POLICY BRIEF

July 2025
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Institutionalising the safe implementation of direct potable reuse (DPR) in South Africa: Lessons from a laboratory to pilot demonstration project

A long-term collaborative project between the Water Research Commission (WRC) and Umngeni-uThukela Water (UUW) has provided critical insights for advancing water utility-led implementation of direct potable reuse (DPR) schemes in South Africa. Findings from the project have underscored the importance of foundational research, technology demonstration, and technical oversight as key components of the roadmap toward full-scale DPR implementation. The successful demonstration of a two-megalitre-per-day pilot plant at UUW has highlighted both the capabilities and requirements of a water utility to be able to effectively plan, design, operate, and maintain a DPR scheme. Furthermore, findings from the pilot demonstration project have provided valuable information on the technical performance of a multi-barrier DPR process, enhancing both water quality and safety, while avoiding the energy-intensive process of reverse osmosis (RO). Based on the outcomes of this project, a structured regulatory framework is recommended to mandate the implementation of DPR schemes in the water services sector in South Africa to ensure that there is planning oversight and that the reuse technologies to be deployed are rigorously tested, optimised, and monitored before full-scale implementation.

Introduction

Water scarcity is an escalating global challenge, with the recent United Nations World Water Development Report projecting that between 1.7 and 2.4 billion of the urban population will face water scarcity by 2050[1]. South Africa is already facing growing water stress due to being a water-scarce country, and the pressures of climate change, population growth, and urbanisation. South Africa's current water services provision strategy relies heavily on surface water resources, which are increasingly unreliable due to climate variability and pollution.

The National Water Resource Strategy II (NWRS-2)[2] emphasises the importance of integrating water reclamation and reuse into the country's water-supply system. South Africa's National Strategy for Water Reuse[3] was developed as part of the NWRS-2, and it was formulated following the first phase of comprehensive water reconciliation strategies, which concluded in 2011. Despite these efforts, the adoption of water reuse practices has been slower than anticipated.

While unplanned and indirect potable reuse (IPR) practices are common, the implementation of direct potable reuse (DPR) remains contentious in South Africa. Unlike DPR, indirect potable reuse involves the treatment of wastewater and releasing it into a water resource environment, which serves as a buffer, where it can then be abstracted, treated further, and integrated into the potable water distribution network. On the other hand, DPR involves treating wastewater to a high standard and directly distributing it into the drinking water system.

The South African contention on DPR is due to several challenges, including concerns for water safety considering the prevalent non-compliance of wastewater treatment works (WWTWs), public trust issues, high costs, and the technical expertise required for design and operation. For this reason, there are a few DPR plants in operation in South Africa. International DPR case studies have demonstrated that the success of such plants depends on a clear policy framework that mandates oversight from planning to operation, the implementation of a tried and tested treatment regime, continuous monitoring, as well as proactive and continuous public engagement.

[1] United Nations. (2023). World Water Development Report 2023: Water for sustainable living. United Nations Educational, Scientific and Cultural Organization (UNESCO).
[2] Department of Water Affairs (DWA) (2013) National Water Resource Strategy II: Managing water for an equitable and sustainable future. Republic of South Africa.
[3] DWA. (2011). National Strategy for Water Reuse. Republic of South Africa.

To accelerate progress, the National Water and Sanitation Master Plan (NW&SMP)[4] was introduced in 2018, aiming to fast-track priority actions for addressing water security. The plan identifies the diversification of the water resources portfolio to include alternative water supply means such as the treatment of wastewater effluent into potable (drinking) water quality (water reuse), for securing a sustainable and resilient water supply. The Water Partnership Office (WPO)[5], established in collaboration with the Development Bank of Southern Africa (DBSA) and the South African Local Government Association (SALGA), plays a pivotal role in fostering public-private partnerships within the water sector. The WPO has established a dedicated Water Reuse Programme (WRP) to expedite the implementation of water reuse projects, including Direct Potable Reuse (DPR), across the country.

Furthermore, the plan positions research, technology, and innovation as foundational elements in transforming South Africa's water and sanitation sector, with the Water Research Commission continuing to play a pivotal role in driving advancements on water reuse. Owing to significant research investments and valuable insights gained from a long-term collaborative DPR project with Umngeni-uThukela Water (UUW), the WRC is in a position to fulfil its role in providing recommendations for the institutionalization of the safe implementation of Direct Potable Reuse (DPR) in South Africa.

Collaborative project on DPR

Background

uMngeni-uThukela Water (UUW) is a state-owned entity, legislated to provide bulk potable water and other related services in KwaZulu-Natal. In line with providing a sustainable solution to water scarcity, UUW has an interest in investigating the implementation of water reuse. From 2009 to 2018, the WRC, in collaboration with UUW, commissioned a three-phased research programme aimed at investigating aspects of water reuse that would inform the implementation of a full-scale DPR plant at Darvill Wastewater Treatment Works.

Scope of the research and objectives

- **Phase one**: **laboratory and bench-scale investigations** – To evaluate the performance of a range of DPR unit process configurations to produce water that meets the mandatory national drinking water quality standards (SANS 241), and to establish an effective reclamation treatment process train for the Darvill Wastewater Treatment Works (WWTW) in KwaZulu-Natal.

- **Phase two: integration of MBR technology with advanced treatment processes –** To evaluate the integration of MBR technology with advanced treatment processes and establish the cost and operational aspects for the most effective configuration for a full-scale water reclamation plant. For this phase, five treatment trains, namely, MBR-RO-UV, MBR-O3/GAC-NF-UV, MBR-NF-O3/GAC-UV, MBR-NF-UV and MBR-O3/GAC-UF-UV were investigated.

- **Phase three: pilot demonstration** – Based on the findings from phases one and two, a 2 megalitre-per-day DPR pilot plant was installed and commissioned at Darvill WWTW. The aim of the plant to demonstrate the effectiveness of the selected treatment processes for the removal of microbial contaminants and contaminants of emerging concern (CECs) in the feed water to produce safe drinking water, assess lifecycle costs, and develop practical guidelines for the implementation, operation, and public acceptance of a full-scale Direct Potable Reuse (DPR) plant.

Key findings and lessons

- **Value of research, innovation and technology demonstration** – The water board's commitment to science-based decision-making and advancing water security has been central to this initiative. The results of the laboratory and bench-scale studies informed the overall design and technology selection for a 2 ML/day demonstration DPR plant, which successfully produced water compliant with SANS 241 standards. The foundational research conducted also informed the selection of UF membrane technology over NF and RO. This is because UF membranes have higher water recovery rates, reduced energy consumption, lower operational costs, and operate effectively with minimal chemical use. Conducting a technology demonstration was critical in ensuring that innovative water reclamation technologies are scientifically validated, that operational risks are minimised, and that public trust in the safety and reliability of DPR systems is maintained. Incorporating these elements as part of the pathway to full-scale DPR implementation provides a clear understanding of the technological, operational, and regulatory challenges involved.

[4] Department of Water and Sanitation (2018) National Water and Sanitation Master Plan Volume 1: Call to Action.
[5] South African Government News Agency. (2024). ***Water partnerships office to support funding for municipal infrastructure.***

- **Operation and maintenance aspects** – The success of the demonstration phase underscores the critical value of adequate infrastructure investment and skilled operator training to ensure reliable and continuous operation of DPR systems. However, the **shortage of national laboratory capacity** to monitor a comprehensive list of priority contaminants of emerging concerns (CECs) remains a significant challenge. This highlights the need for enhanced laboratory infrastructure and dedicated water quality standards for potable reuse plants to support ongoing monitoring, testing, and ensure water safety. Moreover, the success of this demonstration emphasizes the need to expand the risk-based framework for regulating drinking water quality from DPR plants, ensuring comprehensive oversight of both traditional contaminants and emerging risks.

- **A Learning Forum** was established as a dynamic platform to facilitate knowledge exchange, stakeholder engagement, and capacity-building throughout the WRC-UUW demonstration project. This forum also played a critical role in providing a structured space for public engagement and addressing societal concerns around DPR, contributing to greater acceptance and trust. Surveys indicate that while the public acknowledges the benefits of water reclamation, there remains resistance to DPR for drinking purposes. Therefore, structured public engagement and awareness campaigns are necessary to build public trust.

- **Role of the Reference/Technical Advisory Group in concretising findings** – A dedicated reference group played a pivotal advisory role throughout the WRC-UUW collaborative project on DPR. Comprising experts from government agencies, academic institutions, and industry stakeholders, the group provided critical oversight and strategic direction. The reference group's input was instrumental in ensuring that treatment processes met national and international drinking water safety standards, identifying potential operational and social risks, and translating the research insights into actionable policy recommendations, bridging the gap between scientific innovation and practical implementation.

Policy Recommendations

To ensure the safe and sustainable implementation of Direct Potable Reuse (DPR) in South Africa, a comprehensive and structured regulatory framework for DPR is recommended.

This regulatory framework should address the following key areas of implementation:

- **Oversight** – The WRC-UUW collaborative project demonstrated the importance of expert panels in providing guidance, unbiased evaluation of the study and promotion of transparency. Case studies from countries like Australia, Namibia, and the United States have shown that mandating the establishment of an independent advisory panel for providing oversight on planning and implementation significantly contributes to the successful implementation of DPR. Thus, making provisions for an independent advisory panel in South Africa's DPR regulatory framework would similarly enhance its implementation.

- **Planning and permitting DPR schemes** – A robust DPR planning and permitting process should be stipulated to provide a structured, transparent, and scientifically grounded process for approving DPR projects. The framework should make provisions for project planning and preparation through the Water Partnerships Office (WPO). The mandatory list of requirements to ensure that the DPR scheme is technically sound, environmentally sustainable, socially accepted, and legally compliant with national policies and regulations should be established, all of which should have clear guidelines.

- **Full-scale plant design and operational standards** – To ensure science-based decision making and safe DPR scheme implementation, the regulatory framework should have provisions for research, innovation and technology demonstration. The regulatory framework should make provisions for a multi-barrier treatment process to produce water that meets safe drinking water quality standards. Furthermore, the regulatory framework should be clear on the skill requirements and the regulatory certification programme to ensure DPR facilities are operated effectively.

- **Water quality compliance and monitoring** – An adaptive risk-based framework for managing water quality from DPR plants should be established. Key issues that need to be actioned include establishing the regulatory requirements for continuous water quality monitoring, enhancing national laboratory capacity for the detection of contaminants of emerging concern (CECs), establishing independent bodies responsible for auditing DPR systems and enforcing compliance with water safety regulations.

- **Training and knowledge sharing** – The regulatory framework should make provisions for a dedicated professional body for personnel involved in DPR. Such a body shall be mandated to develop specialized training programs and foster partnerships between government agencies, research institutions, and the private sector to facilitate knowledge exchange and promote innovation in water reuse technologies.

By integrating these regulatory measures, South Africa can enhance public confidence in DPR, mitigate risks, and ensure that potable reuse contributes to long-term water security.

Conclusion

Continuous collaborations between government, water service institutions, academia and regulatory bodies are essential to ensure the integration of water reuse into national water management strategies to ensure long-term water security. DPR represents a sustainable and viable solution to South Africa's water crisis, but its success depends on addressing regulatory, economic, technical, and social challenges. By implementing a structured regulatory framework, investing in technology and capacity building, and fostering public trust, South Africa can unlock the full potential of DPR as a resilient water supply strategy.

Further reading – Relevant WRC Reports

Metcalf G, Pillay L, Murutu C, Chiburi S, Gumede N and Gaydon P (2014) Wastewater reclamation for potable reuse. Volume 1: Evaluation of membrane bioreactor technology for pre-treatment. WRC Report No. 1894/1/14. ISBN 978-1-4312-0564-6.

Metcalf G, Pillay L, Murutu C, Chiburi S, Gumede N and Gaydon P (2014) Wastewater reclamation for potable reuse. Volume 2: Integration of MBR technology with advanced treatment processes. WRC Report No. TT 611/14. Available at: https://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/TT%20611-14.pdf

Maduray P, Getahun S, Maharaj B and Nayager K (2024) A demonstration of treatment technologies for direct potable reuse. WRC Report No. TT 942/24. ISBN 978-0-6392-0649-3. Available at https://www.wrc.org.za/wp-content/uploads/mdocs/TT%20942%20final%20web.pdf

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