ATTACHMENT 6

Rational for implementing the ROD-recommended geomorphic flows in 2013
Gaeuman, April 1, 2013

This briefing was prepared in response to the March 28 recommendation by the flow workgroup to reduce the peak flow duration of the 2013 spring release to two-fifths of the ROD recommended duration. Two reasons are provided below describing why the full 5 days of dry-year peak flows described in the ROD should be maintained. The first reason is that the workgroup misinterpreted the meaning of recent bedload transport monitoring data and used their interpretation to justify their proposal. The second reason is related to a specific objective for the flow release for the Upper Junction City (UJC) rehabilitation site.

Bedload Transport Data

The flow workgroup cites a data report from Graham Matthews and Associates as justification for eliminating 60% of the ROD-recommended geomorphic flow. That report has undergone no peer-review, and more importantly, does not make such a recommendation.

The flow workgroup relied on a PowerPoint presentation given by Graham Matthews in February in which he discussed evidence of clockwise hysteresis in bedload transport rates. The workgroup appears to have taken that to mean that sediment transport ceases everywhere in the river after the first day or two of the release peak. That interpretation is incorrect. Hysteresis is not universal and it is not absolute. In other words, it does not occur everywhere in the river and where it does occur it does not mean that sediment transport ceases. Figure 1 is one of the graphics from Mr. Matthews' presentation, showing an example of clockwise hysteresis.

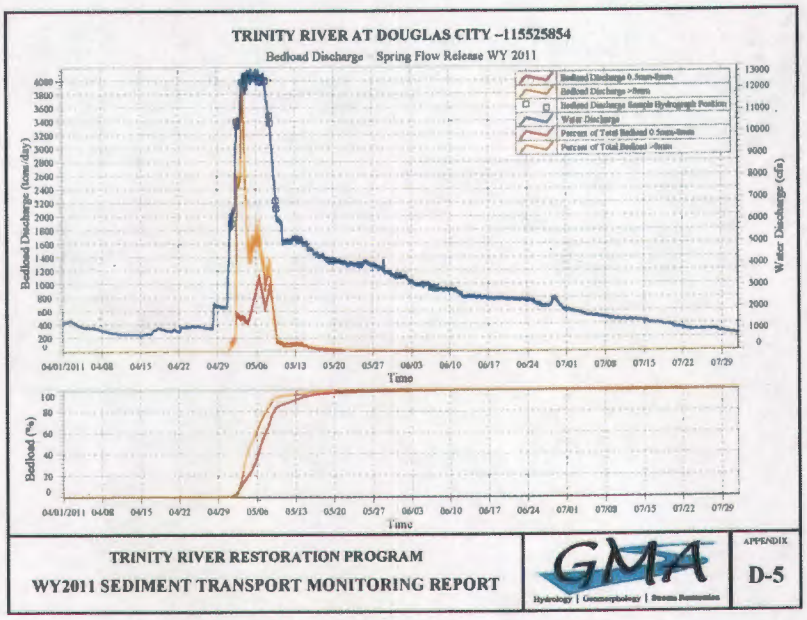

Figure 1: 2011 bedload transport in the Trinity River at the Douglas City monitoring transect.

Figure 1 shows about a 50% reduction in the rate of coarse bedload transport (gold trace) after the first day of the flow release. However, note that it also shows an increase in the rate of fine

bedload transport (red trace) late in the peak – approximately the 3rd and 4th days. Compare that to Figure 2, also from Douglas City but obtained in the following year. The data for that year shows clockwise hysteresis in the fine bedload transport, but the coarse bedload transport rate is greatest later in the peak. The 2012 trend is essentially opposite the 2011 trend.

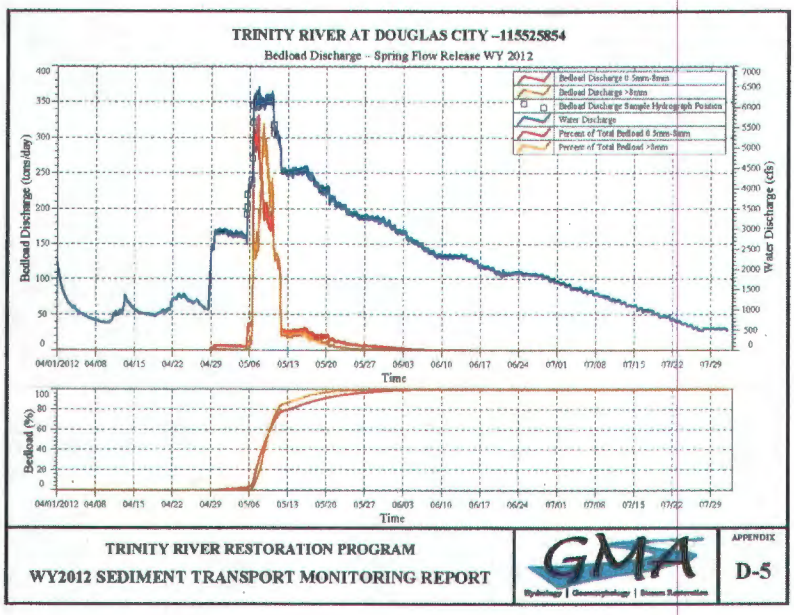

Figure 2: 2012 bedload transport in the Trinity River at the Douglas City monitoring transect.

Figure 3 shows another case from Graham's presentation illustrating clockwise hysteresis. That sedigraph, collected at the Lewiston transect, shows coarse bedload transport dropping off by about 50% after the first couple of days of the peak.

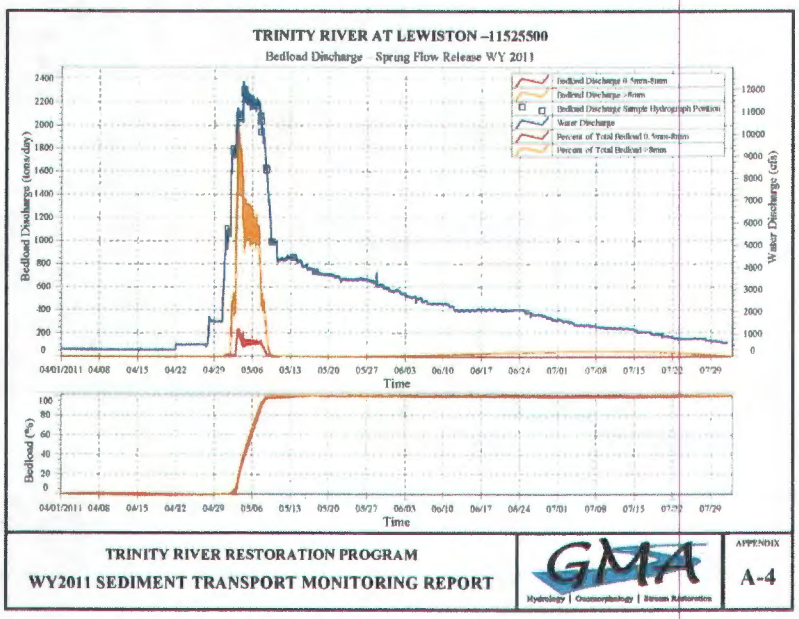

Figure 3: 2011 bedload transport in the Trinity River at the Lewiston monitoring transect.

This relative magnitude deserves further consideration. Is it appropriate to interpret the transport after the second day as negligible, so that the remaining 3 days of the hydrograph can be cut off without affecting the geomorphic impact of the release? Figure 4 re-plots the actual coarse bedload transport and flow data from the Lewiston location to quantify the relative significance of the first 2 days of the high flow versus the remaining days.

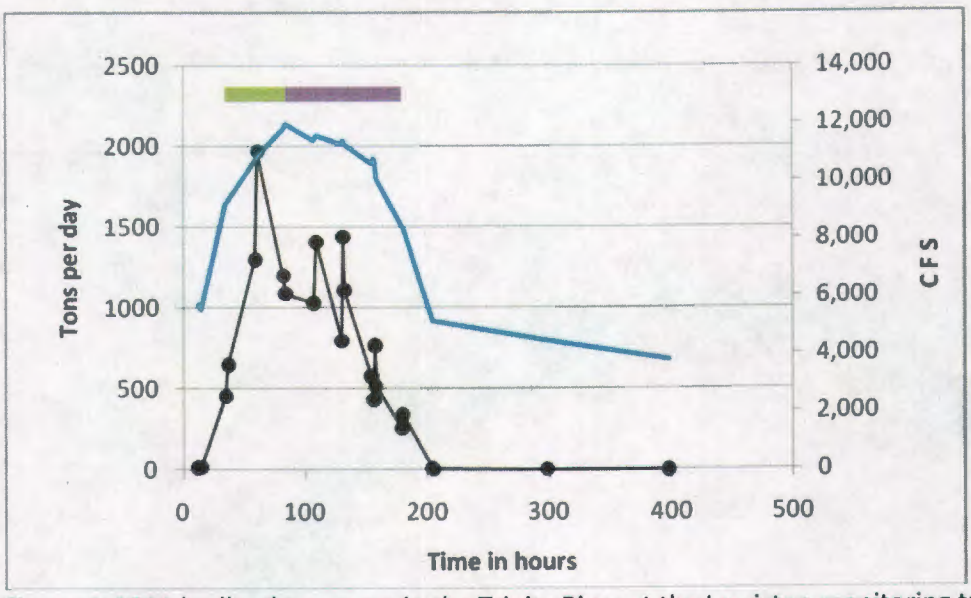

Figure 4: 2011 bedload transport in the Trinity River at the Lewiston monitoring transect.

Integrating under the sediment transport curve in Figure 4 from time 1 to time 2 gives the total bedload load transported during the time interval. The total transport calculated from the first 49 hours of the rising limb and release peak (the interval indicated with the green bar) is 2,558 tons. The total transport calculated from the next 95 hours (the interval indicated with the purple bar) is 3,389 tons. Thus, even in this particular case where clockwise hysteresis is apparent, more than half the total load was transported after the second day of the peak, that is, by the part of the hydrograph that the flow workgroup recommendation seems to regard as disposable. It is perhaps also worth pointing out that, in the case of Figure 4, the entire proposition that hysteresis exists at the site rests on a single data point.

The overall points of the above discussion are that:

1) Even though clockwise hysteresis is frequently observed at the standard sediment monitoring transects, there are also frequent exceptions. This fact implies that bedload transport rates are sustained at high levels or may even increase late in the hydrograph over a significant proportion of the river. Basic principles of bedload transport suggest that relatively large and sustained transport rates are most likely in areas where channel configuration is actively adjusting, such as areas that have recently been modified by channel rehabilitation actions.
2) When clockwise hysteresis does occur, the magnitude of the decrease is frequently on the order of 50%, in which case more than half of the total bedload is transported after the first 2 days of a 5-day release.

The UJC Site

The UJC rehabilitation project was completed in the fall of 2012. The design includes 2 elements that could benefit from a spring flow release designed to maximize or at least maintain the potential for doing geomorphic work at the site.

The first of these is a split-low channel around an island at the upstream end of the site, labeled "SF" in Figure 5.

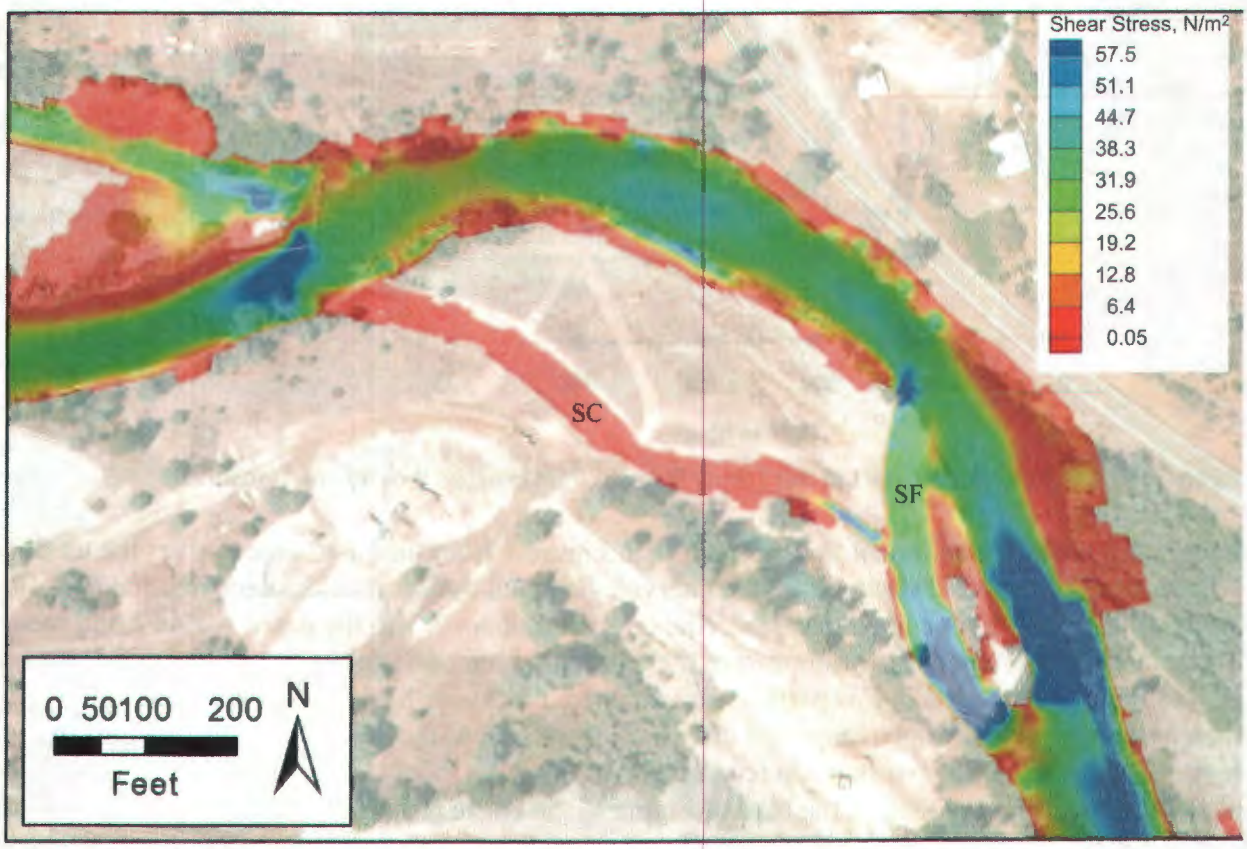

Figure 5: Modeled shear stresses at 4500 cfs in the upstream half of the UJC site. Modeled was conducted with SRH-2D and design topography.

That channel split was intended to carry up to 30% of the total discharge. However, the channel currently conveys much less flow than that due to aggradation that occurred during a brief flood that occurred on December 2012. The aggradation was the result of failure of the left bank in the upstream third of the split-flow channel. That portion of the channel was cut into a high terrace surface (> 10' above the baseflow water level), leaving a high and unstable bank. That bank was expected to fail during subsequent high flow events, but the very brief event of December 2 was not anticipated. The short duration of the event is evident in the hydrograph from the USGS gage at the site (Figure 6) and in the graphical representation of various flow durations in Figure 7. As is clear from Figure 7, the peak lasted only 15 minutes, the total duration of flows greater than 6000 cfs was less than 3 hours, and the hydrograph exceeded 4500 cfs for just 8 hours.

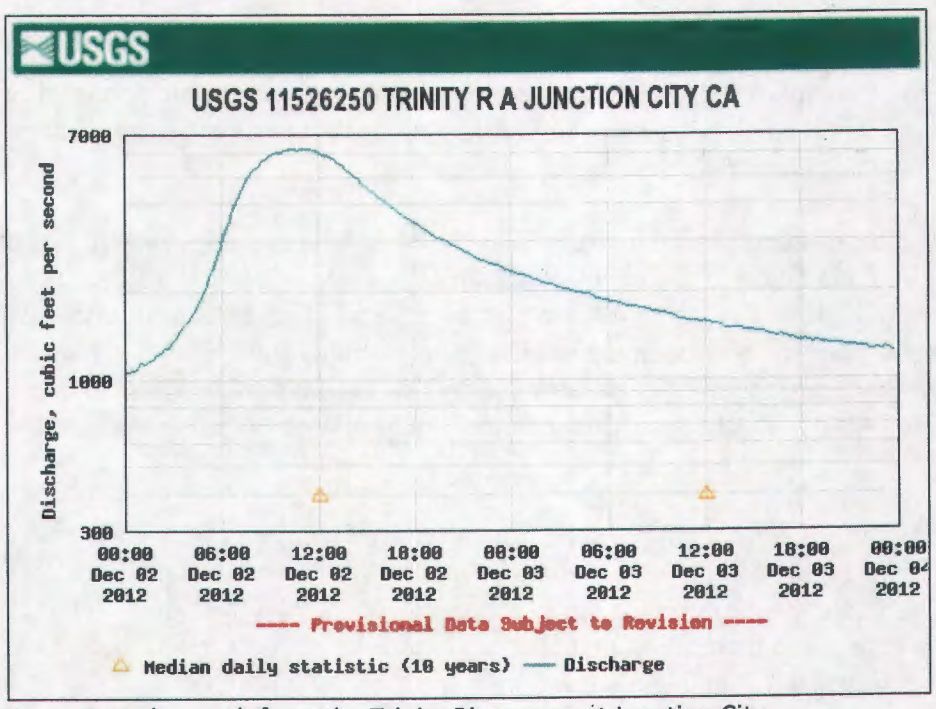

Figure 6: Hydrograph from the Trinity River gage at Junction City.

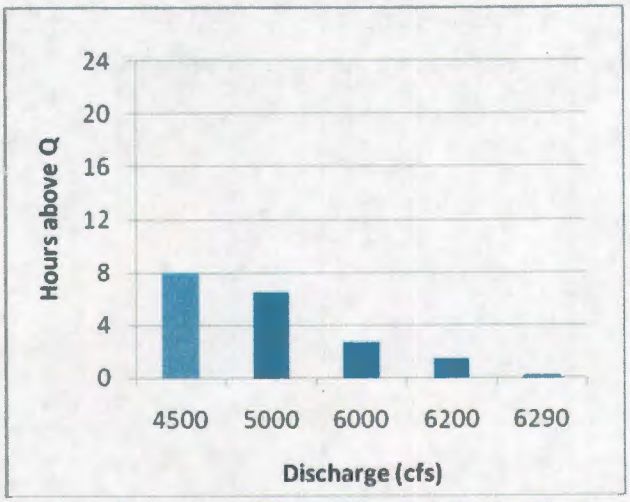

Figure 7: Durations of flow greater than the discharges indicated over the December 2 storm.

The left terrace bank retreated 10 ft or more during the storm. All of that bank material was sloughed directly into the constructed channel. Although the flood was sufficient to cause bank failure, the duration of the flood was too short to flush the sloughed material from the channel. Not only was the flood peak brief, but it is likely that the bank failure occurred late in the hydrograph, because most bank failures occur when water is draining out of the bank during the falling limb of a flood.

Given the situation describe above, one potential benefit of the 2013 flow release could be to clear this sloughed material from the split-flow channel. While it is not clear that the reduced conveyance of that channel is harmful in any way, it is of scientific interest and in the spirit of

adaptive management to determine if the ROD-recommended dry year release is capable of reversing the effects of the December 2 storm. To arbitrarily reduce the geomorphic potential of the ROD release to 60% of its recommended level would be to fail to properly evaluate whether the UJC split-flow channel can function as designed.

Estimates of sediment transport using the shear stress field shown in Figure 5 suggest that a flow of 4500 cfs could result in degradation in the split flow channel at a rate of up to 0.3 ft per day (Wilcock-Crowe transport equations assuming 40 mm gravel and Shield parameter of 0.034). There is no reason to expect the rate of adjustment to change appreciably until the adjustment is complete. Thus, with a 2-day peak, the maximum degradation that is likely in the split-flow channel just 0.6 ft. With a 5-day peak, the split-flow channel could restore up to 1.5 ft of its as-built depth.

The second design element at UJC that would benefit from a relatively large peak event is the side channel labeled "SC" in Figure 5. The inlet to that channel begins to inundate at about 2800 cfs. The relatively high elevation of the entrance to the channel means that a mainstem flow of about 6000 cfs is needed before bed material in that channel begins to be entrained. The bed of that channel is currently covered with sand and silt left over from construction, because the channel was excavated into terrace deposits that contain a high proportion of fine sediment. One objective of the high-magnitude but short duration peak flow proposed by the physical workgroup was to remove the sand that remains in that channel from construction, so that habitat conditions will be more favorable for salmonid use. However, 4500 cfs is insufficient to mobilize sand in that channel, so that objective is not relevant to a discussion about the duration of a ROD dry-year release peak.