WaterSOURCE



City and Enterprise Briefs

WaterSOURCE

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About this document

This document brings together a series of city and social enterprise briefs that document efforts taken to tackle water management in South Africa, organised around the five circular economy strategies framing ICLEI Africa's WaterSOURCE project: Recover, Regenerate, Reduce, Reuse, and Rethink. Each brief is based on interviews with the practitioners and officials directly involved, and is intended to capture not only the technologies and approaches used, but also the institutional, financial, and community conditions that made them work.

The case studies are deliberately diverse in scale, geography, and sector, ranging from a Metro's repair systems to a single riverbank, and from a public-private partnership (PPP) to a decentralised water kiosk in a rural village.

Contents

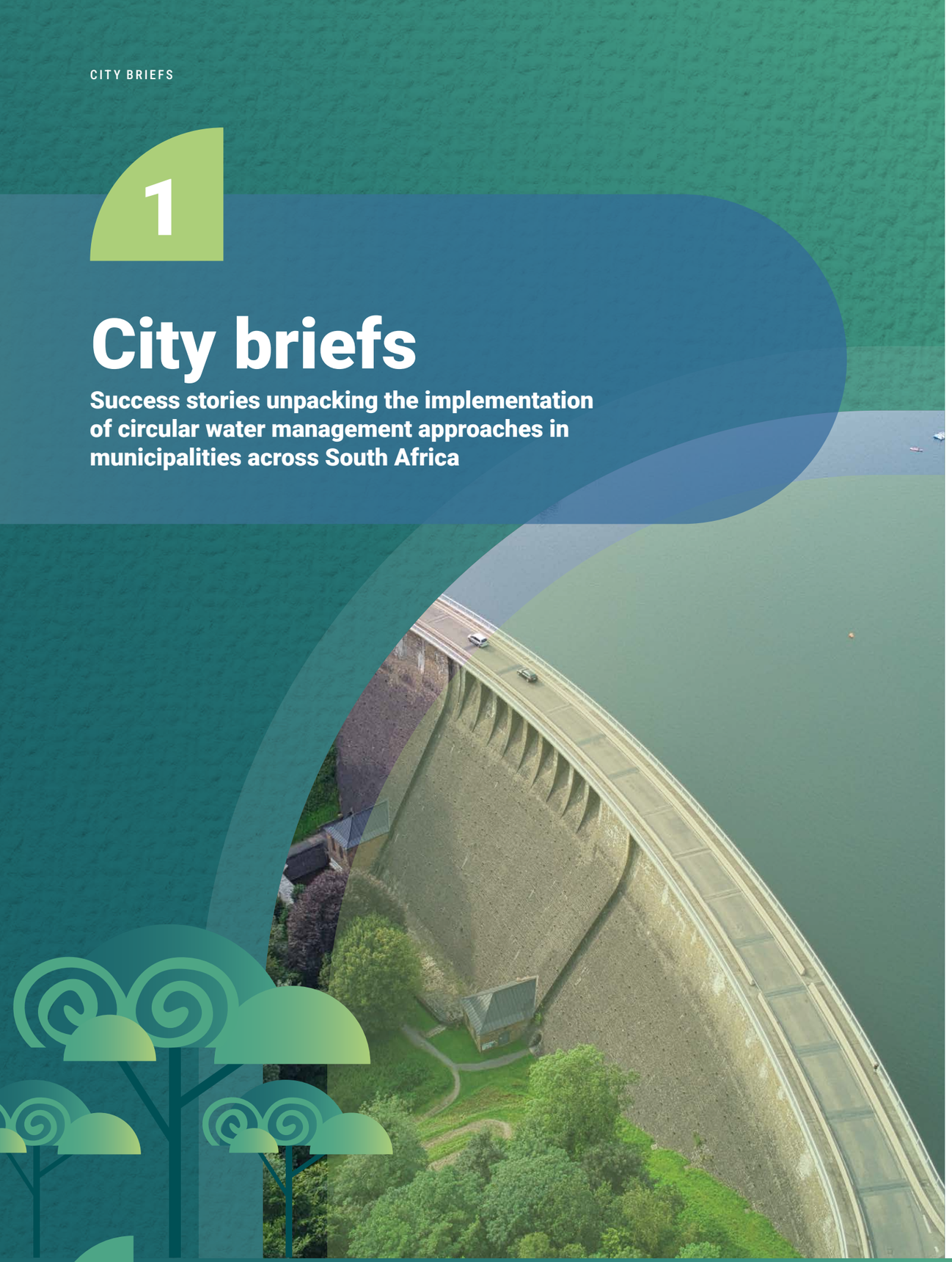
1. **City briefs** 02
2. **Social enterprise briefs** 08
3. **What this means for circular water in South Africa** 24

References 50

1

City briefs

Success stories unpacking the implementation of circular water management approaches in municipalities across South Africa



1.1. Recover: Cape Town

Recovering lost water through data-driven asset management and repair systems

The City of Cape Town has built one of South Africa's most advanced municipal approaches to recovering water lost through network failures, leaks, and burst pipes. The City draws on three data streams: customer complaints, network sensors, and work order data. This is supported by a technical operations centre, asset management, pressure management, data collection driven by a custom-built mobile field application (RIMA), and supporting spatial dashboards. These data sources can be assessed together to identify and triangulate problems in real time and deploy the right team to the right location; however, they are not yet fully integrated across the City's Enterprise Resource Planning (ERP) system and currently require some manual effort to link.

Much of the City of Cape Town's system traces back to the response required by the 2000[1] drought and the 2017-2018 "Day Zero" drought, when the value of every drop became viscerally apparent and conventional approaches to water and asset management proved inadequate. The suite of tools now underpins how Cape Town reduces non-revenue water (NRW), manages response times, and informs longer-term infrastructure decision-making.

Context and motivation

The City of Cape Town's approach to water recovery emerged from a confluence of pressures. Although the City had consistently maintained NRW loss around 13-15 per cent since the 2000 drought[2], the water-sensitive region's limited supply forced the City to double down on reducing losses from burst pipes and leaks.

Two parallel motivations drove the development of the recovery-focused approach. The first was operational: with more than 11,000 kilometres of pipeline[3] to manage and mostly reactive maintenance, the City needed better data to prioritise interventions. The second was administrative. Before digitisation, the water department was processing up to 300,000 paper job cards per year, creating a substantial administrative burden. The paper-based system also risked under-recovery and missed opportunities to capture critical asset performance data. The existing system tracked notification closure and cost recoveries rather than actual resolution time, so it did not support measuring municipal responsiveness.

Following the 2017 drought, a technical assistance grant from the UK Foreign and Commonwealth Office, delivered with PwC as consultants, funded the City's first "data-driven asset management" project. This focused on two high-cost assets: mini-substations (electricity) and pressure management valves (water). This was the foundational moment when the City began asking whether newer data feedback could replace blunt, rules-based decisions about when to repair infrastructure that is mostly buried underground and difficult to inspect.

Since the 2017 drought, the City's latest performance report recorded NRW at 23.9 per cent in September 2025, against an annual ceiling of 29 per cent.[2]



RIMA

The Reactive Incident Management Application (RIMA) is the operational backbone of the City's broader efforts to digitalise city processes (including recovery functions) and reduce the administrative burden on enforcement officers. Initiated in 2016, it has since evolved through three versions:

1. **RIMA 1:** A basic notification-based mobile app (only transacting via notifications), still active and used by the City's water inspectors (monitoring contraventions, high water users, and alternative water source applications).

2. **RIMA 2:** This version has enhanced functionality, captures more information, links to the notification, and is work-order-based, enabling it to pull financial information at the same time and improve cost recovery.

3. **RIMA 3:** The current version features intuitive design, structured prompting, measurement of travel time and distance, and business warehouse reporting that feeds directly into National Treasury reporting and the City's scorecards.

RIMA is hosted on smart tablets and lets field teams record when work stops because an area is volatile or requires law enforcement support. The City uses a Samsung Tab S5, which also lets teams take and upload photographic evidence to the Systems, Applications, and Products in Data Processing (SAP) platform. Field teams capture photographs, structure feedback, and record timestamps directly on site, eliminating the administrative trip back to the depot. This provides an evidential trail when residents escalate complaints alleging no work was done.

In a recent batch of 48 customer disputes, the City provided adequate feedback on 40 cases directly from the system. RIMA was developed internally as a SAP mobile application (SAP is the City's business solution) for field-based data capture and reporting. The Corporate Services Department supports City departments with maintenance and management of SAP systems and mobility solutions.

During COVID, the City developed a "lite" version of the app, allowing branches to operate paperlessly when staff were dispersed, isolated, and without access to office equipment.

Pressure management and leak detection

The City radically expanded its pressure management system during the drought.[4] The drought increased the complexity of managing the water distribution network, as growing water scarcity placed greater emphasis on the efficient use of available water resources. As a result, the City applied novel pressure-management approaches to reduce losses and maintain supply. By splitting the network into zones with variable pressures, the City reduced overall pressure, detected anomalies earlier, and substantially reduced the burst rate. Together, these measures reduced demand and bursts, helping address day-zero challenges.

The City has also established a control room that hosts the Ignition Web-Based Platform, integrating Supervisory Control and Data Acquisition (SCADA) data from various systems into a central platform. One recent initiative developed through this platform is a dashboard for pressure management zones. The new operational dashboard consolidates data from these zones and is intended to support near-real-time anomaly detection, allowing operational teams to respond more quickly to potential failures. The early alarm detection functionality is not yet live, with further testing currently underway.[5]



Spatial dashboards and supporting tools

The City's internal data science unit has built several supporting dashboards, mostly for operational rather than public use. A drill-down notification tool lets staff filter by department, complaint code, suburb, or section to identify hotspots, while heat maps visualise the top complaint types per suburb. A notification dashboard tracks recurring faults at the same location and prompts deeper investigation, while daily admin performance reports track who closes notifications, within or outside the target. This has created a friendly competitive dynamic that has improved closure rates. Finally, a service alerts platform publishes confirmed burst pipes to the City's website and pushes them to community groups, including maps of the affected areas and estimated restoration times.

Public-facing dashboard tools remain limited. The supply-demand-dam-levels service alerts platform sends weekly updates to residents and was instrumental in drought communication. It is the main resident-facing platform.

Results and impact

While no single approach produced a clear, isolated outcome, several measurable improvements emerged. These are summarised in the table below:

INDICATOR	BEFORE	AFTER
NRW	± 13 per cent (already below the international benchmark)	Maintained below benchmark
Burst rate (per 100 km)	± 20-25 per cent	Significantly reduced due to pressure management
C3 system	• Inability to achieve target closure rate of C3 notifications • Less than 80 per cent of notifications closed within 29 days	91 per cent of notifications closed within 29 days
Burst pipe response time	Less consistently tracked – unable to obtain reliable data	• Average Response: Within 7.92 hours • Target: 80 per cent response within 48 hours (formal Indicator) = Achieved (and measured) 94 per cent FY2026 period
Cost recovery on work orders	Assumed under-recovery	"Almost on par" with planning due to improved electronic reporting as opposed to manual reporting
Admin trips to the office	High paper burden	Largely paperless from digital platforms like RIMA

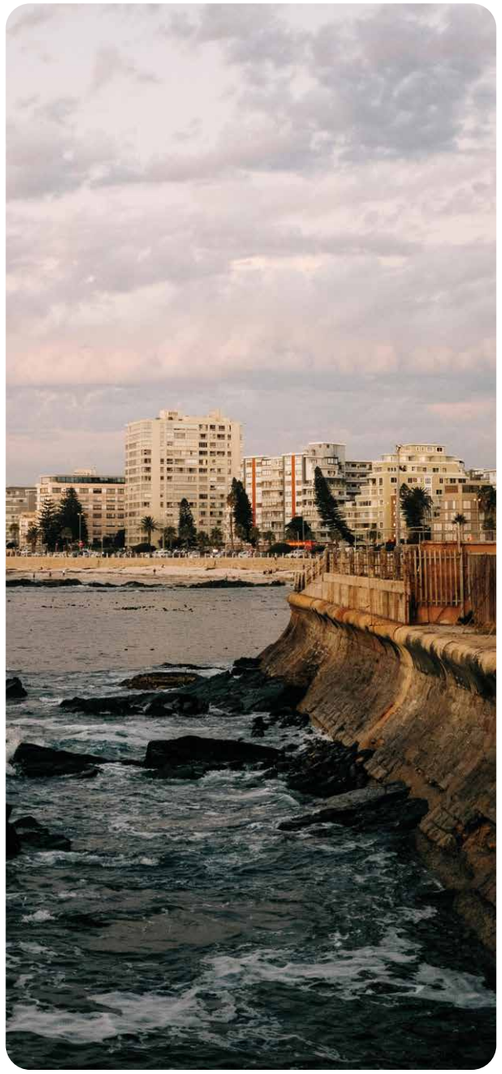
Enablers and challenges

"Don't let a good crisis go to waste."

Several enabling conditions shape the approach's success. The 2000 drought and Day Zero in 2017 were the main catalysts, creating political space for pressure management, tariff reform, and digital investment that might otherwise have been blocked. In the years since, electricity and water have "slipstreamed" each other on financial and asset management reforms, with each department's progress opening the door for the other.

The water department's relative agency, with utility-like autonomy and its own revenue base, has allowed it to make independent business cases for technology investment. Operationally, the co-located technical operations centre brings customer complaints, sensor feeds, and work order data into a single space, enabling staff working side by side to triangulate in real time. At the corporate level, a city-wide executive director task team on asset management has raised the discipline's profile across departments. Additionally, institutional muscle memory built through drought-era partnerships with provincial governments and community groups has carried over into successive pandemic and energy crisis responses.

In contrast, several difficulties persist. The most structural is system integration between finance, spatial data, and asset management. The data layers do not overlap seamlessly, which can reduce data fidelity. Integration with the Roads Infrastructure Management, which manages drainage and road reinstatement after water repairs, remains incomplete despite the obvious operational overlap. Informal settlement reporting presents a different challenge: complaint clustering paradoxically shows more complaints in affluent suburbs, partly because location data in informal settlements pings to the nearest formal address rather than the actual fault. WhatsApp pin-drops have not resolved this due to cell tower density limitations. Field operations face their own constraints, with connectivity dropping in some areas and tablets seen as theft-attractive devices in volatile zones, limiting their use precisely where they are most needed.



Beyond system challenges, officials worry about the fragility of public trust. The absence of a repeat drought appears to have weakened the population's perception of urgency; investments into infrastructure stop-gaps like desalination are being received as if no drought ever happened, and recent tariff disputes (the City has been challenged in court by five bodies in the last budget cycle) may erode the historically high collection ratios that have funded these investments.

Replicability for other municipalities

1. **Start with process, not technology.**
   a. RIMA succeeded because it was built around defined operational processes; the technology was configured to fit the process, not the other way round.

2. **Bring users along from the start.**
   a. Skipping user-centred design at the outset cost the project goodwill and functionality that had to be retrofitted.

3. **Secure Information and Communication Technology (ICT) buy-in.**
   a. Departmental innovation that runs ahead of corporate ICT creates tools that integrate awkwardly with city-wide systems.

4. **Use crises wisely.**
   a. The droughts created political space for reform; the institutional habits formed then have now outlasted the crisis itself.

5. **Make data informative, not just available.**
   a. Cape Town's experience suggests the gains come less from raw dashboards and more from structured field feedback, evidence-based decision-making, and operational accountability built into daily routines.

6. **Manage the City as a system**
   a. Integration with roads, electricity, law enforcement, and informal settlements infrastructure is essential. The water network does not fail in isolation.



1.2. Regenerate: uMngeni

Regenerating ecological infrastructure through citizen science, wetland rehabilitation, and community stewardship

The uMngeni catchment has become an enduring example of community-led ecological restoration. Centred on the Mthinzima wetland and the Mpophomeni township that drains into it, this initiative combines three reinforcing strands of work:

1. long-running citizen science monitoring of rivers, streams, and wastewater infrastructure by trained community members;
2. the physical rehabilitation of the Mthinzima wetland to restore its function as a natural filter before water from the Mthinzima stream reaches Midmar Dam; and
3. a growing body of work to formalise river monitoring as a recognised green economy occupation.

The initiative demonstrates how regenerating ecological infrastructure depends as much on community stewardship and inter-institutional partnerships as on engineering works.

Context and motivation

The Mpophomeni township, located in the uMngeni Local Municipality (UMLC), KwaZulu-Natal, sits within the Mthinzima catchment in the uMngeni River system, upstream of Midmar Dam, a major regional source of drinking water. By the late 2000s, the township faced severe sanitation failures: overflowing sewer manholes discharged raw sewage onto streets and school routes (in some cases for as long as eight years), and most of this untreated wastewater drained into Midmar Dam. The Mthinzima River itself had been channelised, and the wetland drained, for agricultural purposes. Consequently, where the wetland would historically have buffered and filtered wastewater flows, an artificial channel along one side of the wetland diverted polluted water directly from the wetland into the dam.

Against this context, a meeting convened in 2009 brought together concerned residents, the uMgungundlovu District Municipality (UMDM), Duzi–uMngeni Conservation Trust (DUCT), the Wildlife and Environment Society of South Africa (WESSA), Midlands Meander Education Project (MMEP), and GroundTruth to address the interrelated issues of failing built infrastructure and degraded ecological infrastructure. This meeting led to a series of community education and monitoring programmes driven by volunteer residents of Mpophomeni. This work has endured, in various forms and under varying funding and partnership arrangements, for over a decade and a half.

The citizen science model: from Enviro Champs to Amanzi Champs

The first generation of community monitoring commenced in 2011 through a collaborative partnership between Mpophomeni community members, UMDM, DUCT, MMEP, and GroundTruth. Through the Enviro Club, the MMEP taught children and adults alike about wetland ecology and wastewater management. In addition, the Mpophomeni Drama Group performed educational street theatre at taxi ranks and other public spaces, using humour to broach uncomfortable topics such as what not to flush down a toilet. Building on this educational foundation, community volunteers, known as Enviro Champs[6], conducted a door-to-door awareness-raising campaign. During this phase, GroundTruth developed a citizen science programme and inexpensive, accessible monitoring tools. Enviro Champs were trained to use these tools to measure water quality using the mini stream assessment scoring system (miniSASS)[7]. This involved taking monthly readings and clarity tube samples across the river, identifying and monitoring overflowing manholes, recording GPS coordinates, and reporting results to UMDM.

Over the years, funding for the Enviro Champs initiative has been piecemeal, coming from DUCT, the UMDM Environmental Impact Program, the South African National Biodiversity Institute (SANBI), and the Presidential Employment Stimulus. Before formal stipends became possible, early funders provided airtime and data as in-kind support for citizen reporting. During these funding gaps, a core group of citizen scientists has continued monitoring the river. Today, these community members call themselves Amanzi Champs to reflect a more institutionalised arrangement: uMngeni-uThukela Water, the regional water board, employs a core group of 12 citizen scientists, with a parallel group of volunteers working alongside them.

Wetland rehabilitation: hard and soft infrastructure

The data collected by the Enviro and Amanzi Champs proved integral to securing institutional support for the rehabilitation of the Mthinzima wetland. UMLC, UMDM, and uMngeni-uThukela Water[8] funded this work, based on rehabilitation plans drawn up by GroundTruth.[9] The plans were put out to tender for implementation. GroundTruth oversaw work in the lower wetlands, and a second contractor oversaw the upper wetlands.

The upper wetland has been rehabilitated to receive overflow from the local wastewater treatment works (WWTW) and direct it under a bisecting road into the lower wetland. Rehabilitation efforts in the lower wetland combined modest hard infrastructure with more extensive soft infrastructure that intersects and disperses water flows from the Mthinzima stream inflow point through the wetland landscape. The hard infrastructure comprised four concrete weirs installed in the river channel to slow inflows, with the co-benefit of reducing E. coli levels through aeration and sunlight exposure. Flood-out points were built into each weir to push water out into the wetland at high flows. The remaining rehabilitation work took the form of soft infrastructure, built by community members through the Working for Wetlands programme. Community members dug earthen berms by hand to cut off the artificial diversion channel in the lower half of the wetland. This, paired with filling in historical drains in the centre of the wetland, helped redistribute water flows across the wetland's surface so vegetation and soil could absorb and process excess nutrients from wastewater.

To track ecological responses to these rehabilitation measures, GroundTruth has further trained Amanzi Champs in wetland monitoring. Although limited funding halted rehabilitation progress at approximately 60 per cent, before the final phase could be implemented, subsequent monitoring has demonstrated considerable success, namely increased water levels and nutrient loads (reflecting improved diversion and treatment of polluted wastewater in the wetland system) as well as the establishment of wetland vegetation species (indicating successful absorption and storage of excess nutrients in the soil).

Linking citizen science to municipal action

Collectively, the Enviro and Amanzi Champs initiatives have produced a body of long-term, community-held environmental data covering nearly 15 years in a single catchment, generated by residents with a personal stake in the water quality of their own community.

Beyond laying the groundwork for the rehabilitation of the Mthinzima wetland, this precedent has also driven institutional change in the nearby informal settlement of Shiyabazali, located on the edge of the uMngeni valley near Howick, where the local WWTW was discharging non-compliant effluent directly into the uMngeni River. A single resident, using a

clarity tube[10] and supported by GroundTruth and DUCT, monitored the discharge's turbidity over time, building an independent dataset that challenged municipal compliance reports. Within months of a subsequent meeting with the mayor and the municipality's environmental manager, wastewater treatment improved markedly and has remained compliant since.

This experience demonstrates the potential for citizen science to fill gaps in formal municipal reporting. Recent master's research, conducted in collaboration with GroundTruth, has examined how citizen-science data can supplement the national Green Drop, No Drop, and Blue Drop reports, where official datasets are often incomplete or inconsistent with conditions on the ground.

Results and Impact

INDICATOR	STATUS
Years of continuous monitoring	2009-2011 (informal) 2011-Present (formal)
Active Amanzi Champs	12 employed by uMngeni-uThukela Water, supplemented by volunteer Enviro Champs
Mthinzima lower wetland rehabilitation	~60 per cent complete; higher water levels, increased nutrient loading, positive vegetation response
Howick WWTW compliance	Improved within months of citizen monitoring intervention; sustained since
Published research outputs	Multiple peer-reviewed papers and a recently completed MSc documenting the outcomes of citizen science initiatives



Enabling factors and governance

Several conditions have enabled the work to persist and deepen over time. The presence of a long-standing local non-profit ecosystem, with DUCT and WESSA working closely with GroundTruth and the MMEP, provided continuity through funding gaps and a shared base of relationships with residents. This helped to build the community-driven knowledge and evidence base needed for institutional actors like UMDM, and later uMngeni-uThukela Water, to recognise the value of community-generated data and directly fund further citizen science work.

Linked to this, the personal commitment of long-standing Enviro Champs and Amanzi Champs, several of whom have continued monitoring with or without compensation amid varying levels of institutional support, has been critical to building long-term datasets. This reflects the value that communities place on the quality of their environment. Throughout, participants' underlying motivation has been direct: visible health impacts on their own families and the recognition that water quality problems translate into missed workdays, health risks, and lost income. Much of this awareness was built through extensive educational work preceding training in river and wetland monitoring.

In monitoring and rehabilitation, accessible tools lowered the technical barrier to entry. Working for Wetlands also used employment-intensive "soft infrastructure" methods to align ecological rehabilitation with local livelihoods, rather than treating these as competing aims.



Challenges and limitations

The most persistent challenge to sustained community-based wetland monitoring and rehabilitation has been varying levels of institutional support and piecemeal funding. Although uMngeni-uThukela Water currently employs the Amanzi Champs, future funding at the required scale remains uncertain. This reflects a broader need for greater integration of community-based stewardship into formal environmental management systems. Specifically, the Quality Council for Trades and Occupations has not yet recognised citizen scientists like the Amanzi Champs as a formal occupation. This constrains the formalisation of training, career pathways, and consistent recognition across municipalities.

The ecological response to rehabilitation work also poses a complication: the lower wetland has been colonised by large stands of Persicaria senegalensis, an annual plant that absorbs nutrients efficiently but, when it dies and decomposes, deposits those nutrients into the soil in bioavailable form. Over time, this could saturate the wetland's soil and convert it from a nutrient sink into a nutrient source, with potential consequences for downstream water quality in Midmar Dam. Further research is needed to study water–plant–soil dynamics and consider options for harvesting and composting nutrient-absorbing plant species to support the local economy.





Replicability for other municipalities

The Mthinzima experience offers several lessons for other municipalities seeking to implement similar models. Although citizen science is not a substitute for institutional water management, it can fill data gaps that municipalities themselves often cannot, particularly in informal or under-serviced areas where formal monitoring is patchy. However, sustained results depend on long-term institutional anchors. Where funding sources and amounts vary, a stable coalition of partners (in this case, a core group of citizen scientists, a network of non-governmental organisations (NGOs), the local water board, and local and district municipalities) supports the continuity needed.

Long-term partnerships matter because ecological rehabilitation is not a one-off intervention. Wetlands continue to respond to inflows over years and decades; continued monitoring is vital to understand how the system changes in response to various interventions, including the possibility of unintended consequences such as nutrient saturation.

Another crucial success factor has been designing the programme around community needs alongside ecological outcomes; for example, through accessible monitoring tools, soft infrastructure relying on local labour, and tangible compensation. This has produced better data and more sustainable stewardship than either would alone. The resulting long-term dataset has proven immensely valuable in building the case for further investment in water, as shown by translating data into action to improve wastewater treatment compliance in Howick.

Finally, the success of citizen science in uMngeni shows that residents value taking an active role in their environment's health, which is directly connected to their own health and their ability to work and earn an income. This personal investment, more than any single funder or programme, has sustained the progressive monitoring of the uMngeni River and rehabilitation of the Mthinzima wetland.

1.3. Reduce: Rustenburg

Reducing NRW through infrastructure renewal, smart metering, and inter-departmental reform

Rustenburg Local Municipality (RLM) in the North West Province has run a multi-pronged programme since 2024 to reduce NRW losses. The approach combines accelerated replacement of aged asbestos cement (AC) pipelines; a smart metering programme procured through National Treasury's RT29 transversal contract targeting unbilled areas; renewal of valve and pressure-reducing infrastructure; and active enforcement campaigns such as "War on Leaks" and the Mayor's "City at Work" programme. These are supported by operational systems for complaint tracking, water balance accounting using the International Water Association (IWA) water balance system methodology, and emerging cross-departmental work with the municipal finance and billing function. While the programme is still relatively young, early results show a year-on-year reduction in NRW from 51.7 per cent to 48.6 per cent, and officials reported fewer water quality complaints in renewed zones.

Context and motivation

Rustenburg's NRW challenge stems from two long-standing structural issues.

First, much of the municipality's ageing infrastructure includes AC pipes installed in the late 1990s, now well past their viable service life. These aged AC pipes not only burst frequently but also degrade water quality, as deposits accumulate on the internal surfaces over years of use. Investigations repeatedly find significant internal byproduct deposits in pipeline lines, leading to discoloured water reaching residents and reduced water quality.

Second, RLM serves a complex mix of urban areas, villages, and informal settlements, with widespread illegal connections in informal settlements and old water meters that have not been replaced in years, providing inaccurate data; however, the municipality is targeting the replacement of these meters.

Together, these drove NRW to high levels, with the 2024/2025 financial year recorded at 51.7 per cent, equating to a daily loss volume of 64.1 megalitres (ML). Recognising the municipality's high NRW losses, recurring bursts, and water quality complaints, it launched a coordinated NRW reduction programme in the 2024/2025 financial year. The municipality initially focused on replacing ageing infrastructure, starting in the town centre, where high system pressures caused frequent bursts.

How the programme works

Rustenburg's approach to reducing NRW operates across several interlocking workstreams rather than a single platform or dashboard.

1. **AC pipeline replacement**
   The flagship intervention is the systematic replacement of AC pipelines with HDPE and PVC alternatives, which have a design life of 50 years or more[11]. Work is sequenced ward by ward, starting with the town centre where pressure and burst rates were highest. Approximately 70 per cent of the town centre's replacement is now complete, with projects in Phatsima and Monnakato beginning in March 2026. The programme is scheduled to run through to 2027 in its current form, with extensions intended to bring the municipality to a target of approximately 80 per cent of the network being AC-free by 2030.

2. **Smart metering (RT29 programme)**
   Smart meters are being installed in residential properties[12] and at key network points, with two main aims: replacing old, unreliable meters that have not been changed in years, and bringing previously unbilled areas (including some informal settlements such as Boitekong) into the metering system so that consumption can be monitored. The municipality is installing magnetic flow meters on bulk pipelines for the same monitoring purpose. Standpipes serving water tankers and unconnected informal settlements are also metered.

3. **Valve and pressure reducing valve (PRV) renewal**
   The municipality is replacing non-functional valves, pressure-reducing valves, and isolation valves to improve its ability to isolate sections of the network during repairs and manage pressure more effectively.

4. **Operational campaigns**
   Two complementary campaigns are running alongside the infrastructure improvements. The "War on Leaks" programme deployed the water unit intensively into a specific area for a defined period (around two weeks) before moving to the next ward, allowing concentrated leak detection and repair. The Mayor's "City at Work" programme operates on a similar rolling-ward basis with political backing and visibility.

The IMQS Repair Tracking System

Repair requests and faults are managed through a system called IMQS, operated through a municipal call centre. Community members log complaints, whereby call centre operators code them by location (for example, an identifiable area such as Tlhabane district), pipe size, and material type, before dispatching the call to the appropriate water unit team. Emergency teams handle major bursts, while separate teams focus on smaller leaks at meters and connections. The municipality aims to respond to reported faults within 24 hours of a complaint being logged during operational hours. Complaints logged at night have longer response times, as field teams cannot always be reached. Once the field team completes a repair, it calls the centre to close the call, which then notifies the resident. The water unit can also access IMQS directly to monitor outstanding complaints and track turnaround times.

Data management and the IWA water balance

RLM uses the International Water Association (IWA) water balance template, supplied by the Department of Water and Sanitation (DWS), to manage and analyse NRW data. The template is used to separate revenue water from NRW and to distinguish physical losses (such as leaks and bursts) from commercial losses (such as under-metering, unbilled consumption, and illegal use). Monthly meetings are held with the billing department to compare results and develop a shared understanding of NRW reporting. Using the IWA water balance methodology, the water unit tracks billed versus unbilled water, including informal settlement meters, standpipe meters for water tankers, and bulk meters at water board offtake points. Officials acknowledge that the municipality does not yet have purpose-built NRW monitoring dashboards or metrics platforms; the IWA spreadsheet remains the primary tracking and analytical tool.

Results and early impact

Although the programme is only in its second financial year, several measurable improvements have emerged.

Beyond the headline NRW figures, officials reported a clear reduction in water quality complaints in areas where AC pipes have been replaced, and a corresponding reduction in collateral damage to roads, sidewalks, and surface infrastructure caused by frequent bursts and the associated reinstatement gaps with the Department of Public Works and Roads. The billing function has also improved, with more water flowing into the billed category rather than disappearing into losses.

INDICATOR	2024/2025	2025/2026 (CURRENT)
NRW (per cent)	51.7 per cent	48.6 per cent
Daily NRW volume	64.1 ML/day	54.8 ML/day
Customer complaints (renewed zones)	Moderate (water quality issues and pipe bursts)	Notably reduced in areas where AC pipes were replaced.

Enabling factors and governance

Several conditions have enabled the programme's progress to date. A renewed municipal focus on infrastructure renewal in the 2024/2025 financial year enabled effective budget allocation and the implementation of the AC replacement programme. The DWS has supported the municipality by providing the IWA water balance template to classify and report NRW and facilitating regular peer-learning engagements with other municipalities. Held every two to three months, these engagements give officials an opportunity to exchange experiences and learn from municipalities that have made progress in reducing NRW.

Partnerships with the bulk water boards, principally Rand Water and Magalies Water[13], are providing the necessary support. They help identify leaks and illegal connections along bulk pipelines by comparing dispatched volumes against municipal metering points, share check-meter and pressure data from plant to reservoir, and join municipal teams on the ground when tackling illegal connections.

Internally, monthly meetings between the water unit and the billing department have shifted the relationship from parallel and disconnected (where billing tracked only revenue losses and estimated meters they could not read) to one of joint accounting, with the water unit walking the billing team through the IWA water balance and the categories of unbilled, physical, and commercial losses. At least three private sector contractors[14] are supporting aspects of the NRW programme, although further details on this engagement were unavailable during the interview.

Challenges and limitations

Several persistent challenges shape the programme. The legacy of decades of misaligned metering and billing, with the water unit and billing unit operating largely in parallel, has only recently begun to be addressed. Illegal connections in informal settlements remain a prominent source of physical and commercial losses, requiring both technical and enforcement responses. The aged infrastructure backlog is substantial, with much of the AC network over 30 years old and requiring sequenced, ward-by-ward replacement rather than a quick fix. The municipality is also candid that its technological capability is still developing. As one official noted, RLM is a small and growing municipality whose technologies are "still behind"; therefore, partnerships currently play a larger role than technology in supporting NRW reduction. After-hours response times remain constrained where field teams cannot be reached, and visibility into private-sector contractor activity is uneven within the municipality itself.

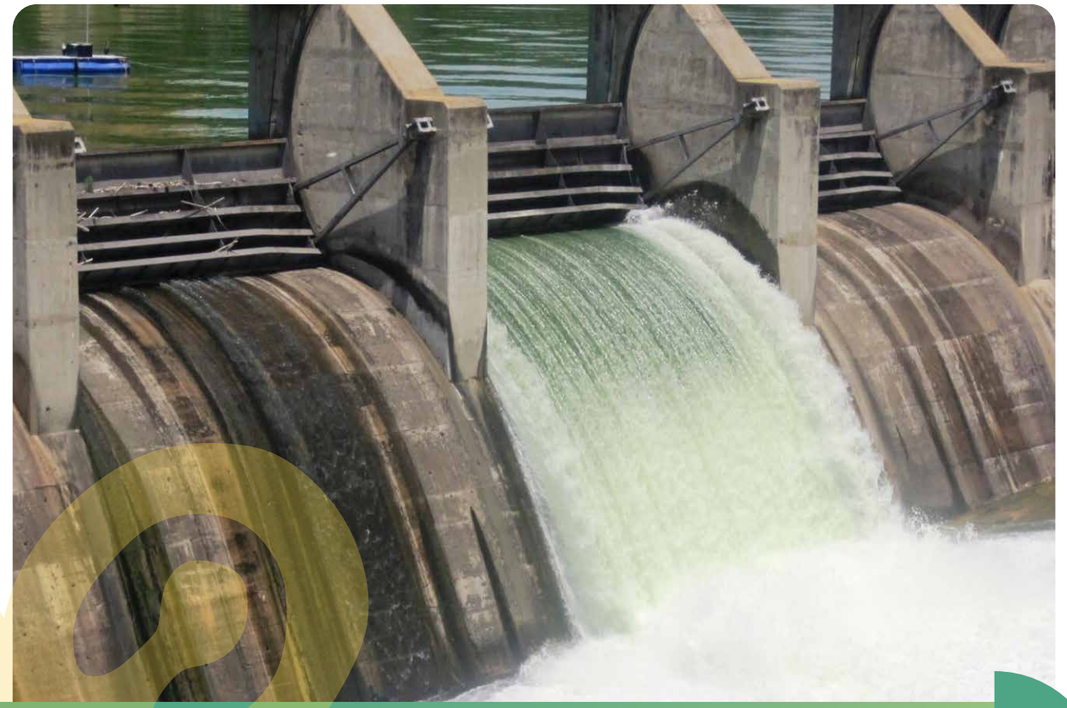
Lessons for other municipalities

RLM officials shared three principal lessons that other South African municipalities should consider when aiming to reduce NRW.

First, prioritise partnerships, both horizontally with other municipalities (through DWS-convened forums) and vertically with bulk water boards, who often have visibility into network performance that municipalities themselves lack.

Second, do not treat NRW as a water-only problem; involve the finance and billing department early and regularly, since a substantial share of "losses" originates in metering, estimation, and billing practices rather than physical leaks.

Third, in resource-constrained contexts, partnerships are likely to generate faster returns than technology investment: the municipality's technological capability is still developing, making partnerships particularly valuable at this stage.



1.4. Rethink: Mbombela

Rethinking municipal water service delivery through a long-term public-private partnership

Since 1999, the City of Mbombela Local Municipality in Mpumalanga has delivered water and sanitation services across roughly half of its supply area through a long-term, 30-year PPP with Silulumanzi, one of South Africa's[15] earliest water service concessions. The arrangement was conceived as a structural alternative to direct municipal provision at a moment when the newly consolidated municipality lacked sufficient capacity to address service backlogs inherited from the post-1994 amendments to municipal boundaries. Twenty-seven years on, the concession has become a working example of how a private operator can be embedded within a municipal governance framework. As the concession nears the end of its initial lifespan, it also speaks to the current debate over the future direction of municipal water and sanitation policy and service provision in South Africa.

Context and motivation

The City of Mbombela Local Municipality was formed by combining several apartheid-era local authorities, with territories transferred from the former KaNgwane administration in April 1994. The newly consolidated municipal council immediately faced a mismatch between its operational capacity and the scale of basic service backlogs, particularly in water and sanitation.

With National Treasury piloting alternative service delivery models, Mbombela undertook due diligence that recommended procuring a long-term water and sanitation service provider. The municipality issued an international tender, established a special purpose vehicle, and appointed Silulumanzi to design, invest in, operate, and maintain portions of the municipal water and sanitation system over a 30-year concession.[16]

Concession structure

Under the concession, Silulumanzi provides water and sanitation services to approximately 50 per cent of the municipal population, covering the urban centre of Mbombela itself (formerly Nelspruit), peri-urban growth nodes such as Pienaar and Matsafeni, and the townships of Matsulu and KaNyamazane. This includes providing 6,000 litres (L) of water per household per month, as per the national Free Basic Water policy instituted in 2001.

Operating on a source-to-tap basis, Silulumanzi is responsible for water purification, distribution, revenue collection, customer service, sewer network operations, and pre-treatment of wastewater before discharge. The company therefore has its own engineering, finance, and operations departments, with a staff complement of just over 300[17]. Its role has also evolved beyond those functions originally stipulated in the concession contract to include calculating service contributions, reviewing building plan applications, providing input on township establishment, and commenting on land-use management processes such as rezonings, subdivisions, consolidations, and special consents.

The City of Mbombela Local Municipality in turn assumes the role of the water services authority and all associated upstream governance functions: regional water planning with the national DWS, tariff approval, by-law enforcement, oversight through a concession monitoring unit, and integration of the concession's master planning into the Municipal Spatial Development Framework (MSDF) and Integrated Development Plan (IDP). With each five-year supplementary agreement cycle, Mbombela and Silulumanzi review tariffs, capital expenditure allocation, compliance, and key performance indicators. To ensure further transparency, the two entities share a common master planning approach, use similar consultants for continuity of service, and hold mutual viewing rights to certain data. The two bodies conduct quarterly reviews, with day-to-day correspondence supporting continuous, open communication.

Operational tools and customer interface

Silulumanzi operates pressure-reducing valve management systems with alarm thresholds for out-of-range performance, and appoints private contractors to undertake leak detection and pipe replacement. A digital application supports customer engagement, allowing residents to download monthly water statements, make payments, submit enquiries, and file complaints. This is supplemented by social media platforms, most notably several community-level WhatsApp groups (through which customers can contact the company and receive service disruption notifications) as well as Facebook and Instagram. Finally, Silulumanzi operates a control room staffed 24/7 and accessible by telephone, cell phone, and email.

Results and public perception

The partnership between Mbombela and Silulumanzi is credited with safeguarding water service continuity in the municipality's economic hub. Additionally, Silulumanzi holds Blue Drop and Green Drop compliance and conducts daily water quality sampling. Overall, public satisfaction with water and sanitation services has increased over time, reflecting improvements in service reliability, water quality, communication, and responsiveness to issues. As a result, the concession has been widely benchmarked, and delegations from other municipalities have visited Mbombela to understand the model and share best practices.

Challenges and limitations

Despite real gains in water and sanitation service delivery, two main challenges characterise managing and implementing such a concession agreement.

First, from a governance perspective, the varying, clearly demarcated mandates among Silulumanzi, Mbombela, and DWS can create critical bottlenecks. For example, as an external service provider, Silulumanzi cannot supplement limited municipal capacity to enforce by-laws, creating compliance issues. Similarly, bulk water provision largely falls outside the concession's scope, with DWS overseeing raw water supply and dam management. DWS is conducting a feasibility study for a new dam to address growing raw water constraints[18], a crucial requirement for Silulumanzi and Mbombela to expand bulk infrastructure and meet their service delivery mandates. At various points, poorly streamlined communication channels have made it harder to align priorities. Addressing these institutional, governance, and coordination challenges between the City of Mbombela and Silulumanzi has required ongoing collaboration and open dialogue. The City has addressed this by establishing regular review sessions, clear reporting structures, and joint problem-solving initiatives, which have helped build trust and improve operational efficiency.

Second, in operations, both Mbombela and Silulumanzi face persistent gaps in water supply and service reliability between well-serviced, formal areas and peripheral informal settlements. Demand outstrips supply, and illegal water connections on bulk water pipelines reduce reservoir inflows, with residents frequently citing inconsistent supply. Non-payment of water tariffs further threatens operational sustainability, particularly in peri-urban areas and informal settlements, exacerbating service discontinuity. Customer perception in peri-urban and informal areas, illegal connections on bulk water mains, the political sensitivity of water as both a basic right and a costed service, and the broader inheritance of a national public discourse that has at times suggested water should be free, are all recurring tensions that affect day-to-day operations and revenue stability.

Lessons for other municipalities

Looking back over more than 25 years of operation, the concession between Mbombela and Silulumanzi offers several lessons for other South African municipalities considering a PPP approach to the provision of water services.

Transparency between the authority and the operator has proven foundational, supported by regular reviews, clear reporting structures, and joint planning and problem-solving. The five-year supplementary agreement structure has enabled adaptability within a long-term contract horizon, particularly important given the considerable shifts in the regulatory environment since 1999 (e.g., Free Basic Water policy, promulgation of the Municipal Finance Management Act, and Blue Drop and Green Drop compliance). This flexible approach to problem-solving and willingness to adapt have been cited as essential to the partnership's success. The Mbombela-Silulumanzi partnership further demonstrates that a concession works best when it covers full source-to-tap operations, rather than narrow functions, and when it is paired with an active monitoring body that meets with the operator on an ongoing, rather than purely contractual, basis.

Finally, the current concession lets the service provider ring-fence water revenue to fund its work. However, for the model to be financially sustainable in the long term, the municipality must also share in the operating returns. The municipality can then reinvest these returns in capital and operational expenditure, supporting the ongoing development of water and sanitation infrastructure and reliable service delivery.





CITY BRIEFS

1.5. Reuse: Siza Water – KwaDukuza

Reusing treated wastewater for potable supply through a direct reuse plant

The Dolphin Coast concession (WSP), forming part of the iLembe District Municipality (WSA), serving the areas of Zimbali, Ballito, Chaka's Rock, Salt Rock, Tinley Manor, Shakashead, Umhlali, Shakaskraal, and Etete is home to one of South Africa's operational direct potable reuse plants, where treated municipal wastewater is recycled directly into the potable water supply.

Siza Water, the concession holder under a PPP with the local water services authority, designed, built, and operates the direct potable reuse plant, which was commissioned in 2016[19] in response to the regional drought that began in 2014. The plant draws final effluent from the existing sewer treatment works and passes it through a multi-stage advanced treatment process modelled on Singapore's reuse system[20]. The plant then blends the treated water with potable water from the conventional bulk supply in the final reservoirs before pumping it into the distribution network.

At full operation, it supplies approximately 3.6 ML per day[21] and has served as a drought intervention, an emergency continuity asset during the 2022 KwaZulu-Natal floods, and a financial saving against the cost of bulk water purchases.

Context and motivation

By 2015 the drought had brought the Hazelmere Dam, the bulk water source to the concession area, to roughly 26 to 27 per cent of capacity, with projections that at 19 per cent the rising silt load would push turbidity to a point where only 10 to 20 per cent of required daily supply could be delivered. As an alternative, boreholes were considered; however, they could supplement only about 5 to 10 per cent of the system's required water supply, which was insufficient to maintain basic service levels. Additionally, the local rivers offered neither sufficient flow nor adequate quality to serve as a viable substitute. Desalination was also considered but ruled out as too expensive and too time-consuming.

With the area's major shareholder at the time being Sembcorp[22], Siza Water visited these operations, adapted the Singaporean model to local conditions, and progressed rapidly from initial design, procurement of a service provider, financing, and construction, to a commissioned and operational direct reuse plant within approximately six months, beginning mid 2015. Class 2 reuse water was made available to local pool maintenance businesses before the full direct potable reuse system was operational in early 2016.

The treatment process

The primary water source for the plant is drawn from the chlorination tanks at the existing sewer treatment works. This extraction point was chosen to keep the entire operation within a single property and avoid land ownership complications.

The treatment process comprises a holding tank providing approximately 24 hours of buffered supply, followed by media filtration (recently upgraded from the original sand filters, which has extended ultrafiltration membrane life from five to six years to around eight), ultrafiltration, reverse osmosis, ultraviolet disinfection, and re-chlorination. The product water is blended with the conventional potable bulk supply in the final reservoirs before being pumped back into the network. Quality compliance is monitored against the national standard for drinking water quality (SANS 241), with hourly sampling at multiple points around the plant, an on-site "mini lab" for immediate testing, and a larger laboratory as the deciding reference when results between the two diverge.

A critical upstream control is the protection of the source. Because the plant's economics and safety depend on a predictable, primarily domestic wastewater input, Siza Water sets strict discharge limits on any non-domestic dischargers to the sewer treatment network. For example, the local hospital laboratory has individual discharge limits, with the understanding that anything in excess must be discharged elsewhere. Without this upstream control, the plant would be more expensive and more complex to run.

The principal constraint on further expansion is not the treatment technology itself but the brine discharge from the reverse osmosis (RO) stage, which must remain within the existing license parameters for the sewer plant's discharge. Without a solution for the brine, the plant cannot scale up beyond its current footprint.

Public participation and the yuck factor

The direct potable reuse plant required formal public participation as a district requirement, and Siza Water invested heavily in face-to-face communication with affected communities during the drought, which improved public perception. Siza Water obtained approval from public consumers; the result was approximately 96 to 97 per cent in favour. The plant was not switched on for the first two weeks after the announcement; when a small number of residents reported feeling unwell and attributed it to the recycled supply, Siza Water demonstrated that the plant had not yet started. The plant was then quietly commissioned, with no further complaints.

The "yuck factor" has nevertheless persisted in parts of the public conversation, and Siza Water has consistently addressed it by framing direct potable reuse alongside conventional surface water supply. In a river system where successive upstream towns extract water, treat their sewage, and discharge it back to the river while the next downstream town extracts again, residents elsewhere in the country are effectively drinking treated wastewater that has passed through similar systems. By contrast, the recycled supply is treated to a higher specification.

Operational management

The plant runs 24 hours a day on two 12-hour shifts, with process control staff on site at all times. Operations are largely automated through a programmable logic controller (PLC) system, allowing remote monitoring to ensure water quality stays within operating parameters. Maintenance is performed by an internal team, with specialist contractors brought on board on a case-by-case basis (for example, for the recent upgrade from sand to multimedia filters). Operations include a planned maintenance shutdown of about two days per month, during which the affected supply zones are temporarily fed from the conventional bulk supply via a dual-feed arrangement. Load shedding has been a significant operational issue, and the plant has developed specific protocols to shut down before scheduled outages and restart safely afterwards. In late 2025, Siza Water commissioned a grid-tied solar photovoltaic (PV) system at the plant to supplement its electricity use and reduce its grid exposure.

Adaptive governance, regulation, and enabling conditions

An adaptive governance approach enabled the implementation of the direct potable reuse plant in response to the 2015-2016 drought. Rather than following a conventional approval process, implementation was coordinated through a Drought

War Room platform, convened across the eThekwini Municipality, iLembe District Municipality, and key sector departments including the DWS (then Department of Water Affairs), the Department of Health, and the Department of Cooperative Governance and Traditional Affairs (CoGTA), along with other key stakeholders. The platform met weekly to bi-weekly and provided a mechanism to share information on water demand pressures, water availability, planned interventions, and implementation progress across the broader supply system. This continuous engagement kept regulatory authorities informed throughout implementation and facilitated coordinated decision-making during the drought response.

The crisis context of the drought provided a more flexible regulatory process. Despite the emergency context, regulatory oversight remained in place throughout implementation. The DWS and other regulatory authorities were continuously engaged and updated, with site inspections undertaken during implementation and compliance verified against South African National Drinking Water Standards. Although the plant was designed, constructed, and commissioned within approximately six months to respond to the drought, delays still occurred in issuing the formal water use license.

The project design itself also considered regulatory requirements. The advanced treatment system was implemented as a direct potable reuse system within a single property boundary. As a result, it avoided the additional regulatory complexity of transferring water across property boundaries. Environmental compliance focused on managing RO, with existing water use licence conditions governing brine discharge and wastewater treatment plant effluent limits, ensuring alignment with environmental discharge requirements throughout operation.

Public participation formed a formal requirement of the approval process and was central to securing social buy-in to operate. The District Municipality required public approval, and Siza Water undertook structured engagements, including direct face-to-face community meetings. These meetings communicated the severity of the water shortages and built understanding of the need for alternative water supply solutions. This strengthened public acceptance amid severe water scarcity.

Several institutional factors further enabled rapid project implementation. The PPP concession structure concentrated technical, financial, and operational decision-making within a single entity, enabling efficient decision-making. In addition, Siza Water's relationship with Sembcorp provided access to an existing direct potable reuse design and operational experience from the Singapore model, reducing the need to develop an entirely new treatment approach.

Results and Impact

INDICATOR	STATUS
Plant capacity	~3.6 ML per day
Time from design to operation	Approximately six months
Public approval at consultation	96 to 97 per cent in favour
Membrane replacement interval	~8 years (vs typical 5 to 6)
Water losses in the network	Below 10 per cent
Energy supplementation	Grid-tied solar PV commissioned late 2025

The plant's value has been demonstrated under two very different stress conditions. During the drought, it stabilised supply when bulk supply was projected to drop sharply due to increasing turbidity, and allowed Siza Water to enforce a 16 per cent demand reduction without resorting to wholesale tankering. This reduction was supported by "drought washers" fitted at customer meters that reduced household instantaneous flow by approximately 40 per cent.

During the 2022 KwaZulu-Natal floods, when the bulk supplier was effectively offline for three to four weeks because turbidity overloaded its sand filters, the recycled plant recovered from its own turbidity issues within three days – faster than conventional systems. The plant also opened tanker filling points for more affluent areas (free for any consumer to access), with tankering reserved for poorer areas where households could not collect, dramatically reducing tankering costs. The plant also opened to residents of neighbouring Tongaat, whose treatment works had been washed away[23], and remained open to them for two to three months after Siza Water's own supply returned to normal.

Financially, the recycled supply costs less per litre than buying the same volume from the bulk supplier. Maintaining supply continuity through both drought and floods sustained revenue from metered sales, while comparable areas dependent solely on conventional supply suffered both service failure and revenue loss. Post-drought consumption has returned roughly to pre-2014 trend levels, though Siza Water notes that the company's financial recovery took approximately six years.



Challenges and limitations

The brine discharge limit imposed by the sewer plant's existing licence conditions remains the binding constraint on plant expansion. Load shedding has been disruptive and required specific protocols, partially mitigated by the recent solar installation. The plant's automation requires specific instrumentation and PLC programming skills, which must be maintained internally or reliably contracted. The "yuck factor" in public perception has not entirely disappeared, even with strong technical evidence and a decade of operation. Source water protection requires constant vigilance: new business or industrial customers in the catchment must be individually assessed and limited. The operator's financial recovery after the drought took longer than expected, reflecting the real cost of running a service during a demand-suppression intervention. And the long-term future of the plant beyond 2029 is conditional on the future of the concession itself: if the contract is not extended, the asset will transfer to the successor (likely the Water Services Authority or a future PPP), and decisions about ongoing operation will sit with that successor.



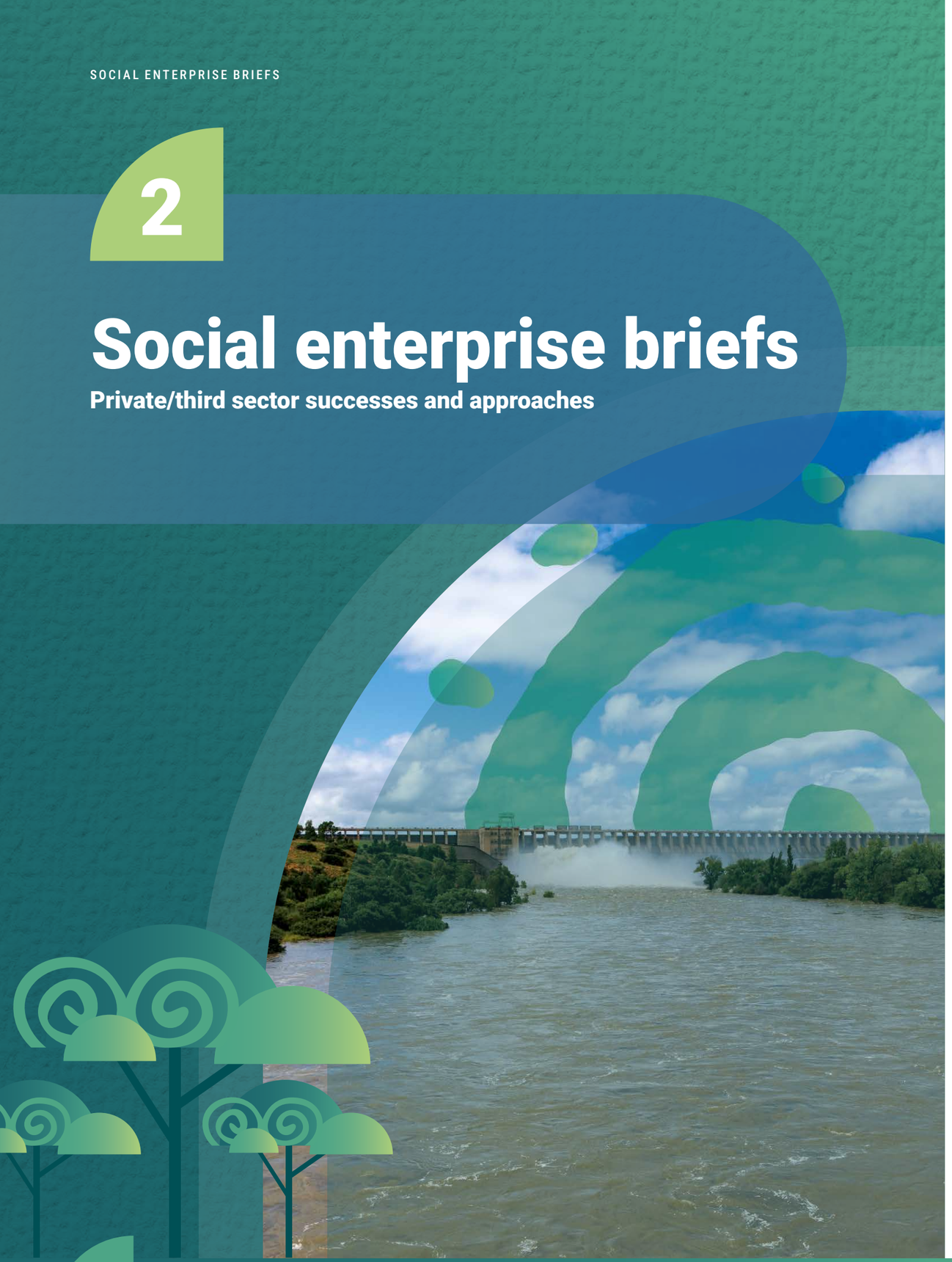
Lessons for other municipalities

Several lessons emerged from the Siza Water experience that have direct relevance to other South African water service providers considering direct potable reuse. The cost comparison with desalination is decisive: reuse is substantially cheaper, faster to commission, requires far less floor space, and avoids the high-cost, high-risk maintenance regime of marine intakes (including the occupational health and safety burden of dive inspections). Strict control of the source water is non-negotiable: without limits on what enters the sewer network upstream, the plant becomes both more expensive and more complex. Automation and continuous in-house process control allow lean operating teams, but require investment in the right skill mix. Honest, sustained public participation is what makes direct potable reuse socially viable; framing the technology against the unacknowledged reality of water sources of conventional river-based supply systems has been an important part of that conversation. And finally, building reuse infrastructure during a crisis is faster and easier than building it in calm conditions; the same technology proposed outside a drought context would likely face a far more demanding regulatory and public engagement process.

2

Social enterprise briefs

Private/third sector successes and approaches



2.1. Recover: Mintek

Recovering water and valuable minerals from acid mine drainage through applied metallurgical research

Mintek, the Council for Mineral Technology, serves as South Africa's national mineral research entity, under the Department of Mineral and Petroleum Resources. At the applied end of research and development, it generates knowledge and develops technologies that industry can adopt. Over the past decade, Mintek has built a growing footprint at the interface between mining and water, developing processes that recover usable water and saleable by-products from acid mine drainage (AMD). Two technologies anchor this work:

- SAVMIN™, an active chemical process that recovers its own reagents and yields commercial-grade gypsum; and
- cloSURE™, a passive-to-semi-passive biological process that produces irrigation-quality water and elemental sulphur.

Both operate in an institutional environment that needs reform to realise the water-security benefits of emerging AMD treatment and water-recycling technologies.

Context and Motivation

Mintek was established in 1934 as the Minerals Research Laboratory, attached to the Department of Metallurgy and Assaying at the University of the Witwatersrand, in response to the needs of the mining sector on which Johannesburg had been built. It became the Government Metallurgical Laboratory in 1944, gained statutory independence as the National Institute for Metallurgy in 1966, and adopted its present name in 1981.[24] Its milestones span the minerals value chain, including the carbon-in-pulp process for gold recovery, platinum group and base metal processing, uranium extraction, direct current arc furnace technology, and cyanide measurement instrumentation.

Circa 2019, Mintek adopted an organisation-wide water programme, identifying capabilities across its three research and innovation clusters that could be applied to industrial wastewater, AMD, and potable water. The focus on water responds to a specific South African problem. While AMD is an international issue, local geology creates an unusually harsh chemical composition: high sulphate loading, high concentrations of iron and other metallic species, and high acidity, resulting from pyrite oxidation to form sulphuric acid. Historically, mining in the Witwatersrand goldfields required extensive dewatering to depths of up to four kilometres. When pumping ceased, the mine voids rebounded, ultimately prompting government intervention through the Trans-Caledon Tunnel Authority (TCTA) and treatment plants in the Western, Central, and Eastern Basins.[25] AMD's long-term impacts on water quality place it at the intersection of the mining sector, agricultural water security, and the country's largest urban region.

SAVMIN: sulphate removal with reagent recovery

SAVMIN is a trade name covering approximately seven patent families, the first registered in 1998, with successive modification through pilot and demonstration stages. The process is designed to remove residual sulphate from AMD. Although conventional neutralisation employed in most mines already uses lime or calcium carbonate to precipitate free acid and dissolved metals, this leaves calcium sulphate in solution at roughly 2.6-2.8 grams per litre[26], far above the maximum allowable discharge limits of 0.08 grams per litre for calcium and 0.4 grams per litre for sulphate as stipulated by the DWS.

The Trans-Caledon Tunnel Authority (TCTA) currently neutralises and then dilutes AMD with dam water, an approach that is constrained by the finite volume of water available for dilution at the considerable scale required, with the Eastern Basin plant alone designed for approximately 110 ML per day. [27]

SAVMIN is an active process relying on chemical dosing, pumps, and process control. Lime and aluminium hydroxide are added to mine water to neutralise it from acidic to alkaline and then precipitate dissolved calcium sulphate as ettringite, which can then be removed to produce sulphate-free, potable water.[28] This process reduces reagent consumption by up to 50 per cent, enables recycling of aluminium hydroxide, and allows recovery of treated calcium sulphate as clean gypsum with commercial potential.[29] The recovery and recycling of aluminium hydroxide from the ettringite distinguishes SAVMIN from other ettringite-based treatment methods.[30] However, SAVMIN is limited in its ability to treat monovalent compounds, such as chlorides and nitrate. By comparison, RO can treat monovalent compounds to produce potable water but leaves behind hypersaline brine, which is stored for long periods in large ponds and creates a long-term environmental liability.[31] Positioning SAVMIN upstream of RO would eliminate calcium sulphate scaling and extend membrane run times. Mintek's commercialisation process is currently funding a pilot plant to further test this technology.[32]

cloSURE: biological treatment producing irrigation water and sulphur

cloSURE takes a different approach, based on two coupled passive biological processes: sulphate reduction to hydrogen sulphide, followed by sulphide oxidation forming elemental sulphur as a valorisable precipitate. Laboratory demonstrations have achieved 87 per cent sulphate removal and up to 98 per cent sulphide removal, raising pH to 7.5 and bringing metal concentrations within South African irrigation-water quality limits.[33] Both processes can in principle be tuned to produce water of higher, potable quality.

Three factors shape the process design. The first is the carbon source. Rather than fossil-derived ethanol or laboratory-standard acetates and lactates, Mintek uses waste products from other sectors, including Mpumalanga's agricultural sector, effectively using waste to treat waste. The second is security. In the rural settings where treatment is most often needed, pumps and electronics are highly vulnerable to theft; cloSURE's passive processes, requiring minimal equipment and on-site staffing, substantially lower this operational risk. The third is limited optimisation. Specifically, maximising sulphate reductions results in excessive alkalinity, negatively affecting the soil quality of irrigated land. Thus, the extent of passive treatment is determined by the desired pH level, soil conditions, and application, rather than optimised around the single parameter of sulphate removal.



Legislative and institutional environment

Despite the availability of potential treatment technologies, no large coal mine in South Africa has received a closure certificate since 2011, largely because of unresolved water management issues and a lack of institutionalised solutions to address AMD.[34] A mine remains liable for associated environmental impacts of AMD, which continues to be generated even when mining operations cease. Certification is further constrained by inadequate financial provisions, high standards of reducing residual risk, and limited regulatory capacity. Where the responsible mining company no longer exists, the state assumes responsibility for mitigating and addressing the environmental impacts of legacy mines.

When technologies such as SAVMIN and cloSURE successfully treat AMD, institutional bottlenecks, not technical challenges, constrain the supply of treated mine water to municipal consumers. Specifically, while the technical capabilities exist to treat AMD to potable standards, current legislation does not permit mines to sell potable water at scale, thus limiting the outputs of SAVMIN, cloSURE, and other treatment systems to water for irrigation purposes. Additionally, because water services authorities are responsible for retail water services, mines must enter into a water procurement agreement with municipalities, for which no standard tariff or contracting model exists.

In the relatively few instances that procurement arrangements have been established, they have proven effective. For example, the eMalahleni Water Reclamation Plant, commissioned in 2007 and expanded to a capacity of up to 50 ML per day, treats AMD to a potable standard and supplies both the municipality and contributing mines, with operations financed partly through associated revenue.[35] The municipality is licensed to abstract 75 ML per day from Witbank Dam, but in reality abstracts approximately 120 ML per day,[36] and the eMalahleni plant's treatment capacity could resolve this discrepancy and unsustainable overabstraction. However, without a standardised pathway to valorise potable-quality output, the economics of treating mine water to that standard do not hold together, and partnerships between mines and municipalities must be built on a case-by-case basis.

A related constraint takes the form of regulatory inertia. Established water treatment processes such as Reverse Osmosis enjoy a standing that newer processes do not, in large part because standards and guidelines have not been updated to reflect advances in alternative treatment technologies. This poses a challenge for institutions like Mintek, which sits between what legislation currently permits and what mines can achieve with relatively high efficacy. These vital institutional dimensions are central to the recently approved Mine Water Management Policy, which aims to proactively manage mine water by adopting appropriate, cost-effective treatment technologies and enabling PPPs to deliver the dual benefits of mitigating water pollution and supplying potable water.[37]



Partnerships and development pathway

Developing and implementing AMD treatment technologies is a long, expensive, multi-partner process. Universities and research institutions formulate technical problem statements through literature reviews, then address them through targeted experiments and optimisation of specific aspects of treatment processes.

Mintek partners with academic institutions to direct emerging technologies and processes into the realm of applied research and potentially industrial-scale adoption through successive testing at the lab, bench, pilot, and finally demonstration scale, each step running for up to five years. Once a given technology has reached a certain level of efficacy, Mintek works closely with prospective end users, understanding their needs and how these shape implementation.

Finally, funders such as the Technology Innovation Agency and National Treasury play a key role in financially supporting the lengthy process of developing, testing, and implementing technologies, as well as building and managing partnerships. This work is informed by earlier South African precedents, notably the Rhodes BioSURE Process, which progressed to a full-scale 10 ML per day plant at ERWAT's Ancor Water Care Works, using primary sewage sludge as a carbon source.[38]

The cloSURE project involves at least six partners: the Technology Innovation Agency, Mintek, the University of Pretoria, Coaltech, the Water Research Commission, and the client, with specialist analytical providers supplying capabilities outside the alliance. Where the public sector does not create conditions for demonstration, Mintek works with private partners able to absorb the risk of trialling new technology.

Challenges and limitations

The legislative and institutional environment within which AMD treatment technologies are developed creates several challenges that limit their application at scale. The current absence of regulations and a standard contracting pathway for selling potable-quality treated water to municipalities and end-users removes a vital revenue stream that would make post-mine closure water treatment financially sustainable. Additionally, this limits the extent to which water treatment technologies can address South Africa's water security challenges by restricting agreements to the sale of irrigation-quality water only. These limitations stem from legislated standards and guidelines that do not account for newer treatment processes and remain highly stringent. Because irrigation-quality water reuse is agriculture-centric, current treatment systems tend to focus on rural areas, where pumps and equipment are susceptible to vandalism.

Regarding policy implementation, mandates are often fragmented, with Mintek working closely with both the national Department of Mineral and Petroleum Resources and the DWS, whose functions and responsibilities overlap at the water-mining interface but remain largely compartmentalised through separate legislation and siloed decision-making. At the local government level, municipalities lack sufficient enforcement capacity to hold mining companies accountable under relevant legislation such as the Mining Charter. This limited capacity extends to municipalities' ability to adopt, operationalise, and integrate new water treatment solutions into existing municipal systems.

The final challenge is relational in nature. Amid long timelines and the extensive effort and funding required to sustain multi-stakeholder partnerships over a decade or more, civil society plays a decisive role in applying pressure for greater accountability and proper enforcement of mining regulations. However, communities often lack access to the information needed to drive regulatory shifts toward novel water-treatment solutions. Instead, inaccurate or alarmist accounts circulating in affected communities, combined with the broader erosion of trust in public and scientific institutions, hold organisations like Mintek to an exceptionally high standard of scientific communication.

What municipalities can learn

Ultimately, AMD is both a mining and an environmental and water security issue; legislative and management approaches that treat it as a sector-specific matter understate this interconnectedness. Most importantly, treated mine water is a latent municipal resource, but institutional, rather than technical, barriers currently limit its use. The eMalahleni arrangement shows how a mine can potentially supply potable-quality water into a municipal system where local government has a direct stake in developing a standard contracting and tariff model, while pursuing the more readily available irrigation-quality pathway in the interim.

Adopting a pragmatic approach, design targets should be set against the actual receiving use rather than the highest achievable purity. Furthermore, recovery is only meaningful where a receptor for associated by-products exists; therefore, AMD treatment initiatives should focus as closely on the potential applications of materials with commercial potential, like gypsum, as on water output. Passive systems, which require no pumps or on-site staffing, are more likely to remain functional in rural settings where treatment is most needed. Finally, deeper and more strategic relationships between municipalities, national departments, and the mining sector remain the missing enabler, supported by sustained pressure for accountability and enforcement.



SOCIAL ENTERPRISE BRIEFS

2.2. Regenerate: Water for the Future

Regenerating an urban river through community-led restoration, alien invasive removal, and nature-based solutions

Water for the Future is a Johannesburg-based non-profit organisation working to ecologically restore part of the Jukskei River, where it emerges from an underground channel in Bertrams and flows through the neighbourhood of Lorentzville, before flowing further north through Alexandra and draining into the Crocodile River Basin. Co-founded in 2017[39] by a community-anchored designer and social entrepreneur, in partnership with an environmental artist, the initiative has grown over eight years into a multi-partner programme, spanning water quality studies, environmental education, public art, community employment, alien invasive removal, indigenous grassland and wetland restoration, and sustainable urban drainage pilots. It shows how an urban river can be rehabilitated through grassroots stewardship and institutional partnership, while also highlighting the challenges of sustaining collaborative, community-based initiatives amid limited state capacity and varied funding sources.

Context and motivation

The founder's journey to river restoration was unconventional. With a background in interior design and African crafts, and several years of philanthropic work for a private employer in southern Mozambique (indigenous landscaping on a peri-urban farm), she returned to Johannesburg, residing in close proximity to a stretch of the Jukskei River that had become ecologically degraded through a combination of polluted stormwater, invasive alien vegetation, and illegal dumping. Initial work to address these challenges in a private capacity emerged from the founder's personal stake in the beauty and health of the riverine environment and a joint decision by two private landowners with a physical presence at the daylight point (the founder's long-standing employer and an award-winning mixed-use precinct) to provide initial seed funding.

Baseline studies and initial work

Early work focused on building legitimacy. With the seed funding, Water for the Future commissioned a series of expert reports on the river's condition. The then-chairman of the Jukskei River Catchment Management Forum provided valuable mentorship and helped connect the initiative with a network of local experts. After his passing, the University of Johannesburg stepped in to fund a formal environmental impact assessment (EIA). These baseline studies, grounded in commissioned scientific enquiry, were instrumental in securing meetings and building a relationship with the City of Johannesburg's Open Space Planning, Water Management & Biodiversity Directorate. The combination of baseline information, a network of expert partners, and municipal endorsement opened the door for small-scale pilot projects to test sustainable urban drainage systems (SUDS)[40] along the river, supported by the Johannesburg Development Agency.

Community participation and workforce development

Lorentzville and neighbouring areas along the Jukskei River are home to a diverse population, including Afrikaans- and isiZulu-speaking communities as well as a large African diaspora. Collaboration with these communities emerged from the understanding that, without their voices, river restoration efforts are unlikely to achieve the necessary longevity and sustainability. As such, before the organisation proceeded with further physical interventions, it used a R100,000 grant from the British Council in South Africa and Goethe-Institut to appoint a community-embedded partner and launch a public-participatory programme with residents living along the river.

From a pop-up office at the daylight point, Water for the Future facilitated walking tours, community mosaics, children's art, and educational mapping (the latter illustrating the river's path, existing public spaces, and government-owned land), all of which improved residents' ecological literacy and understanding of the river system. Given the pervasive challenges of poverty, substance abuse, and gang activity, community trust-building proceeded slowly, greatly supported by partnerships with local organisations and a two-day symposium co-hosted with the South African Research Chair in Science Communication[41].

The community programme expanded significantly in December 2022 when Water for the Future successfully applied for the Social Employment Fund (SEF) (a Presidential Employment Stimulus programme with the Industrial Development Corporation as fund manager)[42], as part of a consortium of ten inner-city NGOs managed by the Johannesburg Inner City Partnership. This funding, coupled with a prior R40,000 grant from another private landowner, enabled the progressive implementation of a river management plan informed by the baseline studies, including invasive alien clearing and strategic rehabilitation.

With SEF backing, staffing capacity rose from four to 110 paid positions, with several jobs allocated to community groups conducting similar restoration activities in other parts of the catchment, including the Alexandra-based Water Warriors. A site manager with extensive experience in chainsaw operation and team management was hired to lead day-to-day operations, and community members with deep local knowledge filled office support roles. The local workforce was ultimately employed on a basis of two days per week at minimum wage over three 10-month rounds. Beyond employment, daily operations facilitated upskilling in areas such as chainsaw operation, alien invasive identification, and crafts, intended to provide avenues for income generation beyond the contract.

International funding and scaling

In late 2023, Water for the Future was approached by the World Resources Institute to act as implementing partner in an international project for Scaling Urban Nature-based Solutions for Climate Adaptation in Sub-Saharan Africa (SUNCASA), funded by Global Affairs Canada[43]. The SUNCASA work ran for over a year on a full-time basis, expanding alien invasive removal and strategic rehabilitation along the river and drafting a river management plan. However, the transition from a largely domestic, community-led funding and implementation model to an international funder with stringent procurement, payroll, and reporting requirements also strained a small organisation, requiring the appointment of a dedicated fund manager. It also highlighted potential difficulties in aligning external funding priorities with local realities, such as whether to restore riverbanks through tree-planting or use more contextually appropriate grassland species endemic to the local biome.

Outputs and innovations

Over eight years, Water for the Future has produced a body of research, restoration, and community work that spans multiple areas: baseline studies and an EIA; a river management plan; sustainable urban drainage pilot projects; invasive alien clearance and the planting of indigenous species; ongoing water quality monitoring with academic partners; community education and awareness-raising through various engagements, posters, and art; and an active workforce of community members trained in alien invasive removal and other skills.

In a notable area of innovation that has attracted public-sector interest, Water for the Future adopted Wild2Earth, an application developed by Biosyntrix that maps ecological restoration work using geographic information system (GIS) and satellite data. With an expert consultant's help, the project integrated environmental conditions into the application to create a transparent monitoring and evaluation system, enabling workers on the ground to capture verifiable, real-time data that can serve as valuable evidence for municipal partners and funders. The next phase will feed these data into a site-specific water impact calculation system, adapting the peer-reviewed RSB Water Impact Indicator Methodology developed with WWF South Africa and Stewards of Nature.

Another key innovation has been incubating green businesses built around processing alien invasive biomass from clearing sites (e.g., for firewood, chipwood, and weaving), alongside other initiatives such as urban agriculture, beekeeping, and bokashi composting. Water for the Future's work brings its teams into contact with several forms of waste; as such, the organisation prioritises separation-at-source initiatives, embracing a holistic approach to land stewardship linked to value addition and income generation. The organisation's focus on sustainable livelihoods has led to the early-stage development of a financial product with the banking sector, intended to channel stock exchange-linked finance to grassroots NGOs working on nature-based solutions as a potentially more sustainable funding model.

Challenges and limitations

The most fundamental challenge facing Water for the Future has been that of financial sustainability. The founder's own time and office space have been subsidised throughout by her position with a private employer situated at the daylight point, ensuring continuity that would otherwise not have been possible. Limited rounds of funding enabled all subsequent work, the most recent of which concluded in mid-2026, necessitating additional finance to support ongoing operations. However, even when work was funded, wages paid to the community workforce did not always reflect the conditions under which they worked, including health risks and crime. This underscores a broader undervaluation of nature-based restoration work in the South African labour market. Furthermore, when funding is secured, a potential challenge lies in navigating relationships among the donor, implementing organisation, and community members, as external parties' rationalities and priorities can conflict with local socio-economic complexities and ecological systems.

Operationally, Water for the Future works in constant negotiation with municipal mandates, where parks, water, waste, biodiversity, and law enforcement units have historically operated within their own scope. This can make it difficult for NPOs and the City to achieve holistic, place-based, community-driven river stewardship outcomes. Furthermore, with high unemployment and crime rates, police enforcement of environmental regulations and by-laws is understandably a critical missing layer in river restoration. Without enforcement, however, the same stretches of river see repeated instances of illegal dumping, undermining the gains made by community restoration efforts.

What municipalities can learn

Several practical lessons emerge for municipalities seeking to support similar community-based action.

First, urban river corridors are not single-function assets; therefore, realising contextually sensitive, place-based stewardship of complex socio-ecological systems requires greater departmental integration across water, sanitation, waste, parks, biodiversity, and law enforcement mandates. Municipalities that coordinate these functions around a specific catchment and its associated community, even informally, can see disproportionately positive returns.

Second, NGOs deeply embedded with residents on the ground are an under-recognised source of evidence and knowledge, which can supplement official datasets at low cost if relationships are maintained.

Third, community restoration programmes can deliver real ecological and social benefits, but only when paired with stable employment, fair wages, structured upskilling, and a credible pathway beyond the contract period.

Lastly, the most cost-effective municipal action to support community-based restoration activities is consistent by-law enforcement.



2.3. Reduce: SOSNPO

A circular approach to water savings and demand through decentralised, source-separating sanitation in schools and informal settlements

SOSNPO is a non-profit organisation that designs, pilots, implements, and advocates for decentralised, circular water and sanitation solutions in informal settlements, schools, and other under-serviced contexts across South Africa and, increasingly, the African continent.

The organisation was founded in 2018, in the aftermath of the Cape Town water crisis, and originally operated as "Water for Cape Town". Its work rests on two premises:

- Conventional, centralised water and sanitation systems have fundamental limitations, especially in rural communities and peri-urban areas with rapidly growing informal settlements. Context-based solutions, particularly decentralised sanitation, are key to addressing structural and operational gaps.
- Human waste, separated and managed at source, can be a valuable resource rather than something to dispose of.

Through eight years of on-the-ground piloting, often in socio-economically challenging environments where new technologies have rarely been tested at scale, SOSNPO has built a working evidence base for non-sewered, water-efficient sanitation systems. It now operates as the implementing arm of a wider family of international initiatives. These include the W12+ Programs, Megacities Alliance for Water and Climate (MAWAC), Out the Blue programmes[44] and engagement with the Organisation for Economic Co-operation and Development (OECD), UNESCO Intergovernmental Hydrological Programme (IHP), UN-Water, and UN-Habitat's water provisioning networks.

Origins and context

The organisation was founded amidst the Cape Town water crisis of 2018, as the city stood approximately 40 days from exhausting its potable water supply (Day Zero). According to SOSNPO's calculations, the original Day Zero contingency plan, which would have required Capetonians to queue at approximately 200 collection points for 25 L of water per person per day, was mathematically unfeasible[45]. Meanwhile, strict, uniform water demand management and policing measures across the city disproportionately harmed the livelihoods of low-income areas. The subsequent civil society-based work undertaken by SOSNPO crystallised two seminal insights:

- A crisis requires a range of tailored, equitable solutions that support livelihoods (rather than disproportionately favouring high-income residents who can supplement their water supply through other means).
- Any sustainable response would need to reduce water demand at source through circular measures.

In the years since, SOSNPO has visited approximately 160 communities across all nine South African provinces, documenting water, sanitation, and health (WASH) conditions. This highlighted the deep-seated need for alternative models to the traditional, centralised system of water provision and sanitation, with the national goal of universal coverage remaining a distant and arguably unlikely reality in many municipalities across the country, particularly for rural communities and informal settlements. Since 2025, SOSNPO has expanded its scope to a continental scale. The organisation describes its operating philosophy as "fail harder", emphasising continuous learning and treating on-the-ground work as a way to stress-test new technologies and approaches before codifying them for replication elsewhere.

Decentralised, source-separating approach

As a core principle, SOSNPO rejects the global convention of using drinking water to flush toilets and relying on centralised sewerage systems as the only way to manage wastewater. The resulting faecal sludge is unmanageable at scale, putting pressure on ageing wastewater treatment plants. It also turns a potentially valuable source of organic matter into an environmental pollutant. Drawing on historical reference points and contemporary international research, the organisation has built its solutions around separating urine and solid waste at source, drying and treating solid waste in situ (sometimes using ventilated black-pipe heat exchangers for dehydration), and recovering the resulting by-products as agricultural fertiliser or biochar.

In practice, two technology families address this goal of waste treatment at source. Water-Efficient Sanitation Systems (WESS) operate similarly to traditional flushing toilets, but based on an optimised mechanism that uses only 2 L of water per flush instead of the standard 9-18 L. Non-Sewered Sanitation (NSS) utilises a container with a flap to seal the chamber and a pipe ventilation system to redirect air and dry out the waste. Secondary drying and treatment then produce a fertiliser by-product. This ISO-certified mechanism allows NSS units to operate without water, eliminates odour, and mitigates health and safety risks associated with pit latrines, including ventilated improved pit (VIP) toilets, in which children continue to drown.

Managing at source ultimately requires a receptor and use-case for the associated organic by-products. As such, SOSNPO has also developed different ways to utilise or further process organic by-products, tailored to different contexts. Here, the organisation's role has been to:

- operate as a field-testing partner for internationally developed technologies in collaboration with local R&D partners (namely, Amalooloo and Sanitation Ambassadors' sanitation-as-a-service model) and other South African providers; and
- translate test results into evidence that can be presented to policymakers, the DWS, the Water Research Commission, and municipalities to encourage formal, systematic adoption.

Community-led implementation

In deploying WESS and NSS technologies, SOSNPO prioritises community-led implementation from the outset. Engagement with residents typically begins with local leadership, which is often male-dominated in rural and informal settlements. Working with these focal points, SOSNPO includes and trains female-led community groups to conduct daily cleaning and routine repairs (including tap replacements and simple plumbing fixes). This ensures that WESS and NSS infrastructure can continue operating without relying on certified tradespeople who are unlikely to reliably reach informal or outlying rural settlements.

Upskilling also lets community members earn their own income, with job creation treated as a core deliverable. Additionally, because they are involved from the design stage and play a key role in ensuring continued operation, maintenance teams gain important status within communities, helping address leadership imbalances between men and women. This gendered approach has also improved infrastructure maintenance, with women-led teams often achieving higher success rates in long-term system performance.

In the organisation's experience, community acceptance and adoption of source-separating sanitation systems take time: approximately three to six months from initial installation to broad uptake. This requires continuous on-site presence by the implementation team. To protect infrastructure from

vandalism, SOSNPO sources materials for WESS/NSS units from local, often informal, businesses wherever possible. This is based on the observation that people tend not to damage what they themselves have had a direct hand in building.

Outputs and impact

To date, SOSNPO has worked with dozens of communities to deliver decentralised sanitation systems. One of the organisation's flagship school projects, located at Ivory Park in the City of Johannesburg, serves 2,368 children and 115 staff members; previously, the school recorded 42 days of closure in the first half of the year alone due to a lack of water, which rendered its toilets non-functional. Following the installation of an off-grid sanitation system, together with a structured water classification approach (treating drinking, grey, and black water as separate streams), the school saw increased reliability in its sanitation as well as a reduction in its water bill from approximately R70,000 to nil, freeing up funds for additional staff and system maintenance. Similar improvements and reductions in costs have been documented at other school sites.

Beyond cost savings, the organisation has reported compounding benefits in terms of greater community pride, reduced vandalism, decreased risk of pit toilet drowning among children, and reduced exposure of women and girls to "sextortion" – the coerced exchange of sexual acts for access to functional toilets, which remains a persistent and under-discussed occurrence associated with municipally provided chemical toilet sites. Demand for SOSNPO's work has therefore grown markedly over the years: the organisation currently receives six to seven requests per week from communities and schools that have seen the benefits of decentralised sanitation systems in neighbouring areas.

Challenges and limitations

The most persistent challenge to implementing decentralised sanitation systems is regulatory and institutional. To date, most South African municipal by-laws do not clearly recognise decentralised, off grid sanitation, and water and sanitation master plans assume a centralised system that has proven consistently difficult to expand to rural and informal areas. Because this approach is entrenched, public sector institutions require substantial evidence demonstrating the efficacy of alternative systems. Another challenge is that municipal departments are often siloed, with education, water, sanitation, health, and other units rarely coordinating beyond specific facilities or initiatives. This runs counter to the holistic approach decentralised, community-based sanitation requires.

Once WESS and NSS infrastructure has been deployed on the ground, vandalism remains an ongoing operational risk, despite efforts to ensure community buy-in. In urban settings, SOSNPO has also encountered more direct security threats. At times, contractors and intermediaries benefiting from the status quo (e.g., by controlling access to municipal chemical toilets or selling such infrastructure on the black market) have actively obstructed the implementation of alternative systems. In one case, this required SOSNPO to temporarily suspend operations and liaise with the monitoring team remotely.

Furthermore, the broader system in which the organisation operates is often characterised by poorly managed, corruption-prone tendering processes, where companies without sufficient sector experience are awarded sanitation contracts and incentivised to minimise delivery costs, potentially at the expense of service quality. These issues have attracted increasing attention from the national government, with the President committing to curb corruption, criminality, and so-called "mafia" tactics in the water and sanitation system.[46]

What municipalities can learn

As SOSNPO's experience suggests, centralised sewerage systems have limitations in providing reliable, equitable sanitation services, particularly in rural and rapidly densifying informal settlements. Complementary, context-based solutions, notably decentralised sanitation, can address the resulting structural and operational gaps. As SOSNPO's success in numerous communities and schools demonstrates, and as other organisations implementing similar technologies globally have shown, decentralised separation of urine and solid waste at source is technically mature, substantially reduces downstream treatment burdens and upstream water demand, and makes a compelling economic case by reducing water bills. It thereby frees budget that can be ringfenced for operations, maintenance, and additional staffing.

However, to deploy such systems at scale and meet certifiable standards, municipalities and other spheres of government need to make explicit provision for implementation to address the current lack of policy guidance at both the national and local levels. This requires continuous data collection from existing and future programmes to build a robust case for systematic adoption alongside other WASH infrastructure models.

Finally, these technologies work best when designed and implemented through a community-led approach rather than a top-down delivery method. This entails working with local leadership, empowering women, training residents in maintenance to create income-generating opportunities, using locally sourced materials, and investing the time needed to ensure community buy-in and ownership. If these lessons are adopted, decentralised sanitation can serve as an additional viable tool, alongside traditional centralised systems, that municipalities can use to provide safe, dignified sanitation for residents.



2.4. Rethink: Kusini Water

Rethinking rural and peri-urban water service delivery through decentralised, solar-powered, community-led systems

Kusini Water is a South African social enterprise, founded in 2016.[47] Kusini designs, deploys and operates decentralised water treatment and distribution systems in primarily peri-urban and, to a lesser extent, rural communities where conventional municipal infrastructure has not yet been established. Kusini Water delivers water through two core service offerings: community water kiosks and the mini-grids.

Kusini Water sources water using solar-powered extraction systems, then treats it through locally manufactured filtration media (derived from South African macadamia nut shells as the carbon source), nanofibre membrane filtration, multimedia filtration, and ultraviolet (UV) sterilisation. Trained local water champions operate both service models under community-owned, revenue-sharing arrangements, with ongoing technical support from Kusini Water and the relevant municipality.

Across approximately 100 communities, the organisation has built an operational base of around 92 water kiosks and six mini-grids, created over 325 jobs, and demonstrated a social return on investment of roughly R2.96 for every R1 spent. The core proposition is not that decentralised systems should fill gaps in conventional service delivery, but that they should be understood as the foundation layer of a different water infrastructure model altogether.

Origins and context

Kusini Water's founder grew up in a Limpopo village where people routinely carried water in a wheelbarrow. Returning years later, after a career in the public sector, he found the same water-collection method being practised by a young boy, which prompted the organisation. The underlying observation, refined across many communities in Limpopo, Mpumalanga, Eastern Cape, KwaZulu-Natal, and the Western and Northern Cape, was that the South African government's water service delivery system is not keeping pace with the realities on the ground. Population growth, the spatial distribution of communities, and the actual structure of household needs. Kusini Water's response has been to return to first principles: what is the source water, how can it be brought to a regulated quality standard rapidly, and how can the system be operated, maintained, and paid for at the community scale without relying on infrastructure that may never arrive.

Technology and design

The organisation's treatment system is built around the principle that everything should be as local as feasible. The organisation extracts source water (predominantly groundwater, with smaller surface water, rain, and spring sources in a few projects) via solar-powered pumps fitted with sensors that monitor flow rate and aquifer recharge. The treatment train comprises activated carbon made from macadamia nut shells (South Africa is the world's largest macadamia producer[48], making the feedstock abundant and locally sourced), nanofibre membrane filtration, multimedia polishing, and ultraviolet sterilisation. The entire system can run on solar power, reducing dependence on the electricity and water grids.

Around this technical core sit two distribution models:

- Water kiosks serve as community-scale retail points where residents fetch treated water and pay per litre.
- Mini-grids reticulate treated water into communal standpipes (with progression to in-home connections planned as the model matures), and are being piloted with both municipal meters (in the Mbombela area) and Kusini's own meters (in Limpopo).

After ten years of running a broader product range that also included rainwater harvesting, greywater recycling, household filters, water testing services, and subscription products, the organisation made a deliberate decision in 2025 to stop everything except the kiosk and mini-grid offers, on the grounds that depth of implementation in fewer communities would produce better outcomes than breadth across many.

Community-led operating model

The community engagement component is integral to the technology, not an add-on. New communities are identified through three channels: the DWS's Blue Drop status report (with attention given to municipalities and water service providers scoring below 70 per cent compliance), referrals from existing partners and donors, and word of mouth. Within each community, Kusini convenes and sits on water committees, typically working first through the tribal council and, where the institutional framework allows, through local government. Committee members are nominated and selected by the community itself. From this base, water champions are recruited through an open call and selected against a structured matrix that combines community input with Kusini's criteria.

For both service models, operators are selected from the local community in consultation with the tribal council and community members. Once selected, Kusini Water trains them to manage the day-to-day operation of either the water kiosks or the mini-grids under revenue-sharing arrangements. Operators establish a community cooperative with a bank account to manage revenue, retain a portion, and return a smaller share to Kusini Water for ongoing technical support, inventory, and oversight. Documented operator income trajectories show baseline earnings of around R1,000 per day rising to approximately R4,000 within twelve months of taking over a kiosk, with the model also tracking participation by women and people living with disabilities among operators.

Water quality assurance is layered. Water quality checks are performed at the kiosk daily, while Kusini Water commissions quarterly testing through SANAS-accredited third-party laboratories, funded by its sponsors. In some communities, municipalities also support water quality oversight by collecting samples or conducting compliance testing, although this depends on where municipal capacity exists.

Governance challenges and partnership approaches

A major barrier to scaling the model is institutional rather than technical: local governments in most rural and peri-urban contexts simply lack a clear mandate to enter the kind of operational partnership decentralised water provision would require. Mandates flow through three different layers (financial through National Treasury, operational through the national water department, and locally applied at municipal level) and are not consistently aligned. An example of this approach played out in the Mbombela area, where the municipality holds a water and sanitation mandate that includes the provision of water tankers. Kusini Water operated within this mandate by adopting its decentralised water system in a manner similar to a water tanker.

In other communities, Kusini Water has instead partnered directly with traditional authorities, who hold land-use rights and can authorise access to land and water resources in ways municipalities cannot. Across approximately 100 communities, only three have functioning direct partnerships with the relevant municipality; elsewhere, municipalities most commonly engage only at the water-quality oversight stage, once a system is already operational and visible in the community.

Kusini Water's own assessment is that the country needs a clearer framework, conceptually closer to

the PPP models used in the solar sector, to enable decentralised water provision within a regulated and accountable structure, but without privatising water itself.

Sustainability tension: mission versus commercial

A recurring tension in Kusini's operating model is balancing its social mission of providing affordable water in low-income communities where cost recovery is structurally difficult with the enterprise's commercial sustainability. Many kiosks do not break even financially because of the socio-economic conditions of the communities they serve and the limited prices they can charge for water. Pricing cannot be raised without cutting off the market that the model is intended to serve, but cannot be set too low without making the system financially unviable. Capital costs for both kiosks and mini-grids are high, payback periods are long, and the return-on-investment profile is incompatible with most private equity expectations unless the social return is explicitly priced in.

As a result, the organisation remains heavily dependent on grants. Much of its income comes from enterprise and supplier development (ESD) funding and corporate social investment (CSI) grants from partners such as Nedbank, AECI, and the Department of Science, Technology and Innovation (DSTI), which funded much of the IP development in the early years. Long-standing corporate relationships also sustain the organisation, with many funding and opportunities arising through referrals and introductions from organisations such as Nedbank and AECI. The founder's own framing is that no social enterprise in this space is genuinely 50/50: a clear choice has to be made between leaning towards mission or towards commercial scaling, and the search for funding sufficient to do both is a permanent feature of the operating environment.

What municipalities can learn from this

Several lessons emerge for municipalities considering how decentralised water provision fits into their service delivery strategy.

The first lesson is regulatory: most peri-urban and rural municipalities lack the legal framework to partner with decentralised providers in any operational way. Even modest reforms (an emergency response mandate or a recognised contracting mechanism, analogous to the water tanker mandate that enabled Mbombela's adoption) could enable municipalities to make greater use of decentralised water systems.

The second lesson is operational: where municipalities cannot afford to extend bulk infrastructure, they can play an important role by supporting water quality oversight and compliance monitoring, rather than direct service provision. A municipality can provide accredited testing and Blue Drop verification at relatively low marginal cost, while community-based champions handle the operating layer.

The third lesson concerns design: decentralised systems work best when materials, labour, and operating teams are sourced locally. Procurement approaches that support local materials, labour, and service providers may therefore strengthen decentralised delivery models.

Finally, the fourth lesson is conceptual: decentralised infrastructure should not be framed only as a stop-gap pending the arrival of conventional networked services. Many of the contexts where Kusini operates, networked services may never be the most appropriate solution.



SOCIAL ENTERPRISE BRIEFS

2.5. Reuse: Atlantis SEZ

Reusing water at the industrial cluster scale through a net zero water strategy

Atlantis Special Economic Zone (ASEZ), a green technology (greentech) industrial cluster being developed on roughly 94 hectares of greenfield land north of Cape Town[49], is implementing one of the more deliberate examples in South Africa of cluster-scale industrial water reuse. Rather than adding reuse infrastructure once industries are established, the ASEZ integrated water stewardship into its civil infrastructure design from the outset. Its explicit goal is to operate at "net zero water", meaning that the water the site loses as non-reusable is balanced against the rainwater landing on the site. The first 22-hectare zone has completed its civil infrastructure, the first factory is nearing operational handover, and the site is positioned to operate with minimal dependency on the bulk municipal water grid. The GIZ Natural Resources Stewardship Programme[50] supported the model through a study and partnered in its development. It is now being trialled in practice as the rest of the zone develops.

Origins and context

The SEZ identifies itself as "greentech" at its core, with sustainability framed as foundational to its existence: green in both the products manufactured and how they are manufactured. The current development includes a first 22-hectare zone with completed civil infrastructure, ten further parcels ready for construction, and a refurbished standalone factory.

The first factory, nearing commissioning, will produce acetylene and oxygen gas[51], for welding processes that support steel-component manufacture for solar and other ground-mounted renewable infrastructure. The 22-hectare zone is fully subscribed, with no remaining land available in that section, but the ASEZ remains in the early stages of physical build-out. While the civil infrastructure is complete and the first factory is nearing operation, much of the wider cluster remains to be developed. This means many elements of the net zero water strategy are either already installed in the initial phase or planned for implementation as additional tenants join.

Critically, the site sits on an aquifer, with sandy substrate that allows stormwater infiltration in a way a clay site could not. This single geological fact has shaped much of the water strategy: the ASEZ is able to design for recharge in a way that would not be feasible on most South African urban industrial sites.

The net zero water strategy

The strategy is structured around five strategic objectives for water stewardship, with each ring representing a more ambitious step away from a business-as-usual industrial water profile.

- The innermost ring is reduction: optimising operational and manufacturing systems and changing the underlying attitudes towards water use.
- The second ring is source-matching: being thoughtful about which water source is used for which activity. For example, using potable water for drinking, greywater for irrigation, rainwater for industrial processes, and so on, rather than treating all water as a single undifferentiated resource.
- The third ring is reuse and recycling, where used water is treated and routed back into other appropriate uses.
- The fourth ring, treated explicitly as a last resort before net zero is reached, is off-site offsetting. This involves either shifting a water-intensive step up the value chain so it happens elsewhere, or drawing on external greywater or similar sources.
- The fifth and final position is net zero water itself.

At the time of interview, the ASEZ described itself as fully implementing the first ring, with reductions pushed to the practical limit of current operations, while starting to move into the planning and early implementation of the second and third ring of source matching and beginning to implement reuse and recycling measures within the first factory. Off-site offsetting is actively avoided where possible, on the principle that displacing a water burden elsewhere defeats the purpose of the strategy.

Civil infrastructure and water stewardship design

Much of the work that determines whether net zero water is achievable is, in the ASEZ's own framing, embedded in the civil infrastructure: on what happens to water between leaving the individual building and either entering the City of Cape Town's network or returning to the ground. Conventional concrete V-drains have been replaced with half-moon swales along the road network, designed to slow stormwater, allow infiltration, and feed the aquifer below. Landscaping forms part of the site's water management approach, with vegetation and infiltration designed to support aquifer recharge. This infrastructure has been put in place well before tenants need it, on the explicit reasoning that the space and opportunity to incorporate these features is largely lost once buildings are constructed around permanent supporting infrastructure.

The first factory has two greywater systems and rainwater-harvesting infrastructure. Rainwater, which requires minimal treatment, is being routed for both industrial process use and domestic consumption in the office areas. The factory recycles greywater for showers and reuses it in industrial processes. The ASEZ estimates that, once operational, this factory will run solely on rainwater for more than half the year, with no draw on the municipal grid during those periods. A project is underway to extract borehole water from the underlying aquifer to augment supply. At the same time, irrigation will be progressively reduced, with the intention of relying on greywater for irrigation where possible.

Industrial symbiosis, with a caveat

The ASEZ subscribes to industrial symbiosis as a principle: where water cannot reasonably be reused at source within a single facility, the intention is to route it for reuse elsewhere within the zone. The fact that the entire site is held under a single legal land parcel (one Erf) significantly simplifies inter-factory water transfers, removing the regulatory complications that would arise if water were crossing property boundaries.

However, the ASEZ is explicit that industrial symbiosis should be treated as a value-add rather than a foundation. Building entire facilities on the assumption that they will depend on the outputs of another tenant introduces cascading vulnerabilities: if an anchor industry moves or ceases operations, downstream tenants are left exposed. The design principle is that each facility must be resilient enough to operate independently, with symbiotic links between tenants treated as competitive and value-adding opportunities rather than operational necessities. This framing reflects a broader caution that runs through the strategy: technologies and concepts that are promising in specific contexts should not be deified as universal solutions.

Challenges and limitations

The most practical challenge is that industrial water demand varies dramatically between tenants in ways that confound conventional planning assumptions. The ASEZ has seen agribusiness facilities indicating water demand of up to 300 kl per day, alongside other manufacturing operations whose demand is low enough to be met entirely by on-site harvested water in winter. Standard engineering estimates do not reliably predict this, which makes designing shared infrastructure ahead of tenant signing difficult.

Taking on the financial and legal responsibility for internal water management is also significantly more demanding than the path-of-least-resistance

alternative of subdividing the site and letting each tenant interface directly with the City. Additionally, the model is still in early implementation: the first factory's projected dependency on rainwater and water reuse has yet to be tested against real operating conditions.

What municipalities can learn from this

Several lessons emerge for municipalities working with or hosting industrial developments.

The civil infrastructure layer, typically established through the development approval process before individual tenants begin operating, determines industrial water outcomes. This means municipalities could increasingly build swale-based drainage, aquifer recharge design, and stormwater retention requirements into development conditions rather than relying solely on voluntary implementation.

Industrial sites with shared land tenure are administratively much easier for municipalities to manage as bulk customers than subdivided ones, and may also simplify municipal management and monitoring of NRW within those developments.

Matching water sources to use (potable, rainwater, greywater, and groundwater) is technically straightforward but requires planning and infrastructure design to recognise these as separate flows rather than treating all water as a single grid-supplied input.

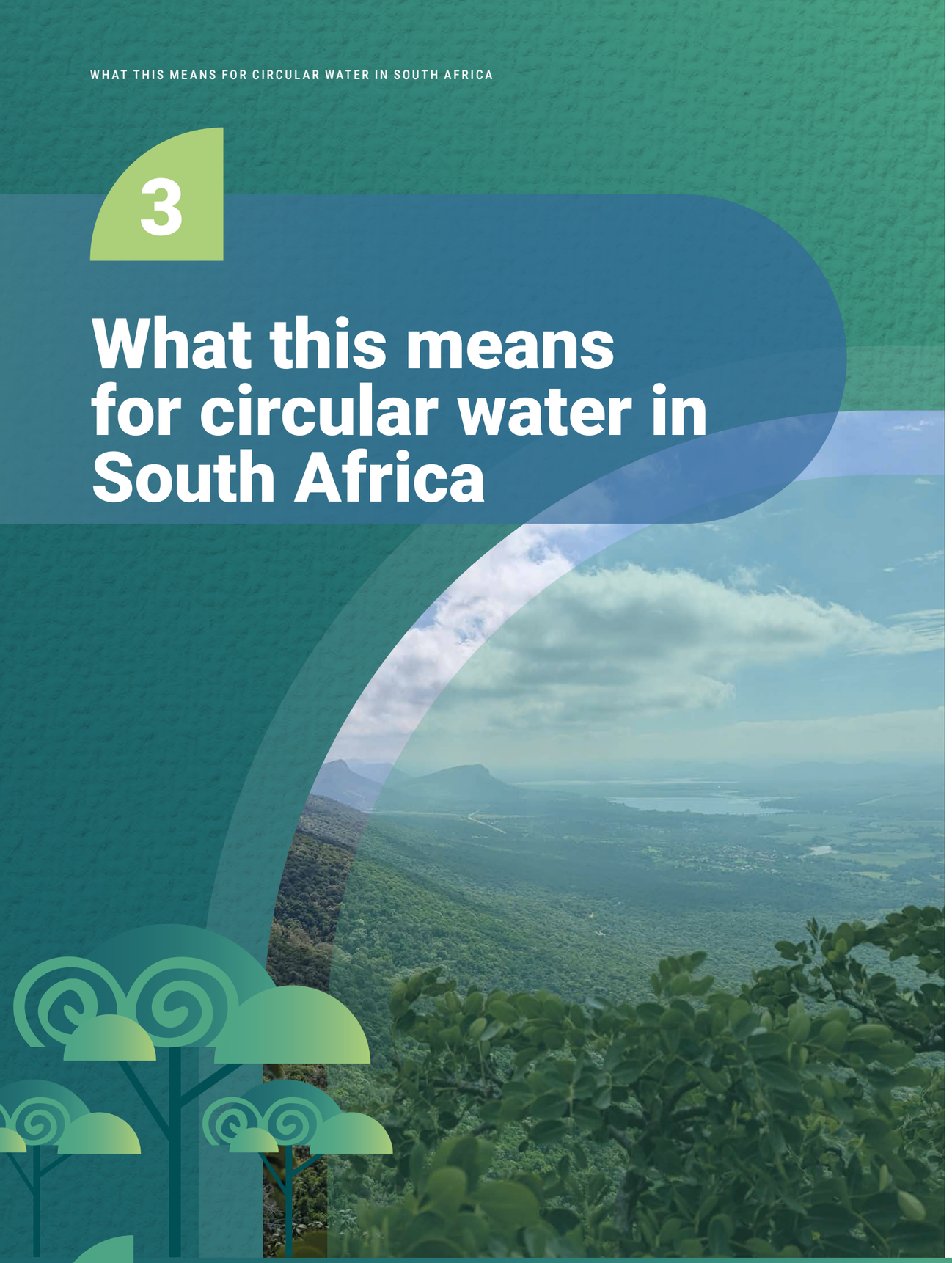
In the ASEZ's framing, the municipal role in encouraging water retention on industrial sites is comparable to the role it already plays in requiring traffic-reduction measures from new developments: the City has a direct interest in reducing the burden flowing into its own infrastructure, and can use development approval to require it.

"You've got to approach it [water] how business owners look at money... You don't want to waste it. If you had cash flow coming in, you wouldn't want to be letting your company bleed money into the City for no good reason... In the same way, why are we letting good water resources wash off our site into the City's infrastructure, where it is going to get contaminated and ultimately get fed into the sea?"



3

What this means for circular water in South Africa



WHAT THIS MEANS FOR CIRCULAR WATER IN SOUTH AFRICA

Together, these case studies reveal consistent patterns about what enables circular water management to take hold in the South African context, and what consistently obstructs it.

None of these municipalities or social enterprises operates within a standard regulatory, financial, or political environment, and yet each has found ways to make circular interventions work at a meaningful scale. The recommendations that follow draw on those shared patterns and offer a pragmatic pathway for municipalities, sector partners, and policymakers seeking to turn the tide on circular water management in South Africa.

1 **Treat crises as windows for structural reform, not just for emergency response.** Across Cape Town's recovery work, KwaDukuza's direct potable reuse plant, and the founding of SOSNPO, the same pattern recurs: South Africa's most ambitious circular water interventions were built during drought conditions, when political latitude, regulatory flexibility, and public approval temporarily aligned. The lesson is not to wait for the next crisis, but to identify and pre-position the institutional reforms (tariff structures, licensing pathways, and public participation processes) that crises typically unlock, so that the next window is used more fully.

2 **Make NRW reduction a precondition for any other circular investment.** Rustenburg's experience makes the point sharply: a municipality losing close to half its supply[52] cannot meaningfully invest in reuse, recovery, or augmentation until physical and commercial losses are brought under control. Cape Town's parallel point is that even at 15-25 per cent NRW, pressure management, repair tracking, and pipe replacement remain the foundation on which everything else sits. NRW reduction should be the first circular investment, not the last.

3 **Bring finance and billing departments into water planning from the start.** Rustenburg identified a common blind spot: a substantial share of what is recorded as "water loss" is in fact a billing and metering problem, not a leak. Joint accounting between water and finance, using methodologies such as the IWA Water Balance, consistently surfaces commercial losses that physical inspection alone cannot find. This is one of the lowest-cost, highest-return circular water interventions available to South African municipalities.

4 **Build the data layer before the dashboard layer.** Cape Town's and Rustenburg's systems both demonstrate that the value lies less in the dashboards themselves than in the structured field feedback (photographs, timestamps, location codes, and work order data) that feeds them. Municipalities considering smart metering, AMR, or asset management platforms should design data systems first for source-data integrity and second for visualisation.

5 **Recognise decentralised systems as foundational, not transitional.** Kusini Water and SOSNPO both argue that centralised, networked infrastructure will not realistically reach every rural, peri-urban and informal context in South Africa within any reasonable planning horizon. Decentralised solar-powered treatment and source-separating sanitation should be treated as a permanent component of the national water system, with bylaws, procurement processes, and operational mandates updated accordingly, rather than as stop-gaps awaiting conventional bulk supply.

6 **Create a regulated contracting pathway for decentralised water providers.** The single biggest scaling barrier Kusini Water (and SOSNPO) identified is that local government lacks a clear mandate to enter into operational partnerships with decentralised providers. An "emergency response mandate" or a recognised contracting mechanism (analogous to the water tanker mandate that enabled Mbombela's adoption) would unlock substantial latent capacity without requiring the privatisation of water itself.

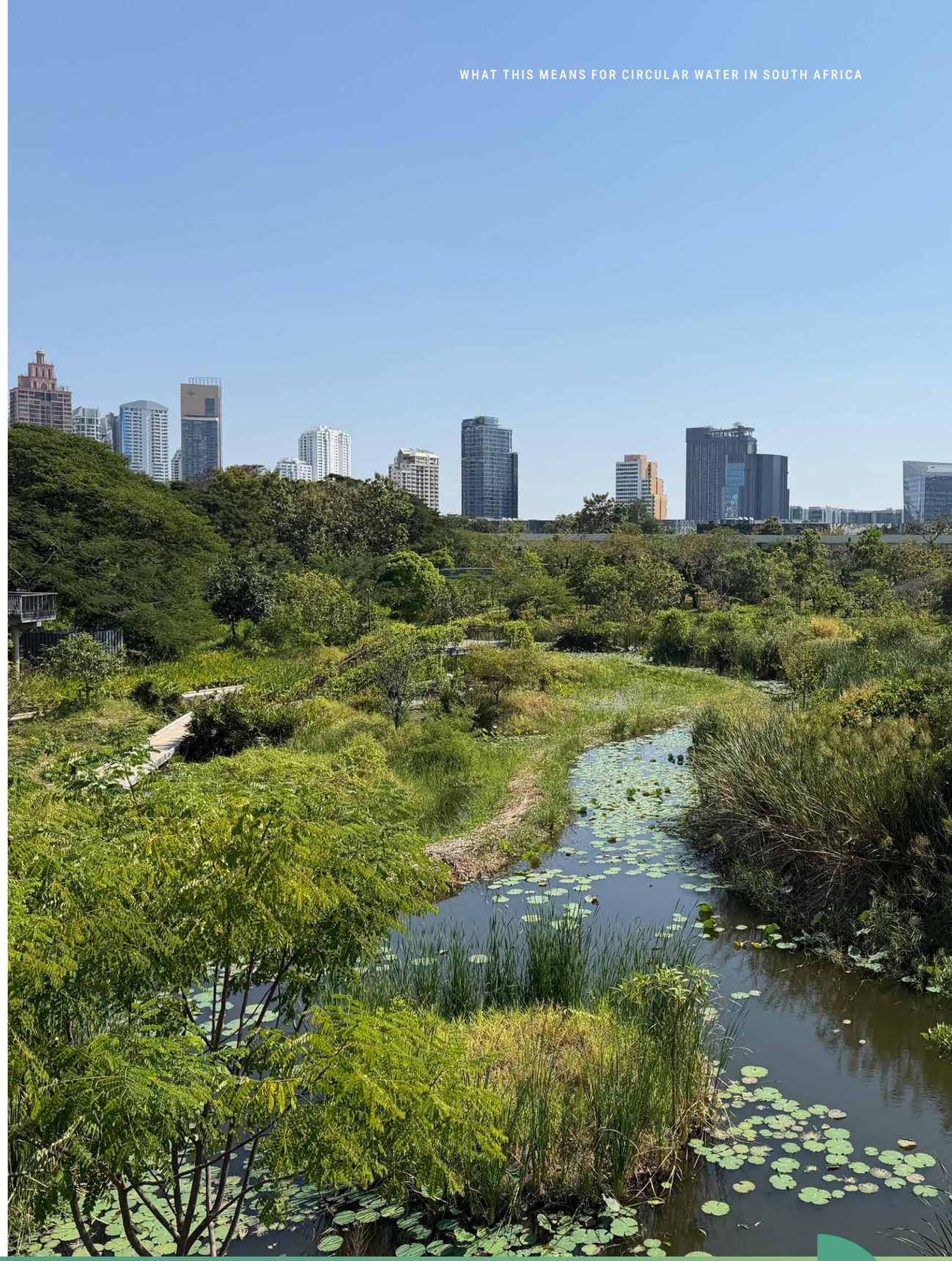
7 **Embed circular water requirements in development approval and civil infrastructure conditions.** ASEZ makes the case that the civil infrastructure layer (drainage design, aquifer recharge, stormwater retention, and source-matching of water uses) is where industrial water outcomes are determined, and that this layer is largely controlled by municipal review and approval rather than by tenants. Requiring swale-based drainage, on-site retention, and source-separated reticulation as conditions of development approval would shift the cost of circular design upstream where it is most efficient to absorb.

8 **Design for community-led operations from day one.** The GroundTruth-trained Amanzi Champs, Water for the Future's site-based workforce, Kusini Water's water champions, and SOSNPO's monitoring teams all converge on the same finding: long-term system survival depends on local operators with a direct stake in the outcome, supported by structured upskilling, fair remuneration, and genuine ongoing presence. In SOSNPO's experience, female-led maintenance teams have frequently achieved better long-term system performance. Municipalities that treat community operations as core delivery rather than as a participation exercise will see compounding returns.

9 **Coordinate around catchments and corridors, not departmental boundaries.** Water for the Future identifies departmental siloing (parks, water, waste, biodiversity, and law enforcement) as a structural barrier to urban river stewardship, and the same pattern is presented in Cape Town's incomplete integration with the Road Infrastructure Management and in Mbombela's strained relationship between Silulumanzi and other line functions. Municipalities that coordinate these mandates around a specific catchment, river corridor, or industrial cluster, even informally, see disproportionate returns relative to the administrative effort involved.

10 **Plan for the long term: water reform takes longer than a political cycle.** The Mbombela concession is twenty-seven years old. The uMngeni catchment work has been running for fifteen years. Cape Town's recovery infrastructure traces back to the 2000 drought. KwaDukuza's reuse plant took the operator six years to recover financially after the drought it was built to address. The pattern is clear: circular water management is a multi-decade institutional project, and financing models, performance frameworks, and accountability structures must be designed for that horizon rather than shorter political or budget cycles. The most replicable feature of the South African case studies is not any single technology, but the patience required to keep the work alive between crises.

WHAT THIS MEANS FOR CIRCULAR WATER IN SOUTH AFRICA



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