Inside view of a delivered Weeefiner 4D Scavenger® Container

A handle on H2O

From advanced water treatment solutions to water stewardship, Paul Moore looks at a range of approaches and technologies in mine water management

Mine water management, including the management of water in tailings, is a core issue in the drive by mining companies to achieve greater sustainability – and is also a major factor in mining's social licence to operate. Rio Tinto states: "Water is a shared resource critical to sustaining biodiversity, people and economic prosperity. Increasingly disrupted weather patterns and more extreme weather events due to climate change, and a growing world population, mean efficiently managing water is more important than ever."

It continues: "The way we think about water, and manage associated risks, reflects the diversity of our operations and geographic locations. A small proportion of our assets operate in water-scarce regions, while others must remove excess water to allow safe mining operations. These are examples of the many potential risks we manage across the life cycle of our diverse operations. We share water with the communities and nature surrounding our operations, so we aim to avoid permanent impacts on water resources, including lakes, streams and groundwater aquifers, by carefully managing the quality and quantity of the water we use and return to the environment. This means balancing the needs of our operations with those of local communities and local ecosystems. We do this while considering the impact of climate change, already felt in the level of rainfall and water security at some of our operations."

To address this complexity, Rio Tinto adopts a catchment-level approach to developing potential solutions and managing the risks and impacts within our operations. It uses 2030 water stress as determined by the World Resources Institute to identify operational catchments of most concern.

Plus as ICMM members, it reports its water practices against the commitments outlined in the ICMM water stewardship statement: to apply strong and transparent water governance; to manage water at operations effectively; and to collaborate to achieve responsible and sustainable water use.

Benckmarking to improve water management practices

A recent presentation by **SRK Consulting** Senior Consultant Noah Levin discusses mine water efficiency improvement. To help mines assess and improve their water management practices, SRK Consulting has developed a comprehensive database and benchmarking tool.

Levin: "In 2020, investors highlighted water scarcity as one of the largest increasing risks to the mining and metals sector they expected to face by 2025. With 2025 now here, water scarcity is not only a pressing environmental issue, but an operational challenge for the mining industry, which requires a reliable water supply to create salable product from ore. The impact to bottom line is significant."

In response to these challenges, the International Council of Mining and Metals (ICMM) introduced its Water Stewardship Framework in 2017. This framework urges mining companies to improve water management practices, focusing on increasing water recycling, reducing withdrawals, and using lower-quality water where possible. Since then, most ICMM members have committed to these goals, with sustainability reports showcasing significant efforts to enhance water efficiency.

Levin states: "However, achieving water efficiency is not one-size-fits-all. Every mining operation is unique, facing specific water challenges based on location, geology, and operational needs. Some sites may not be recycling water efficiency, while a site recycling water at a high rate may benefit more from making its processing plant more efficient. An operation relying on high-quality groundwater might have access to lower-quality surface water, which could offset freshwater usage. Mines in water-surplus regions may focus less on reuse and more on managing excess water to avoid environmental and operational risks."

He argues that understanding how your operation ranks in water management compared to similar mines allows you to pinpoint the most impactful areas for improvement.

To help mines assess and improve their water management practices, SRK Consulting has developed a comprehensive database and benchmarking tool. This tool evaluates key water management metrics across the industry, leveraging widely recognised ICMM and GRI water accounting standards. The key metrics in the benchmarking tool include:

- Water Withdrawals: How much water is brought on to site for operational usage.
- Recycle/Reuse Rate: How much water is used more than once for operational usage.
- Water Discharged: How much water is released to the environment.
- Other Water Managed: Water that is managed on site but not actively used.
- Water Consumed: How much water is lost to the environment through leaks, evaporation, or entrainment.
- Water Replacement Ratio: The amount of water that is withdrawn and replenished to the environment.

Each metric is broken down by water quality (high or low) and source (surface water, groundwater, seawater, or third-party water). This granular approach allows mines to compare their performance with others and identify specific areas for improvement.

Levin adds: "A meaningful benchmark considers the unique characteristics of each operation. For example, an open-pit copper mine in a dry climate will have different needs than an underground gold mine in a tropical region. The SRK tool allows users to apply filters - such as mine type, location, climate, and processing methods - to ensure a like-for-like comparison."

Levin considers an anonymous open-pit copper mine in Chile that withdraws 1.62 m^3/t

ore processed. "When benchmarked against all mines, it ranks in the 38th percentile for water withdrawals, indicating it withdraws less water than 62% of mines. This may seem efficient. However, when compared only to other open-pit copper mines in dry climates, it ranks in the 64th percentile, suggesting there is room for improvement. This is because copper mines generally withdraw less water per tonne of ore than gold mines. Additionally, open-pit copper mines can recycle more water than underground mines, and mines in dry climates typically use less water than those in wetter regions. Factors such as ore grade, tailings type, geology, and processing pathways also influence water usage."

By considering these nuances, benchmarking reveals that this mine could reduce water withdrawals further. It could also draw inspiration from other operations with similar characteristics that manage to withdraw less water.

"Benchmarking is just the starting point for improving water efficiency. Once an operation identifies its rankings, it is critical to understand the factors driving its performance. For example, water that is consumed may be lost in different ways, such as through evaporation or entrainment in tailings. Addressing evaporation losses might involve minimising surface exposure, while entrainment losses could be reduced through adjustments in tailings management practices. Similarly, high water withdrawals may not always indicate inefficiency. In some cases, they could reflect process requirements, such as the need to manage ores with high impurity levels. Understanding whether a high metric results from operational inefficiencies or process needs is key to selecting the right interventions."

Levin argues that the insights gained from benchmarking can form the basis of the improvement process, and tools like marginal abatement cost curves and multiple accounts analyses can be used to prioritise high impact low cost opportunities for improvement.

Like any tool, benchmarking has its limitations. "The SRK database relies on self-reported data, which can introduce inaccuracies. While about 90% of companies adhere to ICMM and GRI standards, there is no universal method to verify the data. Additionally, the tool compares operations to industry norms rather than theoretical maximum efficiencies, and regional reporting standards can vary. Despite these challenges, benchmarking provides invaluable insights. By identifying areas of improvement, operations can reduce both their environmental impact and the risks associated with water scarcity."

He concludes: "Water scarcity remains a critical risk to the global mining industry, but our pathway to improved water efficiency is attainable. Benchmarking offers a practical starting point for mines to assess their performance and prioritise actions. By leveraging data and learning from peers, mining operations can take meaningful steps toward sustainable water management - ensuring both their operational resilience and their environmental stewardship for decades to come."

Innovation drives efficiency – Clean TeQ Water

At a site level, achieving these big picture water management goals is underpinned by companies delivering state of the art technologies. One of the companies at the forefront of innovative water treatment solutions is **Clean TeQ Water**, helping mining companies achieve more efficient, cost-effective, and environmentally responsible operations.

As an example, over the past year Clean TeQ Water says it has been demonstrating its ATA® Rapid Tailings Dewatering technology for several major players in the mining industry, including BHP and Anglo American. Will McLean, Clean TeQ Water Sales Manager, told ***IM*** that results to date have been excellent, with up to 90% w/w solids achieved using vacuum filtration alone on ATA® treated solids.

He adds: "These results show that under the appropriate conditions ATA® can eliminate the need for pressure filtration in dry stacking. ATA® offers a simpler, more cost-effective solution and makes dry stacking viable for sites where it was previously cost-prohibitive. After successful pilots up to 25 t/h, the first full-scale commercial demonstration of ATA® technology is about to launch at a site in South Africa with Harmony Gold, marking a major step toward sustainable tailings management in the industry."

After successful pilots up to 25 t/h including the installation shown, the first full-scale commercial demonstration of Clean TeQ Water's ATA® technology is about to launch at a site in South Africa

Nutrient removal technology is another rapidly growing sector in water treatment, Clean TeQ Water's first PHOSPHIX® plant is now in the design phase for a major industrial company in Ireland, where it will remove phosphate to meet strict ultra-low concentrations for environmental compliance. The technology it says is well suited to the mining sector, particularly in addressing nutrient discharges from wastewater and tailings storage facilities with the added benefit of recovering a saleable phosphorous product.

Beyond phosphate, Clean TeQ Water says it is also tackling nitrate pollution, a common issue in the mining industry from blasting operations. An ammonium nitrate remediation plant is currently being commissioned in Australia to treat water in a large storage dam, a rapidly growing sector in water treatment. A large-scale nitrate polishing system is already operational at a coal mine in China, ensuring compliance with stringent <1 mg/L total nitrogen water quality regulations.

Another game-changing innovation is Clean TeQ's CLEAN-IX® technology, designed to improve the extraction, concentration and purity of metals streams while minimising water and reagent consumption. The first full-scale CLEAN-IX® plant has just entered the commissioning stage for Heathgate Resources in South Australia, where the U-Column Elution System will bring a range of benefits to the expansion project. Typical benefits of CLEAN-IX® include a 50% increase in product concentration and 20% reduction in water usage, a crucial advantage for mines operating in water-scarce regions. Additionally, the technology can reject impurities such as iron within the U-column, simplifying downstream processing and reducing costs.

Finally, recent piloting of Clean TeQ Water's sulphate removal technology at a metals refinery in Europe has demonstrated that the technology effectively removes both sulphate and selenium, achieving selenium levels below 2 ppb which is critical for meeting tightening discharge limits. The main waste stream produced by the system is gypsum, which can be sold to local industries for use in a range of applications.

Weeefiner finds new efficiencies

The uncertain outlook of the raw materials market and rapid changes encourage the mining industry to invest in efficiency while meeting stringent environmental requirements. Finland's **Weeefiner** told ***IM*** that it has addressed these challenges head-on with its selective recovery and water treatment system, tailored specifically for the dynamic needs of the mining sector.

Modular 4D Scavenger® technology is the cornerstone of Weeefiner's solution for mining industry. Technology can be delivered housed in a shipping container designed for both ease of

transportation and durability. This self-contained unit it says excels in outdoor environments and remote locales, making it an ideal choice for diverse mining applications. Weeefiner also provides a Skid solution for indoor applications. "Overall, modular design of 4D Scavenger® allows for customisation, seamlessly integrating with existing infrastructure to provide flexibility and convenience."

The company adds: "Autonomous operation 24/7 reduces the need for constant human oversight allowing mining companies to allocate resources more judiciously. With remote control capabilities, companies enjoy uninterrupted monitoring and adjustment, ensuring maximum efficiency throughout the metal recovery process."

Selective metal recovery increases efficiency and directly impacts operational costs. Weeefiner says its technology selectively targets dissolved raw materials, isolating and extracting valuable metals from the water. This precision not only streamlines operations but significantly cuts costs associated with metal recovery, positioning it as both a high-impact environmental and economic solution.

"From improving raw material yields to lessening environmental impacts - a combination providing a compelling reason to believe in Weeefiner's transformative technology. Beyond metal extraction, the system facilitates the recycling of purified process water. This capability reduces water consumption and waste output, aligning closely with the mining sector's goals to manage resources more sustainably and comply with environmental regulations."

Weeefiner adds that its technology is gaining recognition and application within respected industry leaders, such as Rio Tinto and Eramet. "Through collaborative efforts, we are employing our 4D Scavenger® technology to enhance the selectivity and efficiency of metal recovery. This collaboration not only exemplifies the trust placed in our solutions but also highlights our shared commitment to sustainable practices and resource management."

"Our mission is clear: to drive transformative change in water treatment and material recovery by providing innovative, selective solutions that combine environmental stewardship with economic value, particularly in sectors like mining where every drop and ounce matter," said CEO Mikko Hänninen.

Checking the health of your water data management

Mining companies invest heavily, both financially and in resourcing, to ensure production activities run efficiently and effectively. But can the same be said for managing environmental obligations such as water quality monitoring?

EnviroSys, acQuire's environmental data management solution, empowers companies to assess and report compliance across various types of environmental data in real-time

Stuart van de Water, Environmental Leader at **acQuire**, told ***IM***: "While on the surface managing water obligations may seem simple, companies often don't recognise that a single obligation can involve collecting and managing records for millions of data points annually."

He adds: "Water obligations are one of many environmental obligations mining companies are required to perform, with environmental stewardship teams undertaking and managing these critical activities often resource-stretched and time poor."

Water data management requires environmental professionals to collect data on water quality, quantities, usages and balance, for a range of programs, at different frequencies or for specific events such as during extraction or dewatering. This is collected using different sampling methods and devices outputting data in a number of different formats, coming from different providers, and often external to the company.

"Water data management isn't easy but it's important to get right," van de Water advises. The implications of not managing water data in a timely, accurate and verifiable way can have material environment, health and safety effects. Not managing your water data effectively can have lasting impacts on the health and safety of workers on-site and in local communities, the surrounding biodiversity, and puts operations at risk of non-compliance and reputational damage, simply through poor data management and governance.

"With the volume and breadth of obligations, conditions, activities and data to manage, it's critical to ensure water-related data is being managed in a solution that can help you ensure data is validated, complete and auditable," says van de Water. "Companies need to have their finger on their state of compliance in real time not just for water data, but any type of environmental data."

With a fit-for-purpose environmental data management solution, companies can seamlessly load environmental data from anywhere, at any time. EnviroSys, acQuire's environmental data management solution, empowers companies to assess and report compliance across various types of environmental data in real-time. This enables them to answer 'are we compliant right now?' with confidence.

Gradiant water solution for the complete mining lifecycle

Boston, USA-headquartered **Gradiant** offers an extensive range of solutions for the complete mining life cycle. This covers everything from freshwater supply and wastewater reuse, often in remote locations, to advanced treatment and extraction in preparation for processing ore. Plus innovative brine mining processes concentrate lean liquors and transform waste into new mineral resources.

It states: "Mining operations are highly complex and increasingly water-intensive with many projects located in arid regions with limited access to water, subject to ever more stringent discharge requirements. We have developed a deep understanding of this complex industrial sector and the challenges it faces. We have proven know-how to yield the high-value end-product the industry demands, efficiently process lower ore grades, and customise solutions for complex process streams. And we ensure environmental discharge compliance plus design and operate facilities in remote locations."

Looking at specific technologies, Gradiant has developed RO Infinity, an advanced platform of membrane-based solutions for complex water and wastewater challenges, that combines its patented Counterflow Reverse Osmosis (CFRO) technology with innovative reverse osmosis (RO) membrane processes. RO Infinity solutions enable mining customers around the world to achieve desalination, brine concentration, brine mining, and sustainability goals.

Its patented Carrier Gas Extraction (CGE) thermal evaporators "go above and beyond traditional evaporative techniques incorporating patented technologies such as novel bubble columns, packed bed, and thermodynamic balancing." The use of carrier gas mimics nature's rain cycle to humidify and dehumidify at the lowest total water cost. "The patented design minimises fouling and scaling to maximise system reliability and availability. The CGE technology is suitable for highly fouling and scaling wastewaters with high TDS that are challenging or costly to treat with reverse osmosis systems."

High saline and contaminated wastewaters and brine are converted into pure freshwater at brine concentrations to the saturation limits of salt (TDS up to 260,000 mg/L NaCl). This

minimises the required capacity of downstream ZLD systems resulting in typical cost savings of more than 50% in CAPEX, OPEX, and Total Water Costs compared to conventional thermal technologies.

Gradiant's Bio Infinity (Bio-I) platform solves wastewater challenges using a range of high-rate biological treatment processes. It allows mines to remove nutrients and biodegradable organics, meet stringent discharge limits, plus reduce capital, operating, and total life cycle costs by up to 50%.

Its SmartOps AI is a digital ecosystem for the control, predict, and perform aspects of water treatment facilities. "We harness the power of digital to re-imagine how facilities are designed, built, and operated based on our foundation of systems expertise learned from the delivery and operations of projects around the world. Our machine learning AI algorithms allow for the optimisation and prediction of plant operations. We're using historical and real-time process data to deliver immediate productivity improvements and cost savings, as well as to reduce the carbon and water footprints in systems where our solutions are installed."

Gradiant's Selective Contaminant Extraction (SCE) technology is one of the most robust and reliable treatment systems in the market for industrial wastewater and water reuse. SCE is a multi-step treatment process customisable to target a wide range of contaminants at varying loads — such as oil & grease, hydrogen sulphide, VOCs and semi-volatile VOCs, and specific ions.

A new Gradiant technology offering, in partnership with a lithium mining client in Clayton Valley, Nevada, it says is unlocking a sustainable lithium extraction process for a reduced time-to-market and environmental footprint. Gradiant's technology is integrated into the client's lithium flowsheet, and enables up to 15x lithium concentration in a fraction of the time versus conventional methods, while also reducing carbon emissions, energy consumption, and capital costs when compared to thermal-based technologies. This technology integration can be applied to new lithium mineral extraction and production sites, opening opportunities to untapped lithium production regions, as well as existing lithium production operations.

The feedwater source is subsurface brine and the technologies used include alkaLi EC2 and RO Infinity with CFRO in a single train, multi-stage configuration. The plant began operation in 2023 using a Design-Build (DB), Operate & Maintain (O&M) model.

In this flowsheet, Gradiant's technology concentrates the lithium solution and generates fresh water, a critical element in sustainable lithium production from brine. Gradiant deployed its unique Concentrate process as part of alkaLi's EC2 technology stack. Gradiant is now operating a RO Infinity with CFRO system to concentrate lithium up to 15 times to enable higher lithium recovery. The innovative brine mining process concentrates the lean liquors to maximise the efficiency of lithium production at the site. The system is fully integrated into the client's flowsheet and ensures that brine is treated and pre-concentrated before the CFRO step. The system operates at normal RO pressures, allowing standard commercially available membranes and components to be used. RO Infinity's high system recovery rates serve to reduce downstream evaporator size and cost and, in some cases, remove the need for them entirely. Squeezing every last drop of water from the DLE process is highly important to the client, given the site's remote location in an arid region with limited access to water. A second RO Infinity system is available at the site to produce fresh water from the DLE waste stream. This minimises or can avoid the need for groundwater withdrawals or the need to truck in water from off-site.

Closing the gap – IDE on meeting tightening sulphate standards in mining

IM also caught up with Rosemary Niechcial, CEO of **IDE Water Solutions** in the USA on the topic of sulphates in mining. She stated: "Current regulations on mine water discharge for the

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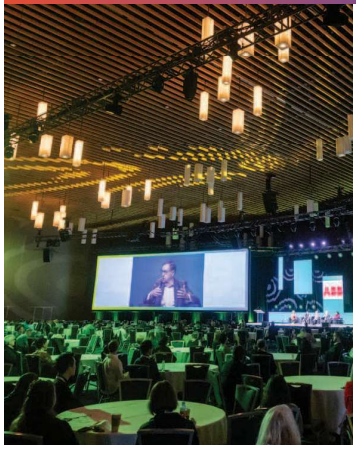

The CIM CONNECT 2025 mainstage events will unite leaders from mining and energy to explore the key issues shaping the future of the industry.

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Keynote Speakers to Date:

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General Manager Technical
Rio Tinto Minerals

Ammar Al-Joundi
President & CEO
Agnico-Eagle Mines

Rohitesh Dhawan
President & CEO
ICMM

CIM ICM Canadian Institute of Mining, Metallurgy and Petroleum / Institut canadien des mines, de la métallurgie et du pétrole

mining industry vary, but are generally becoming more stringent worldwide due to environmental concerns. These regulations demand treatment solutions that can handle high sulphate concentrations commonly found in mine-impacted waters."

Mine water discharge often comes with high sulphates, and when regulations require treatment for other constituents, such as selenium, chlorides and nitrates, sulphate will impede the performance of membrane-based treatment systems.

Niechcial says conventional treatment methods such as HDS and lime addition still require membrane processes to further treat constituents of concern. This gap necessitates alternative technologies that can bridge the disparity between treatment outcomes and the comprehensive regulatory demands.

One major issue with these conventional treatments is gypsum (calcium sulphate) saturation. The effluent from lime treatment and HDS is typically already saturated with gypsum, which significantly increases the risk of scaling when using downstream membrane-based technologies like reverse osmosis (RO). This gypsum scaling can clog membranes, reducing system efficiency, shortening membrane lifespan, and requiring frequent maintenance.

IDE Technologies addresses these challenges with its MAX H2O Desalter technology, which combines reverse osmosis (RO) with an integrated salt precipitation unit. This system enhances sulphate removal efficiency and handles variations in water quality, which are common in mining operations. Unlike traditional methods that struggle with gypsum scaling and high operational costs, the MAX H2O Desalter reduces scaling potential by managing the precipitation of sparingly soluble salts during the treatment process.

The operational benefits of the MAX H2O Desalter are substantial. It achieves high recovery rates, minimising waste and enhancing water reuse opportunities. It also lowers chemical usage and sludge production, resulting in reduced operational costs. The technology provides a robust solution adaptable to the fluctuating qualities of mine water, making it an optimal choice for mining operations looking to comply with stringent environmental regulations while controlling costs.

The MAX H2O Desalter has shown the capability to achieve recovery rates up to 98%, with significant reductions in total dissolved solids (TDS) and sulphate concentrations. In a recent case study in one of the largest zinc mining facilities in Udaipur, India, the 1,296 m^3/day MaxH2O Desalter plant achieved an impressive 92% water recovery rate.

These results IDE says highlight the MAX H2O Desalter's robust potential to bridge the gap between current water treatment outcomes and the stringent environmental regulations in the mining industry. This streamlined approach not only aligns with prevailing environmental standards but also enhances operational efficiency. Moreover, its flexibility in adapting to variable mine water conditions and its reliable performance under diverse operational demands underscore its critical role in advancing the mining sector's sustainability goals.

MAX H2O Desalter recently deployed at a zinc mining facility in India

Automated large-scale risk assessment to quantify mining's water quality impacts

Nigel Moon, Principal Water Resources Engineer and Sarah Luu, Senior Water Resources Engineer, both with **WSP**, recently explained how the company harnessed automation to help a large mining client in Australia to better manage water quality risks, with the project still ongoing.

They state: "Many of our mining clients operate in water-scarce areas and in complex, dynamic catchments which can change throughout the life of the mine. For sustainable operations, our mining clients must optimise water use, maintain water quality standards, minimise erosion and sedimentation, and adapt to the pressures of climate change. In this project, our mining client needed to demonstrate to regulators that it was managing water quality risks associated with its operations, particularly due to surface water runoff interacting with sensitive downstream receptors. Additionally. the water quality is influenced by complex interdependencies. This made it challenging to demonstrate regulatory compliance using conventional approaches."

As a solution, WSP proposed an innovative, automated, GIS-based risk assessment to quantify the risk to the receptors and assess the effectiveness of the client's mitigation controls. "This approach brings together our multidisciplinary services, combining surface water quantity and quality with hydrogeology disciplines and automation to assist with our client with achieving regulatory compliance."

There is a large increase in water stewardship and operators in the mining sector are recognising that water is both a risk and an asset, and that managing water well is as important as the mine's commodity itself. "Our experts worked in collaboration with key client stakeholders and held extensive workshops to develop a framework that captured the relevant water quality sources, pathways and receptors. We identified critical water quality indicator parameters and will expand these in future iterations of the project. For each water quality parameter, we defined the risk by applying rules to quantify the influence of the hydrogeology, topography and soil conditions on the final concentration."

To assess water quality risks, WSP needed to calculate and track water quality concentrations across the entire mine catchment and stream network. To demonstrate regulatory compliance, spatial maps were created showing the existing catchment risk and how these risks could be reduced with proposed mitigation controls.

WSP also developed custom Python scripts to calculate water quality concentrations and risks. "This approach is highly scalable, and the relevant portions of the scripts can be isolated and improved in future work for this client. This workflow enables collaboration with the client to develop a program for future WSP studies, with outputs to be included in the scripts to improve the catchment risk assessment. By improving and expanding the Python scripts, our client can show regulators that the business is continually increasing the confidence of the results as more information becomes available."

Moon and Luu state: "We took the client on a journey and developed a bespoke methodology to the level of detail required for regulatory submission. We used our engineering and science experience to develop a custom framework in lieu of a conventional assessment methodology."

The scripts enable the client to identify areas of higher risk and quickly analyse options for further works to meet water quality objectives. "By applying these innovative Future Ready techniques, WSP empowers our mining clients to comprehend the risks involved in their mining operations, make informed decisions, ensure regulatory compliance, and strive towards sustainable water management practices. It's a crucial contribution to continually improve the mining sector's social and environmental performance, and the sustainable management of our shared water resources in an increasingly uncertain climate."

Fluence's containerised solutions for minesites and remote worker camps

In addition to water treatment for mining

operations, there are also opportunities to improve water and wastewater treatment systems for the workers employed at minesites. In remote workforce housing camps like one in Carlsbad, New Mexico, in the southwestern USA, **Fluence Corporation** is treating the domestic wastewater that is then reused on-site for applications like toilet flushing, dust reduction, equipment washing, and even for reuse in mining operations, reducing overall water use without affecting mining operations.

To address these needs, Fluence offers a proven solution in the customisable Ecobox™. These modular containerised units come factory assembled and tested leafing to streamlined transportation, quick delivery, and easy installation at remote sites with no hidden costs. These units are ideal for lithium mining operations, providing efficient and reliable wastewater treatment to support both domestic and industrial water reuse applications, enhancing site sustainability and operational efficiency.

Containerised systems can also be used for mining operations. For example, Fluence has supplied a containerised ultrafiltration water treatment plant followed by a double-pass reverse osmosis water treatment plant to Eramine, a major player in the South American lithium mining sector. Eramine South America SA is the Argentine subsidiary of Eramet, the global mining group. Eramet owns the mining rights to the Centenario-Ratos salt flat, which allows it to explore and extract lithium and associated minerals from the area.

The Fluence provided plant produces demineralised and drinking water. Fluence also provided engineering services for the development of a lithium brine oxidation operation.

Eramet has developed an innovative direct extraction process to extract the lithium contained in the brine, which is low-cost and environmentally friendly. The Fluence treatment plant was designed to produce different qualities of water using the waste streams of the lithium process. The reuse allows a recovery of 85% of the water used in the process. The plant was designed in containers to reduce the carbon footprint and minimise on-site work. The design provides flexibility to operate at different flow rates, adapt to a wide range of qualities, minimise OPEX and CAPEX, and minimise wastewater discharged.

The three types of water qualities produced are: purified water, deionised water and potable water. All of these must comply with specific parameters established by the process and, particularly the potable water, must meet the specifications of the Argentine Food Code (CAA) to ensure that it is safe for human consumption.

The plant is supplied with well water extracted from the salt flats and has a production capacity of between 476 m^3/h and 618 m^3/h of treated water for multiple uses. The process begins with 130-micron self-cleaning filters, to remove large particles that may damage the downstream systems. These filters are automatically cleaned once a defined volume of water has been filtered, or when a specified difference between inlet and outlet pressures is measured.

The filtered water is sent to the ultrafiltration (UF) system, which acts as a barrier to suspended solids and microorganisms. Part of the filtered water is stored in the UF water tank, which is then used for backwashing the membranes, while the remainder is sent directly to the first step of Reverse Osmosis (RO). This direct connection eliminates the need for an additional pumping system. The ultrafiltration waste, which contains the suspended solids of the raw stream, is treated using a clarifier system. The collected solids are removed, and the recovered water is recycled to the inlet of the plant.

The first step of Reverse Osmosis (RO#1) is designed to reduce the concentration of dissolved solids and the conductivity of water using high rejection RO membranes. The high-quality RO permeate water is sent to the permeate water tank to supply downstream processes. The low-quality RO concentrate stream is stored in a waste tank to be partially recovered.

To produce potable water, a second Reverse Osmosis system with high rejection membranes (RO#2) is fed with water stored in the permeate water tank and designed to further reduce boron and other dissolved solids meeting the local regulatory requirements. Then, the permeate from this system is treated with a remineralisation unit to obtain water suitable for human consumption. Concentrate from this step is also collected in the concentrate tank.

To obtain purified water, a third Reverse Osmosis system with high rejection membranes (RO#3) is used, also fed from the permeate water tank. The concentrate from this process is also collected in the concentrate tank, and the permeate is stored in the ultra-purified water tank.

In the case of the production of deionised water, an ion exchange system is fed from the permeate water tank. The goal of this stage is to reduce the alkalinity of the water by using a strong anionic ion exchange resin. The treated water is stored in the deionised water tank. These ion exchange columns are regenerated when their bicarbonate holding capacity is exhausted, using solutions of sodium chloride (NaCl) and sodium hydroxide (NaOH).

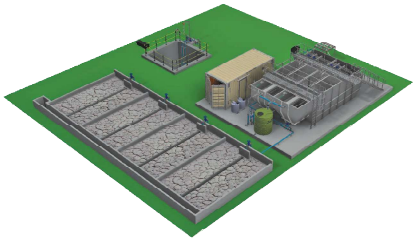
The last stage is the treatment of the concentrate tank water. This is passed through a concentrating Reverse Osmosis system with low fouling membranes (RO#4) to increase the overall recovery of the water used. The permeate is then recirculated into the feed stream and the concentrate is discarded.

This project highlights the various possibilities for reuse in the mining sector, from domestic wastewater treatment for process water production to industrial wastewater reuse and recovery.

WEC Water makes wastewater reusable at Burkina Faso gold mine

WEC Water has recently completed a wastewater reticulation and water treatment plant for a gold mine in Burkina Faso. This project builds on WEC Water's comprehensive experience with water and wastewater treatment in West Africa.

WEC Water was appointed by the mine to conduct an audit of the existing wastewater handling facilities at the mine in February 2023 in anticipation of a planned pit expansion, which would result in an increase in the number of personnel in the area. At the time, the mine was using tanker trucks to remove sewage from seven collection points, including the camps and other operational locations. This method presented the following challenges: increased operating expenditure due to rising diesel costs; undesirable traffic entering the mine area; the risk of sewage storage facilities overflowing, resulting in malodours and disease vector attraction; and loss of reusable water in dry regions.



WEC Water has recently completed a wastewater reticulation and water treatment plant for a gold mine in Burkina Faso

WEC Water's objective was to find a long-term solution to treat the sewage at the mine and reclaim water for use as dust suppression and irrigation, reducing the demand on potable and rainwater reserves. The solution consists of the following three main components: a collection and pumping system that directs sewage to a new, centralised wastewater treatment plant; biological treatment of 60-100 m^3/day of wastewater to reduce COD and nitrogen; and a lagoon to store the treated water before re-use.

The sewage treatment plant (STP) was designed by a WEC Water team of specialist

Sykes Group – energy efficient mine dewatering

IM caught up with **Sykes Group** Global Product Manager, Chris O'Brien, for some insight into the approach and technology that have helped it achieve sustained growth in the mining market

Q You supply some of the most energy efficient pumps in mining - how did you achieve this in terms of the design and is the energy factor an increasingly important part of mining company/contractor decisions when it comes to dewatering pump selection?

A At Sykes Group, we are proud to supply some of the most energy efficient pumps in the mining industry. Our advanced design is anchored by a unique wet end featuring removable shims and gaskets between the front adaptor plate and the casing, allowing for up to 5 mm of clearance adjustment between the impeller and the wear plate. This innovative feature not only negates the need for major overhauls but also enables quick, efficient maintenance to restore pump efficiency swiftly. By optimising the wet end, our pumps require less power to achieve more, a critical advantage in an environment of rising fuel costs and a growing emphasis on sustainability. As mining companies and contractors set ambitious environmental targets, energy efficiency has become a key criterion in dewatering pump selection. Sykes Group is up for the challenge, delivering solutions that reduce operating costs while supporting environmental goals and ensuring our clients receive the best in performance and efficiency. Furthermore, we are constantly exploring new options, including electrically driven and solar powered pump systems, to further reduce power consumption and drive sustainable innovation in the industry.

Q Predicting weather extremes has become more difficult today - are mines having to factor in more contingency when it relates to the ability to respond to extremes such as flash flooding?

A The ingress of water into mining areas due to weather extremes is difficult to predict so it is imperative to factor in contingencies to ensure the mining areas are accessible thus maintaining mining efficiency. Sykes pumps can operate over a wide range of flow rates and heads in order to maintain normal water ingress to dealing with the extreme weather conditions. It is convenient to have a standby pump available to cater for the extraordinary weather conditions. The standby pump can be situated alongside the duty pump and can be activated manually or automatically based on sump water levels by a level transducer. The standby pump can pump in tandem through a common discharge line or have its own dedicated discharge pipe depending on the static discharge head pipe size and length. For sites situated in extremely wet regions subjected to constant heavy rain events it is common to have the pumps mounted on a pontoon to ensure any sudden increase in water level ensures the pumps do not become submerged thus damaging the diesel engine or electric motor. The pump will simply go up and down with the water level. This also ensures the pumps suction capability and performance remains constant when the water level subsides.

Q A lot of mines are getting deeper as brownfield expansion is often an easier prospect than a greenfield mine - does this create extra dewatering demands and how is Sykes placed to meet this demand?

A Around the world mines are getting deeper and expanding their footprint which creates extra demand on their ability to dewater the mining area. As Sykes specialises in dewatering solutions, we are well placed to meet this demand, in terms of both ability to supply direct globally or through our distributors, as well as having an extensive product range specifically designed for these applications. Sykes have a range of High Head and Extra High Head pumps designed to cater for deep mining, where water needs to be moved over significant vertical and horizontal distances. They are designed to generate high discharge pressures, enabling them to lift water from great depths and away from the mining area. These pumps are also available in high-flow rate models which are capable of moving large volumes of water, essential in mines with substantial water ingress. They ensure a rapid response to water accumulation, maintaining safety and operational continuity. All Sykes pump models are available as skid, tow or trailer mounted options which allows pumps to be transported and moved around site quickly and with a minimum of fuss.

Sykes' Extra High Head (XH) pump is helping to meet the increasing demands of the mining sector as open pits go deeper

Q Sykes is a pumps specialist - does that specialism give you greater insight or understanding of the market needs?

A Sykes is a specialist dewatering pump design and manufacturing company, and as such all our people are experts in the challenges faced to dewater mining & construction sites around the world. We pride ourselves in being the global leaders in mine surface dewatering, and this expertise extends to our engineers, production, sales, commissioning, service and aftermarkets

process and mechanical engineers to meet the required discharge standards using a modified Ludzack-Ettinger treatment process. As such, the plant utilises an activated sludge system with nitrogen-reducing capacity.

During the process, the wastewater is pumped through an upfront screenings box and then enters a concrete buffer tank designed to contain peaks and avoid overloading of the biological reactor.

The bioreactor, specifically designed by WEC Water, is comprised of two zones – the anoxic- and aerobic zones – and includes an integrated clarifier. The screened wastewater is pumped into the anoxic zone of the reactor where a submersible mixer maintains constant mixing of the anoxic mixed liquor. An air-lift pump transfers mixed liquor to the aerobic zone, which induces the A-recycle for nitrogen removal. Air diffusers, fed by blowers, drives air into the reactor to maintain the biological oxidation and continuous mixing effect. Sludge recirculation retains healthy sludge in the system and periodic wasting to drying beds ensures a consistent sludge retention within the reactor.

Aluminium sulphate is dosed during the process to enable compliance with local phosphate limits and disinfection is achieved by dosing a hypochlorite solution into the clarifier overflow before entering the chlorine contact tank. Once disinfected, the treated effluent is stored in a lagoon for subsequent reuse as dust suppression, irrigation water or for safe environmental discharge.

Nigel Birchall, Senior Contracts and Project Manager at WEC Water, says: "One of the major challenges of this project arose due to the mine's remote location. This required considerable logistical expertise to ensure the safe delivery of the complete plant to site without damage. The packaged design of the plant simplified the process as most of the plant was built within the footprint of standard shipping containers."

Several WEC Water personnel were on site during the construction and commissioning

teams. As dewatering pumps is Sykes primary focus we understand what is required from a dewatering pump when it comes down to form fit and function. The ability to offer our pumps in various build specifications such as our BR – Basic Range, SR – Standard Range, PR Premium Range, SW - Sewage Range – YR – Yakka Range, AR – Acoustic Range, ER – Electric Range and HR – Hydraulic Range caters for all industries that require dewatering pumps. Having a full range of pumps that cover Low Head, Medium Head, High Head and Extra High Head ensures we have a pump to suit your dewatering needs.

Q If you were to select the mining companies and contractors top factors in their decision making when selecting pump solutions, what would they be and why?

A Experience in pump design and expertise to tailor solutions, as no mine is identical and they often have bespoke requirements. But in general they look for reputation in the industry and proven ability to deliver; product range specialisation; quality of product; material options; diversity of product range; spare part aftermarket and service support; and having locations and a distribution network worldwide.

Q Mines have a choice in pump supplier - what are the Sykes differentiators - the fundamental pump design, quality of materials, market experience, service offering, or a combination of these?

A Sykes have been manufacturing and supplying dewatering pumps and solutions since 1967. Our designs and innovation have stood the test of time and continue to lead the industry. When contractors and mine sites are looking for a pump they ask for a Sykes pump. We will engineer bespoke solutions and continue to innovate. A great recent example is the supply of containerised Variable Speed Drive (VSD) pumps to a remote iron ore mine site located in the Pilbara region in Australia that operates in extreme weather conditions. A key of the Sykes design is its exceptional shaft stiffness. With a stiffness ratio of 0.28, far surpassing the industry standard of 1.5 to 2.5, it ensures resilience against bending, even when operating outside designed parameters. This robustness is crucial, considering the varied and often demanding applications in mining environments. The ratio, calculated as $L3/D^4$ (length from front bearing to impeller centre line over shaft diameter), epitomises the pump's engineering excellence, aligning with standards used in highly demanding applications. The Sykes pump adaptability is further evidenced by its range of material options. The standard configuration includes 316 SS impeller, wear plates and SG Iron volute, priming tee, and NRV. Additional options like Full 316 SS, CS340, CS500, H7A SS, CD4MCU, SAF2205, and SAF2507 cater to varied operational environments, ensuring durability and performance in diverse mining conditions. All Sykes pump models incorporate front and rear wear plates, capable of handling silt and large solids which is crucial for mining operations where water is rarely clean. Pumping solids laden liquids means pumps can be subjected to wear and loss of efficiency because of this. Sykes unique feature of removeable shims or gaskets between the front adaptor plate and the casing allows for up to 5 mm of clearance adjustment between the impeller and wear plate. Such adjustability negates the need for major overhauls, enabling quick and efficient maintenance to regain pump efficiency. Sykes Pumps are supported with parts, commissioning, training and service worldwide through our own service centres and our dealer network. This global footprint is crucial for providing timely and effective solutions, regardless of the mine location. Since becoming part of the Atlas Copco Group in December 2023, Sykes' ability to service its global customers has expanded even further.

phases of the project including process, mechanical, and commissioning engineers, who provided oversight during the installation phase and ensured the plant was successfully installed and commissioned.

BQE Water tackling cyanide and selenium

IM also spoke to David Kratochvil, **BQE Water** President & CEO. Historically, mining projects using cyanide have either been permitted as zero liquid discharge or used large tailings ponds for natural degradation and/or dilution of residual cyanide prior to discharge into the environment. Kratochvil says this practice is changing as new mines need to reduce their footprint, stop relying on dilution, and minimise risks exacerbated by severe and difficult to predict climate.

"Consequently, conventional cyanide destruction plants producing 0.5 to 50 mg/L residual cyanide effluents are not always an option anymore. Instead, a new generation of treatment systems capable of treating leach solution for direct environmental discharge with residual cyanide below 20 ppb and all other constituents at non-toxic levels are needed."

Through rigorous testing and treatment process evaluation for a recent greenfield project, BQE Water developed and is implementing an ion exchange system to meet the end-of-pipe total cyanide target of < 10 ppb. In this system, most of the removed cyanide is recycled back to the metallurgical process. "The ability to implement treatment ahead of the actual need is key. In stark contrast to this, BQE was retained to provide emergency response treatment services involving a fast-tracked temporary system to turn cyanide heap leach solution into nontoxic water for environmental discharge. The system combines the site's equipment not designed for the intended purpose, with off-the-shelf rental equipment. While the effluent discharge criteria are similar in both projects, the inability to plan caused the cost of the temporary system to escalate such that in less than a year, the cost of the emergency response exceeded the estimated 'life cycle' cost of the planned treatment expected to operate for decades."

In addition, while the use of reverse osmosis in the temporary system lowered the concentrations of most toxicants below the respective discharge limits, meeting effluent toxicity criteria consistently proved to be complex. "The industry can leverage BQE's expertise and experience from these two projects to holistically assess the best options for minimising risks and costs of managing water and cyanide throughout the project life cycle."

He also says that the industry wide adoption of BQE's disruptive non-biological selenate removal technology, Selen-IX™, continues with a fifth plant built in less than four years. The technology removes selenium below 1 ppb and produces stable solid residue suitable for re-use. Concurrently, new semi-passive biological systems were installed at other sites. Kratochvil: "However, unlike with Selen-IX, the biological systems lack proof of the long-term stability of selenium solids trapped inside these systems which are designed to remove selenium from water initially but eventually turn into selenium solids waste storage repositories in perpetuity. Regulators assessing environmental risks now consider time horizons of hundreds of years prior to issuing approvals and/or setting bonds."

To help clients better understand long-term risks associated with selenium re-dissolution from semi-passive systems, BQE Water completed a study and published a peer-reviewed article identifying biochemical pathways towards selenium re-mobilisation. The empirical evidence of selenium re-dissolution was subsequently obtained using selenium biosolids from an active biological treatment system. "Selecting the best solution for managing selenium in mining projects can be a complex task and requires access to state-of-the art research data and technology. The ability of Selen-IX to eliminate concerns about long-term solids stability is an important consideration." IM