Acid Mine Drainage Effects and Possible Solutions

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One of the most devastating pollution problems in the Appalachian region is acid mine drainage (Keefer 278). Acid mine drainage can result in substantial loss of biological productivity, the degradation of land and water, and also damage to groundwater aquifers. Acid mine drainage results from an outflow of acidic water from coal mines or metal mines. And while acidic water flow can occur naturally at the earth’s surface from erosion in certain environments, large-scale earth disturbances created from mining, or even other large-scale construction, can enhance and increase the otherwise minimal acidic water flows (Lawhorn).

A local area watershed in Southeast Ohio suffering from acid mine drainage is the Leading Creek Watershed. The drainage area is 150.1 square miles and is tributary to the Ohio River (Bauers 8). The Leading Creek Watershed does not have the severe and widespread acid mine drainage impact that most of southern Ohio has. Two tributaries to Leading Creek, Paulins Run and Thomas Fork have had an impact on the abundance of fish and macro-invertebrate communities, and three sub-watersheds, Thomas Fork, Paulins Run, and Titus Run are also affected by mine runoff. Thomas Fork and Paulins Run have been chemically affected from acid mine drainage, and Titus Run has been impacted from mine sediments. The total cost to repair this watershed and the tributaries, which are marginally less impacted than others in surrounding areas, is between 1.8 million and 2.5 million dollars (6).

The high cost of repairing and reclaiming watersheds that have been negatively impacted by acid mine drainage comes from the complex damage acid mine drainage causes. Acid mine drainage qualifies as a complex environmental stressor that can damage aquatic ecosystems with high levels of acidity, elevated concentrations of dissolved metals, and/or the deposition of metal precipitants (Bauers 14). Several reactions beginning with the exposure of pyrite to water and oxygen starts the damage of acid mine drainage (Balliet 127). Inside coal mines, pyrite forms around coal seams or surrounding shale and sandstone. The oxidation of pyritic minerals results in the production of sulfuric acid and the pH lowers. This highly acidic, sulfate-rich drainage passes over the rock strata, coal overburden, or streambed. This then causes heavy metals like iron, manganese, and aluminum to be mobilized into the water flow (134).

Early in the 1950s, Lake Erie suffered from a phosphate phosphorus distribution. This resulted from acid mine drainage drifting current patterns from the discharge of the Maumee and the Detroit Rivers (Curl 66). Phosphorus, a scarce element in the earth’s crust, occurs less than 0.05 per cent by weight (67). And even though phosphorus is an important micro-element for the nutrition of aquatic plants, the amounts that were present became toxic. The phosphorus level was elevated from acid mine drainage in other tributaries that flowed into Lake Erie. Below in the figure, the dashed line indicates turbidity.
distribution and the full lines indicate phosphorus distribution. It also shows where the phosphorus travelled and the areas that it would affect.

Acid mine drainage not only affects local area watersheds, but Figure 2a shows that the small tributaries can easily transport the chemicals like phosphorus and pyrite into other lakes and streams, and soon the entire local drainage basin can be polluted with chemicals from the acidic water flow from uncared for coal and metal mines (Curl 71). The increase in coal usage also increases the production of acid mine drainage precipitants because the more coal being used means that more coal mines are created. Once a mine has been used and companies mining move on to other locations, an improper mine closing can cause acid mine drainage to occur more rapidly. And while acid mine drainage can be an expensive and time consuming problem, there are solutions available to the fix it.

In Coshocton County, Ohio acid mine drainage caused a large volume of black amorphous sludge has accumulated in several of the county’s constructed wetlands. The sludge contained high concentrations of sulfur, iron, aluminum, and acidity and an anaerobic biofilm containing a large population of sulfur-reducing bacteria (Riefeler 222). This type of biofilm can create problems for investigators conducting ecological studies and assessments. If these biofilms are sampled when contaminated, the EEAs might represent conditions associated with succession rather than the current conditions (Smucker 736). The system performed well and generated 26 kg CaCO₃/d of alkalinity and captured 5.0 kg/d of iron and 1.7 kg/d of aluminum. The researchers studying this event said that the alkalinity generated by limestone dissolution
and by sulfate reduction was determined (Riefler 222).

The use of anaerobic solid-substrate reactors for treating acid mine drainage has been studied widely by numerous researchers. In these systems, acid mine drainage is passed through biodegradable waste like manure or compost. Many abiotic and microbially catalyzed reactions probably occur in these systems, but it is also hypothesized that sulfate reduction, mediated by sulfate-reducing bacteria, is responsible for the pH neutralization and sulfate and toxic metals removal observed in these systems (Drury 1244). Sulfate removal was significant in both reactors before day 335 with greater removal in the reactor with whey addition. The actual SSR decreased from 250 to 40 mmol/d*m³ substrate in the reactor without whey addition (1247). The results of this are shown in the Figure 4.

Even though acid mine drainage is a large-scale problem, there are solutions available to reduce and eliminate the chemicals infiltrating and damaging local watersheds and large drainage basins. Using anaerobic bacteria has been proved to be effective in lab studies as well as in the field to treat chemicals like phosphorous, sulfate, and pyrite. They have also been able to reduce the presence of aluminum in the waterways. And while safer and more environmental friendly mining procedures would greatly reduce the occurrence of acid mine drainage, having solutions available to remove the invading chemicals from watersheds and drainage basins remains as a necessary systems to continue to study.
Works Cited


