%		…	…	discarded previous sample, reprogrammed sampler
3/22/05 13:45	cw	5.67	R	…	…	…	…	12.9	370	491	7.9	9.7	92%	WQ	…	…	collected ammonia and mercury grab samples; retrieved composite sample, woody debris d/s gage
4/1/05 14:20	bkh, sb	4.63	F	45.5	…	AA	g	12.8	413	550	8.1	10.3	97%	Qss	7.2	3/22/05	turbid, stage high for this time of year
5/17/05 15:00	jg	3.80	B	5.30	…	PY	f	16.0	725	888	7.4	8.2	80%	…	…	…	water clear, trees fully leafed out
5/19/05 13:45	jo, jg	5.55	B	…	…	…	…	17.0	545	650	8.3	8.4	87%	…	…	…	overnight rain, creek up;clear but turbidity > than Los Trancos, serviced rain gage
6/28/05 17:45	jg	3.63	B	2.90	…	PY	f	19.5	794	890	8.0	8.3	93%	…	…	…	water clear; some algae growth on rocks
8/18/05 17:00	jo	3.34	B	0.44	…	PY	f	20.6	1072	1170	8.3	7.7	87%	…	…	…	several 6" fish in pool, many 3/4" fish in rocks, water clear, brown algae on rocks
9/7/05 14:40	jo, zr	3.33	B	0.24	…	PY	g	17.4	1070	1264	8.1	8.8	92%	…	…	…	programmed sampler, water clear, many 3" fish in pool, brushed algae off intake
9/8/05 15:50	cw, zr	3.34	B	…	0.12	visual	p	17.3	1106	1297	8.0	7.3	77%	WQ	…	…	collected ammonia and mercury grab samples; retrieved composite sample, water clear
9/14/05 11:23	jg. zr	3.33	B	…	0.4	visual	p	14.5	1046	1297	7.7	7.4	75%	…	…	…	found a discarded tarp and cabinet beneath bridge

Observer Key: aa is Anne Ardillo, jo is Jonathan Owens, jg is John Gartner, cw is Chris White, bkh is Brian Hastings, bjm is Bonnie Mallory, sb is Scott Brown, gg is Greg Guensch, zr is Zan Rubin

Stage: Water level observed at outside staff plate

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B), or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (vis. est.).

Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) = +/- > 9%

High-water mark (HWM): Measured or estimated at location of the staff plate

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25°C by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, WQ = collect ammonia and mercury grab samples while composite sampling for water quality suite; other symbols as appropriate

Table 4. Hydrologic summary for the period of record, Bear Creek at Sand Hill Road, Los Trancos and San Francisquito Creeks at Piers Lane

	Annual Flow [4]				Sediment Discharge [4]				Peak Flow		
Water Year [1]	Mean Annual Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Suspended Sediment	% suspended	Bedload Sediment	% bedload	Peak Flow	Peak Stage [5]	Date Time
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(tons)*		*(tons)*		*(cfs)*	*(ft)*	*(24-hr)*
Bear Creek at Sand Hill Road [2, 6]											
2000	10.65	684	0.01	7728	24,426	93%	1,778	7%	2050	8.81	2/13/00 20:45
2001	3.71	113	0.01	2689	681	87%	98	13%	353	4.26	1/25/01 16:45
2002	5.12	189	0.01	3704	1,681	91%	171	9%	733	5.78	12/2/01 7:45
2003	6.86	434	0.01	4965	11,258	94%	762	6%	2231	9.29	12/16/2002 5:45
2004	5.87	282	0.01	4260	5624	91%	555	9%	1186	7.28	1/1/04 12:15
2005	10.77	257	0.01	8113	2460	96%	98	4%	487	5.35	12/30/2004 21:30
Los Trancos Creek at Piers Lane [3, 7]											
2003	2.67	123	0.01	1,934	2,494	…	…	…	649	7.58	12/16/02 6:30
2004	2.70	136	0.00	1,461	2,991	…	…	…	582	5.47	2/25/04 11:00
2005	3.56	67	0.02	2,575	1,424	94%	85	6%	357	4.33	2/18/05 6:00
San Francisquito Creek at Piers Lane [3, 7]											
2003	15.40	782	0.09	11,146	10,097	…	…	…	2,706	12.46	12/16/02 6:30
2004	11.02	453	0.12	8,002	6,910	…	…	…	1,474	9.67	1/1/04 13:15
2005	24.35	509	0.05	17,627	9,463	…	…	…	7	7.77	2/15/05 21:00

Notes:

General: Values displaying more than 2 or 3 significant figures are the result of electronic calculations; no additional precision is implied.

1) Hydrologic monitoring is conducted by "water years", rather than calendar years, to encompass whole rainfall seasons. Water year 2004 (WY2004) extends from October 1, 2003 through September 30, 2004 and corresponds to the water year used by most federal agencies.

2) The period of record for this station is October 12, 1999 to Sept. 30, 2005.

3) The period of record for these stations is October 2002 to Sept. 30, 2005; the partial record from the initial season (WY2002) of monitoring is not shown.

4) Daily flow values were computed from instantaneous flow calculated at 15-minute intervals. Sediment discharge values were totalled from calculations at 15-minute intervals.

5) Stage is the staff plate reading; the staff plate is set at an arbitrary datum and does not represent the absolute depth of water in the creek.

6) Year-long sediment discharge totals have not been calculated prior to WY2000, even though occasional sediment-transport measurements were performed.

7) Sediment totals for water year 2003 were recalculated by applying the sediment rating curves from water year 2004, which were revised after analysis of the WY2004 data.

Table 5. Summary of water quality for Bear Creek at Sand Hill Road, water year 2005.

Field observations [1]							*Nutrients* [2]				*Pesticides*		*Others* [3]	
Date and Time	Observer	Gage Height	Hydrograph	Discharge	Water Temperature	Specific conductance	**Ammonia-N**	**Nitrate-N**	**Nitrate-N + Nitrite-N**	**Phosphate-P**	**Chlorpyrifos**	**Diazinon**	**Total Suspended Solids**	**Hardness**
		(feet)	*(R,F,B,U)*	*(cfs)*	*(°C)*	*(µhos/cm @ 25°C)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(ug/L)*	*(ug/L)*	*(mg/L)*	*(mg/L)*
Analytical detection limits [5]						**10/18-19/2004**	0.2	…	…	0.02	0.05	0.05	0.5	1.0
						12/7/2004	0.2	0.1	0.1	0.02	0.05	0.05	0.5	1.0
						12/30-31/2004	0.2	...	0.1	0.02	0.05	0.05	0.5	1.0
						3/21-22/2005	0.2	...	0.1	0.02	0.05	0.05	0.5	1.0
						9/7-8/2005	0.2	...	0.1	0.02	0.05	0.05	0.5	1.0
Bear Creek at Sand Hill Road														
10/19/2004	cw, aa	comp.	**F**	**6.48**			0.44	ns	…	1.87	ND	ND	94	170
10/19/2004 12:26	cw, aa	2.50	F	68	14.2	283								
12/6-7/2004	jo	comp.	**R, P, F**	**39.9**				0.74	0.76	0.86	ND	ND	94	230
12/7/2004 6:55	jo, gg	2.45	F	52	10.3	269	ND							
12/29-31/2004	bjm	comp.	**R, P, F**	**200**				…	0.90 (0.93)	1.59	ND	ND	220	94
12/30/2004 10:06	bjm, aa	3.04	F	126	10.0	246	0.26							
3/21-22/2005	bjm	comp.	**R, P, F**	**77.6**				…	0.50	1.35	ND	ND	150	163
3/22/2005 12:00	cw, aa	2.60	R	88	12.4	296	0.32							
9/7-8/2005	jo, zr	comp.	**B**	**0.19**				…	0.2	0.57	ND	ND	1.8	246
9/8/2005 14:00	cw, zr	1.03	B	0.13	16.2	675	ND							
Minimum over period of record							0.20	0.74	0.10	0.25	ND	ND	1.8	94
Maximum over period of record							0.44	0.74	1.10	1.87	ND	ND	420	246
SF Bay RWQCB (1995)--Aquatic acute toxicity: 1-hour average							---[6]	---[7]	---[7]	---[7]	---[8]	---[8]	---[9]	None
SF Bay RWQCB (1995)--Aquatic chronic toxicity: 4-day average							---[6]	---[7]	---[7]	---[7]	---[8]	---[8]	---[9]	None

10/19/2004 composite programmed sampler to start 10/19/04 at 13:30 and collect 20 500-ml samples at 30-minute intervals; sample collection ended 10/19/04 at 23:00
12/6-7/2004 composite programmed sampler to start 12/6/04 at 18:00 and collect 38 500-ml samples at 30-minute intervals; sample collection ended 12/7/04 at 12:30
12/29-31/2004 composite programmed sampler to start 12/29/04 at 21:00 and collect 38 500-ml samples at 60-minute intervals; sample collection ended 12/31/04 at 10:00
3/21-22/2005 composite programmed sampler to start 3/21/05 at 17:00 and collect 38 500-ml samples at 30 minute-intervals; sample collection ended 3/22/05 at 11:30
9/7-8/2005 composite programmed sampler to start 9/7/05 at 14:00 and collect 32 500-ml samples at 60-minute intervals; sample collection ended 9/8/05 at 15:15

Table 5. Summary of water quality for Bear Creek at Sand Hill Road, water year 2005 (continued).

Field observations [1]		*Trace Metals* [4]															
Date and Time	Discharge	**Aluminum (total)**	**Aluminum (dissolved)**	**Copper (total)**	**Copper (dissolved)**	**Lead (total)**	**Lead (dissolved)**	**Mercury (total)**	**Mercury (dissolved)**	**Nickel (total)**	**Nickel (dissolved)**	**Selenium (total)**	**Selenium (dissolved)**	**Silver (total)**	**Silver (dissolved)**	**Zinc (total)**	**Zinc (dissolved)**
	(cfs)	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*
Analytical detection limits: [5]	**10/18-19/2004**	500	10	0.6	0.6	0.4	0.4	0.0010	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	12/7/2004	500	20	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	12/30-31/2004	100	100	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	3/21-22/2005	100	100	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	9/7-8/2005	100	100	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
Bear Creek at Sand Hill Road																	
10/19/2004	**6.48**	5,000	76	29.0	10.6	9.0	0.9			20.0	7.0	0.3	0.1	ND	ND	68	38
10/19/2004 12:26	68							0.066	0.0039								
12/6-7/2004	**39.9**	2,800	33	12.9	3.8	4.9	ND			13.0	3.9	0.2	0.1	ND	ND	80	31
12/7/2004 6:55	52							0.0380	0.0037								
12/29-31/2004	**200**	6,900	190 (190)	21.0	9.2	8.0	ND			22.0	3.7	0.3	0.1	ND	0.3	86	15
12/30/2004 10:06	126							0.0320	0.0076								
3/21-22/2005	**77.6**	5,100	ND	60.0	6.1	7.0	0.4			17.0	3.9	0.2	ND	1.3	ND	50	18
3/22/2005 12:00	88							0.021	0.0062								
9/7-8/2005	**0.19**	ND	ND	1.4	1.4 (1.4)	ND	ND (ND)			3.7	3.7 (3.7)	ND	0.1 (0.3)	ND	ND (0.2)	27	24 (21)
9/8/2005 14:00	0.13							0.0017	0.0010								
Minimum over period of record		ND	ND	1.20	1.2	ND	ND	0.0017	0.0010	3.2	3.6	ND	ND	ND	ND	8	6
Maximum over period of record		9,000	190	60	10.6	15.0	0.9	0.1100	0.0076	22	7.0	0.6	0.3	1.3	0.3	86	41
SF Bay RWQCB (1995)--Aquatic acute toxicity: 1-hour average [10]		None		None	13.4 - 61.2	None	64.6 - 352.5	2.4	2.4	None	468 - 1,827	20	20	None	3.4 - 55.0	None	117 - 458
SF Bay RWQCB (1995)-- Aquatic chronic toxicity: 4-day average [10]		None		None	9.0 - 35.4	None	2.5 - 13.7	0.025	0.025	None	52 - 203	5	5	(instantaneous maximum; no acute or chronic toxicity		None	118 - 462

Table 5. Summary of water quality for Bear Creek at Sand Hill Road, water year 2004 (continued).

Notes: **ND = not detected** **ns = not sampled,**

1) Observer Key: aa is Anne Ardillo; bjm is Bonnie Mallory; cw is Chris White; gg is Greg Guensch; jo is Jonathan Owens; zr is Zan Rubin
Hydrograph: R=Rising; P=Peak; F=Falling; B=Baseflow; U=Uncertain Discharge: estimates are in italics
All specific conductance and temperature measurements were made in the field.
2) Ammonia and phosphate samples were preserved upon collection with sulfuric acid (H2SO4) to pH<2. Nitrate samples were iced but not preserved if analysis could occur within 48 hours; otherwise, nitrate samples were also preserved with sulfuric acid.
3) All total suspended sediment (TSS) analyses of *composite* samples were performed by the RWQCP lab (City of Palo Alto) with a detection limit of 0.5 mg/L.
Results of TSS *grab* samples, analyzed by Soil Control Lab (Watsonville, CA) with a detection limit of 5.0 mg/L, are presented elsewhere in this report.
4) Total recoverable metals samples were preserved (unfiltered) upon collection with nitric acid (HNO3). Dissolved metals samples were filtered in the laboratory, then preserved with nitric acid.
5) Reporting Limits vary with analytical method, laboratory, quality control measures, and sample concentration, due to the dilution needed to bring the sample into analytical range.
Thus, the reporting limit may vary slightly among samples collected at different sites on the same day.
Aluminum, nitrate, organophosphate pesticide (diazinon, chlorpyrifos) and mercury analyses performed by Caltest (Napa).
Laboratory analyses for all other metals, ammonia, phosphate, hardness and suspended sediment (composite samples only) performed by the City of Palo Alto RWQCP.
6) Un-ionized ammonia concentrations chronically in excess of 0.025 mg/L (annual median value) can be toxic (RWQCB, 1995).
The fraction of total ammonia that is in the toxic, un-ionized form increases with increases in pH and temperature. Mean daily temperatures in Bear Creek varied from about 4.7 to 19.7°C, and pH measurements ranged from 7.3 to 8.2 during the water year 2005 monitoring period.
The proportion of total ammonia in the un-ionized form increases as a function of pH and temperature.
7) Biostimulatory constituents should not be present in amounts that stimulate excessive aquatic growth (RWQCB, 1995).
8) Waters should remain free of toxics at concentrations lethal to or adversely impacting aquatic organisms (RWQCB, 1995).
9) Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses (RWQCB, 1995).
10) Selected trace metals objectives are hardness-dependent (RWQCB, 1995). The range shown is for hardness of 100 to 500 mg/L as $CaCO_3$.
The California Toxics Rule, recently (2004) adopted by the Regional Board, approved by the U.S. EPA and incorporated into the Basin Plan establishes aquatic acute and chronic toxicity objectives for dissolved concentrations of metals, based on hardness. The objectives are calculated based on the following equations:

Dissolved Copper, 1-hour average = (e{0.9422 [ln(hardness)] - 1.700}) x (0.960)
Dissolved Copper, 4-day average = (e{0.8545 [ln(hardness)] - 1.702}) x (0.960)

Dissolved Lead, 1-hour average = (e{1.273[ln(hardness)] - 1.460}) x (1.46203 - {[ln(hardness)] x [0.145712]})
Dissolved Lead, 4-day average = (e{1.273[ln(hardness)] - 4.705}) x (1.46203 - {[ln(hardness)] x [0.145712]})

Dissolved Nickel, 1-hour average = (e{0.8460 [ln(hardness)] + 2.255 }) x (0.998)
Dissolved Nickel, 4-day average = (e{0.8460 [ln(hardness)] + 0.0584}) x (0.997)

Dissolved Silver, instantaneous maximum = (e{1.72 [ln(hardness)] - 6.52}) x (0.85)

Dissolved Zinc, 1-hour average = (e{0.8473 [ln(hardness)] + 0.884 }) x (0.978)
Dissolved Zinc, 4-day average = (e{0.8473 [ln(hardness)] + 0.884}) x (0.986)

Table 6. Summary of water quality at San Francisquito and Los Trancos Creeks at Piers Lane, water year 2005.

Field observations [1]							*Nutrients* [2]				*Pesticides*		*Others* [3]	
Date and Time	Observer	Gage Height	Hydrograph	Discharge	Water Temperature	Specific conductance	**Ammonia-N**	**Nitrate-N**	**Nitrate + Nitrite-N**	**Phosphate-P**	**Chlorpyrifos**	**Diazinon**	**Total Suspended Solids**	**Hardness**
		(feet)	*(R,P,F,B,U)*	*(cfs)*	*(°C)*	*(µhos/cm @ 25°C)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(ug/L)*	*(ug/L)*	*(mg/L)*	*(mg/L)*
Analytical detection limits: [5]						**10/18-19/2004**	0.2	0.1	…	0.02	0.05	0.05	0.5	1.0
						12/7/2004	0.2	0.1	0.1	0.02	0.05	0.05	0.5	1.0
						12/30-31/2004	0.2	…	0.1	0.02	0.05	0.05	0.5	1.0
						3/21-22/2005	0.2	0.1	0.1	0.02	0.05	0.05	0.5	1.0
						9/7-8/2005	0.2	…	0.1, 0.5	0.02	0.05	0.05	0.5	1.0
San Francisquito Creek at Piers Lane														
10/19/2004	cw, aa	comp.	**R, P, F**	**12.0**			0.31	1.20	…	0.86	ND	ND	98	450
10/19/2004 15:53	cw, aa	4.36	F	29.0	14.6	612								
12/6-7/2004	jo	comp.	**R, P, F**	**37**				1.50	0.98	0.80	ND	ND	94	310
12/7/2004 8:05	jo, gg	5.13	F	91	10.1	294	ND							
12/29-31/2004	bjm, cw	comp.	**R, P, F**	**359**				…	0.63 (0.76)	1.53	ND	ND	220	129
12/30/2004 11:10	bjm, aa	6.35	F	410	9.6	454	ND							
3/21-22/2005	cw	comp.	**R, P, F**	**318**				0.38	0.38	1.01	ND	ND	130	238
3/22/2005 13:45	cw, aa	5.67	R	164	12.9	481	0.73							
9/7-8/2005	jo, zr	comp.	**B**	0.22				...	2.7	0.69	ND	ND	2.2	643
9/8/2005 16:00	cw, zr	3.34	B	0.05	17.4	1070	ND							
Minimum over period of record							ND	0.38	0.38	0.18	ND	ND	2.2	101
Maximum over period of record							1.2	5.5	3.3	3.98	ND	ND	377	643
Los Trancos Creek at Piers Lane														
10/19/2004	cw, aa	comp.	**R, P, F**	**0.8**			0.31	4.4	…	2.15	ND	ND	12	590
10/19/2004 14:50	cw, aa	1.27	F	1.5	15.5	1032								
12/6-7/2004	jo	comp.	**R, P, F**	**5.5**				2.3 (2.3)	2.3 (2.4)	0.89	ND	ND	25	550
12/7/2004 7:43	jo, gg	1.61	F	9.1	10.4	531	ND							
12/29-31/2004	bjm, cw	comp.	**R, P, F**	**42.2**				…	1.9 (1.9)	2.39	ND	ND	300	255
12/30/2004 10:47	bjm, aa	2.17	F	37.7	9.9	343	0.22							
3/21-22/2005	cw	comp.	**R, P, F**	**24.3**				0.87	0.91	1.26	ND	ND	110	255
3/22/2005 13:30	cw, aa	2.00	R	30.3	13.0	488	0.32							
9/7-8/2005	jo, zr	comp.	**B**	0.21				...	5.2	0.55	ND	ND	1.8	538
9/8/2005 17:00	cw, zr	0.82	B	0.13	17.4	1441	ND							
Minimum over period of record							ND	0.43	0.91	0.15	ND	ND	1.5	184
Maximum over period of record							0.79	5.7	5.2	7.05	ND	ND	527	830
SF Bay RWQCB (1995)--Aquatic acute toxicity: 1-hour average							---[6]	---[7]	---[7]	---[7]	---[8]	---[8]	---[9]	None
SF Bay RWQCB (1995)--Aquatic chronic toxicity: 4-day average							---[6]	---[7]	---[7]	---[7]	---[8]	---[8]	---[9]	None

Table 6. Summary of water quality at San Francisquito and Los Trancos Creeks at Piers Lane in Water Year 2005 (continued).

Field observations [1]		*Trace Metals* [4]															
Date and Time	Discharge	**Aluminum (total)**	**Aluminum (dissolved)**	**Copper (total)**	**Copper (dissolved)**	**Lead (total)**	**Lead (dissolved)**	**Mercury (total)**	**Mercury (dissolved)**	**Nickel (total)**	**Nickel (dissolved)**	**Selenium (total)**	**Selenium (dissolved)**	**Silver (total)**	**Silver (dissolved)**	**Zinc (total)**	**Zinc (dissolved)**
	(cfs)	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*	*(ug/L)*
Analytical detection limits: [5]	**10/18-19/2004**	100	100	0.6	0.6	0.4	0.4	0.0010	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	12/7/2004	100	20	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	12/30-31/2004	100	100	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	3/21-22/2005	100	100	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
	9/7-8/2005	100	100	0.6	0.6	0.4	0.4	0.0005	0.0005	0.6	0.6	0.1	0.1	0.2	0.2	5.0	5.0
San Francisquito Creek at Piers Lane																	
10/18-19/2004	**12.0**	2,700	100	58.0	9.9	7.0	1.1			17.0	7.0	0.5	0.3	ND	ND	76	38
10/19/2004 16:15	29.0							0.0320	0.0039								
12/7/2004 0:00	**37**	2,700	29	31.0	4.7	4.8	ND			14.0	4.2	0.3	0.2	ND	ND	51	21
12/7/2004 13:30	91							0.0430	0.0041								
12/29-31/2004	**359**	6,700	120 (120)	22.0	4.7	8.0	0.4			23.0	4.6	0.5	0.2	ND	ND	46	17
12/30/2004 13:20	410							0.024	0.0037								
3/21-22/2005	**318**	3,800	ND	22.0	6.6	6.0	ND			16.0	5.0	0.2	0.1	ND	ND	44	26
3/22/2005 16:30	164							0.0160	0.0042								
9/7-8/2005	**0.22**	ND	ND	1.5	1.8	ND	ND			6.0	6.0	0.3	0.3	ND	ND	8	34
9/8/2005 16:00	0.05							0.0014	0.0010								
Minimum over period of record		ND	ND	1.5	1.3	ND	ND	0.0009	ND	3.7	3.0	0.2	0.1	ND	ND	ND	ND
Maximum over period of record		12,000	190	74.0	17.0	17.0	1.10	0.13	0.042	38.0	9.0	1.3	0.4	ND	0.3	110	38
Los Trancos Creek at Piers Lane																	
10/18-19/2004	**0.80**	720	110	18.0	10.9	2.8	0.5			11.0	12.0	0.4	0.3	ND	ND	50	50
10/19/2004 16:15	1.45							0.0290	0.0049								
12/7/2004 0:00	**5.50**	620 (630)	ND (ND)	7.1	3.9	1.3	ND			6.0	3.6	0.3	0.2	ND	ND	33	21
12/7/2004 13:30	9.10							0.0230	0.0041								
12/29-31/2004	**42.2**	6,500	110 (ND)	28.0	10.6	8.0	0.9			36.0	6.0	0.3	0.1	ND	ND	65	21
12/30/2004 13:20	37.7							0.0770	0.0080								
3/21-22/2005	**24.3**	3,300	ND	15.0	4.9	4.6	ND			15.0	4.1	0.1	ND	ND	ND	40	17
3/22/2005 16:30	30.3							0.0220	0.0042								
9/7-8/2005	**0.21**	ND	ND	1.7	1.4	ND	ND			5.0	5.0	0.2	0.4	ND	ND	39	5
9/8/2005 17:00	0.13							0.0015	0.0011								
Minimum over period of record		ND	ND	ND	1.4	ND	ND	0.0010	ND	3.0	2.9	ND	ND	ND	ND	ND	ND
Maximum over period of record		33,000	110	82.0	10.9	30.0	1.2	0.270	0.008	117	12.0	2.1	0.4	0.3	ND	180	50
SF Bay RWQCB (1995)--Aquatic acute toxicity: 1-hour average [10]		None		None	13.4 - 61.2	None	64.6 - 353	2.4	2.4	None	468 - 1,827	20	20	None	3.4 - 55.0	None	117 - 458
SF Bay RWQCB (1995)-- Aquatic chronic toxicity: 4-day average [10]		None		None	9.0 - 35.4	None	2.5 - 13.7	0.025	0.025	None	52 - 203	5	5	(instantaneous maximum; no acute or chronic toxicity		None	118 - 462

Table 6. Summary of water quality at San Francisquito and Los Trancos Creeks at Piers Lane, water year 2004 (continued).

Notes: **ND = not detected** **ns = not sampled,** **na = not analyzed**

1) Observer Key: aa is Anne Ardillo; bjm is Bonnie Mallory; cw is Chris White; gg is Greg Guensch; jo is Jonathan Owens; zr is Zan Rubin
Hydrograph: R=Rising; P=Peak; F=Falling; B=Baseflow; U=Uncertain Discharge: estimates are in italics
All specific conductance and temperature measurements were made in the field.

2) Ammonia and phosphate samples were preserved upon collection with sulfuric acid (H2SO4) to pH<2. Nitrate samples were iced but not preserved if analysis could occur within 48 hours; otherwise, nitrate samples were also preserved with sulfuric acid.

3) All total suspended sediment (TSS) analyses of *composite* samples were performed by the RWQCP lab (City of Palo Alto) with a detection limit of 0.5 mg/L.
Results of TSS *grab* samples, analyzed by Soil Control Lab (Watsonville, CA) with a detection limit of 5.0 mg/L, are presented elsewhere in this report.

4) Total recoverable metals samples were preserved (unfiltered) upon collection with nitric acid (HNO3). Dissolved metals samples were filtered in the laboratory, then preserved with nitric acid.

5) Reporting Limits vary with analytical method, laboratory, quality control measures, and sample concentration, due to the dilution needed to bring the sample into analytical range.
Thus, the reporting limit may vary slightly among samples collected at different sites on the same day.
Aluminum, nitrate, organophosphate pesticide (diazinon, chlorpyrifos) and mercury analyses performed by Caltest (Napa).
Laboratory analyses for all other metals, ammonia, phosphate, hardness and suspended sediment (composite samples only) performed by the City of Palo Alto RWQCP.

6) Un-ionized ammonia concentrations chronically in excess of 0.025 mg/L (annual median value) can be toxic (RWQCB, 1995).
The fraction of total ammonia that is in the toxic, un-ionized form increases with increases in pH and temperature. Mean daily temperatures varied from about 4.9 to 19.8°C in San Francisquito Creek and from about 6.3 to 19.4°C in Los Trancos Creek during the water year 2005 monitoring period. pH measurements ranged from 7.1 to 8.3 in San Francisquito Creek and from 7.3 to 8.4 in Los Trancos Creek during water year 2005.
The proportion of total ammonia in the un-ionized form increases as a function of pH and temperature.

7) Biostimulatory constituents should not be present in amounts that stimulate excessive aquatic growth (RWQCB, 1995).

8) Waters should remain free of toxics at concentrations lethal to or adversely impacting aquatic organisms (RWQCB, 1995).

9) Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses (RWQCB, 1995).

10) Selected trace metals objectives are hardness-dependent (RWQCB, 1995). The range shown is for hardness of 100 to 500 mg/L as $CaCO_3$.
The California Toxics Rule, recently (2004) adopted by the Regional Board, approved by the U.S. EPA and incorporated into the Basin Plan establishes aquatic acute and chronic toxicity objectives for dissolved concentrations of metals, based on hardness. The objectives are calculated based on the following equations:

Dissolved Copper, 1-hour average = (e{0.9422 [ln(hardness)] - 1.700}) x (0.960)
Dissolved Copper, 4-day average = (e{0.8545 [ln(hardness)] - 1.702}) x (0.960)

Dissolved Lead, 1-hour average = (e{1.273[ln(hardness)] - 1.460}) x (1.46203 - {[ln(hardness)] x [0.145712]})
Dissolved Lead, 4-day average = (e{1.273[ln(hardness)] - 4.705}) x (1.46203 - {[ln(hardness)] x [0.145712]})

Dissolved Nickel, 1-hour average = (e{0.8460 [ln(hardness)] + 2.255 }) x (0.998)
Dissolved Nickel, 4-day average = (e{0.8460 [ln(hardness)] + 0.0584}) x (0.997)

Dissolved Silver, instantaneous maximum = (e{1.72 [ln(hardness)] - 6.52}) x (0.85)

Dissolved Zinc, 1-hour average = (e{0.8473 [ln(hardness)] + 0.884 }) x (0.978)
Dissolved Zinc, 4-day average = (e{0.8473 [ln(hardness)] + 0.884}) x (0.986)

10/19/2004	**composite:**	programmed sampler to start 10/19/04 at 00:00 and collect 24 500-ml samples at 60-minute intervals; sample collection ended 10/19/04 at 23:00
12/6-7/2004	**composite:**	programmed sampler to start 12/6/04 at 18:00 and collect 38 500-ml samples at 30-minute intervals; sample collection ended 12/7/04 at 12:30
12/29-31/2004	**composite:**	programmed sampler to start 12/29/04 at 21:00 and collect 38 500-ml samples at 60-minute intervals; sample collection ended 12/31/04 at 10:00
3/21-22/2005	**composite:**	programmed sampler to start 3/21/05 at 19:00 and collect 38 500-ml samples at 30-minute intervals; sample collection ended 3/22/05 at 13:30
9/7-8/2005	**composite:**	programmed sampler to start 9/7/05 at 16:00 and collect 32 500-ml samples at 45 minute intervals; sample collection ended 9/8/05 at 15:15

Table 7. Water quality objectives for dissolved trace metals concentrations at hardnesses typically observed in the San Francisquito Creek watershed.

Trace Metal	Water Quality Objectives [1]	Ambient Total Hardness Levels [2] (mg/L as $CaCO_3$) 100	200	300	400	500
Copper	CMC (1-hour average)	13.4	25.8	37.8	49.6	61.2
Copper	CCC (4-day average)	9.0	16.2	22.9	29.3	35.4
Lead	CMC (1-hour average)	64.6	136.1	208.6	280.8	352.5
Lead	CCC (4-day average)	2.5	5.3	8.1	10.9	13.7
Nickel	CMC (1-hour average)	468	842	1186	1513	1827
Nickel	CCC (4-day average)	52	94	132	168	203
Silver	Instantaneous Maximum	3.4	11.4	22.8	37.4	55.0
Zinc	CMC (1-hour average)	117	211	297	379	458
Zinc	CCC (4-day average)	118	213	300	382	462

Notes:

1. Water quality objectives adopted by the Regional Water Quality Control Board, Region 2 (San Francisco Bay), then approved by the State Water Resources Control Board on July 22, 2004 and by the California Office of Administrative Law on October 4, 2004. The criteria maximum concentration (CMC) is equivalent to the prior aquatic "acute" toxicity objective, while the criteria continuous concentration (CCC) is equivalent to the prior aquatic "chronic" toxicity objective.
2. Since calcium and magnesium are the primary components of hardness, the convention is to express total hardness in terms of an equivalent concentration of calcium carbonate ($CaCO_3$).

Table 8. Measurements and calculation of sediment transport, Bear Creek at Sand Hill Road, water year 2005

Field Observations [1]						Bedload Sampling Details						Sediment Transport				
Sample Date:Time	**Observer(s)**	**Stage**	**Stream Condition**	**Streamflow Discharge**	**Streamflow Value Source**	**Active Bed Width**	**Sampler Width**	**No. of Verts.**	**Time/Vert.**	**Total Time**	**Sample Dry Weight**	**Bedload Discharge**	**Bedload Discharge**	**Suspended Sediment Concentration**	**Suspended Sediment Discharge**	**Turbidity**
		(ft)	*R,F,B,U*	*(cfs)*	*M,R,E*	*(ft)*	*(ft)*		*(sec)*	*(sec)*	*(gm)*	*(lb/sec)*	*(tons/day)*	*(mg/l)*	*(tons/day)*	*(ntu)*
Bear Creek at Sand Hill Road																
10/19/04 comp.	cw	comp.	F	**6.5**	R, F									**94**	**1.64**	…
12/6-7/2004 comp.	jo, gg	comp.	comp.	**40**	R, F									**94**	**10.12**	…
12/7/04 6:30	jo, gg	2.45	F	64	R	…	…	…	…	…	…	…	…	190	32.94	…
12/7/04 7:00	jo, gg	2.45	F	50	R	1.0	0.25	1	120	120	10.0	0.001	0.03			
12/7/04 11:55	jo, gg	1.71	F	14	R	…	…	…	…	…	…	…	…	41	1.51	…
12/27/04 10:22	jo, cw	1.93	R	73	R	…	…	…	…	…	…	…	…	111	21.71	88
12/30/04 9:58	bjm, aa	3.04	F	128	R	…	…	…	…	…	…	…	…	349	120	140
12/29-31/04 comp.	cw	comp.	comp.	**200**	R, F									**220**	**119**	…
12/31/04 16:35	cw	2.46	F, R	69	R	…	…	…	…	…	…	…	…	49	9	39
2/15/05 15:40	jo	3.50	R	218	R	too deep and fast to sample for bedload								247	145	173
3/4/05 10:15	sb, bkh	2.32	F	53	M	tested for bedload, none moving								18	2.56	33
3/21-22/2005 comp.	cw, aa	comp.	comp.	**78**	R, F									**150**	**31**	…
3/22/05 12:10	cw, aa	2.60	R	91	R	…	…	…	…	…	…	…	…	70	17	78
3/22/05 12:25	cw, aa	2.75	R	103	R	10	0.25	7	60	420	49	0.010	0.43	…	…	…
3/22/05 16:50	cw, aa	5.15	F	475	R	too deep and fast to wade								1117	1,431	600
4/1/05 10:04	bkh, sb	1.66	F	14	F	…	…	…	…	…	…	…	…	19.3	0.73	11
5/19/05 12:15	jo, jg	1.57	F	10.6	R	no bedload moving								24.7	0.71	32
9/7-8/2005 comp.	jo, zr, cw	comp.	B	**0.19**	R	no bedload moving								**1.8**	**0.00092**	…

Notes and explanations

1) Observer Key: jo= Jonathan Owens; cw= Chris White ; bjm = Bonnie Mallory; bkh = Brian Hastings; jg = John Gartner; gg = Greg Guensch; aa = Anne Ardillo; sb= Scott Brown; zr= Zan Rubin
Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain
Streamflow discharge is the measured or estimated instantaneous flow at the time that sediment was sampled. The value is usually taken from the datalogger record and typically differs from the mean flow for the day. **Bold** flow values indicate average flow during the period of composite sampling.
Streamflow Value Source: M = measured; R = rating curve; E = estimated; Streamflow for composite samples is mean flow for the sampling period.

2) Active Bed Width is estimated by the field observer as the width through which significant amounts of bedload are being transported.
Sampler Width and Type: 0.25 = 3-inch Helley Smith; 0.50 = 6-inch Helley Smith

3) Values for sediment discharge showing more than two to three digits are the result of calculations; increased precision is not implied.
Bedload Discharge (lbs/sec) = [active bed width (ft) * sample dry weight (gm) * 0.002205 (lbs)]/ [sampler width (ft) * sampling time (sec)]
Bedload Discharge (tons/day) = [active bed width (ft) * sample dry weight (gm) * 86,400 (sec)]/ [sampler width (ft) * sampling time (sec) * 907,200 (gm)]
The detection limit for suspended sediment is 5 mg/L ; values shown as <5 indicate that the sample was below the detection limit. .
If the creek is visibly clear, then suspended sediment samples are not collected because concentrations would likely be below the detection limit.

Table 9. Measurements and calculation of sediment transport,
San Francisquito and Los Trancos Creeks at Piers Lane, water year 2005

Field observations					*Bedload Sampling Details*						*Bedload Discharge*		*Suspended sediment*		
Date and Time	Observer	Stage	Stream Condition	Discharge	**Active Bed Width**	**Sampler Width**	**No. of Verts.**	**Time/Vert.**	**Total Time**	**Sample Dry Weight**	**Bedload-Sediment Discharge Rate**	**Bedload-Sediment Discharge Rate**	Total Suspended Solids	Suspended Sediment discharge	Turbidity
		(feet)	*(R, F, B)*	*(cfs)*	*(ft)*	*(ft)*		*(sec)*	*(sec)*	*(gm)*	*(lb/sec)*	*(tons/day)*	*(mg/L)*	*(tons/day)*	*(NTU)*
San Francisquito Creek at Piers Lane															
10/19/04 comp.	cw	comp.	comp.	**12**	…	…	…	…	…	…	…	…	98	3.17	…
10/19/2004 15:55	cw, aa	4.36	F	28.7	…	…	…	…	…	…	…	…	150	11.61	…
12/6-7/2004 comp.	jo, gg	comp.	comp.	**37**	…	…	…	…	…	…	…	…	94	9.38	…
12/7/2004 8:05	jo, gg	5.13	F	94.2	…	…	…	…	…	…	…	…	226	57.43	230
12/7/2004 13:10	jo, gg	4.23	F	22.4	…	…	…	…	…	…	…	…	91	5.50	
12/27/2004 9:05	jo, cw	4.2	R	21.5	…	…	…	…	…	…	…	…	115	6.67	130
12/27/2004 12:55	jo, cw	4.75	R	50	…	…	…	…	…	…	…	…	95	12.81	76
12/29-31/04 comp.	cw	comp.	comp.	**359**	…	…	…	…	…	…	…	…	220	213.06	…
12/30/2004 11:13	bjm, aa	6.35	F	407	…	…	…	…	…	…	…	…	102	111.99	110
12/31/2004 18:10	cw	5.50	R	157	…	…	…	…	…	…	…	…	73	30.92	96
2/15/2005 14:15	jo	5.85	R	244	…	…	…	…	…	…	…	…	143	94.13	131
2/17/2005 14:55	bkh	4.73	F	42.4	…	…	…	…	…	…	…	…	41	4.69	46
3/4/2005 13:22	bkh, sb	5.25	F	96.2	…	…	…	…	…	…	…	…	23	5.97	31
3/22/2005 13:40	cw, aa	5.67	R	164	…	…	…	…	…	…	…	…	91	40.26	60
3/22/2005 17:40	cw, aa	7.45	R	732	…	…	…	…	…	…	…	…	1070	2112.91	570
3/21-22/2005 comp.	cw, aa	comp.	comp.	**318**	…	…	…	…	…	…	…	…	130	111.52	…
4/1/2005 14:42	bkh	4.63	F	44.4	…	…	…	…	…	…	…	…	20	2.40	24
9/7-8/2005 comp.	jo, zr, cw	comp.	B	**0.22**	…	…	…	…	…	…	…	…	2	0.00	…

	Field observations				Bedload Sampling Details						Bedload Discharge		Suspended sediment		
Date and Time	Observer	Stage	Stream Condition	Discharge	**Active Bed Width**	**Sampler Width**	**No. of Verts.**	**Time/Vert.**	**Total Time**	**Sample Dry Weight**	**Bedload-Sediment Discharge Rate**	**Bedload-Sediment Discharge Rate**	Total Suspended Solids	Suspended Sediment discharge	Turbidity
		(feet)	*(R, F, B)*	*(cfs)*	*(ft)*	*(ft)*		*(sec)*	*(sec)*	*(gm)*	*(lb/sec)*	*(tons/day)*	*(mg/L)*	*(tons/day)*	*(NTU)*
Los Trancos Creek at Piers Lane															
10/19/04 comp.	cw	comp.	F	**0.8**									12	0.03	
10/19/2004 14:55	cw, aa	1.36	R	2.5	…	…	…	…	…	…	…	…	71	0.48	…
12/6-7/2004 comp.	jo, gg	comp.	comp.	**5.5**									25	0.37	
12/7/2004 7:30	jo, gg	1.69	F	10.1	…	…	…	…	…	…	…	…	47	1.28	…
12/7/2004 13:44	jo, gg	1.15	F	1.2	…	…	…	…	…	…	…	…	6.4	0.02	…
12/27/2004 8:55	jo, cw	1.57	R	7	…	…	…	…	…	…	…	…	67	1.27	44
12/27/2004 12:35	jo, cw	1.84	R	17	…	…	…	…	…	…	…	…	127	5.82	110
12/29-31/04 comp.	cw	comp.	comp.	**42.2**									300	34.15	
12/30/2004 10:57	bjm, aa	2.19	F	37.7	…	…	…	…	…	…	…	…	301	30.61	300
12/31/2004 18:40	cw	1.29	R	3	…	…	…	…	…	…	…	…	23	0.19	19
2/15/2005 14:10	jo	1.92	R	20.6	…	…	…	…	…	…	…	…	52	2.89	121
2/15/2005 14:30	jo	1.95	R	22.2	6	0.25	5	60	300	95.7	0.017	0.71	…	…	…
2/17/2005 13:45	bkh	1.42	F	6.3	…	…	…	…	…	…	…	…	4.4	0.07	8.1
3/4/2005 12:40	sb, bkh	2.40	F	49.2	…	…	…	…	…	…	…	…	…	…	…
3/4/2005 12:42	sb, bkh	2.40	F	49.2	6	0.25	4	30	120	264.3	0.117	4.89	102	13.54	96
3/22/2005 13:30	cw, aa	2.21	R	30.3	…	…	…	…	…	…	…	…	95	7.77	79
3/22/2005 14:05	cw, aa	2.55	R	43	7	0.25	7	60	420	384.4	0.057	2.37	…	…	…
3/22/2005 17:25	cw, aa	3.15	R	110.9	…	…	…	…	…	…	…	…	1351	404.18	590
3/21-22/2005 comp.	cw, aa	comp.	comp.	**24.3**									110	7.21	
4/1/2005 15:22	sb, bkh	1.55	F	8.8	…	…	…	…	…	…	…	…	11.8	0.28	5.1
9/7-8/2005 comp.	jo, zr, cw	comp.	B	**0.2**									1.8	0.00	

Notes:

Observer Key: jo= Jonathan Owens; bjm= Bonnie Mallory; cw= Chris White ; sb= Scott Brown; jg = John Gartner; aa = Anne Ardillo; gg = Greg Guensch

Streamflow discharge is the measured or estimated instantaneous flow when sediment was sampled, usually from the datalogger record, and usually differs from the mean flow for the day.

Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain

Bold flow values indicate average flow during the period of composite sampling

Values for sediment discharge having more than two to three digits displayed are the result of calculations; increased precision is not implied.

The detection limit for suspended sediment is 5 mg/L, values shown as <5 indicate that the sample was below the detection limit.

During site visits when the creek water is clear, suspended-sediment samples are not normally taken because the sample is expected to be below the detection limit.

Sediment samples taken on Feb. 18, 2004 were taken to evaluate the bias of a fixed-point, composite sampler

FIGURES

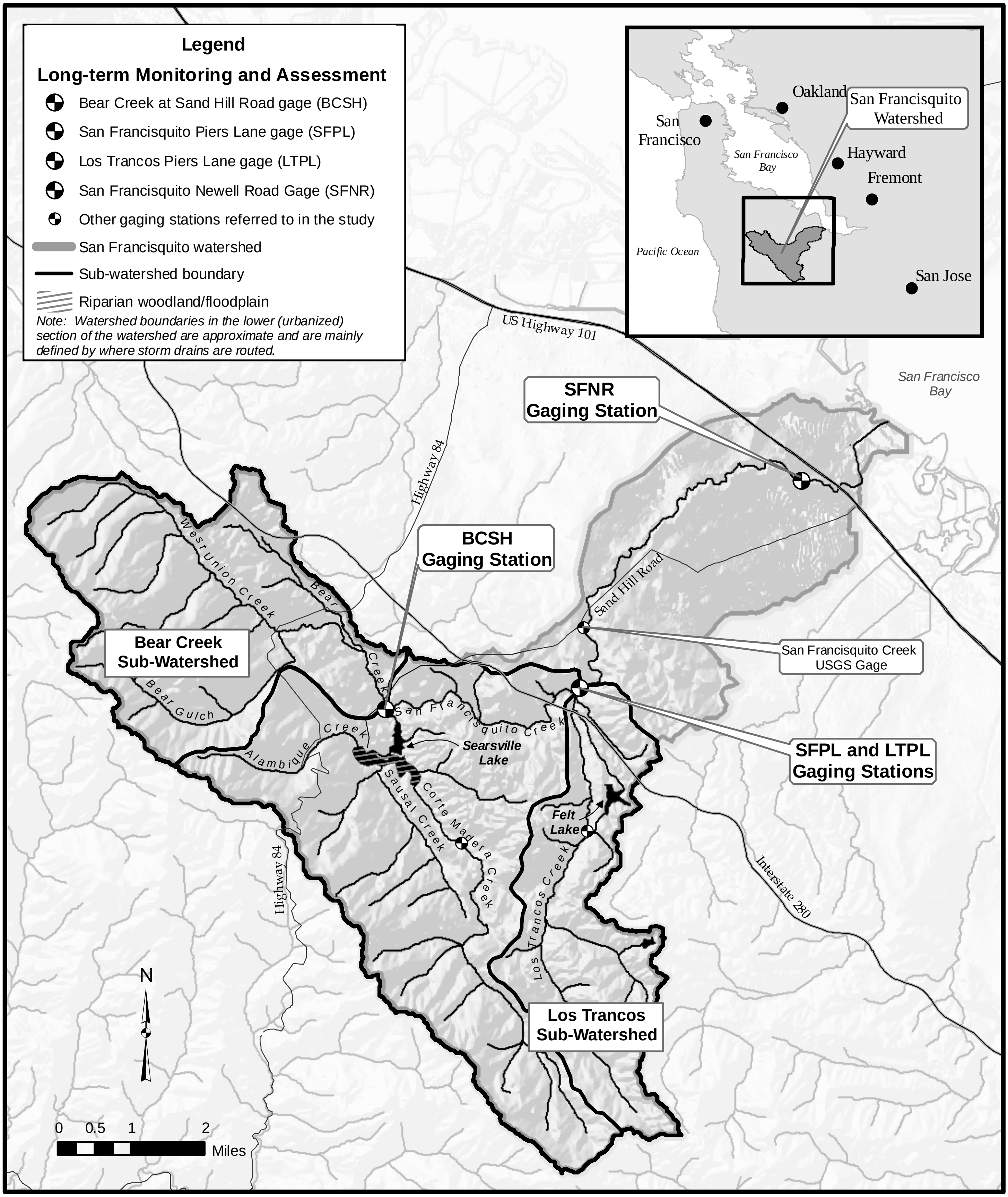


Figure 1. Stream monitoring location in the San Francisquito watershed
The Piers Lane stations are located just above the confluence of San Francisquito and Los Trancos Creeks. The Bear Creek station is located downstream of Sand Hill Road.

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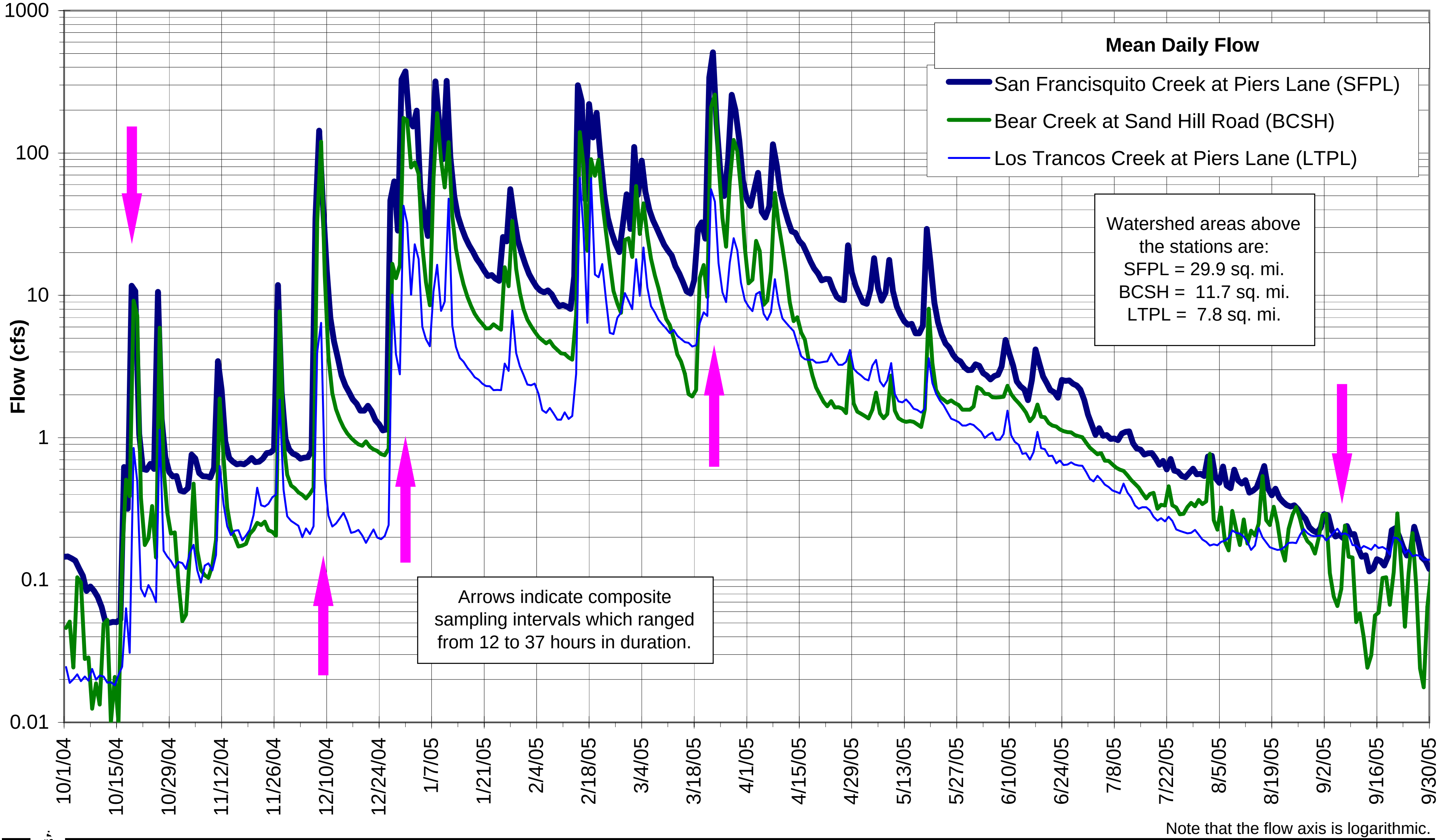

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Figure 2. Daily flow hydrographs for San Francisquito, Los Trancos and Bear Creeks, water year 2005. Flow in San Francisquito Creek is generally greater than flow in Bear Creek or Los Trancos Creek, as one would expect from its larger drainage area. The composite sampling dates were chosen to measure water quality during the first flush, winter and spring storms, and summer baseflow.

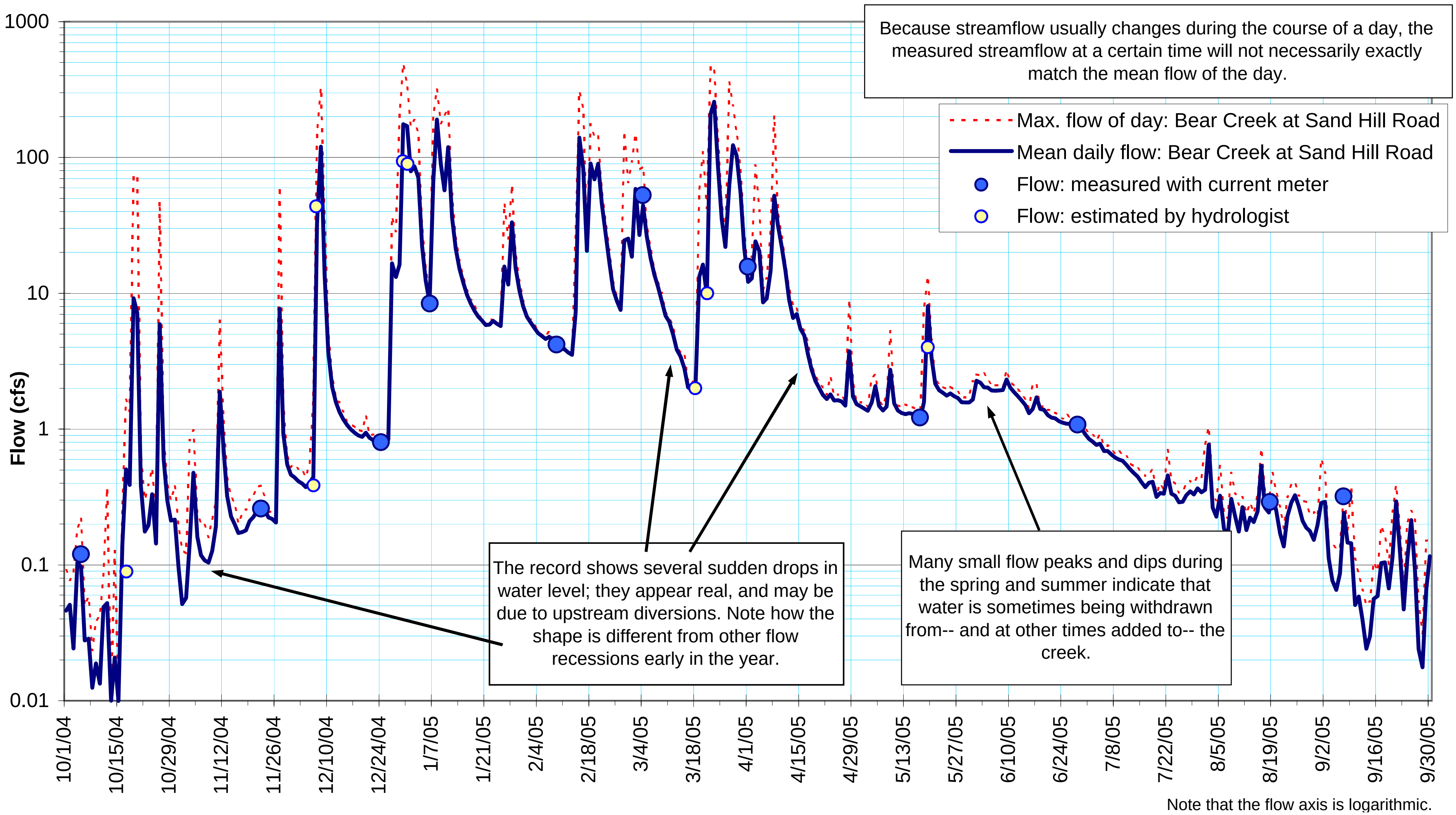

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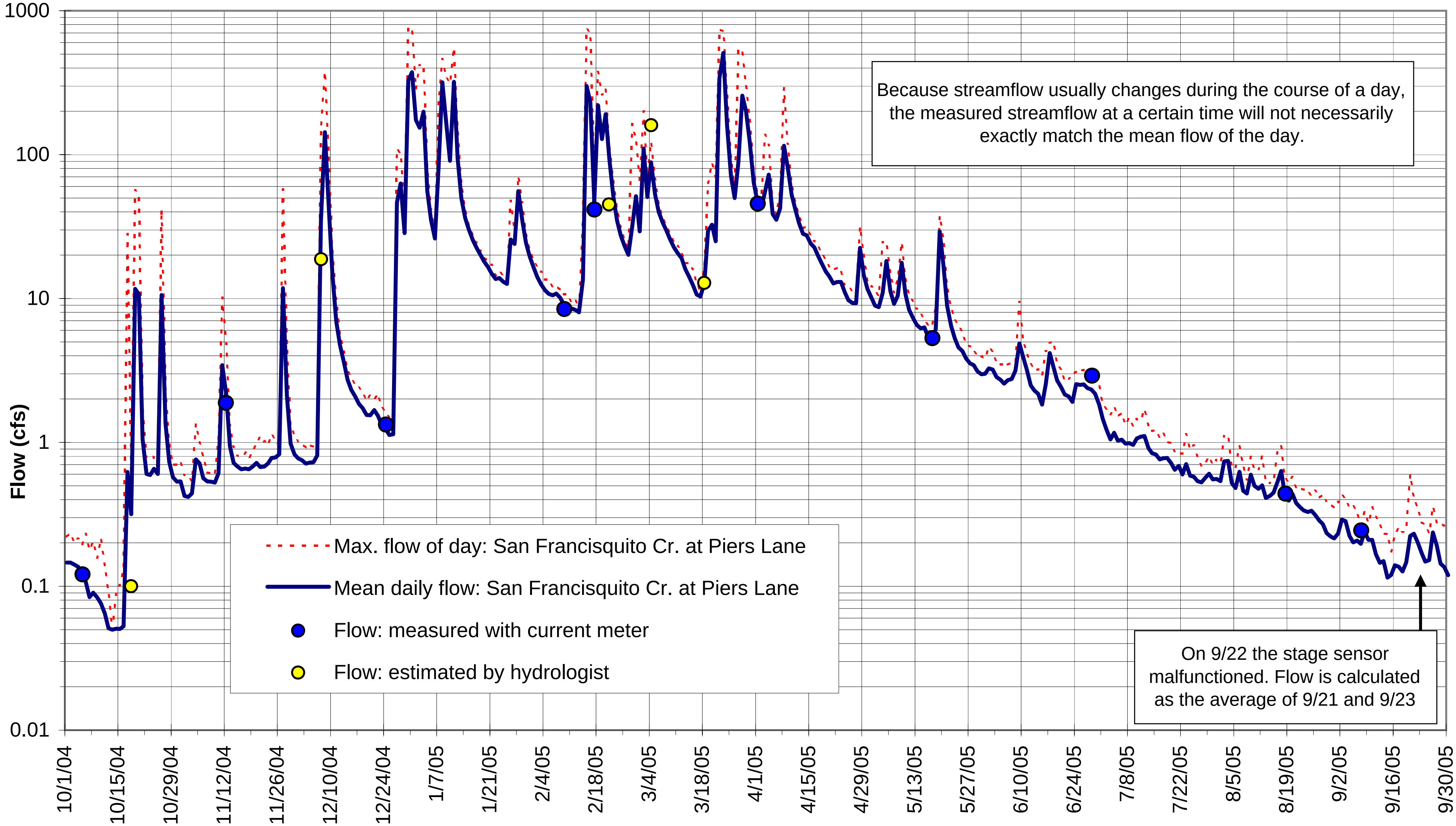
Figure 3. Daily flow hydrograph for Bear Creek at Sand Hill Road, water year 2005. Some flow regulation occurs upstream of this station. The peak flow of approximately 487 cfs was recorded on December 30, 2004 at 9:30 PM. A flow of 0.01 cfs approximates our detection limit; flow below that level can be considered almost zero flow.



Note that the flow axis is logarithmic.

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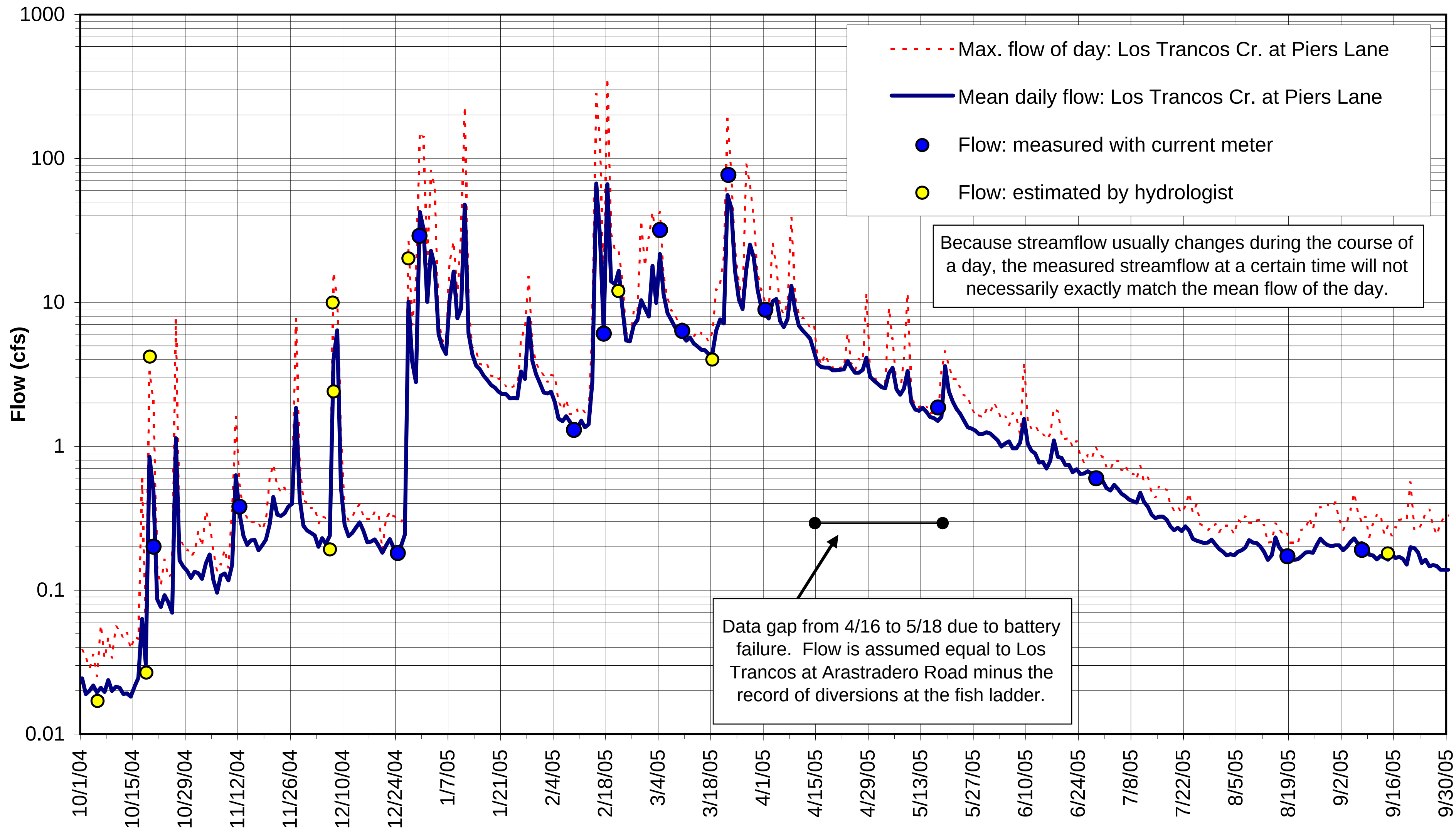
Figure 4. Daily flow hydrograph for San Francisquito Creek at Piers Lane, water year 2005. Three peak flows of approximately 745 cfs were recorded on December 30, 2004, February 15, 2005 and March 22, 2005. These peaks occurred on different storms than the peak flow for Los Trancos Creek.



Note that the flow axis is logarithmic.

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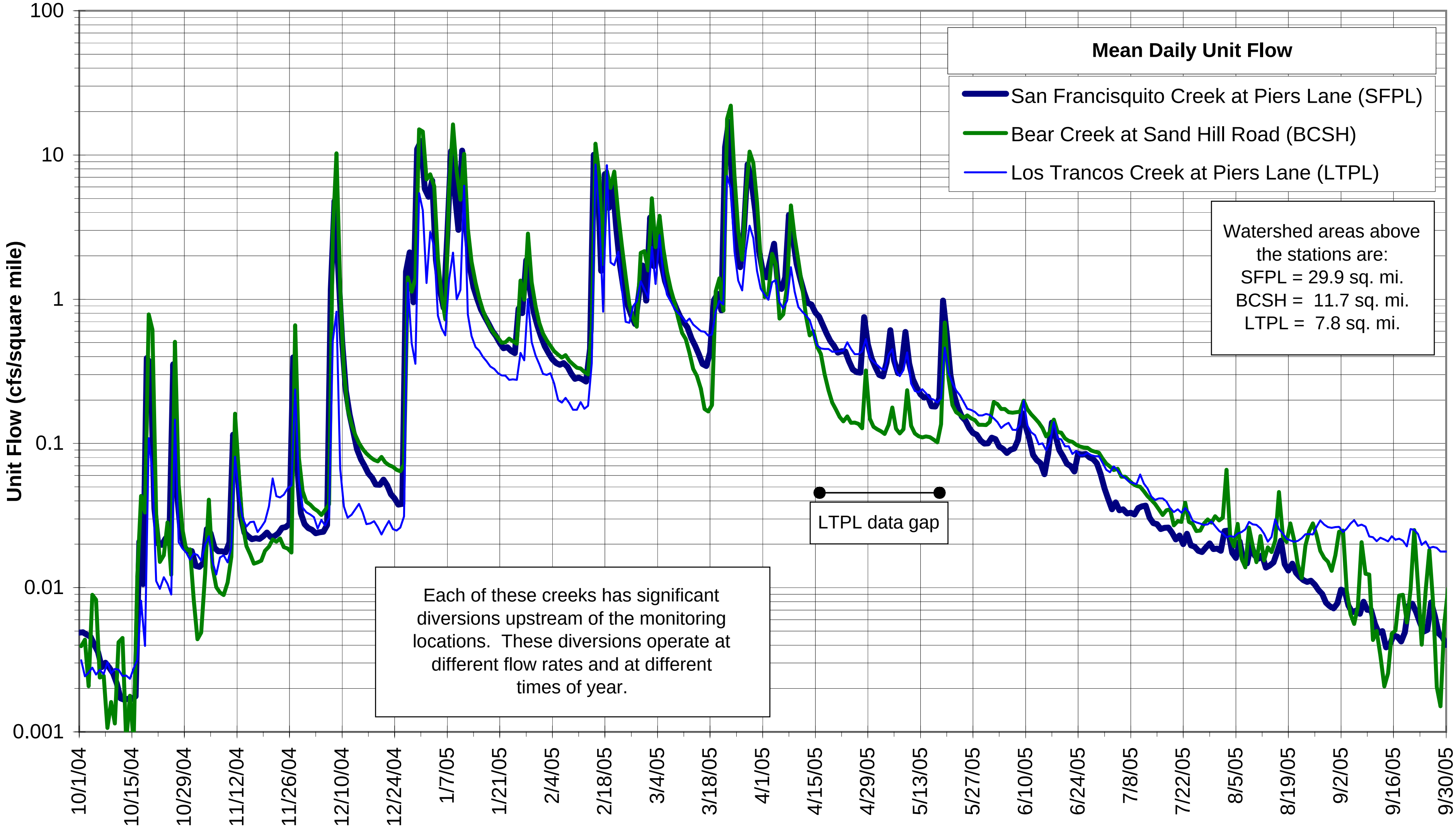
Figure 5. Daily flow hydrograph for Los Trancos Creek at Piers Lane, water year 2005. The peak flow of approximately 357 cfs was recorded on February 18, 2005 at 6:00 AM.



Note that the flow axis is logarithmic.

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Figure 6. Unit flow hydrographs for San Francisquito, Los Trancos and Bear Creeks, water year 2005. Unit flow is calculated by normalizing flow by watershed area. On a unit-flow basis, wet-season baseflow is lower in Los Trancos Creek and summer baseflow is lower in San Francisquito Creek. In most cases, this lower flow is probably due to diversions, but is also influenced by geology and topography.

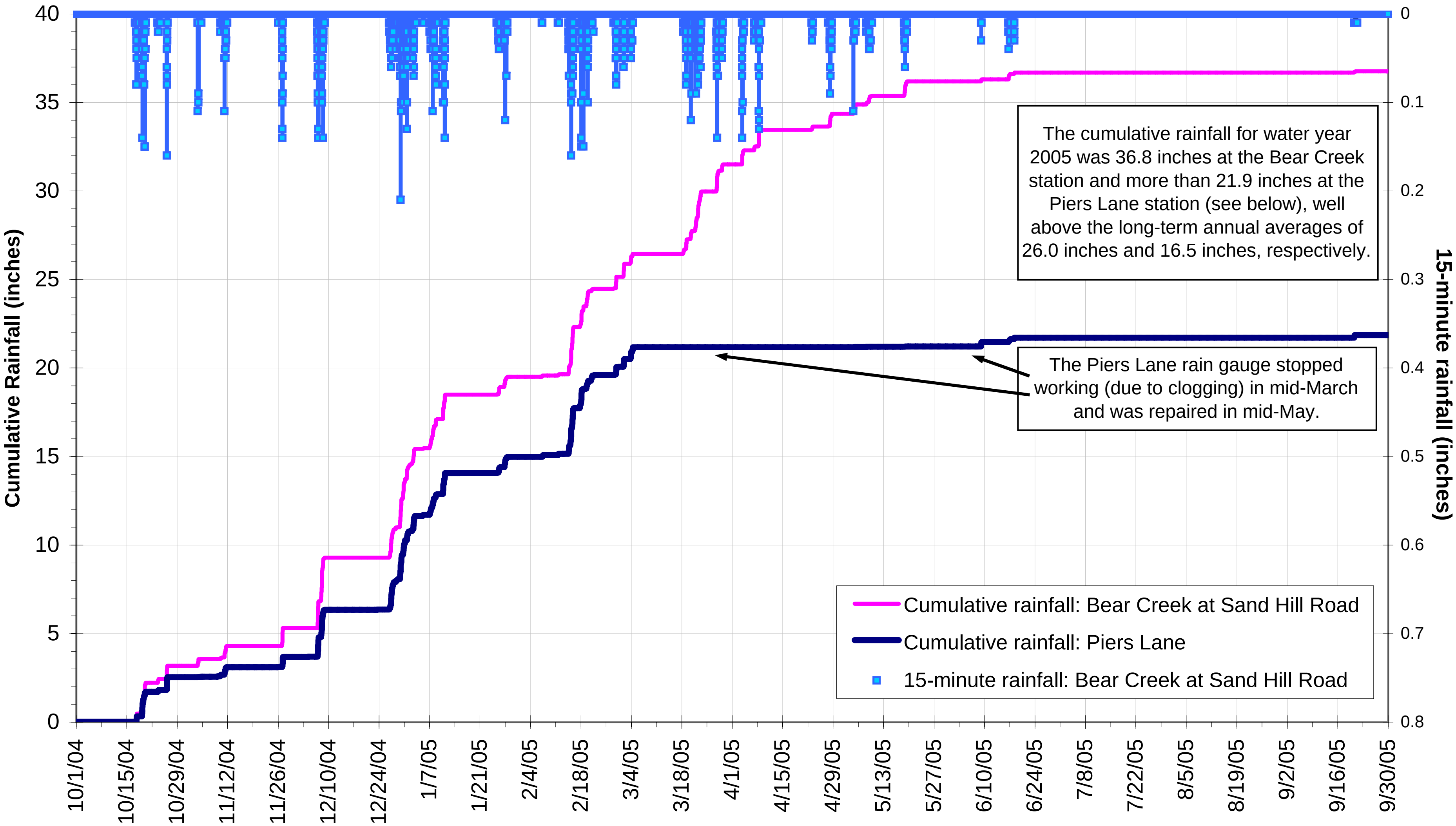

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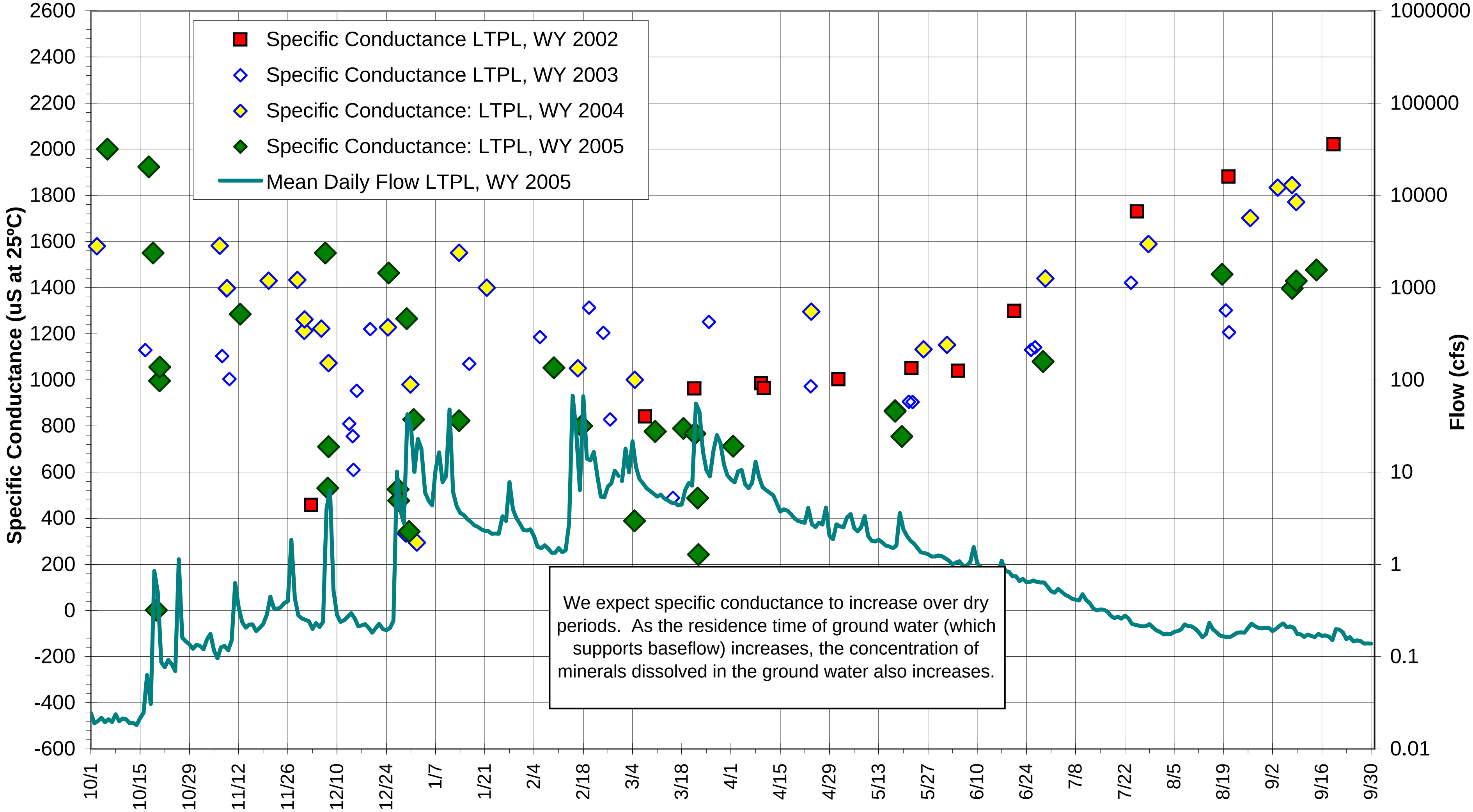
Figure 7. Cumulative and 15-minute precipitation record at Bear Creek at Sand Hill Road, and San Francisquito Creek at Piers Lane. Total rainfall for water year 2005 was about 40 percent above average at the Bear Creek station. Differences in rainfall through early March illustrate the rainfall gradient between the two stations due to the change in elevation.



Note that the flow axis is logarithmic.

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Figure 8. Specific conductance measurements, Los Trancos Creek at Piers Lane, water years 2002 to 2005. Specific conductance measurements during water year 2005 are higher in Los Trancos Creek than in San Francisquito or Bear Creek. This difference between creeks may be due to geologic influences or human causes.

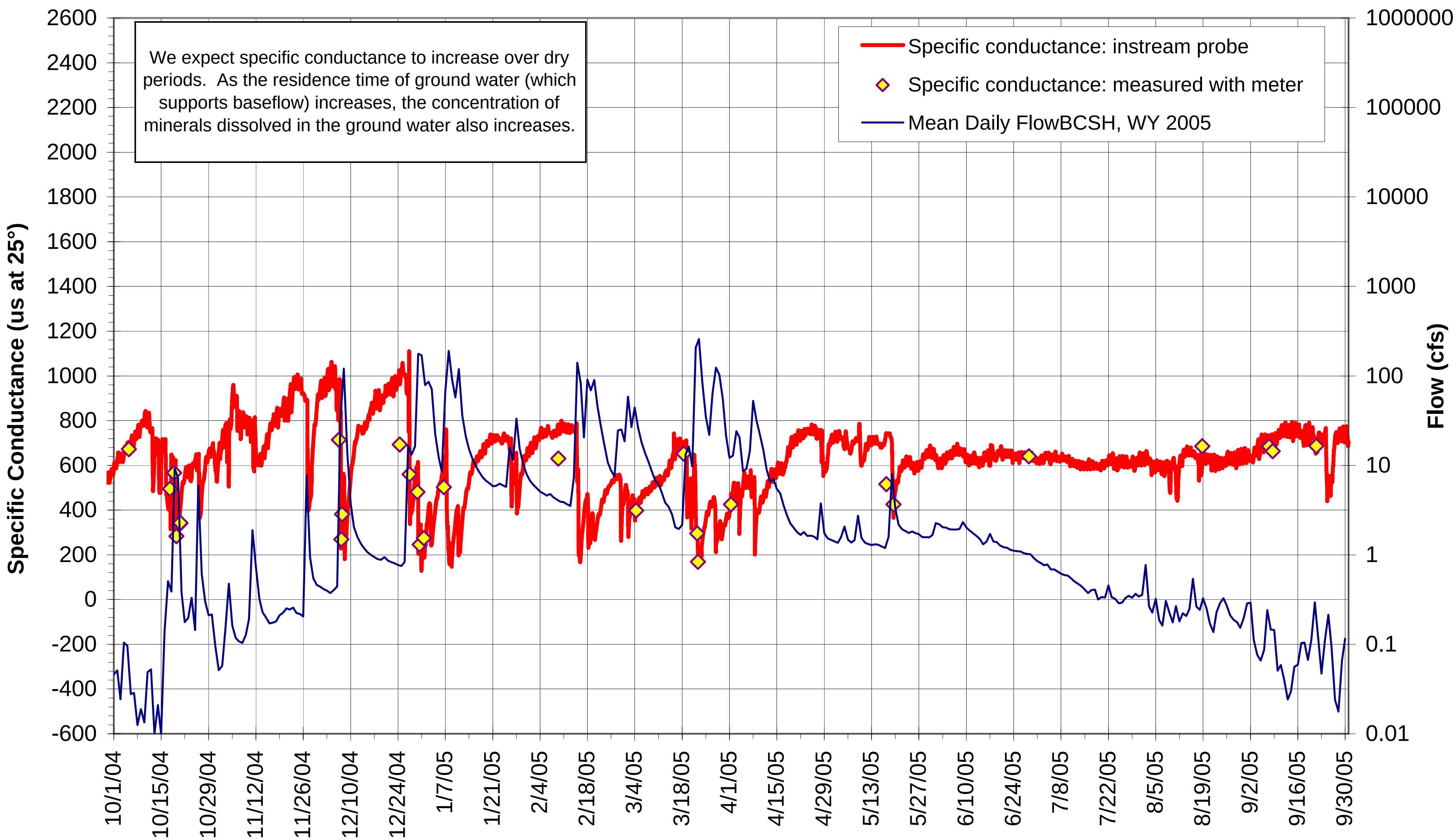

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Figure 9. Specific conductance measurements, Bear Creek at Sand Hill Road, water year 2005. Specific conductance is a proxy for the amount of dissolved ions in the water. It drops during storms because rainwater has fewer dissolved ions than groundwater, which has more contact with weathered rocks and soil. The flow record is plotted for reference.

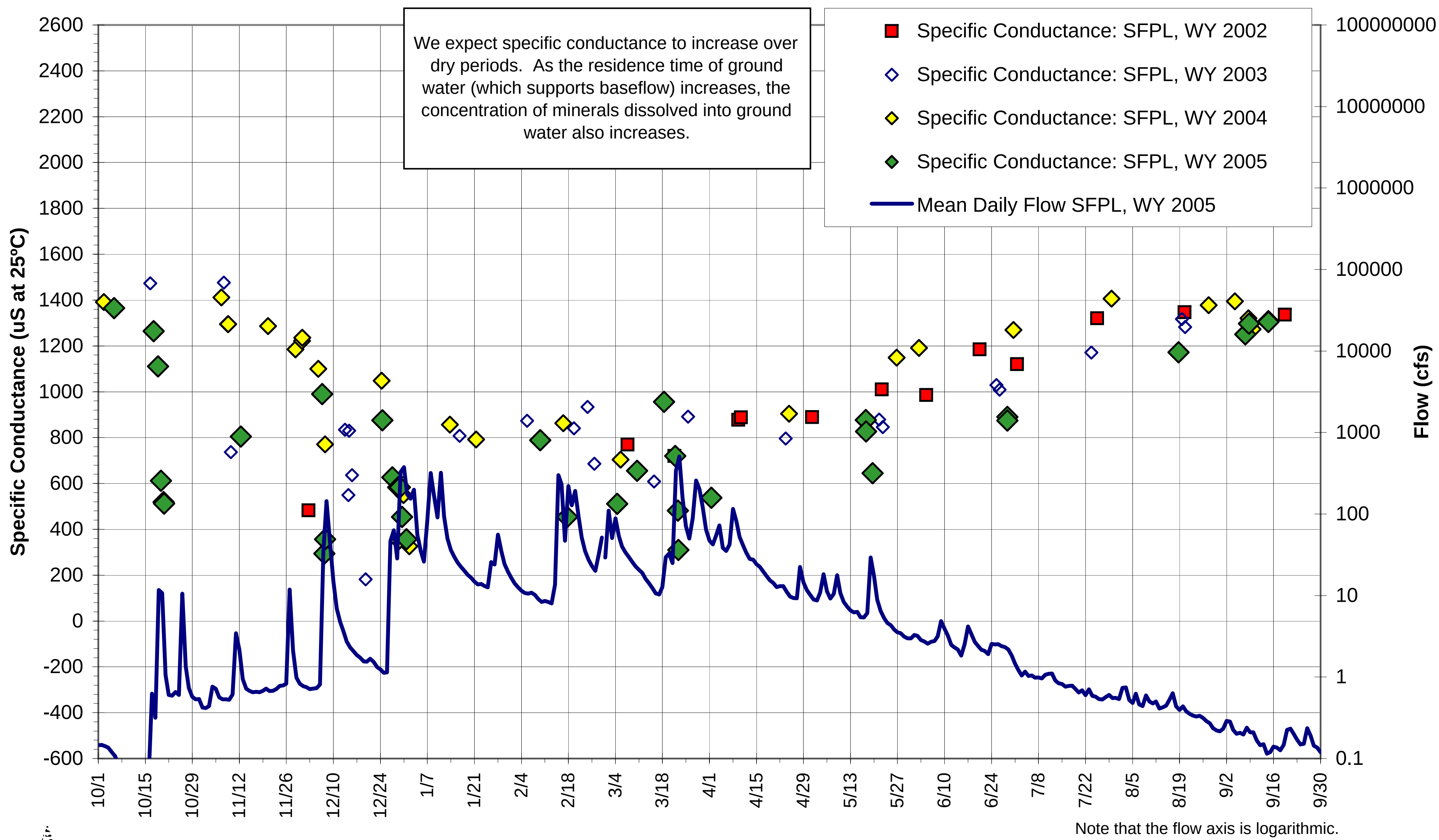

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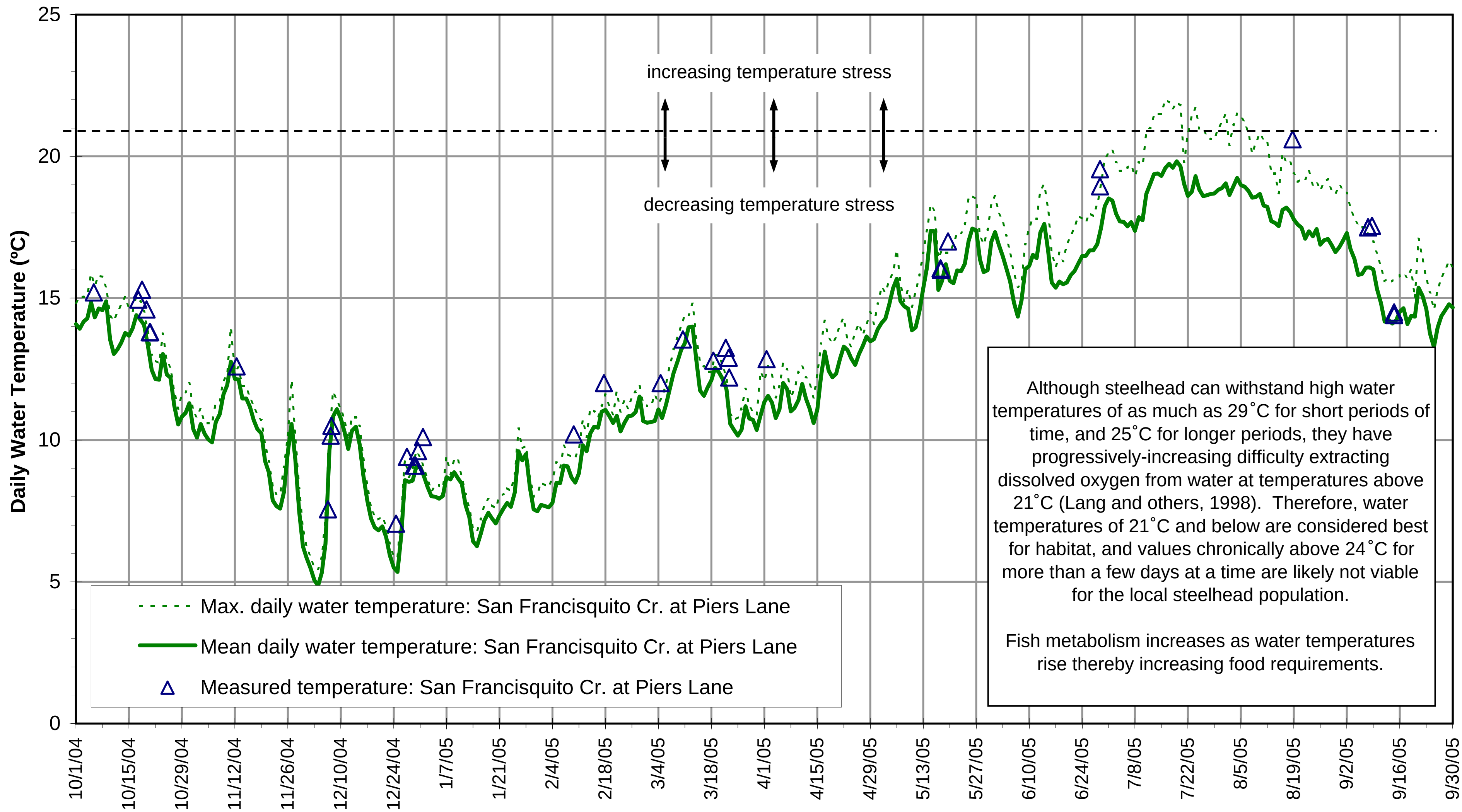
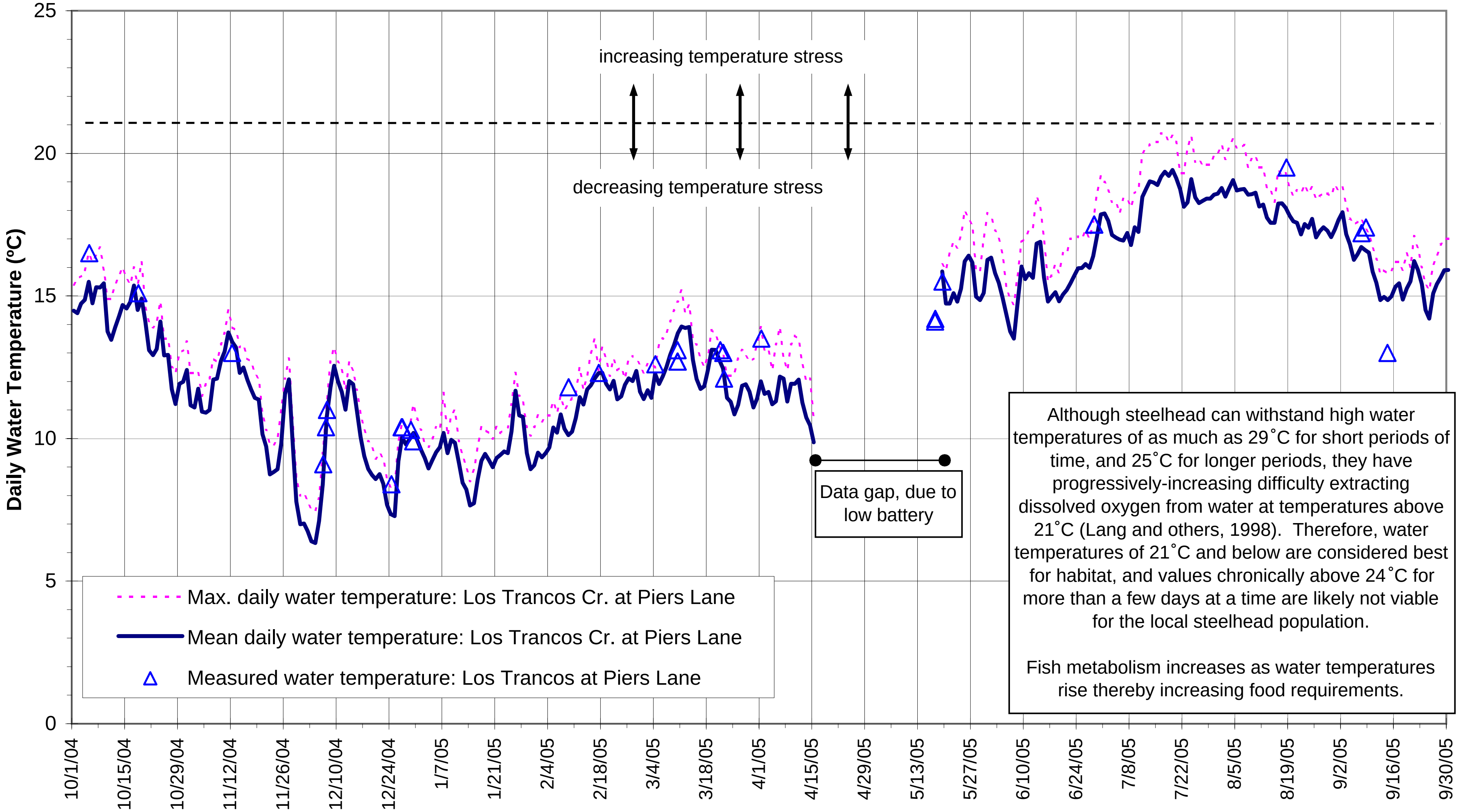
Figure 10. Specific conductance measurements, San Francisquito Creek at Piers Lane, water years 2002 to 2005. Flow records are plotted for reference. Specific conductance measurements are generally similar for all four years, with lower values during storms. The values during summer baseflow may be lower in 2005 due to the several small rain storms from May to June.



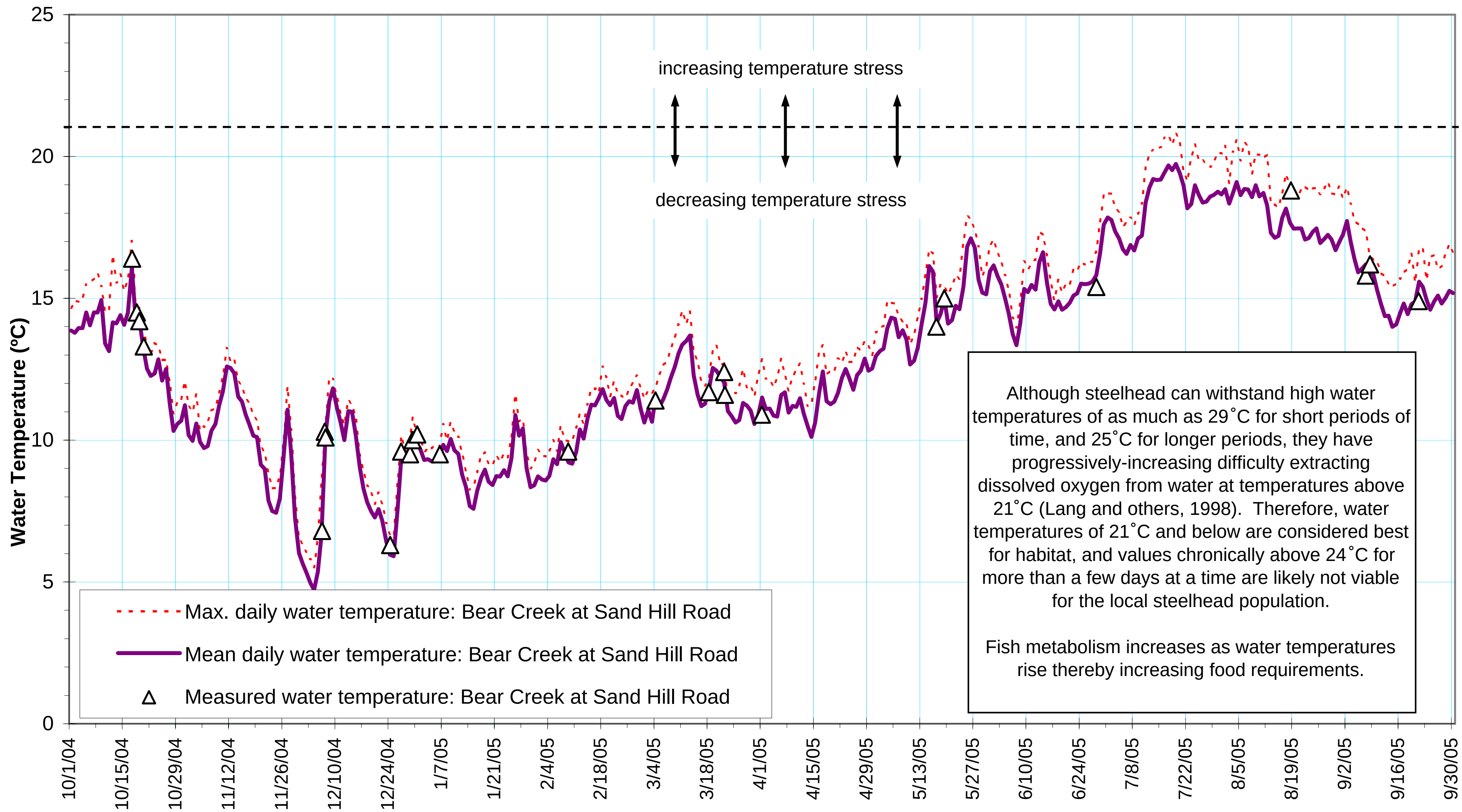
Balance Hydrologics, Inc.

Figure 11. Daily water temperature record for San Francisquito Creek at Piers Lane, water year 2005. Temperature patterns are similar at the San Francisquito Creek and Los Trancos Creek stations. Water temperatures seem to be slightly cooler in San Francisquito Creek than in Los Trancos Creek during the winter months and warmer during the summer.



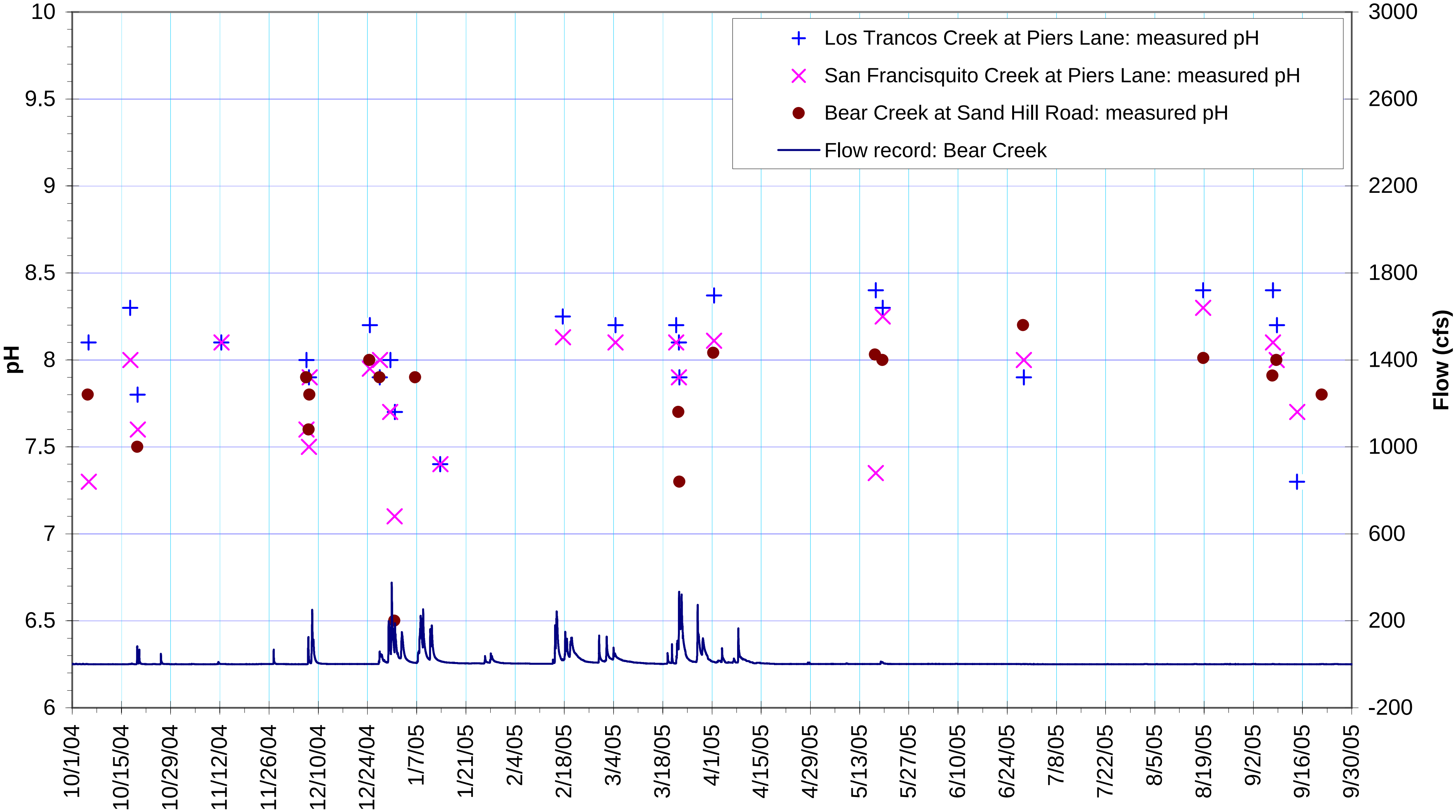
Balance Hydrologics, Inc.

Figure 12. Daily water temperature record for Los Trancos Creek at Piers Lane, water year 2005. Temperature patterns are similar at the San Francisquito Creek and Los Trancos Creek stations. Water temperature seems to be slightly warmer in Los Trancos Creek than in San Francisquito Creek during winter months and cooler during the summer.



Balance Hydrologics, Inc.

Figure 13. Daily water temperature record for Bear Creek at Sand Hill Road, water year 2005. During the wet season, Bear Creek was slightly cooler than San Francisquito Creek and markedly cooler than Los Trancos Creek. During the dry season, Bear Creek was cooler than Los Trancos Creek and much cooler than San Francisquito Creek.



Balance Hydrologics, Inc.

Figure 14. pH measurements in San Francisquito, Los Trancos and Bear Creeks, water year 2005. pH values in Los Trancos Creek are slightly higher. Field measurements were made primarily with hand-held pH meters, and occasionally with pH strips. Instream pH probes at all three stations were inoperable. The Bear Creek flow record is plotted for reference.

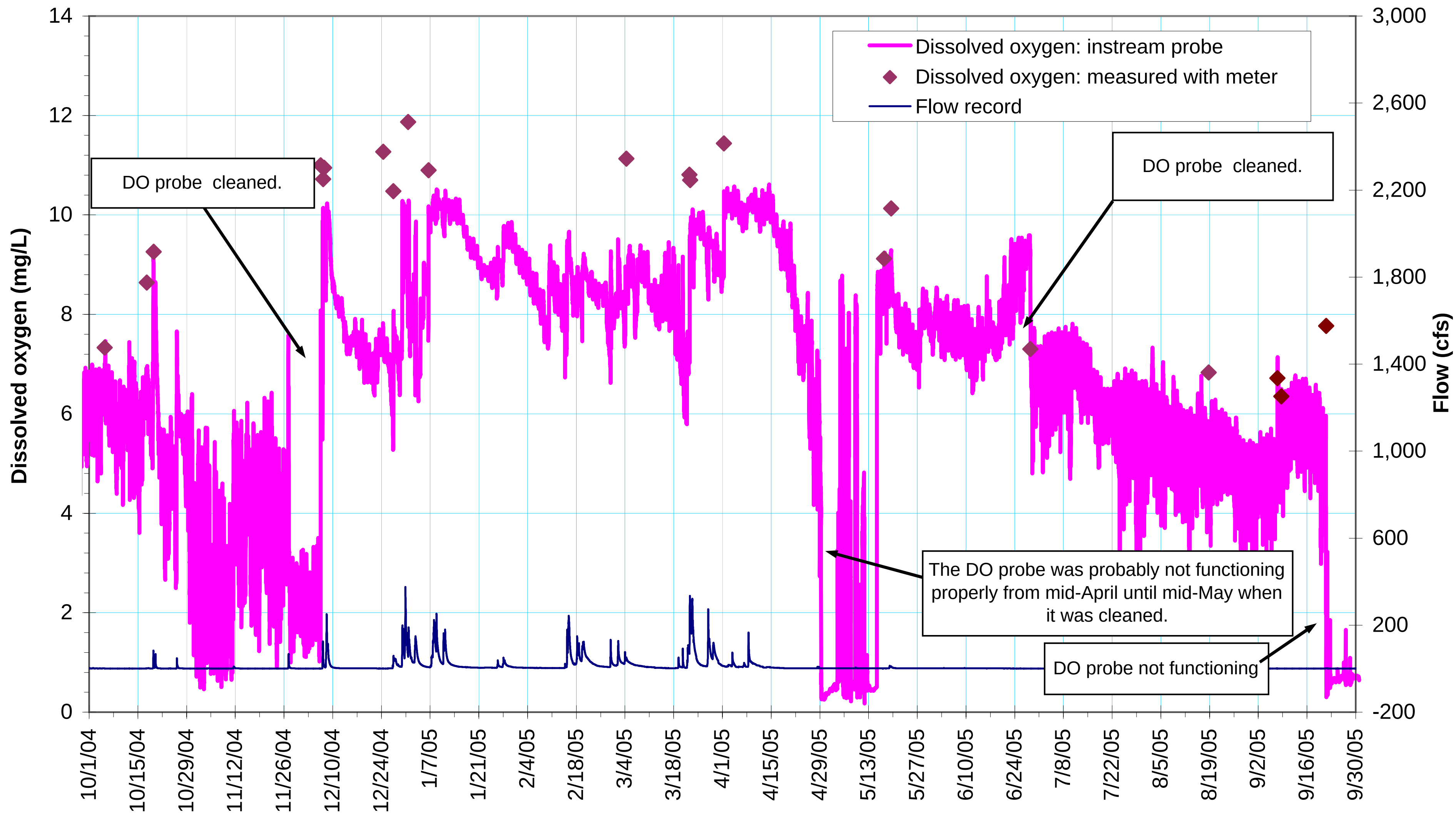


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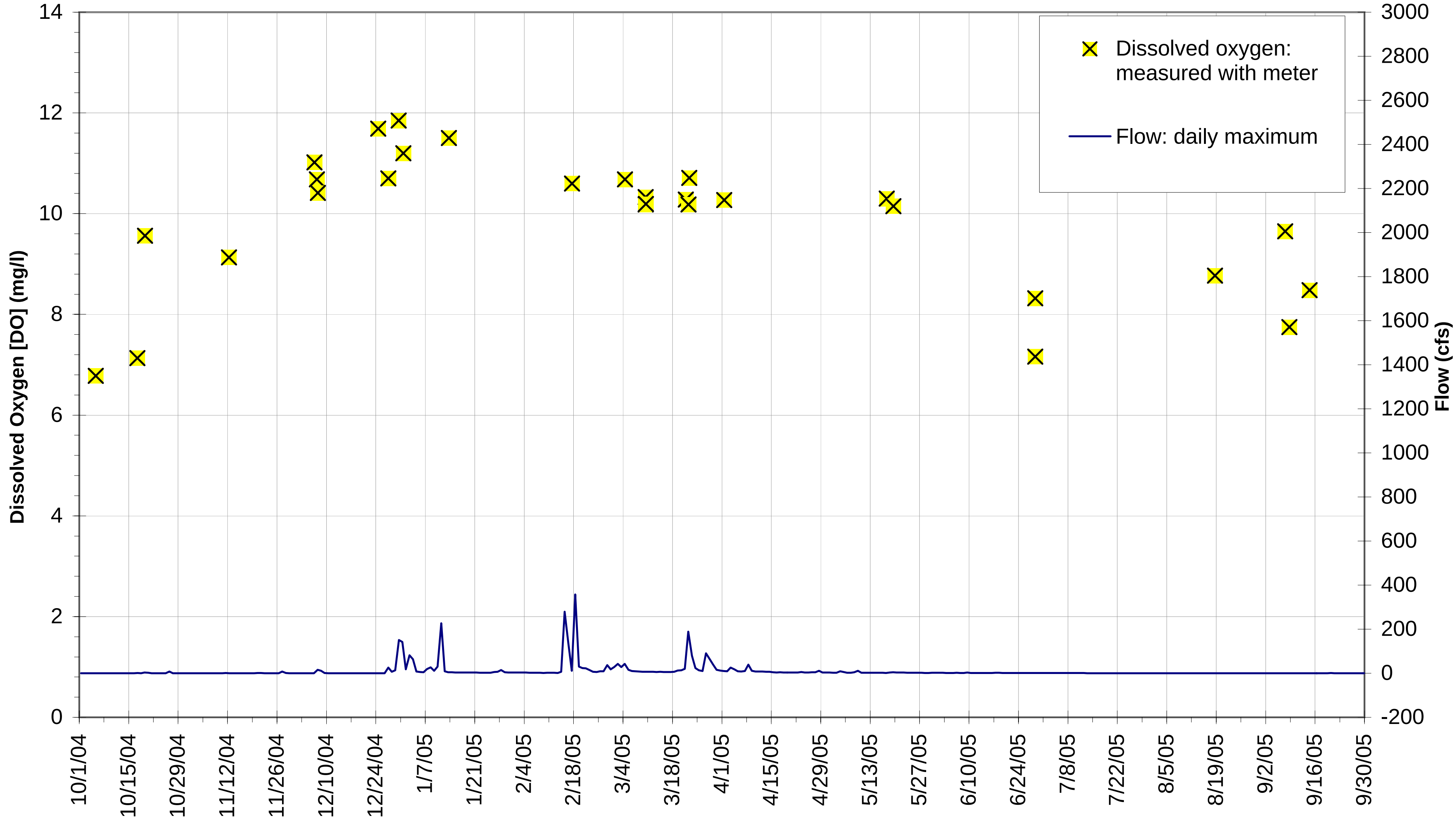
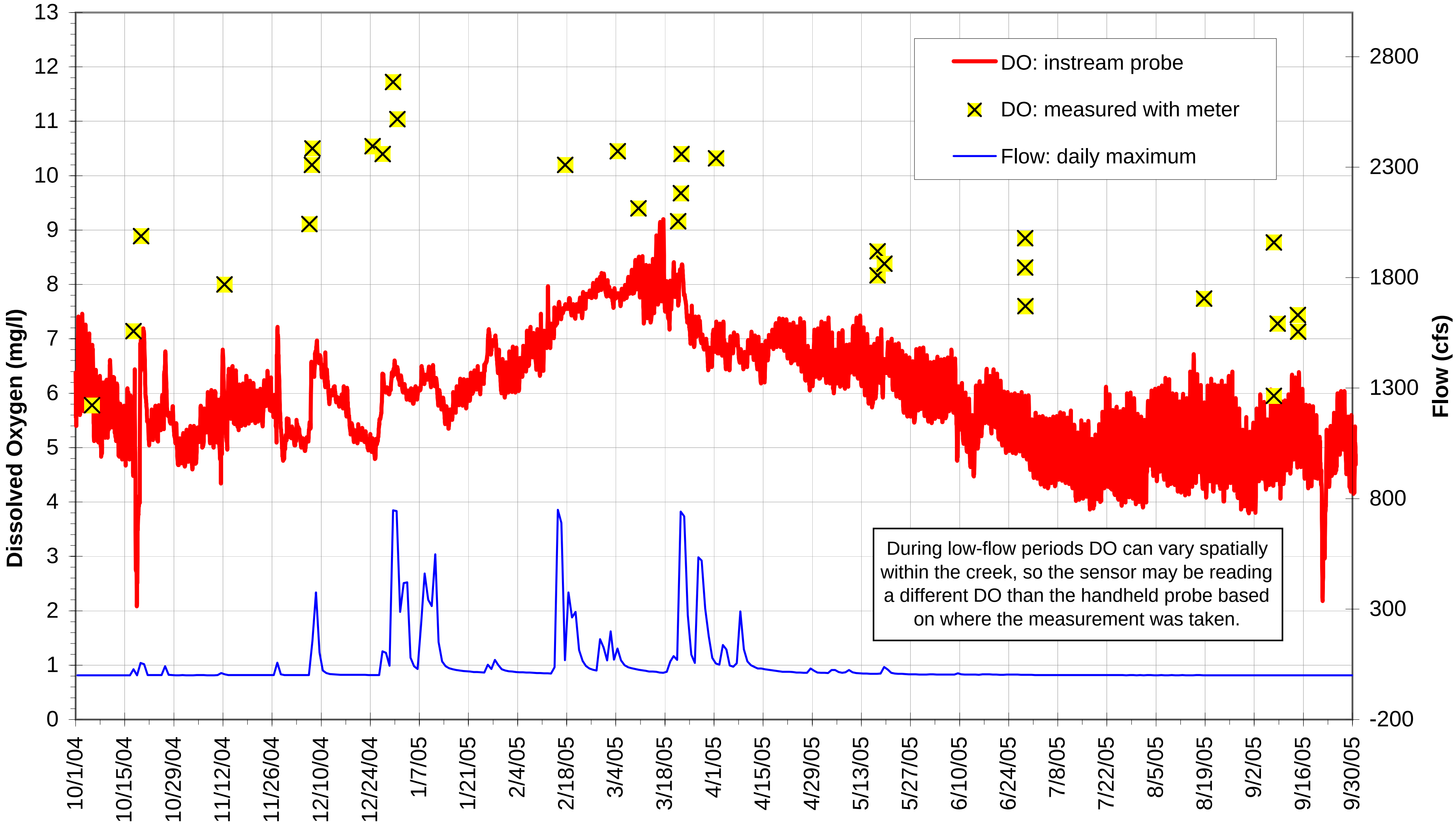
Figure 15. Dissolved oxygen record in Bear Creek at Sand Hill Road, water year 2005. We expect the lowest values of the year to occur in the autumn, before high flows flush fallen leaves out of the creek. Field measurements with a dissolved oxygen (DO) meter are the main source of record for the year. The instream probe needs to be cleaned regularly, and thus did not function well during all periods of the water year. Percent saturation of dissolved oxygen measurements are presented in the observer log (Table 1).

202094 WY2005 BCSH 15min, DO



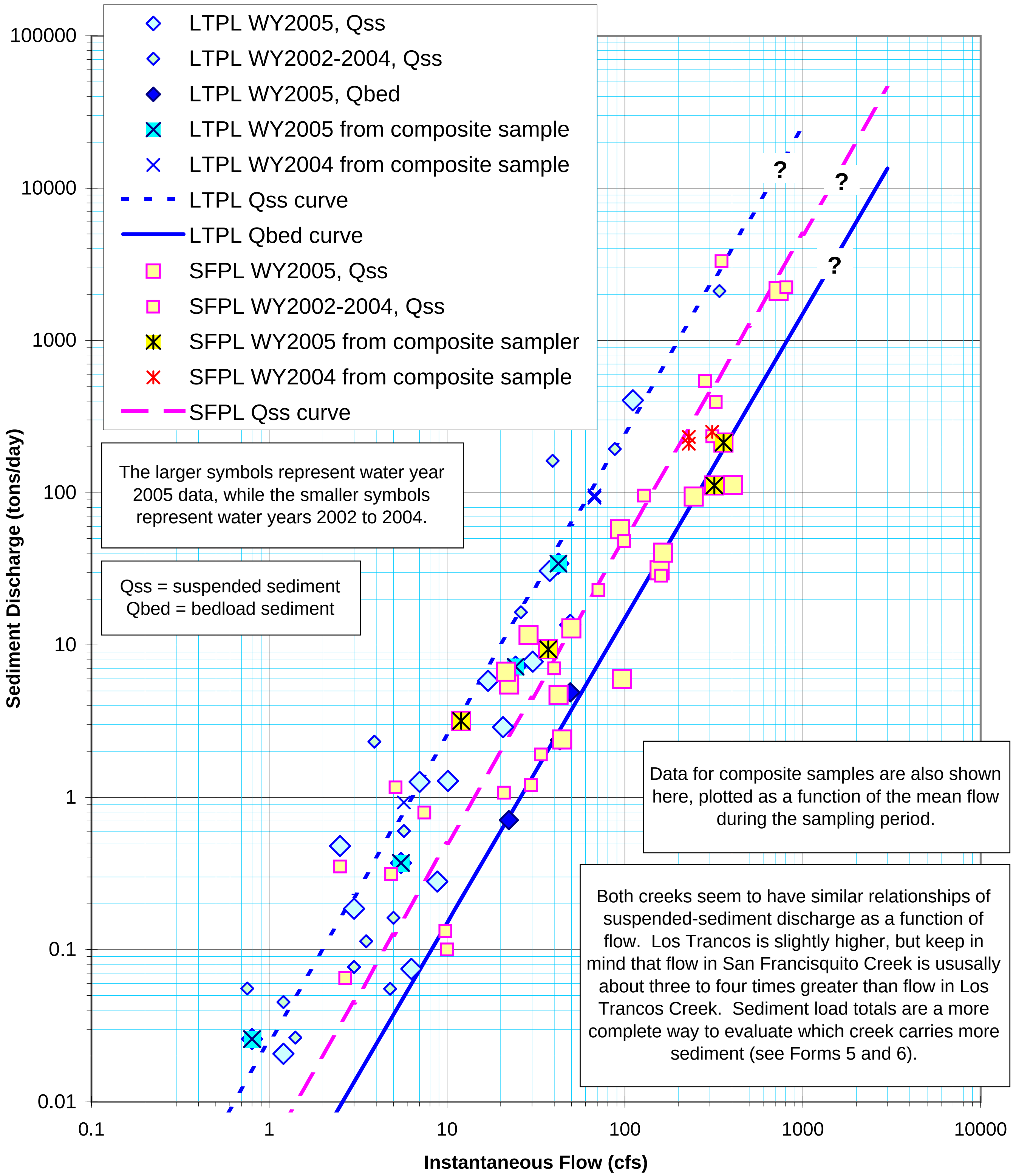
Balance Hydrologics, Inc.

Figure 16. Dissolved oxygen concentrations in Los Trancos Creek at Piers Lane, water year 2005. The dissolved oxygen probe did not function properly. Field measurements by Balance staff indicate that dissolved oxygen concentrations are lower during summer low flows when water temperatures are higher and stream turbulence is lower. The flow record is plottted for reference.



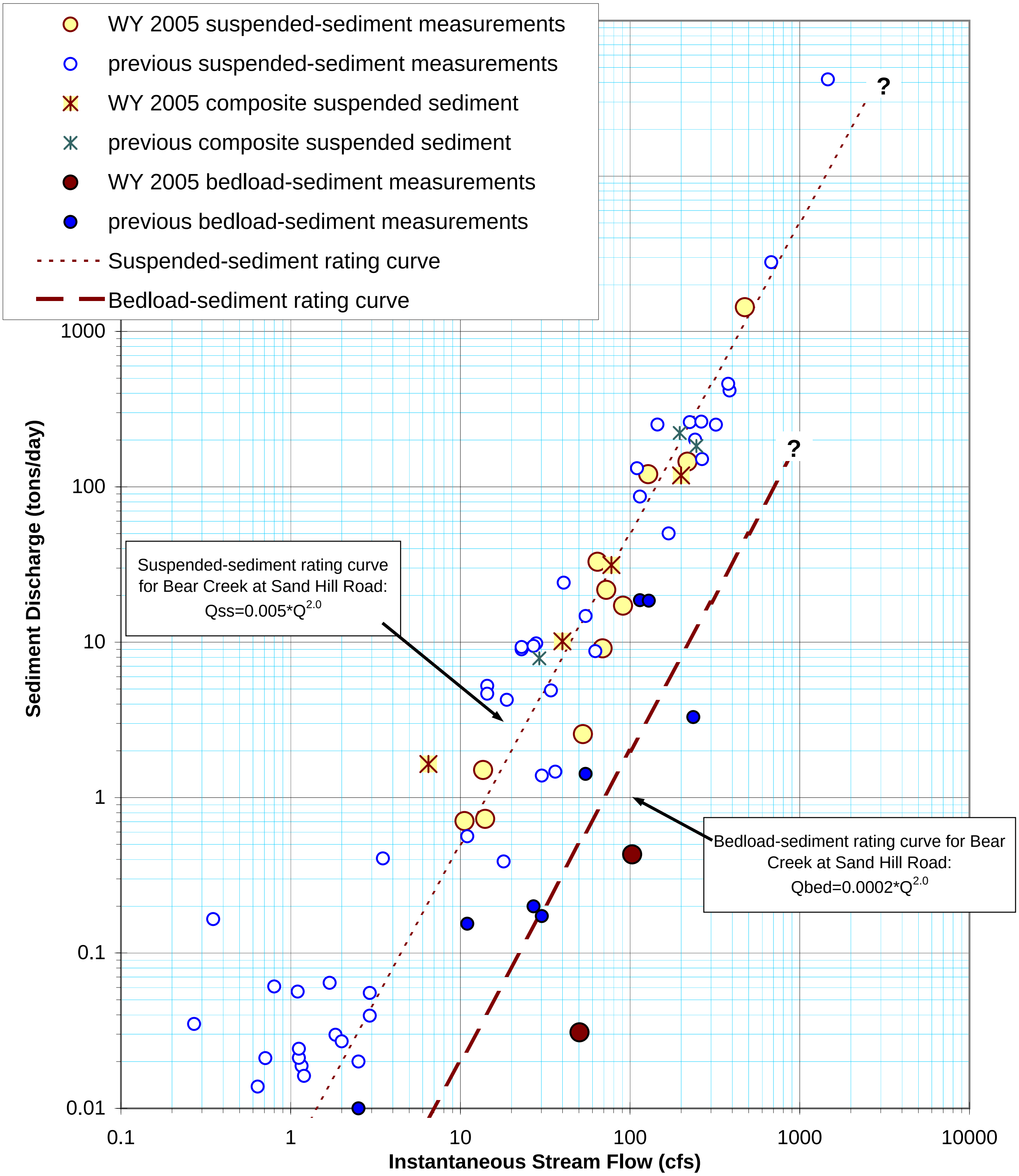
Balance Hydrologics, Inc.

Figure 17. Dissolved oxygen concentrations in San Francisquito Creek at Piers Lane, water year 2005. The dissolved oxygen (DO) probe did not function well. However, values recorded by the in-stream probe indicate a similar pattern to measured values, showing low DO during the summer and fall until rains wash dead leaves out of the creek. The flow record is plottted for reference.



Balance Hydrologics, Inc.

Figure 18. Sediment measurements and rating curves for the Piers Lane stations. In both creeks, the sediment discharge as a function of flow appears to be slightly lower in water year 2005 than previous years.



Balance Hydrologics, Inc.

Figure 19. Sediment measurements and rating curves for Bear Creek at Sand Hill Road, water years 1998 to 2005. Sediment dsicharge as a function of flow seems slightly lower than during previous years; the rating curves have been shifted to account for this factor.

APPENDICES

APPENDIX A

Laboratory results and chain of custody forms
(Piers Lane Stations)

Not included in electronic version of report

APPENDIX B

Laboratory results and chain of custody forms
(Bear Creek)

Not included in electronic version of report

APPENDIX C

Detailed hydrographs of wet-season periods during which composite samples were collected

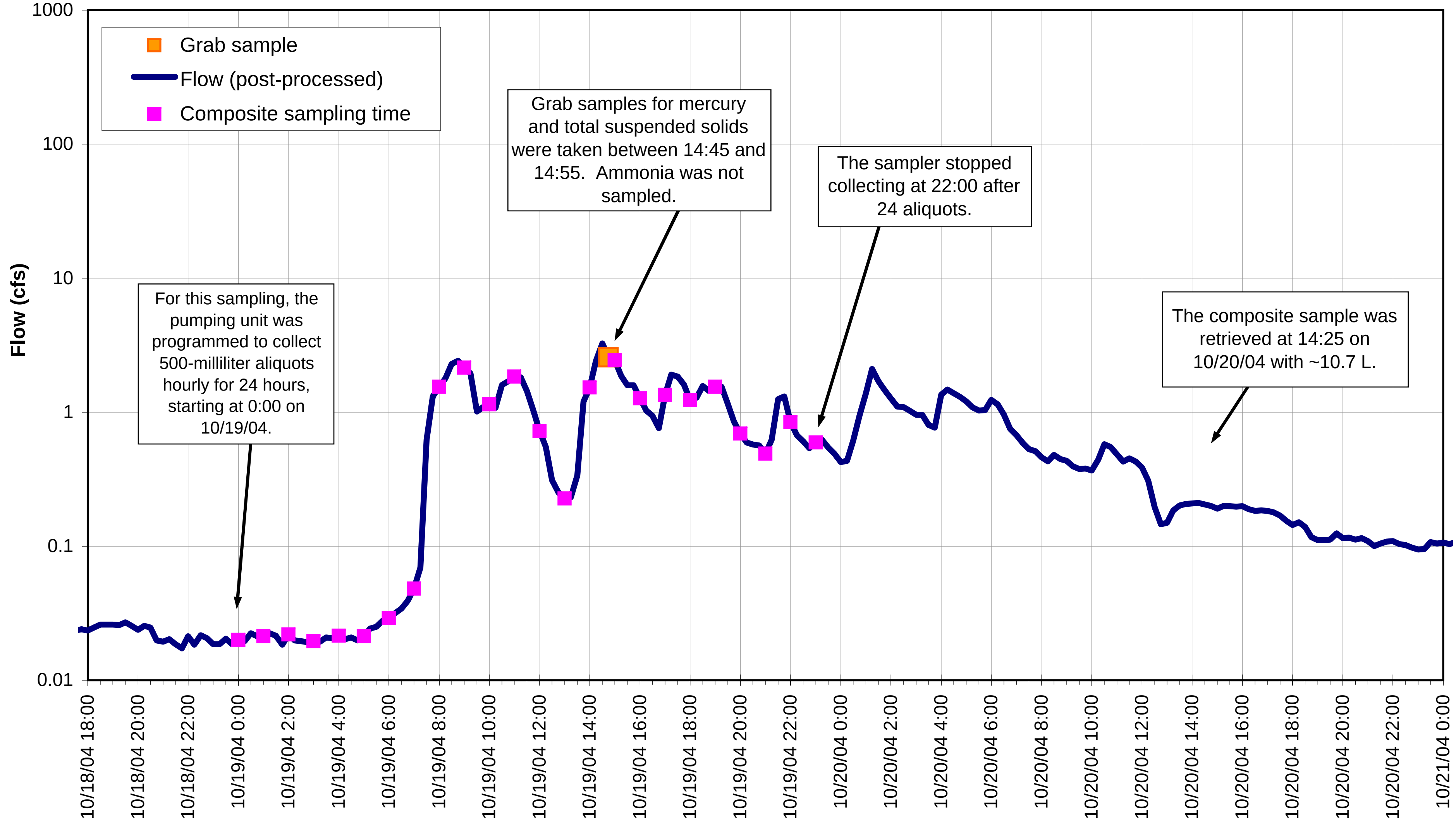


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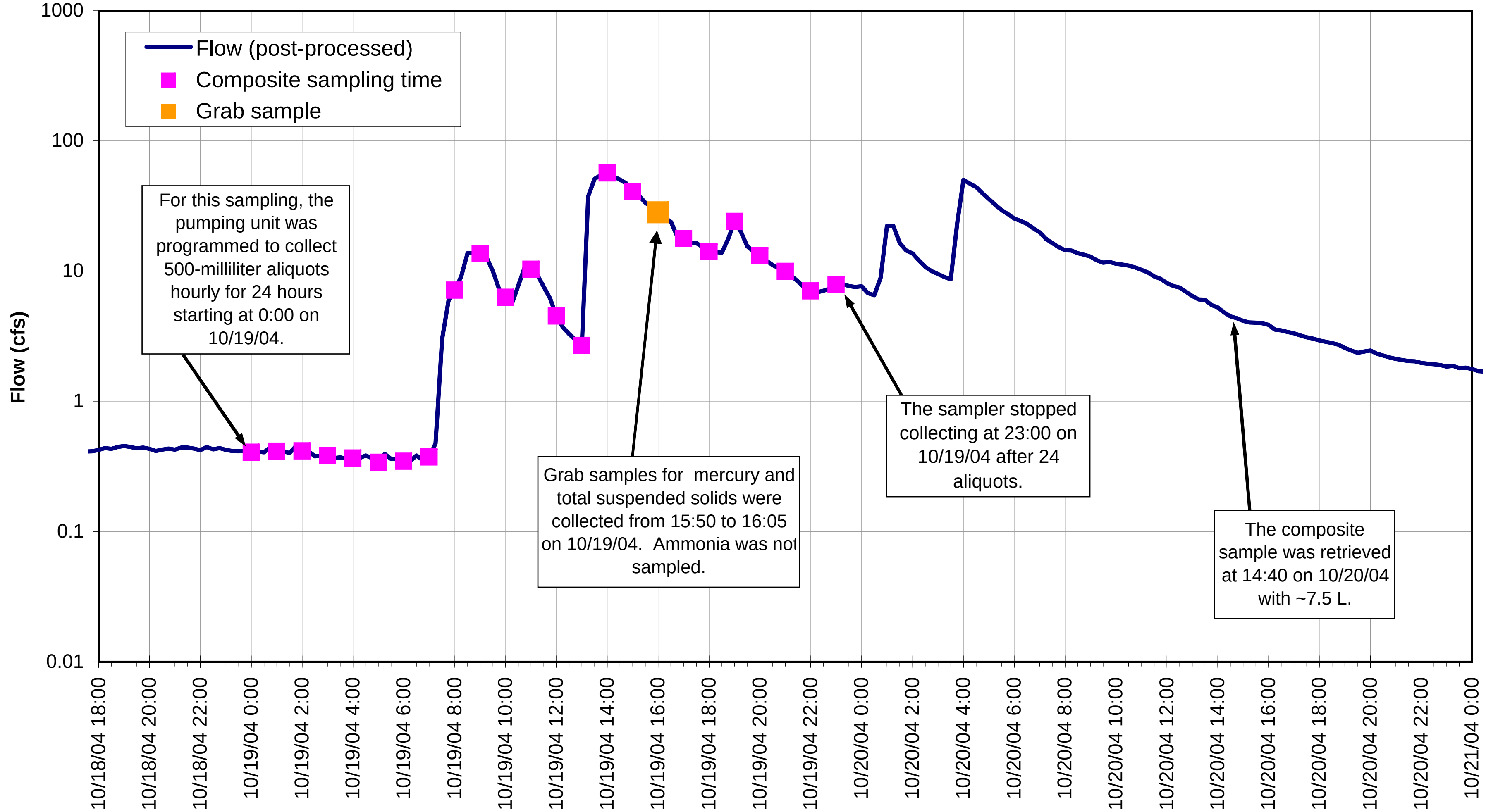
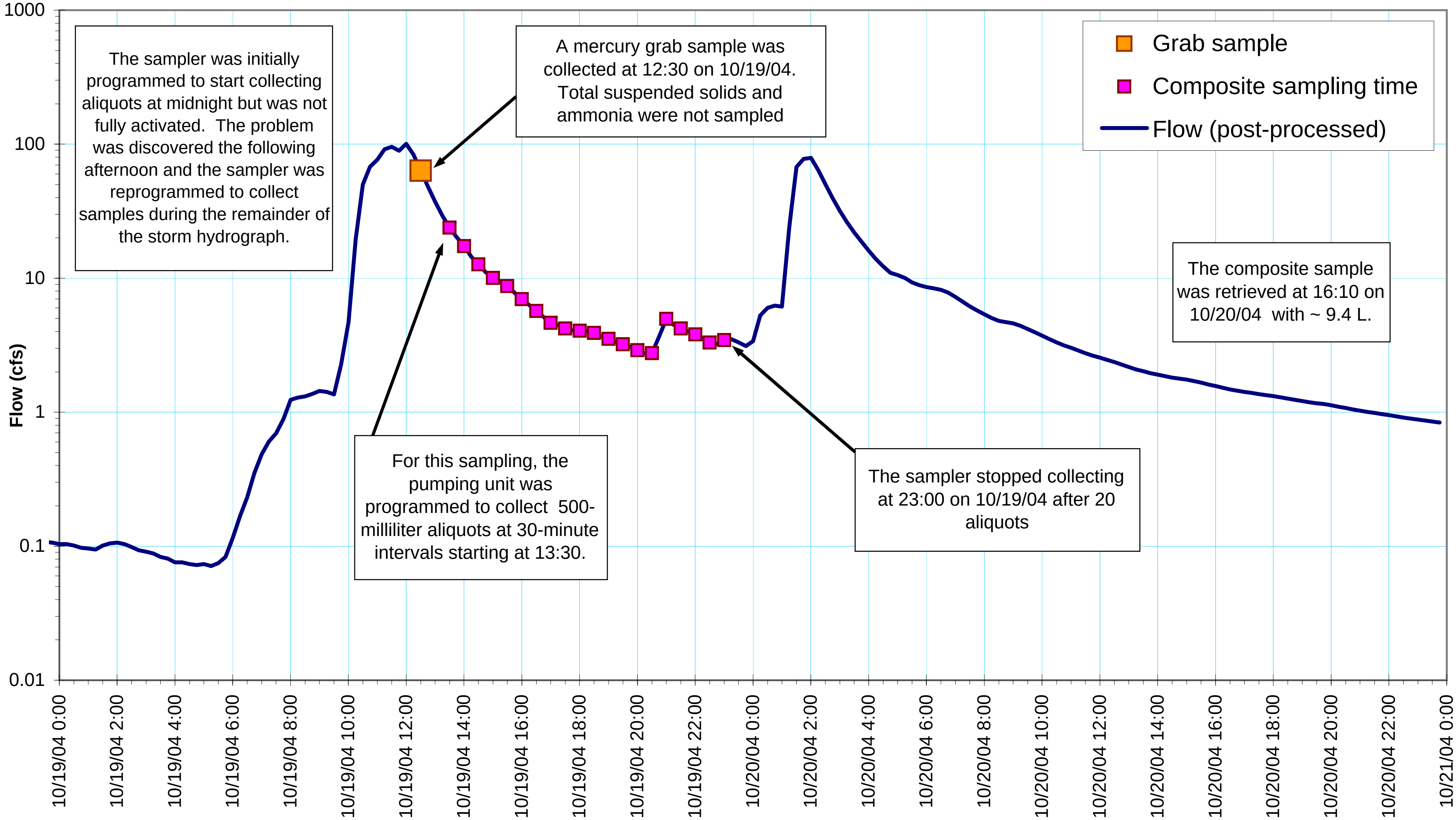
Figure C1. Water-quality sampling detailed hydrograph, October 19, 2004, Los Trancos Creek at Piers Lane. This sampling was intended to capture runoff from the first-flush event. The sampling was time-paced and grab samples were collected at the flow peak. We sampled a much smaller peak two days before but discarded the sample and reprogrammed the unit to sample this event instead.



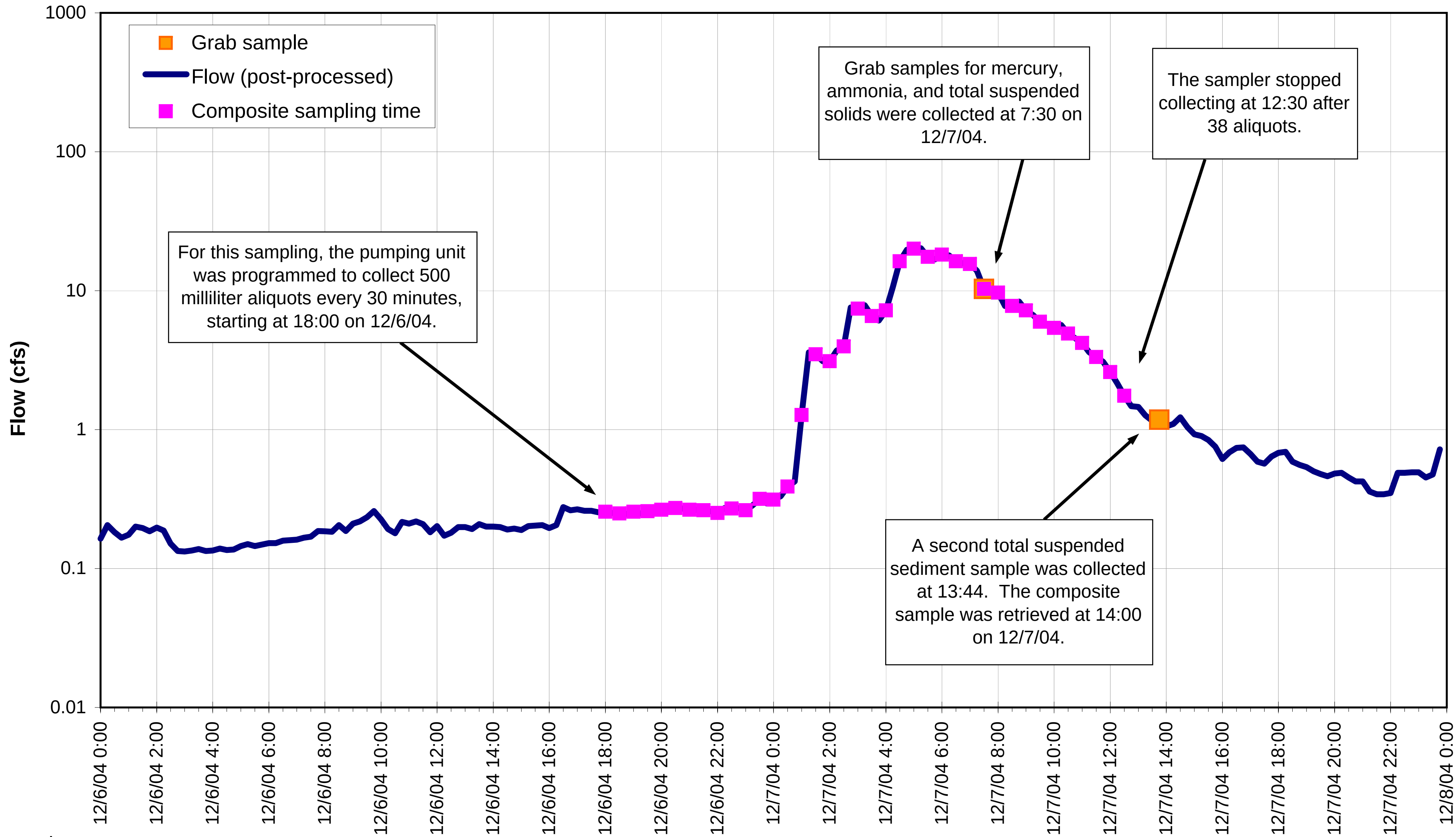
Balance Hydrologics, Inc.

Figure C2. Water-quality sampling detailed hydrograph, October 19 to 20, 2004, San Francisquito Creek at Piers Lane. This sampling was intended to capture runoff from the first-flush event. The sampling was time-paced and grab samples were collected at the flow peak.



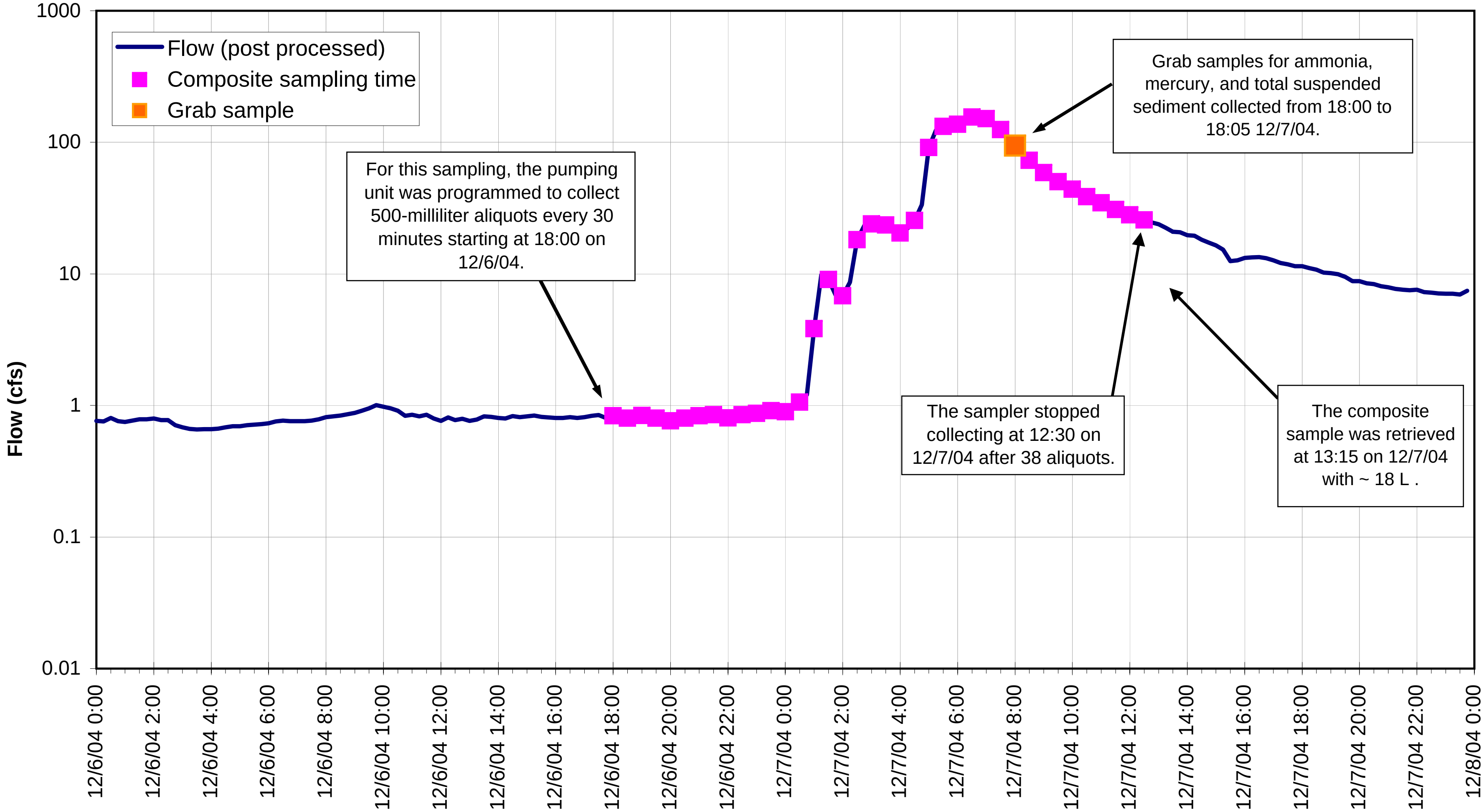
Balance Hydrologics, Inc.

Figure C3. Water-quality sampling detailed hydrograph, October 19, 2004, Bear Creek at Sand Hill Road. This sampling was intended to capture runoff from the first-flush event. The sampling was time-paced and grab samples were collected just after the flow peak.



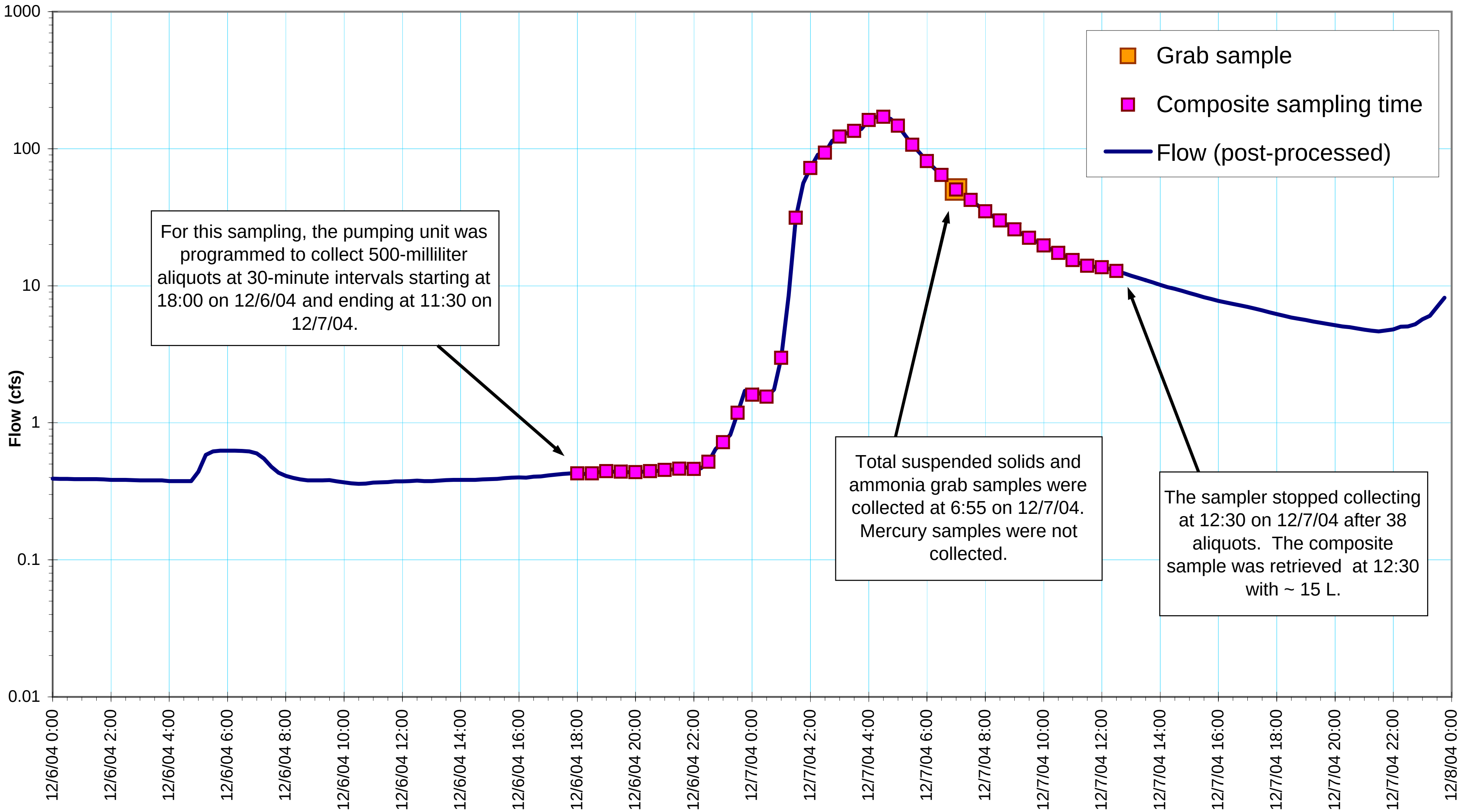
Balance Hydrologics, Inc.

Figure C4. Water-quality sampling detailed hydrograph, December 6 to 7, 2004, Los Trancos Creek at Piers Lane. This sampling was intended to capture runoff from a moderate winter storm. The sampling was time-paced and grab samples were collected just after the flow peak.



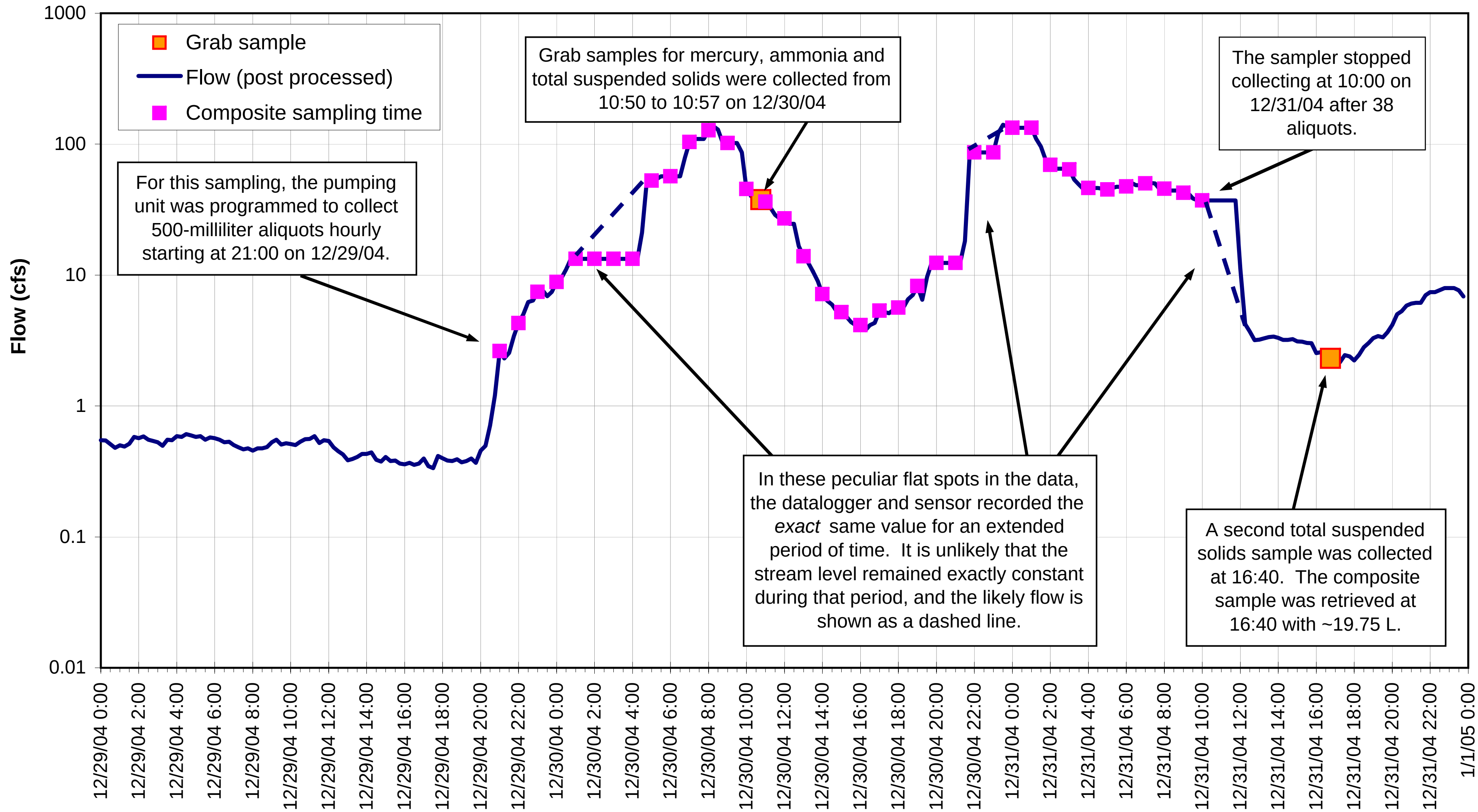
Balance Hydrologics, Inc.

Figure C5. Water-quality sampling detailed hydrograph, December 6 to 7, 2004, San Francisquito Creek at Piers Lane. This sampling was intended to capture runoff from a moderate winter storm. The sampling was time-paced and grab samples were collected just after the flow peak.



Balance Hydrologics, Inc.

Figure C6. Water-quality sampling detailed hydrograph, December 6 to 7, 2004, Bear Creek at Sand Hill Road. This sampling was intended to capture runoff from a large winter storm. The sampling was time-paced and grab samples were collected after the flow peak.



Balance Hydrologics, Inc.

Figure C7. Water-quality sampling detailed hydrograph, December 29 to 31, 2004, Los Trancos Creek at Piers Lane. This sampling captured runoff from a winter storm with moderately high flows. The sampling was time-paced and grab samples were collected just after the flow peak.

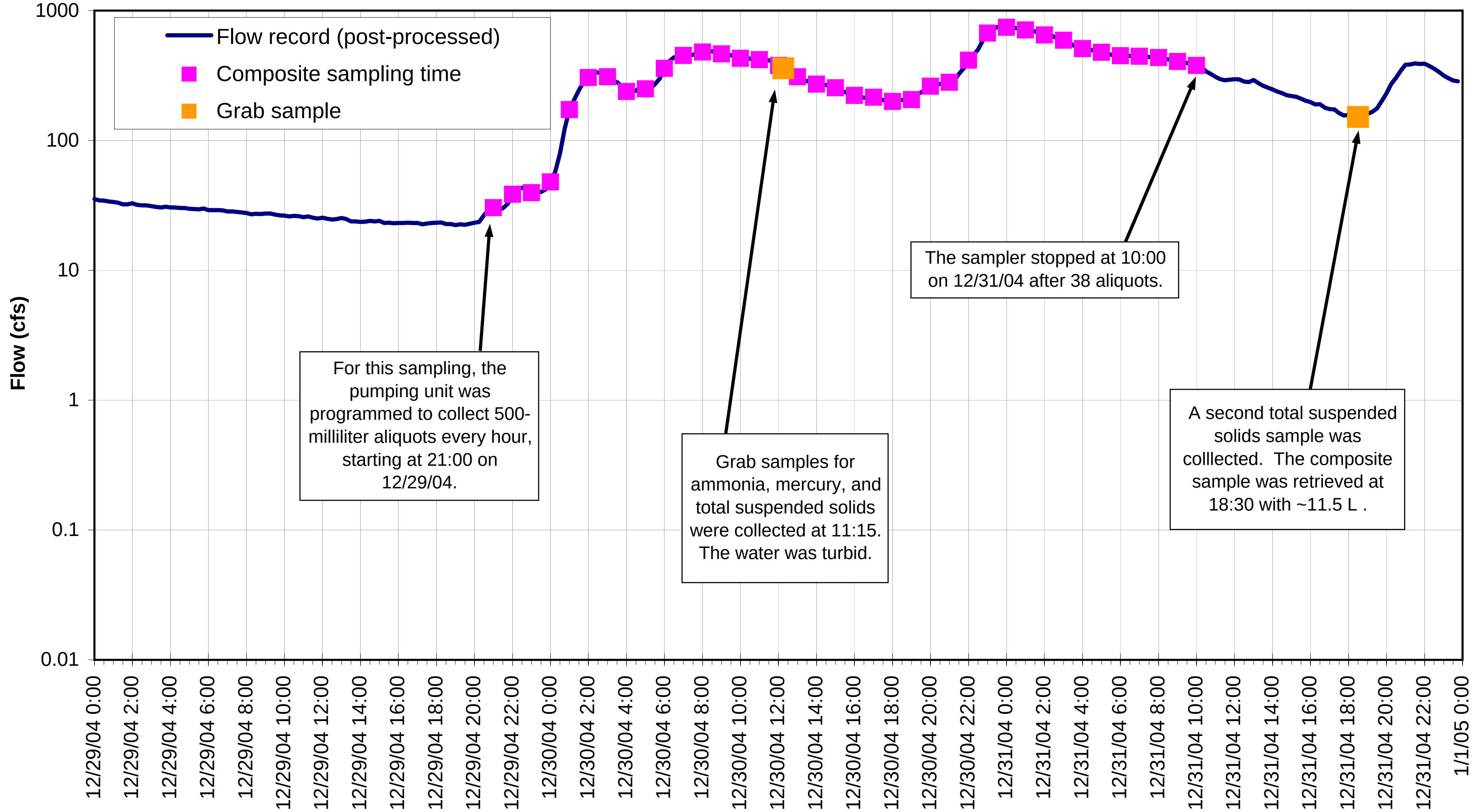


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Figure C8. Water-quality sampling detailed hydrograph, December 29 to 31, 2004, San Francisquito Creek at Piers Lane. This sampling captured runoff from a large winter storm event, with flows among the highest of the water year. Sampling was time-paced and grab samples were collected at the flow peak.

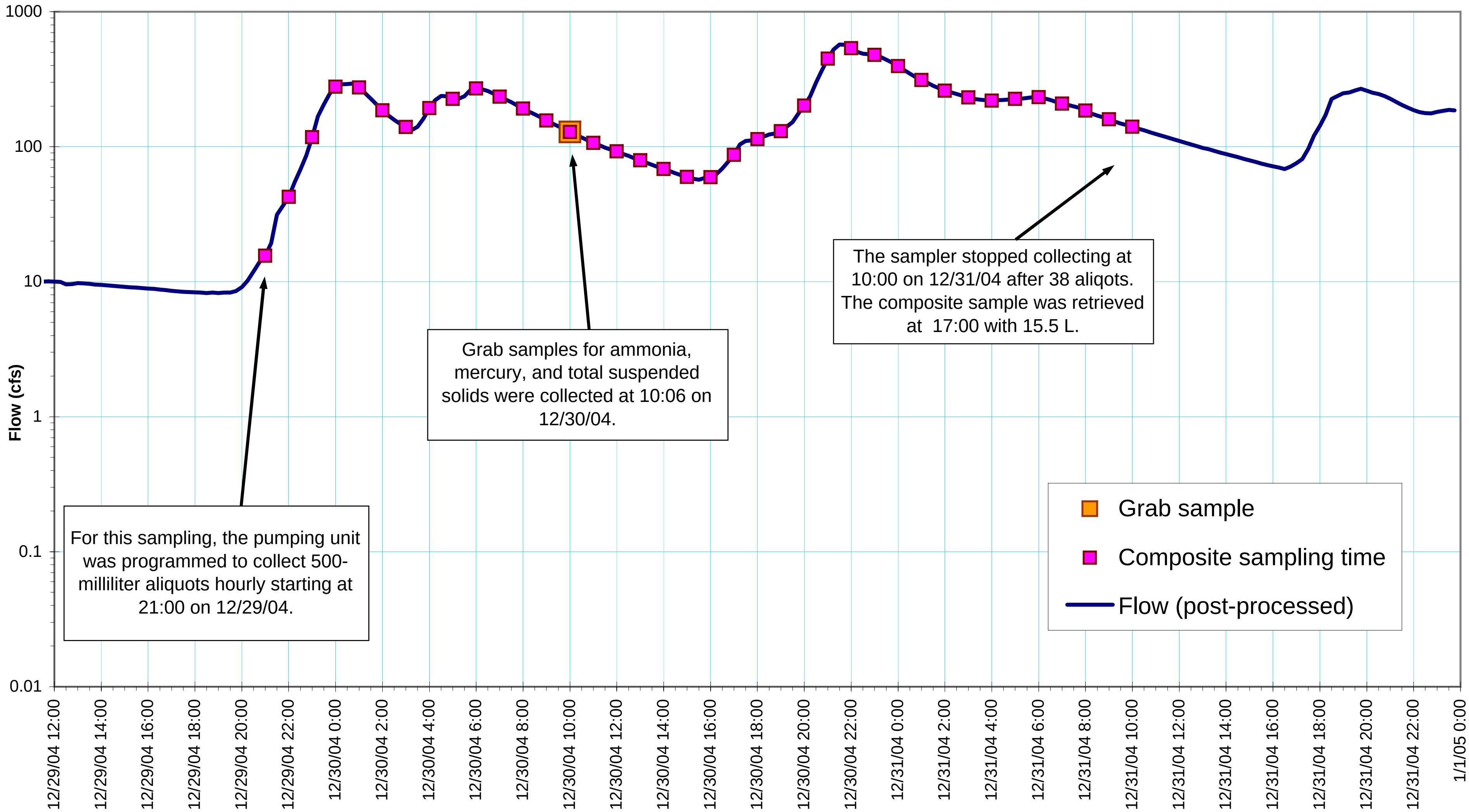

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Figure C9. Water-quality sampling detailed hydrograph, December 29 to 31, 2004, Bear Creek at Sand Hill Road. This sampling was intended to capture runoff from a large winter storm. The sampling was time-paced and grab samples were collected at the flow peak.

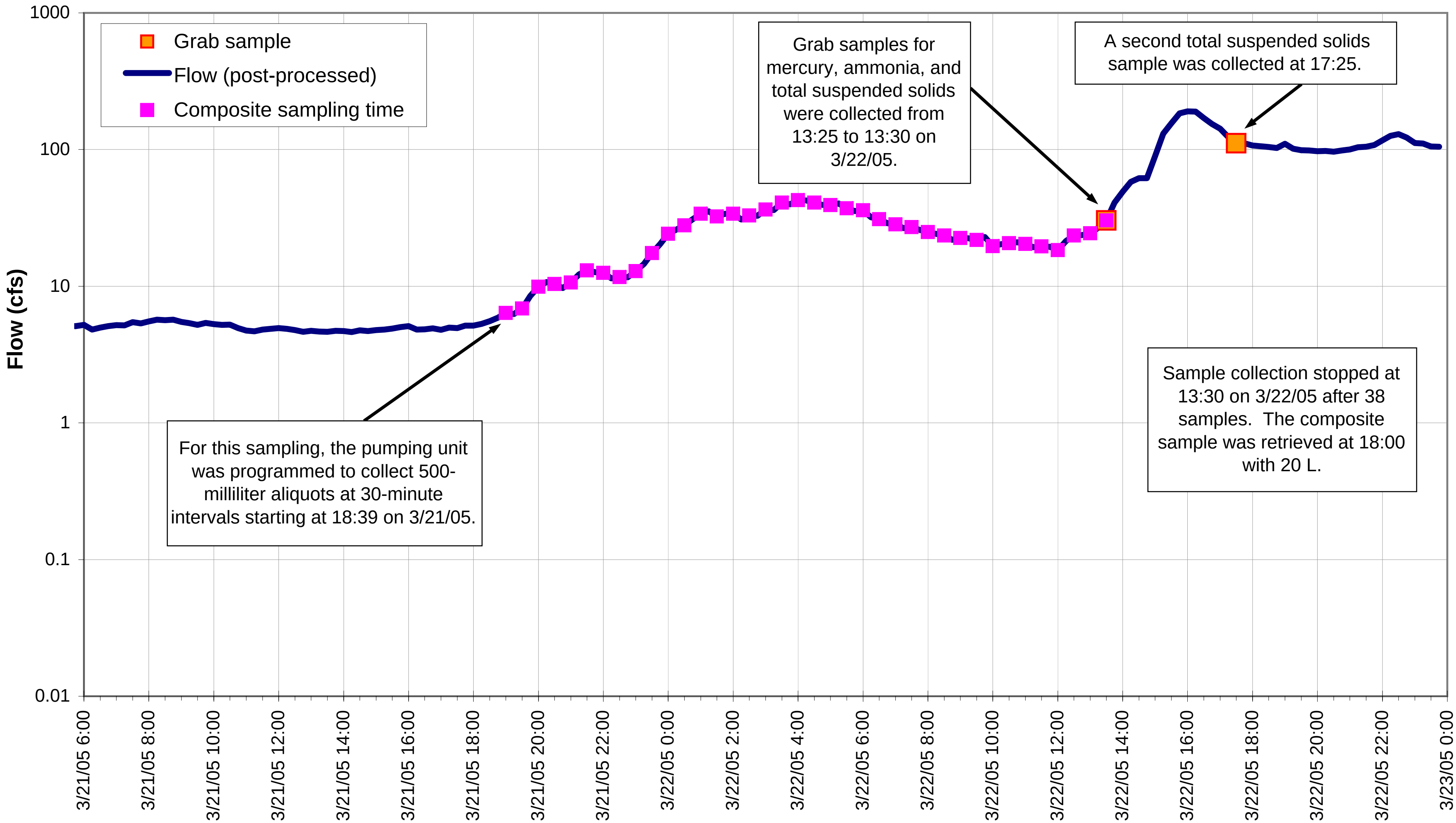

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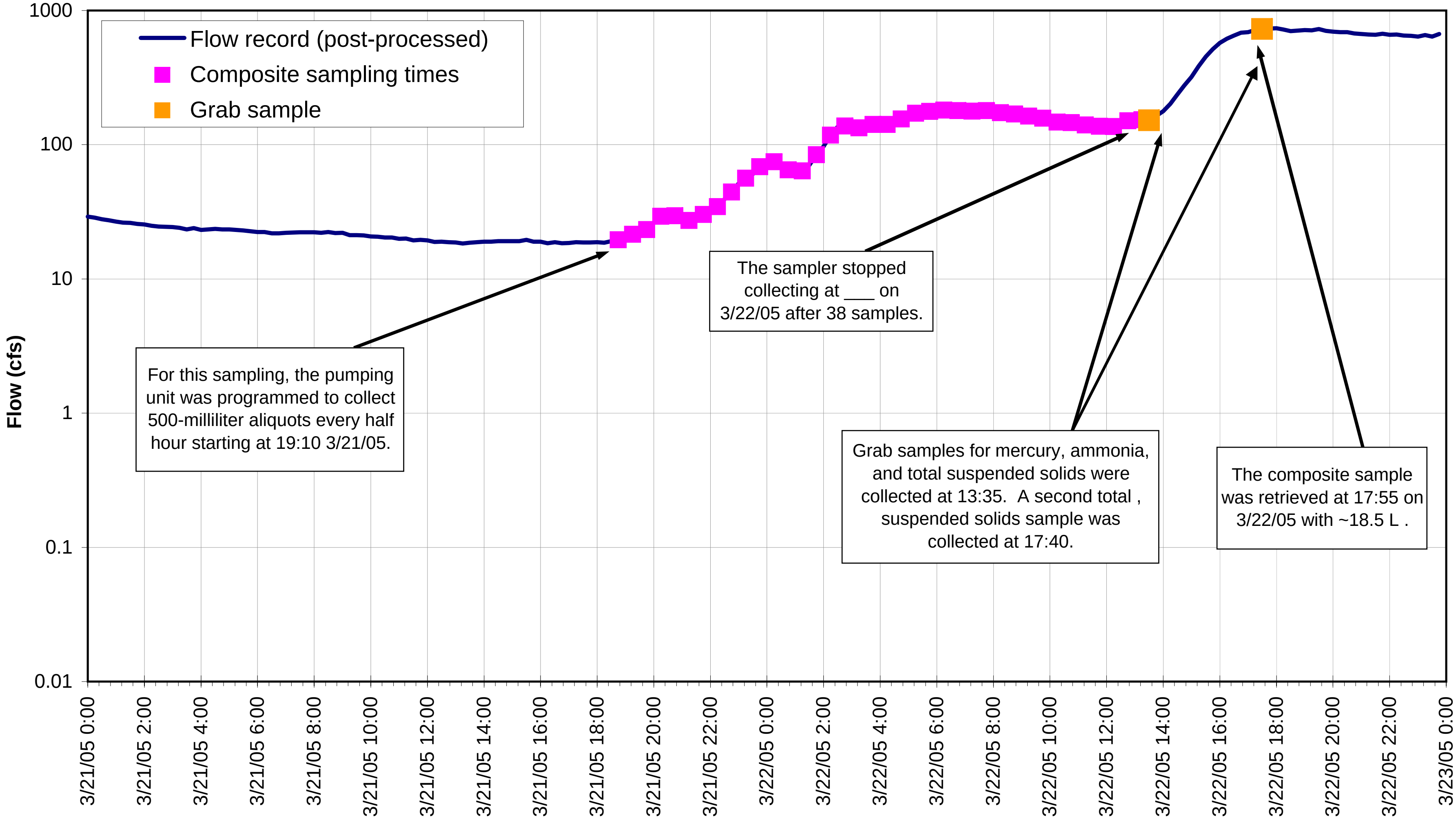
Figure C10. Water-quality sampling detailed hydrograph, March 21 to 22, 2005, Los Trancos Creek at Piers Lane. This was a large spring event. The time-paced sampling pattern shown above collected many aliquots during the initial peak but before the second, higher flow peak.



Balance Hydrologics, Inc.

Figure C11 Water-quality sampling detailed hydrograph, March 21 to 22, 2005, San Francisquito Creek at Piers Lane. This was a large spring event. The time-paced sampling collected many aliquots during the initial peak but before the second, higher flow peak. We collected grab samples mid-storm on March 22 during a period of high flow.

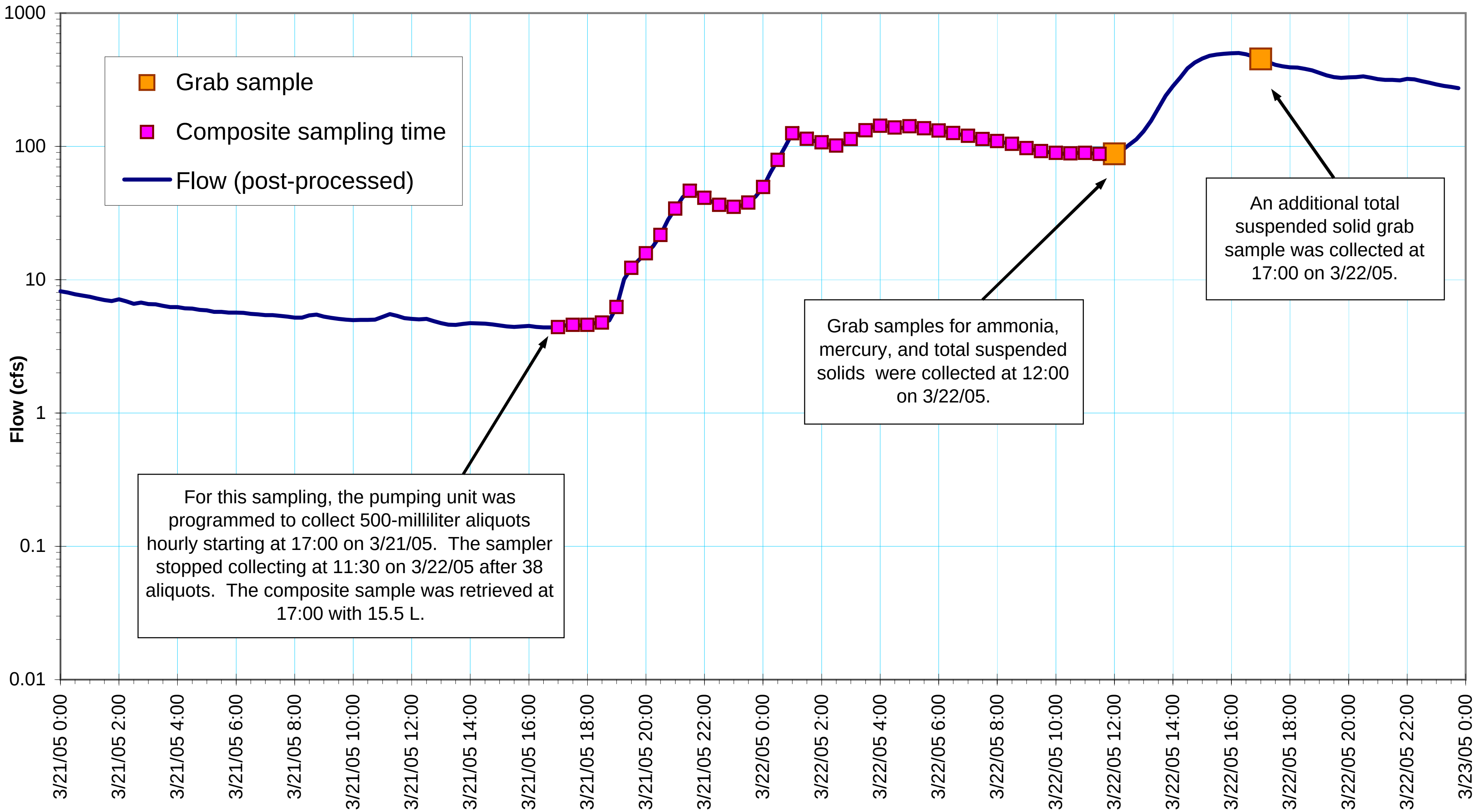


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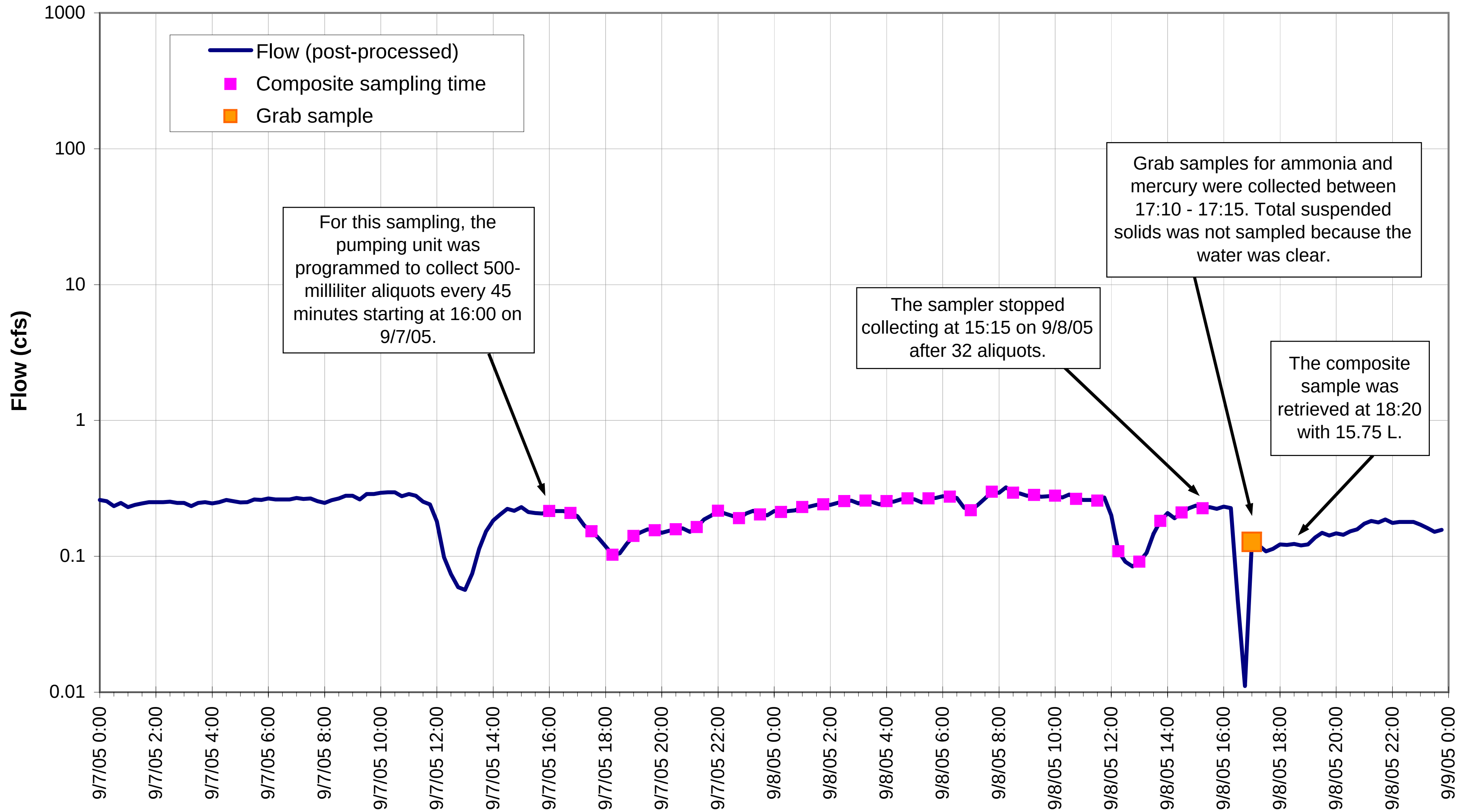
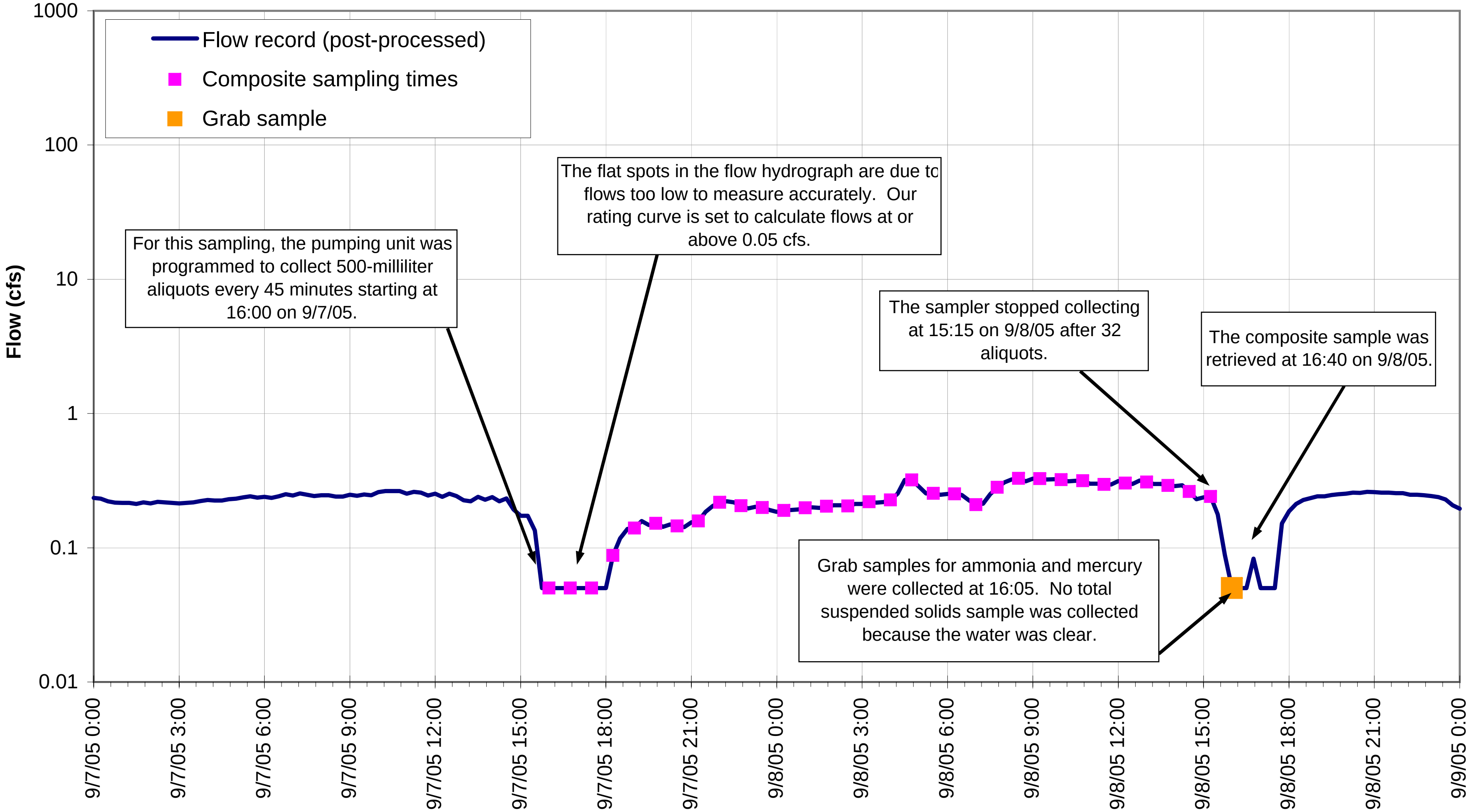
Figure C12. Water-quality sampling detailed hydrograph, March 21 to 22, 2005, Bear Creek at Sand Hill Road. This sampling was intended to capture runoff from a large spring storm. The sampling was time-paced and grab samples were collected at the end of the sampling period.



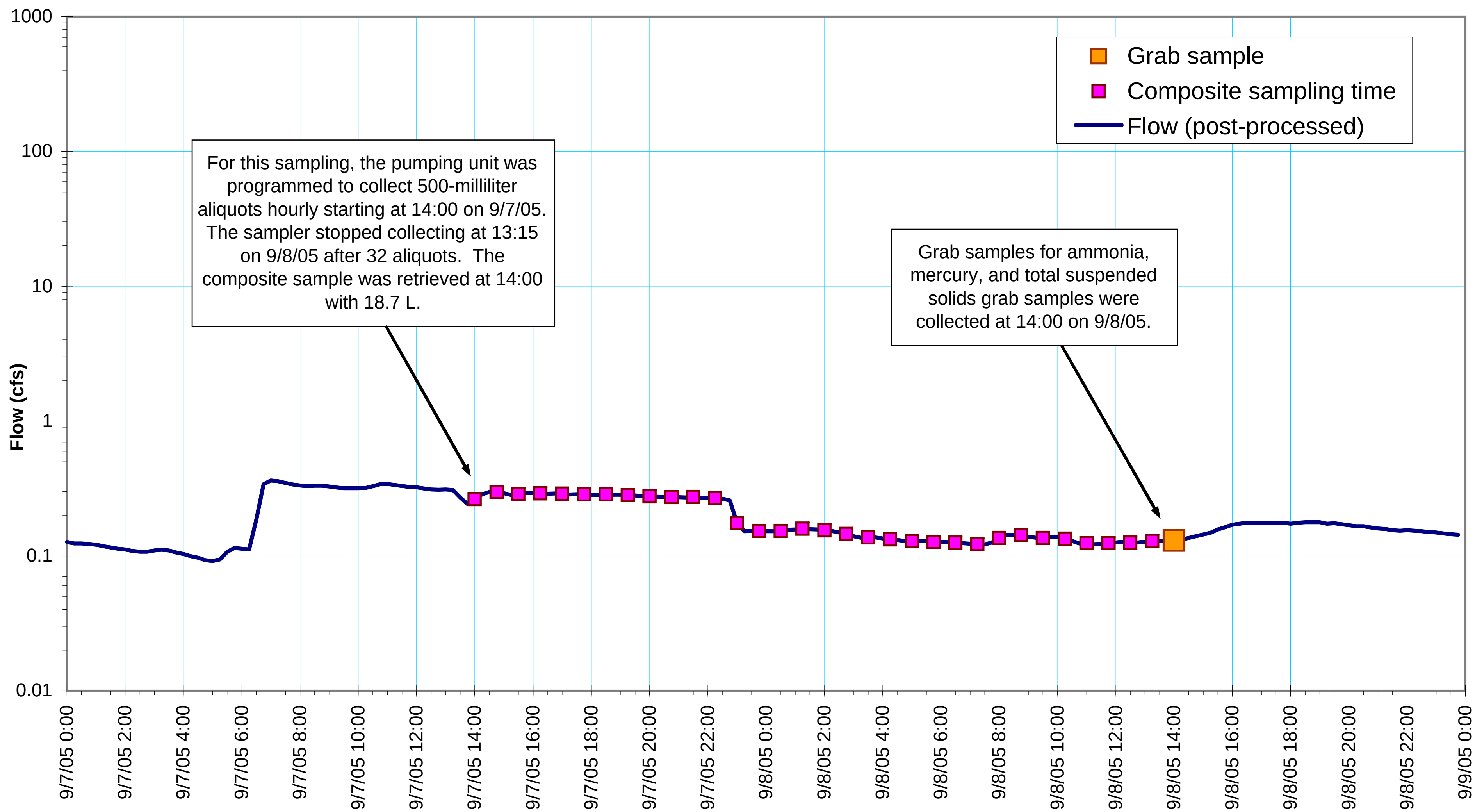
Balance Hydrologics, Inc.

Figure C13. Water-quality sampling detailed hydrograph, September 7 to 8, 2005, Los Trancos Creek at Piers Lane. This time-paced sampling was intended to characterize low flows at the end of the dry season.



Balance Hydrologics, Inc.

Figure C14 **Water-quality sampling detailed hydrograph, September 7 to 8, 2005, San Francisquito Creek at Piers Lane.** This time-paced sampling was intended to characterize low flows at the end of the dry season. Sampling was time-paced and flows ranged from approximately 0.05 to 0.3 cfs .



Balance Hydrologics, Inc.

Figure C15. Water-quality sampling detailed hydrograph, September 7 to 8, 2005, Bear Creek at Sand Hill Road. This sampling was intended to capture summer baseflow. The sampling was time-paced and grab samples were collected at the end of the sampling period.