



Mining Remediation in the Chalk Creek Watershed: Project Demonstrates Exciting Possibilities

Hard-rock mining in the Chalk Creek watershed of central Colorado was extensive, continuing on and off from the late 1870s into the 1950s. Chalk Creek and its tributaries drain the eastern slopes of the Collegiate Range, and the creek enters the Arkansas River 10 miles south of Buena Vista. The Colorado Division of Wildlife maintains the Chalk Cliffs Fish Rearing Unit in the lower reaches of the creek. The single greatest contributor of heavy metals to the creek is the Mary Murphy Mine, located 1 mile above the town of St. Elmo. The Mary Murphy developed steeply dipping gold-silver deposits and lead-zinc sulfide fissure-vein deposits through extensive underground workings on 14 different levels in the Tertiary-aged Mount Princeton quartz-monzonite. The two lowest adit levels, the 2200 level Golf Adit (10,400-foot elevation) and the 1400 level Main Adit (11,200-foot elevation), continue to discharge at a rate of 222 gallons per minute (gpm), contributing 66.2 pounds per day of zinc to Chalk Creek at high flow. Chalk Creek was identified on Colorado's 1998 303(d) list as impaired due to zinc; the TMDL is scheduled for completion in 2006. The watershed first came under scrutiny in 1986 after a fish kill at the rearing unit. The kill was attributed to elevated concentrations of metals in Chalk Creek during spring runoff. Water quality sampling at that time found zinc and cadmium at levels exceeding state water quality standards. The effects were reduction of the number of brown trout and elimination of young fish for a 12-mile stretch below the mining district. Metal concentrations in Chalk Creek peaked in the vicinity of the Mary Murphy Mine and the Iron Chest tailing piles. At that time it was suspected that interaction between mine drainage, creek flows, and the tailings piles contributed most of the metals in the stream.

Diversion to reduce metal loadings

A 319 project in 1991 consolidated five tailings piles to a location just below the Mary Murphy mill ruins. The consolidated tailings were stabilized and revegetated with grasses, forbs, and trees. The drainage from the mine works was diverted around the consolidation pile into a constructed wetland between the consolidated tailings and Chalk Creek.

Biotic sampling conducted by the Division of Wildlife in 1994 and 1997 found the recovery zone had moved upstream, from 12 miles to approximately 4 miles below the mining activity. Greater numbers of individuals, greater species diversity, and more diverse age classes are now represented in the creek. However, despite the impressive reductions in metal loadings from the now-reclaimed tailings sites, zinc loads still exceed state water quality standards.

Underground approaches to control continued discharges

The Colorado Division of Minerals and Geology (CDMG) completed hydrologic characterization at the Mary Murphy Mine in 1997. This work suggested that most of the flow coming from the adit portals was groundwater intercepted at discrete fault/fracture structures within the mine workings. Based on this work, underground inspection of the Golf Adit workings, and historical records of mining activity, an underground source-controls approach was developed and proposed, through the 319 NPS program and two other Clean Water Act grant sources.

In 1998 CDMG received \$310,000 through three separate grants—\$98,000 in 319 funds, \$62,400 in 104(b)(3) funds, and \$150,000 in an EPA multimedia grant—to implement underground flow characterization and control work over a 3-year period.

CHALK CREEK WATERSHED

This project was designed to demonstrate the source control approach, on a pilot scale, in only one level of the underground mine. This effort would essentially "untangle the plumbing" of the underground metals sources by determining where the groundwater was interacting with mineralized rock. A loading analysis developed from flow and metals concentration data showed that 85 percent of the metals load exiting the Main Adit was attributed to one inflow from the north drift on the Mary Vein. The inflow constituted only 1.5 percent of the total discharge from the adit, but at high flow it had a total zinc concentration of 190,200 micrograms per liter (mg/L). The contaminated inflow was traced back to an ore chute on a high-sulfide stope on the north vein, which drained 15 gpm. This same high-concentration source also accounts for 70 percent of the zinc load discharging from the Golf Adit.

Flow measurements taken along the cross-cut adits of the Main level and Golf level indicated that clean groundwater inflows intercepted by the workings downstream from the contaminated stope inflow accounted for 70 percent of the total mine discharge volume. This proved that, at a minimum, it is possible to segregate the clean groundwater inflows from the mine discharge, reducing the total discharge needing treatment from the 90 to 222 gpm (low flow-high flow) range to the 5 to 20 gpm range. At these low volumes and high concentrations, many more passive or semipassive treatment options are available.

Success realized

CDMG conducted a demonstration of an underground diversion to control metals loading on the Main Adit level. A temporary, underground earthen dam was constructed by hand to divert the high-concentration flow. Subsequent sampling showed this diversion reduced dissolved zinc in the Main Adit flow from 5,000 mg/L to 250 mg/L, essentially eliminating the need for a treatment alternative at the 11,200-foot elevation site. This project demonstrated exciting possibilities for addressing acid mine drainage. If clean inflows can be segregated, the volume of contaminated flows is greatly reduced and the scale of treating the remaining waste stream is greatly reduced. It now appears technically feasible to isolate underground sources of pollution to such an extent that it might be possible to eliminate 80 percent of the pollution source within a mine, rather than having to treat the discharge in perpetuity.

Primary Sources of Pollution:

- hard-rock mining
- acid mine drainage

Primary NPS Pollutants:

- zinc
- cadmium

Project Activities:

- diversion of mine works drainage into constructed wetland
- underground diversion/earthen dam to segregate contaminated flows

Results:

- surface diversion moved recovery zone upstream from 12 miles to 4 miles below the mining activity
- underground diversion decreased dissolved zinc flows from 50,000 mg/L to 250 mg/L

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