acid rock drainage and metal leaching (ARD/ML) services

Acid rock drainage (ARD) is an environmental issue often encountered in hard-rock mining, coal operations, and activities involving geologic materials with sulfide mineralogy. Acid and sulfate are produced by the oxidation of sulfide minerals (such as pyrite) when exposed to oxygenated water. Metal leaching (ML) occurs when ARD-related oxidation or acidity causes minerals to dissolve and associated metals (such as arsenic, selenium, cadmium, copper, nickel, and zinc) to be released into the groundwater and surface water.

Geochemists at Barr have proven expertise in characterizing the potential for ARD and ML as well as assessing their impacts, designing and implementing measures to mitigate ARD generation, and evaluating technologies for treatment of ARD and ML-impacted water.

Barr has assisted mining operations with the management of ARD for decades. Since the 1980s, we have worked with our clients to find cost-effective, reliable solutions for the ARD-generating materials on their sites. Often this will include preparing a feasibility study of options to manage ARD. We assess a range of options—from capping and source control to limestone channels and wetland treatment—and identify the cost and incremental benefit for each option.

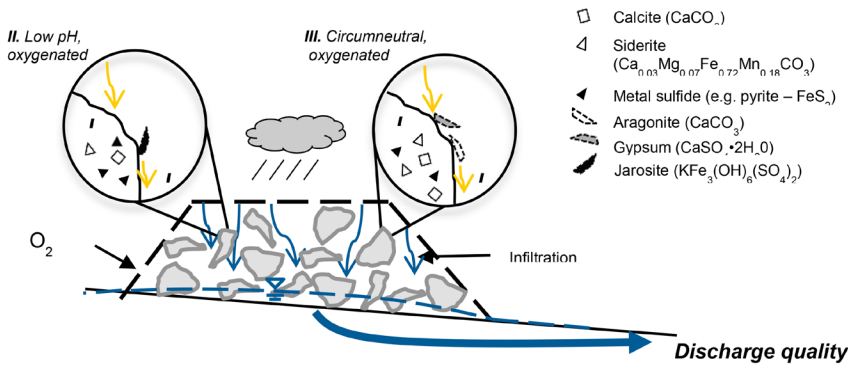
The solutions implemented have included a variety of approaches, tailored to the specific conditions at the property. Solutions have included membrane capping or vegetative covers to reduce infiltration, limestone-rock-lined channels to provide neutralization of the drainage, wetland treatment, sequestering the materials so they remain below the water table post-closure, blending neutralizing materials with the ARD material, placing liners around or below the waste, and a variety of other techniques. We have designed custom solutions for clients around North America, including in Montana, Minnesota, Missouri, Michigan, British Columbia, and Saskatchewan.

assistance with ARD/ML at a Montana mine

Barr helped address environmental impacts associated with historical mining activities at a former mill and mine in Montana. Our work included evaluating the impacts of ARD and ML at six inactive mine sites. Barr assessed groundwater in the bedrock and identified potential sources of inflow to the mine workings; we also conducted a geotechnical evaluation of waste-rock piles at the site and assessed potential locations for an engineered repository. By consolidating the waste rock in a central location and capping it with a cover designed to minimize infiltration from rain and snow, the amount of water passing through the waste material and becoming ARD was reduced.

geochemical modeling approach

Barr models pit lake, mine discharge, and tailings basin porewater quality by first developing a model framework that captures the most important geochemical conditions and processes at each modeled step. For modeling constituent concentrations in mine drainage, this means first understanding and quantitatively describing the important dissolution, precipitation, and adsorption reactions within the mining materials and along the drainage flow path. The model can then be used to predict discharge or drainage chemistry (pictured at right).



Discharge water quality from mining materials can be passed to a mixing or flow model where reactions between solutes and the gas and mineral phases are applied. To execute these mass balance and equilibrium calculations, Barr's geochemists and hydrologists often use modeling packages (such as GoldSim and CHEMCAD) to track mass balance and PHREEQC and Geochemist's Workbench to simulate kinetic reactions and equilibrium conditions. We are also careful to address the implications of non-equilibrium, which is common for many constituents, by developing models to simulate these conditions.

ARD assistance for highway construction

A section of Highway 1/169 between Ely and Tower, Minnesota, was realigned to improve safety and traffic flow. Construction required extensive earthwork and exposed rocks, gravel, and soil containing sulfide minerals that could generate ARD and adversely affect water and air quality. The Minnesota Department of Transportation (MnDOT) developed an acid-generating-rock mitigation plan and hired Barr's qualified professional geologists to oversee plan execution. Barr sourced neutralizing amendment materials, including limestone and slaked lime byproduct from the local paper industry. The project called for specific dosing of ARD-generating materials with amendments and constructing a large-scale, long-term covered repository. Barr was on site daily to assess the materials' acid-generating potential, collect samples for analysis, and implement mitigation measures as needed. Mitigation included adjusting lime amendments based on chemical and statistical characterization of excavated material and working

with the construction contractor to determine appropriate construction techniques. Our work helped confirm that excavated material remained within the mitigation plan's safety factors. Close collaboration also helped keep construction on schedule while enabling MnDOT to better manage risk and understand the onsite implications of implementing an ARD mitigation plan. Since completion, the project's long-term monitoring has indicated chemical and geotechnical stability of the ARD rock repository. Following this project, Barr was hired to produce a guidance manual for MnDOT about assessing, mitigating, and monitoring acid-generating materials during roadway construction.