National Science and Technology Forum

S.E.T. for socio-economic growth

A message from the NSTF Executive Director

Water services take a nosedive

In this era of sophisticated technology and extensive research of relevant issues, why is it that water service delivery can still fail in a major metropolitan area?

It's hard to think of anything but water when you're thirsty, and it's almost as hard if the area where you live has been without piped water for **ten** days and counting, in the midst of a heat wave. This is not a remote rural area, it's a northern suburb of Johannesburg, the economic powerhouse of South Africa, and one of the powerhouses of the Continent. It's close to Sandton, and the cost of living here is not cheap. This emergency is not related to climate change, or even drought. Nor is it a war. The way the City of Johannesburg (CoJ) is handling this crisis is disappointing, and the Mayor was silent for a week, until residents threatened to refuse to pay property rates, at which point he did respond, but not to address the crisis itself. The water tankers are few, not available in the early morning, and without definite distribution points.

And yet, I know that we're lucky in this area. The Ward councillors are active here, and so are the community WhatsApp groups that share information. The neighbours are kind and look out for one another. We bought this old house 18 years ago, and like most of those in the area, it has a swimming pool. The pool has been converted to a (very natural) fish pond some years ago. Right now, it acts as a reservoir, allowing our house's sanitation system to keep on functioning with the help of buckets, without sacrificing drinking water. We installed a rainwater tank some years ago and that is also serving us well for all the other purposes for which one uses water. If you want to put a positive spin on things: you can see it as being frog-marched into eco-friendly living!

How did this crisis happen?

On about 4 March there were reported problems with the electricity substation at Eikenhof, where a large water distribution pump station is located. This was reported to affect the West Rand: Eikenhof power station: Water supply severely affected (citizen.co.za), but the effects were more widespread than that. The Eikenhof substation repairs were completed by City Power late on 5 March and it was reported in the news on 6 March that it had been done successfully: Eikenhof Substation: Power supply restored (citizen.co.za). At time of writing, it is now six days later. It seems that while the electricity supply was down, and the pumps providing large areas in Gauteng couldn't function, vast lengths of the piping system ran dry, as residents continued to use water as usual and a heat wave nudged its use even higher. There were pipe leaks, and probably still are. It's long been estimated that 30% of municipal water in SA goes to waste due to leaks in the system.

When the water service was restored to most people's homes (which was fortunate indeed after several days), three reservoirs still did not recover: Linden 1, Linden 2 and Blairgowrie. On 8 March, and early morning on 9 March there was a little water in the area's pipes, but it did not last long, and then not a drop more was seen, to date. Neighbours accused each other of watering gardens with what little there was, but perhaps there just wasn't enough water in the system to supply the whole area. However, it's not inconceivable that people are illegally hoarding municipal water when it comes back onstream, for fear of it drying out again…

Why, when it became apparent that the entire system was not restored, was the reason for this not found out and communicated, even if it was a weekend?

Three very active ward councillors of an opposition party in my area had meetings with Rand Water and Joburg Water on 9 and 11 March respectively. It was confirmed on 9 March that no water was flowing through at all, and promises were made to inspect the major valves in the system. On 10 March there was no news, and still not a drop from Linden1 reservoir. On 11 March, a trickle of news from the ward councillors, still no water.

Besides poor communication, and lack of disaster management, what would help in future, or would have helped to prevent this situation? When this is resolved, what will be done to prevent a re-occurrence of this crisis?

It is stipulated by the Water Services Authority's by-laws that a minimum of 25 litres per person per day be provided for domestic consumption and personal hygiene. When there are major problems in providing this through the pipe infrastructure, alternatives must be made available. How will the City of Johannesburg ensure that it provides sufficient water in future?

Reliability, Availability and Maintainability (RAM)

Municipal water management is well understood. The expertise is taught at our institutions of higher education. There is a principle in water management called Reliability, Availability and Maintainability (RAM). According to N.J. Kiewiet and A. Telukdarie (School of Engineering Management, University of Johannesburg (UJ)) in a 2018 article: *Water Distribution System's Network Reliability, Availability and Maintainability, South Africa* (in the Proceedings of the International Conference on Industrial Engineering and Operations Management, October 29 – November 1) it says:

RAM "are three crucial subsets of a system and its operational support."

"The reliability of water distribution systems is critical in guaranteeing public safety and the continuous operation of urban activities. In this manner, careful preparation of infrastructural planning, resources allocation, maintenance, and operational activities for water distribution systems is essential."

Water makes it possible to prevent, and address, other emergencies. Potable water is essential for health, and sterile water for cleaning wounds. Clean water is also essential for children, and as we have all learnt during the pandemic, to stop the spread of infections. Flames can be doused with water, as we noted – not without amusement – in the case of the 'fire pool' at Nkandla. Not having piped water, one has to be mobile – able to walk to where there is water, or have a car available to drive. These are assumptions that are unreasonable for elderly, disabled and poor residents. Schools in our area have closed, due to the unavailability of water making it unsafe to bring the learners together.

Not to speak of businesses. Small businesses across South Africa have always had the challenge of obtaining water and electricity during interruptions of service, but again, these are not expected to be hugely disruptive in a fairly well-heeled area such as this. During such crises, business people have to purchase bottles of water, and/or run out with a bucket to find a water tanker in the street at unpredictable times and places. They have to ensure hygienic conditions for their customers, particularly at food outlets, and some operations, such as food production, require water itself.

It was the hope of the drafters of the National Development Plan (NDP) that small business would create the required jobs and save the economy. How must this happen under current circumstances of restricted access to both electricity and water?

The above article says, "Problems such as burst water pipes, poor water pressure and continuous pipe replacements compromise water security, which is being experienced, but could be prevented. *Currently [2019], the City of Johannesburg has a reactive maintenance system instead of proactive for the water distribution systems.* Developing countries like South Africa have made extraordinary strides in tending to the disparities of the past, through the provision of water. *It is unfortunate that the focus on expanding service provision has often been at the expense of maintaining existing infrastructures. This has seen the City of Johannesburg constantly controlling damages caused by aging water infrastructure."* [My emphasis]

The urgent needs to be addressed were therefore already understood in 2019, but have not been instituted.

Materials from which water pipes are made

At some stage water pipes in Johannesburg were made from cement with some asbestos as an additive to give them strength. These are generally not any longer used, but older parts of the city may still have some of these pipes underground. It wasn't known at the time, but they become brittle and when under stress, they crack and leak. Once such a pipe has cracked, joining the pipe to more modern plastic pipes is difficult, making the repair especially challenging, and a cascade of leaks across the system can be the outcome. Dry pipes also tend to crack more easily than wet pipes.

Where are the engineers?

As we at the NSTF always say when there is a disaster – where are the engineers? Did the City consult the engineers, and are they being involved to resolve the problem as speedily as possible?

According to Johannesburg Water, the Johannesburg Water Operation's department is responsible for operating and maintaining water distribution systems and mechanical equipment at water or wastewater treatment plants and pumping stations. "Work is done under the supervision of the General Manager: Operations, Bulk Waste Water Manager, Networks Manager, Technical Service Manager, *Contract Engineers* and Best Practice, Monitoring and Evaluation Manager. *The high-level structure consists of qualified engineers with over five years' experience.* Engineers are expected to ensure compliance with global standards for design and safety of products and services, and to guide efforts to ensure reliability and maintainability of equipment, processes, utilities, facilities, controls, and safety/security systems [Johannesburg Water, 2016]." [my emphasis]

Is this still the case, that Joburg Water has enough engineers with sufficient experience? How many are contracted and what is the duration of contracts? There are more questions than answers at this stage.

Expansion and human settlements

Access to essential services affects everything, including the very hope that cities in South Africa can expand to accommodate it residents with dignity and maintaining safety and health. See the recent study done for the Water Research Commission (WRC): Evaluating MEGA Human Settlements from a Water Sensitive Planning Perspective, by Hildegard Edith Rohr, of Jones Lang LaSalle (Pty) Ltd and North-West University (NWU), Potchefstroom Department of Natural and Agricultural Sciences, Urban and Regional Planning, of October 2023. The report points out that the Gauteng Province faces "a major housing backlog of approximately 687,015 units which, according to the Gauteng City-Region Observatory [GCRO], is estimated to increase by over 50,000 units each year."

"If not planned properly, MEGA Human Settlements are likely to result in satellite cities relying on *costly overstretch infrastructure networks, high levels of unsustainable resource consumption*, spatial fragmentation, and dislocation causing increased strain on the surrounding ecological infrastructure." [my emphasis]

It would appear that Johannesburg already suffers from 'unsustainable resource consumption', and the alternatives have not been explored. Some residents understandably turn to boreholes as a solution to water access, but if the drilling of boreholes is not strictly regulated and coordinated, it will have dire effects for the population as a whole, as well as for water availability in the areas of planned expansion.

The Report points out: "Water Security – Gauteng has limited natural water resources and therefore relies on a *very large and highly engineered system* called the Integrated Vaal River System (IVRS) which draws water from five different river basins across six provinces. The Gauteng Water Security Perspective (GCRO, 2019) calls for five interventions: (1) reduce water demand; (2) manage variability to prepare for drought and/or water scarcity; (3) invest in alternative water sources and tools for conservation; (4) manage water quality and limit pollution and achieve environmental goals, and (5) establish effective institutions for water security."

The cautionary note from the GCRO in 2019 above has not been heeded. Yet city expansion is urgent, as schools, clinics and housing are in short supply.

“Mega Human Settlements represents a shift in housing policy away from the RDP housing model … towards large-scale integrated human settlement development projects – ultimately to achieve Smart City developments.”

“The MEGA Human Settlements strategy is a radical human settlements delivery mechanism that seeks to yield between 5,000 and 20,000 housing units per project, either as part of an existing development cluster or as a new nodal development project. To date, 39 sites have been identified spanning over 24,000 ha of provincial land. Information provided by the Gauteng Department of Human Settlements indicates that 14 of the 39 MEGA projects are already in the implementation phase while the remaining 25 are still in the planning phase. It is anticipated that MEGA Human Settlements project will deliver over 300,000 new housing units together with a selection of complementary amenities, including but not limited to, primary schools and secondary schools, crèches, hospitals and clinics, municipal office centres, shopping centres, business facility sites, civic centres, higher order community facilities, local community facility sites, multi-modal hubs, local parks, community gardens/allotment, industrial and manufacturing zones, theme parks, hotels and convention centre.”

The Report urges the authorities to take a water sensitive approach to development. “Water Sensitive Design and Planning have been proven to improve water quality and water security. MEGA Human Settlements offer Gauteng a unique opportunity to put this to the test within the South African context.”

It is hoped that the theory and research commissioned by the WRC will pay off, and that the City will at least heed the advice of experts going forward. However, it is very concerning that the City and Johannesburg Water are failing in their maintenance of existing older infrastructure, while establishing vast areas of new infrastructure.

Research and decision support

There have of course been many studies over the years that could inform the management of urban water supply.

For example, the 2004 article: A spatial decision support system for pipe-break susceptibility analysis of municipal water distribution systems, by SA Sinske and HL Zietsman, of the Department of Geography and Environmental Studies, at the University of Stellenbosch (SU). Pipe-break theory, it says, is “a highly specialised field in civil engineering”.

Water pipe-breaks result not only in disrupting service but also in significant loss of water. “Existing decision support systems available in the field of water distribution system maintenance mainly focus on leak detection and pipe rehabilitation/replacement strategies. These existing systems, however, do not address the actual causes of pipe-breaks.”

A model was developed for pipe-break occurrence and has been tested and calibrated successfully (Sinske, 2002) by comparing the model results with the actual pipe-break occurrence data collected and made available by the Paarl Municipality, Western Cape. The model, called the SDSS, has “special functions and operations to support the following pipe-break susceptibility analyses, viz. pipe age, airpocket formation and damage to pipes by tree-roots.”

I do not know whether this model, or similar ones, are currently available for the management of the Johannesburg water system, but they ought to be. The point is that if such specialised modelling is possible to assist municipal managers, it should be utilized as a matter of urgency. Although pipe breakage is not the original cause of the current crisis, leakages are frequent across the city, and often it takes very long for them to be repaired. So they aggravate disasters such as the current one.

Finally – will public perceptions change?

The Water Services Barometer Study 2022 (User perceptions of the current provision of water services in South Africa) concluded that consumers living in metros are still more satisfied with their

municipalities' water services than consumers in other urban areas and rural areas, and believed they received better service with safer tap water and less interruptions. However, the proportion of consumers who held such positive views has dropped substantially since 2015. For example, the perception that water supply has become less reliable: In 2015, 82% of consumers in Metros and other urban areas said that they seldom (less than once a month), or never, experienced interruptions in their water supply. In 2022, this figure dropped to 67%. I wonder whether public perceptions in Johannesburg are now taking a sharp turn for the worst as this article is being read, due to this past week's fiasco with Johannesburg Water?

Conclusion

Service delivery problems, with water in particular, are hardly new to South Africa. From one perspective, it is simply my residential area's turn to go without water. However, it's hard to avoid concluding that many years of neglect and mismanagement have culminated in this particular and localised crisis. The occurrence of service delivery crises seem to be more frequent and wide-spread. The electricity crisis causes crises in water provision. Crises in both these key areas are responsible for more dire effects, impacting health, safety, education and well-being.

It is urgent that ample numbers of experienced engineers are appointed to manage key aspects of metropolitan areas. Well-trained engineers are able to identify the problems and causes of disasters early-on, and work on effective solutions. It is advisable that South African cities should also attract young expertise in data and computer related fields, so that 4IR technologies can be deployed to aid decision making, and ongoing repair and maintenance efforts could benefit from semi-smart systems. Expansion of city areas should only be done with careful planning of the provision for water and sanitation.

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- Denis Hunt, for his knowledge about material for water pipes in Johannesburg

For further reading:

- Choosing the Right Pipe Material | WaterWorld
- Chapter_09_Vol_IIwatersupply.pdf (csir.co.za)

The opinions expressed above are those of the Executive Director, Ms Jansie Niehaus, and do not necessarily reflect the views of the Executive Committee or members of the NSTF.