Stillwater Sciences

279 Cousteau Place, Suite 400, Davis, CA 95616 Phone (530) 756-7550 Fax (530) 756-7586

TECHNICAL MEMORANDUM

TO: Dave Hanson
Sacramento Municipal Utility District
P.O. Box 15830
Sacramento 95852-1830

FROM: Roman Pittman, Stillwater Sciences
Cc: Scott Wilcox, Krista Orr

DATE: 12 February 2006

SUBJECT: Technical memorandum on the fall 2005 monitoring of stream channel conditions at Rubicon Dam Reach and Robbs Peak Dam Reach study sites.

1 INTRODUCTION

The purpose of this technical memorandum is to describe the geomorphic response of the stream channels along the South Fork Rubicon (SFFR) and Rubicon rivers, below Robbs Peak and Rubicon dams, respectively, to high flows experienced in the spring of 2005. Morphological description (Rosgen Level II) data collected in the summer of 2003 at the Robbs Peak Dam Reach and the Rubicon Dam Reach sites (SMUD Channel Morphology Report 2004) is compared to repeat measurements made in the fall of 2005.

1.1 Site Description

1.1.1 Robbs Peak Dam Reach Site (Geomorphology Site RPD-G1)

The 5.6-mile-long Robbs Peak Dam Reach on SFRR extends from the base of Robbs Peak Forebay (elevation 5,205 feet) downstream to the confluence with the Rubicon River (3,540 feet), and has a mean gradient of approximately 0.055 (5.5 percent). Major tributaries to this reach include Gerle and South creeks.

The SFRR watershed is underlain by Mesozoic granitic rocks, glacial moraine deposits, minor outcrops of the Miocene Mehrten Formation, Jurassic metasedimentary rocks of the Sailor Canyon Formation, and Paleozoic metasedimentary rocks. Upstream of the Gerle Creek confluence, the river flows through a glaciated, low relief granitic landscape. Downstream of the Gerle Creek confluence, the river is characterized by progressive entrenchment within the surrounding canyon. For the first two miles, the river is confined by moderate granitic canyon slopes. A contact between granitic and Paleozoic

metasedimentary rocks marks a transition from the moderate canyon to a deep gorge with 1,500-foot walls (pp. 24-25 in the *Channel Morphology Technical Report*, DTA and Stillwater Sciences 2004).

1.1.2 Rubicon Dam Reach Site (Geomorphology Site RD-G1)

The 4.1-mile-long Rubicon Dam Reach on Rubicon River extends from the base of Rubicon Dam (elevation 6,548 feet) downstream to the confluence with Miller Creek (elevation 6,030 feet), and has a mean gradient of approximately 0.019 (1.9 percent). There is a 1.5-mile, low-gradient meadow (at Rubicon Springs) at the lower end of the reach and another short, lower gradient section of river just upstream of the meadow. No major tributaries enter this reach.

The Rubicon River drains a glaciated watershed, much of which is designated as wilderness, and flows through many sections of exposed granite and steep, confined bedrock chutes. Approximately 75 percent of the watershed is underlain by Mesozoic granitic and dioritic rocks. The remainder consists of the Miocene Mehrten Formation, glacial moraine deposits, and minor outcrops of the Jurassic metasedimentary rocks of the Sailor Canyon Formation (p. 17 in the *Channel Morphology Technical Report*, DTA and Stillwater Sciences 2004).

1.2 Morphological Description and Channel Condition Assessment from 2003

1.2.1 2003 Robbs Peak Dam Reach Site (Geomorphology Site RPD-G1)

Morphological descriptions (Level II) and channel condition assessment data (Level III) were collected along a 900-foot section of the SFRR, approximately 0.5 miles below Robbs Peak Forebay at an elevation of 5,130 feet. In order to avoid confounding effects from upstream project facilities on Gerle Creek, this site is located upstream of the SFRR/Gerle Creek confluence.

At this site, valley slopes are gentle (<30 percent) with relatively high plant density and vigor, and there was evidence of infrequent mass wasting episodes. The floodplain is characterized by irregular meanders (S=1.00) with numerous mid-channel bars and overflow channels. The mid-channel cobble bars and streambanks are heavily vegetated with willows, and small conifers are growing on recently scoured surfaces. Survey measurements indicate a C4 channel type with slight entrenchment (2.1-4.1), high width-to-depth ratio (16-33), mean local bed slope of 0.002 (0.2 percent), and gravel-dominated substrate. Coarse sands also represent a moderate fraction of the surface grain size distribution. This site exhibits primarily plane-bed and pool-riffle morphology. Medium to large sized woody debris (e.g., large limbs, branches, small logs, and/or portions of trees) occupied up to 10 to 30 percent of the active cross-sectional area above the low-flow wetted perimeter. Key LWD pieces that span the channel were not observed at this site (pp. 24-25 in the *Channel Morphology Technical Report*, DTA and Stillwater Sciences 2004).

1.2.2 2003 Rubicon Dam Reach Site (Geomorphology Site RD-G1)

Morphological description (Level II) and channel condition assessment (Level III) data were collected along a 500-foot section of the Rubicon River located approximately 1.6 miles below Rubicon Reservoir at an approximate elevation of 6,140 feet. The site is located downstream of a narrow canyon, where the river enters a wide alluvial valley. A mature conifer forest grows along the channel and on moderately steep (30-40 percent) valley slopes. The banks are well vegetated with thick grasses and deciduous understory. Survey measurements indicate that the channel at this site is an F4 channel type, with a moderate channel entrenchment (1.1-1.7), high width-to-depth ratio (41-125), local bed slope of 0.007 (0.7 percent), and a gravel-dominated substrate. This site is comprised of well-vegetated, lateral and mid-channel gravel bars and has irregular meanders (S=1.12) with pool-riffle morphology. Raw banks of up to 12 inches were observed, but there was no evidence of recent sediment deposition or bar development. Woody debris was sparse in floodprone areas. Key LWD pieces that span the channel were not observed at this site at the time of the survey (pp. 17 and 21 in the *Channel Morphology Technical Report*, DTA and Stillwater Sciences 2004).

2 METHODS

The following site-scale measurements were re-collected along the stream channels at the Robbs Peak Dam Reach and Rubicon Dam Reach sites in fall 2005:

- Three channel cross-sections, each surveyed at intervals sufficient to clearly depict channel geometry and any possible changes (Harrelson *et al.* 1994)
- Pebble counts of channel substrate at cross-sections (Wolman 1954).

Monumented cross-sections established on July 9, 2003 at the Robbs Peak Dam site and August 25, 2003 at the Rubicon Dam site were reoccupied November 18, 2005 and October 13, 2005, respectively. To ensure the quality of data comparisons, all data were collected using the same techniques and approaches employed during the 2003 surveys. In addition, any observations of channel change were recorded and the channel and banks of each site were thoroughly photo-documented to compare to 2003 photographs.

3 RESULTS

3.1 Hydrograph

The SMUD gage below the SFRR and Gerle creek confluence recorded a spike in flow of 589.3 cfs on May 16, 2005, up from an average of about 15 cfs the previous 15 days. The spike was short-lived, lasting only one day before dropping to 16.4 cfs on May 17. This was quickly followed by another day-long spike on May 19 of 623.2 cfs that quickly receded to 61.3 on May 20 (Figure 3.1-1).

The SMUD gage below Rubicon Reservoir records a similar series of peak flows with the second spike lasting somewhat longer. Flow descended from a high of 632 cfs on May

16 to a low of 13.6 cfs May 17. Discharge then climbs through May 18, peaking on May 19 at 1,143 cfs and drops slightly to 1,006 cfs on May 20. The decline continues the next day to 563 cfs before nearly bottoming out on May 22 at 26 cfs (Figure 3.1-2).

3.2 Cross-Section Profiles

3.2.1 Robbs Peak

Between 2003 and 2005, erosional and depositional processes appear to be more or less equivalent at all three cross-sections. The thalweg of the cross-section one was slightly scoured, leaving a substrate of cobble and gravel. Areas of deposition included cobble and gravel on the left bank and organic material downstream of mid-channel vegetation (Figure 3.2-1). Cross-sections two and three exhibited little change from 2003 to 2005 (Figures 3.2-2 and 3.2-3).

3.2.2 Rubicon

Areas of scour slightly exceeded deposition at the cross-section one (Figure 3.2-4). Most of this scour occurred in a high-flow side channel, while the channel within the wetted width experienced little overall change. Cross-sections two and three, with cobble and gravel dominating the substrate within the wetted width, remained relatively unchanged in profile between years (Figures 3.2-5 and 3.2-6).

3.3 Pebble Count

3.3.1 Robbs Peak

In cross-sections one and two, there was little discernable change in any particle size class from 2003 to 2005 (Figures 3.3-1 and 3.3-2). The D16 (the median particle diameter for which 16 percent of the cumulative sample is finer) decreased from 12 mm to 7 mm in cross-section two, which otherwise remained static (Table 3.3-1). Particle size increased notably on cross-section three, with D50 and D84 roughly doubling (Figure 3.3-3).

3.3.2 Rubicon

Particle size more than doubled on cross-sections one and three, with the D16 reflecting the largest increase (Figures 3.3-4 and 3.3-6). A similar particle size redistribution occurred on cross-section two, although the D84 increased by only 50 percent (Table 3.3-1 and Figure 3.3-5).

Table 3.3-1 Particle size (mm) distribution by cross-section.						
(D)*	**Robbs Peak**					
	Cross-section One		**Cross-section Two**		**Cross-section Three**	
	2003	2005	2003	2005	2003	2005
D16	1	1	12	7	1	18
D50	39	43	40	36	28	58
D84	79	86	63	88	78	156
(D)*	**Rubicon**					
	Cross-section One		**Cross-section Two**		**Cross-section Three**	
	2003	2005	2003	2005	2003	2005
D16	11	38	6	42	5	41
D50	30	61	34	78	31	75
D84	60	142	93	139	67	149
* Diameter for which given percent (16, 50, or 84) of the cumulative sample is finer than.						

3.4 Photo Documentation

3.4.1 Robbs Peak

Photographs taken before and after the high flow event revealed removal of sapling willows and coarsened substrate in the river-left overflow channel of cross-section one with mature vegetation left intact. Cross-section two remained largely unchanged with the exception of debris jams deposited high in alder brush and one piece of large woody debris newly deposited in the river-right overflow channel. Sand deposition on the left bank of cross-section two remained static. Woody debris jams in the river-right overflow channel of cross-section three were largely undisturbed. Fixed geomorphic points, such as large boulders, were similarly unaffected. Algae covering the substrate, noted in 2003 photographs, was absent in 2005. An index of photographs from the Robbs Peak Dam site is presented in Appendix A.

3.4.2 Rubicon

Redistribution of large woody debris represented the most apparent change in the Rubicon Dam Reach. A piece of woody debris (approximately 35 feet in length) was removed from cross-section two. A log of similar length but greater diameter was introduced near cross-section three. Sand deposition is also evident slightly upstream of cross-section three. Significant changes in substrate and banks were not apparent. Mature vegetation remained undisturbed. An index of photographs from the Rubicon Dam Reach site is presented in Appendix B.

4 DISCUSSION AND CONCLUSION

Although the comparison of 2003 and 2005 data indicate shifts in particle size distribution and movement of woody debris due to spring high flows, evidence of large-scale geomorphic response is absent. Discharge duration and intensity were insufficient to scour riparian vegetation and erode stream banks. Stable stream banks prevented channel migration and almost all geomorphic change, such as particle size redistribution, took place within the channel.

Analysis of pebble count data from the Robbs Peak site revealed a coarsening trend at cross-section three, yet cross-sections one and two exhibited little change (Table 3.3-1). This is likely attributable to the thick vegetation present at cross-sections one and two. Vegetation can increase roughness and impede the channel's ability to pass water, as well as provide a velocity refuge for entrained particles. In addition, the effect of high flows was dispersed across the broad width and multiple channels of cross-section one. As the stream's capacity to transport sediment decreased in this area fines were deposited in cross-section two, as illustrated by the decrease in the D16 and D50 (Table 3.3-1). Thus, although the coarsening trend observed at cross-section three suggests that the flow was high enough to scour some areas, mobilized fines were likely redeposited in the vicinity of the reach.

Comparatively, the high flows may have had a greater effect on the channel bed grain size distribution in the reach below Rubicon Reservoir. Pebble count data from the Rubicon River site indicate that particle size increased across all size classes at all three cross-sections (Table 3.3-1). Yet, channel profiles at these cross-sections show very little change (Figures 3.2-3 – 3.2-5). These seemingly contradictory results can be explained by a possible scouring of the existing finer grained bed surface followed by the deposition of transported coarse material.

Overall, however, there was little evidence of significant channel alteration at either the Robbs Peak or Rubicon River sites, although some shifts were observed. The coarsening of substrate coupled with static cross-sectional profiles indicates a shift in particle size as the channel bed was turned over and sorted, but not removed or aggraded. In summary, the spring flows of 2005 were sufficient to redistribute substrate particles and mobilize large woody debris, but not large enough to significantly alter channel morphology.

5 LITERATURE CITED

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