Santa Clara Valley Water District

TECHNICAL MEMORANDUM

PROJECT: Upper Berryessa Flood Control Project **DATE**: December 9th, 2015

SUBJECT: Long Term Sediment Transport Analysis for O&M

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1. PURPOSE

This report aims to address Army Corps comments made in the Independent External Peer Review (IEPR) process. The comments made by the IEPR recommended that analysis be performed to determine the approximate amount of sediment removal and maintenance that would need to be performed on Upper Berryessa Creek during future operations.

2. BACKGROUND

A sediment transport study[1] was performed by Tetra Tech as a part of its design contract with the District. The focus of this study was to determine channel stability in the 1% flood event, as well as multiple 10% flood events to simulate several large storms. Sensitivity analyses were performed between different transport functions and sediment supply boundary conditions. The results showed a relatively stable channel in the project reach.

However, it was determined that these analyses were not sufficient to determine long-term future sediment removal operations, which was the catalyst for this study.

3. ASSUMPTIONS

A key assumption in this study is that sediment sources above the upper Berryessa Reach are managed by District channel maintenance and a debris basin upstream. This routine maintenance serves to remove any significant sediment loads before the project reach, in effect creating an equilibrium input sediment boundary condition upstream. This was supported by Jordan[2] and his observations that the channel reaches seem relatively stable, indicating an equilibrium condition.

The sediment modeling will confirm that no sedimentation will occur in the project reach based on this assumption. Available sediment to the project reach would also be from localized rill and gully erosion observed in the existing conditions. The proposed channel design will limit any

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[1] Tetra Tech. Berryessa Sediment Transport Memo 60%. July 14th, 2015.

[2] Jordan, et al. An Urban Geomorphic Assessment of the Berryessa and Upper Penitencia Creek Watersheds in San Jose, California, Colorado State University. 2009. Section 6.7.1.

significant local erosion from and eliminate this sediment source. Given these facts, an equilibrium load seems reasonable for this study.

4. METHODOLOGY

The original Tetra Tech sediment model would be used, since it is based off the 60% design model, which will be very close to the final design. Very little change in the channel design is expected from 60% to final. Model variables, such as bed gradation, were left as-is. The only change was the removal of Old Piedmont Avenue Bridge, which experienced significant sedimentation and threatened model stability. This is far outside the project limits, and would be conservative in our aggradation estimates, allowing more sediment to flow to the project reach.

Model inflows would be modified to include a long-term hydrograph to capture an expected 50-year time frame to help determine the amount of sediment accretion expected in the project reach.

5. INFLOW HYDROGRAPH

Typically, historical gauge data would be used to predict future inflows, assuming stationarity. However, Berryessa Creek has limited gauge data. The only gauge exists at Calaveras Blvd, and has data from 1967 to 1983, and again from 2005 until present. This sums to only approximately 25 years of data, with large El Nino years (such as 1995, 1997, and 1998) missing.

Near Berryessa Creek, Upper Penitencia Creek has a stream gauge that has been operating since 1943. Given the record extent, it was decided to reproduce Berryessa flows from Upper Penitencia Creek records. The process was as follows:

- Upper Penitencia 15-minute increments were downloaded from 1943 to 2014.
- Flows less than 10cfs were removed to reduce input file size, with the assumption made that any flows below 10cfs would be negligible in sediment transport.
- Flows between 10cfs and 100cfs were averaged into a 12-hour time steps to reduce input file size, while flows over 100cfs were left at a 15-minute time step.
- These remaining Upper Penitencia flows were converted into a return frequency based on a flood frequency analysis[3] done on the Upper Penitencia stream gauge.
- The return frequency was converted to an Upper Berryessa flow rate based on the project hydrology[4].
- Flows were scaled per time step for all the different input locations along Upper Berryessa based on the relationship at the upstream inflow location (Piedmont)

[3] Jack Xu, SCVWD. Coyote Creek Hydrology Study. 2015.

[4] Northwest Hydraulic Consultants. Berryessa Creek Watershed Hydrology Report. April 2003, amended October 2006.

The final inflow dataset ended up reproducing 70-years of future creek flows, in excess of the 50-years originally slated. The final model runs ended up running over 7 years using the 12-hr or 15-min time steps.

6. MODEL PARAMETERS

The Yang transport function was used to characterize sediment movement. Previous sensitivity studies by Tetra Tech revealed little change among using Meyer Peter Mueller, Ackers White, and Yang. Yang was also the equation of choice based on research conducted on Berryessa by Jordan.

The equilibrium input sediment boundary condition was used at the upstream end, which only inputs as much sediment as the first cross section can handle. Initially, the model was tested using the sediment rating curve (Figure 1) produced by the Corps[5]. This produced too much sediment inflow and filled up cross sections in the model within 10%-20% of the model runtime. This was also observed in Tetra Tech's study.

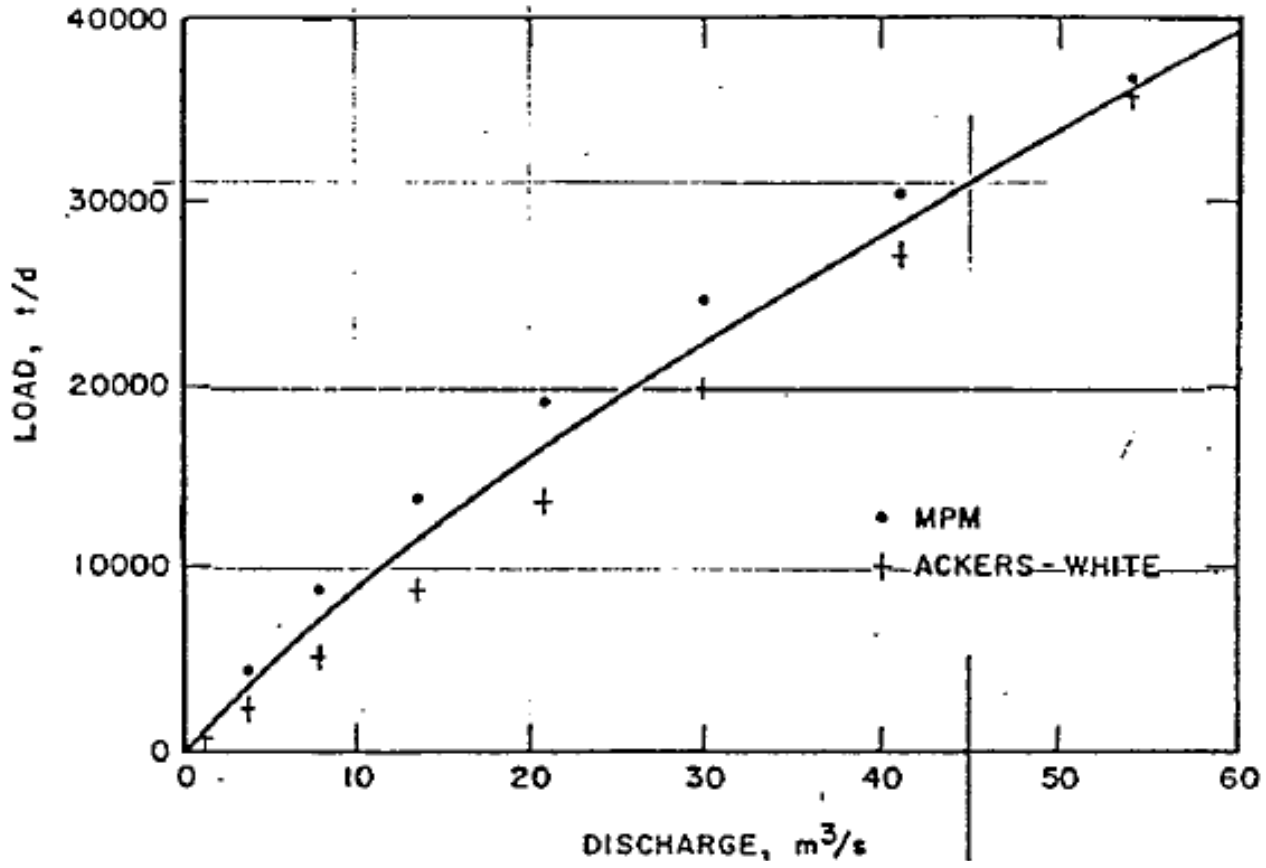

Figure 1: 1993 Corps Sediment Rating Curve @ Piedmont

[5] Northwest Hydraulics Consultants. Upper Berryessa Creek Existing Conditions Sediment Transport Assessment. 2003.

7. RESULTS

Figure 2 details the channel thalweg after the model run. Modeling results show degradation along the upstream end of Berryessa Creek outside the project reach, which may be attributed to the decreased sediment input using equilibrium load. Actual conditions may have an increased sediment input coupled with sediment removal operations.

In the project reach, there are some sections that exhibit erosive characteristics, which seem to be limited to transition zones between natural and hardscape. However, most of the channel is armored and there is little to no aggradation in the project reach. The results from the modeling predict no future sediment removal maintenance for the Upper Berryessa project reach.

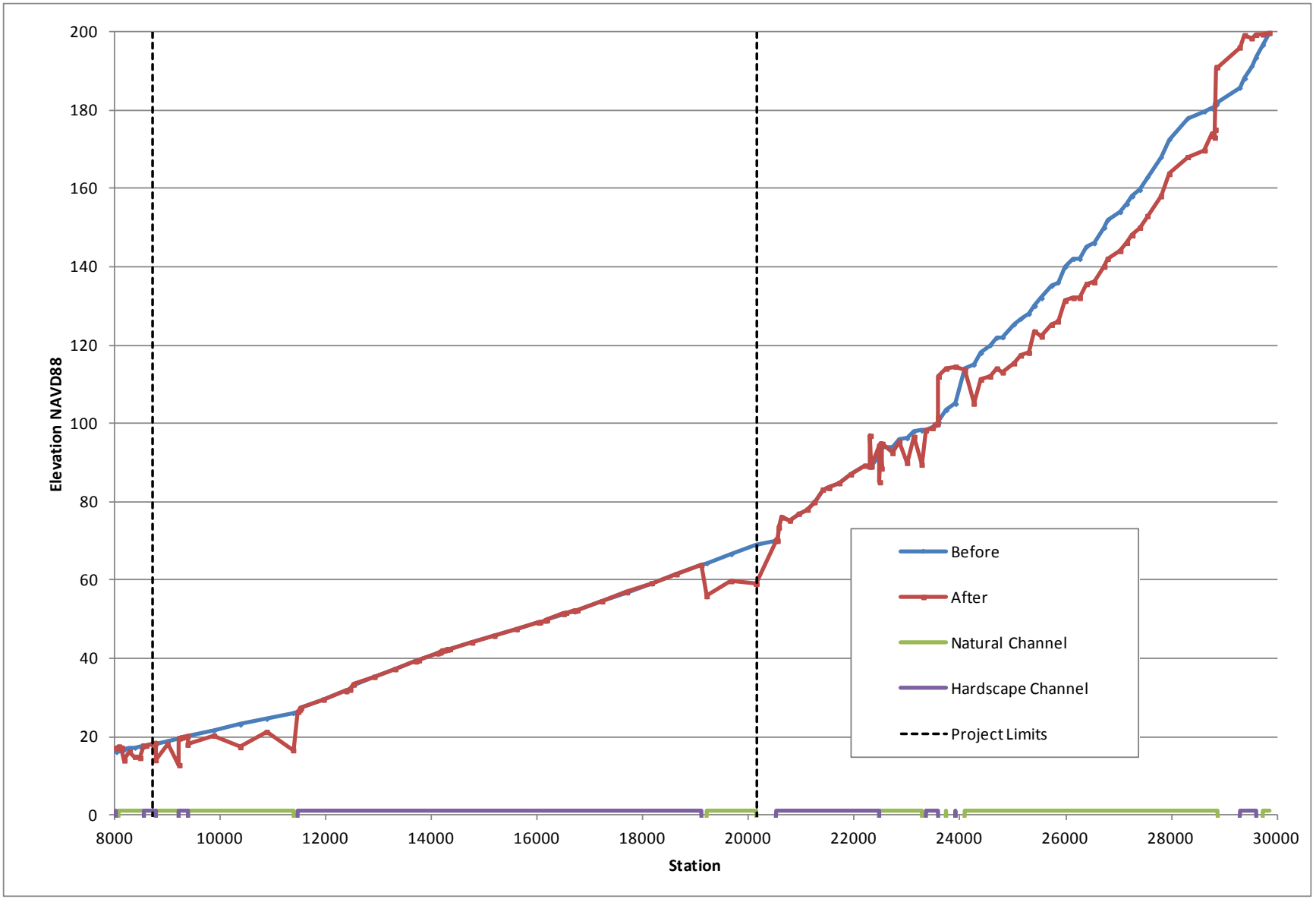

Figure 2: Sediment Transport Results