# Modular wastewater treatment solutions

In response to South Africa's urgent wastewater treatment needs, Wayne Taljaard highlights the benefits of adopting modular wastewater solutions from WEC Water, which include conventional activated sludge (CAS) reactors; trickle filters; and moving bed biofilm reactors (MBBRs).

Based on mature, traditional technologies, WEC plants can all be customised and modularised to offer cost-effective, durable solutions, begins Wayne Taljaard, MD of WEC Water South Africa. "Modular solutions are often seen as quick ways to support capacity shortcomings and ageing infrastructure, but the modular wastewater plants we offer are much more than that. Some of our WEC Water plants were installed over 30 years ago and they are still working perfectly well today."

Outlining some of the reasons for infrastructure decline in South Africa's water sector, Taljaard highlights the lack of attention to maintenance over many years. Many plants have also been vandalised to a point where they are no longer able to operate at the level they were designed for. "Critically though, in spite of ongoing growth in housing developments, there continues to be far too little investment in South Africa's water and wastewater infrastructure. For the past eight to ten years, we haven't built any significant wastewater treatment plants to meet ever growing demand," Taljaard tells *MCA*.

## The role of modular treatment plants

Package or modular wastewater treatment solutions are seen as quick to implement compared to traditional cement-built plants: "But they are also long-term solutions. While traditional plants might be designed for the 20 or 30 year lifecycle, our modular plants are designed to last at least 15 to 20 years, and potentially longer," he points out, adding that these are not off-the-shelf plastic tank solutions.

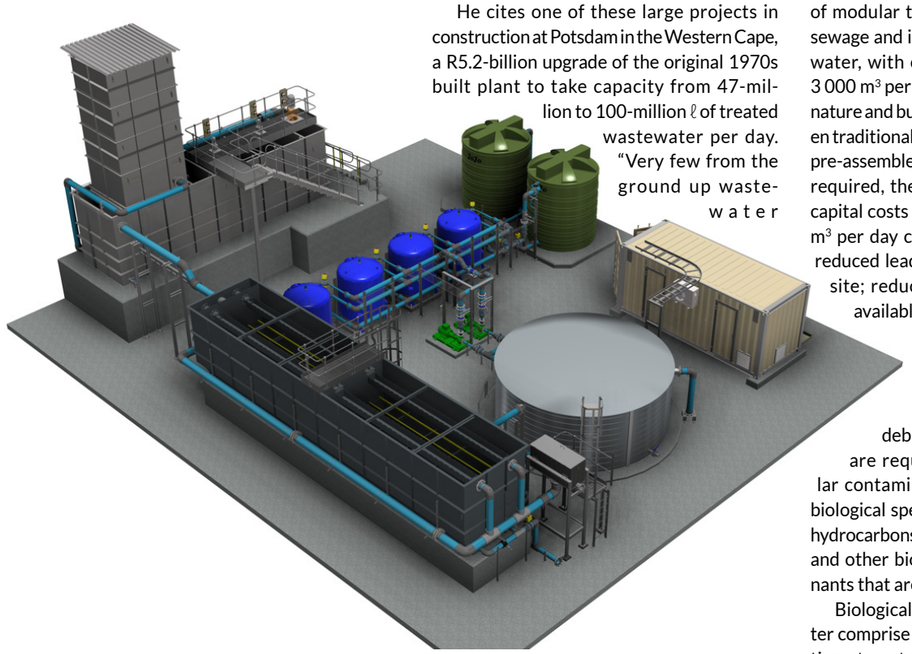
"WEC Modular plants are custom designed and factory-built systems that are disassembled for shipping and then reassembled onsite. There is a misconception that they offer only a short-term solution," he adds.

Concrete infrastructure projects, he continues, are largely dominated by consultants, who define the needs and then design a treatment plant, before starting to pour large amounts concrete onto the ground. This is what we might want in a plant looking at 50 to 100 years of life, but these involve four or five year build cycles from the time of conception to completion and commission, which might take up to six years, depending on the plant capacity and the region.

He cites one of these large projects in construction at Potsdam in the Western Cape, a R5.2-billion upgrade of the original 1970s built plant to take capacity from 47-million to 100-million ℓ of treated wastewater per day. "Very few from the ground up wastewater treatment plants have been built in recent years, however," Taljaard point out.

Residential developments are being built across South Africa, many of which have never been connected to a water or sewage network before. The water these residents need has to come from somewhere and the sewage produced needs to be safely removed for treatment. Many of these new areas cannot be connected to existing water infrastructure because it is either not yet built or because the current infrastructure capacity is already overloaded.

It is in these situations that modular water treatment plants make the most sense. They enable residential areas to expand without having to further overload current capacity or wait until new large scale investment projects are built and commissioned. "We are increasingly seeing off-grid water and wastewater treatment developments where private providers will put down the infrastructure to provide the services needed for a new or expanding residential zone," Taljaard tells *MCA*.



*A 3D model of a conventional packaged water treatment plant for a gold mine in Zimbabwe, designed to provide the mine with safe, reliable drinking water.*

## The modular advantage

WEC Water, he continues, can offer a variety of modular treatment plants, for domestic sewage and industrial or agricultural wastewater, with capacities of between 50 and 3 000 $m^3$ per day. All of these are modular in nature and built around robust and well-proven traditional treatment technologies. "Being pre-assembled with minimum site installation required, these solutions all offer reduced capital costs – typically by 20% or more per $m^3$ per day compared to traditional plants; reduced lead times; easy transportation to site; reduced maintenance with readily available spares; and smaller footprints.

Describing the different requirements for treating typical wastewaters, he says, following screening to remove any debris, several treatment processes are required, each targeting particular contaminants in the water. "Different biological species are used to 'consume' the hydrocarbons, phosphates, ammonia, nitrates and other biological and chemical contaminants that are typically present in sewage.

Biological treatment plants for wastewater comprise equipment and tank configurations to establish variations of anaerobic, anoxic and aerobic conditions. The anaerobic stage, which is not necessarily present in all systems, handles the biosolids and biodegradable contaminants in an oxygen-free environment. The process converts predominantly carbon pollutants to methane and a digestate, commonly known as sludge.

The anoxic zone is included for specific bacterial species to denitrify the wastewater, which is critical in ensuring the treated wastewater is suitable for release into water courses within legislated general or special discharge limits. These denitrifying bacterial species systematically break-down the nitrates in the wastewater, releasing it into back into atmosphere as nitrogen gas ($N_2$).

The heart of the process is, however, the aerobic zone in which remaining carbon pollutants and ammonia are oxidised to carbon dioxide and nitrates, respectively. The carbon dioxide is released into the atmosphere, while the nitrates are further reduced to nitrogen gas in the anoxic zone.

After these biological reaction processes, a clarifier/settler separates biomass created by the biological reactions from the treated water, so that it can then be safely discharged.

"It is possible to do all of these treatment processes in the same modular reactor vessel. But the whole process has to be accurately designed and managed to make sure that the bacteriological population in the activated sludge has just enough of the right type of wastewater and operating conditions to continue to proliferate," Wayne Taljaard informs *MCA*.

## Key modular technologies

For wastewater treatment, Taljaard describes four of the key modular technologies that are readily available for customisation from WEC Water: Conventional Activated Sludge (CAS) reactors; trickle filters; moving bed bio reactors (MBBRs); and membrane bioreactors (MBRs).

Modular (CAS) reactors are ideal for treating domestic sewage for safe discharge into the environment. "Depending on the capacity, we offer five solutions, with the smallest, our Model A reactor unit, able to deliver 60 $m^3$ of treated water per day, to our Model E, which is effectively five CAS units coupled together in a single tank that can handle 300 $m^3$/day of water.

These modules are designed to be upscaled or downscaled, depending on the volumes of wastewater being treated, which makes them ideal for the start-up and scale down phases of a mine, for example, where we can start with a Model A, or B CAS solution and then upscale or downscale it to best suite changing demand.

Trickle filters have the wastewater flowing down the reactor from the top instead of horizontally. In addition, the different bacteria used is grown on the filter media. The wastewater is sprayed over the top of the filter and allowed to trickle down, making contact with the bacteria on the filter media, which starts to consume the hydrocarbons, the phosphates and the ammonia. At the bottom, the water is collected and fed into an external tank for denitrification, which cannot be done using fixed-form media, Taljaard explains, adding that trickle filters are simple, low-cost options that need very little electrical power, making them ideal for being powered, fully or partly, using solar solutions.

In a similar way to a trickle filter, a moving bed bio reactor (MBBR) has a built-in biological media carrier that provide a large surface area for microbial growth. Instead of being fixed, however, this carrier is rotated in the reactor tank, leading to higher reaction rates and raised efficiency of treatment. "With MBBR technology, the media is grown on the surface of the carrier, and the rotation improves mixing with the wastewater," Taljaard explains.

"With CAS technology, we are limited to using about 4 000 mg/ℓ of activated sludge in a tank, before competing species' issues begin to arise. With an MBBR, the carriers of the bio media are kept in suspension using a mixer, which reduces the amount of air required. It also enables the concentration of active biological species to be increased to 8 000 mg/ℓ, typically doubling the water treatment capacity, or halving the footprint of the reactor required," Taljaard explains.

"For over 25 years, WEC Water specialists have developed niche expertise in all of these modular technologies. We have the capability to adapt our range of applications to a wide range of wastewater treatment applications for a variety of known contaminants. We also offer flexibility: we can take clients from using conventional activated sludge, then add media when capacity needs to be increased, and remove it again when capacity decreases, for example.

"For municipal and industrial water treatment, our modular solutions can play a significant role in better and more rapidly meeting growing capacity requirements, with reduced lead times and at lower total costs," concludes Wayne Taljaard.

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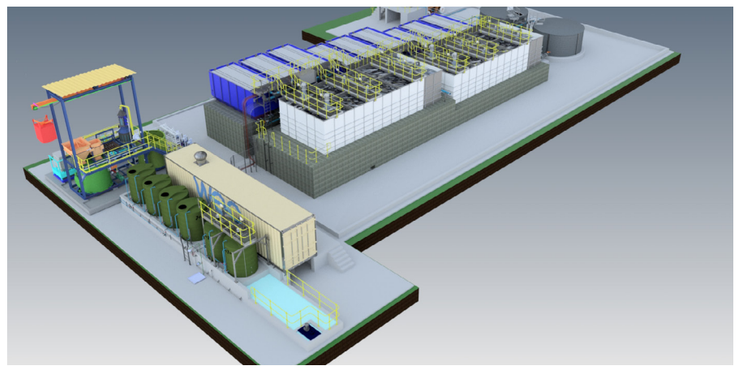
*A view of a trickle filter plant delivered to a fruit producer. The first phase of the plant was delivered at the end of 2024 and WEC Water recently commissioned Phase 2 and 3 to enable the total treatment capacity to be increased to 3.9 MLD by 2026.*



*A moving bed bio reactor (MBBR) plant for a mine in Mali that was customised to remove arsenic and then to treat the wastewater to the required discharge standards.*