Surf's up but costs are down

Step aeration, which can be a tricky process to manage, has the advantage of minimising energy consumption as simultaneous anoxic conditions can be created, while producing clean water.

New types of proprietary technology have been combined at a wastewater treatment works to dramatically lower costs. *Frances Ringwood* reports from the Fountains' site north-west of Jeffreys Bay.

Eastern Cape coastal town Jeffreys Bay may be famous for Africa's best surfing and for hosting the annual international J-Bay Open, but from now on water industry experts will hold the town in high regard for a very different reason – it's an example of excellence in applying new wastewater treatment engineering.

"When a wastewater treatment plant goes out to tender, it's expected the contract may be worth as much as R15-million (USD1,4-million) per megalitre (Mℓ). But this plant cost only R5-million per Mℓ. The cost saving is staggering," says Willem Hofmeyr, WorleyParsons' technical director of water and civil infrastructure.

Global resource and energy specialists WorleyParsons had a hand in building the original works in 1982 for irrigating a local farm near Jeffreys Bay and had taken over its management.

It has been upgraded in the last two years from treating 3Mℓ per day to 8Mℓ per day so that with some small future plant adjustments it can augment municipal supply. In addition, because of the system's current efficiency, engineers predict that treatment capacity can be easily pushed to 10Mℓ per day at a relatively low cost by adding an extra clarifier.

"When we got approval for the project, the Department of Water Affairs (DWA) required that the initial oxidation ponds be scrapped and used for storage. But, working with Tecroveer, we developed technology that enables us to put a portion of water through the original oxidation pond system to clean water to the requisite standard. As a result, rather than create a system capable of treating the initial need of 5Mℓ of water per day, the plant is capable of treating 8Mℓ per day," says Hofmeyr.


All pictures by Frances Ringwood

WorleyParsons saw it as an opportunity to explore the potential of new local technologies by asking for design proposals from other companies. That led to the involvement of South African company Tecroveer Projects, which designed the innovations that this plant impressive.

"In the past, it was thought that effluent from old works with ponds like this was a liability. But this changes all that: water from this plant can be treated with just one further process to be brought up to potable standards. It's no longer a liability but an asset," says Hofmeyr.

Maintenance will be another factor that decides the future of the plant and engineers are working with the Kouga Local Municipality, to ensure operators are correctly trained to manage the plant.

Vernon Stuurman, acting mayor of Kouga, was at the plant's official launch last month along with Cllr Patrick Kota and representatives from DWA. A choir from Pellsrus Primary School sang, with the air that day filled with only the sweet sound of children's voices.

"The municipality has started its latest term obsessed with speed, effectiveness and efficiency. We want Kouga to move forward when it comes to service delivery. This plant unlocks that growth in Jeffreys Bay, the fastest growing town in the country," said Kota.

"Nearby Kruisfontein (an area adjoining Humansdorp) also needs wastewater treatment, and government wants the same for that town too. In Kruisfontein, we want to move with the same speed we moved with to upgrade the Fountains plant to unlock more potential for human settlements development by installing a turnkey project such as this."

Kouga Local Municipality provided some of the funding for the Fountain's upgrade and the DWA stepped in with contributions from the Municipal Infrastructure Grant fund to make the project happen. "Never once was a payment on this project late and I'd like to commend Kouga for that," said Piet van der Merwe, Tecroveer's managing director.

Thriving town

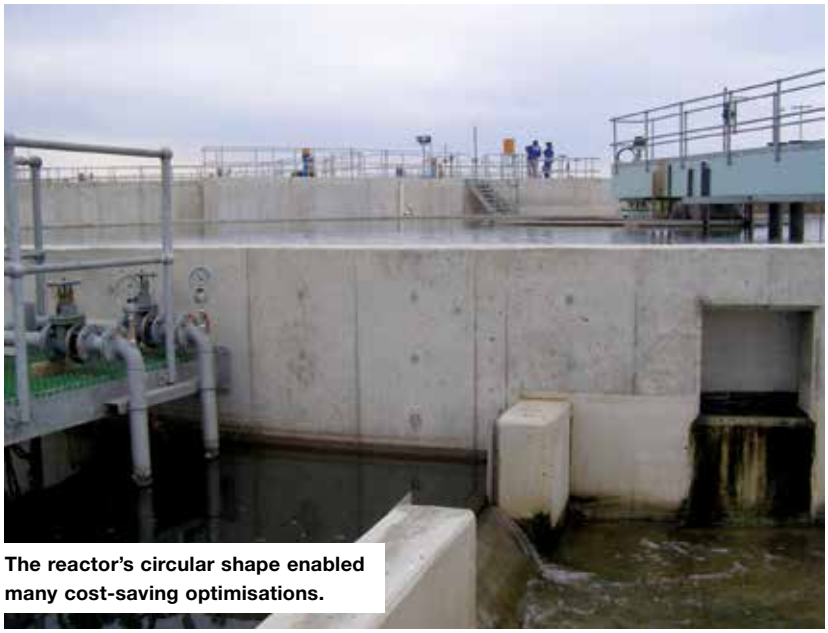
Jeffreys Bay has been found by recent government census to be the fastest growing town in South Africa, because of the business opportunities the area affords with the development of renewable energy infrastructure and its growth as a holiday destination.

At the start of the upgrade project in 2012, there were four oxidation ponds but which were limited in size and

Project summary

Client	**Kouga Local Municipality**
Consulting engineers	**WorleyParsons**
Design and supply contractor	**Tecroveer Projects**
Cost	**R40-million**
Capacity	**8Mℓ per day**
Timeline	**Initial plans submitted 2006.**
	Construction started in 2012.
	Plant starts operating in 2013.
	Works officially launched 2014.

"When a wastewater treatment plant goes out to tender, it's expected the contract may be worth as much as R15-million (USD1,4-million) per megalitre (Mℓ). But this plant cost only R5-million per Mℓ. The cost saving is staggering."



The reactor's circular shape enabled many cost-saving optimisations.

"The system is more concise than the older types of plants where all the components are visibly separate, and that is where Tecroveer has been innovative. Water that moves through this system is visibly clear before it enters the settling ponds and that shows how well it works."

capacity by a set inflow volume. The extension included installing a mechanical process (see below) to control.

At the launch, Tecroveer marketing manager Gary Brown took guests on a plant tour and explained "stepped aeration", one of Tecroveer's technical innovations:

The activated sludge process is well-established and has been around since 1924, all over the world. Fundamentally, wastewater treatment is the separation of solids and liquids and it's largely a biological process, with bacteria feeding on the substrate and breaking down oxidisable compounds.

The biological reactor introduces oxygen into the water for aerobic digestion. Conditions in some zones within the main reactor are quieter with no dissolved oxygen input. In these zones, bacteria are forced to break down certain target contaminants that do not require oxygen – anaerobic digestion.

The aerators' operation has been optimised in the process configuration and are controlled by sensors to determine oxygen levels in the wastewater. Other aerators rotate more slowly, using the minimum amount of energy required to ensure water is cleaned to the desired standard."

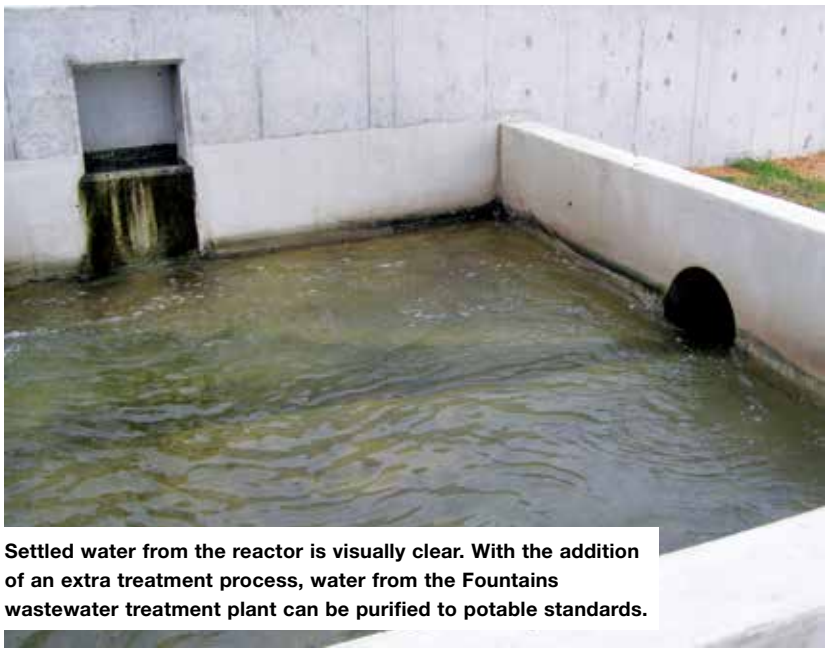
"Maintaining the correct balance of oxygen in the water also helps with denitrification and the biological removal of phosphates, key in removing residual nutrients in the wastewater," explains Brown.

End products

Behind the main structure is a secondary clarifier. Separating solids and liquids results in two end products: clean water and a residual organic sludge. Some of the sludge separated from the process has to be reintroduced to maintain the correct population of bacteria to keep the process running optimally. The residual waste sludge passes through mechanical dewatering to make it manageable as compost for farmers and brick makers.

"In addition, particles of sand and dust enter the system, as well as tins, rags, and plastics which are not biodegradable. These need to be removed before the flow reaches the biological process, so mechanised and automated inlets have been built, which remove non-biodegradable material from the inflow. The potential for odour generation at the inlet works is mitigated by the automated removal of accumulated residues, and as a result the Fountains works don't have a foul odour," adds Brown.

Cradock-based company LRC Civils handled the construction of the reactor. LRC director Lou Scoccia, says that Fountains earned its name, because high levels of groundwater caused mud to slip into the pit during construction, creating an unstable work surface.



Settled water from the reactor is visually clear. With the addition of an extra treatment process, water from the Fountains wastewater treatment plant can be purified to potable standards.

Wastewater enters the reactor, sunk 6m deep in to the ground, and circulates between the aerobic, anaerobic and anoxic phases, before being discharged to the settling tank. Settled sludge is then returned back to the reactor.

"The scraper arm moves the solid material that accumulates on the bottom of the settling tank, which also has pipes to convey wastewater up and into a round screen, from where there there's another pipe which takes it back up to the return activated sludge (RAS) box on top of the structure, at which point the cycle begins again," says Scoccia.

RAS is defined in *Manual on the Design of Small Sewage Works 1988* as: "In order to retain the required level of solids in the reactor the sludge settling in the clarifier is returned continuously, with the rate being governed by the settle ability of the sludge and the mean solids concentration required by the reactor".

The clearer water that rises towards the surface flows over the concrete tank wall with a v-notch weir plate and discharges into the chlorine tank, a semi-circular concrete structure surrounding the clarifier. Chlorine is then introduced at the inlet end of the structure at the chlorine contact tank, with the amount of chlorine needed to sanitise the water being automatically controlled, before it moves to the oxidation ponds, explained Scoccia.

Building started in 2011 and most of the structure was finished in August last year. From July last year until February this year, the inlet works were completed. The works have been running since then and operators are in training to manage the plant's day-to-day processes.

All concrete, stone and sand was sourced in Jeffreys Bay, with used materials supplied by the local hardware store, so revenue was generated for the local community wherever possible. Local labour was used too.

"The system is more concise than the older types of plants where all the components are visibly separate, and that is where Tecroveer has been innovative.

Process controllers at the Fountains' wastewater treatment works spent a year training to operate and maintain the technology.

Water that moves through this system is visibly clear before it enters the settling ponds and that shows how well it works.

"But it's not just a once off process where water is then sent back into the river or used for irrigating. Water is recycled several times," says Scoccia.

Innovative ideas

After the launch, *Water Sewage and Effluent* caught up with Tecroveer group president Zack van den Berg, to get more information on what makes the Fountains plant special. "WorleyParsons was the consulting engineer and what I really appreciate is that although the company has its own process department, they put this job out to tender to see what technologies were available. Tecroveer applauds this boldness. For the company as a design and supply contractor, business is generally limited to small projects but the scale of this project allowed us to come up with some really innovative ideas.

"There are several innovations that helped us make the project cost effective. There was the use of the existing pond systems. In South Africa there is a huge number of old wastewater treatment works with oxidation ponds and when plants are upgraded, these ponds are usually discarded.

"Other plusses this plant has is the

From left, WorleyParsons' technical director of water and civil infrastructure Willem Hofmeyr, acting Kouga mayor Vernon Stuurman, Kouga councillor Patrick Kota and Tecroveer's managing director Piet van der Merwe.

The secondary clarifier is positioned behind the biological reactor.

Lou Scoccia, a director of Cradock-based LRC Civils who built the reactor.

configuration of the reactor, which is circular, using much smaller structural components. The reactor was also optimised, and having the transfer mixers means there are no pumps doing the major re-cycling, which is a world first."

The quality of the water before the project was implemented was poor, but it now meets the general limit, as prescribed in the National Water Act, making it suitable for irrigation. That limit is easily being reached. In fact, there's a special limit" which is for a much higher standard of water, which can be introduced directly into lagoons and sensitive rivers. The effluent that comes out of the Fountains wastewater treatment works at the moment is close to that special limit.

Tecroveer has patented technologies developed at the site and soon it will not only be Africa to benefits from some of these fresh ideas, but wastewater treatment plants around the world.

Engineers and government representatives watch the Volute Dehydrator sludge dewatering machine which can provide raw materials for agriculture and making bricks.

Lighter note

When the Fountains wastewater treatment plant comprised only oxidation ponds, frogs would get caught in the holes along the inlet pipe, causing blockages and a bad smell. Once the mechanical portion of the plant was added to optimise and augment treatment, water birds such as terns and kori bustards returned to the plant, which no longer smelled bad, to eat the frogs. Engineers joked among themselves that they could patent the system to removed frogs from wastewater plants experiencing similar problems.

Innovations at Fountains' works

What has been achieved at the Fountains site is exceptional in that 8Mℓ is being treated per day at a plant costing R40-million, which is about a quarter of the Department of Water Affairs current cost calculation guidelines.

"The technologies used at the site are geared towards sustainability. Energy use is kept to a minimum and the site uses solar power, being close to the Jeffreys Bay wind farm, which feeds to the grid.

"We were able to treat 8Mℓ as opposed to the originally planned 5Mℓ because we combined the existing infrastructure with a Petro Process, where we used algae and solar power to purify an extra 3Mℓ per day at zero extra cost," Piet van der Merwe, Tecroveer's managing director, explains to *Water Sewage and Effluent*.

The Petro Process is an integrated treatment process, making it possible to reduce loading to plants. Introducing the process presented the considerable challenge of having to apply strict control measures because if the available organic load is reduced too far, the remaining available carbon fraction in the wastewater may be too little to allow for the denitrification process to be effective and in order for the effluent to be compliant with the required standards.

The system depends on round shapes. In a circular reactor, rig testers are contained, which means there are no corners to construct, making it much more economical. In addition, this facilitates a "plug-flow system", or "step aeration", similar to that which occurs in nature to purify water.

"A world first at this plant is the full-scale application of the transfer mixer. This is important as far as global innovation is concerned, because we have used no return activated sludge pumps. With the technology here, we are able to mix and return sludge at the same time," says Van der Merwe.

There is no other plant on earth that is capable of this at present. In a typical treatment facility there is usually a pump for re-cycling and a pump normally needs a head, which can block easily and cause problems. Tecroveer's transfer mixers induce a low-pressure zone so it's possible to gravitate water and sludge to the lower pressure areas.

The first plant of this kind was developed by Tecroveer for a platinum mine in Wonderkop, North West Province. But what sets the Fountains site apart is that it is the first time Tecroveer has activated sludge actually returning from the settling tank. A full-scale model had to be built at Tecroveer's factory to confirm and calibrate the theoretical model.

"The benefits are power savings, once again, and also there is one less item of mechanical equipment to be managed, maintained and repaired. That adds a lot of flexibility," says Van der Merwe.

The settling tank, parallel to the contact channel that collects clean water, is also circular.

"The solar-driven Petro Process on the ponds required a dredger to remove historically accumulated surplus sludge on the first of a series of ponds and at varying levels. The dredger was created for the specific site because if the pond's full process volume was not available it would have negated the performance of the pond treatment phase. Tecroveer developed the specific dredger technology needed for the job.

"There is also a mechanical sludge dewatering device sourced from a Japanese supplier. It's easy to operate and the benefit of the machine is that the sludge can be recycled not only for making compost but also for making bricks," says Van der Merwe.