Mining and Water Quality

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Issue

The extraction and processing of mined materials generally require water. Water is also the primary vehicle by which mining-related contaminants can inadvertently be transported into the environment and worsen the quality of water resources. Impacted water quality is a major environmental concern associated with historical and abandoned mines in the U.S. and worldwide. In modern mine planning and permitting, considerable analysis and planning are often required by regulatory agencies during the project design phase to minimize potential impacts to water resources. Prevention of water quality degradation is an important step in ensuring environmental sustainability in mining areas.

Background

Water use and potential environmental impacts to surface and ground water vary greatly and depend on the size of the mine, its proximity to water resources, the commodity mined (base or precious metals, coal, industrial minerals, aggregates, etc.), the type of deposit (e.g., skarn, porphyry, placer), the method of ore processing (crushing, screening, washing, flotation, leaching), and the mining method (underground, solution, open pit, or dredging). Potential mining-related impacts include both physical and chemical degradation of surface and ground waters. These impacts include sediment discharge and deposition in rivers and lakes and discharges of salty or acidic waters that can often contain dissolved metals and other mine-related constituents.

The legacy of historic mining in the United States is estimated to include more than 500,000 abandoned or inactive mines[1]. Nearly all of these were operated before modern day mining and environmental controls were instituted. Many of these abandoned mines have the potential for acid generation or other processes that can cause water quality impacts. Internationally, artisanal mining continues to use many of these earlier techniques, creating additional regions of mine-impacted waters.

Common Water Quality Issues

A major water quality concern related to mining is the formation of acid rock drainage (ARD), sometimes also called acid mine drainage. ARD results from the reaction of water and oxygen with sulfide minerals (pyrite, pyrrhotite, etc.) contained in mined or exposed rock. It leads to acidic waters that mobilize toxic metals, sulfate, and other dissolved solids. When these waters are discharged into surrounding aquifers, lakes, and streams, they can make the water unsafe for people to drink and degrade habitat suitability for aquatic species. Not all types of ore deposits can generate ARD, but metals and other contaminants still can be released.

Another common water quality issue in mining is the physical transport of sediment into water, creating suspended solids. This process can happen as a result of erosion of the ground surface or stored geologic materials. When the amount of suspended solids in water is too high, the water can be less suitable for on-site reuse, requiring more water consumption. When suspended solids are transported to natural waters, they can increase temperature and decrease dissolved oxygen and light penetration, degrading habitat.

The chemicals used in the extraction and processing of ores can also present water quality issues. Although large-scale modern mines carefully manage on-site chemical usage, historic and artisanal mines can release these compounds, such as mercury and cyanide from gold processing.

[1] abandonedmines.gov

Management and Treatment

Important elements of modern mine permitting include assuring the public and government agencies that the potential for water quality impacts is clearly understood and disclosed and that sound water management practices have been incorporated in the planning and design the new mine, including during the pre- and post-mining phases. During operations, mines also have the regulatory and social responsibility to monitor and report on the effectiveness of the water management procedures.

Water discharged from mining operations must meet stringent water quality standards. Federal, state, and local regulations govern mine waste and water management, as well as closure planning and post-closure mitigation and monitoring. Financial assurance requirements have also evolved to better accommodate the known costs of environmental cleanup and mine closure, including any post-closure water treatment requirements, which can be significant and long-term.

Water quality control options can consist of methods to limit reactions between water and mine wastes, manage the flow of potentially impacted waters, and treat impacted waters prior to discharge. Methods that limit the potential for reactions between water and mine wastes include locating mine wastes in areas with limited usable water resources, isolating mine wastes from the environment through the use of liners and caps, and subaqueous disposal of tailings and other mined materials, which uses overlying water to limit the amount of oxygen that can react with the materials. Management of water flow on a mine site can include leachate collection systems, diversion features for run-on and run-off water, and tunnels and cut-offs (e.g., grout curtains or bulkheads) for water within underground workings. Treatment can consist of active measures, such as wastewater treatment plants with reverse osmosis, aeration, or clarification systems, or passive treatments, such as engineered wetlands and reactive barriers or drains. Many of these options can be applied at new and operating mines as well as at historic mines, where they are used by mining companies and government agencies to remediate contamination from historic mining, such as in the stream shown in Figure 1.

Figure 1: Mining-impacted stream before and after treatment (PA DEP https://www.ahs.dep.pa.gov/NewsRoomPublic/articleviewer.aspx?id=21946&typeid=1)

SME Statement of Technical Position

SME supports the goals to continually improve management of water at mines and minimize the effects of mining on water quality by:

- Preventing or minimizing the generation of acid drainage and the migration of mine-related contaminants to surface and ground water resources;
- Maximizing water recycling during operations to minimize consumption and discharge; and
- Integrating pollution prevention and water treatment measures in mine planning and design during the entire mining lifecycle.

These goals can be achieved by:

- Facilitating research, education, and training in scientific approaches to improving water quality at mining operations;
- Developing additional water re-use technologies for water encountered at mine sites;
- Developing mine dewatering approaches that minimize water extraction rates and reduce water quality impacts;
- Promoting cooperation among international stakeholders engaged in scientific or engineering work in the field of mine water problems and related sciences; and
- Promoting the exchange and publication of water-related scientific and engineering information.

References

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