

# ALGAE:

## Nutrient Harvesting for Improved Wastewater Effluent Quality

*"A low cost, green solution for wastewater treatment"*

### In Brief

A low cost green technology exists that has proven to achieve greater treatment efficacy with existing wastewater treatment infrastructure.

Waste stabilisation pond systems still exist in most rural communities and towns and are ideally suited for sewage treatment because they are simple and economical to operate and maintain. The algae-based treatment process utilises a specific consortium of algal species to remove nutrients and create conditions for effective solar disinfection to reduce pathogens in such pond systems. The self-sustaining system operates

independent of electricity or expensive chemicals and can be effectively managed within financial and capacity constraints.

Governance and technical constraints often hampers or prevents successful implementation of people's constitutional rights and provisions. This approach provides a technical solution for improved wastewater effluent quality, combined with governance guidance and ownership; thereby supporting effective policy implementation.

## Policy context

The South African Constitution guarantees people the right to an environment that is not harmful to their health or well-being and to have the environment protected, for the benefit of present and future generations. The Water Services Act supports this by stating that *“Everyone has a right of access to basic water supply and basic sanitation”* and that *“Every water services institution must take reasonable measures to realise these rights”*.

The National Development Plan states that in 2030 *“We have created a home where everybody feels free yet bounded to others; where everyone embraces their full potential. We are proud to be a community that cares”*. The subsequent Approach to Change, which sets out to enhance capabilities and active citizenry, states that *“Citizens have the right to expect government to deliver certain basic services, and to hold leaders accountable for their actions.”*

### What you need to know

*“Untreated or poorly treated wastewater is severely affecting the quality of water in many areas, as well as negatively impacting on the environment”.*

*Source: Department of Water and Sanitation, Strategy Plan for 2015/16-2019/20*

## Background

The urban population in African cities is expected to quadruple by 2037 (World Bank, 2012). With this increase, there will be an increased demand for water, and associated increase in wastewater production, whereas current infrastructure cannot meet the existing demand (United Nations World Water Development Report, 2017).

The Department of Water and Sanitation (DWS) reported a total of 318 non-compliant wastewater systems were monitored against the Green Drop regulatory tool in their 2016/17 Annual Report. In this context, the CSIR conducted research into

algae-based wastewater treatment. This technology was deployed in different parts of the country to assess its effectiveness and associated benefits.

The principal objective of the initiative was to facilitate the effective and efficient removal of nutrients and pathogens in effluent streams in Wastewater Treatment Works (WWTW). These contaminants pose a risk to the health and development opportunities of downstream communities and water users and threaten the integrity of water resources.

## The Challenge

Besides population growth, urbanisation, coupled with the increase in households with access to improved sanitation, is likely to increase the pressure on our WWTW. The 2014 Green Drop Assessment (which covers the entire value chain from reticulation to pumping, treatment and discharge) confirmed that WWTW in South Africa in general and especially in the rural areas are facing significant challenges, with nearly one quarter of all wastewater treatment systems in a “critical state.”



### What you need to know

- Nationally, 63% of households rated the quality of water-related services they received as 'good'. Satisfaction has, however, been eroding steadily since 2005 when 76% of users rated the services as good.
- The percentage of households with access to improved sanitation increased from 62% in 2002 to 81% in 2016. The majority of households in Western Cape (94%) and Gauteng (91%) had access to adequate sanitation, while about half those in Limpopo (57%) and 67% in Mpumalanga had adequate access.

*Source: StatsSA, 2016. Household Survey.*



## The Solution

Conventional pond systems used for wastewater treatment depend on sludge separation and natural degradation in a series of ponds. The proposed algae-based treatment process utilises the existing infrastructure at WWTW, where the consortium of algal species, which has been isolated and cultured in the lab, is introduced to the treatment ponds. The algae species work through complementary mechanisms to assimilate nutrients and create conditions for effective solar disinfection to reduce pathogens.

The main objective of the technology is to ensure that any effluent that is discharged from WWTW is free of pathogens and contains acceptable levels of nutrients, thereby reducing human health risks, protecting downstream ecosystem services, and creating economic opportunities.

*The intention is to implement a self-sustaining system that is independent of electricity or expensive chemicals and that can be effectively operated within financial and capacity constraints.*

## The case study: Brandwacht WWTW, Mossel Bay Local Municipality, Western Cape Province

Working closely with the Mossel Bay local municipality, the team identified the Brandwacht WWTW as an optimal site for pilot testing the technology in a coastal region of South Africa.

Brandwacht WWTW, close to Mossel Bay in the Eden District, is one of many waste stabilisation pond wastewater treatment systems in the Western Cape and treat domestic waste for a population of approximately 1 470 people. The system operates without mechanical aeration and the average total effluent that the system has been designed to treat is 0.5 ML/day. Brandwacht WWTW consists of 8 ponds organised so that seven ponds are operated at a time, while the other pond are cleaned. The pond system is based on a gravity system with overflow from one pond to another.

Engagements with the Mossel Bay Municipality confirmed a general increase in the effluent that enters their wastewater treatment systems (not only Brandwacht) due to an ever growing population, especially over December holidays. General governance issues are also contributing to the increasing burden on the municipality. During these engagements, the Mossel Bay Municipality agreed that long-term, sustainable solutions are urgently required to address the issue. They confirmed their key challenges include aging infrastructure, staff turn-over and limited financial resources.



## How it works

A combination of microalgae species were isolated and cultured in the laboratory for their affinity and ability to remove nutrients from wastewater. These algae were then mass cultured and transported to the Brandwacht WWTW. An operating manual has been developed to assist the operator at the WWTW to monitor the algal cultures in the on-site algal reactors and to dose the selected ponds on an ongoing basis.

Three reactor tanks (with a capacity of 5 000 L each) have been installed at the WWTW with a

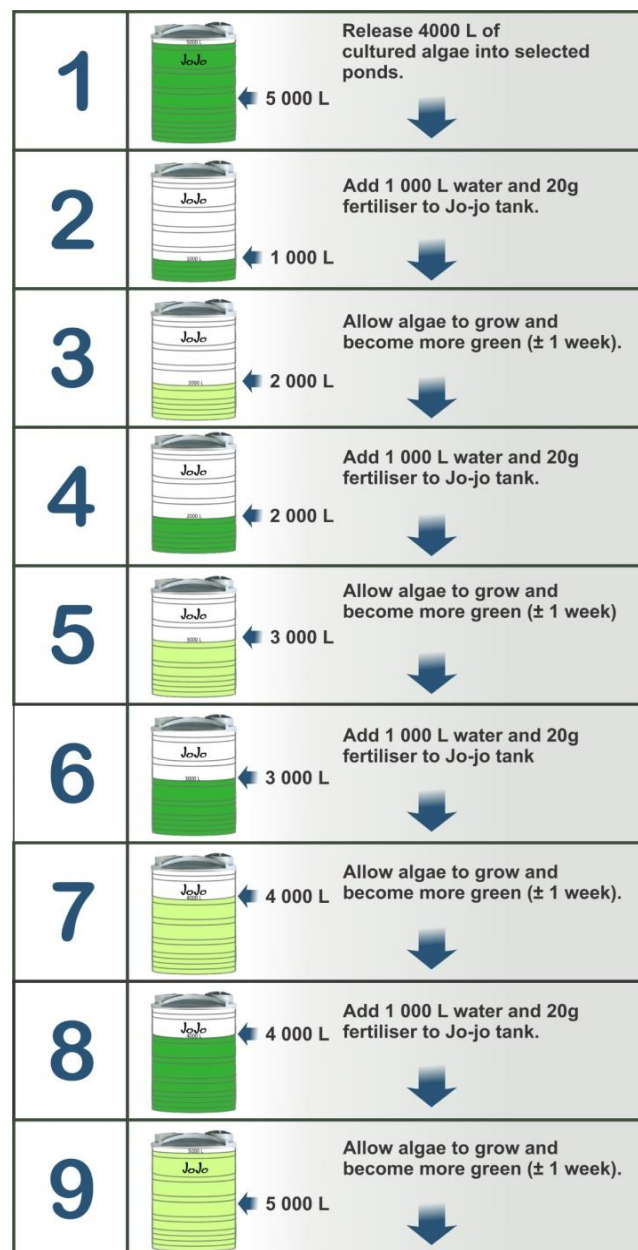
network of pipes and valves that feed the cultures to the relevant ponds. The algae successfully compete with naturally occurring algae and with ongoing dosing, ensures the effectiveness of the treatment process.



Mass culturing of algae in the laboratory



The algae bio-reactors at Brandwacht WWTW



*People have the right to have their dignity respected and protected, to an environment that is not harmful to their health or well-being, and to have the environment protected, for the benefit of present and future generations.*  
– Constitution of South Africa



## Way forward

The successful implementation of the algae-based system in the local municipalities has demonstrated the value of partnering with a municipality that has the interests of its citizens at heart. This example is also highly relevant to smaller municipalities throughout the country, where such a system could reduce the risk to downstream communities and impacts on water resources. Effective treatment of wastewater will improve the quality of water and increase the potential of downstream socio-economic activities, ultimately leading to the improvement of quality of life.

The approach brings significant opportunities for municipalities to address the backlogs in wastewater treatment, since it uses existing infrastructure with a more effective treatment process to address the risks of untreated to partially treated wastewater. While capital investments should be focussed on sustainable solutions in the long term, the algae-based treatment option will provide relief in the short and medium term, while it will continue to provide better wastewater treatment for small and medium-sized communities.

## Policy Implications

The Constitution requires all spheres of government and all organs of state to provide effective, transparent, accountable and coherent government. Engagements with local municipalities have pointed to infrastructure constraints and institutional capacity as key constraints to effective wastewater management, but have also highlighted uncertainties in responsibilities, decision making and information flow as contributing factors.

Data on wastewater generation, treatment and use is an essential part of policy making. It is also needed by researchers, practitioners and institutions to develop action plans to protect environmental health or for the reuse of wastewater. Knowledge about the constituents in wastewater is crucial to protect human and environmental health. While the algae-based technical solution will facilitate the implementation of policies and regulations, cooperative governance should also be improved to expedite planning, decisions and actions to give effect to the Water Services Act and the responsibilities of local government.

*One of the human rights of every South African is the right of access to basic water supply and basic sanitation.*  
- Water Services Act, No. 108 of 1997



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