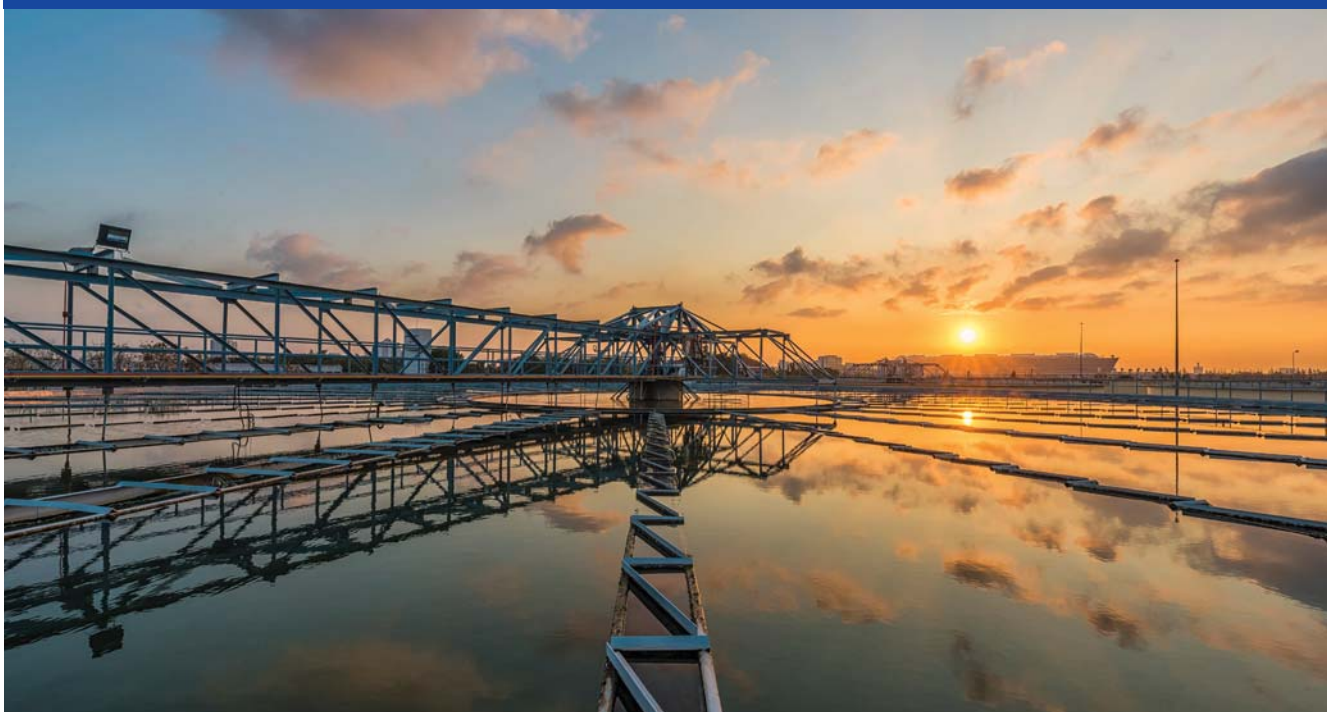
WASTEWATER

Cape Town drought places sewerage systems under pressure

What is the impact of severe drought on local sewerage systems and wastewater treatment plants? Jorisna Bonthuys reports on new research funded by the Water Research Commission (WRC) on this topic.



The ongoing drought in the Western Cape – the worst in recent decades – is not only having a significant impact on agriculture and other local industries but also impacts on wastewater treatment plants in the Cape Metropole region.

This is evident from new research funded by the WRC. The study by Gina Pocock and Hannes Joubert from VitaOne8 (Pty) Ltd considered the extent of negative impacts of the ongoing drought and subsequent water demand management on wastewater influent flows and quality. This Pretoria-based consultancy company does research and development of water treatment technologies, among others.

The researchers wanted to understand how drought affects local wastewater systems and find ways to minimise these impacts on water quality and quantity. Their study titled ***Effects of reduction of wastewater volumes on sewerage systems and wastewater treatment plants*** included a review of international case studies, as well as a local case study focusing on the City of Cape Town's sewerage system.

When the idea of the study was perceived, the impact of the drought extended far beyond the regions of the Western Cape. However, by the time that the study commenced, there was a relief after good rainfall in all the regions except the Western Cape. Most of the regions previously affected by the severe drought were rural areas where information with respect to flows and loads are not recorded, and it could not be used for a quantitative study of the impact of the drought. It was therefore decided to focus the study on the Western Cape, Joubert points out.

The City of Cape Town, in particular, has been under tremendous pressure because of the ongoing drought. By the end of

May last year the drought had been declared the worst in a century. Climatic factors are major causes of the current situation. Other factors that have exacerbated the crisis include population growth, increased water pollution, the state of water infrastructure and its current management. These factors have resulted in the lowest dam levels for the Western Cape ever recorded. The current crisis requires innovative ways of thinking about water resource management in the region, the study highlights. This includes looking at water quality and quantity in sewerage systems.

Very few such studies have been conducted on this topic, with most of the information available emanating from research done in California during the severe drought experienced there in the 1970s. Local conditions differ, highlighting the need for appropriate local guidelines to deal with drought impacts on wastewater treatment works.

The researchers, therefore, reviewed water quality monitoring data from local plants to determine flow and quality changes over the last five years. They also considered how efficient the disinfection systems are under reduced flow conditions and conducted interviews with plant managers and municipal infrastructure managers. They used data from nine wastewater treatment plants in the Cape Metropole area. Reductions in flow due to water restrictions during the study period (July 2016 to June 2017) ranged from 17% to 52%. At a time the region was under level 4b and level 5 water restrictions.

It appears operational challenges experienced by local plants were similar to those experienced internationally. In terms of the raw water quality impacts, the concentration of wastewater parameters, notably the chemical oxygen demand and suspended solids, increased proportionally to the reduction in flow in most cases.

The local case study had some contrary findings to global studies on the topic. There was a reduction of the flow in all the plants studied. In the international case studies, there was also a decrease in plant loading in some cases, which was attributed to solids deposition in the sewers. "While the plant loading in terms of the chemical oxygen demand and suspended solids showed a decrease in most cases, there was no evidence of solids settling or degradation of organic material in the sewers," Pocock points out. This is most likely due to all the sewers being reticulated with pump stations, she says. The decrease in loading was attributed to reduced industrial discharge as a result of the severe water restrictions.

This finding may be specific to the City of Cape Town, according to the research. Other municipalities with gravity fed sewers or reticulated networks with large sumps are likely to experience solids deposition and anaerobic conditions similar to those seen overseas.

In general, in the international studies, plants performed better under low flow conditions in terms of compliance, mainly as a result of longer retention time in final clarifiers. Local plants struggled with compliance issues concerning suspended solids, chemical oxygen demand and ammonia levels. "In most cases, the local plants were already operating above their hydraulic design capacity before the drought, so the potential benefits of a reduced hydraulic load described in the international review were not necessarily realised," Pocock explains. "Even with flow reductions, three plants of the nine surveyed were still operating above their average hydraulic design capacity, and these plants showed the least impact in terms of effluent compliance. These plants may have also had less operational flexibility than those reviewed in the international studies."

The findings of the literature review revealed that conditions such as climate, integration of stormwater with sewerage and the disposal of garbage, such as kitchen waste to the sewers in the global case studies, differed from the South African conditions. Pocock highlights, "The local findings did not correlate well with those of the international studies, mostly due to lower per capita usage under normal conditions, and plants likely not having the same degree of flexibility."

In both the international and local case studies, smaller plants and plants using biofilter technology were the most affected, with larger plants with activated sludge technology being more flexible and more able to handle the increased organic load.

Plants with inherent flexibility, such as the ability to take settling tanks and biological nutrient removal systems offline during low flow conditions, and allow for the recycling of effluent within the plant to maintain hydraulic load were able to withstand low flow conditions better than inflexible systems. "Training of plant managers and operators on mitigation measures can also assist in preventing operational problems and issues of non-compliance," Pocock emphasise.

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Tree roots blocking a sewer pipe.

When blocked sewers were cleared with storm water the plants received a large amount of grit.

From an environmental and health perspective, the treated wastewater becomes a larger fraction of surface water flow when drought conditions caused lower minimum flows in rivers. This results in higher concentrations of selected wastewater contaminants, including conductivity, phosphates, nitrates, and pharmaceuticals and endocrine disrupting compounds. This may place more pressure on wastewater treatment works to comply with even more stringent discharge standards, and may in turn force stricter by-laws in the industrial water users. Pocock elaborates, "In many of the rural areas, and in particular during a severe drought, communities are dependent on natural streams to wash themselves as well their clothes and eating utensils. When the discharge from wastewater treatment plants is the only water available in the region, the risk of infections and spread of diseases may be unacceptably high. It is important for municipalities to consult with local industries and communities to communicate these risks."

The impact of reduced wastewater, especially as a result of unexpected drought conditions rather than planned demand management measures, can also be significant. Pocock explains, "Municipalities and local government are becoming more aware of the need to manage water resources carefully, with many planning the implementation of demand management strategies. The impact of reducing the wastewater volumes through water saving should not be discounted, as the costs to infrastructure and the environment may outweigh savings if necessary measures are not taken into account.

"Any new conveyance (piping, pump stations) infrastructure and wastewater treatment facilities should be designed to be flexible to allow for wider ranges in wastewater flow to prevent blockages, odour and degradation of the wastewater in the conveyance systems and operational and compliance issues at the plant. Where possible, flow reduction should be planned and phased in, whether as a result of drought conditions or demand management, to allow for the appropriate response of the operations and maintenance staff responsible for the conveyance and treatment plant infrastructure."

Pocock says it was "surprising" that so few such studies have been conducted in recent years on this topic, given the impacts of climate change and reduced rainfall in many regions. Very few issues were also reported concerning odour and blockages in the local case study. This was likely due to the sewer lines mostly being reticulated with pump stations.

"While wastewater flow reduction due to drought conditions or demand management in South Africa resulted in many of the impacts described in the international case studies, the different conditions in our case study highlighted the need for

Ponding on biofilter due to blockages.

Sludge bulking in an activated sludge reactor

the development of a guideline document that also draws from local observations and experiences," Pocock says. This was then developed as part of the study.

Although the target audience of this document is municipalities with established wastewater conveyance and treatment infrastructure, the study recommends that undeveloped and rural municipalities should also use it. Where the implications of low flow conditions on these systems can be mitigated efficiently, this may according to the researchers lead to improved Green Drop Assessments for municipalities that may otherwise fail.

The guideline could be used to develop training material for municipalities and plant operators and in awareness campaigns for engineers involved in designing new plants. "As water conserving communities move toward a reduction in system-wide wastewater flow generation, the planning, design, construction, operation, and financial management of a wastewater treatment plant must change to meet the needs of future wastewater collection and treatment facilities that serve them," Pocock says.

Smaller collection systems and flow based wastewater treatment processes may be considered in future when planning infrastructure for water conserving communities. The biological and biosolids treatment and disposal systems for these communities will, however, continue to be similar in size and capacity to the systems needed by those communities that are not conserving water.

In future, local wastewater treatment facilities may also feed more water reuse plants that need predetermined effluent quality. This may impact the design of any proposed reclamation plants, the study highlights. Water reuse is likely to become more prevalent in many municipalities going forward, with some already having implemented this, or at feasibility stage.

And while water-savings or restriction programs are expected to result in some reduction in wastewater flows, they are not expected to reduce the mass of pollutants discharged. The effect of a water conservation programme initiated during the life of the plant will be to reduce expected flows while still retaining the expected pollutant load. In the case of new facilities, the existence of or intention for a water conservation program should be considered in the design process.

The researchers believe more work is needed to expand the database of knowledge of the impacts of more plants of different sizes and to understand the effects of low flow conditions on gravity fed sewers. Currently, information on such systems is lacking.

"Ideally, the research should be extended to include more plants from other regions with extended periods of imposed water restrictions due to demand management or drought conditions," Pocock concludes.

The final report will be available later this year.