CONTINUOUS TURBIDITY MONITORING AS A TOOL FOR EVALUATING SUSPENDED SEDIMENT LOADING IN THE MIDDLE TRUCKEE RIVER AND TRIBUTARIES, PLACER AND NEVADA COUNTIES, CALIFORNIA

Brian Hastings, PG, Geomorphologist, Balance Hydrologics, Inc., P.O. Box 1077, Truckee, California 96161, bhastings@balancehydro.com
David Shaw, PG, Principal Hydrologist/Geologist, Balance Hydrologics, Inc. P.O. Box 1077, Truckee, California 96161, dshaw@balancehydro.com
Stefan Schuster, PE, CPESC, Principal, CDM Smith, 12313 Soaring Way, Truckee, California 96161, schustersl@cdmsmith.com
Beth Christman, Restoration Director, Truckee River Watershed Council, 10418 Donner Pass Road, Truckee, California 96161, bchristman@truckeeriverwc.org

Abstract

The Middle Truckee River is currently listed by the California State Water Resources Control Board as being impaired by excessive sediment. Water quality is of particular concern because the river is habitat for two federally-listed fish species, cui-ui (*Chasmistes cujus*) and Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*). The Lahontan Regional Water Quality Control Board (Lahontan Water Board) has developed a Total Maximum Daily Load (TMDL) for suspended-sediment concentration to attain sediment-related water quality objectives in the Middle Truckee River, the segment of the Truckee River extending from the outflow of Lake Tahoe at Tahoe City to the California-Nevada state line near Farad, California. A four year study (WY 2011–WY 2014) was conducted to: a) document suspended-sediment loads; b) evaluate the relationship between streamflow, suspended-sediment concentration, turbidity, and suspended-sediment transport rates, and; c) evaluate changes in these relationships over time in response to land management, sediment control strategies, and other implementation measures outlined in the TMDL. Note that The Water Year (WY) begins on October 1 and ends on September 30 of the named year. Water year 2014 began on October 1, 2013 and ended on September 30, 2014.

Cold Creek, Donner Creek, and Trout Creek were monitored in the Town of Truckee, California. Cold Creek is largely undeveloped with a history of logging, road-building, and railroad infrastructure, Donner Creek is heavily urbanized, and Trout Creek is a mix of open space with lightly developed suburban/recreational land uses. Additional monitoring was initiated on the mainstem of the Middle Truckee River across two years (WY 2013 and WY 2014) at two stations located upstream and downstream of the tributaries and used to evaluate significance of these tributaries in delivering suspended sediment to the Truckee River.

Monitoring, analysis and computations have been used to characterize suspended-sediment production and delivery (i.e. yields and loads) at each of the six stations and compare suspended-sediment loads between watersheds and across all years and calculate contributions from each tributary to the mainstem. We also have compared suspended-sediment loads and load durations to a regulatory target set forth in the Middle Truckee River TMDL.

At four of the six stations, we calculated suspended-sediment loads using two methods: 1) establishing relationships between instantaneous suspended-sediment transport rates and

instantaneous streamflow ("streamflow-suspended sediment rating curve"), then applying that relationship to the near-continuous streamflow record, and; 2) establishing relationships between instantaneous suspended-sediment concentration and turbidity ("turbidity-suspended sediment rating curve"), and applying that relationship to the near-continuous turbidity and streamflow records. In the absence of a continuous-logging turbidity meter at the remaining two stations, loading was calculated using only the streamflow-based rating curve method.

The initial year of monitoring (WY 2011) was much wetter than average, with significantly above average snowpack and a longer than normal runoff period. The following three years constituted one of the driest three-year periods on record. A range of runoff and sediment-delivery events occurred during the period, and can generally be classified as rain-on-snow, rain-on-ground, summer thunderstorms, or spring snowmelt. Our conclusions can be summarized as follows:

- Comparison of results between two computational methods suggests that a continuous record of turbidity is better able to capture discrete events or more accurately assess changes in loading during an event, thereby providing more accurate estimates of daily and annual suspended-sediment loading.
- Suspended-sediment load duration curves for turbidity-based loads (15-minute data) can be used to evaluate if streams met regulatory targets or water quality guidelines for the watershed.
- Comparisons of streamflow-based sediment rating curves to historical data were used to evaluate improvements or further degradation; these data currently do not indicate reductions in loading to the Middle Truckee River over time.
- In WY 2013 and WY 2014, Cold Creek, Donner Creek, and Trout Creek delivered 27 and 19 percent of the total suspended-sediment load in the Middle Truckee River, respectively. These subwatersheds only represent 5 percent of the total watershed below Lake Tahoe.
- In all years, Donner Creek delivers higher loads and yields (loads normalized by watershed area) when compared to Cold Creek and Trout Creek. These results appear to reflect the urban nature of the subwatershed, with high hydrologic connectivity between impervious surfaces and the stream.