

# Reducing the Risks of AMD

## Acid Mine Drainage Treatment Using HydroFlex™

Acid mine drainage (AMD) is a source of significant liability for the mining industry and potentially an environmental risk. HydroFlex™, an innovative water processing technology from Winner Water Services, is an effective tool for the removal of contaminants from AMD to meet stringent effluent regulations for environmental discharge—and can be a safe and effective source of water for water-intensive applications like hydraulic fracturing. HydroFlex™, by design, is a flexible technology capable of being a standalone treatment for the removal of metals and anions (sulfate, selenate, nitrate), or it can be incorporated into existing treatment operations to focus on challenging contaminants; enabling a facility or mine to meet challenging regulatory requirements.

### The Challenge of AMD

Mining is an important and necessary industry. The utilization of minerals and metals is a critical element of society, and important to production of energy and goods. In order to access these needed materials, mines often expose sulfide and other elements that lead to water containing complicated mixtures of dissolved metal cations and anions. This water should be treated before release of the water into the environment. Expanded regulatory programs continue to reduce discharge limits, intensifying stress in a financially difficult time for mining operations. Widely utilized oxidation techniques such as the use of lime, peroxide and sodium hydroxide coupled with settling, clarification and filters will reduce contaminant levels. However, these approaches produce voluminous waste sludge and in some cases leave valuable materials such as aluminum, copper, nickel, cobalt, and others bound in unusable forms.

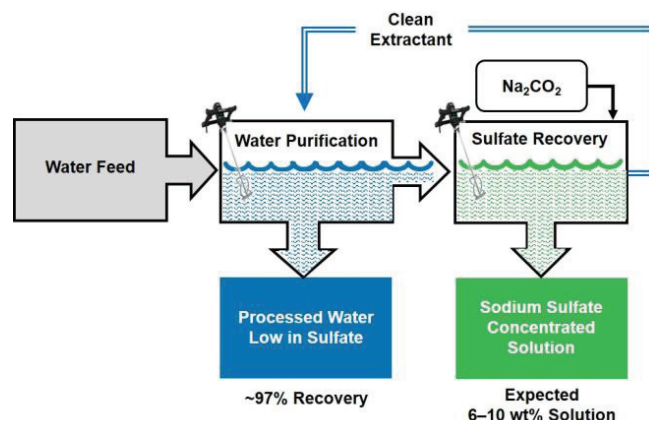
In addition, oxidative water treatment will not typically remove the more difficult anion contaminants such as sulfate, selenate and nitrate to acceptable discharge limits. Conventional precipitation methods struggle to reduce sulfate concentrations below 1,200 mg/L, and costly membrane-based processes are subject to fouling and generate large streams of rejected waste.

### The HydroFlex Solution

HydroFlex is a platform technology based on well-understood solvent extraction principles. Solvent extraction has been practiced in the mining industry for decades to recover copper, uranium and other metals from leach solutions. Winner Water has developed a proprietary process that deploys solvent extraction principles to enable safe and effective wastewater treatment.

The HydroFlex process provides distinct advantages over current technologies in the areas of water purification, treatment efficiency, selective contaminant removal and reduced waste.

- Water Purification: Sulfate is reduced 70–90% in the process.
- Treatment Efficiency: HydroFlex produces >99% clean discharge, with no reject stream.
- Selective contaminant removal: HydroFlex focuses treatment efforts to control costs.
- Reduced waste: The selective extraction process yields concentrates that may have the potential for reuse.



The flexibility inherent to the process allows Winner Water to meet clients' effluent and/or process goals without paying for treatment that isn't needed or required.

## Proven Results

HydroFlex has been tested on sulfate-containing streams for several different applications, and consistently meets removal targets for a range of incoming sulfate concentrations. The process conditions can easily be tuned to remove more or less sulfate as the application demands.

**Table 1. HydroFlex Sulfate Removal Demonstrations.**

Application	Incoming Sulfate Concentration	Outlet Sulfate Concentration	Percent Removal
Sodium Sulfate Removal Test	1,300 mg/L	25 mg/L	98%
St. Michael, PA Mine Water Remediation	1,032 mg/L	133 mg/L	87%
Folldal, Norway Copper Mine Effluent Treatment	6,200 mg/L	1,200 mg/L	81%
Sarver, PA Mine Water Remediation for Use as Oil and Gas Source Water	600 mg/L	100 mg/L	83%

HydroFlex removed between 81% and 98% of sulfates from impacted mine water in demonstration projects. The resulting water met effluent limits for environmental release in most cases; for water with extremely high starting levels of sulfates, additional process steps can be added to bring sulfate levels down to acceptable limits.

## HydroFlex Field Installations

Water purification and sulfate recovery have been demonstrated at two separate mine impacted water sites in Pennsylvania. The Hydroflex operation has demonstrated the ability to treat water to a variety of standards depending on user requirements or discharge. The current 100 gpm HydroFlex system consists of interchangeable, movable skid-mounted units that can treat a variety of water sources at various locations.

## Repurposing Mine Influenced Water for Hydraulic Fracturing

With HydroFlex, mine influenced water can potentially go from a liability to a valuable asset. Many closed and abandoned mines are located in the same areas currently under development for the oil and gas industry. A single gas well can use up to 5 million gallons of water between initial fracturing and well completion. Using AMD instead of freshwater allows fracking companies to reduce their environmental footprint significantly and reduce friction with local communities.

The HydroFlex demonstration projects have shown that HydroFlex effectively removes metals and sulfates in AMD that can interfere with fracking chemistry. The resulting water is a safe and sustainable resource for fracking and other water-intensive industrial applications.



A 30 gpm HydroFlex system was demonstrated in Pennsylvania, processing over one million gallons of mine impacted waters. The sulfate was reduced from ~1,000 mg/L to 133 mg/L. Recovery of the feed water was greater than 98% and process wastes were less than 5% of the incoming feed volume.



A 100 gpm HydroFlex system is currently being demonstrated in Pennsylvania for production of oil and gas source water from acid mine drainage.