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FINAL TECHNICAL MEMORANDUM

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MONITORING THE IMPACTS ON THE TUOLUMNE RIVER FROM PEASLEE CREEK EROSION AND RUNOFF EVENTS OF JANUARY 2008.

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1 INTRODUCTION

Beginning on January 6, 2008 the lower Tuolumne River experienced several episodes of extremely high turbidity resulting from fine sediment input and runoff from the Peaslee Creek watershed (Figure 1). The Turlock Irrigation District (District) discovered the situation on January 11, 2008, at which time the District began to take action by notifying the nearby La Grange office of the California Department of Fish and Game (CDFG) and through subsequent turbidity monitoring in the Peaslee Creek watershed and upstream/downstream of the Peaslee Creek confluence with the Tuolumne River (Figures 2 – 4).

On March 7, 2008, the District followed up with a letter to the Central Valley Regional Water Quality Control Board (Regional Board) addressing the District’s concerns regarding the potential impacts from the Peaslee Creek runoff events to downstream Tuolumne River habitats. Within the letter to the Regional Board, the District provides potential analyses that could be done to identify if there was any damage to recent restoration projects and other aquatic resources downstream of Peaslee Creek (Appendix A). One restoration project of concern was Bobcat Flat (RM 43). Bobcat Flat is a 303-acre parcel adjacent to 1.6 miles of the Tuolumne River, located approximately 10 miles east of Waterford, California and approximately 2 miles downstream of the confluence between Peaslee Creek and the Tuolumne River. During the summer of 2005, Phase I of restoration efforts at Bobcat Flat placed 10,820 yd3 (McBain & Trush, Inc., 2006) of washed coarse sediment within the Tuolumne River active channel. Apart from being a recent coarse sediment augmentation project, monitoring efforts at the Bobcat Flat restoration site provided baseline information to assess impacts as a result of the Peaslee Creek erosion and runoff events. A summary of monitoring parameters, methods, and dates is provided in Table 1.

As part of the District's efforts to evaluate impacts to the Tuolumne River below Peaslee Creek and follow up with the recommendations made to the Regional Board, the District hired McBain & Trush, Inc. to monitor and conduct analysis at Bobcat Flat to attempt to document potential fine sediment impacts as a result of the Peaslee Creek runoff events (Table 2). Unfortunately, assessment effort could not occur until after the spring pulse flow period on the river, by which time much of the fine sediment coating of the river bed, originally observed by the District, was no longer evident. McBain & Trush, Inc. field efforts took place between May 28 and May 30, 2008. This technical memorandum summarizes the monitoring and analysis done on the Tuolumne River.

Table 1. Summary of Bobcat Flat monitoring parameters, methods, and dates.

Monitoring Parameter	**Method**	**Pre-project**			**As-built**	**Post-Project Monitoring**	
		2003	**2004**	**2005**	**2005**	**2006**	**2008**
Channel cross section	Level and total station surveys	•			•	•	
Channel profile	Level and total station surveys	•			•	•	
	Acoustic bathymetry survey			•			
Augmentation patch topography, volume and area	Total station survey (1-ft contour DTM)				•	•	
Bed texture	Pebble counts	•			•	•	•
	Bulk samples				•	•	•
Bed mobility thresholds	Marked rock experiments				•	•	
Floodplain Topography	Total station survey (1-ft contour DTM)	•					
	Kinematic GPS survey (1-ft contour DTM)				•		
	LIDAR survey (2-ft contour DTM)				•		
River Stage and Shallow Groundwater Table Fluctuations	2 staff plates installed along river channel				•		
	5 staff plates installed in dredger ponds	•	•				
Photo Points	Photo documentation of site	•	•	•	•	•	•
Invertebrate Sampling	Benthic macroinvertebrate sampling						•
Chinook salmon spawning	Spawning habitat mapping	•			•	•	•
	Redd counts		•		•		

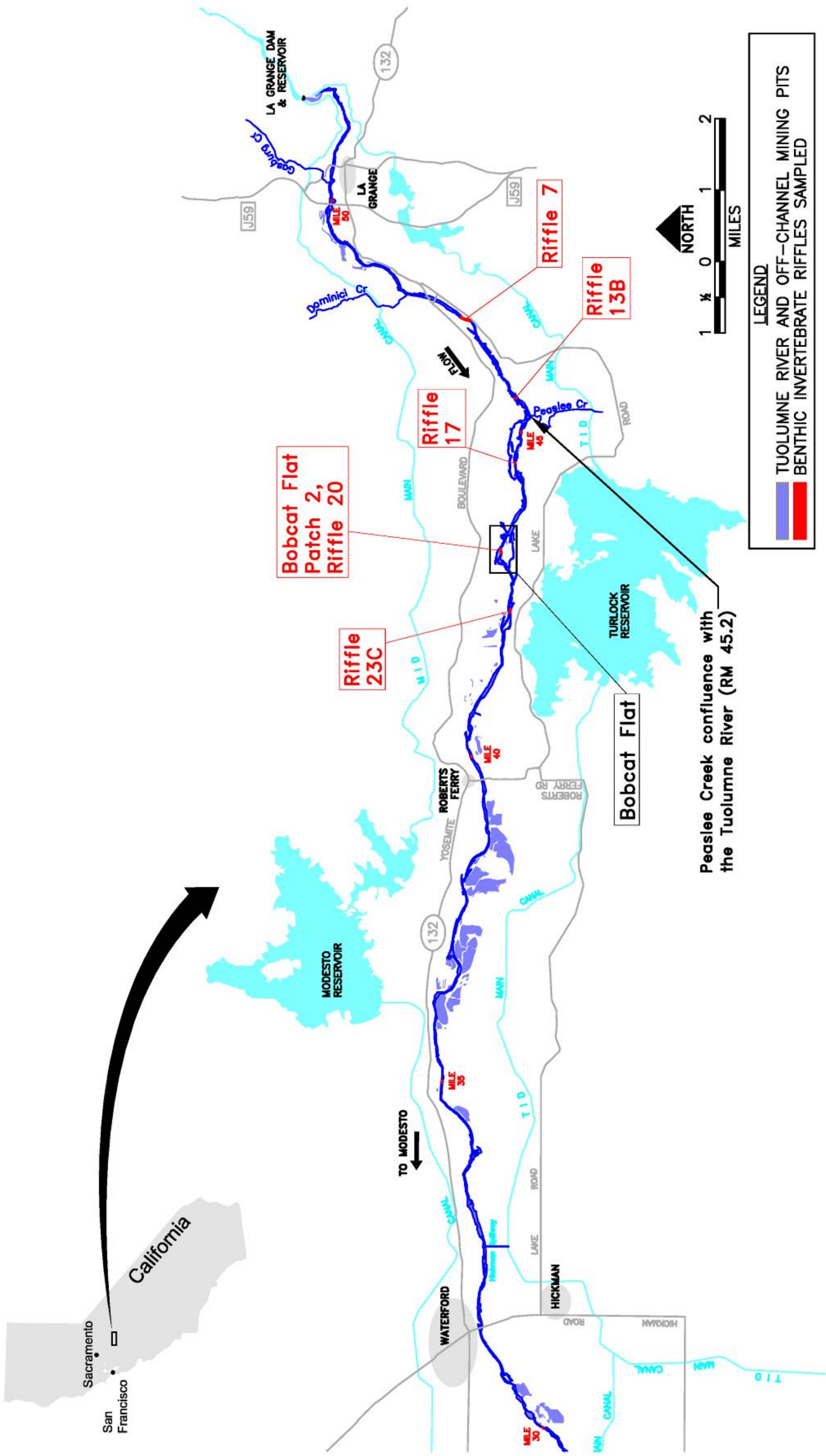

Figure 1. Location map of Peaslee Creek, invertebrate sampling riffles, and Bobcat Flat

Table 2. Summary of potential monitoring efforts as described in the District's comments to the Draft Cleanup and Abatement Order.

Potential Monitoring Efforts	Monitoring Location	Included as part of monitoring effort, analysis, and report
Bulk sediment sampling	Bobcat Flat coarse sediment augmentation Patches 1, 3, 4, and 5 placed in 2005	Yes; Bulk sediment samples were taken at 4 of 6 patches (Figure 5)
Reoccupy existing photopoints	Bobcat Flat Photopoints 1-5 of coarse sediment augmentation patches placed in 2005	Yes; All 5 photopoints were reoccupied (Figure 5)
Surface substrate pebble counts or mapping	Bobcat Flat coarse sediment augmentation cross sections 2412+90 and 2394+00	Yes; Photographs of 2x2 paint patches were taken at cross sections 2412+90 and 2394+00 (Figue 5)
Cross section surveys of pools	None	This was not done as part of the field effort as there was no recent pre-event data to compare the surveys to
Benthic macroinvertebrate species richness and abundance surveys	Upstream and downstream of the Tuolumne River confluence with Peaslee Creek	Yes; surveys were done at five sites (Figure 1)

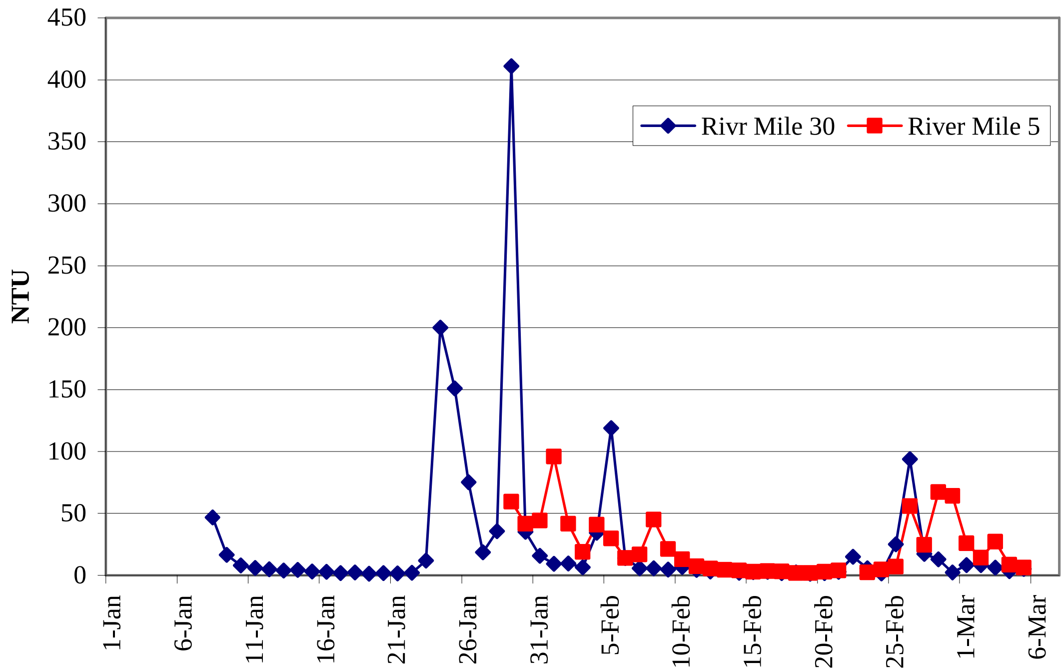

Figure 2. Tuolumne River daily average turbidity readings at two sites downstream of Peaslee Creek.

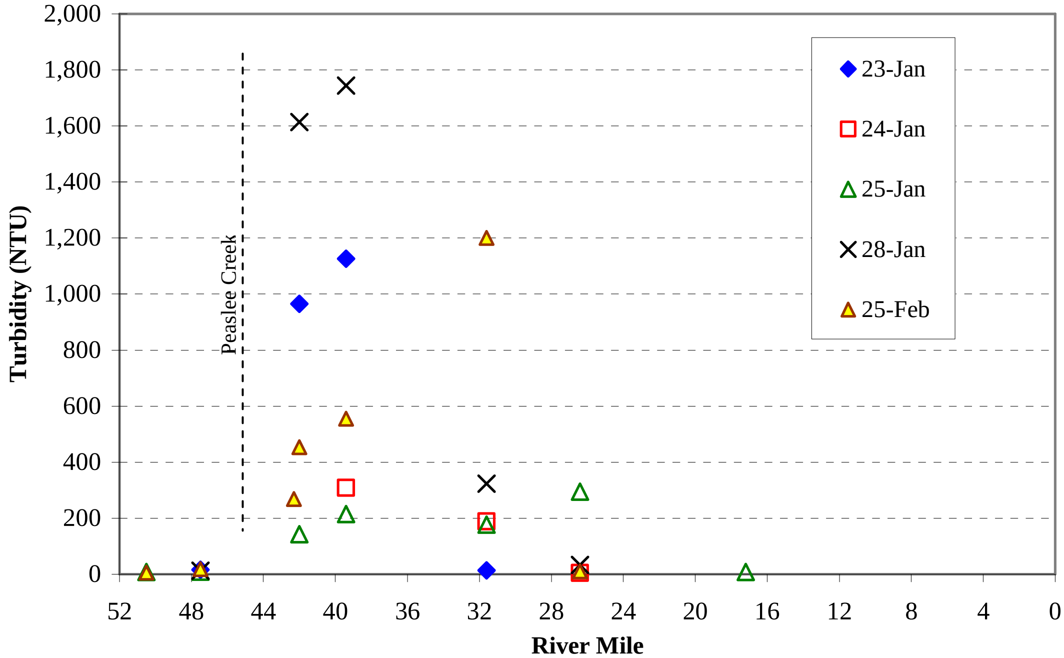

Figure 3. Spot turbidity measurements on the Tuolumne River upstream and downstream of the confluence with Peaslee Creek (RM 45.2).

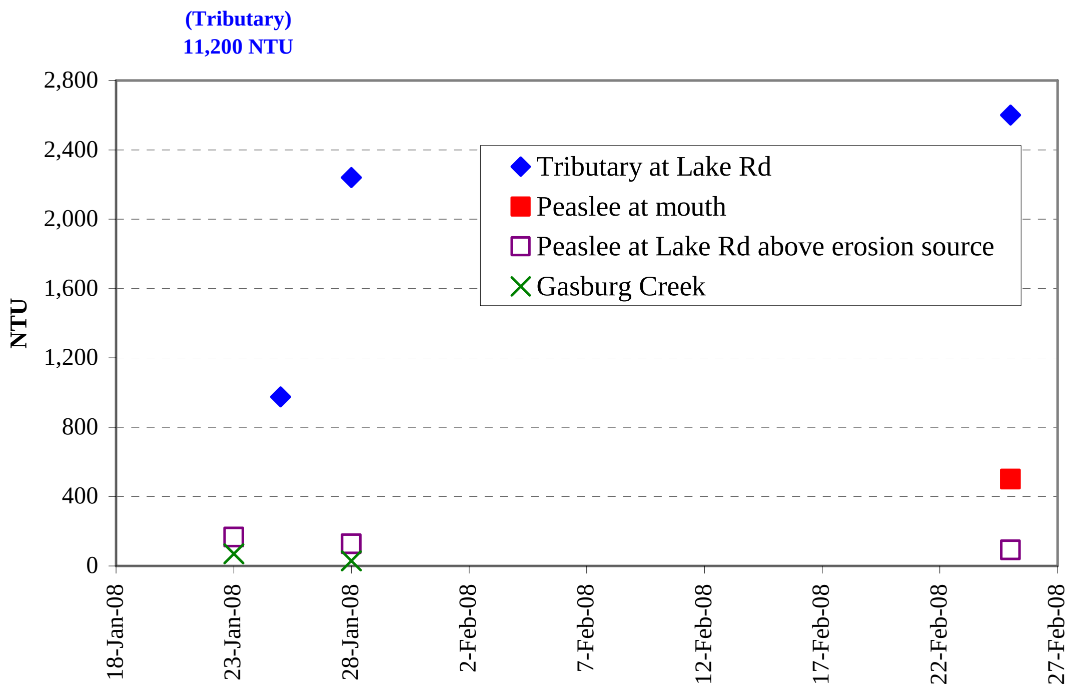

Figure 4. Turbidity measurements on Gasburg Creek for control and Peaslee Creek upstream and downstream of erosion source tributary during storm runoff events, and the Peaslee Creek tributary flowing from the erosion source.

2 DESCRIPTION OF FINE SEDIMENT EVENTS

On January 6, 2008 the first of several high turbidity events took place on the Tuolumne River as a result of erosion runoff into Peaslee Creek, which flows into the Tuolumne River at River Mile 45.2 (Figure 1). A primary and clearly evident source of the erosion and subsequent turbidity was been identified as graded land draining a tributary of Peaslee Creek belonging to the Stanislaus Almond Ranch LLC and Lake Road Grizzly Ranch LLC (Appendix A). Those seasonally dry channels cross Lake Road and enter Peaslee Creek between its crossing of Lake Road and the Tuolumne River. Periodic local runoff and extreme sediment input during those events occurred through February 2008. Since the fine sediment events, the Regional Board has made efforts to remedy the source situation through Cleanup and Abatement Order No. R5-2008-0701 (Appendix B).

Following a rainfall event on January 23, 2008 (Figure 5), the Peaslee Creek erosion source tributary turbidity readings were 11,200 nephelometric turbidity units (NTU) near the graded land, and 167 NTU on Peaslee Creek upstream of the tributary erosion source (Figure 4). Gasburg Creek, a nearby small seasonal tributary to the river used as a control, measured 70 NTU at the time. Two later readings in excess of 2,000 NTU were obtained in the Peaslee Creek tributary (Figure 4). Spot river readings exceeding 1,000 NTU were recorded on three separate dates (Figure 3).

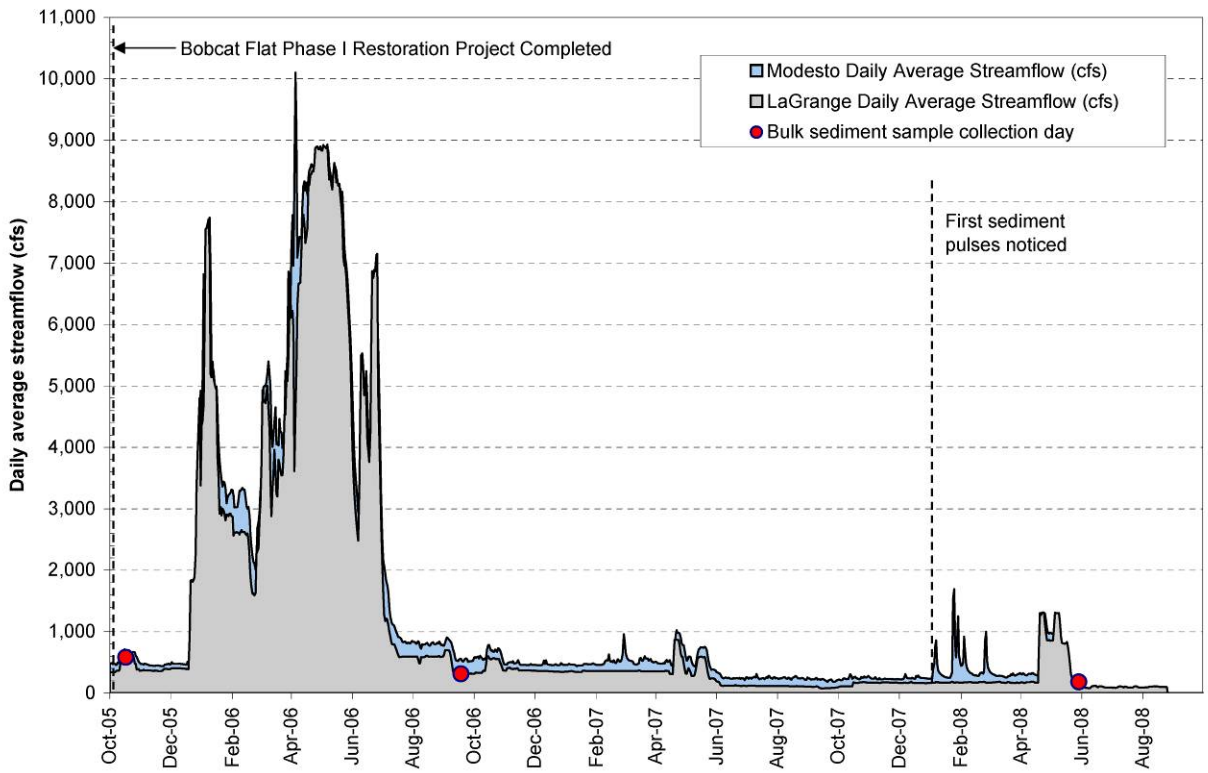

Figure 5. Bobcat flat post-construction monitoring and bulk sampling collection dates overlaid on the daily average streamflow on the Tuolumne River at Modesto, CA (USGS Stn 11-290000) and at La Grange, CA (USGS Stn 11-289650).

3 BULK SEDIMENT SAMPLING AT BOBCAT FLAT

Three sampling events occurred between October 2005 and May 2008 (Figure 5). Initial sampling was conducted in October 2005, where sampling areas (patches) were delineated and bulk samples were collected to document Phase I post-construction conditions. Following the WY 2006 high flows, a second sampling event was conducted in September 2006 to document changes in particle size distributions following the first year. A third sampling event was conducted in May 2008 in response to the Peaslee Creek fine sediment discharge event. This section evaluates whether particle size distributions computed from the 2008 sampling show evidence of bed fining, and if so, can the fining be linked to the Peaslee Creek event.

3.1 Field Methods and Sampling Frequency

Six individual patches of similar-sized placed coarse sediment were identified and mapped in October 2005 (Figure 6). Within each sediment patch, four individual sampling locations were selected and then samples collected from each patch to yield a total target sample mass of 300 lb. This sample mass was estimated to provide a representative sample mass for particle size analysis, following the guidelines of Bunte and Abt (2001). The subsamples were then combined to generate a patch-average particle size distribution.

The October 2005 sampling was conducted at six the defined sediment patches (see McBain & Trush 2006). Sampling in September 2006 was limited due to budget constraints, and sampling was conducted at Patch 1 and Patch 3 only. Similar to 2006, the 2008 sampling also had budget constraints and sampling was conducted at four of the six sediment patches (see Table 3).

Table 3. Summary of patches sampled by sampling event.

Patch	***October 2005***	***September 2006***	***May 2008***
Patch 1	x	x	x
Patch 2	x		
Patch 3	x	x	x
Patch 4	x		x
Patch 5	x		x
Patch 6	x		

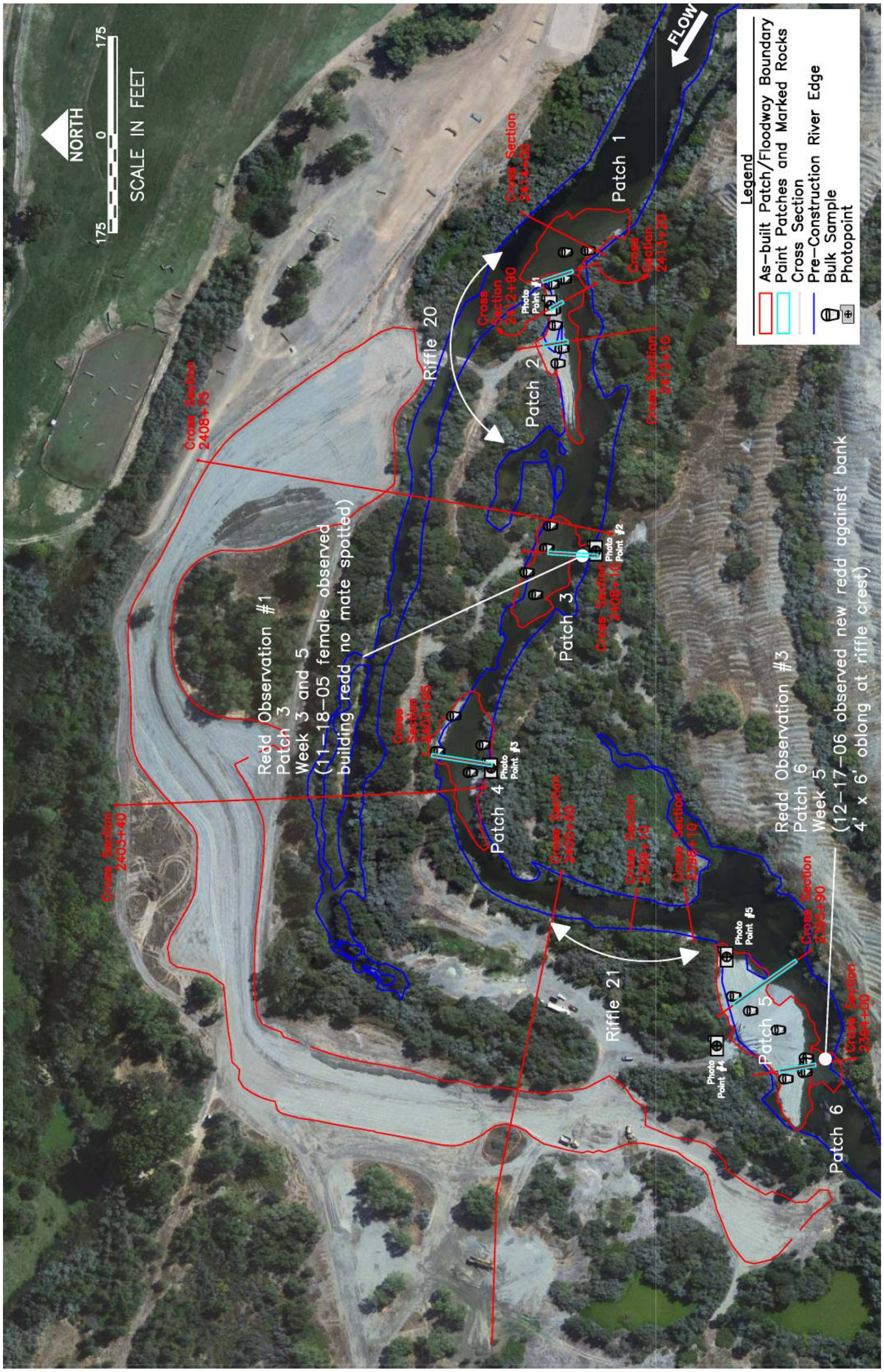

Figure 6. Map of Bobcat Flat Coarse Sediment Augmentation Site (RM 43) showing as-built coarse sediment placement boundaries and monitoring locations.

In October 2005, as-built bulk samples were collected using a shovel. At each selected sampling location, the bed was shoveled into a nylon feed bag and then labeled. Normally bulk samples are collected using a McNeil or similar kind of sampler, which is designed to prevent the escape of fine sediments from excavation to container; however, because the October 2005 sampling occurred immediately following site construction (and the placed sediments contained no particles finer than 4 mm) the risk of fine sediment loss using a shovel was low. Subsequent sampling was done using a 30 cm diameter by 60 cm tall McNeil-type sampler. The sampler was manually worked into the bed and the substrate carefully removed by hand and placed into plastic 5-gallon buckets. For all sampling events, all subsamples were grouped by patch and then transported to Kleinfelder, Inc., for particle size analysis. The samples were dried, weighed, and sieved following ASTM specifications. The size gradations used for all sample processing are shown in Table 4.

Table 4. Sieves used in particle size analysis for all sampling events. Particle size classes using the Wentworth scale are defined as follows: cobble, 64mm – 256mm; gravel, 2mm – 64mm; sand, 0.063mm – 2mm; silt and clay, finer than 0.063mm.

Sieve designation	**Sieve opening (in)**	**Sieve opening (mm)**	**Sieve designation**	**Sieve opening (in)**	**Sieve opening (mm)**
6 inch	6	152.4	3/8 inch	0.38	9.53
5 inch	5	127.0	#4	0.19	4.75
4 inch	4	101.6	#8	0.09	2.36
3 inch	3	76.2	#16	0.046	1.18
2 inch	2	50.8	#30	0.024	0.60
1.5 inch	1.5	38.1	#50	0.012	0.30
1 inch	1	25.4	#100	0.006	0.15
¾ inch	0.75	19.1	#200	0.0028	0.075
½ inch	0.50	12.7	Pan	N/A	N/A

3.2 Analysis, Results, and Discussion

Kleinfelder Inc., reported sample results as percentages of sediment retained on each sieve screen used. From these results, we computed cumulative size distributions, plotted particle size gradation curves, and computed statistical size parameters (e.g., D_{84} and D_{50}). Because this analysis focuses on changes to the particle size distributions in each patch, results are presented for Patches 1, 3, 4, and 5. Patches 2 and 6 were sampled only once, and thus did not have subsequent sampling from which to compare changes. Patch-averaged cumulative particle size distribution curves are shown in Figures 7 through 10.

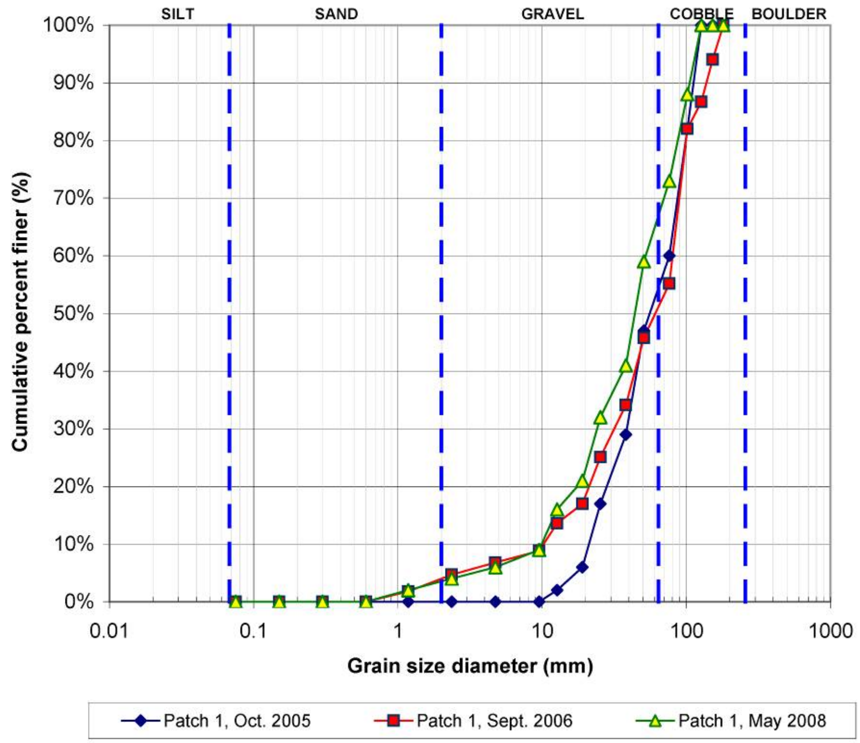

Figure 7. Patch 1 average cumulative size distribution of bulk sediment samples.

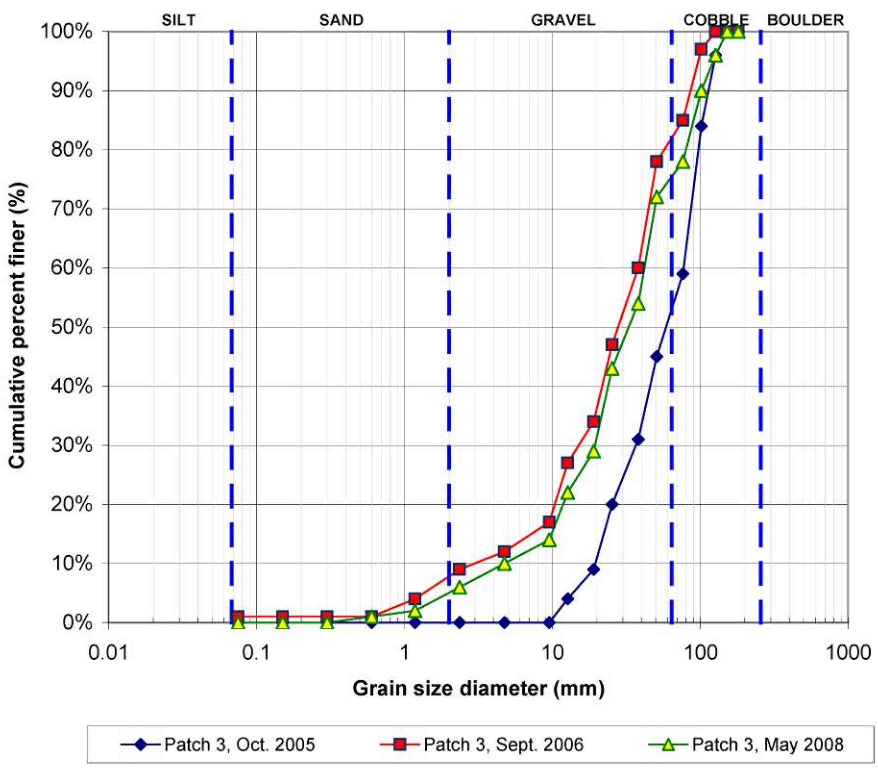

Figure 8. Patch 3 average cumulative size distribution of bulk sediment samples.

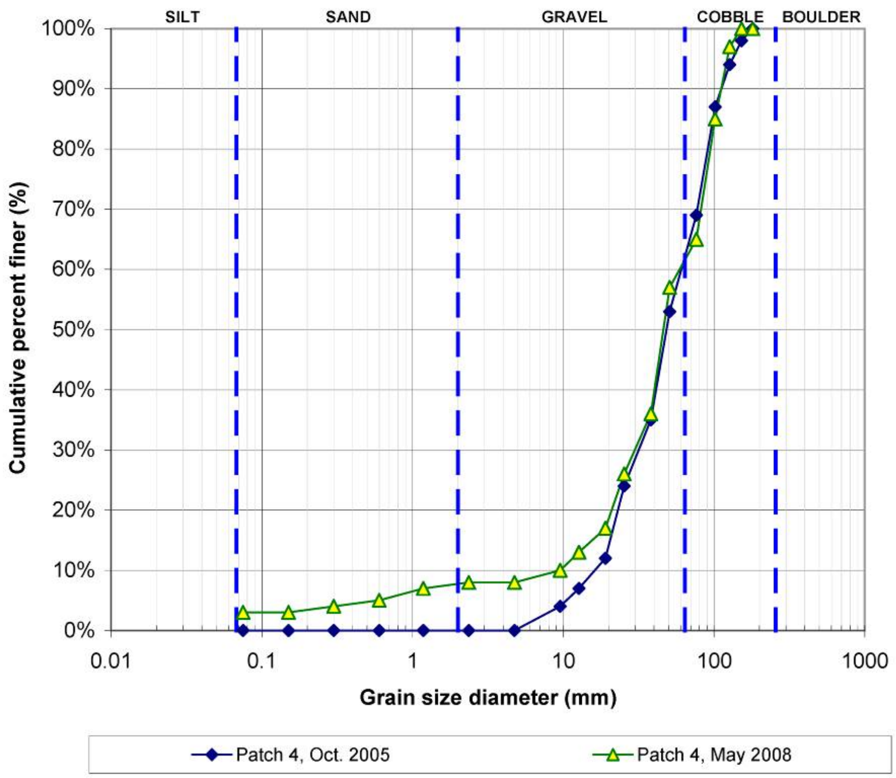

Figure 9. Patch 4 average cumulative size distribution of bulk sediment samples.

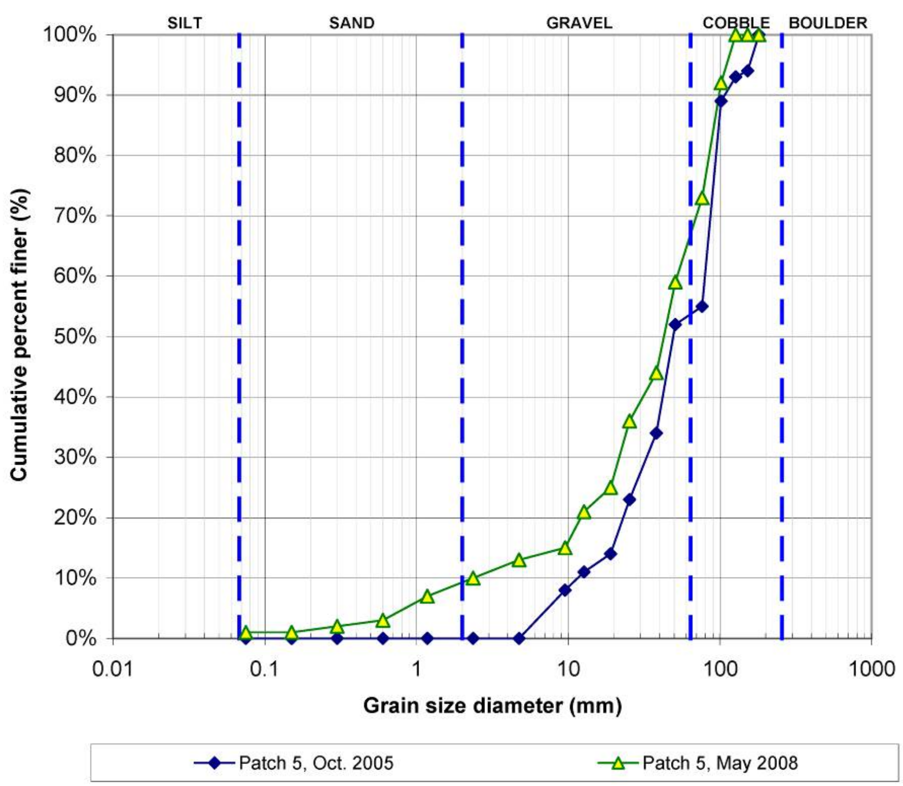

Figure 10. Patch 5 average cumulative size distribution of bulk sediment samples.

Overall bed fining at Patches 1, -3, -4, and -6 has occurred since October 2005; all cumulative distribution curves show a shift to the left, indicating the percentage of fine sediment has increased. These results were somewhat expected, given the newly-constructed “clean” alluvial features built at the site were subjected to fine sediment deposition from upstream sources. Patch 1 and Patch 3, the only patches to be sampled three times, suggest the primary shift occurred before September 2006 and that the May 2008 sampling did not reveal much difference from September 2006 (suggesting the Peaslee Creek event did not contribute a detectable amount of fine sediment to these patches).

Figure 11 and 12 show the changes in the patch average size distribution between sampling dates for a particular particle size at Patches 1 and 3 (respectively). Although some fining occurred at Patch 1 from September 2006 to May 2008, the portion showing fining is for particles greater than 10 mm. The sediment discharged from Peaslee Creek contained an appreciable amount of fine suspended sediment (Figure 4, Appendix B), and if this sediment were deposited at Patch 1 we would expect to see an increase in the percentage of particles finer than 10 mm. Conversely, Patch 3 showed slight coarsening for all particle sizes between September 2006 and May 2008, suggesting the Peaslee Creek event may not have affected the bed at Patch 3. Figure 11 and 12 indicate all major substrate fining below 10 mm occurred between the October 2005 and September 2006 sampling dates and that no change for particles less than 10 mm was measured between the September 2006 and May 2008 sampling dates.

To explore this further, and to account for any potential bias caused by larger particles sampled, the cumulative particle size distributions were re-computed for particles finer than 1 inch (25.4 mm). By truncating the samples at 1-inch, we were able to focus on the changes to the finer fraction of the particle size distribution curves shown in Figures 7 – 10. The truncated curves are shown in Figures 13-16 and show similar results to Figures 7 – 10, suggesting: (1) large particle bias is not apparent when viewing results for all particle sizes sampled, and (2) the most significant bed fining occurred between October 2005 and September 2006, largely affecting the cumulative size distribution for particle sizes finer than 10 mm.

It is important to note the period between September 2006 and May 2008 had comparatively very little flow compared with the October 2005 to September 2006 period. Sediment mobilizing flows, if they occurred, were limited to fine particle sizes and we do not expect to have seen an appreciable change in particle size distributions.

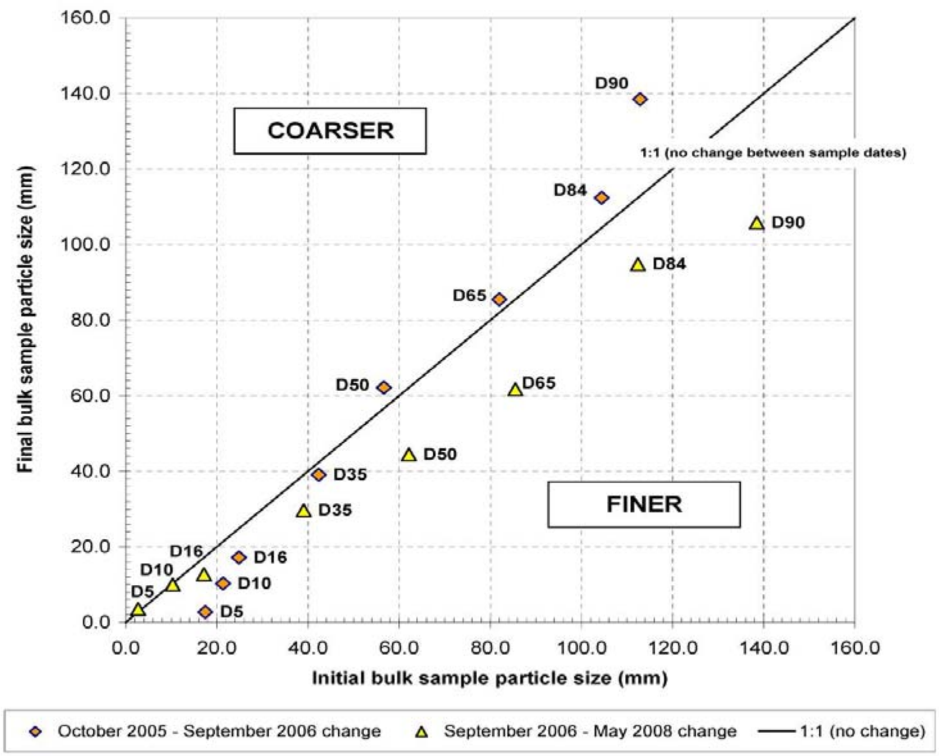

Figure 11. Bobcat Flat Patch 1 ratio of first sampling to second sampling, and second coarse sediment sampling to third sampling patch-averaged particle size parameters.

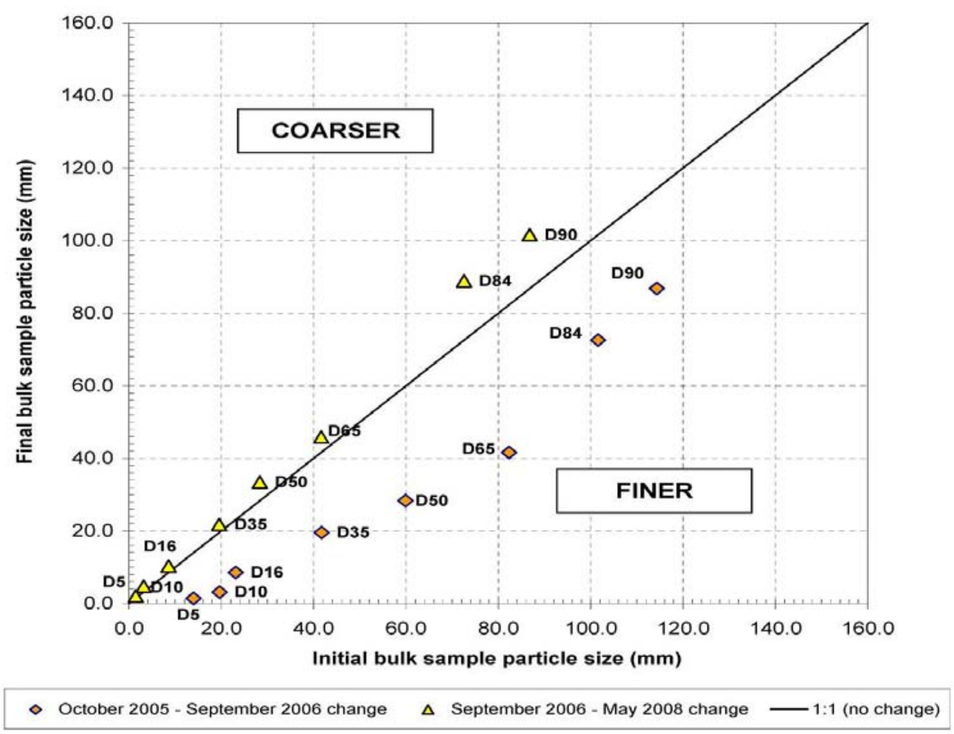

Figure 12. Bobcat Flat Patch 3 ratio of first sampling to second sampling, and second coarse to third sampling patch-averaged particle size parameters.

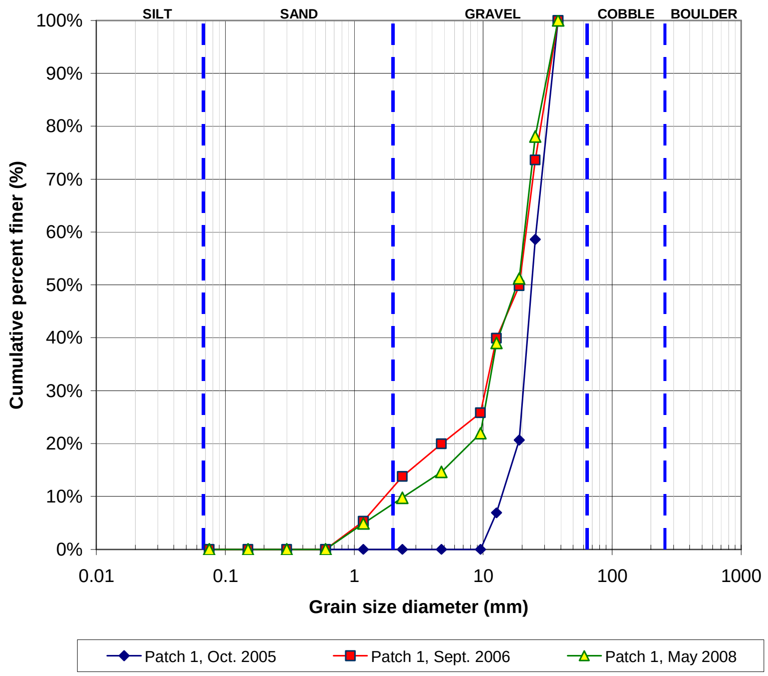

Figure 13. Truncated patch 1 average cumulative size distribution of bulk sediment samples for the fraction of the sample finer than 1 inch. Compare to complete sample cumulative distribution shown in Figure 7.

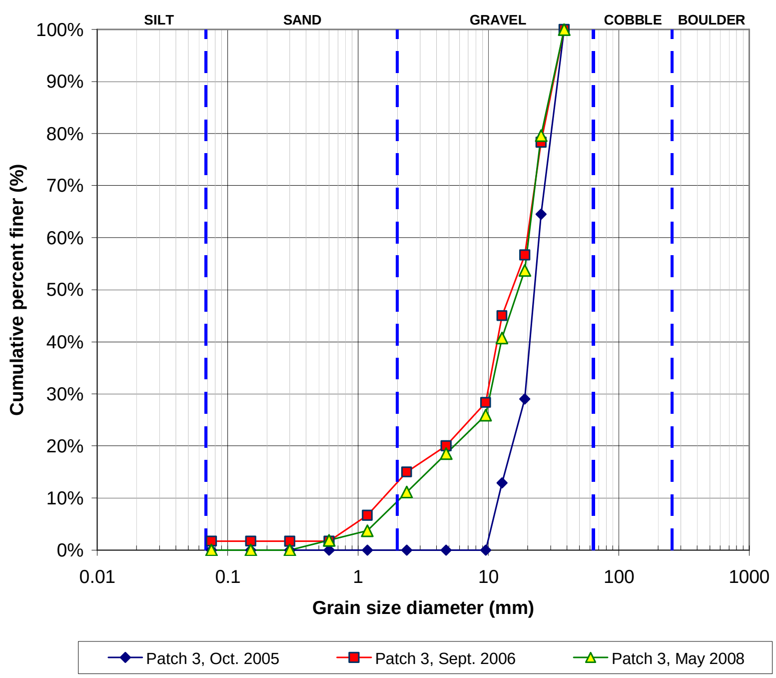

Figure 14. Truncated patch 3 average cumulative size distribution of bulk sediment samples for the fraction of the sample finer than 1 inch. Compare to complete sample cumulative distribution shown in Figure 8.

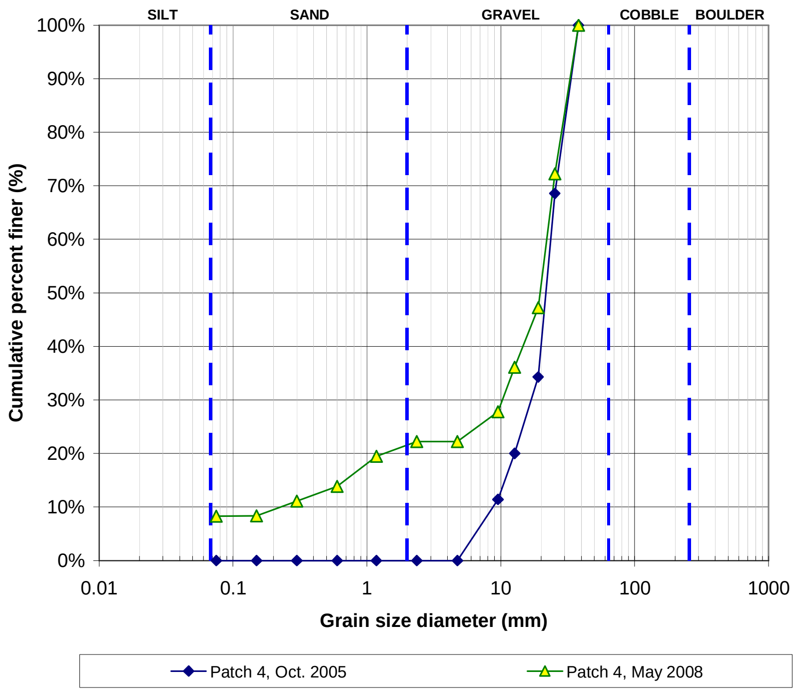

Figure 15. Truncated patch 4 average cumulative size distribution of bulk sediment samples for the fraction of the sample finer than 1 inch. Compare to complete sample cumulative distribution shown in Figure 9.

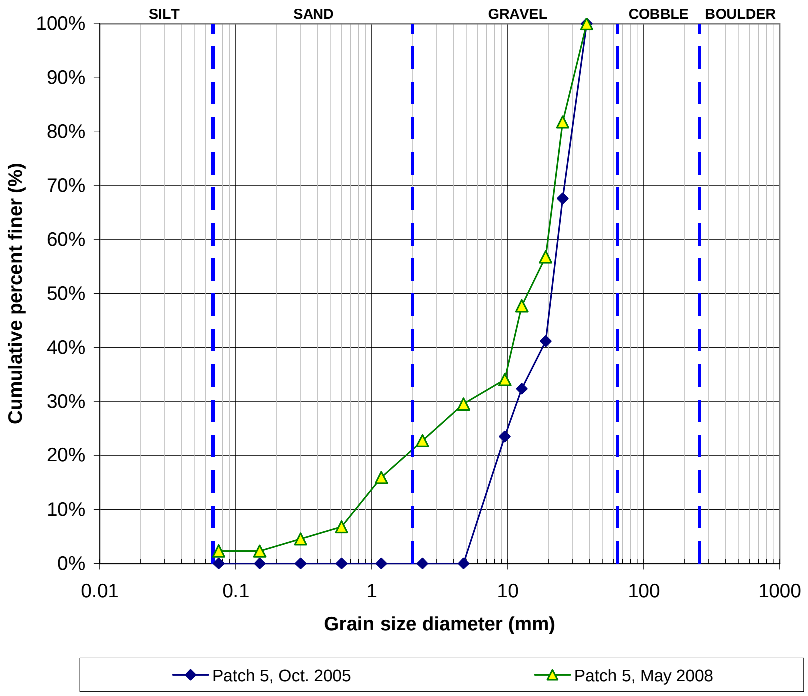

Figure 16. Truncated patch 5average cumulative size distribution of bulk sediment samples for the fraction of the sample finer than 1 inch. Compare to complete sample cumulative distribution shown in Figure 10.

Although the sampling results illustrate general trends in bed particle size changes since October 2005, the results of the bulk sampling do not show a compelling effect from the Peaslee Creek fine sediment event on the percentage of fine sediments at the site. Because the last sampling date prior to the Peaslee Creek event occurred in 2006, there is no information on how the bed had changed up to the Peaslee Creek event. Moreover, if the Peaslee Creek event did deposit fine sediment at the site, a subsequent spring dam release occurred in mid-April 2008 which may have flushed out any fine sediment deposited from Peaslee Creek (Figure 5).

Without sampling having occurred at least immediately following the Peaslee Creek event, results cannot quantify the amount (and therefore the significance) of fine sediment the Peaslee Creek event may have deposited at the site.

In addition to the bulk sediment samples, additional geomorphic and biologic monitoring activities were conducted at the Bobcat Flat site (concurrent with the sediment sampling). Photographs taken at the site in May 2008 suggest fine sediments were recently deposited at the site, but these were in areas generally outside the bulk sampling patches, higher up on bar surfaces. Photographs show a veneer of fine sediments (sand and silt) that deposited over certain areas (Figures 17 and 18), which suggests the Peaslee Creek event did deposit fine sediments at the bulk sediment sampling patches, but that the sediment had already been transported from the site where flows could recruit it. Although the bulk sediment sampling did not describe how the Peaslee Creek event affected the particle size distribution at sampling locations, it appears the Peaslee Creek event did supply fine sediment to the site.

Figure 17. Example of silt deposits along right bank deposited over clean coarse sediment placed during 2005 construction at Bobcat Flat, Patch 2, Cross Section 2412+90.

Figure 18. Example of silt dusting of bulk sediment sampling location at Patch 2 just after excavation.

4 PHOTO DOCUMENTATION

During the May 2008 field work, fine sediment (sand and silt) deposits were observed along the right and left bank of the channel above the low flow water surface (Q = 180 cfs at La Grange) at all coarse sediment augmentation patches. To document this, we duplicated bed mobility experiment photos at Cross Sections 2412+90 and 2394+00 and all photopoints taken during the 2005 and 2006 monitoring efforts (Figure 6).

4.1 Methods

4.1.1 Bed Mobility Paint Patch Photographs

Bed mobility experiments were established between October 10 – 14, 2005 at cross sections 2413+20, 2412+90, 2412+10, 2408+10, 2403+95, 2395+90, and 2394+00 (Figure 6, Table 1). Experiments consisted of painted rock sets placed along monitoring cross sections in the wetted channel (during flows of ranging from 360 – 610 cfs at La Grange) and painted *in-situ* patches on dry bar surfaces. The painted *in-situ* patches at each cross section consisted of 2-foot by 2-foot square “boxes” painted onto the bar surface at four-foot spacing (spacing between the center of each box). Paint patches were photographed to document initial conditions (Figure 19), then photographed again during the fall of 2006 to document mobility and changes to surface substrate of *in-situ* particles resulting from the spring 2006 high flow event (peak daily average flow = 9,000 cfs at La Grange)

As part of the Peaslee Creek 2008 monitoring efforts, photographs of the *in-situ* paint patches at cross sections 2412+90 and 2394+00 were taken to document changes to surface particles of *in-situ* paint patches. Although observations of fine sediment deposits were similar at all coarse sediment augmentation patches, the presence of remnant paint patches at cross sections 2412+90 and 2394+00, and that these cross sections locations provided an upstream and downstream boundary to the project area made them ideal choices during the 2008 monitoring effort.

Figure 19. Example of 2 ft x 2 ft paint patches set at Patch 6 as part of the as-built monitoring in 2005.

4.1.2 Photopoints

No fixed photopoints were established prior to construction; however, casual photos were taken throughout the Bobcat Flat Phase I project site between 2003 and prior to construction in 2005 to document existing conditions.

As-built photopoints were established at each of the six augmentation patches in October 2005 (Figure 6). Photopoint locations were mapped using a total station to provide recoverable long term photopoint locations. As-built photographs were taken at each of the five photopoints during a flow of 360 cfs at La Grange. Photopoints were reoccupied September 2006 and again in May of 2008 as part of the site monitoring. Flows at La Grange were 311 cfs and 180 cfs respectively. These photos allow a comparison of differences before and after the Peaslee Creek fine sediment events.

4.2 Analysis and Discussion

4.2.1 Bed Mobility Paint Patch Photographs

Since September 2006 and prior to the runoff events in January 2008 daily average flows at Modesto ranged between 200 and 700 cfs, except for a ten day period in April 2008 when spring dam releases increased the daily average flow to range between 700 – 1,020 cfs (Figure 5). Post construction surveys of cross section 2394+00 provide a water surface elevation of 589 cfs at La Grange that does not inundate the bars surface where the paint patches were established (Figure 20). As a result, storm peaks exceeding 1,000 cfs in January 2008, combined with high turbidity from Peaslee Creek, and dam releases in exceeding 1,000 cfs in April 2008, provided the material and flows to deposit fine sediment along the right and left banks at Bobcat Flat.

Although the fine sediment deposits can't be directly attributed to the high turbidity from Peaslee Creek, it is likely that it did contribute to the fine sediment deposition on the coarse sediment augmentation patches at Bobcat Flat. Photos of paint patches provide evidence of fine sediment deposition over these surfaces (Figure 21).

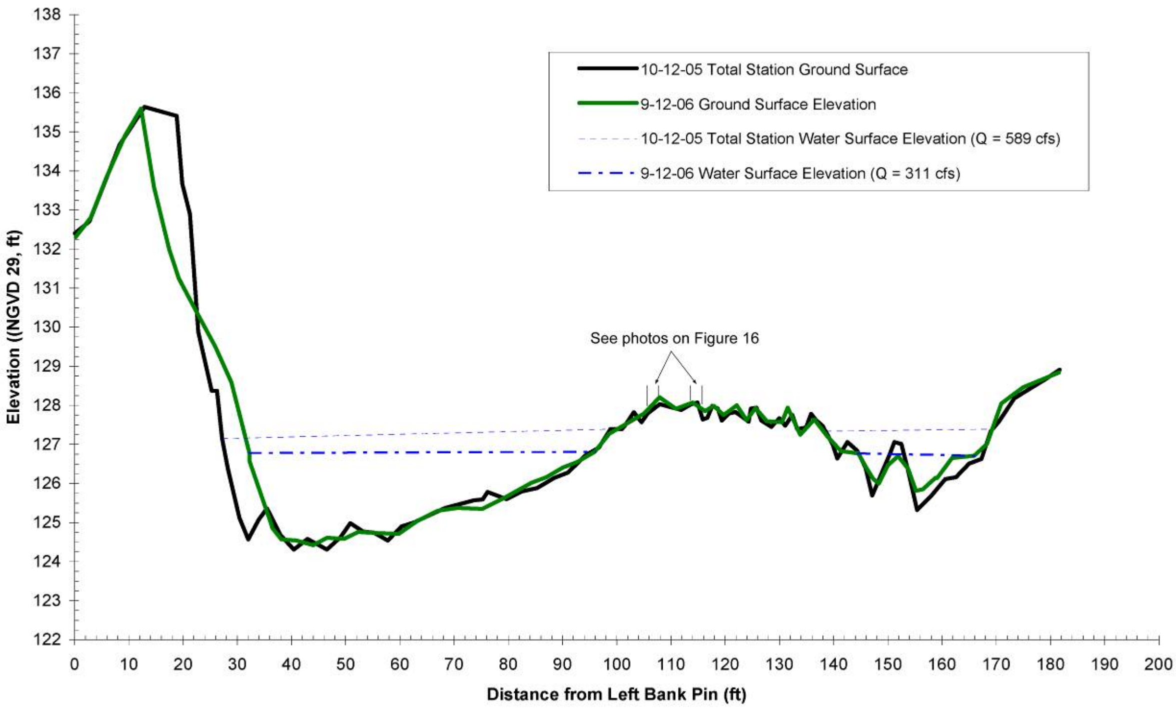

Figure 20. Surveys of cross section 2394+00 showing water surface elevations and paint patch areas of fine sediment deposition.

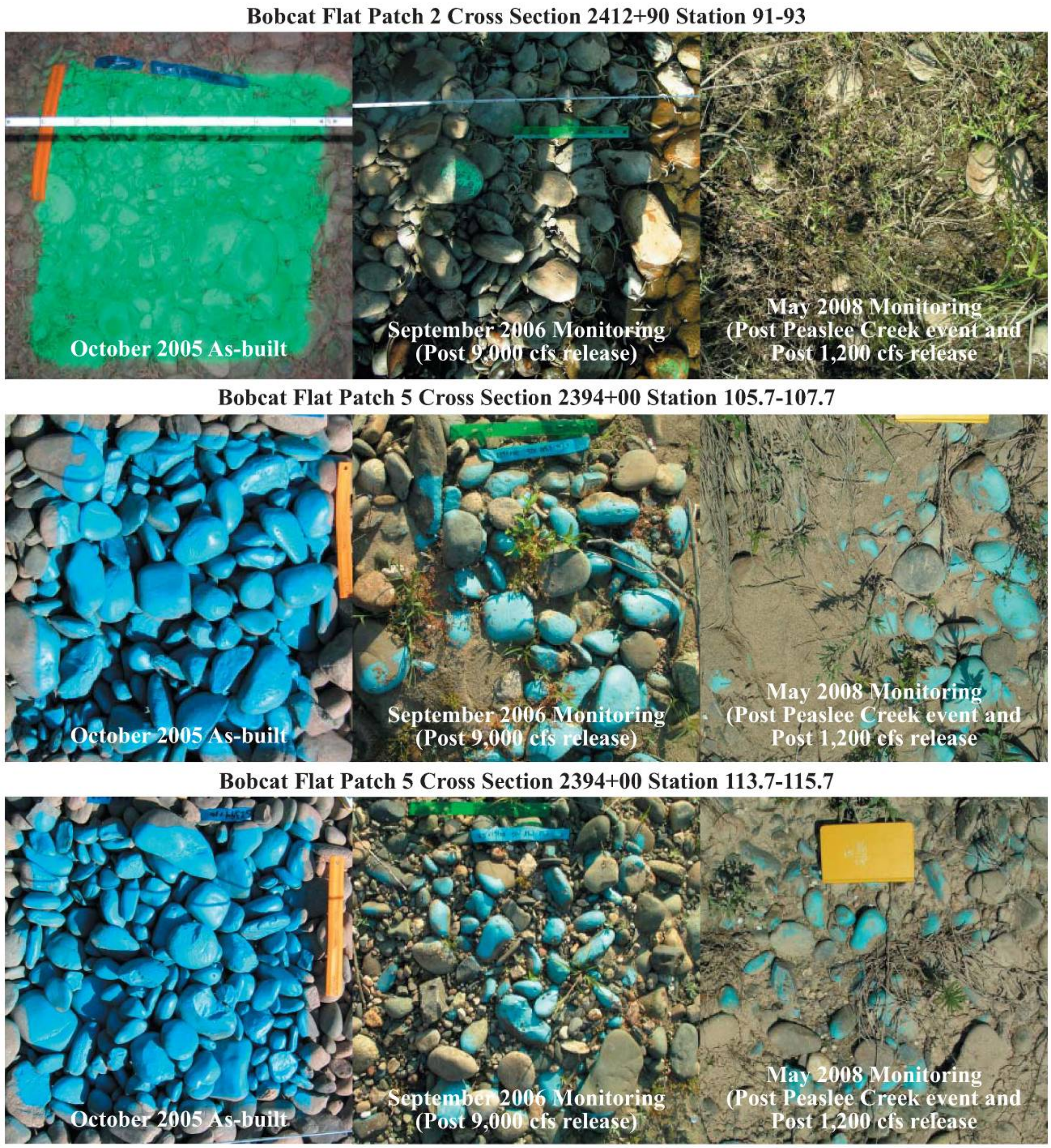

Figure 21. Paint patch examples showing fine sediment deposition along the right bank at Patches 2 and 5.

4.2.2 Photopoints

Photopoints illustrate broad changes to topography and surface substrate. As an example of this, Figures 22 and 23 (photopoint #3 and #5) shows changes to surface substrate as a result of runoff events between October 2005 and September 2006, and September 2006 and May 2008.

Tracking of broad topographic changes through photopoints and subtle substrate changes through photo documentation of bed mobility experiments should continue as part of future monitoring at Bobcat flat. Photographs provide a simple way to document these changes and can assist monitoring efforts by shifting monitoring efforts to empirically address changes observed in photographs.

October 14, 2005 Photopoint #5 looking from right bank downstream at Patch 6, for as-built conditions (Q = 585 cfs at La Grange).

September 12, 2006 photopoint #5 looking from right bank downstream at Patch 6 post 9,000 cfs flow event (Q = 311 cfs at La Grange).

May 28, 2008 Photopoint #5 looking from right bank downstream at Patch 6 post Peaslee Creek fine sediment events and 1,200 cfs release (Q = 180 cfs at La Grange).

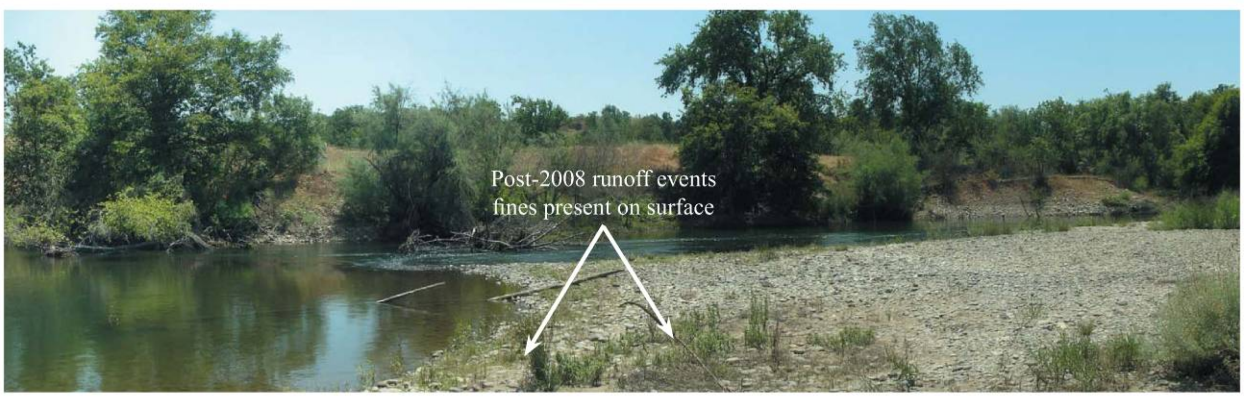

Figure 22. Photopoint #5 showing changes to surface substrate between October 2005 and May 2008.

October 14, 2005 Photopoint #3 looking from left bank to rigth bank at Patch 4, for as-built conditions (Q = 585 cfs at La Grange).

September 12, 2006 photopoint #3 looking from left bank to right bank at Patch 4 post 9,000 cfs flow event (Q = 311 cfs at La Grange).

May 28, 2008 Photopoint #5 looking from left bank to right bank at Patch 4 post Peaslee Creek fine sediment events and 1,200 cfs release (Q = 180 cfs at La Grange).

Figure 23. Photopoint #3 showing changes to surface substrate between October 2005 and May 2008.

5 BENTHIC MACROINVERTEBRATE SAMPLING

The objective of the benthic macroinvertebrate sampling was to provide an alternative to bulk sediment sampling, as a way to assess fine sediment impacts from the Peaslee Creek events. A rapid bioassessment protocol (RBP) based upon invertebrate composition indices have been adopted by CDFG as the California Stream Bioassessment Procedure (CBSP) (CDFG 1999). The CSBP is a standardized protocol for assessing biological and physical/habitat conditions of wadeable streams, and is an adaptation of the national Rapid Bioassessment Protocols outlined by the U.S. Environmental Protection Agency (EPA/841-B99-002).

5.1 Field Methods

The CSBP was used to sample benthic macroinvertebrate (BMI) species richness and abundance at five riffle sites along the gravel-bedded reach of the Lower Tuolumne River. All sampling sites were located in riffle habitats dominated by cobble and gravel substrate. Kick-net sampling consisted of collecting composite samples in general accordance with the Non-point Source Sampling Design as described in the CSBP (CDFG 1999). The methods employed in the May 2008 Tuolumne River study were a slight variation of the CSBP methods. Five riffle sites with relatively uniform conditions (substrate composition, riffle depths and slope, etc.) were selected based on the Districts' and consulting scientists' knowledge of the reach in proximity to Peaslee Creek. Two riffle sites were chosen upstream of Peaslee Creek, and three sites were chosen downstream (Figure 1). Riffles 7 and 13B were considered reference sites since they were upstream from the 2008 Peaslee Creek fine sediment debris event (Figure 1). The downstream three sites included one riffle located as close as possible downstream of Peaslee Creek (Riffle 17), one riffle site recently reconstructed as part of the Bobcat Flat, Phase I project (Riffle 12), and one riffle (Riffle 23C) that is part of annual river-wide BMI data collection (Figure 1).

At each of the five riffle sites, the riffle length was measured, and three randomly selected transects were chosen and marked along the bank with survey flagging. A one-foot wide D-Frame kick-net was used to collect a composite sample of invertebrates. Invertebrates were collected at three stations along the transect representing the stream center and side margins. At each kick-net location, the net was placed firmly on the stream bottom, larger grave and cobble particles were scrubbed by hand within a one-foot wide by two-foot long rectangle (2 ft^2) upstream of the kick-net, then the riverbed was aggressively disturbed by churning the bottom with a wader boot. Three composite samples were therefore collected at each riffle site. Samples were preserved in the field in 95% ethanol, and the bottle labeled with the location, date, sampling technique, and replicate number. Once invertebrate samples were collected, physical habitat data were collected for each site using the standard field form provided by the CSBP methodology (Appendix C). Upon returning from the field, invertebrate samples were stored at ambient temperatures until sample processing.

5.2 Invertebrate Identification Methods

A rapid bioassessment protocol based upon invertebrate composition indices has been adopted by the California Department of Fish and Game as the California Stream Bioassessment Protocol (CSBP) (CDFG 1999). Revisions to the CSBP have been ongoing and are primarily based on standards established for the Pacific Northwest by Aquatic Biology Associates, Inc (ABA). This report uses the current standard level of taxonomic effort as documented by the California Aquatic Bioassessment Laboratory Network (CAMLnet).

Sample picking, sorting and identification was performed by Aquatic Biology Associates, Inc. (Corvallis, OR). During sample processing, samples are decanted, picked and sorted based on protocols outlined in the CSBP (CDFG 1999). Excessively large samples, or samples with large numbers of individuals in them are sub-sampled to save processing time. Each sample is quantitatively reduced, the invertebrates from a known portion of the sample counted, and these counts extrapolated back to the entire sample.

Revisions to the level of taxonomic effort may impair the ability to make direct comparisons of results from this report to those from previous years, although many of the metrics calculations used would be largely unaffected unless the specific taxon in question were very abundant in the sample. Quality Assurance (QA) guidelines outlined in the CSBP (CDFG 1999) include Sample Handling and Custody, Sub-sampling, Taxonomic Identification and Enumeration, Organism Recovery, and Taxonomic Validation. All archived samples were well preserved with ethanol in jars labeled with river name, sample date and time, location, and sample ID number. Sample tally sheets recorded counts of organisms, grid information, and notes on discarded organisms due to mis-identification or fragmentation. Sample remnants were inspected to ensure they contained fewer than 10% of the total organisms sampled (e.g., 30 for a 300 count sample).

5.3 Summary of Results

General habitat conditions was assessed for the reach extending from Basso Bridge just upstream of Riffle 7 (the upstream-most site) down to Turlock Lake State Recreation Area (TLSRA) by recording riffle conditions at each site. This information was recorded on the CSBP field forms (Attachment C). Riffle lengths ranged from 150 ft (Riffle 13B) to over 900 ft (Riffle 7). Average channel widths (measured on randomly selected transects) ranged from 195 ft to 275 ft. Average depths in riffles in this reach (measured at kicknet sites) ranged from 0.9 ft to 1.9 ft; daily average flow at La Grange was 180 cfs; average velocities (instantaneous velocities at mid-water column measured at kicknet sites) ranged from 1.3 ft/s to 3.5 ft/s. Riffle slopes ranged from 0.20% to 0.45%. Substrate embeddedness and the percentage of fine sediments within the gravel cobble mix were relatively low (5-15 % fines) except at Riffle 13B, which had a high percentage of fine sediments, mostly sand embedded within the riffle substrates. In general, the best riffle conditions for benthic invertebrates were observed at Riffle 7, which had relatively low percent fines, coarse gravel-cobble substrates, and good depths, velocities, and slope. The poorest conditions for benthic invertebrate habitat were observed at Riffle 13B, which had shallow depths, slow velocities, and a high percentage of fine sediment and embeddedness. A summary of selected physical variables is presented in Table 5; additional information is available in Appendix C.

From among the numerous benthic invertebrate metrics provided by ABA (Appendix D) and based on recommendations from ABA, we selected a few metrics (Table 6) that would best highlight changes in the invertebrate community that could have resulted from a fine-sediment input event such as occurred from Peaslee Creek in 2008. We were also informed that later in 2008, ABA will perform their own internal evaluation of BMI metrics of all benthic invertebrate samples provided to them by the Districts consultants including the five riffle samples discussed here, and river-wide samples collected annually by Stillwater Sciences.

Table 5. Summary of physical variables collected at each transect from which benthic invertebrate samples were collected.

	Riffle 7			Riffle 13B			Riffle 17			Riffle 20			Riffle 23C		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Average Depth (ft)	1.4	1.2	1.7	1.4	1.3	1.2	1.6	1.6	1.9	1.3	1.3	1.3	1.5	0.9	1.1
Average Velocity (ft/s)	2.1	2.5	1.8	2	1.3	1.5	1.7	1.7	1.9	3.6	2	1.7	1.6	3.5	3.2
Riffle Embeddedness (0-20 scale*)	14	1.8	14	12	11	12	13	13	13	14	14	9	15	16	17
Substrate Consolidation**	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L
Transect Station (ft)	150	350	600	10	70	130	55	110	165	0	117	191	30	60	105
Channel Width (ft)	70	70	85	60	70	70	80	95	110	55	80	80	65	70	65
Canopy Cover (%)	0	1	5	0	0	2	2	2	4	5	3	0	15	20	20
Channel Gradient (%)	0.25%			0.20%			0.14%			0.45%			0.30%		

* Embeddedness Score: 0-5=more than 75% embedded; 6-10=50-75% embedded; 11-15=25-50%embedded; 16-20=0-25% embedded.

** Substrate Consolidation: L=Loose; M=Moderate; F=Firm.

Table 6. Selected benthic invertebrate metrics from samples collected with D-Frame kicknet at five riffle sites in the Tuolumne River. A list of the five dominant taxon for each riffle is included in Appendix D.

	Riffle 7	Riffle 13B	Riffle 17	Riffle 20 (Bobcat Flat Patch-2)	Riffle 23C
River Mile (RM)	46.9	45.5	44.4	43.2	42.3
Total Number of Taxa	45	45	46	45	42
Total Invertebrate Abundance	2,874	1,011	1,187	1,719	1,784
Number EPT Taxa	15	13	14	14	12
EPT Abundance	1,980	715	809	922	1,308
Hilsenhoff Biotic Index	5	4	4	5	5
#1 Dominant Taxon	635	152	315	267	742
#2 Dominant Taxon	463	143	158	234	269
#3 Dominant Taxon	423	133	130	207	143
#4 Dominant Taxon	232	116	64	175	78
#5 Dominant Taxon	161	108	58	99	73
Subtotal 3 Dominants	1,520	428	603	707	1,154
Subtotal 5 Dominants	1,913	651	725	981	1,305
A Tolerant Organisms	3	6	4	6	5
B Intolerant Organisms	8	6	8	9	6

The most obvious metric that highlights varying riffle conditions is the Total Invertebrate Abundance, which is the mean of the three composite samples collected at each riffle site. Total Abundance was highest at Riffle 7, lowest at Riffle 13B, and increased in a downstream trend between Riffle 13B and Riffle 23C. The Total Abundance data corroborate our field observations of the highest quality substrate at Riffle 7 and the lowest quality substrate (based on high embeddedness and percentage of fine sediment) at Riffle 13B. Conditions at Riffle 17, the first site downstream of Peaslee Creek, were not obviously physically impaired by substrate, based on field observations, but the Total Invertebrate Abundance at this site was poor relative to the uppermost reference site – Riffles 7.

The Total Number of Taxa were relatively constant at each of the five riffle sites, with the downstream-most Riffle 23C having only slightly fewer taxa. The consistency in the Total Taxa counts may indicate that the three replicate transects each with three composite kicknet samples was intensive enough to collect representatives of the majority, if not all, macroinvertebrate species.

The EPT Taxa (EPT=Ephemeroptera, Plecoptera, Trichopera) and Abundance metrics, and the Dominant Taxa, present results with trends similar to the Total Abundance: Riffle 7 had the highest EPT Taxa and Abundance; Riffle 13B had the lowest EPT counts, and the remaining three sites increased moving downstream. The number of Tolerant/Intolerant Organisms did not indicate a trend that matched field observations or the other abundance metrics.

5.4 Discussion

Based on our field observations during benthic invertebrate data collection in May 2008, and based on the results of the invertebrate taxonomic analyses, there appears to be varying riffle conditions within the reach between Basso Bridge and TLSRA. Riffle 7, the upstream-most site, had the highest BMI abundance. Several riffles within the vicinity of Peaslee Creek had lower BMI abundances, possibly indicating they are impaired by excess sediment or other conditions. Both Riffles 13B and 17 had relatively poor conditions based on field observations and had lower BMI abundances than the other sampling sites. However, given that Riffle 13B is located upstream of Peaslee Creek, several conclusions are possible. First, site-specific independent events or conditions may have occurred (and may still be occurring) that have constrained benthic invertebrate abundance within several riffles sampled in May 2008, including Riffles 13B and 17. This scenario might include a high sediment-input event from Peaslee Creek affecting Riffle 17, below which the effects diminish with distance downstream. Alternatively, channel migration or other channel disturbance(s) in the reach between Riffles 7 and 13B may be a dominant source of fine sediment degrading riffles more broadly within the reach between approximately Riffles 13B and 20 (where BMI metrics indicate conditions start to improve). In this case, a high sediment-input event from Peaslee Creek may not have left a detectable signature at riffles sampled in May 2008.

6 RECOMMENDATIONS AND NEXT STEPS

If additional upstream tributary sediment discharge events are likely and given the extremely low numbers of returning fall-run Chinook salmon, a sediment and BMI sampling and monitoring program could be considered. The objective of such a program would be to identify critical habitat areas and develop a monitoring program designed to detect changes from potential future fine sediment events, so the effects of these events can be documented and their significance weighed. At the Bobcat Flat site, sediment Patches 1, -3, -4, and -5 should be sampled and photographed at least twice annually, once in fall (before winter floods but when water levels are low) and again after flows recede following a winter or spring flood event. This would document impacts from fine sediment sources such as Peaslee Creek and provide evidence of the geomorphic benefits of spring releases on the Lower Tuolumne River.

Photographic documentation should continue as an inexpensive way to track broad topographic changes as well as subtle substrate changes.

Next steps could include:

1. Gravel Quality
    - Bulk samples at Bobcat Flat, Phase I, Patches 2 and 6 to get 2008 conditions for all patches
    - Re-do bulk samples after future events including:
        - Mainstem Tuolumne River flows exceed 3,500 cfs, and
        - Peaslee Creek fine sediment is detected through turbidity monitoring.
2. Photomonitoring
    - Photograph paint patches at Cross Sections 2395+90 and 2412+10 in anticipation of re-occupying after future fine sediment event; and
    - Add photopoint(s) directly downstream of Peaslee Creek at or near Riffle 17 in anticipation of future fine sediment events.
3. BMI
    - Compare BMI metrics collected in May 2008 with other sites upstream and downstream of the five May 2008 sites and correlate with assessment of local slopes to gain a better understanding of previous year's range of invertebrate species richness and abundance;
    - Expand BMI sampling by including Bobcat Flat Patches, 3, 4, Riffle 21, and Patch 6; and
    - Compare BMI metrics with fine sediment data from the five riffle sites.

7 REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B99-002. US Environmental Protection Agency, Office of Water, Washington, D.C.

Bunte, K. and S.R. Abt 2001. *Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring*, Fort Collins, CO, U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Research Station Vol. 428

CDFG (California Department of Fish and Game). 1999. *California Stream Bioassessment Procedure.* California Department of Fish and Game Aquatic Bioassessment Laboratory, Revision Date: December 2003.

McBain & Trush, Inc. 2006. Bobcat Flat RM 43 – Phase 1 As-Built Monitoring Final report.

APPENDIX A

Turlock Irrigation District Letter to the Central Valley Regional
Water Quality Control Board

TURLOCK IRRIGATION DISTRICT
333 EAST CANAL DRIVE
POST OFFICE BOX 949
TURLOCK, CALIFORNIA 95381
(209) 883-8300

Don Pedro Dam and Powerhouse

March 7, 2008 VIA E-MAIL

Sue McConnell, P.E.
Senior Engineer
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670-6114

Dear Ms. McConnell,

RE: February 29, 2008 Draft Cleanup and Abatement Order, Stanislaus Almond Ranch LLC and Lake Road Grizzly Ranch LLC, Stanislaus County

The Turlock Irrigation District appreciates the Regional Board's efforts in addressing recent sedimentation related stormwater impacts to the Tuolumne River downstream of Peaslee Creek. It is the District's hope that the Draft Cleanup and Abatement Order will not only help ensure the river is protected from future sedimentation from this source, but also provide a mechanism for remediating the impacts from the 2008 stormwater season. The comments provided below were developed to assist the Regional Board in understanding the District's concerns with respect to potential river habitat impacts, as well as the information and resources available to help the discharger and Regional Board in their efforts.

As you may know, the Tuolumne River provides important habitat for numerous species. Nineteen miles of the river downstream of Peaslee Creek is a designated salmonid spawning area (Fish and Game Code 1505), with additional riffles areas extending further downstream. Of particular concern to the District are the initial and ongoing impacts to the river's salmonid populations, their habitats and food sources. The 2007 Tuolumne River fall salmon run was near record low levels. Life stages within gravels (eggs/alevins) both this year, as well as in future years, may be directly impacted due to sedimentation accumulated in the spawning reaches. In addition, growth and survival of swimming life stages may continue to be negatively affected. There are similar concerns for rainbow trout, including impacts to winter spawning success. Another concern is that accumulated deposits of fine sediments in the river below Peaslee Creek may be further mobilized when river flow increases occur later next month, during spring pulse flow operations, unless remediation is quickly pursued.

The District believes the Stabilization and Cleanup Plan (Plan) required by the Draft Order should identify and require complete clean up and full mitigation of damages to the river's biological and physical environment, including spawning gravel areas. Examples of analyses to evaluate impacts could include:

(1) bulk gravel samples examining fine sediment infiltration into gravels,
(2) other sampling examining degradation of spawning gravel quality,
(3) photo documentation of surface storage of fine sediment,
(4) surface substrate counts and/or mapping documenting storage of fine sediment,
(5) cross section surveys and determination of fine sediment storage within pool areas, and
(6) macrobenthic invertebrate and other biotic surveys.

The Tuolumne River is the site of recent restoration projects to improve instream salmonid habitat, including several downstream of Peaslee Creek, There is some baseline data that could be useful for initial impact assessment as a result of prior work on a river, including a restoration project completed just two miles downstream of Peaslee Creek. The District's aquatic biologist, Tim Ford, has worked for over 25 years studying the river and developing programs to preserve and protect Tuolumne River habitat and fisheries. He has an extensive knowledge and understanding of the river. Please do not hesitate to contact Tim for further information on the data available to assist in evaluating the temporal and/or spatial impacts associated with the sedimentation.

The Turlock Irrigation District thanks the Regional Water Quality Control Board for their attention to this serious issue impacting the Tuolumne River. Should you have any questions regarding the above comments, please do not hesitate to contact either Tim Ford at (209) 883-8275 or myself at (209) 883-8428.

Sincerely,

Debra C. Liebersbach
Water Planning Department Manager

cc: Walter Ward - Modesto Irrigation District
Donn Furman - City and County of San Francisco
Kirk Ford – Stanislaus County
California Department of Fish and Game – Fresno office
NMFS – Sacramento office
USFWS – Sacramento office
ACOE – Sacramento office
TRTAC - e-mail list

APPENDIX B

California Regional Water Quality Control Board
Cleanup and Abatement Order No. R5-2008-0701

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

CLEANUP AND ABATEMENT ORDER NO.R5-2008-0701

FOR
STANISLAUS ALMOND RANCH, LLC
LAKE ROAD GRIZZLY RANCH, LLC
STANISLAUS COUNTY

This Order is issued to Stanislaus Almond Ranch, LLC and Lake Road Grizzly Ranch, LLC based on provisions of California Water Code (CWC) section 13304, which authorizes the Regional Water Quality Control Board, Central Valley Region (Regional Water Board) to issue a Cleanup and Abatement Order (Order), and CWC section 13267, which authorizes the Regional Water Board to require the submittal of technical and monitoring reports.

The Assistant Executive Officer of the Regional Water Board finds that:

1. Stanislaus Almond Ranch, LLC and Lake Road Grizzly Ranch, LLC (hereafter Dischargers) have graded over 1,000 acres of land in Stanislaus County, causing significant discharges of sediment into Peaslee Creek and the Tuolumne River. The property is in Sections 10, 11, 13 and 14, Township 4 South, Range 13 East MDB&M. The Dischargers own the property (APNs 020-008-012, 020-008-013, 020-010-003, and 020-010-004).

2. On 21 February 2008, the Stanislaus County Public Works Department informed Regional Water Board staff of the grading activities and forwarded information from the Turlock Irrigation District regarding impacts from the graded area. Turlock Irrigation District staff obtained turbidity measurements from Peaslee Creek upstream of the graded area and from the tributary of Peaslee Creek near the graded area. Turbidity measurements taken on 23 January 2008 were 11,200 nephelometric turbidity units (NTU) near the graded area and 167 NTU upstream of the graded area. Turbidity measurements taken on 28 January 2008 were 2240 NTU near the graded area and 127 NTU upstream of the graded area. Turlock Irrigation District staff provided photographs of the graded area and the turbid surface waters downstream, which are included as Attachment A to this Order. The photographs show large exposed areas with eroding slopes and stockpiles of manure on-site.

3. Sediment, when discharged to waters of the state, constitutes as a “waste” as defined in CWC section 13050. The Dischargers have discharged waste directly into surface waters which are tributary to the Tuolumne River

4. The *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, Fourth Edition*, (hereafter Basin Plan) designates beneficial uses, establishes water quality objectives, contains implementation programs for achieving objectives, and incorporates by reference, plans and policies adopted by the State Water Resources

Control Board. The beneficial uses of the Tuolumne River, as identified in Table II-1 of the Basin Plan, are municipal and domestic supply; agricultural supply; water contact recreation; non-contact water recreation; warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development of aquatic organisms; and wildlife habitat.

5. The Basin Plan lists specific water quality objectives for inland surface waters. These objectives include limitations on increased temperature, sediment, settleable and suspended material, and turbidity. Turbidity data obtained by the Turlock Irrigation District indicate that the grading activities caused violations of the Basin plan's objective for turbidity.

6. Section 13304(a) of the California Water Code provides that:

   "Any person who has discharged or discharges waste into waters of this state in violation of any waste discharge requirements or other order or prohibition issued by a regional board or the state board, or who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged or deposited where it is, or probably will be, discharged into the waters of the state and creates, or threatens to create, a condition of pollution or nuisance, shall upon order of the regional board clean up the waste or abate the effects of the waste, or, in the case of threatened pollution or nuisance, take other necessary remedial action, including, but limited to, overseeing cleanup and abatement efforts. A cleanup and abatement order issued by the state board or a regional board may require provision of, or payment for, uninterrupted replacement water service, which may include wellhead treatment, to each affected public water supplier or private well owner. Upon failure of any person to comply with the cleanup or abatement order, the Attorney General, at the request of the board, shall petition the superior court for that county for the issuance of an injunction requiring the person to comply with the order. In the suit, the court shall have jurisdiction to grant a prohibitory or mandatory injunction, either preliminary or permanent, as the fact may warrant."

7. The Dischargers' grading activities have resulted in the discharge of waste into surface waters, which have created, or threaten to create, a condition of pollution or nuisance.

8. Section 13304(c)(1) of the California Water Code provides that:

   "If the waste is cleaned up or the effects of the waste are abated, or, in the case of threatened pollution or nuisance, other necessary remedial action is taken by any governmental agency, the person or persons who discharged the waste, discharges the waste, or threatened to cause or permit the discharge of waste within the meaning of subdivision (a), are liable to that governmental agency to

the extent of the reasonable costs actually incurred in cleaning up the waste, abating the effects of the waste, supervising cleanup or abatement activities, or taking other remedial action. The amount of the costs is recoverable in a civil action by, and paid to, the governmental agency and state board to the extent of the latter's contribution to the cleanup costs from the State Water Pollution Cleanup and Abatement Account or other available funds."

9. Section 13267(b)(1) of the California Water Code provides that:

   "In conducting an investigation specified in subdivision (a), the regional board may require that any person who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge waste within its region, or any citizen or domiciliary, or political agency or entity of this state who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge waste outside of its region that could affect the quality of waters of the state within its region shall furnish, under penalty of perjury, technical or monitoring program reports which the regional board requires. The burden, including costs, of these reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained from the reports."

10. The technical reports required by this Order are necessary to assure compliance with this Order and to protect the waters of the state. The technical reports are necessary to demonstrate that appropriate methods will be used to clean up waste discharged to surface waters and to ensure that cleanup complies with Basin Plan requirements. The Dischargers named in this Order own and operate the site from which waste was discharged.

11. The issuance of this Order is an enforcement action taken by a regulatory agency and is exempt from the provisions of the California Environmental Quality Act, pursuant to Section 15321(a)(2), Title 14, California Code of Regulations.

12. Any person adversely affected by this action of the Regional Water Board may petition the State Water Resources Control Board (State Water Board) to review the action. The State Water Board must receive the petition within 30 days of the date of this Order. Copies of the law and regulations applicable to filing petitions may be found on the Internet at www.waterboards.ca.gov/centralvalley or will be provided upon request.

IT IS HEREBY ORDERED THAT, pursuant to CWC sections 13267 and 13304, Stanislaus Almond Ranch, LLC and Lake Road Grizzly Ranch, LLC shall:

1. Immediately take all actions to cease the discharge of sediment and other wastes to waters of the state, including but not limited to Peaslee Creek and its tributaries, and to the Tuolumne River.

2. Immediately clean up and abate the sediment discharged to surface waters in accordance with the following minimum schedule:

   (a) By **31 March 2008**, submit and immediately implement a *Stabilization and Cleanup Plan* (Plan). The Plan must describe how the site will be stabilized to prevent future discharges of sediment and all other wastes, and must give a proposed timeline for the work. The timeline shall not extend beyond **15 August 2008**. The Plan must describe how sediment-impacted surface waters will be cleaned up as appropriate and must include timelines and long-term monitoring to assess the effectiveness of the stabilization and cleanup efforts. The Plan must be prepared by a professional knowledgeable and experienced in erosion and sediment control measures. Comments from Regional Water Board staff should be incorporated into the Plan. The Plan shall be subject to approval by the Regional Water Board, and failure to submit an acceptable Stabilization and Cleanup Plan by the aforementioned deadline may result in the imposition of administrative civil liability.

   (b) By **1 September 2008,** submit a *Completion Report* describing in detail how the *Stabilization and Cleanup Plan* has been implemented, and showing that the site and impacted surface waters have been fully remediated. The Dischargers shall provide staff access to areas of the property, as needed.

3. If requested, reimburse the Regional Water Board for reasonable costs associated with oversight of actions taken in response to this Order. By **1 April 2008,** submit the name and address to be used for billing purposes for oversight charges.

Any person signing a document submitted under this Order shall make the following certification:

> *"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my knowledge and on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."*

As required by Business and Professions Code sections 6735, 7835, and 7835.1, all technical reports shall be prepared by, or under the supervision of, a California Registered Engineer or Professional Geologist and signed by the registered professional.

If, in the opinion of the Executive Officer, the Dischargers fail to comply with the provisions of this Order, the Executive Officer may refer this matter to the Attorney General for judicial enforcement or may issue a complaint for administrative civil liability.

Failure to comply with this Order may result in the assessment of an Administrative Civil Liability up to $10,000 per day of violation pursuant to CWC sections 13350, 13385, and/or 13268. The Regional Water Board reserves its right to take any enforcement actions authorized by law.

This Order is effective upon the date of signature.

JACK E. DEL CONTE, Assistant Executive Officer

10 March 2008
(Date)

APPENDIX C

CSBP Stream Habitat Characterization Field Forms

CSBP Stream Habitat Characterization Form

Pollution Case:	**Date:** 5-29-08
Waterbody Name: TUOLUMNE RIVER	**Time:** 12:05 START
Site Code: RIFFLE 7	**Crew:** D. Mierau; S. Kirihara
GPS Latitude: °N 37 38.328	**Elevation:** 141'
GPS Longitude: °W 120° 30.070	**Sampling Method:** D-Frame Kicknet

SECTION 1. REACH-WIDE PHYSICAL HABITAT SCORES (scores are based on overall habitat (riffle, run and pool) characteristics with a range between 0-20. See EPA's RBP habitat scoring guide for detailed scoring guidelines)

HABITAT MEASURE		**SCORE**	**COMMENTS**	**TOTAL PHYSICAL HABITAT SCORE:** 145 **/200**
Epifaunal Substrate		13		
Embeddedness		14	Transfer from previous data forms	
Velocity/ Depth Regimes		17		
Sediment Deposition		17	"REACH" = BASSO TO TLSRA	
Channel Flow		16		
Channel Alteration		12		
Riffle Frequency		12		
Bank Vegetation	Left Bank 7	Right Bank 7		
Bank Stability	Left Bank 9	Right Bank 9		
Riparian Zone	Left Bank 6	Right Bank 6		

SECTION 2. TRANSECT-SCALE PHYSICAL HABITAT CHARACTERISTICS (measures relate to individual riffle or pool transects from which each replicate sample is taken)

	T1	T2	T3		T1	T2	T3			T1	T2	T3
Average Depth (~~cm~~ FT)	1.4	1.2	1.7	**Transect Length (m)**	150	350	600	**Substrate Composition** (percentage composition measured along transect)	**Fines (<0.1")**	5	5	5
Average Velocity (~~m~~ FT/s)	2.1	2.5	1.8	**Channel Width (m)**	70	70	85		**Gravel (0.1-2")**	55	35	40
Riffle Embeddedness (0-20 scale)	14	14	14	**Canopy Cover (%)**	0	1	5		**Cobble (2-10")**	40	60	55
Substrate Consolidation (loose, moderate and firm)	L	L	L	**Substrate Complexity (0-20 scale)**	12	12	12		**Boulder (>10")**	–		
Gradient (this should be recorded as % slope (rise/ run), not degrees of slope or inches of drop)					0.25% (ESTIMATED)				**Bedrock (solid)**	–		

SECTION 3. CHEMICAL CHARACTERISTICS (one per site) TURB = 1.28

Specific Conductance (µmhos/cm@25°C)	41	**pH**	7.2
Water Temperature (°C)	13.1	**Salinity (ppt)**	
DO (mg/L)	N.T.	**DO (%)**	N.T.

SECTION 4. PHYSICAL CHARACTERISTICS

Habitat Type (Riffle-Run-Pool): RIFFLE
Length (~~m~~ FT): 900
Photo #: PHOTO 3+4 FACING U/S

5+6 GRAVEL CLOSE-UP

TRANS. 1 DEPTH	VEL	TRAN. 2 DEPTH	VEL	TRAN 3 DEPTH	VEL
1.1	1.4	0.7	2.17	1.5	1.02
1.6	1.89	1.2	2.49	1.8	2.28
1.4	2.85	1.7	2.95	1.7	2.21

CSBP Stream Habitat Characterization Form

Pollution Case:	Date: MAY 29, 2008
Waterbody Name: TUOLUMNE RIVER	Time: 14:15
Site Code: RIFFLE 13B	Crew: D. MIERAU, S. KIRIHARA
GPS Latitude: °N 37° 37.715	Elevation: 124. FT
GPS Longitude: °W 120° 31.278	Sampling Method: KICK NET D-FRAME

SECTION 1. REACH-WIDE PHYSICAL HABITAT SCORES (scores are based on overall habitat (riffle, run and pool) characteristics with a range between 0-20. See EPA's RBP habitat scoring guide for detailed scoring guidelines)

HABITAT MEASURE		SCORE	COMMENTS	TOTAL PHYSICAL HABITAT SCORE: 145/200
Epifaunal Substrate		13		
Embeddedness		14	SEE OTHER DATA SHEETS	
Velocity/ Depth Regimes		17		
Sediment Deposition		17		
Channel Flow		16	HIGH SAND CONTENT THROUGHOUT	
Channel Alteration		12	THE RIFFLE	
Riffle Frequency		12		
Bank Vegetation	Left Bank 7	Right Bank 7	"REACH" = BASSO TO TLSRA	
Bank Stability	Left Bank 9	Right Bank 9		
Riparian Zone	Left Bank 6	Right Bank 6		

SECTION 2. TRANSECT-SCALE PHYSICAL HABITAT CHARACTERISTICS (measures relate to individual riffle or pool transects from which each replicate sample is taken)

	T1	T2	T3		T1	T2	T3			T1	T2	T3
Average Depth (~~cm~~) FT	1.4	1.3	1.2	Transect Length (m)	10	70	130	Substrate Composition (percentage composition measured along transect)	Fines (<0.1")	30	40	30
Average Velocity (~~m~~/s) FT	2.0	1.3	1.5	Channel Width (m)	60	70	70		Gravel (0.1-2")	30	20	30
Riffle Embeddedness (0-20 scale)	12	11	12	Canopy Cover (%)	0	0	2		Cobble (2-10")	40	40	40
Substrate Consolidation (loose, moderate and firm)	L	L	L	Substrate Complexity (0-20 scale)	13	13	13		Boulder (>10")			
Gradient (this should be recorded as % slope (rise/ run), not degrees of slope or inches of drop)					0.20% (ESTIMATED)				Bedrock (solid)			

SECTION 3. CHEMICAL CHARACTERISTICS (one per site)

Specific Conductance (µmhos/cm@25°C)	45.5	pH	7.2
Water Temperature (°C)	15.9	Salinity (ppt)	
DO (mg/L)	N.T.	DO (%)	N.T.

SECTION 4. PHYSICAL CHARACTERISTICS

Habitat Type (Riffle-Run-Pool): RIFFLE
Length (~~m~~): 150'
Photo #: 2 PHOTOS FACING U/S; 2 PHOTOS OF SAND IN SUBSTRATE

TRANS. 1 DEPTH	VEL	TRANS. 2 DEPTH	VEL	TRANS. 3 DEPTH	VEL
1.5	2.17	1.1	1.09	1.2	1.69
1.2	2.00	1.4	1.44	1.3	1.48
1.4	1.82	1.5	1.34	1.2	1.35

CSBP Stream Habitat Characterization Form

Pollution Case:	**Date:** 28 MAY 08
Waterbody Name: TUOLUMNE	**Time:** 17:30
Site Code: RIFFLE 17	**Crew:** D. MIERAU S. KIRIHARA
GPS Latitude: °N 37 37.709	**Elevation:** 124 QUESTIONABLE CONSIDERING R20 READING
GPS Longitude: °W 120 32.461	**Sampling Method:**

SECTION 1. REACH-WIDE PHYSICAL HABITAT SCORES (scores are based on overall habitat (riffle, run and pool) characteristics with a range between 0-20. See EPA's RBP habitat scoring guide for detailed scoring guidelines)

HABITAT MEASURE		SCORE	COMMENTS	TOTAL PHYSICAL HABITAT SCORE: 145 /200
Epifaunal Substrate		13	ORIGINALLY DETERMINED AT R20	
Embeddedness		14	"REACH" = BASSO TO TLSRA	
Velocity/ Depth Regimes		17		
Sediment Deposition		17		
Channel Flow		16		
Channel Alteration		12		
Riffle Frequency		12		
Bank Vegetation	Left Bank 7	Right Bank 7		
Bank Stability	Left Bank 9	Right Bank 9		
Riparian Zone	Left Bank 6	Right Bank 6		

SECTION 2. TRANSECT-SCALE PHYSICAL HABITAT CHARACTERISTICS (measures relate to individual riffle or pool transects from which each replicate sample is taken)

	T1	T2	T3		T1	T2	T3			T1	T2	T3
Average Depth (cm)	1.6	1.6	1.9	**Transect Length (m)**	55	110	165	**Substrate Composition** (percentage composition measured along transect)	**Fines (<0.1")**	15	20	15
Average Velocity (m/s) ft	1.7	1.7	1.9	**Channel Width (m)**	80	95	110		**Gravel (0.1-2")**	45	50	30
Riffle Embeddedness (0-20 scale)	13	13	13	**Canopy Cover (%)**	2	2	4		**Cobble (2-10")**	40	30	35
Substrate Consolidation (loose, moderate and firm)	L	L	L	**Substrate Complexity (0-20 scale)**	12	12	12		**Boulder (>10")**			
Gradient (this should be recorded as % slope (rise/ run), not degrees of slope or inches of drop)					0.14 % (SURVEYED)				**Bedrock (solid)**			20

SECTION 3. CHEMICAL CHARACTERISTICS (one per site)

Specific Conductance (µmhos/cm@25°C)	45.5	**pH**	7.2
Water Temperature (°C)	16.5	**Salinity (ppt)**	
DO (mg/L)	9.2	**DO (%)**	94

TURB 2.01

SECTION 4. PHYSICAL CHARACTERISTICS

Habitat Type (Riffle-Run-Pool): RIFFLE
Length (m): 220'
Photo #:

CSBP Stream Habitat Characterization Form

Pollution Case:	**Date:** 28 MAY 08
Waterbody Name: TUOLUMNE RIVER	**Time:** 14:30
Site Code: RIFFLE 20 - BOBCAT FLAT	**Crew:** D. MIERAU, S. KIRIHARA
GPS Latitude: °N 37 37.936	**Elevation:** ~~88'~~ 130 FT
GPS Longitude: °W 120 33.589	**Sampling Method:** KICKNET COMPOSITE

SECTION 1. REACH-WIDE PHYSICAL HABITAT SCORES (scores are based on overall habitat (riffle, run and pool) characteristics with a range between 0-20. See EPA's RBP habitat scoring guide for detailed scoring guidelines)

HABITAT MEASURE		**SCORE**	**COMMENTS**	**TOTAL PHYSICAL HABITAT SCORE:** 145 **/200**
Epifaunal Substrate		13		
Embeddedness		14	TRANSECT 3 9	TRANSECT 1+2 14
Velocity/ Depth Regimes		17		
Sediment Deposition		17		
Channel Flow		16	THE "REACH" IS CONSIDERED FROM BASSO	
Channel Alteration		12	BRIDGE DOWNSTREAM TO TURLOCK LAKE	
Riffle Frequency		12	STATE RECREATION AREA.	
Bank Vegetation	Left Bank 7	Right Bank 7		
Bank Stability	Left Bank 9	Right Bank 9		
Riparian Zone	Left Bank 6	Right Bank 6		

SECTION 2. TRANSECT-SCALE PHYSICAL HABITAT CHARACTERISTICS (measures relate to individual riffle or pool transects from which each replicate sample is taken)

	T1	T2	T3		T1	T2	T3
Average Depth (~~cm~~) ft	1.3	1.3	1.3	**Transect Length (m)**	0	117	191
Average Velocity (~~m~~/s) ft	3.6	2.0	1.7	**Channel Width (m)**	55	80	80
Riffle Embeddedness (0-20 scale)	14	14	9	**Canopy Cover (%)**	5	3	0
Substrate Consolidation (loose, moderate and firm)	L	L	M	**Substrate Complexity (0-20 scale)**	13	13	9
Gradient (this should be recorded as % slope (rise/ run), not degrees of slope or inches of drop)	0.45% (SURVEYED)						

Substrate Composition (percentage composition measured along transect)	T1	T2	T3
Fines (<0.1")	10	10	20
Gravel (0.1-2")	30	40	50
Cobble (2-10")	60	50	30
Boulder (>10")			
Bedrock (solid)			

SECTION 3. CHEMICAL CHARACTERISTICS (one per site)

Specific Conductance (µmhos/cm@25°C)	48.6	**pH**	6.8
Water Temperature (°C)	16.5	**Salinity (ppt)**	
DO (mg/L)	11.05	**DO (%)**	114.5

SECTION 4. PHYSICAL CHARACTERISTICS

Habitat Type (~~Riffle-Run-Pool~~): RIFFLE	
Length (m): 191	
Photo #: 4467-4475	

TURB 1.56

FROM PHOTO PT 1

RM 43

191
-74
117

TRANS. 1 DEPTH VEL
3.6 1.0 2.05
1.5 4.3
1.2 3.9

TRAN. 2 D V
0.9 .95
1.6 2.4
1.3 2.5A

TRAN. 3 D V
1.4 1.6
1.5 1.9
1.1 1.5

CSBP Stream Habitat Characterization Form

Pollution Case:	**Date:** 5-29-08
Waterbody Name: TUOLUMNE RIVER	**Time:** 0915
Site Code: RIFFLE 23C	**Crew:** D.MIERAU, S.KIRIHARA
GPS Latitude: °N 37° 37.812'	**Elevation:** 118 FT
GPS Longitude: °W 120° 34.488	**Sampling Method:** D-Frame Kicknet

SECTION 1. REACH-WIDE PHYSICAL HABITAT SCORES (scores are based on overall habitat (riffle, run and pool) characteristics with a range between 0-20. See EPA's RBP habitat scoring guide for detailed scoring guidelines)

HABITAT MEASURE		**SCORE**	**COMMENTS**	**TOTAL PHYSICAL HABITAT SCORE:** 145/200
Epifaunal Substrate		13		
Embeddedness		14	ORIGINALLY DETERMINED AT R.20	
Velocity/ Depth Regimes		17	ON 5/28/08	
Sediment Deposition		17		
Channel Flow		16	"REACH" = BASSO TO TLSRA	
Channel Alteration		12		
Riffle Frequency		12		
Bank Vegetation	Left Bank 7	Right Bank 7		
Bank Stability	Left Bank 9	Right Bank 9		
Riparian Zone	Left Bank 6	Right Bank 6		

SECTION 2. TRANSECT-SCALE PHYSICAL HABITAT CHARACTERISTICS (measures relate to individual riffle or pool transects from which each replicate sample is taken)

	T1	T2	T3		T1	T2	T3			T1	T2	T3
Average Depth (cm) FT	1.5	0.9	1.1	**Transect Length (m)** FT	30	60	105	**Substrate Composition** (percentage composition measured along transect)	**Fines (<0.1")**	5	5	5
Average Velocity (m/s) FT	1.6	3.5	3.2	**Channel Width (m)** FT	65	70	65		**Gravel (0.1-2")**	40	35	50
Riffle Embeddedness (0-20 scale)	15	16	17	**Canopy Cover (%)**	15	20	20		**Cobble (2-10")**	55	60	45
Substrate Consolidation (loose, moderate and firm)	L	L	L	**Substrate Complexity (0-20 scale)**	15	15	15		**Boulder (>10")**			
Gradient (this should be recorded as % slope (rise/ run), not degrees of slope or inches of drop)					0.3 % (ESTIMATED)				**Bedrock (solid)**			

SECTION 3. CHEMICAL CHARACTERISTICS (one per site) TURB=

Specific Conductance (µmhos/cm@25°C)	46.8	**pH**	7.4
Water Temperature (°C)	15.4	**Salinity (ppt)**	Ø
DO (mg/L) meter misfunction		**DO (%)**	

SECTION 4. PHYSICAL CHARACTERISTICS

Habitat Type (Riffle-Run-Pool): Riffle
Length (m): ~190 FT
Photo #: 1 FACING D/S OF SITE 2 RIVER RIGHT (FLAGGING OF TRANSECT)

TRANS. 1 DEPTH	VEL	TRANS. 2 D	VEL	TRAN 3 D	VEL
1.4	1.49	1.0	3.40	0.7	2.5
1.2	1.28	1.1	3.34	1.2	3.43
[illegible]	[illegible]	[illegible]	[illegible]	1.4	[illegible]

Habitat Parameters	Categories			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE ____	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. 35	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE ____	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
3. Velocity/ Depth Regimes	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE ____	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE ____	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE ____	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE ____	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE ___	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
8. Bank Stability (score each bank) Note: determine left of right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank 10 9	**8 7 6**	**5 4 3**	**2 1 0**
	Right Bank 10 9	**8 7 6**	**5 4 3**	**2 1 0**
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one- half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	**8 7 6**	**5 4 3**	**2 1 0**
	Right Bank 10 9	**8 7 6**	**5 4 3**	**2 1 0**
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	Left Bank 10 9	**8 7 6**	**5 4 3**	**2 1 0**
	Right Bank 10 9	**8 7 6**	**5 4 3**	**2 1 0**

CSBP Stream Habitat Characterization Form

Pollution Case:	**Date:**
Waterbody Name:	**Time:**
Site Code:	**Crew:**
GPS Latitude: °N	**Elevation:**
GPS Longitude: °W	**Sampling Method:**

SECTION 1. REACH-WIDE PHYSICAL HABITAT SCORES (scores are based on overall habitat (riffle, run and pool) characteristics with a range between 0-20. See EPA's RBP habitat scoring guide for detailed scoring guidelines)

HABITAT MEASURE		SCORE	COMMENTS	TOTAL PHYSICAL HABITAT SCORE: /200
Epifaunal Substrate				
Embeddedness				
Velocity/ Depth Regimes				
Sediment Deposition				
Channel Flow				
Channel Alteration				
Riffle Frequency				
Bank Vegetation	Left Bank	Right Bank		
Bank Stability	Left Bank	Right Bank		
Riparian Zone	Left Bank	Right Bank		

SECTION 2. TRANSECT-SCALE PHYSICAL HABITAT CHARACTERISTICS (measures relate to individual riffle or pool transects from which each replicate sample is taken)

	T1	T2	T3		T1	T2	T3			T1	T2	T3
Average Depth (cm)				**Transect Length (m)**				**Substrate Composition** (percentage composition measured along transect)	**Fines (<0.1")**			
Average Velocity (m/s)				**Channel Width (m)**					**Gravel (0.1-2")**			
Riffle Embeddedness (0-20 scale)				**Canopy Cover (%)**					**Cobble (2-10")**			
Substrate Consolidation (loose, moderate and firm)				**Substrate Complexity (0-20 scale)**					**Boulder (>10")**			
Gradient (this should be recorded as % slope (rise/ run), not degrees of slope or inches of drop)									**Bedrock (solid)**			

SECTION 3. CHEMICAL CHARACTERISTICS (one per site)

Specific Conductance (µmhos/cm@25°C)		**pH**	
Water Temperature (°C)		**Salinity (ppt)**	
DO (mg/L)		**DO (%)**	

SECTION 4. PHYSICAL CHARACTERISTICS

Habitat Type (Riffle-Run-Pool):
Length (m):
Photo #:

APPENDIX D

Benthic Invertebrate Metrics Results Provided by Aquatic Biology Associates, Inc

Riffle 7, May 29, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU01

Total invertebrate abundance	= 2874.0	EPT abundance	= 1979.6
Total number of taxa	= 45	Number EPT taxa	= 15
Hilsenhoff Biotic Index	= 4.70	Brillouin H	= 2.56

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	5	32.2	1.13
Odonata	0	0.0	0.00
Ephemeroptera	7	1283.6	44.67
Plecoptera	1	160.6	5.59
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	7	535.4	18.62
Lepidoptera	1	4.4	0.15
Coleoptera	1	0.7	0.02
Misc. Diptera	2	71.1	2.48
Chironomidae	21	786.0	27.34

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	166.4	5.79
Parasite	1	1.4	0.05
Collector-gatherer	21	1815.8	63.20
Collector-filterer	4	566.8	19.72
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	2.1	0.07
Scraper	6	120.3	4.17
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	5	94.1	3.27
Unknown	2	107.1	3.73

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	634.7	22.09
Hydropsyche	462.6	16.10
Acentrella species	422.7	14.71
Orthocladius Complex	231.9	8.07
Isoperla	160.6	5.59
SUBTOTAL 5 DOMINANTS	1912.5	66.56
Serratella micheneri	140.6	4.89
Tvetenia Vitracies Group	121.4	4.22
Orthocladius	116.9	4.07
Chironomidae-pupae	103.7	3.61
Simulium	66.1	2.30
TOTAL 10 DOMINANTS	2461.2	85.65

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant organisms	3	50.3	1.75
B Intolerant mayflies	8	383.8	13.35

Riffle 7, May 29, 2008
CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU01

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 2.52
Hydropsychidae/Total Trichoptera	= 0.86
Baetidae/Total Ephemeroptera	= 0.82

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.21
Scraper/(Scraper + C.-filterer)	= 0.18
Shredder/Total organisms	= 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 90.62
Community Tolerance Quotient (d) = 87.34

DIVERSITY MEASURES

Shannon H (loge)	= 2.59
Shannon H (log2)	= 3.74
Evenness	= 0.68
Simpson D	= 0.11

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	1526.2	53.10
Univoltine	1336.2	46.49
Semivoltine	11.6	0.40

Riffle 7, May 29, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU01

IDENTIFICATION CODE	R1	R2	R3
Replicate subsampling conversioı	1.15	5	2.31
CONVERSION (M2)	1.79		

CAMLnet January 2003 coding parameters.

Taxon	**R1**	**R2**	**R3**	**MEAN**	**STDEV**	**%**
Oligochaeta	10	10	16	21.8	6.2	0.76
Gyraulus	2	0	2	2.8	2.4	0.10
Crangonyx	1	0	7	4.8	6.6	0.17
Caecidotea	0	0	2	1.4	2.4	0.05
Acari	0	0	2	1.4	2.4	0.05
TOTAL: NON INSECTS	14	10	30	32.1	19.0	1.12
Acentrella species	167	350	192	422.7	177.9	14.71
Baetis tricaudatus	189	665	210	634.7	481.6	22.09
Centroptilum/Procloeon	0	0	2	1.4	2.4	0.05
Ephemerella excrusians	2	5	5	7.1	2.6	0.25
Serratella micheneri	38	140	58	140.6	96.9	4.89
Ecdyonurus criddlei	17	30	30	46.1	13.2	1.60
Tricorythodes minutus	12	15	25	31.0	13.0	1.08
TOTAL: EPHEMEROPTERA	424	1205	522	1283.7	761.3	44.66
Isoperla	43	155	72	160.6	104.5	5.59
TOTAL: PLECOPTERA	43	155	72	160.6	104.5	5.59
Glossosoma	18	45	25	53.0	24.7	1.84
Protoptila	3	5	14	13.3	10.1	0.46
Hydropsyche	62	600	113	462.6	531.5	16.10
Hydroptila	0	0	2	1.4	2.4	0.05
Oxyethira	1	0	0	0.7	1.2	0.02
Mystacides	0	5	0	3.0	5.2	0.10
Polycentropus	0	0	2	1.4	2.4	0.05
TOTAL: TRICHOPTERA	85	655	157	535.3	555.5	18.63
Petrophila	2	5	0	4.4	4.5	0.15
TOTAL: LEPIDOPTERA	2	5	0	4.4	4.5	0.15
Ordobrevia nubifera	1	0	0	0.7	1.2	0.02
TOTAL: COLEOPTERA	1	0	0	0.7	1.2	0.02
Simulium	18	90	2	66.1	83.6	2.30
Antocha	1	5	2	5.0	3.5	0.18
TOTAL: DIPTERA	20	95	5	71.1	86.7	2.47
Chironomidae-pupae	18	130	25	103.7	111.9	3.61
Cardiocladius	0	0	2	1.4	2.4	0.05
Cladotanytarsus	3	0	7	6.2	6.2	0.22

Cricotopus	21	45	0	39.2	40.3	1.36
Cricotopus Bicinctus Gr.	5	10	0	8.7	9.0	0.30
Eukiefferiella	9	45	23	46.1	32.3	1.60
Eukiefferiella Devonica Gr.	1	15	5	12.4	12.9	0.43
Orthocladius Complex	66	240	83	231.9	171.9	8.07
Orthocladius	71	60	65	116.9	10.2	4.07
Parakiefferiella	0	0	7	4.1	7.2	0.14
Paratanytarsus	1	0	5	3.4	4.3	0.12
Pentaneura	1	5	2	5.0	3.5	0.18
Polypedilum	8	10	21	23.2	12.3	0.81
Potthastia Gaedii Gr.	0	0	2	1.4	2.4	0.05
Rheocricotopus	1	10	5	9.4	8.0	0.33
Rheotanytarsus	5	0	5	5.5	4.8	0.19
Synorthocladius	1	5	5	6.4	3.8	0.22
Tanytarsus	16	20	18	32.6	3.5	1.13
Thienemanniella	0	0	7	4.1	7.2	0.14
Thienemannimyia Complex	0	5	0	3.0	5.2	0.10
Tvetenia Vitracies Group	22	140	42	121.4	113.3	4.22
TOTAL: CHIRONOMIDAE	250	740	328	786.2	471.6	27.35
GRAND TOTAL	838	2865	1113	2874.0	1967.8	100.00

Riffle 13B, May 29, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU02

Total invertebrate abundance	= 1010.5	EPT abundance	= 715.3
Total number of taxa	= 45	Number EPT taxa	= 13
Hilsenhoff Biotic Index	= 3.59	Brillouin H	= 2.62

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	11	21.3	2.10
Odonata	0	0.0	0.00
Ephemeroptera	5	393.0	38.89
Plecoptera	1	9.8	0.97
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	7	312.5	30.92
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	5	21.2	2.10
Chironomidae	16	252.7	25.00

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	7	18.3	1.81
Parasite	1	1.2	0.12
Collector-gatherer	16	527.0	52.14
Collector-filterer	6	104.1	10.31
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	1.2	0.12
Scraper	9	301.4	29.82
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	3	34.1	3.37
Unknown	1	23.2	2.29

DOMINANT TAXON	ABUNDANCE	PERCENT
Serratella micheneri	151.7	15.01
Protoptila	142.7	14.11
Glossosoma	133.3	13.19
Acentrella insignificans	115.7	11.45
Baetis tricaudatus	108.0	10.68
SUBTOTAL 5 DOMINANTS	651.4	64.44
Cladotanytarsus	70.9	7.02
Tanytarsus	50.0	4.95
Hydropsyche	33.5	3.32
Orthocladius Complex	31.3	3.09
Eukiefferiella	24.4	2.41
TOTAL 10 DOMINANTS	861.5	85.23

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant organisms	6	34.7	3.43
B Intolerant organisms	6	445.4	44.06

Riffle 13B, May 29, 2008
CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU02

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 2.83
Hydropsychidae/Total Trichoptera	= 0.11
Baetidae/Total Ephemeroptera	= 0.57

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 2.90
Scraper/(Scraper + C.-filterer)	= 0.74
Shredder/Total organisms	= 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 91.51
Community Tolerance Quotient (d) = 81.35

DIVERSITY MEASURES

Shannon H (loge)	= 2.69
Shannon H (log2)	= 3.89
Evenness	= 0.71
Simpson D	= 0.09

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	374.3	37.04
Univoltine	630.0	62.35
Semivoltine	6.2	0.61

Riffle 13B, May 29, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU02

IDENTIFICATION CODE	R1	R2	R3
Replicate subsampling conversior	1	1.03	1.03
CONVERSION (M2)	1.79		

CAMLnet January 2003 coding parameters.

Taxon	**R1**	**R2**	**R3**	**MEAN**	**STDEV**	**%**
Turbellaria	2	0	0	1.2	2.1	0.12
Oligochaeta	0	3	3	3.7	3.2	0.36
Pisidium	0	2	0	1.2	2.1	0.12
Corbicula fluminea	1	3	2	3.7	1.9	0.36
Lymnaea	0	1	0	0.6	1.1	0.06
Physa	0	2	0	1.2	2.1	0.12
Gyraulus	3	3	0	3.6	3.1	0.36
Menetus	2	2	2	3.7	0.1	0.36
Crangonyx	1	0	0	0.6	1.0	0.06
Caecidotea	0	1	0	0.6	1.1	0.06
Acari	1	1	0	1.2	1.0	0.12
TOTAL: NON INSECTS	10	19	7	21.3	10.6	2.11
Acentrella insignificans	57	65	72	115.7	13.5	11.45
Baetis tricaudatus	78	46	57	108.0	28.9	10.68
Serratella micheneri	75	87	93	151.7	16.1	15.01
Ecdyonurus criddlei	7	8	3	10.9	4.8	1.08
Tricorythodes minutus	1	8	2	6.7	7.0	0.67
TOTAL: EPHEMEROPTERA	218	214	227	393.1	11.3	38.89
Isoperla	2	6	8	9.8	5.7	0.97
TOTAL: PLECOPTERA	2	6	8	9.8	5.7	0.97
Glossosoma	72	63	89	133.3	23.4	13.19
Protoptila	64	70	105	142.7	39.7	14.11
Hydropsyche	15	21	21	33.5	5.8	3.32
Hydroptila	0	1	0	0.6	1.1	0.06
Oxyethira	0	1	0	0.6	1.1	0.06
Nectopsyche	0	2	0	1.2	2.1	0.12
Polycentropus	0	1	0	0.6	1.1	0.06
TOTAL: TRICHOPTERA	151	159	214	312.6	61.8	30.92
Agathon	3	0	2	3.0	2.7	0.30
Empididae-pupae	1	3	1	3.1	2.1	0.30
Chelifera/Metachela	0	1	1	1.2	1.1	0.12
Simulium	9	4	5	10.9	4.6	1.08
Antocha	2	2	1	3.0	1.0	0.30
TOTAL: DIPTERA	15	10	10	21.2	4.9	2.10

Chironomidae-pupae	11	15	12	23.2	4.1	2.29
Cardiocladius	2	1	0	1.8	1.8	0.18
Cladotanytarsus	19	79	21	70.9	61.5	7.02
Corynoneura	1	1	0	1.2	1.0	0.12
Cricotopus	0	0	11	6.8	11.7	0.67
Eukiefferiella	11	5	25	24.4	18.0	2.41
Orthocladius Complex	5	12	35	31.3	28.0	3.09
Parakiefferiella	0	0	3	1.8	3.2	0.18
Phaenopsectra	3	0	1	2.4	2.7	0.24
Polypedilum	5	5	4	8.5	1.0	0.84
Rheotanytarsus	4	3	1	4.8	2.7	0.48
Synorthocladius	3	2	3	4.9	1.0	0.48
Tanytarsus	20	47	16	50.0	30.3	4.95
Thienemanniella	2	1	3	3.7	1.8	0.36
Thienemannimyia Complex	0	1	0	0.6	1.1	0.06
Tvetenia Vitracies Group	9	13	5	16.4	7.4	1.63
TOTAL: CHIRONOMIDAE	95	187	141	252.7	82.8	25.00
GRAND TOTAL	491	595	608	1010.8	114.8	100.00

Riffle 17, May 28, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU03

Total invertebrate abundance	= 1187.3	EPT abundance	= 808.9
Total number of taxa	= 46	Number EPT taxa	= 14
Hilsenhoff Biotic Index	= 4.32	Brillouin H	= 2.63

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	8	14.6	1.24
Odonata	0	0.0	0.00
Ephemeroptera	7	671.3	56.54
Plecoptera	1	38.1	3.21
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	6	99.5	8.38
Lepidoptera	1	18.6	1.56
Coleoptera	1	0.8	0.07
Misc. Diptera	4	14.1	1.20
Chironomidae	18	330.3	27.82

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	47.0	3.97
Parasite	2	2.8	0.24
Collector-gatherer	20	825.4	69.52
Collector-filterer	6	77.4	6.53
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	5.6	0.47
Scraper	8	116.5	9.81
Shredder	1	0.7	0.06
Xylophage	0	0.0	0.00
Omnivore	2	53.7	4.52
Unknown	1	58.2	4.90

DOMINANT TAXON	ABUNDANCE	PERCENT
Acentrella insignificans	315.2	26.55
Serratella micheneri	157.8	13.29
Baetis tricaudatus	130.0	10.95
Orthocladius Complex	64.2	5.41
Chironomidae-pupae	58.2	4.90
SUBTOTAL 5 DOMINANTS	725.4	61.10
Orthocladius	52.8	4.44
Ecdyonurus criddlei	50.8	4.28
Hydropsyche	49.0	4.13
Isoperla	38.1	3.21
Glossosoma	34.8	2.93
TOTAL 10 DOMINANTS	950.9	80.09

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant organisms	4	27.2	2.30
B Intolerant organisms	8	249.2	20.99

Riffle 17, May 28, 2008
CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU03

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 2.45
Hydropsychidae/Total Trichoptera	= 0.49
Baetidae/Total Ephemeroptera	= 0.67

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 1.51
Scraper/(Scraper + C.-filterer)	= 0.60
Shredder/Total organisms	= 0.00

Biotic Condition Index

Community Tolerance Quotient (a) = 90.43
Community Tolerance Quotient (d) = 86.26

DIVERSITY MEASURES

Shannon H (loge)	= 2.69
Shannon H (log2)	= 3.89
Evenness	= 0.70
Simpson D	= 0.12

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	613.5	51.67
Univoltine	566.1	47.68
Semivoltine	7.7	0.65

Riffle 17, May 28, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU03

IDENTIFICATION CODE	R1	R2	R3
Replicate subsampling conversion	1.36	1.11	1.11
CONVERSION (M2)	1.79		

CAMLnet January 2003 coding parameters.

Taxon	**R1**	**R2**	**R3**	**MEAN**	**STDEV**	**%**
Nematoda	1	0	0	0.8	1.4	0.07
Oligochaeta	3	0	1	2.3	2.4	0.19
Pisidium	0	1	0	0.7	1.1	0.06
Corbicula fluminea	1	8	0	5.4	7.4	0.46
Lymnaea	0	1	0	0.7	1.1	0.06
Gyraulus	0	0	1	0.7	1.1	0.06
Crangonyx	0	2	1	2.0	2.0	0.17
Acari	0	2	1	2.0	2.0	0.17
TOTAL: NON INSECTS	5	14	4	14.5	9.8	1.22
Acentrella insignificans	193	174	161	315.2	28.9	26.55
Baetis tricaudatus	68	32	118	130.0	76.8	10.95
Centroptilum/Procloeon	0	2	0	1.3	2.3	0.11
Ephemerella excrusians	0	1	0	0.7	1.1	0.06
Serratella micheneri	56	128	81	157.8	65.3	13.29
Ecdyonurus criddlei	4	24	57	50.8	47.4	4.28
Tricorythodes minutus	8	16	2	15.5	11.9	1.30
TOTAL: EPHEMEROPTERA	329	377	418	671.2	80.1	56.54
Isoperla	10	9	46	38.1	37.5	3.21
TOTAL: PLECOPTERA	10	9	46	38.1	37.5	3.21
Glossosoma	10	19	30	34.8	18.3	2.93
Protoptila	1	2	12	9.4	10.8	0.79
Hydropsyche	12	44	26	49.0	28.9	4.13
Hydroptila	3	4	0	4.3	4.0	0.36
Oxyethira	0	1	1	1.3	1.1	0.11
Lepidostoma	0	1	0	0.7	1.1	0.06
TOTAL: TRICHOPTERA	26	72	69	99.5	46.2	8.38
Petrophila	12	9	10	18.6	3.1	1.56
TOTAL: LEPIDOPTERA	12	9	10	18.6	3.1	1.56
Ordobrevia nubifera	1	0	0	0.8	1.4	0.07
TOTAL: COLEOPTERA	1	0	0	0.8	1.4	0.07
Empididae-pupae	0	1	0	0.7	1.1	0.06
Chelifera/Metachela	3	1	1	2.9	1.7	0.25
Simulium	5	3	7	9.2	3.0	0.78
Antocha	0	2	0	1.3	2.3	0.11

TOTAL: DIPTERA	8	8	8	14.1	0.4	1.19
Chironomidae-pupae	35	46	17	58.2	26.2	4.90
Cardiocladius	0	7	2	5.3	6.1	0.45
Cladotanytarsus	15	4	1	12.2	12.9	1.03
Corynoneura	0	3	0	2.0	3.4	0.17
Cricotopus	39	14	3	34.1	33.1	2.87
Cricotopus Bicinctus Gr.	10	7	1	10.3	7.7	0.87
Eukiefferiella	11	14	9	20.4	5.0	1.72
Orthocladius Complex	30	72	6	64.2	60.3	5.41
Orthocladius	46	32	10	52.8	32.7	4.44
Parakiefferiella	0	1	0	0.7	1.1	0.06
Phaenopsectra	0	1	0	0.7	1.1	0.06
Polypedilum	14	27	16	33.3	12.6	2.80
Pseudochironomus	0	1	0	0.7	1.1	0.06
Rheotanytarsus	1	1	0	1.5	1.3	0.12
Synorthocladius	4	6	1	6.4	4.0	0.54
Tanytarsus	10	6	4	11.6	4.8	0.98
Thienemanniella	7	6	1	8.0	5.4	0.68
Tvetenia Vitracies Group	5	4	3	7.9	1.9	0.66
TOTAL: CHIRONOMIDAE	227	252	74	330.2	172.1	27.82
GRAND TOTAL	619	741	629	1187.2	121.7	100.00

Riffle 20 @ Bobcat Patch-2, May 28, 2008
CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU04

Total invertebrate abundance	= 1719.4	EPT abundance	= 921.8
Total number of taxa	= 45	Number EPT taxa	= 14
Hilsenhoff Biotic Index	= 4.92	Brillouin H	= 2.82

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	9	67.6	3.93
Odonata	0	0.0	0.00
Ephemeroptera	7	789.1	45.89
Plecoptera	1	39.5	2.30
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	6	93.2	5.42
Lepidoptera	1	17.3	1.01
Coleoptera	1	8.1	0.47
Misc. Diptera	3	28.3	1.64
Chironomidae	17	676.3	39.37

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	2	40.6	2.36
Parasite	2	6.1	0.35
Collector-gatherer	21	1138.6	66.24
Collector-filterer	6	268.4	15.61
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	21.2	1.23
Scraper	7	113.9	6.62
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	3	42.2	2.47
Unknown	1	86.4	5.03

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	266.7	15.51
Serratella micheneri	233.6	13.59
Acentrella insignificans	206.7	12.02
Cricotopus	175.2	10.19
Tanytarsus	98.7	5.74
SUBTOTAL 5 DOMINANTS	980.9	57.05
Cricotopus Bicinctus Gr.	95.0	5.52
Chironomidae-pupae	86.4	5.03
Ecdyonurus criddlei	60.6	3.52
Rheotanytarsus	60.5	3.52
Hydropsyche	45.0	2.62
TOTAL 10 DOMINANTS	1328.4	77.26

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant organisms	6	57.7	3.37
B Intolerant organisms	9	328.5	19.11

Riffle 20 @ Bobcat Patch-2, May 28, 2008
CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU04

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 1.36
Hydropsychidae/Total Trichoptera	= 0.48
Baetidae/Total Ephemeroptera	= 0.60

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.42
Scraper/(Scraper + C.-filterer)	= 0.30
Shredder/Total organisms	= 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 90.93
Community Tolerance Quotient (d) = 91.29

DIVERSITY MEASURES

Shannon H (loge)	= 2.87
Shannon H (log2)	= 4.14
Evenness	= 0.75
Simpson D	= 0.08

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	910.8	52.97
Univoltine	757.1	44.03
Semivoltine	51.5	2.99

Riffle 20 @ Bobcat Patch-2, May 28, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU04

IDENTIFICATION CODE	R1	R2	R3
Replicate subsampling conversior	1.43	1.76	1.67
CONVERSION (M2)	1.79		

CAMLnet January 2003 coding parameters.

Taxon	**R1**	**R2**	**R3**	**MEAN**	**STDEV**	**%**
Nematoda	0	4	0	2.1	3.6	0.12
Oligochaeta	1	4	15	11.9	13.1	0.69
Pisidium	0	0	2	1.0	1.7	0.06
Corbicula fluminea	0	0	62	36.9	63.9	2.14
Ferrissia	0	0	3	2.0	3.5	0.12
Crangonyx	1	0	3	2.8	3.0	0.17
Stygobromus	1	2	7	5.9	5.3	0.34
Hyalella	0	0	2	1.0	1.7	0.06
Acari	0	2	5	4.0	4.5	0.23
TOTAL: NON INSECTS	4	11	99	67.7	94.3	3.93
Acentrella insignificans	187	106	53	206.7	120.8	12.02
Baetis tricaudatus	293	134	20	266.7	245.6	15.51
Centroptilum/Procloeon	1	2	0	1.9	1.7	0.11
Ephemerella excrusians	0	2	0	1.1	1.8	0.06
Serratella micheneri	86	197	109	233.6	105.3	13.59
Ecdyonurus criddlei	20	60	22	60.6	40.3	3.52
Tricorythodes minutus	0	19	12	18.5	17.5	1.08
TOTAL: EPHEMEROPTERA	588	519	215	789.0	354.7	45.89
Isoperla	40	21	5	39.5	31.4	2.30
TOTAL: PLECOPTERA	40	21	5	39.5	31.4	2.30
Glossosoma	20	7	12	23.1	11.8	1.34
Protoptila	1	2	0	1.9	1.7	0.11
Hydropsyche	41	11	23	45.0	27.8	2.62
Hydroptila	0	4	23	16.1	22.6	0.93
Oxyethira	0	5	3	5.1	4.8	0.30
Nectopsyche	0	0	3	2.0	3.5	0.12
TOTAL: TRICHOPTERA	63	28	65	93.2	37.1	5.42
Petrophila	1	18	10	17.3	14.5	1.01
TOTAL: LEPIDOPTERA	1	18	10	17.3	14.5	1.01
Ordobrevia nubifera	0	5	8	8.1	7.6	0.47
TOTAL: COLEOPTERA	0	5	8	8.1	7.6	0.47
Agathon	1	0	0	0.9	1.5	0.05
Ceratopogoninae	0	2	0	1.1	1.8	0.06
Simulium	37	5	2	26.3	35.0	1.53

TOTAL: DIPTERA	39	7	2	28.2	35.7	1.64
Chironomidae-pupae	43	33	68	86.4	32.4	5.03
Cladotanytarsus	1	2	12	8.9	10.4	0.52
Cricotopus	24	107	162	175.2	124.1	10.19
Cricotopus Bicinctus Gr.	16	62	82	95.0	60.6	5.52
Cricotopus Trifascia Gr.	0	0	3	2.0	3.5	0.12
Dicrotendipes	0	2	3	3.0	3.0	0.18
Eukiefferiella	4	11	8	13.8	5.7	0.81
Orthocladius Complex	0	40	32	43.1	38.1	2.51
Orthocladius	0	2	0	1.1	1.8	0.06
Polypedilum	9	12	23	26.4	13.8	1.54
Potthastia Longimana Gr.	0	0	3	2.0	3.5	0.12
Procladius	0	0	3	2.0	3.5	0.12
Rheotanytarsus	11	28	62	60.5	45.9	3.52
Synorthocladius	7	11	23	24.5	15.3	1.43
Tanytarsus	20	33	112	98.7	88.8	5.74
Thienemanniella	4	11	35	29.8	29.1	1.73
Tvetenia Vitracies Group	1	2	3	3.9	1.8	0.23
TOTAL: CHIRONOMIDAE	142	356	636	676.2	444.1	39.33
GRAND TOTAL	877	964	1040	1719.3	146.7	100.00

Riffle 23C, May 29, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU05

Total invertebrate abundance	= 1783.8	EPT abundance	= 1308.2
Total number of taxa	= 42	Number EPT taxa	= 12
Hilsenhoff Biotic Index	= 5.08	Brillouin H	= 2.20

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	9	18.5	1.03
Odonata	0	0.0	0.00
Ephemeroptera	5	1207.6	67.70
Plecoptera	1	28.3	1.59
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	6	72.3	4.05
Lepidoptera	1	5.7	0.32
Coleoptera	1	2.2	0.13
Misc. Diptera	3	86.0	4.83
Chironomidae	16	363.2	20.35

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	63.8	3.58
Parasite	0	0.0	0.00
Collector-gatherer	17	1357.1	76.07
Collector-filterer	5	165.6	9.29
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	3.2	0.18
Scraper	8	80.2	4.50
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	4	50.8	2.84
Unknown	1	63.1	3.54

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	742.4	41.62
Acentrella insignificans	268.8	15.07
Serratella micheneri	142.7	8.00
Simulium	78.2	4.39
Orthocladius Complex	72.6	4.07
SUBTOTAL 5 DOMINANTS	1304.7	73.15
Chironomidae-pupae	63.1	3.54
Orthocladius	58.9	3.30
Hydropsyche	51.4	2.88
Ecdyonurus criddlei	48.7	2.73
Cricotopus	37.9	2.12
TOTAL 10 DOMINANTS	1564.7	87.72

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant organisms	5	46.2	2.58
B Intolerant organisms	6	198.5	11.13

Riffle 23C, May 29, 2008
CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU05

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 3.60
Hydropsychidae/Total Trichoptera	= 0.71
Baetidae/Total Ephemeroptera	= 0.84

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.48
Scraper/(Scraper + C.-filterer)	= 0.33
Shredder/Total organisms	= 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 92.98
Community Tolerance Quotient (d) = 87.08

DIVERSITY MEASURES

Shannon H (loge)	= 2.24
Shannon H (log2)	= 3.23
Evenness	= 0.60
Simpson D	= 0.21

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	1053.0	59.03
Univoltine	721.2	40.43
Semivoltine	9.5	0.53

Riffle 23C, May 29, 2008

CA: Tuolumne River, Turlock Irrigation District. For Stillwater Sciences.
CA protocol, riffle habitat, 3 replicates, each 6 ft2, 500+ subsample, 500 um.
Replicate data = full sample basis. Mean = m2 basis. ABA, Inc. FILE:08TU05

IDENTIFICATION CODE	R1	R2	R3
Replicate subsampling conversior	1.15	2.14	1.88
CONVERSION (M2)	1.79		

CAMLnet January 2003 coding parameters.

Taxon	**R1**	**R2**	**R3**	**MEAN**	**STDEV**	**%**
Turbellaria	5	0	0	2.7	4.8	0.15
Oligochaeta	3	0	2	3.2	3.1	0.18
Corbicula fluminea	3	4	2	5.7	2.2	0.32
Lymnaea	1	0	0	0.7	1.2	0.04
Gyraulus	1	0	0	0.7	1.2	0.04
Crangonyx	0	2	0	1.3	2.2	0.07
Stygobromus	1	0	0	0.7	1.2	0.04
Hyalella	0	0	2	1.1	1.9	0.06
Caecidotea	0	2	2	2.4	2.1	0.13
TOTAL: NON INSECTS	15	9	8	18.5	7.2	1.04
Acentrella insignificans	268	79	103	268.8	183.9	15.07
Baetis tricaudatus	117	610	517	742.4	468.5	41.62
Serratella micheneri	36	66	137	142.7	93.3	8.00
Ecdyonurus criddlei	17	19	45	48.7	27.8	2.73
Tricorythodes minutus	2	4	2	5.0	2.3	0.28
TOTAL: EPHEMEROPTERA	440	779	805	1207.7	363.8	67.70
Isoperla	1	26	21	28.3	23.2	1.59
TOTAL: PLECOPTERA	1	26	21	28.3	23.2	1.59
Glossosoma	7	11	6	13.9	4.7	0.78
Protoptila	5	0	0	2.7	4.8	0.15
Hydropsyche	17	26	43	51.4	23.7	2.88
Hydroptila	3	0	0	2.1	3.6	0.12
Oxyethira	0	0	2	1.1	1.9	0.06
Polycentropus	0	0	2	1.1	1.9	0.06
TOTAL: TRICHOPTERA	32	36	53	72.3	19.3	4.05
Petrophila	6	0	4	5.7	5.2	0.32
TOTAL: LEPIDOPTERA	6	0	4	5.7	5.2	0.32
Ordobrevia nubifera	0	0	4	2.2	3.9	0.13
TOTAL: COLEOPTERA	0	0	4	2.2	3.9	0.13
Agathon	3	2	4	5.6	1.5	0.31
Chelifera/Metachela	0	0	4	2.2	3.9	0.13
Simulium	3	45	83	78.2	71.0	4.39
TOTAL: DIPTERA	7	47	90	86.1	74.6	4.82
Chironomidae-pupae	25	43	38	63.1	16.1	3.54

Cardiocladius	21	19	9	29.5	11.0	1.65
Cladotanytarsus	1	0	0	0.7	1.2	0.04
Corynoneura	2	2	2	3.8	0.4	0.21
Cricotopus	31	19	13	37.9	16.3	2.12
Eukiefferiella	3	24	34	36.3	27.7	2.03
Eukiefferiella Devonica Gr.	1	2	9	7.6	8.1	0.42
Orthocladius Complex	47	41	34	72.6	11.9	4.07
Orthocladius	35	49	15	58.9	30.7	3.30
Polypedilum	3	0	2	3.2	3.1	0.18
Rheocricotopus	0	4	2	3.7	3.8	0.21
Rheotanytarsus	1	4	6	6.6	4.1	0.37
Synorthocladius	1	2	6	5.3	4.2	0.30
Tanytarsus	14	13	13	23.7	0.9	1.33
Thienemanniella	7	0	4	6.4	6.2	0.36
Tvetenia Vitracies Group	5	0	2	3.9	4.1	0.22
TOTAL: CHIRONOMIDAE	198	223	188	363.0	31.9	20.35
GRAND TOTAL	699	1119	1171	1783.8	463.3	100.00