Pall Corporation

www.pall.com

Mine Water Treatment

Filtration and Separation Technologies for Mine Water Treatment

*Filtration. Separation. Solution.*SM

Mine water treatment

Water and wastewater treatment is becoming a major component of mine operations worldwide. Water supply, scarcity and regulatory constraints are changing the landscape of mine site water management.

In addition, disposal of mine drainage for operational and safety purposes poses a significant risk of pollution to surface waters if not responsibly handled, yet this water can be treated to positively redress the site water balance.

Pall can help with innovative, sustainable filtration solutions that allow mines to meet **discharge requirements**, treat water for **reuse** (e.g. as process water or to cope with shortages in arid areas), help mines improve their **water use index** and become less dependent on external water supplies.

Mine Water Drivers and Standards

A tremendous amount of water is used in mining operations. It is not uncommon for a gold mine to use over 1 million US gallons (157 m^3/h) of incoming water each day for make-up water and operations, potentially placing considerable stress on the environment (upon discharge) and surrounding communities. For this reason, it is easy to see how the global mining water market spend exceeds 7 billion dollars each year.

Much of this is being driven by changing mine water standards. Mine water standards are becoming more stringent with greater enforcement. New standards have set individual constituents, have defined maximum daily loads, and are emphasizing human health/aquatic life.

Typical Objectives and Drivers

Driver	Scarcity Reduction	Quality Improvement	Cost Reduction	Meet Discharge Regulations
Reduce water use index (i.e. Ratio of fresh vs. recycled)			●	
Treatment and re-use of mine water	●	●	●	
Develop alternative water sources, e.g.			●	
▸ Industrial waste water usage	●			
▸ Municipal sewage plant effluents	●			
▸ Seawater / brackish water	●			
▸ Surface water	●	●		
▸ Minimize trucking water to site	●		●	
Meet discharge values – avoid penalties, meet requirements		●	●	●
Reinject water into aquifer		●		●
Dust suppression, cooling water, make-up water etc.		●	●	

Mining investment in water treatment technologies should be such that the solution enables the mining company to meet current and future discharge regulatory requirements while coping with the high variability and potential changes of raw water / mine water quality.

	Treatment		
Operator Benefits	Treat mine discharge water	Recycle treated water for process use	Recycle treated water for potable water
Environmental compliance	●	●	●
Operator safety		●	●
Asset reliability		●	
Public health protection and reduced cost of ownership	●	●	●
Process control/efficiency	●		

Mine water sources

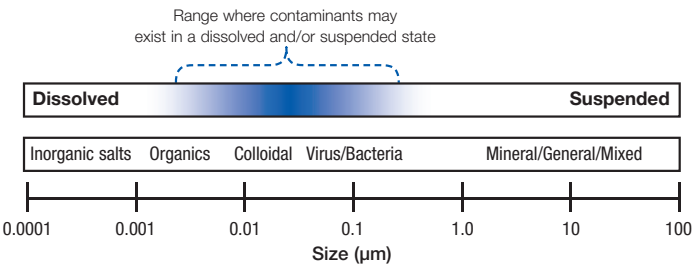
Water in mining comes from several sources:

- Surface water (lake, river, sea…)
- Ground or spring water
- Municipal water (town water)
- Secondary effluent (from biological waste water treatment plants)
- Pond/pit water (may include run-off water, storm water, intrusion water, groundwater, mining drainage water or dewatering wells)
- Tailing storage facilities (TSF)

Depending on where the water is coming from and where the water is used, contaminants in the water can be harmful for the operation (assets and efficiency), staff/people (health) and/or environment (nature).

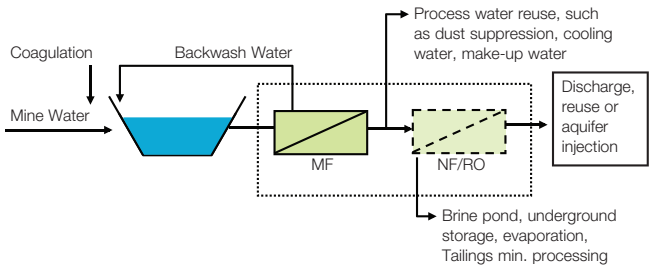
Contaminants in Mine Water

Water contaminants can be dissolved solids and/or suspended solids. Depending on the water source, contaminants can be present across the entire range.



Suspended solids are typically removed via bulk settlement in a pond/lagoon or by using clarifiers followed by microfiltration systems or disposable filtration products.

Dissolved contaminants are typically removed via oxidation, coagulation or precipitation followed by Microfiltration (MF), Reverse Osmosis (RO)/Nanofiltration (NF), or Ion Exchange (IX). It should be noted that it is necessary to protect RO, NF and IX with upstream MF.



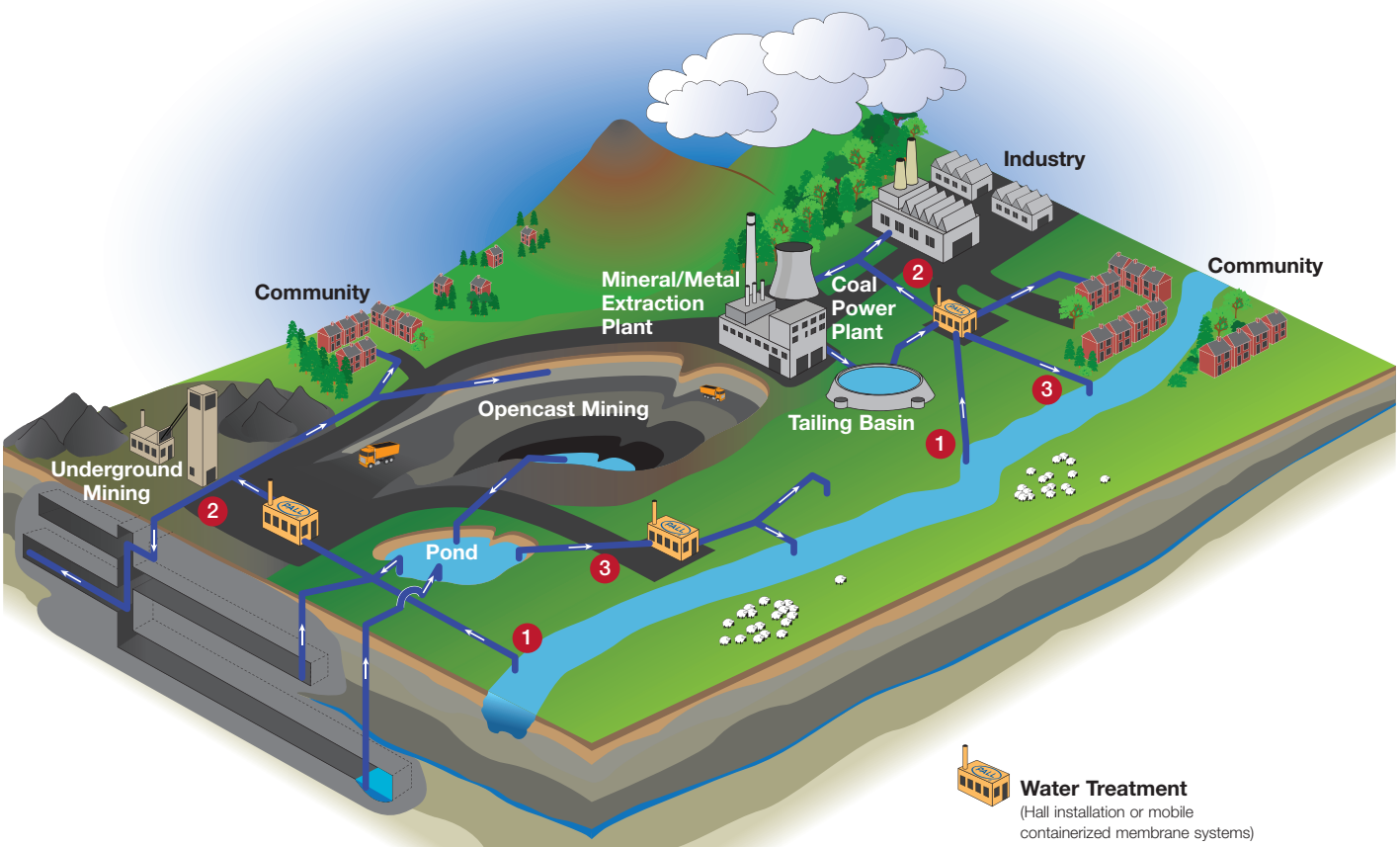
Mine Water Treatment Applications

Water Source	Application
Incoming water	Where quality or quantity is not sufficient for use in the process or for potable water needs.
Incoming water alternatives	Municipal secondary effluent requires treatment to control TSS and TDS through the use of Integrated Membrane Systems (MF/RO)
Discharge (waste) water	Where water needs treatment (TSS, turbidity, specific ions, etc.) prior to use / reuse or discharge.

Typical Mine Water Treatment Solutions

Mine water treatment requires advanced, reliable technologies such as MF and RO, installed downstream of conventional bulk removal mechanisms like coagulation, flocculation and/or settling ponds.

Mine water treatment solutions



1 Incoming Water

Appropriate incoming water quality is important for operation of the mine, downstream processing steps or potable purposes

- Incoming water for process use needs Total Suspended Solids (TSS) to be controlled in order to protect process equipment (pumps, nozzles/jets, cooling equipment, longwall equipment, etc.). In some applications, there is also the need to control Total Dissolved Solids (TDS) or conductivity
- Incoming water used for mineral processing/metal production needs TSS and TDS control to meet conductivity based specifications for critical chemical processes
- Incoming water for potable use for work crews needs TSS control and microbial removal to meet drinking water requirements, even in remote locations

2 Recycled Water for use as Process Water

Process water can be made available by treating discharge water or mine drainage water and recycling it back into the process. Alternative sources like treated secondary effluent water sourced from municipalities, purified surface water, or ground water can be used as well for process water purposes. For example, this treated water can be used within ore recovery or mineral processing steps, for boiler feed water, or for cooling towers.

3 Discharge (Waste) Water

Formation, intrusion, dewatering well, mine drainage, tailings water, or mineral processing water can be treated for reuse or discharge. Treatment must ensure local discharge regulations/standards are met, so disposal to surface water or re-injection into aquifer is possible.

Pall Aria™ microfiltration technology

Mine Water Treatment Solution (Solid Contaminants)

Pall Aria MF membrane technology is considered the leading solids removal solution with significant benefits over conventional technologies.

At the heart of each Pall Aria system is a highly permeable hollow-fiber membrane with high flow per unit area and a high recovery rate. Pall Aria systems can remove the following contaminants from diverse water sources:

- Suspended solids/turbidity and colloids
- Iron and manganese oxides
- Arsenic oxides
- Organics
- Cysts and oocysts
- Viruses and bacteria

Pall Aria systems are suitable for stand-alone use or for integration with your existing equipment. The modular design offers flexibility and allows you to customize a system for your specific process application and integration requirements.

Pall's dedication to a simplified process and control design has produced a family of MF systems that are characterized by distinct advantages over other filtration technologies such as sand or multi-media filters (MMF)

Pall Aria MF Mine Water Value Proposition

Features/ Performance Evaluation	Sand Filter/MMF	Pall Aria MF	Additional Benefit of Pall Aria MF
Reliability	●	●●●	Superior strength of HC-PVDF membranes
Modular and expandable	●	●●●	Can meet future needs, by adding modules or banks
Flexibility to cope with variable feeds and hydraulic loads	●	●●●	Broad operation range, handles upsets
Effluent quality	●	●●●	Absolute barrier for fines and microbiol contaminants; SDI <3
Waste minimization	●	●●	Unique air-scrub feature for high recovery
Integrity testable	–	●●●	Allows safe potable water supply
Consistency in performance	●	●●●	Consistency in high performance
Protection of potential RO	●	●●●	Removes fines < 0.1 NTU (and all oxidized Fe, Mn, As, colloids to analyt. stand. limits)
Use to recycle water	●	●●●	Excellent quality for process water
Footprint	●	●●	Compact design, small footprint
Fine PSD removal	●	●●●	0.1 µm rating removes all fines
Microbial removal	●	●●●	6 log removal rate for microorganism and pathogens
Response to oil in feed	●	●●	Clean in place (CIP) will clean membranes while sand filters (SF) block

– Not Available, ● Medium/Average, ●● Good, ●●● Excellent

The Pall mobile water treatment system comprises a complete, automated, packaged Pall Aria MF membrane system mounted in a box trailer or container. With appropriate site preparation and minimal labor, the system can be operational within hours.

Using state-of-the-art hollow fiber membranes, one mobile system can treat up to 2 million US gallons of water a day (300 m^3/h). The system has a flexible configuration and can be engineered to operate in tandem with other water treatment technologies, such as RO.

Integrated membrane system solutions

Mine Water treatment Solution (Dissolved Contaminants)

Since water contaminants can be both dissolved solids and suspended solids, dissolved solids may need to be removed as well. This is typically done using RO prefiltered by MF technology.

Integrated Membrane System Solution

Many mine water applications require an integrated membrane system solution which typically incorporates a staged module design including, but not limited to, MF and RO.

Integrated membrane systems have common/shared control systems (SCADA/HMI) and chemical cleaning systems with dosing facilities to control and facilitate safe secure operation of system processes, and flexible designs based on high recovery rates.

Recycling of treated mine drainage/discharge water for process and potable purpose within coal mining industry, Australia

Application Success Example

Application: Coal seam methane gas produced water treatment

Location: Queensland, Australia

Capacity: 9 MLD (375 m^3/h), upgraded to 12 MLD (500 m^3/h) in 2008

Solution: Integrated Membrane System
4 x Pall Aria MF systems
3 x Pall RO skids

Status: Installed December, 2007
Upgraded to 12 MLD (500 m^3/h) in 2008

This project involved the design, fabrication, supply, and commissioning of a complete Integrated Membrane System for a coal seam gas development. Due to the remote nature of the site, a high degree of modularized (or skid mounted) systems were required, minimizing on-site labor costs and time. Project scope included pre-strainers, MF skids, RO skids, interconnecting pipe work, MCCs and ancillary equipment (CIP skids, chemical transfer and dosing, compressed air systems, and plant-wide control / SCADA).

Global expertise… delivered

Pall's Global Mining Presence

Pall Corporation is a filtration, separation and purification leader providing solutions to meet critical mine water treatment objectives of mining customers for open cut and underground installations. With offices around the world, Pall can provide detailed **water process chemistry review** and offer industry leading membrane technologies and services. These products and services are specifically designed and optimized to meet both mining customer objectives and to be environmentally compliant to external regulatory controls.

For more than 50 years Pall has been a dependable source of innovative technical solutions designed to ensure water chemistry optimization, deliver maximum productivity, and have predictable equipment operating costs.

Total Cleanliness Management (TCM)

Total Cleanliness Management (TCM) is a comprehensive program specifically designed for each of Pall's mining customers. TCM begins with an in-depth review/analysis of each customer's water chemistry. Then we recommend and build a package of selected membrane filtration and separation equipment, diagnostic/monitoring devices, and on-site consulting services that will help the customer achieve the highest process efficiency at the lowest operating cost.

Pall's mine water team can help mining customers:

- **…with innovative filtration solutions for challenging incoming water or discharge (waste) water streams, allowing mines to meet discharge requirements**
- **…by treating water for reuse (e.g. as process water or to cope with shortages in arid areas)**
- **…become less dependent on external water supplies and reduce their water use index ratio**

Making the World Safer, Greener, Better

At Pall we thrive on helping customers protect people, the environment and our natural resources. We are often called "the original clean technology company" because our products provide clear environmental benefits.

Pall solutions enable industrial customers to purify and conserve water, consume less energy, make alternative energy possible and practical, and minimize emissions and waste.

Pall's approach to environmental stewardship is proactive and is anchored in a culture of continuous improvement. We team with our customers in ways specific to their industries, providing them with technologically superior products and engineered process solutions that improve and strengthen their businesses while reducing their environmental impact.

FTSE4Good

CARBON DISCLOSURE PROJECT

LLOYD'S REGISTER QUALITY ASSURANCE ISO 14001

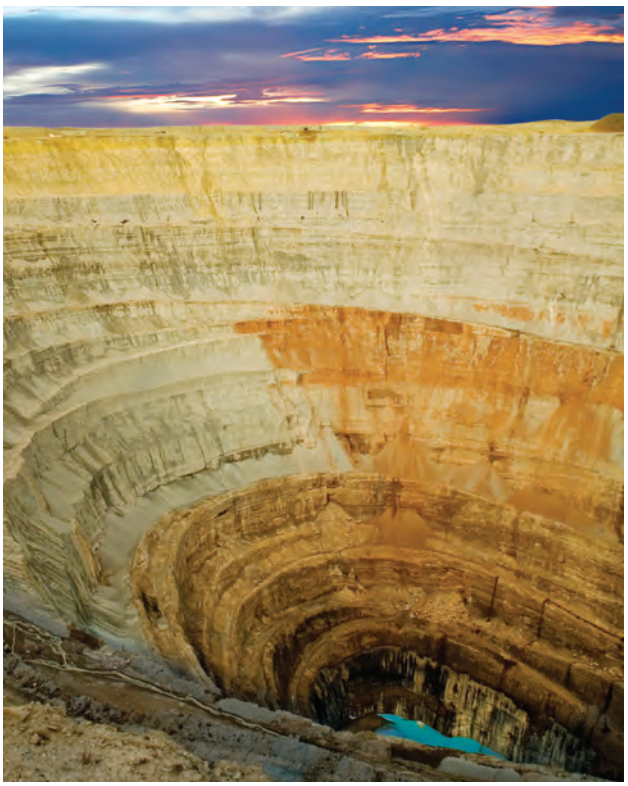
CLIMATE LEADERS U.S. Environmental Protection Agency

ENABLING A GREENER FUTURE℠

Mine water treatment

Pall Aria™ Innovative Membrane Solutions for the Mining Industry

- Surface water treatment, e.g. from lakes and rivers
- Waste water and process water
- Water from mine dewatering, mine drainage
- Cooling tower water treatment
- Potable water
- Boiler feed water
- Water for dust suppression
- Make-up water
- Fluids treatment for long wall mining
- Ground water treatment
- Cooling water for underground mining equipment
- Discharge water
- Process water for ore processing/metallurgical plants
- Recycle water



Pall Corporation

25 Harbor Park Drive
Port Washington, NY 11050
+1 516 484 3600 telephone
+1 888 333 7255 toll free US

ENABLING A GREENER FUTURE℠ To see how Pall is helping enable a greener, safer and more sustainable future, visit www.pall.com/green.

Visit us on the Web at www.pall.com/mining

Pall Corporation has offices and plants throughout the world. For Pall representatives in your area, please go to www.pall.com/contact

Please contact Pall Corporation to verify that the product conforms to your national legislation and/or regional regulatory requirements for water and food contact use.

Because of technological developments related to the products, systems, and/or services described herein, the data and procedures are subject to change without notice. Please consult your Pall representative or visit www.pall.com to verify that this information remains valid.

© Copyright 2012, Pall Corporation. Pall, PALL, and Pall Aria are trademarks of Pall Corporation. ® indicates a trademark registered in the USA. ENABLING A GREENER FUTURE.SM and *Filtration. Separation. Solution.SM* are service marks of Pall Corporation.

Filtration. Separation. Solution.SM

M&EMWTEN Produced in the UK March 2012