COMPARISON OF APATITE II™ TREATMENT SYSTEMS AT TWO MINES FOR METALS REMOVAL[1]

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Abstract. Two abandoned lead-zinc mine sites, the Nevada Stewart Mine and Success Mine, are located within the Coeur d'Alene Mining District, in northern Idaho. Apatite II™ (US Patent Number 6,217,775), a form of cleaned fishbone apatite material, was used as the treatment media in both treatment systems to treat metal-laden water. The difference in water quality from the two lead-zinc sites resulted in different design requirements for the two sites. This poster presentation will provide a comparison of these Apatite II Treatment Systems from system design and performance monitoring perspectives. Lessons learned during operation of the treatment systems and recommendations for future applications of Apatite II will also be presented.

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Project Description

Two abandoned lead-zinc mine sites, the Nevada Stewart Mine and Success Mine, are located within the Coeur d'Alene Mining District, in northern Idaho. Apatite II™ (US Patent Number 6,217,775), a form of cleaned fishbone apatite material, was used as the treatment media in both treatment systems to treat metal-laden water. The water chemistry at the Nevada Stewart Mine and the Success Mine differed and so did the treatment system designs. System performance was monitored at both sites by measuring flowrate treated and water quality composition. Water quality parameters of interest included: pH, Cd, Fe, Pb, Mn, and Zn. The Nevada Stewart Mine's treatment system was monitored monthly from November 2002 through August 2004. The monitoring of the treatment system at the Success Mine began in January 2001, and this system continues to be monitored every two to three months. Table 1 summarizes the performance monitoring data and some features of each treatment system.

Table 1. Comparison of Design Strategies at the Nevada Stewart and Success Mines

	Success Mine Treatment System		Nevada Stewart Mine Treatment System	
Target Water Description	Groundwater impacted by a tailings pile		Adit discharge	
System Description	System consists of two cells (East and West cells), each are 3.66 m (12 ft) high, 1.83 m (6 ft) wide, and 13.7 m (45 ft) long.		Fully-contained subsurface 5680 L (1500 gal) retention basin with internal baffles and three 11,350 L (3000 gal) treatment tanks	
Treatment Media Selected	West cell contains 100% Apatite II. East cell contains 1:1 Apatite II to clean pea gravel by volume overlain by 10.2 cm (4 in) of cedar shavings		3:1 Apatite II to clean gravel by volume overlain by 7.6 cm (3 in) of gravel	
Amount of Apatite II Used	90,700 kg (100 tons)		4540 kg (5 tons)	
Flowrate Treated	up to 121 L/min (32 gpm)		19.3 L/min to 114 L/min (5.1 to 30 gpm)	
Odor Control System	10.2 cm (4 in) of cedar shavings over the media and burlap sacks containing granulated activated carbon at the discharge		Vents containing granulated activated carbon	
Ranges of pH and and Dissolved Metals Performance Monitoring Data	Influent (µg/L) pH—4.2 – 5.2 SU Cd—316–714 Fe—<20 – 100 Pb—525–1,360 Mn —885–1,210 Zn—42,400–107,000	Effluent (µg/L) pH—6.5 – 7.0 SU Cd—<2 – 11 Fe—<20 Pb—<5 – 58 Mn— 47–50 Zn—<5 – 7680	Influent (µg/L) pH—5.3 – 7.0 SU Cd—<1 Fe—190 – 870 Pb—0.5 – 2.3 Mn—500 – 690 Zn—5500 – 8000	Effluent (µg/L) pH—5.3 – 8.0 SU Cd—<1 Fe—<10.1 – 580 Pb—0.54 – 2 Mn—71 – 610 Zn—<5 – 6100
Metals removed	4530 kg (10,000 lbs)		218 kg (480 lbs)	

The focus of the Success Mine treatment system was to reduce the concentrations of Cd, Pb, and Zn. Zinc was the target contaminant of concern for the Nevada Stewart Mine treatment system. Cadmium and Pb concentrations in the influent at the Nevada Stewart were very low. The Apatite II treatment systems at the Success and Nevada Stewart mines also removed some iron and manganese present in the water.

Several problems were encountered during treatment system operation at both sites. Some challenges experienced at the Success Mine included: groundwater flowing beneath and around the vault, requiring additional grouting; clogging of vault pipes and screens, requiring

maintenance on the plumbing system and some media replacement; and strong odors emanating from the vault, so burlap bags of activated carbon were installed within the outflow manholes.

The Nevada Stewart treatment system experienced plugging problems, as well. On several occasions, there were significant flow reductions in this system, requiring permeability enhancements using pressurized air to re-establish flow.

Recommendations

Recommendations for future field installations include:

- Residence time needs to be maximized;
- If the water requiring treatment contains significant concentrations of Fe, it should be eliminated by other means, with apatite used as a polishing step for the remaining metals;
- Depending on the type of system design, permeability of the media must be enhanced, media replacement strategies must be developed and the hydraulics of the tank systems must be improved to prevent clogging and the formation of preferential flow paths through the treatment system; and
- Treatment systems need to be designed to process fluctuating seasonal flows.

Acknowledgement

The Silver Valley Natural Resource Trustees funded the demonstration project at the Success Mine through 2003. Responsibility for operation and maintenance of the Success Apatite II treatment system is now the responsibility of the Idaho Department of Environmental Quality. The Nevada Stewart Mine Project was conducted under U.S. Environmental Protection Agency's Mine Waste Technology Program. The MWTP is implemented by MSE Technology Applications, Inc. with administrative assistance from the U.S. Department of Energy's Western Environmental Technology Office under DOE Contract Number DE-AC09-96EW96405 and technical direction from the EPA National Risk Management Research Laboratory under Interagency Agreement Number DW-89939550-01-1.