

Mine Tailings Restoration

Method uses high grade biosolids to revegetate land

By Susan McGinley

Mine tailings and biosolids don't sound like they go together, but combining the two in the proper ratio actually produces a medium that can support living plants. (The product of wastewater treatment of sewage is known as biosolids.) Ongoing research conducted through the University of Arizona, National Science Foundation Water Quality Center (W-Q-C) offers a solution for covering unsightly bare mine tailing piles while at the same time disposing of sewage sludge without affecting groundwater quality. Tests conducted at commercial sites in southern Arizona show that the remediation method does not release heavy metals or excess nitrogen into the soil.

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Why mix mine tailings with biosolids in the first place? Because each has what the other lacks. Mine tailings, the waste material left over from processing ore, are essentially tons of crushed rock with zero percent organic matter. Deposited in ten-foot "lifts," they are extruded like a thick toothpaste that dries out, according to Ian Pepper, director of the W-Q-C. Thousands of these raised, barren piles dot the Southwest.

"Nothing grows on them; they look like the surface of the moon," he says. "We wondered if we could take biosolids that are primarily all organic materials and add them to mine tailings — the perfect inorganic matrix — to make an instant 'soil.' The answer is yes, you can. As soon as you add the biosolids to the mine tailings, the microbial population jumps from 400 per gram in the tailings to about 10^7 or 10^8 million per gram in the created soil. This microbial population is a prerequisite for growth."



Mine tailings unamended.

I. Pepper

In cooperation with ASARCO and Pima County Wastewater Management Department and with the approval of the Arizona Department of Environmental Quality, Pepper and soil scientist Ed Glenn began their research at the Mission Mine in Green Valley in December 1998. Biosolids were added at the rate of 80 dry tons per acre to a 3.75-acre site that was seeded initially with native Southwest grasses. The area was monitored for plant growth and for the presence of nitrates and metals. In December 2000 the first biosolid amendment was added to a 20-acre site, also at the Mission Mine, as a real-time disposal from a wastewater treatment plant in Pima County. Approximately 150 dry tons per acre were applied to that site, then seeded and monitored. Neither site was irrigated, yet today, grasses and shrubs cover the once stark landscape.

"Given the statistics, natural indigenous Sonoran Desert is only about 20 percent cover," Pepper notes. "We go

way beyond that percentage at these sites." The biosolids proved to be beneficial in adding essential plant nutrients, amending the soil with organic matter, and enhancing soil microbial populations. The resulting vegetation stabilized the mine tailings and reduced wind erosion.

"This is important, because the raw tailings are very prone to air pollution from dust," Pepper says. Although he was pleased with these benefits, Pepper admits he was concerned that the tremendous amount of organic nitrogen going into the ground from the biosolids could cause seasonal nitrate nitrogen (a pollutant) buildup in the groundwater. During the monsoons the moisture causes mineralization and rapid nitrification of nitrogen, particularly in surface soil. Yet the researchers found the nitrates didn't leach, especially during the cooler winter months.

"Heterotrophic bacteria feed on some of this. We speculate that massive



Mine tailings three years after biosolids amendment.

amounts of denitrification were occurring, releasing the nitrogen as gas,” Pepper explains. “There was an overall loss of nitrogen from the system without detrimental effects on underground aquifers.”

Another potential problem was the possibility that the mine tailings still contained high metal concentrations, particularly copper and molybdenum, that could leach into the groundwater; biosolids are characteristically low in metals. Again, there were protective factors: the lack of irrigation inhibited leaching, and Pepper found that biosolids have a tendency to tie up complex metals within the mine tailings, making them less bioavailable. It should be noted that neither site was monitored for the presence of pathogens because the treated sludge used in the research was rated class A “exceptional quality,” or pathogen-free.

This study was designed to evaluate not only the revegetation aspects of adding biosolids to mine tailings, but

also the benefits and hazards of applying liquid digested sludge for agricultural crop production. Since 1983 biosolids have been put on agricultural land in Marana, north of Tucson, but farmland there is becoming scarce, and this method offers an alternative avenue of disposal. The W-Q-C is also examining bioaerosols, chemical odors, pathogen transport through soil, and methods for upgrading of class B biosolids to class A.

The Arizona Mining Association, mining companies, California’s Los Angeles and Orange County Sanitation Districts, and several agribusinesses have shown an interest in this remediation work and the potential for its application on a more widespread basis. 🌱

CONTACT

Ian Pepper
 (520) 626-3328
ipepper@ag.arizona.edu
 For more information:
wqc.arizona.edu

The Water Quality Center

The University of Arizona, National Science Foundation Water Quality Center (W-Q-C) investigates physical, chemical and microbial processes that affect the quality of surface and subsurface waters including potable supplies. Housed in the UA College of Agriculture and Life Sciences Environmental Research Laboratory in Tucson, the center includes an interdisciplinary group of biologists, chemists, physicists, hydrologists, and engineers who work together to resolve water quality problems. Undergraduate and graduate students also participate in conducting research, publishing and presenting papers, and thus gain broad industry perspective and industrial job opportunities. Funding for the center is supplied by companies and agencies interested in specific water quality issues, and by the National Science Foundation.

Research focal areas include water security; the fate and remediation of commercial and industrial contamination; agrochemical products and practices that influence water quality; municipal waste treatment and reuse; mining; and potable water quality.

“It is the dynamic relationship between the private sector and the university, and the integration of the university with industry and governmental agencies that makes this NSF Water Quality Center unique,” says Ian Pepper, director of the Center. “In addition, it is the combination of university expertise and corporate funding that leads to scientific discoveries that can enhance water quality for the community at large.”