Title: Fate and Transport of Metals and Sediment in Surface Water

Investigator(s): Pierre Julien, Professor; Chester Watson, Professor; Brian Bledsoe, Assistant Professor

Institution: Colorado State University

EPA Project Officer: Mitch Lasat

Project Period: October 1, 2001 – September 30, 2003

Project Amount: EPA $201,026; Cost Share $51,807; Project Total $252,833

Objectives/Hypothesis: This effort focuses on surface water and sediment transport, with an emphasis on the fate and transport of metals in rivers from mining wastes. The main thrust of this two-year proposal is to: (1) develop a predictive scientific methodology for evaluating impacts resulting from point sources of metal pollution; and (2) improve and develop computer modeling tools for the simulation of point-source metals and fine sediment contamination in surface waters. The ultimate goal of our research is to improve our mechanistic understanding of the interaction between heavy metals and fine sediment.

Approach: The study entails: (1) field monitoring of contaminated streams; and (2) computer modeling of fine sediment and heavy metals from point sources. The models will be calibrated and tested with field data at a Superfund site related to abandoned mine lands, such as the California Gulch Superfund site in Colorado. One of the main hypotheses to be tested is the relative importance of riffles and pools in the detention and storage of contaminants and as a potential added mechanism for the dispersion of contaminants in mountain streams.

Personnel: Dr. Rosalia Rojas will join the project starting July 1, 2002 as a Research Scientist. Her graduate work at the CSU Civil Engineering Department was focused on the development of GIS-based simulations of distributed rainfall, infiltration, runoff and sediment transport with the model CASC2D-SED. Her expertise is in the computer simulation of the processes of soil erosion, sediment transport and sedimentation by size fractions for both upland areas and channels. We also would like to provide an assistantship to a graduate student in civil engineering during fall 2002.

Progress to date: The PI attended several meetings at CSU, Colorado School of Mines and EPA relative to this project. The PI presented detailed modeling results on a related research project with the model CASC2D-SED at CSM, with a brief presentation at the Tailings and Mine Wastes Conference at CSU. Discussions with Will Clements resulted in direct collaboration between our modeling effort (Project 2) and Project 4. After further discussion with EPA and Will, we decided to focus our modeling effort on the EPA Superfund site at California Gulch near Leadville, Colorado. Our field program has started with a joint
reconnaissance of the field site with visit of the stations used for the analysis of micro-
invertebrates and aquatic habitat in Project 2. Our field program included a reconnaissance
of the watershed characteristics, soil types and vegetation and first indication of particle size
distribution of parent soils, tailings and various deposits along the channel banks and on the
watershed. More specifically, the visit included a preliminary survey of channel
characteristics in terms of hydraulic geometry, dimensions and roughness, followed with an
identification of main geomorphic features and planform geometry. A first assessment of the
relative contributions of surface versus sub-surface components of flow discharges was
obtained at various locations along the river. Sediment samples were collected throughout
the study area for further laboratory analysis of particle size distribution and concentration of
metals, particularly zinc, copper and cadmium. Rosalia Rojas recently completed her Ph.D.
and we started to collect digital information about the field site with regard to topography
(DEM), soil types and land use and precipitation data that will be needed for the simulations.
The areas to be modeled will most likely include California Gulch to the confluence with the
Arkansas River, and possibly a coarser grid model to Kobe farther downstream on the
Arkansas River.

**Expected Results:** The two most important expected benefits of this research are: (1) an
improved understanding of the mechanics of heavy metal fate and transport in mountain streams;
and (2) development and validation of numerical models for the simulation of advection, mixing
and dispersion of fine sediment and heavy metals in mountain streams. Field measurements will
be used to calibrate and test numerical models at several sites where the water quality has been
altered by mining waste contamination.

**Presentations and publications:** The first author participated in several presentations and
publications since the beginning of the project. Besides discussions at the EPA Center in
Denver and discussions at the Colorado School of Mines and at the Mine Tailings
Conference at CSU, the first author has presented some of the related work in terms of the
recent results with the model CASC2D-SED at National and International Conferences. The
list of direct and related activities include:

- Julien, P.Y., B.P. Bledsoe and CC. Watson, “Fate and Transport of Metals and
  Sediment in Surface Waters”, Presentation on January 17, and Proceedings of the
  Ninth International Conference on Tailings and Mine Waste, Fort Collins Colorado,
- Seminar presentation entitled “Fate and Transport of Metals and Sediment in Surface

Related recent publications:

  Proceedings of 22nd Hydrology Days, Fort Collins, Colorado, USA, April 1-4, pp.
  233-244.
  the Korean Water Resources Corporation, KOWACO, Tae-Jon, Korea, May 14, 2002.

**Supplemental Keywords:** streams, water, watersheds, sediments, metals, discharge, effluent, dissolved solids, restoration, aquatic habitat, modeling, monitoring, heavy metals, Rocky Mountains