Confidential

Going beyond the Infrastructure Funding Gap: A South African Perspective

Final Water and Sanitation Sector Report

June 2022

Executive Summary

Purpose and scope of document

South Africa has committed to achieving the Sustainable Development Goals (SDGs) by 2030. The Development Bank of Southern Africa (DBSA) has partnered with the World Bank to take stock of South Africa's progress towards achieving the global SDGs associated with water supply and sanitation. The intention was to apply the approach taken in the 2019 World Bank global *Beyond the Gap* report (Rozenberg & Fay, 2019) to develop scenarios for achieving the Water and Sanitation SDGs in South Africa, with a view to informing policy and practice in the water sector.

The objectives of this research are threefold:

- To quantify the infrastructure funding gap to achieve the water and sanitation SDGs by 2030, covering capital, operations and maintenance spending;
- To outline the implications of policy choices, technologies and service levels on the infrastructure funding gap; and
- To set financing targets for optimizing achievement of the water and sanitation services SDGs by 2030[1].

Methodology

The methodology for this study is based on the World Bank's *Beyond the Gap* analytical framework (Rozenberg & Fay, 2019), shown in Figure ES1.

Figure ES1: *Beyond the Gap* analytical framework (Source: Rozenberg & Fay, 2019)

[1] The model analyses the 10-year period 2021 to 2030, such that the SDGs will be achieved at the end of 2030. Data on spending in 2020/21 and 2021/22 was not available at the time of writing. Presentation of the results for the remaining effective period of the SDGs (i.e. 2022 to 2030), will be updated in the final report in late 2022, which will integrate all of the sectors under investigation for the Beyond the Gap study in South Africa.

Objectives were based heavily on the SDG indicators but interpreted at a country level in the context of South African water sector policy. This interpretation was determined through a review of national water sector policy, engagements with the Department of Water and Sanitation, Water Research Commission, and the broader Water Sector Working Group that was established to guide this study. The first objective is the provision of **universal, safe, and reliable water services**. Secondly, services need to be **financially sustainable** and affordable to both the state and to households. Thirdly, expansion of water services needs to be **resource-efficient** in order not to exceed available resources. Fourthly, water services and water resources need to be planned to **increase water resilience**, or the ability to withstand adverse climatic events, particularly in the context of climate change. Fifthly, **reducing climate change impact** is present throughout South Africa's water sector policy objectives, and in the overarching National Development Plan 2030. Finally, the South African public sector, including local government, needs to have **sufficient institutional capacity** to expand water services access and to operate and maintain these services sustainably. The Water Sector Working Group provided input into identifying metrics for each of the above objectives.

Technical servicing options were identified through the local and international literature and through interviews with water sector experts in South Africa. Climate change and socio-economic growth rates were identified as the main exogenous factors for the achievement of the water and sanitation SDGs and prior research undertaken by the CSIR was used to define these parameters.

The above factors were combined to define 24 scenarios incorporating:

- Two **service level** goals: 1) universal basic servicing; and 2) achievement of SDG 6.1 and 6.2
- Four **technology** options: 1) full conventional technology; 2) low cost technology; 3) alternative technology; and 4) extreme Water Conservation and Demand Management
- Three **socio-economic** scenarios: 1) baseline; 2) urban focus; and 3) rural focus

Each of these scenarios were modelled using two bespoke Microsoft Excel models. The first, a Water Services Model, calculated potable water demand requirements, capital and operating costs, and carbon emissions over a 10-year period from 2021 to 2030. The second, a Water Resources Model, quantified the additional capital and operating expenditure that would be required to be spent on water resources infrastructure to satisfy this potable water demand[2], to determine their cost and the extent to which they place demand on water resources.

Findings

Quantifying the costs to achieve the water and sanitation SDGs and the funding gap

- The total average annual cost (capital and operating) to achieve the SDG water and sanitation access targets varies between 2.3% and 2.7% of 2020 GDP, or between R121 billion and R131 billion (Real 2021 Rands).
- The funding gap to achieve the SDGs varies between 27% and 32% of the required expenditure between the various scenarios, amounting to between R34 billion and R38 billion per annum.
- Without either an increase in the water tariff level or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 targets by 2030.

Universal access to safe and reliable water and hygiene services

- Achieving SDG 6 (clean water and sanitation for all) is not only about the provision of new infrastructure; addressing inadequate management of existing systems is one of the major interventions required.
- For water, 48% of the 'gap' to achieving SDG 6.1 is due to quality and reliability issues.
- For sanitation, 44% of the 'gap' to achieving SDG 6.2 is due to faecal sludge management.
- There is a lack of awareness or knowledge by households, and even service providers, on how to manage faecal sludge safely.
- There is a lack of clarity around who should pay for faecal sludge management services (pit and septic tank emptying) in rural areas.

Affordable financially sustainable water services

- The lowest cost scenarios are those that include extensive Water Conservation and Demand Management, and do not provide individual services to all users.
- Capital expenditure need is dominated by renewal of existing infrastructure.

[2] Non-potable water infrastructure and water resources to satisfy this demand were explicitly excluded from the scope of the study.

- Hygiene expenditure, for both operating and capital costs, is very low compared to water and sanitation.
- There are affordability issues in providing the individual services required by the SDGs in urban informal areas.
- The largest capital investments are required in metros and intermediate city municipalities, followed by B4 rural municipalities.
- The greatest expenditure is required in dense urban areas, where the cost per household is also the lowest, indicating an efficient use of resources.

Reduced demand on freshwater resources

- The increase in demand through providing higher levels of service can be offset through savings in non-revenue water (NRW).
- Aggressive Water Conservation and Demand Management means that universal basic servicing can be achieved without a significant increase in total water demand above current levels.
- The cost of water conservation and demand management is approximately 1% of the total cost of achieving the SDGs (approximately R1.15 billion per annum) but has a significant impact on the environmental impact of the water service.
- South Africa will not achieve the desired water use efficiency targets without drastically influencing technology and behaviours adopted by all water users.

Increased water resilience

- The allocation of water between users is obviously a key policy choice which has a significant impact on urban water security, particularly in those Water Management Areas where the urban allocations are small.
- The additional capital and operating expenditure required to augment the raw water supply to meet the modelled water services scenarios ranges from around R8.7 billion per annum to R14.4 billion per annum, which represents between 6% and 11% of the overall cost.
- Climate scenarios and the levels of invasive alien plant (IAP) infestation have a large impact on water availability and thus on raw water costs.

Minimising or reducing the environmental impact of service delivery

- Reducing demand through aggressive Water Conservation and Demand Management reduces the greenhouse gas emissions in year 10 by to up to 6% below the baseline.
- Scenarios with the highest cost also have the worst environmental outcomes in terms of carbon emissions.

Building adequate institutional capacity

- Current performance of water services in South Africa, particularly in terms of reliability and quality is indicative of a decline in governance at local government level, leading to lack of capacity to manage infrastructure and sustain water services.
- Low numbers of professional engineers in most local governments remains a serious constraint in the provision of water and sanitation services.
- Management instability in the Department of Water and Sanitation is likely to have impacted on water services policy and regulation.
- There is no nationally developed strategy to develop technical capability of municipalities across all categories of municipalities. The implementation of such a strategy would cost approximately R1 billion per annum, 0.6% of the total operating and capital cost of achieving the SDGs.
- Where short- to medium-term capacity gaps exist in municipalities, capacity can be provided through a range of private sector partnership types, including concessions, leases and management contracts.

Recommendations

The recommendations for the attainment of the SDG 6.1 and 6.2 targets are listed below in order of priority, with the responsibility allocated to the relevant primary and secondary stakeholder(s).

Recommendation	Primary responsibility	Secondary responsibility
1. Implement a nationally coordinated strategy for improved governance, capacity building and institutional strengthening in the water sector		
1.1 Stabilize the DWS and introduce mechanisms to ensure accountability for implementing the National Water and Sanitation Master Plan (NWSMP).	Minister of Water and Sanitation	DWS

1.2 Improve governance of water through more coherent regulation, for example through water allocations, tariff regulation and reporting on procurement and capital expenditure.	DWS	Municipalities/ NT
1.3 Increase performance incentives for municipal good governance through peer-to-peer learning and incentive grants.	DWS & National Treasury	SALGA / Municipalities
1.4 Focus on technical capacity in municipalities, but also of national government and support agencies by implementing the capacity building strategy developed by SALGA.	DCOG	SALGA / NT (GTAC) / MISA / NT (CSP) / Municipalities
1.5 Develop mechanisms and refine incentives to facilitate partnerships with the private sector to supplement public sector capacity.	NT (GTAC)	DWS/ NWP (DBSA)
1.6 Investigate and develop measures to improve the attractiveness of the municipal environment for qualified technical personnel.	DCOG	MISA

<u>Estimated cost of quantifiable portion of recommendation 1: R1.0 billion per annum</u>

2. Prioritise Water Conservation Demand Management (WCDM)

2.1 Prioritise and incentivize WCDM through regulation, including through strict WCDM targets, potentially with penalties for not meeting these targets.	DWS	NT/ NWP (DBSA)
2.2 Allocate dedicated funding to WCDM initiatives, either as an incentive grant or as a ring-fenced portion of one of the existing water sector grants.	DWS & NT	NWP (DBSA)
2.3 Initiate the DWS 'No Drop' monitoring programme to collect data and report transparently on the levels of non-revenue water in each municipality.	DWS	Municipalities
2.4 Implement the recommendations made in the Final Report on the Status of Water Losses in the 8 Large Water Supply Systems.	DWS	Municipalities
2.5 Address non-revenue water through focusing on unmetered, unbilled connections, particularly in rural areas, through the installation of meters and flow limiters. This will require political buy-in from councillors and traditional leaders to support measures that may restrict flow but increase assurance of supply and revenue to municipalities.	Municipalities	SALGA/ NWP (DBSA)

2.6 Invest in bulk and zonal meters, including in areas that are intended to be unbilled (e.g. informal settlements).	Municipalities	SALGA/ NWP (DBSA)

Estimated cost of quantifiable portion of recommendation 2: R1.1 billion to R1.5 billion per annum

3. Improve economic regulation of water services to address chronic revenue shortages

3.1 Establish an independent economic regulator to review and regulate water and sanitation tariffs.	DWS	NT
3.2 Undertake water audits to ensure that all connections that are intended to be billed are metered.	Municipalities	SALGA / DWS
3.3 Investigate municipalities with poor cost recovery and provide capacity support to set cost reflective tariffs.	DCOG	MISA/ NT/ DWS
3.4 Undertake a nationwide campaign to address non-payment for water services.	SALGA & DWS	Municipalities

Annual funding shortfall of between R34 billion and R38 billion in the water sector.

4. Incentivise proper integrated asset management

4.1 Incentivise expenditure on operations and maintenance and integrated asset management by re-establishing and sustaining the Blue Drop and Green Drop monitoring programmes.	DWS	NT
4.2 Increase monitoring of water quality downstream of water treatment works to detect non-compliance with effluent discharge standards early.	Municipalities & CMAs	DWS/ DFFE

Estimated cost of quantifiable portion of recommendation 4: Capital expenditure of R21 billion per annum.

5. Make appropriate service level choices

5.1 Avoid the continuation of low capital cost, high operating cost service options introduced as 'interim' or 'emergency' services.	Municipalities	DWS
5.2 Continue to support the research and development efforts in this field of alternative sanitation currently taking place within the DWS and the WRC.	DWS	WRC/ NWP (DBSA)
5.3 Clarify the national policy position on housing provision and the servicing of informal settlements, including service level standards (shared vs individual).	DHS	DWS

6. Initiate a national faecal sludge management programme		
6.1 Include in the National Faecal Sludge Management Strategy a clear policy position on who is responsible for the costs of faecal sludge management (FSM) in rural areas.	DWS	SALGA
6.2 Undertake FSM campaigns, clarifying what constitutes safe FSM, that should progressively replace a focus on toilet provision in rural areas.	DWS	Municipalities
7. Better manage water resource allocations		
7.1 Review water allocations, particularly the urban agriculture split for systems serving large urban centres.	DWS / CMAs	-
7.2 Better regulate the abstraction of raw water.	DWS / CMAs	-
8. Coordinate national efforts on IAP clearing		
8.1 Identify priority areas for invasive alien plant (IAP) clearing and develop catchment protection plans, including IAP management planning at a catchment level, focused on those catchments or sub-catchments that are either at highest risk of reduction due to infestation, or the highest potential increase in yield through clearing.	DWS / CMAs	-
8.2 Clarify institutional responsibility and funding model for IAP clearing.	DWS	-
Estimated cost of quantifiable portion of recommendation 8: R650 million per annum.		

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Abbreviation list

B1	Local municipalities which are secondary cities
B2	Mostly urban local municipalities with a large town as core
B3	Mostly urban local municipalities with small towns
B4	Mostly rural municipalities, typically including former homelands
C1	District municipalities which are not the authority for water and sanitation
C2	District municipalities which are the authority for water and sanitation
CABs	Communal Ablution Blocks
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of Southern Africa
DWAF	Department of Water and Forestry (now named DWS)
DWS	Department of Water and Sanitation
EI	Ecological infrastructure
FC	Full Conventional
FSM	Faecal sludge management
GDP	Gross Domestic Product
GHG	Greenhouse gas
GHS	General household survey (undertaken by StatsSA)
GTAC	Government Technical Advisory Centre
GVA	Gross value added
IAP	Invasive alien plants
ICM	Intermediate City Municipality
IRIS	Integrated regulation information system
IWS	Intermittent water supply
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
l/c/d	Litres per capita per day
LC	Low Cost
LOS	Level of service (the service as experienced by the consumer)

MAE	Mean annual evaporation
MAP	Mean annual precipitation
MAR	Mean annual runoff
MDB	Municipal Demarcation Board
MDGs	Millennium Development Goals
MISA	Municipal Infrastructure Support Agent
Ml	Megalitre (one million litres)
NGS	Next generation sanitation
NRW	Non-revenue water
NT	National Treasury
NWSMP	National Water and Sanitation Master Plan
RCP	Representative concentration pathways (defined under climate change scenarios)
SAICE	South African Institution of Civil Engineering
SALGA	South African Local Government Association
SDGs	Sustainable Development Goals
SIV	System Input Volume
StatsSA	Statistics South Africa
UN	United Nations
VIP	Ventilated Improved Pit latrine
WCDM	Water conservation and demand management
WCWSS	Western Cape Water Supply System

1 Introduction

1.1 Project background and objectives

South Africa has a good track record of infrastructure delivery for new services at scale, resulting in the rapid expansion of access to water and sanitation from 1994 to 2019. Data from the United Nations' (UN) Joint Monitoring Programme (JMP) indicates a gradually improving trend in access to safely managed water services nationally, with the greatest gains in urban areas, largely through the housing process, with slower progress in rural areas. However, access to services has historically been measured based on the type of service and proximity to households, aligned to the Millennium Development Goals (MDGs), and not the more stringent requirements for safety and reliability provided in the Sustainable Development Goals (SDGs). This difference is critical in terms of the sustainability of services.

In urban areas most households already have access to a high level of service (such as waterborne sanitation and piped water into the household). The remaining servicing challenges, however, are concentrated in informal settlements and informal backyard dwellings within formal areas, where the scale of service delivery has not kept pace with rapid urbanisation. The poor condition of wastewater treatments works, predominately in urban areas, and the severe impact these have on the environment and downstream users, is also a challenge for the achievement of the SDGs. Service delivery has been challenged by fast growth and contestation over the legal status of the settlements, often associated with the rights to the land on which they are situated. The failure to address the basic water services[3] backlogs in these rapidly growing peri-urban areas also presents a significant risk to liveability and downstream water quality, which, in turn, impacts water security. The inequality in basic water services also varies significantly between municipalities and is often a legacy of poor planning and project implementation in the past.

In the rural areas of the former homelands, where most rural people live, the major challenge has been addressing the large water services backlog at the time of the political transition in 1994. There have been successes in water supply, both through relatively small schemes, typically in the East of the

[3] In this report and South African law, the phrase 'water services' is the collective term used to describe the provision of both the water and sanitation services, together. Where references to individual services are made, the report will specify the 'water service' or the 'sanitation service'.

country, and through serving dense settlements with larger schemes, typically in the North. However, more recent initiatives to serve more remote areas with limited access to surface water resources using large regional schemes have been fraught with planning, financial and institutional challenges. The high cost of these larger schemes highlights increasing problems with using a large regional scheme approach. The high marginal cost of serving more remote settlements where there is also lower access to water resources is slowing the rate of access to piped water. Large-scale rural sanitation programmes undertaken in the early years of democracy have been successful at delivering discreet units, but the ongoing management of these facilities by municipalities has been inadequately addressed, leaving households responsible for the operation and maintenance of on-site sanitation facilities. As a result, faecal sludge management is a pressing issue in South Africa, particularly in rural areas. Continued population growth, climate change, and environmental degradation are also likely to have a significant impact on the water resource quality and availability, which directly impacts the country's ability to meet the objectives of SDG 6.

"Continued population growth, climate change, and environmental degradation are also likely to have a significant impact on the water resource quality and availability."

Against this background, the Development Bank of Southern Africa (DBSA) has partnered with the World Bank to take stock of South Africa's progress towards achieving the global SDGs associated with water supply and sanitation. PDG was appointed by the World Bank to apply the approach taken in the 2019 World Bank global *Beyond the Gap* report (Rozenberg & Fay, 2019) to develop scenarios for achieving the Water and Sanitation SDGs in South Africa, with Zutari assisting on the water resources aspects of the analysis.

The objectives of the study are:

- To quantify the infrastructure funding gap to achieve the water and sanitation SDGs by 2030, covering capital, operations and maintenance spending;
- To outline the implications of policy choices, technologies and service levels on the infrastructure funding gap; and
- To set financing targets for optimizing achievement of the water and sanitation services SDGs by 2030.

In line with the approach taken by the global *Beyond the Gap* study, the basic servicing of water and sanitation was also modelled as a possible route to the achievement of the SDGs, and a possible outcome if the policy objectives of the country deemed this more appropriate.

1.2 Scope

The scope of the project involves the quantification of the resources required to achieve SDG 6 in South Africa by 2030. SDG 6 aims to "ensure availability and sustainable management of water and sanitation for all" (Figure 1) (United Nations, 2015).

SDG 6 seeks to ensure availability and sustainable management of water and sanitation for all. Access to safe water and sanitation and sound management of freshwater ecosystems are essential to human health and to environmental sustainability and economic prosperity (UN, 2019).

Figure 1: SDG 6 definition

There are eight targets within SDG 6. To align with the global *Beyond the Gap* study methodology and focus on access to water and sanitation, this project will focus primarily on the first two targets, with reference made to the achievement of SDG 6.4 as this is seen as an essential part of achieving SDG 6.1 and SDG 6.2:

- 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
- 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

Although the water demand requirements, and the water sources supplying this demand, need to be considered in the assessment of policy options, water resources planning, and the investigation of alternative water resource options is beyond the scope of the study. However, current and planned availability of water resources were taken into consideration, including a spatially differentiated investigation into the water resources availability and cost, how this might vary with increased climate change, and due to improved investments in ecological infrastructure (EI).

Meeting the water and sanitation SDG targets in South Africa will require strong institutions, staffed with capable people, and with sound operating systems. Therefore, building capable institutions is a critical issue in the country. The capacity needs in the South African public service to deliver a full spectrum of services are large, but for the purposes of this study, the capacity assessment is limited to planning and programme management capacity to roll out water and sanitation infrastructure, and the capacity to operate and manage the services.

1.3 Current levels of access

The starting point in assessing the costs of achieving the water and sanitation SDGs should be the current levels of access and what needs to be done to close the gap. The current levels of access to water, sanitation and hygiene services are described in the sections that follow.

Water access

For this study, six levels of service (LOS) have been defined for water supply, incorporating the three components of a safely managed supply, for both a basic and a full level of service. The General Household Survey (GHS) data used by DWS for the SDG 6 reporting has been cross tabulated according to the local interpretation of the JMP definitions (see Annexure C), to calculate the proportions of the population with access to each of the six levels of service, for the current level of service for each of the four geographies (Table 1).

Table 1: Current levels of household access to water supply

	Inadequate	***Basic - interrupted &/or polluted***	***Full LOS - polluted***	***Full LOS - interrupted***	***Basic - not interrupted & polluted***	***Full LOS - safely managed***
Urban-Formal	2%	1%	8%	14%	1%	74%
Urban-Informal	11%	17%	11%	7%	18%	36%
Rural-Traditional	41%	9%	5%	19%	7%	19%

	Inadequate	***Basic - interrupted &/or polluted***	***Full LOS - polluted***	***Full LOS - interrupted***	***Basic - not interrupted & polluted***	***Full LOS - safely managed***
Rural-Farms	25%	3%	4%	2%	12%	53%
% of total	**16%**	**5%**	**7%**	**15%**	**4%**	**54%**
Population (million)	9.4	2.7	4.2	8.6	2.5	31.8

Table 1 indicates that at present, only 54% of households have access to a 'safely managed' water supply. The service access 'gap' is thus 46% of households, but the water supply to these households is inadequate for several reasons: unimproved source, distance, pollution or service interruptions. The interventions required to address each of these issues is different, and thus the modelling and costing exercises treats each of these cases separately.

Sanitation access

Similar to Target 6.1 for water, the SDGs also use the JMP ladder for sanitation (6.2) to benchmark and assess the level of access to sanitation. An improved sanitation facility is one which is designed to hygienically separate excreta from human contact[4]. A ***basic service*** is one where the excreta is ***not safely managed***. A ***limited service*** is one where an ***improved facility is shared*** between households. All other facilities or practices are defined as inadequate and classified with open defecation. Previous definitions of basic sanitation have included shared facilities, provided these meet the criteria of safely managing excreta and being acceptable to the users. Shared services are commonly provided in dense urban informal settlements where space is a constraint. A secondary metric for universal access to sanitation is therefore the proportion of the population with access to a limited sanitation service[5].

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[4] Either the excreta are treated and disposed of in situ; the excreta are temporarily stored and then emptied and transported to treatment off-site; or transported through a sewer with wastewater and then treated off-site.

[5] Where shared services are defined as adequate if the servicing ratio is higher than one toilet per 5 households.

As for water, the DWS has aligned the definitions of service level categories used by StatsSA with the definitions used in the JMP (see Annexure C). The General Household Survey data used by DWS for the SDG 6 reporting has been cross tabulated according to the local interpretation of the JMP definitions, to calculate the proportions of the population with access to each of the six levels of service, for the current level of service for each of the four geographies (Table 2):

Table 2: Current levels of household access to sanitation

	Open defecation + Unimproved	*Limited (shared, w FSM)*	*Limited (shared, no FSM)*	*Basic (indiv. No FSM)*	*Safely managed*
Urban-Formal	3%	9%	4%	25%	58%
Urban-Informal	34%	29%	12%	8%	17%
Rural-Informal	34%	3%	1%	18%	44%
Rural-Formal	35%	2%	1%	18%	44%
% of total	**16%**	**8%**	**4%**	**22%**	**51%**
Population (million)	9.5	4.8	2.1	12.9	30.1

Table 2 indicates that at present, only 51% of households have access to 'safely managed' sanitation. The service access 'gap' is thus 49% of households, but as for water, the reasons for the service not meeting the JMP/SDG standard varies. In some cases, the sanitation facility needs to be improved, in other cases it needs to be provided on the property (not shared), and in many cases the faecal sludge needs to be properly managed. The interventions required to address each of these issues is different, and thus the modelling and costing exercise treats each of these cases separately.

Hygiene access

The limited data on hygiene that is available in the GHS 2019 (StatsSA, 2019) shows that 11% of households have no access to hygiene facilities (handwashing facilities), and 25% of households have access to only limited hygiene facilities, defined as those that have access to handwashing facilities but no soap. Approximately 64% of South African households therefore have access to adequate hygiene services (handwashing facilities with water and soap). All scenarios developed hereafter, will include the achievement of 100% coverage with adequate hygiene facilities.

2 Methodology

The methodology is based on the World Bank's *Beyond the Gap* analytical framework (Rozenberg & Fay, 2019), shown in Figure 2.

Figure 2: Beyond the Gap analytical framework (Source: Rozenberg & Fay, 2019)

- **Identify objectives:** The SDG objectives are clear, but these are interpreted at a country level. The interpretation of the SDGs for South Africa was determined through a review of national water sector policy, engagements with the Department of Water and Sanitation (DWS), Water Research Commission (WRC), and the broader Water Sector Working Group that was established specifically to make inputs to this research study.
- **Identify metrics:** The metrics flow from the objectives and were workshopped with the Water Sector Working Group to derive the metrics.
- **Identify the types of technical servicing options available in the sector:** Options were identified through the local and international literature and through interviews with water sector experts in South Africa.
- **Identify exogenous factors:** The exogenous factors identified in the study's terms of reference included population growth, urbanisation, and climate change. Additional exogenous factors, such as population density and physical location, that impact on technology choices, were identified through the literature.
- **Estimate cost of achieving objectives:** Once the technical servicing options and exogenous factors had been identified, a set of 24 scenarios were developed which encompassed the full range of possible outcomes for the factors identified. The 24 scenarios were entered into two

interlinked quantitative models to estimate the costs: a Water Services Model and a Water Resources Model. A detailed description of each of the models is presented in Annexure A. The Water Services Model is an adapted version of the Municipal Services Finance Model (MSFM) developed by PDG for DBSA and applied to South African municipalities over the past 15 years, both for assessing policy options for the country as a whole and for investment planning for individual municipalities (Thompson, Palmer & Eberhard, 1996). The acknowledgement in the National Development Plan that rural and urban contexts require different responses implies that the modelling needed to be spatially differentiated by geography type. Hence, for this study, four geographies, aligned to StatsSA settlement types, were defined: Urban-Formal, Urban-Informal, Rural Traditional and Rural Farms[6]. Some of the study's results are broken down into these categories to describe the results and make explicit some of the information required for evidence-based policy development. The cost of additional sector support arrangements was calculated separately and added to the total costs. Data sources for the costs used in the model are listed in Annexure B.

The water resources model for this study combines the outputs of the water services model with previous results derived from similar high-level national studies, complemented by a more detailed analysis of the augmentation options for individual bulk water supply systems and planned augmentation options. This secondary data was used to calculate the capital and operating costs of providing the additional water resources required to achieve SDG 6.

The water resources model is a high-level estimate of the capital and operational costs necessary to provide the additional water resource requirements to meet the *potable* water demand from the different scenarios in the water services model[7]. It is not sufficiently detailed to provide specific

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6 'Urban-formal' are settlements which have been formally planned, with freehold tenure, water on site and waterborne sanitation in most cases. 'Urban-informal' are settlements which are largely unplanned, with insecure tenure and partial services. 'Rural traditional', sometimes referred to as 'Rural-informal' are settlements, mostly in the former homelands, which have no urban economic core, communal tenure and partial services. 'Rural-farms', sometimes referred to as 'Rural formal' are typically settlements on commercial farms where services are provided privately by the farm owner.

7 The water resources calculation has been deliberately restricted to potable water because the potable demand has been modelled in detail as part of this study. The demand for non-potable water (primarily for irrigation) would require a separate modelling exercise around crop selection and water intensity and is also subject to calculation of safe yield per

information for any one system, and it does not consider the costs required to augment the bulk systems for other non-potable water users including agriculture, large industries, and the energy sector. These are addressed in more detail as part of the Reconciliation and Planning studies by DWS and periodically updated as part of the National Water Resource Strategy or Water and Sanitation Master Plan.

No *financing* sources or costs have been included on the basis that the *funding* must ultimately cover the total costs over the long term. The estimate of the overall capital costs and the difference between water service scenarios is presented at a national level, although initial estimates of water supply shortfalls are done at a local level. Some consideration is also given to the impacts of climate change and the assessment of the benefits of protecting critical ecological infrastructure primarily through the clearing of invasive alien plants, a programme that South Africa has been investing in for several years.

3 Definition of sector objectives

The *Beyond the Gap* methodology requires that sector objectives be clarified and defined to model the achievement of these objectives accurately.

3.1 Objective 1: Universal access to safe and reliable water and hygiene services

The main objective in the sector, as defined in the SDG targets and South African national policy, is the provision of universal, safe, and reliable water services. However, while the objectives of the water and sanitation SDGs are clear, their achievement will look different in different countries depending on the definitions and metrics used (see Section 4). In addition to the primary objective of universal access to services, national policy includes other objectives, which either complement or compete with the primary objective.

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resources and policy decisions regarding allocations between municipal and agricultural consumers. These considerations are beyond the scope of the study.

3.2 Objective 2: Affordable financially sustainable water services

> "The water and sanitation sector is currently not financially sustainable."
>
> (Department of Water and Sanitation, 2018)

Water services need to be provided in a financially sustainable manner that is affordable to both the state and to households. The National Water and Sanitation Master Plan (NWSMP) (DWS, 2018) states that "the water and sanitation sector is currently not financially sustainable," with public funding limited "due to the economic recession, reduced revenues and accumulating debt." This will have been further exacerbated by the COVID-19 pandemic and its impact on the fiscus and household income. This implies the need for the lowest life-cycle cost intervention and a financing arrangement that equitably distributes the incidence of that cost.

3.3 Objective 3: Reduced demand on freshwater resources

South Africa is a water-scarce country with a highly uneven distribution of surface water resources. As a result of this, however, South Africa has developed a highly integrated bulk water planning and supply system consisting of several large dams and inter-basin transfers, focused on ensuring water security for the key economic centres of the country. This means that the expansion of water services must occur in a resource-efficient manner that does not exceed the available resources. The National Development Plan 2030 states that there is a need to improve water use and water use efficiency (see Section 4.3), and that the country should reduce water demand in urban areas to 15 percent below the business-as-usual scenario by 2030 (from a 2012 baseline), which implies a reduction of consumption from 237 litres per person per day to 175 litres per person per day.

3.4 Objective 4: Increased water resilience

The scarcity of resources and the increase in service levels increases the risk of water shortages during droughts. The NWSMP (DWS, 2018) warns of a 17% water deficit by 2030. The National Water Resources Strategy[8] is the planning instrument for implementing the National Water Act and its three objectives are for: 1) Water to support development and the elimination of poverty and inequality; 2)

[8] The third version of this strategy is currently out for public comment (March 2022); therefore, the second version will be used as the basis for the *Beyond the Gap* study

Water to contribute to the economy and job creation; and 3) Water to be protected, used, developed, conserved, managed, and controlled sustainably and equitably. Water services and water resources need to be planned to increase water resilience, or the ability to withstand the shock of droughts, particularly in the context of climate change.

3.5 Objective 5: Minimising or reducing the environmental impact of service delivery

Reducing climate change impact is high on the global agenda and features in many, if not all the SDGs. South Africa's National Climate Change White Paper presents the country's climate change response, focussing on "the long-term, just transition to a climate-resilient and lower-carbon economy and society." The response has two objectives, both of which are relevant for water services: 1) to make a fair contribution to the global effort to stabilise greenhouse gas (GHG) concentrations in the atmosphere, and 2) to effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic, and environmental resilience and emergency response capacity. Increased water service access needs to address this through minimising or reducing the GHG emissions from water service provision, as well as becoming more resilient to climate change impacts.

3.6 Objective 6: Building adequate institutional capacity

Finally, the South African public sector, and specifically the local government sector, needs to have sufficient institutional capacity to expand water services access and to operate and maintain these services sustainably.

4 Proposed metrics to monitor the achievement of objectives

Six objectives have been defined above. Some of these objectives will, by design, serve as input assumptions to the modelling (for example, achieving universal access to safe and reliable water services). Other objectives will need to be measured as outputs of the modelling to evaluate the trade-offs, as these are a result of the options chosen (for example, the environmental impact of expanding access). The metrics below are thus a combination of input assumptions and output measures.

4.1 Objective 1: Universal access to safe and reliable water and hygiene services

The SDGs include specific indicator definitions to ensure that countries measure the achievement of these goals consistently. However, some interpretation can take place at country-level to align the SDG indicators with local data sets. Based on the research conducted, it was found that there is good alignment between the SDGs and the South African policy position. The policy positions on drinking water, sanitation and hygiene are discussed in more detail below.

4.1.1 Drinking water

The SDG target for drinking water is: "By 2030, achieve universal and equitable access to safe and affordable drinking water for all," measured through indicator 6.1.1; "Proportion of population using **safely managed** drinking water services." This is the primary metric through which the achievement of the objective will be monitored. The JMP definition of safely managed water supply has three components:

- Source should be 'improved', defined as being accessible on the premises.
- Water should be available when needed.
- Water should be free from contamination.

In reporting on the achievement of the SDG 6 targets, the DWS has aligned the StatsSA GHS data with the definitions used in the JMP (see Annexure C).

Given the historical emphasis on universal *basic* servicing in South Africa, a secondary metric for measuring universal water access would be the proportion of the population with access to a basic water supply. The JMP defines a 'basic' water source as one which does not meet any of the three criteria above, but is an improved source, within a 30-minute round trip (including queueing) of the dwelling. When statistical data is collected in South Africa, a distance threshold of 200m is commonly used as a measure of proximity to a water source. In discussions with the DWS, it emerged that the 200m threshold has been used as a proxy for a 30-minute round trip to be considered 'basic'.

4.1.2 Sanitation

The SDG target for sanitation is: "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations." The target is measured through the indicator 6.2.1a; "Proportion of population using **safely managed** sanitation services." For sanitation to qualify as a safely managed service according to the SDG 6 requirement, effluent from wastewater treatment works, sludge from treatments works, and faecal sludge removed from on-site sanitation facilities, needs to be properly treated, managed, and safely returned to the environment. The National Development Plan 2030 states that "before 2030, all South Africans will have affordable, reliable access to sufficient safe water and hygienic sanitation." The NWSMP states that there should be universal, sustainable sanitation provision by 2030. The national targets for sanitation and the definitions thereof provided in the NWSMP are consistent with the SDG targets. The SDG indicator will therefore be used as the primary metric for universal access to safely managed sanitation. The Medium-Term Strategic Framework sets a target of 100% functional wastewater treatment works by 2024 (Department of Planning, Monitoring and Evaluation, 2019).

4.1.3 Hygiene

South Africa does not have an explicit policy on hygiene, although aspects related to hygiene are included in the Sanitation Policy (DWS, 2016). The policy states that basic sanitation includes "appropriate health and hygiene awareness and behaviour" and a hand washing facility. Objectives which relate to the provision of sanitation access will include basic hygiene facilities, and thus there is alignment between the objectives of the SDGs and the South African government. The SDG indicator will be used as the primary metric for universal hygiene access. The SDGs aim is to have universal access to a handwashing facility for all by 2030, measured through the indicator 6.2.1b; "Proportion of population using a hand-washing facility with soap and water."

4.2 Objective 2: Affordable financially sustainable water services

Given the financial constraints described in the NWSMP, and the low levels of affordability, the objective of affordability and financial sustainability requires that the cost of achieving the universal servicing objective be as low as possible. Low cost is most often traded off against quality, level of service (including reliability of supply) and environmental externalities. An important consideration which is often neglected is the lifecycle costs of infrastructure provision; i.e., the combination of capital and operating costs over the lifespan of the infrastructure. Technological options with lower lifecycle costs should be considered when trying to achieve the SDGs. Based on the *Beyond the Gap* study, the metric used here for financial sustainability is average annual total cost (capital and operating costs over 10 years) for achieving the SDG 6 access targets, expressed as a percentage of Gross Domestic Product (GDP).

The affordability of the chosen scenario depends on a variety of factors, including the cost of the proposed solution, the level of subsidy applied to cover the cost of providing the sanitation service to indigent customers, the design and efficacy of the entity implementing the chosen solution, the level of cross-subsidy applied between customer groups and between jurisdictions (if applicable), and the level of income of the recipient household. An assessment of household affordability requires a detailed assessment of household incomes, water bills and other expenses that is beyond the scope of this study. Affordability will therefore not be directly measured but will be considered when assessing the funding gap. It is assumed that lower cost of service provision will translate into improved affordability to households.

4.3 Objective 3: Reduced demand on freshwater resources

The SDG metric for water use efficiency (Indicator 6.4.1) is related to economic output through the change in the ratio of the Gross Value Added (GVA) to the volume of water use, over time. This indicator is intended to show a decoupling of economic growth from water use. However, given the focus of this study in expanding water and sanitation access to households, it would be more appropriate to measure water use efficiency in relation to population; i.e., potable water consumption per capita. This metric includes the water consumed directly by domestic users, as well as potable water supplied to non-domestic users served by municipalities[9]. It offers a holistic understanding of the level of potable water demand nationally (including water losses). This metric also aligns to the NWSMP target to reduce domestic consumption from 237 to 175 litres per person per day by 2025[10].

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[9] Of current potable demand, 42% is from non-residential land uses and 58% from residential demand (DWS, 2018)

[10] The global average water consumption is 173 litres per capita per day.

A second metric that is useful when assessing resource efficiency is non-revenue water (NRW) as a percentage of system input volume (SIV). The current level of NRW in South Africa is 41% (Figure 3). The bulk of this NRW (85%) is through real losses in the system (technical losses, including leaks and bursts) (see Box 1). The remainder is apparent losses (inaccurate meter reading and unauthorised use). The NWSMP states that a reduction of NRW by 15% in each municipality by 2030 is necessary to increase revenue, reduce costs of water supply and decrease the negative environmental impact of excessive water consumption. While this is an ambitious target, the fact that NRW is currently so high means that it is possible. In the 7 years from 2012 to 2019, municipalities in five of the eight major water supply schemes serving metropolitan areas achieved savings of greater than 15% (over projections without WCDM), and an overall saving of 16.6% (DWS, 2019).

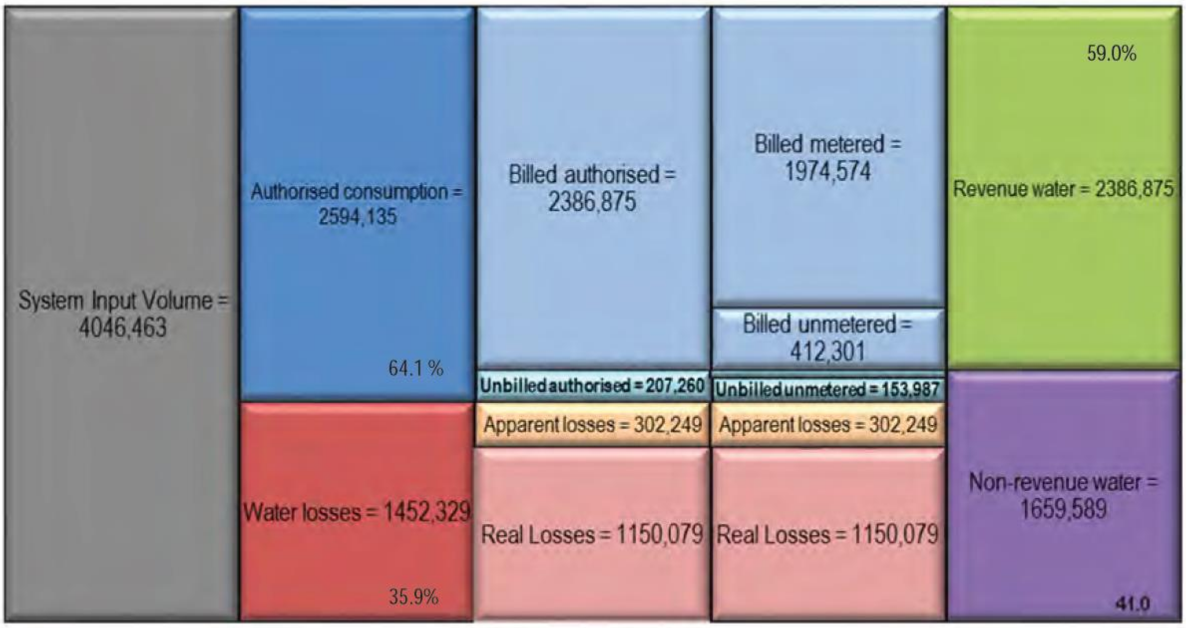

Figure 3: International Water Association water balance applied in South Africa at national level (Source: DWS, 2018:3-26)

Box 1: Reducing 'real' water losses in South African municipalities

The losses due to non-revenue water (NRW) in South African municipalities, highlighted above, are high by international standards. While some of the physical losses due to infrastructure or construction defects may be unavoidable, most are due to poorly maintained infrastructure or slow responses to reports of leakage (McKenzie, 2014).

Technical and non-technical interventions will assist in the reduction of real losses. Non-technical interventions include community awareness and education campaigns, which are essential for ensuring that technical interventions are successful, as this creates community-level stewardship of water conservation measures. Technical interventions rely firstly on sound data management, such as knowing where the infrastructure is, its condition, the volumes of water pumped into different sectors, and the volumes of water consumed in these areas. Municipalities often struggle in this regard (SALGA, 2021). From this, the most appropriate technical measure can be implemented. The most used approach is leak management and repair, and bulk metering. These solutions do not treat the larger problem, which may be failing infrastructure due to age and condition, or high water pressure. Prompt leak repair is important, but it not a sustainable solution, and leaks in some areas may be hard to detect, requiring active leakage control detection equipment. The repairing of pipe leaks is a reactive measure, that does not address the cause of the leak (which may be old pipes, water pressures that are too high, poor workmanship, etc.), and is more expensive over a pipeline's life cycle. Other technical measures which may lead to significant water loss reduction include pressure management and pipe replacement. These interventions are typically implemented due to a lack of maintenance capacity in the municipality. Pressure management has been successfully implemented in the City of Cape Town, Drakenstein Municipality and City of Johannesburg. Pipe replacement is a very expensive intervention and can yield exceptionally high reductions in real losses. eThekwini Metropolitan Municipality has spent over R1 billion replacing its pipelines, with somewhat limited successful reduction in non-revenue water. Other municipalities, such as the City of Tshwane, are incrementally rolling out pipe replacement programmes based on the frequency of pipe bursts in different sectors of their water management network. The effectiveness of these projects is best measured over a 10-year period, which makes cost-benefit analyses of these projects imperative to ensure that there is sufficient political buy-in to the financing and support of these projects (McKenzie, 2014). The prioritisation of some projects over other (capital expenditure prioritisation) is often a challenge due to the competing needs in the municipality, and the limited funding available.

4.4 Objective 4: Increased water resilience

Water resilience focuses on the ability of the entire water system to withstand shocks of various kinds (Johannessen and Wamsler, 2017). To withstand shocks related to drought, which is one of, if not the biggest climate-related risk in South Africa, key concerns are the ratio of available water supply to demand, and the management systems in place to deal with water shortages (see Box 2). The management systems cannot be measured as part of this study, but the balance of supply and demand can be. For each of the major bulk water supply systems in the country, DWS undertakes a periodic review which includes updating of future demands and looking to balance these with updated estimates of potential augmentation options. South Africa already has a highly developed surface water supply system and as a result there are only very few remaining sustainable surface water supply options available, and as such the future augmentation options are increasingly considering alternative supply options such as seawater desalination, groundwater abstraction, and direct potable re-use (DPR). Improved water conservation and demand management (WCDM) is also critical to achieving the desired water balance.

SDG Indicator 6.4.2 measures the level of water stress in the country as the freshwater withdrawal as a proportion of available freshwater resources (after considering environmental water requirements). This measurement aligns to the emphasis in the NWSMP and the National Water Resource Strategy on promoting alternative supplies of freshwater, including direct potable reuse, non-potable reuse for industrial and irrigation purposes, desalination of sea water and brackish water, treatment and use of acid mine drainage, and rainwater harvesting. Decrease in surface water can be a result of either supply decrease, reduced water quality or demand increase. While the water resources model considers a range of alternative water sources, the data is not adequate at a national level to measure the water resilience performance of a proposed scenario from a supply perspective and the modelling treats supply decrease as an exogenous climate-induced factor. Demand, however, is impacted on by several policy choices implicit in the scenarios and an appropriate indicator is therefore the total volume of potable water projected to be used in 2030.

Box 2: Demand responses to drought in Cape Town (2016-2018)

During 2016-2018, there was a period of severe water shortage in Cape Town due to a multi-year drought that had started in 2015. This prolonged period of rainfall well below normal placed enormous pressure on the City of Cape Town's water supply. The Western Cape Water Supply

System (WCWSS) is a largely rainfall-fed water supply system that provides water to an area that generates 14% of the country's GDP.

Domestic consumption in households uses the largest share (70%) of the city's water supply, making actions to curb household water demand essential. The municipal authorities introduced water conservation and demand management (WCDM) strategies that can be divided into price and non-price mechanisms. The price interventions comprised of increasing water tariffs drastically in seven levels, while the non-price mechanisms involved water restrictions (limits on allowed activities, installing water management devices that restrict the flow of water and so limit household consumption to below a set level, and aggressive pressure management interventions) and awareness-raising campaigns (i.e., threat of 'Day Zero' when domestic taps would be completely turned off unless consumption was reduced).

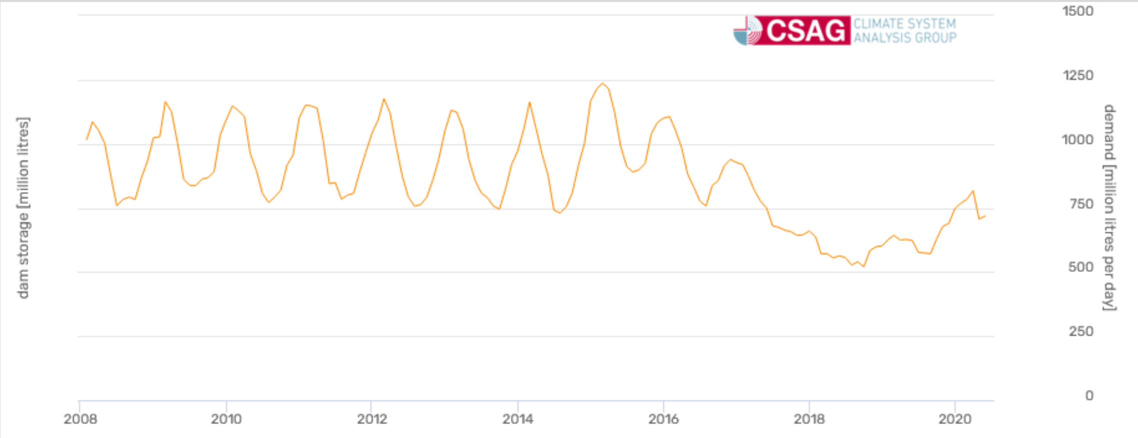

Figure i: Cape Town water demand 2008-2020 (Source: Climate System Analysis Group, 2020).

Research was conducted by Matikinca, Ziervogel & Enqvist (2020) that found that price mechanisms were less effective than non-price mechanisms in changing people's habits and practices regarding water conservation (for paying customers). The authors found that simply adjusting the price of water does not drive down consumption to reach water conservation goals. Non-price mechanisms such as water restrictions and education and awareness-raising were found to be more effective in influencing behavioural change, especially when it came to learning new ways to keep clean. The lesson learned is that behavioural nudges for a stronger water conservation culture should be factored into water demand management strategies.

4.5 Objective 5: Minimising or reducing the environmental impact of service delivery

The objective to reduce GHG emissions means that the policy options to achieve SDG 6 should consider the impact of the proposed solution on both the local and the broader environment. The proposed indicator to assess this impact is the change in the annual tonnes of CO_2 equivalent emitted by the water services sector, including electricity and other energy through the full value chain, as well as direct emissions from wastewater treatment. This indicator aligns with SDG targets 9.4[11] and 13.2[12].

Some servicing strategies may increase water demand (for example, moving from stand pipe to house connection), and may decrease the environmental reserve and have a subsequent negative impact on freshwater ecosystems. A proxy metric to measure this impact would be the increase in domestic water demand, which is the same metric used for water resilience, above.

4.6 Objective 6: Building adequate institutional capacity

Institutional capacity has several dimensions, spanning leadership, governance, systems, and people. None of these are particularly easy to measure. One of the dimensions that has been measured in the past is the number of engineers per 10,000 population. However, data is inadequate to use this as an input metric, and it is also not possible to use this as an output metric, as there is no benchmark or established intervention to increase the number of engineers in the water services sector.

4.7 Summary of metrics

The metrics that have been used as either input assumptions or output metrics for the modelling are given in Table 3.

[11] By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

[12] Integrate climate change measures into national policies, strategies and planning

Table 3: Metrics used to quantify achievement of sector objectives

	Objective		***Metric***	***Target (2030)***	***Metric type***
1	Universal access to safe and reliable water services	Safely managed (JMP definition)	Proportion of population using safely managed drinking water services	100% (SDG achievement)	Input assumption
			Proportion of population using safely managed sanitation services	100% (SDG achievement)	Input assumption
			Proportion of population using a hand-washing facility with soap and water	100% (SDG achievement and universal basic servicing)	Input assumption
		Basic services (DWS policy definition)	Proportion of population with a basic water supply	100% (Universal basic servicing)	Input assumption
			Proportion of population with limited sanitation.	100% (Universal basic servicing)	Input assumption
2	Financially sustainable water services		Average annual total cost (capital and operating costs over 10 years) expressed as a percentage of GDP	Low as possible	Output metric
3	Reduced demand on freshwater resources		Domestic water consumption (including losses) in 2030 divided by population	175 litres per person per day	Output metric
4	Increased water resilience		NRW as a percentage of system input volume	15% reduction against 2020 baseline (all scenarios except WCDM)	Input assumption

	Objective	*Metric*	*Target (2030)*	*Metric type*
			20% NRW by 2030 (WCDM scenarios)	
		As for objective 3: Domestic water consumption (including losses) in 2030 divided by population	175 litres per person per day	Output metric
5	Minimising or reducing environmental impact	Change in the annual tonnes of CO_2 equivalent emitted by the water services sector	<0 (against a 2020 baseline)	Output metric
		As for objective 3: Domestic water consumption (including losses) in 2030 divided by population	175 litres per person per day	Output metric
		None		
6	Building adequate institutional capacity	None		

5 Scenarios

5.1 Scenario definitions

Scenarios are an integral part of the *Beyond the Gap* methodology and are a useful tool to inform policymaking as they distil, and make explicit, the policy choices and trade-offs. Alternative scenarios have been defined in this study to enable rapid cost-effective expansion of water and sanitation services without compromising quality and environmental safeguard standards. They illustrate the trade-offs between potentially competing sector objectives and indicate the robustness of policy choices under differing exogenous circumstances. Scenarios also help to distil the cost drivers behind service provision.

The chosen scenarios for the water services modelling have three dimensions, including two sets of endogenous factors[13] and one exogenous factor[14]:

Endogenous factors:

- Two **service level** goals: Universal basic servicing (Scenario prefix 1); Achievement of SDG 6.1 and 6.2 (Scenario prefix 2) (see Section 5.2)
- Four **technology** options: Full conventional (F); Low Cost (L); Alternative (A); water conservation and demand management (WCDM) (W) (see Section 5.3)

Exogenous factor:

- Three **socio-economic** scenarios: Baseline (B); Urban (U); Rural (R) (see Section 5.4)

A naming convention has been applied to the 24 modelled scenarios. The prefix of (1) and (2) represent the Goal of the scenario being modelled. The second of the three characters in the abbreviation is the socio-economic scenario being modelled (B, U, or R), and the final character is the technology scenario being modelled (F, L, A or W). A summary of the 24 modelled water services scenarios is shown in Table 4 below.

Table 4: Summary of the scenarios modelled

Goal name	***Technology scenario***	***Socio-economic scenario abbreviation***		
		Baseline (B)	***Urban (U)***	***Rural (R)***
Goal 1: Universal Basic Servicing	Full conventional	1BF	1UF	1RF
	Low cost	1BL	1UL	1RL
	Alternative	1BA	1UA	1RA
	Water conservation and demand management	1BW	1UW	1RW

13 Explained or calculated from within the model being studied.

14 Determined by factors outside the model being studied.

Goal name	***Technology scenario***	***Socio-economic scenario abbreviation***		
		Baseline (B)	***Urban (U)***	***Rural (R)***
Goal 2: Achieving the SDGs	Full conventional	2BF	2UF	2RF
	Low cost	2BL	2UL	2RL
	Alternative	2BA	2UA	2RA
	Water conservation and demand management	2BW	2UW	2RW

The water resources modelling includes a set of exogenous climate change scenarios and a set of endogenous factors relating to the management of invasive alien plants (IAPs):

- Three **climate change scenarios** were derived from the Council for Scientific and Industrial Research (CSIR) Greenbook (CSIR, 2019) that include a range of possible future scenarios (10th, 50th and 90th percentile) under the most extreme Representative Concentration Pathway (RCP) 8.5 scenario[15].
- Three **IAP clearing** scenarios were defined as: 'Do nothing,' 'Maintenance,' and 'Active clearing.'

The scenarios are described in more detail in the following sections.

5.2 Service level goals

The difference between the two service level targets is that the universal basic services allow for water and sanitation services to be shared between up to five households in urban informal and rural traditional areas, corresponding to the JMP definition of 'basic' and 'limited' services for water and

[15] The Green Book analysis used six Global Circulation Models (GCMs), the Australian Community Climate and Earth System Simulator (ACCESS1-0), the Max Planck Institute Coupled Earth System Model (MPI-ESM-LR), the Geophysical Fluid Dynamics Laboratory Coupled Model (GFDL-CM3), the Norwegian Earth System Model (NorESM1-M), the National Centre for Meteorological Research Coupled Global Climate Model, version 5 (CNRM-CM5) and the Community Climate System Model (CCSM4) (Beraki, Le Roux and Ludick, 2019).

sanitation respectively (Table 5). The reason this has been defined as a service level goal is that it is consistent with current South African water sector policy on basic service access (described in Annexure C), and it is also consistent with the global *Beyond the Gap* methodology. The achievement of SDG 6.1 and 6.2 uses the strict definition of safely managed services as a target, which includes universal access to individual services on the property.

Table 5: 2030 service level targets for the two service level goals

Settlement type	***Universal basic services***		***Achievement of SDG 6.1 and 6.2***	
	Water	**Sanitation**	**Water**	**Sanitation**
Urban formal	Safely managed	Safely managed	Safely managed	Safely managed
Urban informal	Basic (shared)	Limited (shared)	Safely managed	Safely managed
Rural traditional	Basic (shared)	Limited (shared)	Safely managed	Safely managed
Rural farms	Basic (shared)	Safely managed	Safely managed	Safely managed

The Universal basic services goal is more aligned to the Millennium Development Goals (MDGs) and does not achieve the SDGs by 2030 and thus, strictly speaking, should not be included in a discussion of how much it would cost to achieve the SDGs by 2030 (see Box 3). However, it is presented as a secondary alternative, for comparison purposes and to highlight some of the technical, financial and political trade-offs relevant to the debate.

Box 3: The implications of shifts from MDGs to SDGs in South Africa

The shift from the Millennium Development Goals (MDGs) to the SDGs included a shift in emphasis from simply access, to the concept of 'safely managed' access, which includes the requirement that water be individually provided, uninterrupted and unpolluted, and that sanitation services include safe faecal sludge management. South Africa has a good track record at increasing access to water and sanitation services, but a less successful record at maintaining these at an adequate level. Thus, for South Africa, the shift from the MDGs to the SDGs means a shift in emphasis on capital spending and project management, to the proper and sustainable management of safely managed services.

5.3 Technology options

The principles behind the specification of the technology options are as follows:

- The **full conventional** option provides services using the current technology mix (status quo).
- The **low-cost** option prioritises the lowest cost technologies, and shared services wherever possible (given the applicable goal).
- The **alternative technologies** option attempts to minimise water use and energy use in the collection, storage, transport and treatment of water and wastewater.
- The **WCDM option** is specified with the same technology mix as the alternative technology scenario but pushes demand reduction measures to what can be considered the maximum feasible level. All other scenarios contain a target to reduce technical losses to 26% (i.e., a 15% reduction from 41%) and demand management to limit excessive consumption. The WCDM scenario reduces the technical losses further, down to 20% over the 10-year study period.

The current technology mix is shown in Table 6 for water and Table 7 for sanitation, below. This technology mix is drawn from Community Survey 2016 (StatsSA, 2016), which is the most recent statistically relevant survey at municipal level. Where the full conventional scenario is applied, the inadequate technologies are upgraded into either basic services, or technologies that achieve the SDGs, depending on the scenario being modelled. More information on how the technologies, as defined by StatsSA, are mapped onto the achievement of the SDGS, as defined by the JMP, is available in Annexure C.

Table 6: Current access to services and level of service for new service to achieve SDGs (water)

	Current service mix	Assumed service level for new services to achieve SDG			
		Urban-Formal	Urban-Informal	Rural-Informal	Rural-Formal
Metered household from municipal supply	46%	100%			52%
Onsite supply from own borehole	2%				39%
Onsite supply from well/spring	4%				9%
Metered yard tap from municipal supply	27%		100%	100%	
Roof tank from municipal supply (i.e. regulated supply)					

	Current service mix	Assumed service level for new services to achieve SDG			
		Urban-Formal	Urban-Informal	Rural-Informal	Rural-Formal
Public/communal standpipes from municipal supply	15%				
Inadequate	6%				
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Table 7: Current access to services and level of service for new service to achieve SDGs (sanitation)

	Current service mix	Assumed service level for new services to achieve SDG			
		Urban-Formal	Urban-Informal	Rural-Informal	Rural-Formal
Full flush system, connected to sewer	57%	100%	70%	2%	9%
Full flush system, connected to decentralised treatment					
Full flush system, connected to septic tank	4%			1%	13%
Pour flush system, connected to sewer			15%		
Pour flush system, connected to septic tank					1%
Pour flush with soakaway/leech pit					
VIP with emptying and treatment	21%			95%	77%
VIP double pit (i.e. no emptying and treatment)					
Dry pit with biochar treatment					
Containerised (chemical, container) i.e. requiring offsite treatment	2%	0%	15%	2%	0%
No water, onsite treatment (e.g. composting, UD toilets)					
Water, onsite treatment within unit (most likely NGS)					
Water, onsite treatment (Biodigester/biogas systems)					
Inadequate	16%				
Total	**100%**	**100%**	**100%**	**100%**	**100%**

The specification of the options is summarised in Table 8 and Table 9 respectively.

Table 8: Technology option specification for water

	Full conventional	**Low cost**	**Alternative technologies**	**WCDM**
Urban formal	In-house connection	In-house connection or yard tap	In-house connection or on-site borehole	As for alternative, but with more stringent WCDM measures
Urban informal	Yard tap or public standpipe	Public standpipe or on-site well/spring	Yard tap or public standpipe	As for alternative, but with more stringent WCDM measures
Rural traditional	Yard tap or public standpipe	Local borehole or spring to yard tap or standpipe	Yard tap, public standpipe with decentralised abstraction and treatment, on-site borehole, on-site well/spring	As for alternative, but with more stringent WCDM measures
Rural farms	In-house, on-site borehole, on-site well/spring	Yard tap or public standpipe	On-site borehole or on-site well/spring	As for alternative, but with more stringent WCDM measures

Table 9: Technology option specification for sanitation

	Full conventional	***Low cost***	***Alternative technologies***	***WCDM***
Urban formal	Flush toilet connected to sewerage	Pour flush toilet connected to sewerage	Combination of flush toilets connected to sewerage and some on-site treatment, and maximum realistic uptake of Next Generation Sanitation (NGS) and with decentralised treatment.	As for alternative

	Full conventional	*Low cost*	*Alternative technologies*	*WCDM*
Urban informal	Flush and pour flush toilets connected to sewerage, on-site containerised	Pour flush toilet connected to sewerage	Combination of pour flush connected to sewerage with some on-site treatment and NGS.	As for alternative
Rural traditional	VIP	VIP (single and double), on-site dry (composting and UD)	On-site NGS and on-site treatment	As for alternative
Rural farms	VIP and septic tank	Pour flush toilet connected to septic tank	On-site NGS and on-site treatment	As for alternative

5.4 Socio-economic trajectories

The socio-economic trajectories are a combination of population growth, urban-rural population distribution and economic growth projections, and were developed by the CSIR (see World Bank, 2021). The baseline population projection is based on StatsSA long-term population projections to 2050. All three scenarios contain the same end-point population in 2030, but the Urban and Rural Scenarios represent the population distributions because of unconstrained urbanisation and a rural prioritisation programme respectively. The Baseline (Status Quo) scenario is the demographic projection made by StatsSA based on macro-level demographic trends in fertility, mortality and inter- and intra-national migration patterns. This is largely an extrapolation of historical trends. The Urban scenario assumed that the current trend of urbanisation continues, where people migrate to cities that are experiencing economic growth. This predominately means in-migration from the Eastern Cape, Mpumalanga, Limpopo and North West to the provinces with large urban areas (mainly Gauteng and the Western Cape). The Rural scenario assumes that the government's plans to regenerate rural economies (particularly interventions in rural education, health and sanitation facilities) are successful, and the urbanisation rate decreases. Interventions in areas under traditional tenure (tribal authority) in KwaZulu-Natal, Eastern Cape, Limpopo, Mpumalanga and North West are most likely to reduce out-migration (World Bank, 2021).

Population projections were provided at a municipal level, which were then converted to the four geographies used in the water services model through the 2016 Community Survey[16] split of urban formal, urban informal, rural traditional and rural farms in each municipality, which was assumed to remain constant over time. The annual GDP growth projection for the three socio-economic trajectories varies over the model period (Figure 4), but the maximum difference in the average annual GDP growth between the scenarios is only 0.43% (Table 10).

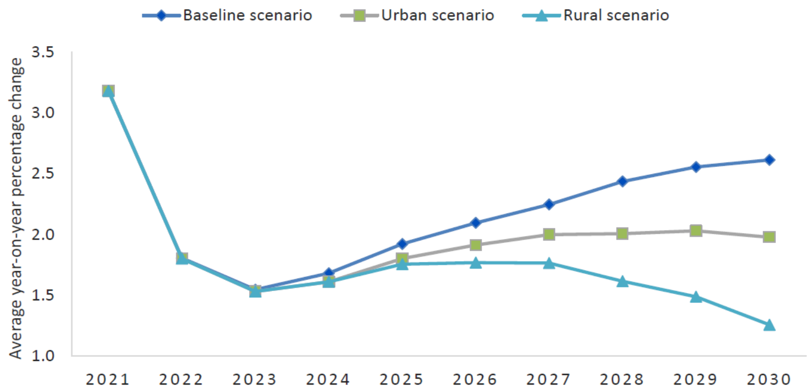

Figure 4: World Bank GDP growth projection for the three scenarios, 2021-2030 (World Bank, 2021)

Table 10: Average annual GDP growth per scenario

Scenario	***Average Annual GDP growth (2021-2030)***
Baseline	2.21%
Urban	1.98%
Rural	1.78%

[16] As mentioned previously the 2016 Community Survey is the most recent statistically significant survey, at municipal level, that contains information on the geography type (i.e., urban vs. rural) and the physical structure surveyed (i.e., formal vs. informal). It allows for the cross-tabulation necessary to differentiate appropriate service level and technology mix per geography type.

Given the small differences in economic growth rate and geographic distribution between the three socio-economic scenarios, the use of these trajectories did not highlight any valuable insight into cost drivers, as the cost differences between them were small. In many of the graphs of the results that follow, the three scenarios are collapsed into one, representing the baseline scenario.

5.5 Climate scenarios

The climate scenarios used in the water resources model draw heavily from the work done for the CSIR Green Book, both in localising global climate projections (Engelbrecht et al., 2019), as well as in assessing the impact of climate change on water supply and demand (Cullis & Phillips, 2019). The Green Book presents two of the globally agreed Representative Concentration Pathways (RCPs) (Intergovernmental Panel on Climate Change, 2007), namely RCP 4.5 and 8.5, and assessed the impact on average temperature, mean annual evaporation (MAE), mean annual precipitation (MAP), and mean annual runoff (MAR) for every municipality in the country. Given the short timeframe of this study (i.e., up to 2030), the difference in the climate change scenarios is small, particularly regarding the mean or median precipitation impacts, and there is often greater variability between models than between different climate scenarios. For this reason, a range of the results from the worst-case RCP 8.5 scenario, are used to provide the clearest indication of how climate change may impact on the costs and policy choices. From the RCP 8.5 scenario, the 10%, 50% and 90% percentile figures are used for the three scenarios, representing dry (10th), median (50th) and wet (90th) scenarios. Changes in water demand were linked to changes in the MAE, changes in surface water supply are linked to changes in MAR, and changes in ground water supply are linked to changes in MAP. The resulting projections of available surface and ground water supply have been used as inputs into the water resources model to assess against the projected increase in municipal potable water demand. It is acknowledged that this is a very simplistic assessment of the impacts of climate change, particularly as it does not consider changes in seasonality or inter-annual variability, which are particularly relevant for water security, but it is sufficient for a first order assessment at a national level. Where more detailed modelling studies of climate change impacts on individual water supply systems are available, including one study of the national system (Cullis et al., 2015), these are considered when interpreting the results of this study. It is also assumed that there are no changes in the allocation of raw water between the different types of users (agricultural, municipal, energy generation, ecological reserve, etc.) as this is a policy decision that requires further investigation which is outside the scope of this study (see Box 4).

Box 4: Water use allocations in Western Cape during the drought (2016-2018)

The Western Cape Water Supply System provides water for urban consumption to several municipalities and provides raw water to agricultural users in the area. During the drought period, there was a need to protect lives and livelihoods, which therefore necessitated a reallocation of water rights between the users.

The agriculture sector was forced to reduce its withdrawal on the WCWSS by up to 60%, while urban areas had their allocations reduced by 45%. Although this was perceived as unfair by agricultural users (Gosling, 2018), it was necessary to ensure sufficient water in the City of Cape Town for basic health and hygiene reasons (Ziervogel, 2019). The DWS negotiated a donation of 10 million cubic metres (approximately twenty days of urban water supply) of water from a privately held dam, managed by the Groenland Water User Association to supplement the City of Cape Town's urban water supply. This was hailed as a significant contribution to the drought response (ENCA, 2018) and one of the reasons that 'Day Zero' was avoided in Cape Town.

5.6 Water resources options

The National Water Resources Strategy outlines the strategic options available for the country's largest water systems. It investigates the measures available to supply raw water from alternative sources, as many of these catchments will be under stress by 2035. Much of the planning for the augmentation of the larger water supply schemes has already been done and continues to be updated on a regular basis through the individual Reconciliation Studies for the major raw water supply schemes and even some of the smaller "stand alone" DWS operated schemes. A national synthesis of the proposed interventions for all the regional raw water supply schemes, including high level cost estimates for the implementation of these interventions, was undertaken by DWS (then DWAF) in 2012. That study forms the basis of the analysis as only a few of the identified schemes have subsequently been implemented. The costs are escalated to current day costs and have been compared with other more recent studies such as the City of Cape Town Water Strategy and any updated Reconciliation Studies, to get the most accurate cost.

In addition to the interventions in the national synthesis report, an alternative option being considered to augment or restore surface water capacity, is the clearing of invasive alien plants (IAPs), which have been shown to have a significant impact on water resource availability, particularly a detrimental impact if allowed to continue to spread (Le Maitre et al., 2013; Cullis et al., 2007). Three scenarios for IAP clearing are considered in the water resource model:

- a **'do nothing'** scenario which results in infestation and a reduction in surface water yield in affected catchments;
- a **'maintenance'** scenario whereby the levels of infestation are maintained at current levels; and
- an **'active clearing'** scenario where IAPs are cleared to produce a maximum increase in surface water yield in affected catchments.

6 Findings

6.1 Quantifying the cost to achieve the water and sanitation SDGs by 2030 and the funding gap

6.1.1 Total expenditure required

The total average annual cost (capital and operating) to achieve the SDG water and sanitation access targets varies between 2.3% and 2.7% of 2020 GDP or between R121 billion and R131 billion (Real 2021 Rands) per annum over 10 years for water services (including water resources to service the potable demand and excluding financing costs). (see Figure 5)[17]. The three socio-economic scenarios (Urban, Baseline, and Rural) are not individually presented in the following graphs, as the cost results for each of these three scenarios are within 2% of each other.

> "The total average annual cost to achieve the water and sanitation access targets varies between 2.3% and 2.7% of 2020 GDP, or between R121 billion and R131 billion (Real 2021 Rands)"

[17] The model analyses the 10-year period 2021 to 2030, such that the SDGs will be achieved at the end of 2030. Data on spending in 2020/21 and 2021/22 was not available at the time of writing. Presentation of the results for the remaining effective period of the SDGs (i.e. 2022 to 2030), will be updated in the final report in late 2022, which will integrate all of the sectors under investigation for the Beyond the Gap study in South Africa.

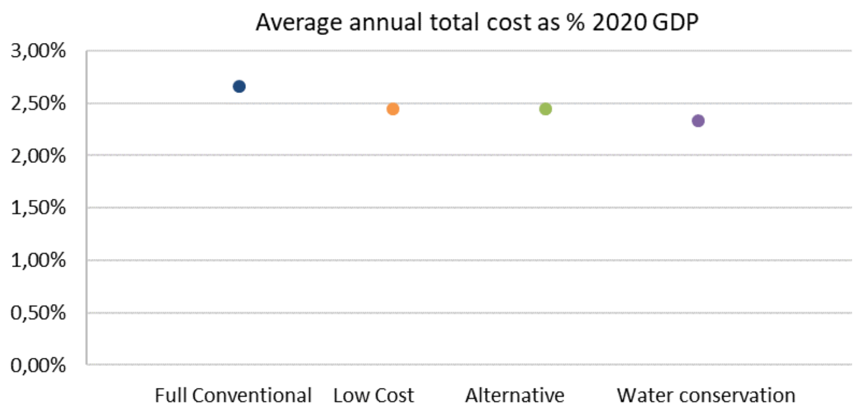

Figure 5: Total cost results for the modelled scenarios to attain the SDGs

6.1.2 Quantifying the funding gap

> "The remaining funding gap varies between 27% and 32% of the required expenditure between the various scenarios, amounting to between R34 billion and R38 billion per annum."

The funding gap is expressed as the difference between the total costs to meet SDG 6 and the available public funding. The estimated available funding in the SDG scenarios is approximately R100 billion per annum (Real 2021 Rands). The remaining funding gap varies between 27% and 32% of the required expenditure between the various scenarios, amounting to between R34 billion and R38 billion per annum[18]. The gap is relatively consistent across scenarios because higher cost, higher service level options are associated with greater user charges and development charges revenue. The funding gap of the 'Basic Servicing' goal, expressed as a percentage of expenditure, is therefore similar to the gap for achieving the full SDG definition of 'safely managed' services. Scenarios representing the high cost ('achievement of the SDGs with Full Conventional services') and low cost ('Basic servicing with aggressive WCDM') scenarios are shown in Figure 6 and Figure 7 respectively below.

[18] The NWSMP (DWS, 2018) calculated the funding gap in the sector to be a similar figure of R33 billion per annum. However, the NWSMP figure includes all water resources infrastructure, whereas this study only includes water resources to satisfy potable demand. Additional funding required to cater for growth in non-potable demand has not been quantified in this study and would need to be added to the funding gap.

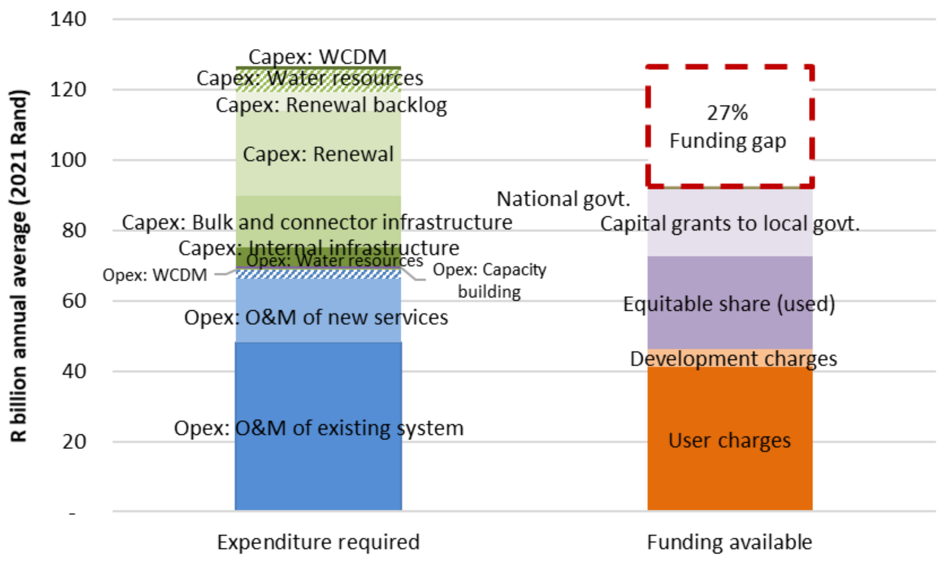

Figure 6: Funding gap for achievement of the SDGs with full conventional services [19]

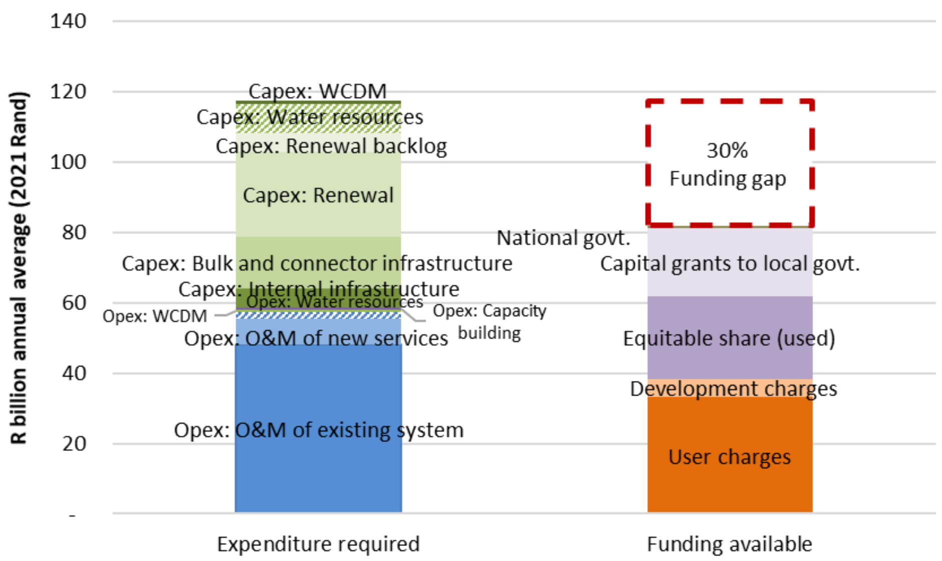

Figure 7: Funding gap for achievement of basic servicing with aggressive WCDM[20]

[19] Graph details available in Annexure E

[20] Graph details available in Annexure E

6.2 Objective 1: Universal access to safe and reliable water and hygiene services

> "Achieving SDG 6 is not only about the provision of new infrastructure; addressing inadequate management of existing systems is one of the major interventions required."

The analysis of the current levels of water and sanitation access found that achieving SDG 6 is not only about the provision of new infrastructure; addressing inadequate management of existing systems is one of the major interventions required. Figure 8 shows that 48% of the households with an inadequate water supply need quality and reliability issues to be addressed. Only 33% of households with inadequate service require improved services, while a further 19% (mostly in rural areas and urban informal settlements) require communal facilities to be replaced with on-site water to meet the SDG 6 requirements. Similarly, Figure 9 shows that for sanitation, only 33% of households with inadequate sanitation require improved facilities, while 23% of households (mostly in urban informal settlements) with inadequate sanitation require communal facilities to be replaced with individual services. The remaining 44% of households in the sanitation 'gap' require infrastructure management issues, particularly with respect to faecal sludge management, to be addressed.

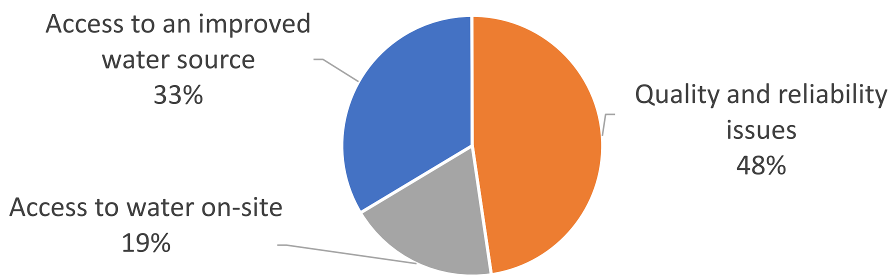

Figure 8: Composition of the 'gap' to achieving water access targets of SDG 6.1

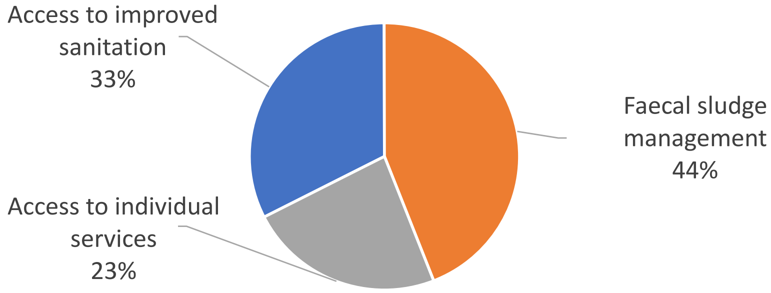

Figure 9: Composition of the 'gap' to achieving sanitation access targets of SDG 6.2

An analysis of the spatial distribution of the 'gap' to achieving SDG 6.1 and 6.2 indicates that the service access backlogs have different characteristics for water and sanitation in urban and rural areas. These are summarised in Table 11 below.

Table 11: Nature of the key challenge in the different geographies

Context	***Water***	***Sanitation***
Urban-Informal	Individual access and continuity of supply (quality and management challenge)	Appropriate technology combined with political stance around the permanence of settlements (technical and political challenge)
Urban-Formal	Water Conservation and Demand Management (management challenge)	Quality of wastewater effluent (management challenge)
Rural-Informal	Access in the face of high cost and low affordability (funding challenge)	Faecal sludge management (funding and management challenge)
Rural-Formal	Continuity of supply in the face of climate change (regulatory and management challenge)	Faecal sludge management (funding and management challenge)

In urban areas, the main backlogs to achieving the water and sanitation SDGs are in dense informal settlements. Density limits the technical options provided in urban informal settlements and makes the provision of individual sanitation services difficult without relocating households. National policy and the fiscal framework have been focussed on addressing informal settlements for a decade, but still the backlogs remain. This is because, as informal settlement upgrading literature acknowledges, provision of services in these areas is not primarily a financial or technical challenge, but rather political and social. This challenge relates to the legal status of the settlements, what services residents are willing to accept from the services provided, and whether the settlements are considered permanent or not (PDG, 2017). Rapid urbanisation and continued densification of informal settlements are the greatest risk to not making progress with achieving the SDG 6 targets in urban areas. The World Bank has promoted the concept of City-Wide Inclusive Sanitation that encourages a diversity of technical solutions that are adaptive, mixed, and incremental. Technical solutions that treat urban informal sanitation as 'temporary' or 'emergency' have been shown to have very high life-cycle costs, are technically inadequate, and are often socially and politically inadequate. Technical solutions need to appreciate the physical constraints of these settlements, but also be permanent and incremental (see Box 5).

Box 5: Communal Ablution Blocks (CABs) as a sanitation solution for informal settlements in urban areas

The Communal Ablution Blocks (CABs) are modified shipping containers installed by the eThekwini Metropolitan Municipality to provide communal water and sanitation facilities to people living in informal settlements in the urban and peri-urban areas of Durban. The facilities comprise separate female and male blocks, provided with flush toilets, showers, hand basins and laundry basins that are connected to the municipal sewerage and water systems. The implementation of community sanitation in 2004 was accompanied by education and training to the communities promoting water conservation and demand management, sanitation, health and hygiene awareness. The advantage of the CAB programme is that it provides access to basic services to families suffering from poor water and sanitation conditions, provides training to people from the community to assist in the installation process thereby equipping them with building skills and provides jobs to caretakers who are paid a regular salary by the municipality. Most households reported that the presence of CABs in communities addressed their household needs and improved their lives.

However, there were some initial challenges with the project based on users' feedback which were addressed as shown in Table i below (Roma, Buckley, Mbatha, Sibiya, & Gounden, 2010).

Table i: Lessons learned from experience and interventions made

Lessons learnt	Interventions
Unhygienic and poor maintenance of the CABSs	Local caretakers were appointed and paid by eThekwini municipality to maintain and clean the facilities
Users did not purchase toilet paper and used newspapers instead causing blockages of the systems	The Municipality provides free toilet paper and cleaning products which are distributed by the caretaker

Crime and anti-social behaviours occur at night in some areas, making it difficult for women and children to use the facilities.	Outside lighting and fences, as well as constant presence of a caretaker to improve safety
Vandalism and theft of copper pipes and other material used for taps	Materials have been replaced by plastic fittings and pipes

This is an example of a successful programme that has contributed to a strong sense of social cohesion within these communities. This intervention, however, does not meet the SDG standard of individual sanitation facilities.

Effluent quality is measured in relation to the standards for effluent discharge, which are reported on through the Green Drop reporting – also stopped in 2014 along with the Blue Drop reports (see Annexure C) – although the data is still recorded in the DWS Integrated Regulatory Information System (IRIS). However, the reported data has been found to be inconsistent in quality and frequency of reporting. The NWSMP states that 56% of the country's 1 150 wastewater treatment works are in poor to critical condition. Thus, access to the service alone is not a useful proxy to determine whether the service is performing adequately, and a considerable number of wastewater treatment works need to be renewed or upgraded to achieve the required standard (See Box 6).

Box 6: Wastewater treatment failures in Emfuleni Local Municipality

The case of Emfuleni Local Municipality has been well documented in media reports for municipal mismanagement that has led to wastewater treatment plants failing. As a result, raw sewage has been leaking into and polluting the Vaal River which provides drinking water to 19 million people on the Vaal and provides water to the agricultural and industrial sectors. The municipality was placed under provincial administration in the face of repeated non-compliance with accounting and service delivery obligations. The South African Human Rights Commission (SAHRC) found a *prima facie* case of violation of human rights in the Emfuleni municipal areas regarding raw sewage flowing not only into the Vaal River but also on residential streets, schools, homes, and other public areas in the jurisdiction of the municipality. It found that the main cause of degradation of the Vaal River was due to inoperative and dilapidated wastewater treatment plants being unable to manage the volumes of wastewater being received. The SAHRC's assessment placed the blame squarely on the municipality for not fulfilling its mandate to provide water supply and sanitation services.

Several interventions were made by the Department of Water and Sanitation (DWS), National Treasury and Gauteng Provincial Treasury to address the sewage problem and general collapse of the Emfuleni Municipality. Despite their efforts, it has not been enough to address the situation occurring in the Emfuleni municipal area. 60% of water samples collected in the week of 7 July 2021 near the Emfuleni treatment plants indicate levels of E. coli that pose a high risk of gastrointestinal disorders. Even though the waste has been removed from the users of the facilities, this wastewater is not safely managed, as it is not treated to the appropriate standard.

The primary challenge for addressing inadequate sanitation in rural areas is faecal sludge management (FSM) of on-site systems. FSM, associated with on-site sanitation systems in rural areas, is not currently monitored and is the reason that South Africa does not report on the levels of safely managed sanitation. Adequate FSM includes the burying of waste on site (either through pit emptying and burying, or covering pits), through digging a new pit, or through pit or septic tank emptying with transport for treatment off-site. In most cases, pit emptying and transportation to centralised treatment facilities is uneconomical. Pit emptying in rural areas is, in limited circumstances, undertaken by the municipality, sometimes undertaken by private service providers, but most typically left to households themselves. Whether this is undertaken safely is unknown and **there is a lack of awareness or knowledge by households and even service providers around how to manage faecal sludge safely.** The DWS has identified this as a constraint in the achievement of SDG 6.2 and is in the process of developing a National Faecal Sludge Management Strategy, to be finalised in 2022. The National Norms and Standards (Water Services Act) should also provide guidance on FSM in rural areas.

Rural sanitation solutions need to be robust and cheap to operate, and it is unlikely that Next Generation Sanitation options will be rolled out on a large scale in the short term. The University of KwaZulu-Natal Pollution Research Group and the eThekwini Water and Sanitation department have set up a sanitation technology test site funded by the Bill and Melinda Gates Foundation. None of the technologies have been commercialised and are at technology readiness levels of 5 to 7 out of 9 (Ruth Cottingham, pers. comm., 18 May 2021). Robustness and cost-effectiveness needs to be proven over the next 1-2 years. Ventilated Improved Pit latrines (VIPs), pour flush toilets or basic composting toilets can provide safely managed sanitation at low costs, but even so, safe FSM still costs money (See Box 7). **There is also a lack of clarity around who should pay for this service**; in some municipalities the municipality provides the service, and in others, households pay for it themselves (Still, 2020).

Box 7: Rural sanitation technology example: Ventilated Improved Pit (VIP) latrines in rural Amathole District Municipality

A consulting firm, Partners in Development, anticipates that by 2025 there will be more than 200 000 VIP toilets for Amathole District Municipality in the Eastern Cape as a result of a mass sanitation campaign (Partners in Development, 2020). The advantages of this simple technology are that the toilets do not require water to work, there are no moving parts, inexpensive and if well designed, built and maintained, provides effective sanitation. The disadvantages are that it may be unsafe and unpleasant to use if badly designed, built and maintained. When the VIPs are full, they are unpleasant to use and emptying the pit is a challenge. There are options to empty the pit, namely manually with the aid of hand tools, machine assisted with some manual power required and fully mechanized systems which employ power from an engine or motor. Manual emptying is difficult and time consuming and if personal protective equipment is not provided or safety practices employed can endanger the health of workers.

A VIP is an example of a safe and effective end-user technology, but to be safely managed it is still reliant on there being a complementary end of life plan in place to address the faecal sludge that remains when the pit is full. The extent to which this is happening in South Africa is unknown. This is often a challenge in rural areas of South Africa, where the sludge is removed, and is often disposed of in an unsafe and unhygienic manner, thus polluting the natural environment and endangering human life.

Water supply systems in South Africa's rural areas are mostly in poor condition with a high proportion of households getting intermittent supplies, and as a result the water supply cannot be considered 'safely managed' in terms of the JMP definition. This is primarily because of lack of technical capacity to operate and maintain the systems properly, to properly manage demand, to contain the spread of unauthorised connections, and to liaise effectively with consumers.

6.3 Objective 2: Affordable financially sustainable water services

The two models, one for water services and one for water resources, used to calculate costs for the various scenarios, have been introduced in Section 2. The results from the two models have been combined into a set of consolidated costs and are summarised below.

6.3.1 Modelling results

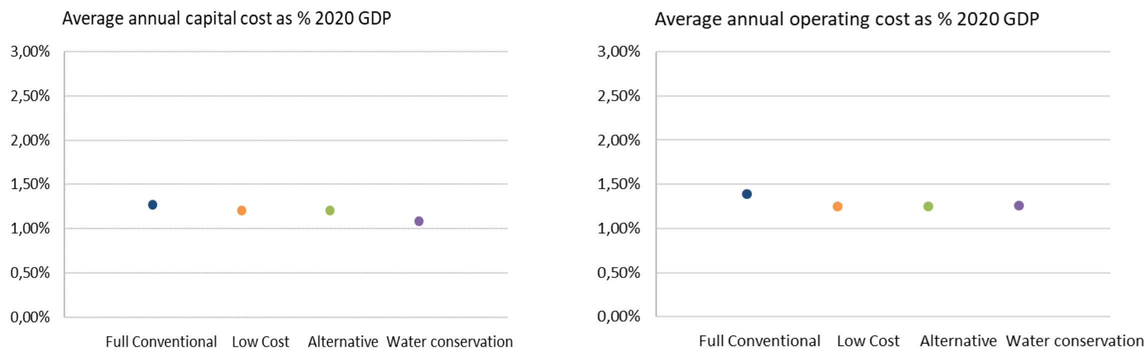

Figure 10: Capital and operating cost results for the modelled scenarios to attain the SDGs

Figure 5 and Figure 10 show us that the **differences in operating costs are small between the scenarios**. This is not surprising, given that the operating costs are calculated as the total expenditure required to operate and maintain all water services, not only new services to achieve the SDGs.

The differences between the three socio-economic projections are small. This is also not surprising, given that the overall population growth projections were equal and the average economic growth projections differed by a maximum of 0.4%. The small difference also highlights the fact that the relative cost differentials in providing services in rural and urban areas tend to offset each other. For example, in comparing a rural household with an on-site borehole and VIP, with an urban household having an on-site piped water connection and a sewered flush toilet, the rural household will have higher water capital costs, but lower sanitation capital costs. Density is an issue that affects costs differently in rural and urban areas. In lower density rural areas, reticulated water supply is more expensive for water, but there are more, cheaper, on-site sanitation options available.

> "The lowest cost scenarios are those that include extensive Water Conservation and Demand Management, and do not provide individual services to all users."

Basic Servicing was also modelled as a potential policy objective, and route to the achievement of the SDGs. These options reduce the overall cost to between R104 billion and R118 billion over 10 years, or between 2.1% and 2.4% of GDP. The main reason for the reduced cost is that the 'Basic Servicing' scenario considers the sharing of sanitation facilities between five households in Urban-Informal and Rural-Informal (Traditional tenure) areas.

The lowest cost scenarios are those that include extensive Water Conservation and Demand Management, and do not provide individual services to all users – i.e., Basic Servicing – WCDM scenarios, followed by the low-cost and the alternative scenarios. The low cost for these scenarios is driven by the maximum use of shared services and the reduced amount of capital required to provide bulk and connector infrastructure. Cost results are particularly sensitive to high-cost, individual, on-site options. Private boreholes are the highest capital cost option for water and the wide adoption of this technology results in high total cost. For sanitation, containerised toilet options used in urban informal settlements have a low capital cost but very high operating costs that results in a high lifecycle cost. Similarly, although water tankers are not considered an adequate supply and have not been included in the study, they are still commonly used in 'emergency' situations but result in excessive expenditure where their use persists beyond emergencies. The difference between the SDG achievement and the basic servicing scenarios are shown in Figure 11 below.

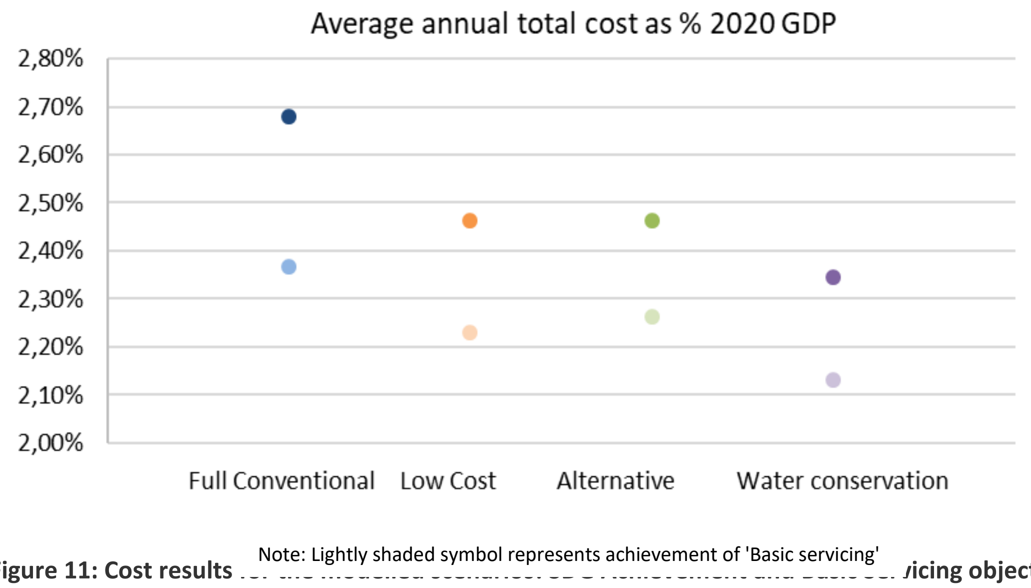

Figure 11: Cost results … vicing objectives

While operating expenditures are dominated by operations and maintenance of the existing infrastructure networks, **the additional operating expenditure required because of new service provision varies considerably between the scenarios** (Figure 12). Two dynamics are at play: Operations and maintenance costs increase as new services are provided, but operating costs also decrease as WCDM interventions reduce bulk water purchase and treatment costs. In the Basic Servicing scenarios, the increase in operation and maintenance costs are negligible, and in some cases even reduce the operations and maintenance costs below current levels. The operations and maintenance costs increase more noticeably in the SDG Achievement scenarios because of higher service levels but is most prominent in the Full Conventional technology option.

The cost of achieving the SDGs are between R121 billion and R131 billion. Approximately 55% of this is operating expenditure, shown in Figure 12, with the remainder being capital expenditure (including the cost of renewal), shown in Figure 13 below.

Figure 12 shows the operating expenditure required to achieve Goal 1 and Goal 2. It is evident that WCDM interventions and capacity building is a small proportion of the overall operating costs. These interventions are aimed at addressing a whole range of the objectives (improved capacity to manage non-revenue water and intermittent water supply, improve water quality, revenue management, etc.), and thus **the potential impact of WCDM and capacity building interventions versus the magnitude of expenditure is potentially large**.

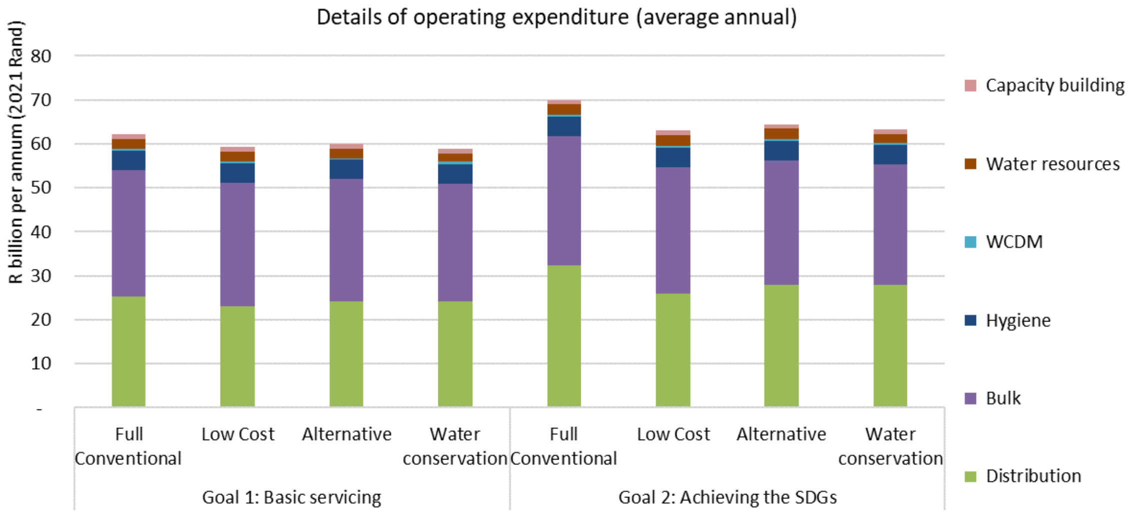

Figure 12: Operating expenditure breakdown per scenario[21]

Capital expenditure need is dominated by renewal of existing infrastructure (Figure 13). This study calculated a figure of R955 billion[22] of water services assets (Current Replacement Cost) in South Africa that require renewal. The fact that the required level of expenditure on renewal is not being incurred is evident in the condition of the infrastructure networks as measured through the water and wastewater quality compliance indicators, such as the level of intermittent water supply or compliance with wastewater effluent standards, and the high levels of technical losses mentioned above. The modelling also calculated the required renewal backlog expenditure that is required to get the currently dysfunctional infrastructure fully functional. This expenditure is a smaller, but not insignificant, portion of the capital need.

21 Graph details available in Annexure E

22 When accounting for inflation, this modelled figure compares closely to the figure of R833 billion given in the Water Investment Framework in 2017 (DWS, 2017)

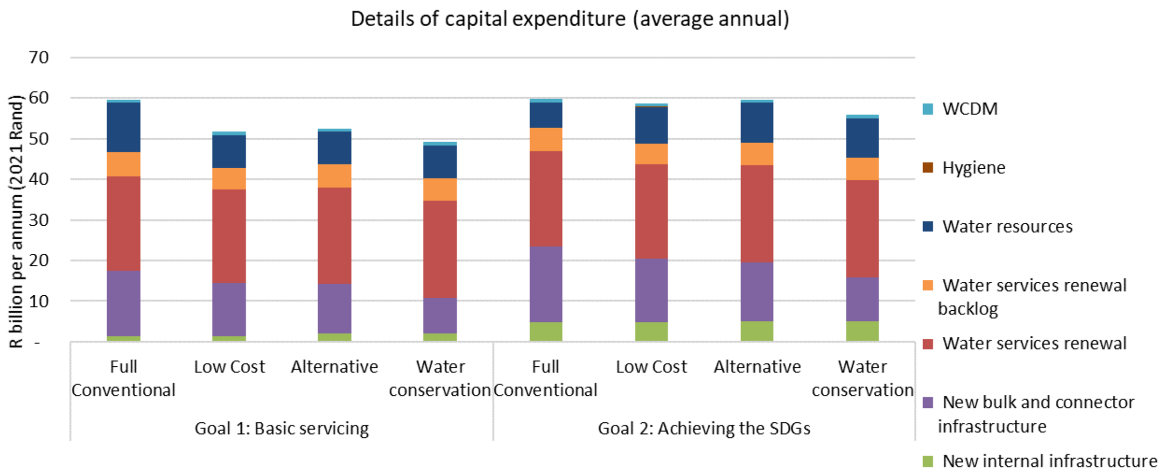

Figure 13: Capital expenditure breakdown per scenario[23]

Hygiene expenditure, for both operating and capital costs, are very low compared to water and sanitation (Figure 12 and Figure 13). Challenges in achieving the hygiene goals are more likely to relate to logistics of reaching households without services and in sustaining a hygiene education programme, particularly in schools.

The costs calculated in the water services model, disaggregated by geography type, are shown for operating costs (Figure 14) and capital costs (Figure 15) below. It is evident that much of the operating expenditure is necessary in Urban-Formal areas, where 62% of customers live, and where the largest proportion of high levels of service currently exist. While the operating cost per household to achieve the SDGs in Urban-Informal areas is 1.4 times the cost of Urban-Formal areas (in the Full Conventional scenario), the total cost is only 14% of the cost of operating services in Urban-Formal areas because of the lower number of households to serve. This is due to the use of expensive, unshared containerised chemical toilets where full flush systems connected to the sewer mains are not possible (in approximately 15% of Urban-Informal households). **This points to affordability issues in providing the individual services required by the SDGs in urban informal areas.**

23 Graph details available in Annexure E

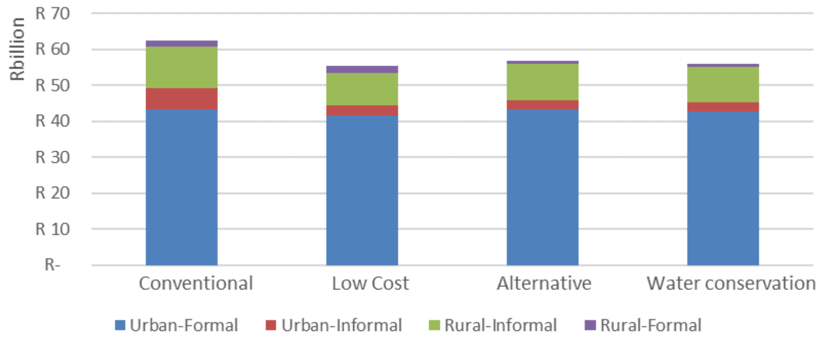

Figure 14: Average annual operating costs of achieving SDG by geography (excluding water resources)

The capital costs of service provision show a similar pattern to those of the operating costs. South Africa is urbanising at a rapid rate, therefore there is a high demand for new services in Urban-Formal areas, as well as the renewal of existing infrastructure. The servicing cost per unit is highest in Rural-Formal (commercial farming) areas, due to the dispersed nature of settlements, but this represents only 3% of the population, thus the total expenditure in these areas is the lowest (Figure 15).

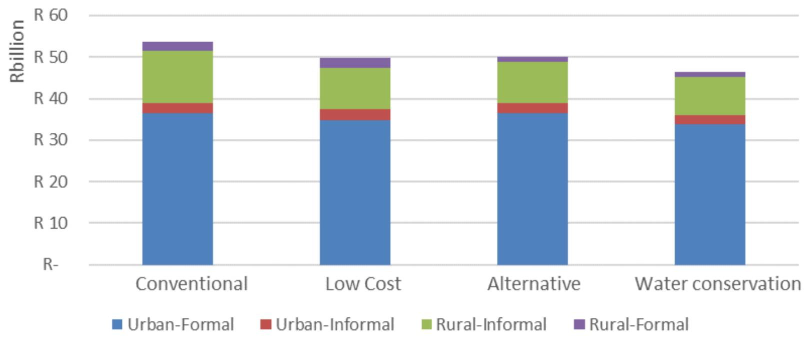

Figure 15: Average annual capital costs of SDG achievement by geography (excluding water resources)

The water services model is set up at a national level with four geography types discussed above. The model results are not disaggregated to sub-national level. However, an attempt has been made to apportion the capital costs of achieving the SDGs to municipalities based on split of geography types and the proportion of inadequate services that the municipalities have in their jurisdiction in the base year. The results for capital expenditure on new internal, bulk and connector infrastructure for water services in the SDG full conventional baseline socio-economic growth scenario are shown in Figure 16 for the five categories of municipality[24]. The results indicate that **the largest capital investments are required in metros and intermediate city municipalities, followed by B4 rural municipalities** (for this scenario)[25].

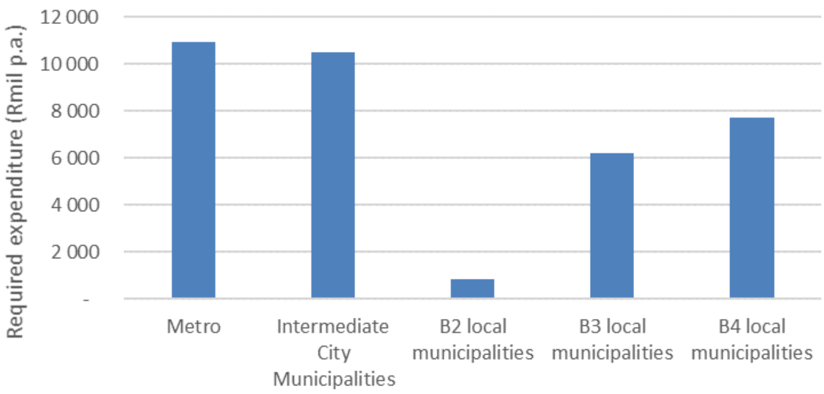

Figure 16: Capital expenditure per annum on new water services infrastructure to achieve the SDGs in the full cost baseline growth scenario

When the capital expenditure in Figure 16 is normalised per household, the relative expenditure patterns shift away from metros (where the number of households is highest) to the more rural, sparsely populated municipalities (Figure 17). **This indicates that the greatest expenditure is required in dense urban areas, where the cost per household is also the lowest, indicating an efficient use of resources.**

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[24] Intermediate City Municipalities, which include secondary cities, are a grouping of 39 municipalities identified by the Department of Cooperative Governance as densifying urban settlements that do not yet have the characteristics of metros. The categories of B2-B4 municipality refer to the DBSA Municipal Infrastructure Investment Framework (MIIF) categorization of municipalities into municipalities with a large town as urban core (B2), largely urban municipalities with small towns (B3) and municipalities dominated by communal land tenure (B4).

[25] Although all scenarios display a similar pattern of investment. The methodology employed to disaggregate the costs to sub-national level does not allow for a meaningful comparison of expenditure distribution between the three socio-economic scenarios.

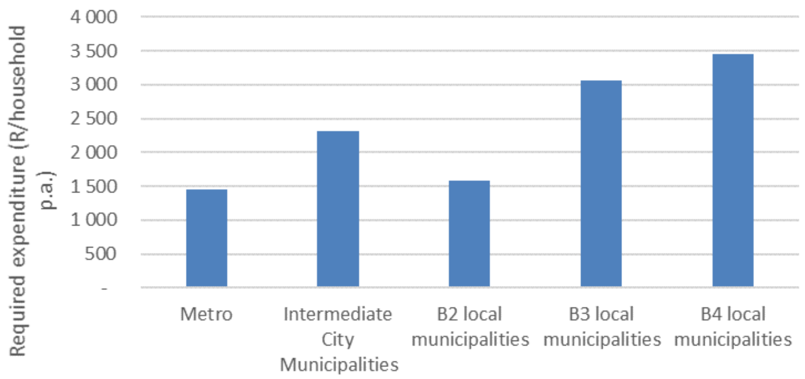

Figure 17: Capital expenditure per annum per household on new water services infrastructure to achieve the SDGs in the full cost baseline growth scenario

The modelling has assumed that the SDGs will be achieved by 2030, with increased investment beginning in 2021. However, if the increased investment does not happen, and it is deferred, the required expenditure in the outer years increases. Figure 18 below shows the exponential growth in expenditure required to achieve the SDGs should the expenditure be deferred.

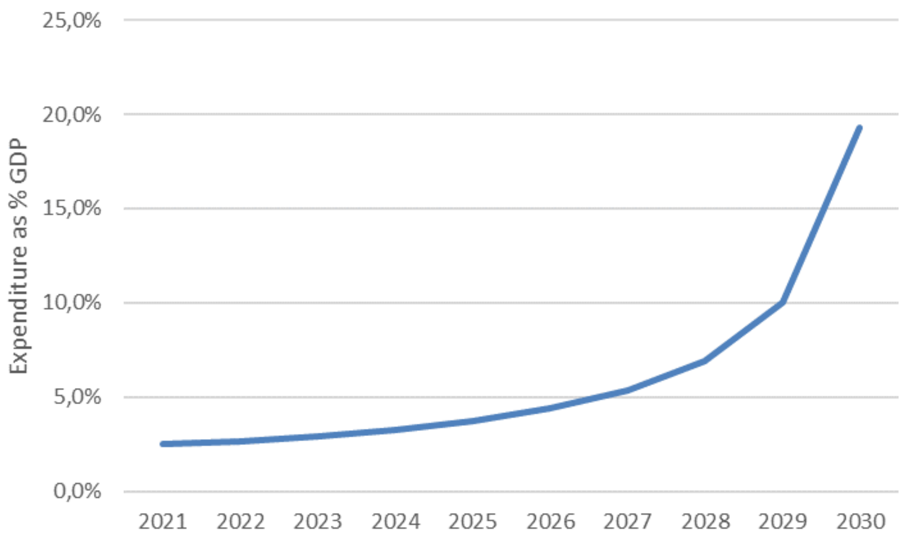

Figure 18: Annual expenditure required to achieve the SDG using Full Conventional technology, as proportion of GDP, if expenditure is deferred and current levels of expenditure continue

6.3.2 Current tariff levels, affordability and non-payment

The modelling conducted for this research found that user charges for water and sanitation cover between 80% and 84% of the required municipal operating expenditure, depending on the scenario.

Although water tariffs in South Africa are lower than the global average (see Box 8), water and sanitation tariffs in most urban areas have been rising rapidly and are typically cost-reflective. However, the analysis found that there are some municipalities with tariffs below the cost of water provision. The opportunity for raising tariffs is a function of current tariff levels and the political context of the municipalities, and the possible increase in revenue through raising tariffs has not been quantified in this analysis.

Box 8: South African water tariffs

The average tariff in South Africa is below the global average price of US$2.04 per cubic metre (Figure ii).

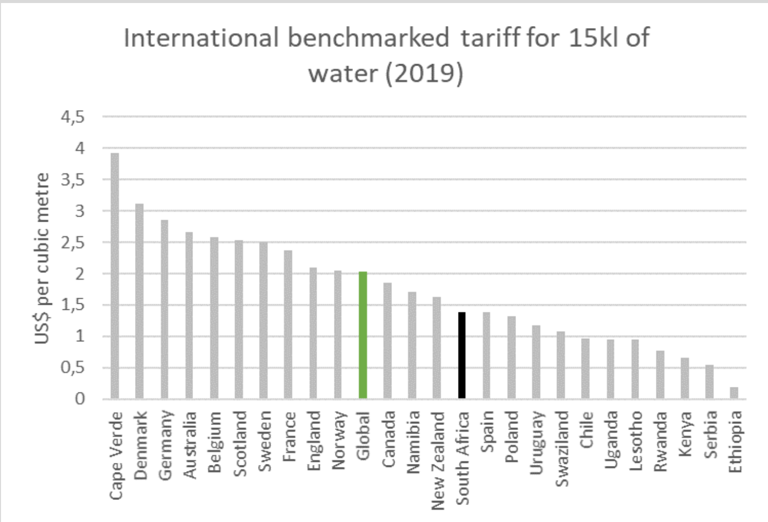

Figure ii: International comparison of tariffs Source: IBNet, 2021

Within the country there is great variation between municipalities. This variation is driven by several factors, including:

- Variable cost of water supply
- Political pressure to keep tariffs low
- Infrastructure age
- Level of maintenance expenditure
- Lack of water pricing regulation

- Inadequate data or capacity to calculate the cost of water supply

The variability of water supply tariffs across the country are shown in Figure iii.

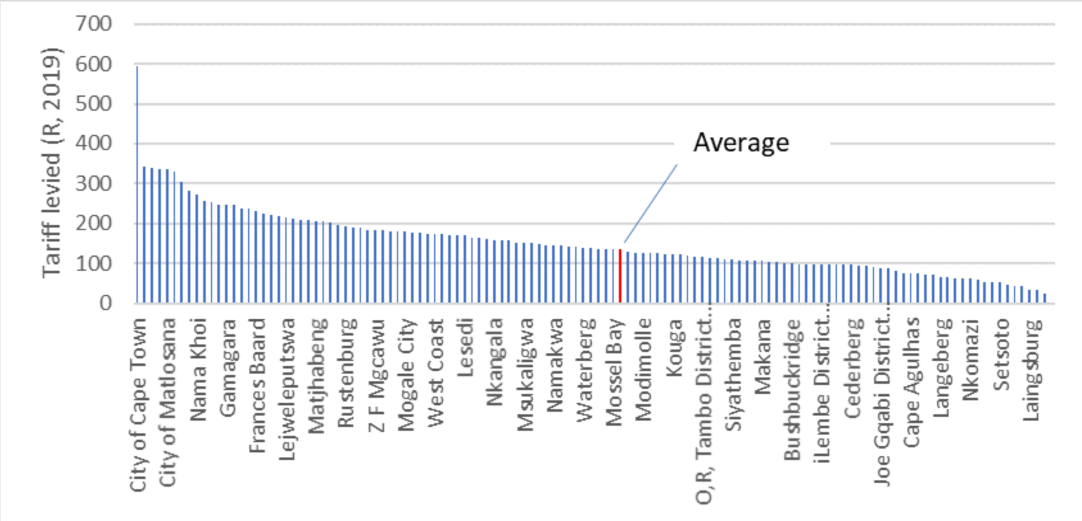

Figure iii: Tariff levied by South African municipalities for 15kl of water (2019) Source: NIWIS Database

The water and sanitation tariffs levied to customers have increased four times faster than inflation since 1996 (see Figure iv). It is therefore unlikely that water tariffs are universally under-priced, but that there are some municipalities that charge below cost, while others make a surplus.

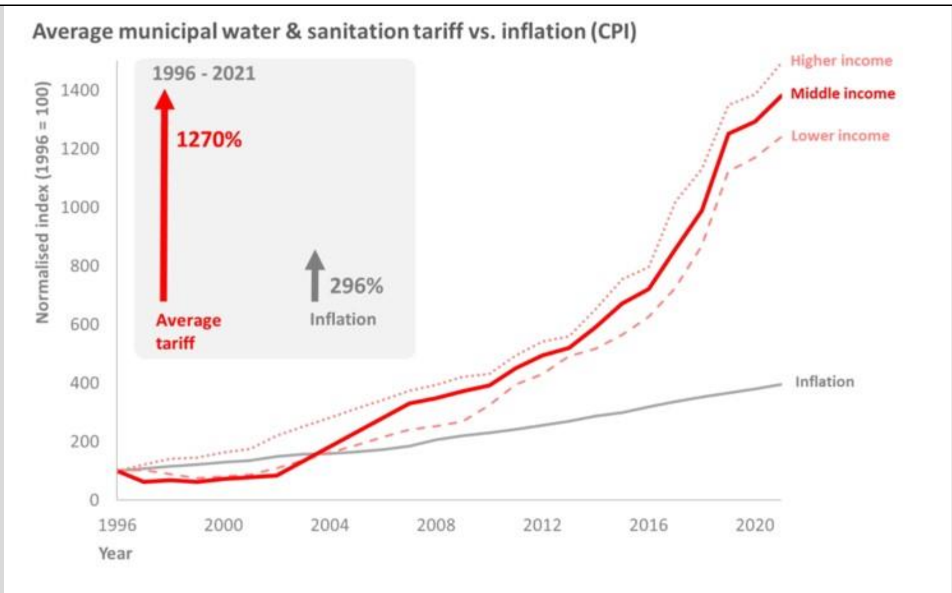

Figure iv: Average municipal water & sanitation tariffs vs. inflation

The spread of surplus and deficits on water services for municipalities in South Africa that provide the service are shown in Figure v. The figure shows that 35% of municipalities made a surplus on water services in 2018/19 before the application of the Equitable Share transfer.

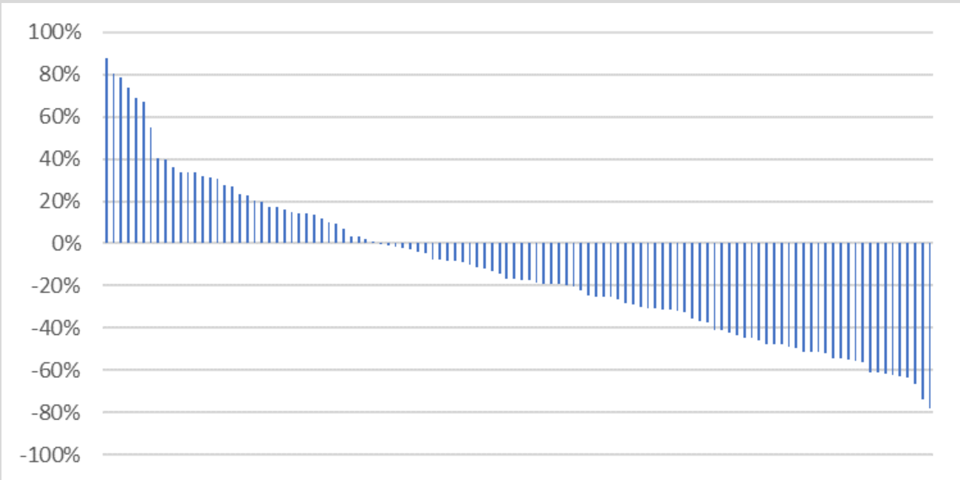

Figure v: Municipal operating surplus/(deficit) for the provision of water services in 2018/19 (Source: Author's analysis using National Treasury Local Government Budget Database)

The increase in water tariffs over time has resulted in lower willingness to pay by those poorer households who use more than the free basic water and sanitation amounts. The most recent audited expenditure data, for 2018/19, from the National Treasury's Local Government Database shows that the collection rate for municipal service charges is 90% on average, but this varies from 98% in some metros to far lower in small, rural municipalities. Revenue for consumption above the Free Basic Water thresholds is not being collected in many areas. This is particularly prevalent in peri-urban areas on communal land that enjoy urban service levels but fall outside of municipal property rating areas. Non-payment and lack of revenue collection is a result of a combination of factors: unregulated supply, unclear payment contracts in communal land areas, historical payment boycotts, lack of municipal management capacity and systems, and a lack of political will to support payment for services. The result is unregulated consumption and minimal tariff revenue.

Tariffs are not required to cover all costs, because the fiscal framework makes provision for operating transfers from national government to cover the cost of providing services to indigent households in the form of the Equitable Share. Because of its unconditional nature, it is not possible to determine how much of this grant is, or should be, allocated to water services. However, the National Treasury publishes the grant allocation formula, which makes specific provision for the grant to subsidise basic services to poor households, including for water and sanitation services. For the modelling, the portion of the Equitable Share assumed to be allocated to water services through the formula, together with current tariff revenue, is sufficiently large to cover water services operating costs in aggregate. However, this does not happen in practice because 35% of municipalities make a surplus on water services without any subsidy (Figure v in Box 8).

6.3.3 Options to address the funding gap

The scenarios have been designed to present a range of feasible cost structures for meeting the SDG 6 targets, with the reduction of cost being an explicit objective. However, the gap may also be reduced or closed through maximising the revenue sources. The modelling considered the value of the following potential additional funding sources to fill the funding gap:

Increase water services tariffs: Increased water services tariffs are the default option for increasing sector funding but need to be considered against customer affordability. This study did not include an affordability analysis, so an estimate of the potential additional revenue through tariff increases was not made. This issue is discussed further in Section 7.1.

Increase raw water tariffs: There is, however, potential to increase national revenue from raw water sales as the raw water tariff has historically been under-priced (DWS, 2013; DWS, 2018). A Draft

Revised Water Pricing Strategy has been published for comment but not yet approved. Raw water tariff setting is beyond the scope of this study, so the potential for closing the funding gap has not been assessed.

Improve collection rates: The modelling indicates that if bad debt for water user charges was reduced by 50% (to achieve a collection rate of 94%), that funding for the sector would be increased by R2 billion per annum.

Increase internal allocation of Equitable Share: If the full amount of Equitable Share calculated in the allocation formula for water services was allocated to the service, this would increase funding available to water services by R7 billion per annum.

Increase Development Charges: Development charges are unlikely to be collected from households that are currently without water services. However, there is scope for development charges revenue to be increased nationally from extending water services to new high-income households and non-residential customers. National Treasury is currently in the process of drafting legislation in this regard. The current revenue for development charges has been assumed to be 60% of the potential revenue from this source. If development charges were to cover the full calculated cost of bulk and connector infrastructure to high income households and non-residential customers (as calculated in the model using the number of new connections and the unit capital costs for bulk infrastructure to these connections), and universally collected, it is estimated that this could potentially raise an additional R7 billion per annum in funding.

Increase capital grants: This study's comparison of the current level of available grants with the required capital found that capital grants / fiscal transfers cover 15% of the required expenditure. Given fiscal constraints in South Africa, it cannot be assumed that the level of capital grants in the sector, to local government, water boards or DWS, will increase. There is evidence of perverse incentives created by grant funding where new infrastructure is prioritised over integrated asset management – it is easier to get grant funding than to allocate limited municipal resources to asset renewal or operations and maintenance. Therefore, no increase in capital grants was assumed to narrow the funding gap.

The potential increases to funding discussed above have the potential to reduce the funding gap to between 19% and 21%, depending on the scenario (see Figure 19 and Figure 20). This means that without either an increase in the water tariff level, potentially impacting on affordability, or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 goals by 2030.

"Without either an increase in the water tariff level… or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 goals by 2030."

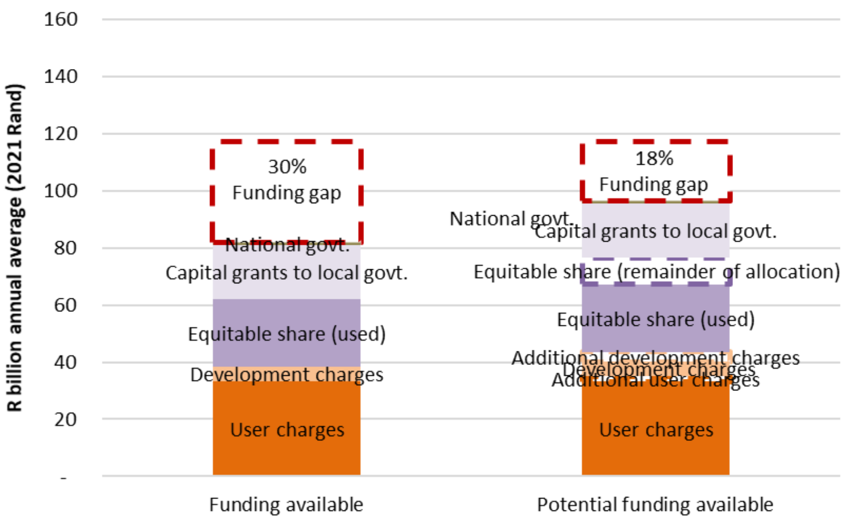

Figure 19: **Potential increase in funding to close the funding gap for the Basic Servicing scenario with aggressive WCDM**[26]

[26] Graph details available in Annexure E

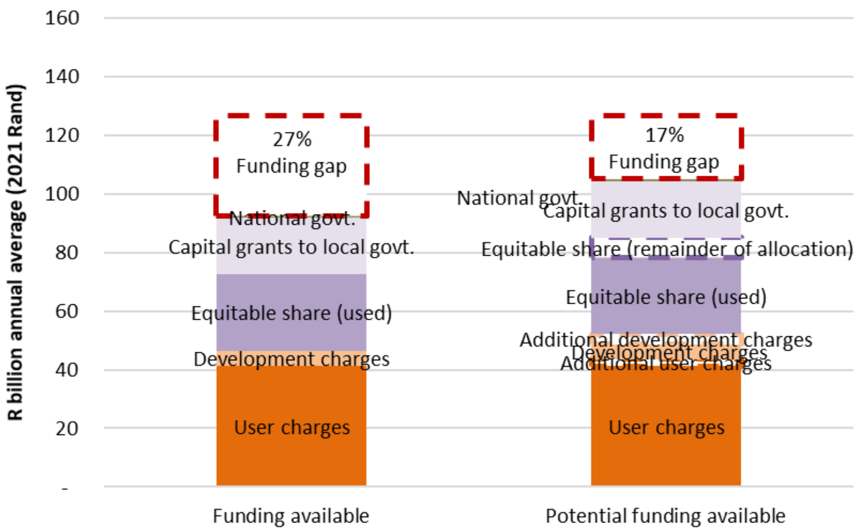

Figure 20: Potential increase in funding to close the funding gap for the achievement of the SDGs with full conventional servicing[27]

6.4 Objective 3: Reduced demand on freshwater resources

South Africa loses 41% of its water to non-revenue water. Approximately 35% of the water that enters into the systems becomes a technical loss, primarily pipe leakage. Other reasons for the high losses are low tariffs, inappropriate infrastructure choices (for example, water borne sanitation in a water scarce country) and inadequate planning and implementation (DWS, 2018). There is no agreed upon benchmark for an adequate level of non-revenue water, but the generally agreed upon best-practice is approximately 15% (DWS, 2018). Figure 21 shows the water balances for the South African metropolitan municipalities for December 2019. It is evident that the municipality which is performing the worst is Nelson Mandela Bay, followed by the City of Johannesburg. The City of Johannesburg loses the most water, as the system input volume (SIV) is extremely high.

[27] Graph details available in Annexure E

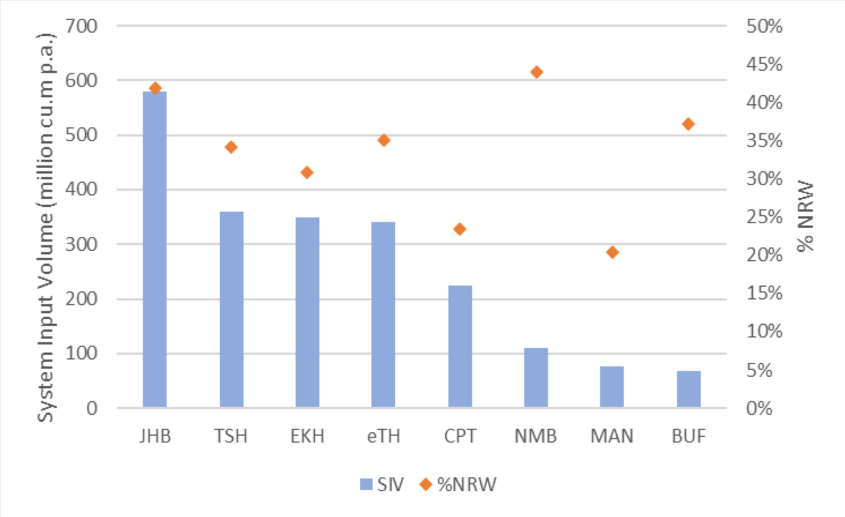

Figure 21: Metro NRW and SIV (DWS, 2019)

Multiple reports and policy documents have recommended that municipalities increase their efforts to reduce NRW and the negative impact it has on their ability to generate own income and run a viable water business. DWS developed reconciliation strategies for all major water supply systems in the country to reconcile future water requirements with water availability. The water demand targets set in the reconciliation strategies are aimed at reducing the SIV and do not specify water loss or NRW targets. NRW challenges in South African municipalities can only be properly understood after the NRW and its components are quantified, and appropriate reduction targets are developed as part of the strategy to improve water use efficiency in the various metros.

In addition to freeing up resources for growth and for productive uses, a reduction in NRW and improved water use efficiency have financial benefits to municipalities. The NWSMP states that municipalities are losing about 1 660 million m³ per year through NRW. At a unit cost of R6/m³ this amounts to R9.9 billion each year. Therefore, addressing NRW is critical to achieving water security in South Africa.

> "Aggressive Water Conservation and Demand Management means that universal basic servicing can be achieved without a significant increase in total water demand above current levels."

The projections of overall potable water demand in **all scenarios result in lower water demand than the status quo scenario**. The status quo scenario is a projection of the current levels of service and current water losses (Figure 22). This is because all scenarios include a target to reduce non-revenue water by 15%[28] at a cost of R660 million per annum (average annual cost). The more aggressive WCDM scenario requires an additional R350 million per annum (average annual). The water demand projections cluster in three groupings: SDG Achievement scenarios have the highest demand (after the status quo), followed by Basic Servicing scenarios grouped together with the SDG Achievement WCDM scenarios. The Basic Servicing WCDM scenarios have the lowest demand, resulting in a flat demand curve from the base year, and 25% lower demand than the status quo scenario in year 10. The results indicate two important points: 1) the **increase in demand through providing higher levels of service can be offset through savings in NRW**; and 2) **aggressive WCDM means that universal basic servicing can be achieved without a significant increase in total water demand above current levels**.

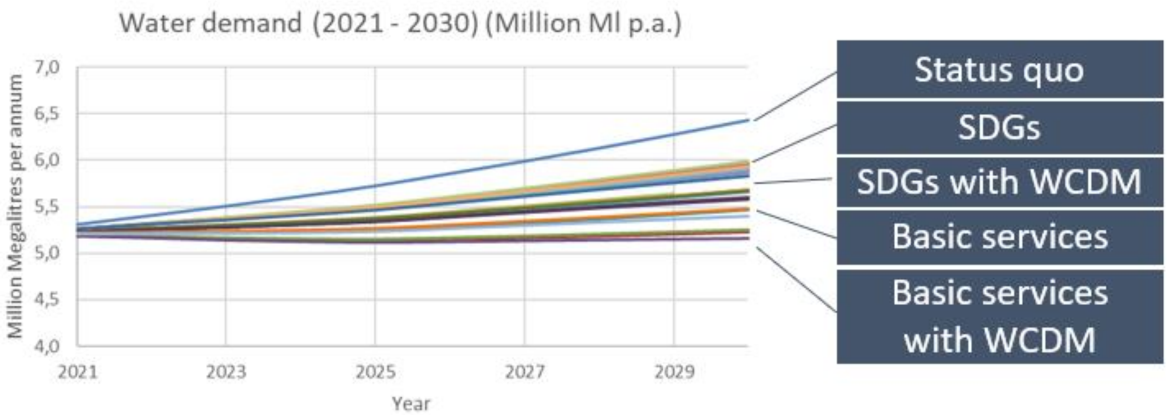

Figure 22: Potable water demand projections (million Ml pa)[29]

Figure 23 below shows the water demand per geography type. Urban-Formal customers in municipalities have the highest demand for potable water, both on an aggregated basis and per customer. Urban-Formal households also have the highest level of service and are typically wealthier

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28 The cost of non-revenue water interventions is included in the modelling. There is a capital cost incurred in the initial investment required to reduce non-revenue water, and an operating cost incurred for each kilolitre of water saved.

29 Graph details available in Annexure E

than other customer types, thus using more water than other geography types. Additionally, most non-residential customers are in Urban-Formal areas, further increasing demand. The proportion of consumption in other geographies increases over time as new services are expanded into these geographies.

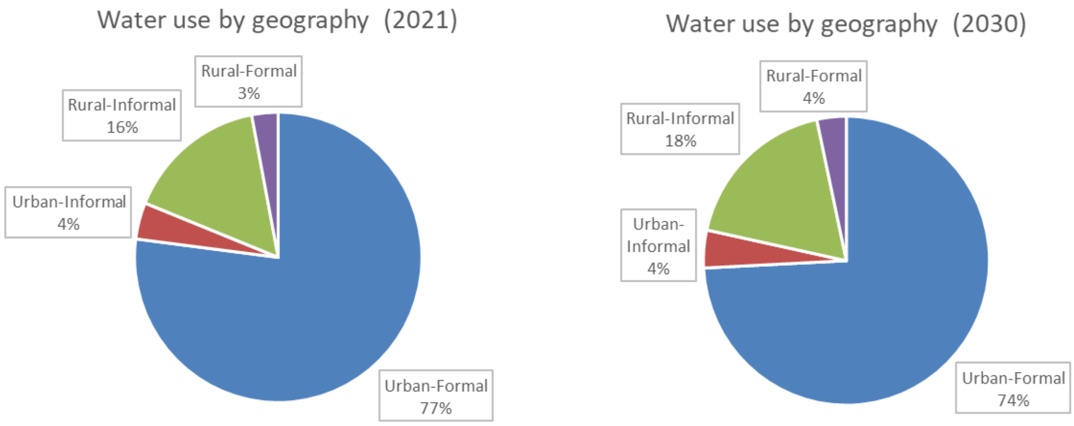

Figure 23: Potable water use by geography type in municipalities in 2021 and 2030

The national target set for water use efficiency is a reduction in non-revenue water by 15% (DWS, 2018). This was used as an input in all scenarios and was therefore assumed to be achieved through a range of technical[30] and non-technical measures[31]. **The cost of water conservation and demand management is approximately 1% of the total cost of achieving the SDGs (approximately R1.15 billion per annum) but has a significant impact on the environmental impact of the water service.**

[30] Examples of technical measures include the replacement of leaking pipes, pressure-releasing valves, reducing night-time pressures and implementing flow-restricted metering.

[31] Examples of non-technical measures include behaviour change that results in a reduction in water consumption, the employment of dedicated staff to address localised water issues (such as rapid identification of leaks and water theft) and the running of communication campaigns about water wastage.

> "South Africa will not achieve the desired water use efficiency targets without drastically influencing technology and behaviours adopted amongst all water users."

The WCDM scenarios extend the assumed saving from 15% to 21%. The base year potable water demand (System Input Volume) was calibrated to the reported figure of 237 l/c/d (DWS, 2018). The status quo scenario results in this figure rising to 260 l/c/d by year 10, while the corresponding figures for the other scenarios range from 242 to 209 l/c/d (Figure 24). This is well short of the national target of 175 l/c/d. However, the savings have been focussed on WCDM in the residential sector, and within municipal networks while still increasing the level of access to the water service. Only nominal savings of 15% over 10 years on non-residential water uses have been assumed for all scenarios. This finding indicates that **South Africa will not achieve the desired water use efficiency targets without drastically influencing technology and behaviours adopted amongst *all* water users**, in addition to technical solutions (such as pipe replacement and pressure management zones).

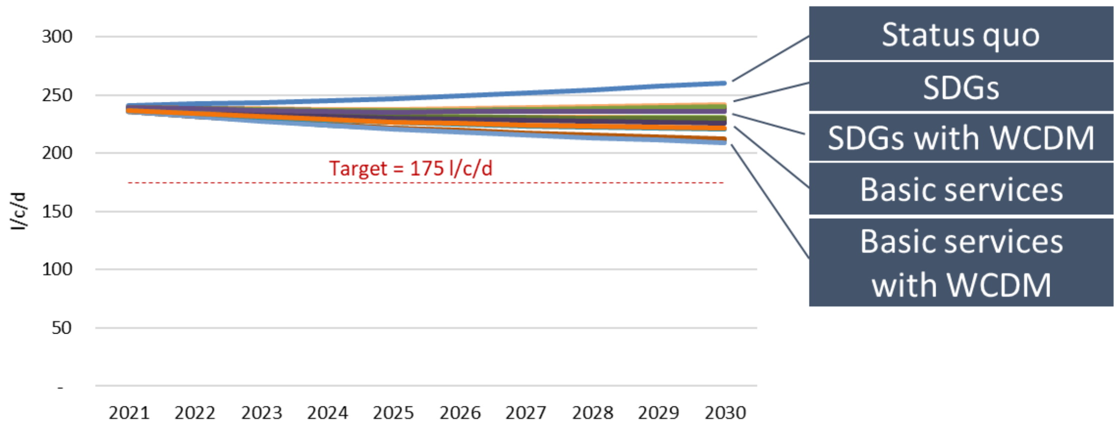

Figure 24: Potable water demand projections (litres/capita/day)[32]

6.5 Objective 4: Increased water resilience

Water resilience means the ability to withstand and recover from shocks that impact on water availability. One means to buffer against these shocks is to increase the difference between available supply and demand under different scenarios. The availability of water supply relative to demand

[32] Graph details available in Annexure E

varies significantly across South Africa and is also impacted by both future population growth and climate change. It is also influenced by the functioning of the integrated bulk water supply system, with systems that are part of the integrated national bulk water supply system showing greater resilience. In South Africa, over 50% of water resources come from only 8% of the land, referred to as the Strategic Water Source Areas. South Africa has a long history of effective and efficient water resources planning and, as a result, has developed complex and integrated bulk water supply systems providing water security to the main economic hubs of the country. But, in recent years these systems have come under threat, primarily due to lack of investment in the operation of the systems, to lack of attention to planning revisions and to adaptation to changes in demand and surface water availability. Delays in the implementation of critical infrastructure such as the Lesotho Highlands Water Project Phase II, the raising of Clanwilliam Dam, the Berg River Voelvlei Augmentation Scheme, the Vaal Gamma-Gamma pipeline, and other schemes, has resulted in an increase in water security risks for the country. Similarly, failure to address the threat of acid mine drainage, and water quality more generally, and to provide sufficient funding for the clearing of invasive alien plants (IAPs), increases the risk further. There are also many smaller and more rural towns and municipalities that are already threatened by a lack of water security and for which significant investments and more innovative solutions are required.

While the major urban centres, large irrigation schemes, and large-scale industrial users (including energy generation) are generally supplied from the major raw water supply schemes, several smaller and more regional centres are also supplied from local surface water schemes and groundwater. Where supply deficits exist at this local level, the options are more varied and context dependent. Options (at any significant scale) that could be considered include surface water augmentation, groundwater, direct potable water re-use, or desalination of seawater. The potential of each of these options has been considered against the geographic context, and estimates made of the future adoption of each. The operating and capital costs of these future supplies have then been calculated. Where the modelled municipal demand exceeded the surface water available from the scheme to which it was allocated (including all planned augmentation of the scheme), the remaining demand is assumed to come from a mix of local surface water sources, groundwater schemes, reuse, and desalination at the marginal unit cost of the treatment technology.

A key assumption in the modelling is that the allocation of the yield from each of the major systems to municipalities ('Urban' in Figure 25)[33], stays fixed in relative terms between users through the analysis period. The allocation of water between users is obviously a key policy choice which has a significant impact on urban water security, particularly in those Water Management Areas where the urban allocations are small. However, this policy discussion is beyond the scope of this study. Nevertheless, changing water allocations between user types was fundamental in assisting Cape Town to respond to the drought experienced in 2016/17 (see Box 4). To inform this type of policy decision, the trade-offs between the different user types should be made explicit, and the water allocations then enforced. The lack of enforcement of agricultural water allocations results in a cost externality for urban water users. In this case, if urban water users need to source additional water resources, at a higher cost, because of agricultural over-use, then the incidence of cost is on the urban water users, and not on agriculture. A system would need to be put in place to internalise this cost for agricultural users. This is typically done through fines, but if enforcement is a problem, an aggregate marginal costing approach for all raw water may need to be adopted.

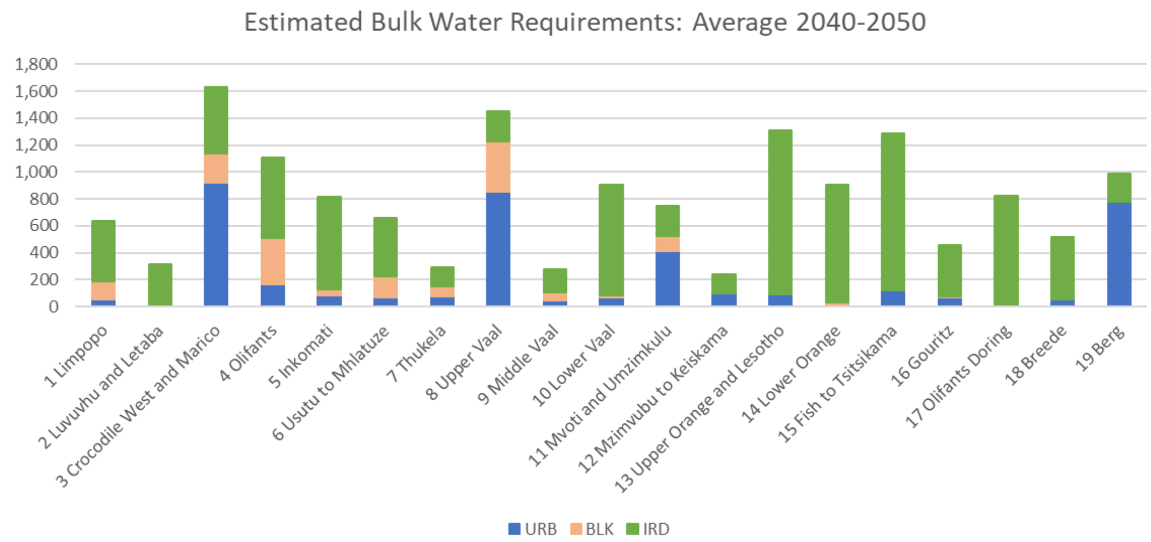

Figure 25: Projected split in demand between Urban ('URB') (municipal demand), Bulk ('BLK') (mining and heavy industry) and Irrigation ('IRD') in each of the Water Management Areas in South Africa

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33 UNU Wider and LTAS Reports (Cullis et al, 2017)

The overall water supply balance nationally for one water services scenario is shown in Figure 26. Due to the regional variability, there are individual systems that are already in deficit and require immediate augmentation, even if the country may have surplus supply. Similarly, there may be some systems that are producing a surplus in the outer years of the 10-year modelling period. This analysis should not replace any water supply system analyses, as it has not considered many factors that influence the availability of raw water, including availability of groundwater, the potential level of uptake of direct potable reuse, non-potable water reuse, and the extent to which other local sources can be utilised.

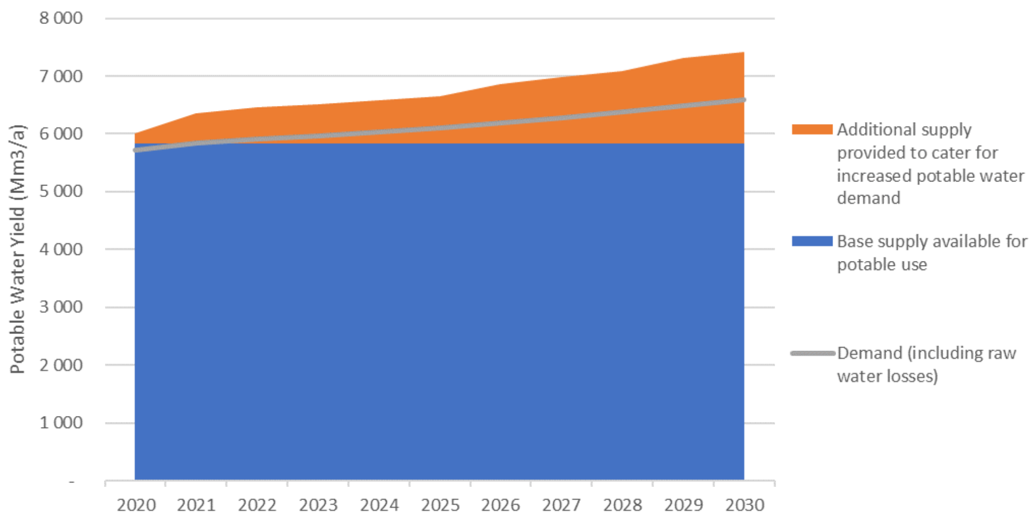

Figure 26: Overall water supply balance for potable use in South Africa

Water resilience is also improved by the diversification of water sources. The NWSMP states that "By 2040, treated acid mine drainage and desalinated seawater will make a significant contribution to South Africa's water mix, groundwater usage will increase, and the overreliance on surface water will reduce." Increasingly the importance of investing in ecological infrastructure (EI), particularly the protection of water supply catchments, is being recognised as crucial to improved water security and resilience against the impacts of climate change. For many years South Africa has been a leader in this regard through innovative programmes such as the Working for Water Programme. The need to provide additional investments to address the spread of IAPs, which reduce water availability (Cullis et al., 2007), must be considered when determining the requirements for closing the gap on SDG 6.

The additional capital and operating expenditure required to augment the raw water supply to meet the modelled water services scenarios ranges from around R8.7 billion per annum for the lowest cost Basic Servicing scenario under a wet climate scenario and maximum IAP clearing, to R14.4 billion per annum for the highest cost SDG achievement scenario under a dry climate scenario and extensive IAP invasion[34] (Figure 27). This represents between 6% and 11% of the overall cost. In all cases some of these impacts could be addressed if consideration is given to potential system benefits and based on more detailed analysis of individual systems. It is also important to note that these results are indicated in terms of changes in the mean annual runoff (MAR)[35] and are not based on potential impact on the yield of the system, or during critical drought periods[36]. Figure 27 illustrates the **large impact of the climate scenarios and the levels of IAP infestation on water availability and thus on raw water costs.** Since this is a national aggregate, the situation in individual catchments can be very different.

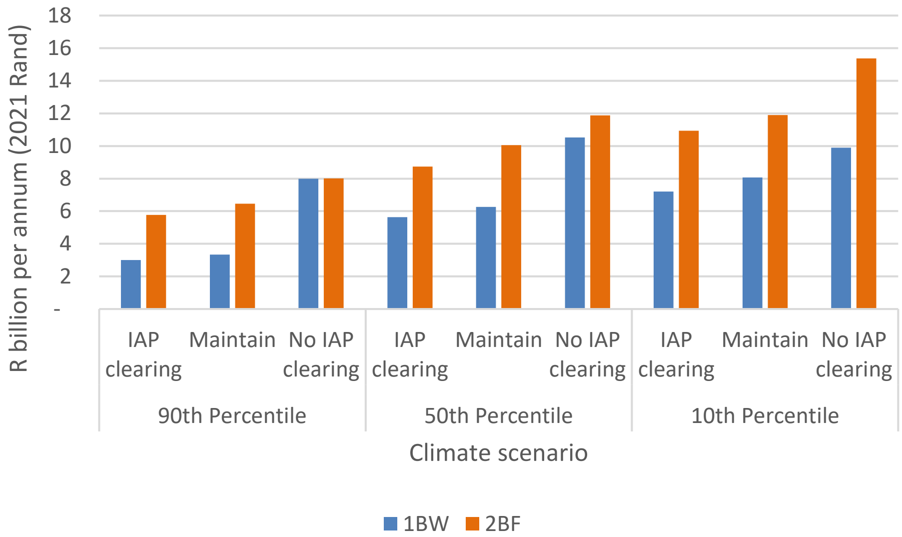

Figure 27: Annual raw water costs (capital and operating) for Basic Servicing: Aggressive WCDM (1BW) and Achieving the SDGs: Full Conventional technology (2BF) scenarios under three climate scenarios and three IAP scenarios

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[34] Note that the water resources modelling relies on thresholds being met for the different water management areas. The result of this is that some scenarios (such as 2BL) will meet a threshold, whereas a scenario with a slightly lower demand (such as 2RL) does not meet this threshold. This results in an uneven cost profile.

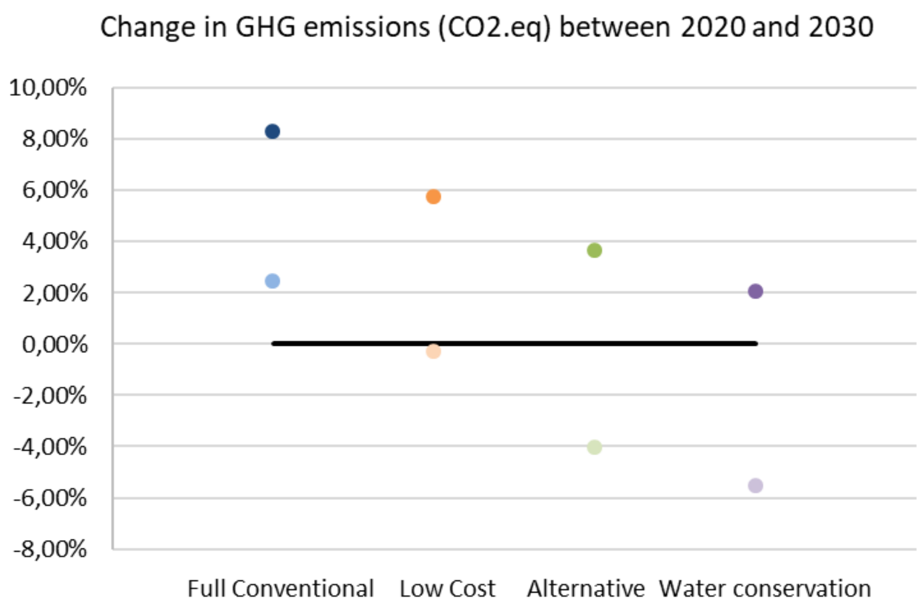
[35] The 10th, 50th and 90th percentiles represent the probability distribution of mean annual runoff across the CSIR Greenbook climate scenarios (Cullis et al, 2019)

[36] The study did not consider seasonal variations or model the specific management rules of any scheme.

6.6 Objective 5: Minimising or reducing the environmental impact of service delivery

> "Reducing demand through aggressive Water Conservation and Demand Management reduces the greenhouse gas emissions in year 10 by to up to 6% below the baseline."

The difference in environmental impact between the scenarios is noticeably large (Figure 28). For the achievement of the SDGs, all technology options result in increased CO_2 equivalents above the baseline due to greater volumes of water and wastewater from higher levels of service. However, the amount of CO_2 equivalents produced in year 10 can be reduced below the levels in 2021 in three of the four Basic Servicing scenarios. The use of alternative technologies that generally rely less on energy-intensive, centralised treatment systems can reduce CO_2 equivalents to 4% lower than the baseline levels. It was to be expected that the alternative technology options produce less CO_2 equivalents than the low cost or full conventional options as this was the basis for the scenario design. However, further reducing demand through aggressive WCDM reduces the GHG emissions in year 10 by to up to 6% below the baseline through a lower requirement for water treatment and pumping and wastewater treatment. For Basic Servicing, the low-cost technology option shows an improvement in levels of CO_2 equivalents, while the full conventional option shows a worsening from current levels.

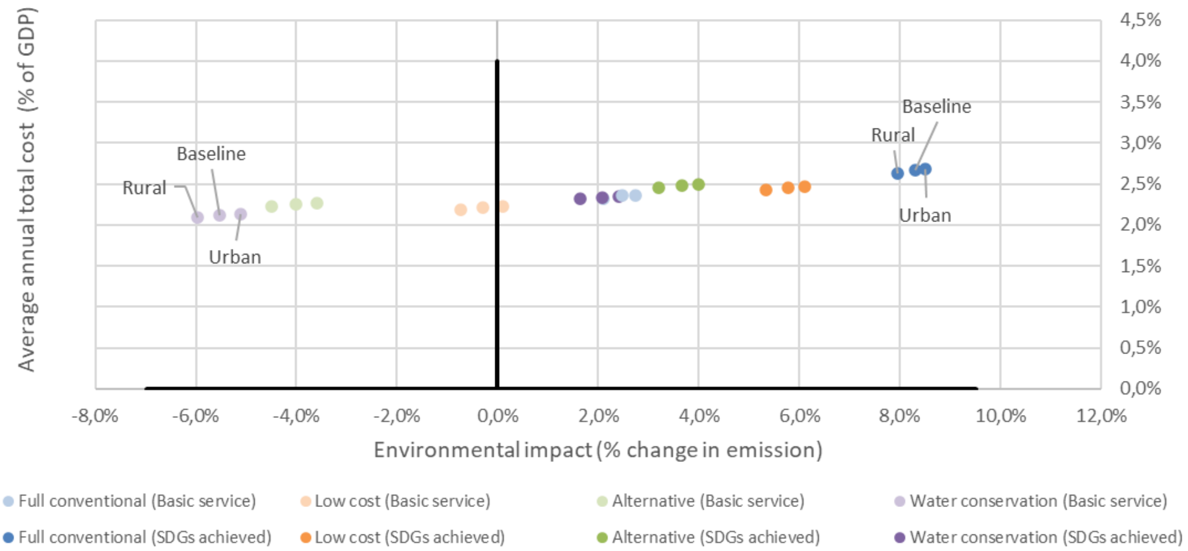


Note: The lighter coloured markers indicate the lower GHG emissions which would result from the achievement of 'Basic Servicing' over the achievement of the SDGs.

Figure 28: Change in C0₂ equivalents as a percentage of baseline emissions (2020-2030)

If the cost and emissions results for each of the 24 scenarios are plotted on a combined axis, as shown in Figure 29, it is evident that **scenarios with the highest cost also have the worst environmental outcomes in terms of carbon emissions**. The increased cost is due to the provision of individual services and increased demand for water for SDG Achievement scenarios. Basic Servicing scenario options have the largest reduction in impact from the baseline. The lowest emissions scenarios are also the least expensive scenarios over the ten-year period. The results of a plot of cost against water savings produces a similar pattern because water demand and emissions are closely correlated due to the electricity consumed in the treatment and pumping of water and wastewater. The rural scenarios are also always the cheapest and have the lowest GHG emissions of the three demographic scenarios, as the services tend to use less water and do not rely on centralised treatment works, thus reducing costs and emissions.

> "Scenarios with the highest cost also have the worst environmental outcomes in terms of carbon emissions"



Note: The lighter coloured markers indicate the lower GHG emissions, and lower cost, which would result from the achievement of 'Basic Servicing' over the achievement of the SDGs. The three socio-economic scenarios for each of the technology scenarios are shown. The Urban scenario will have the highest environmental impact, and the Rural will always have the lowest

Figure 29: Cost versus percentage change in CO_2 equivalent emissions

6.7 Objective 6: Building adequate institutional capacity

6.7.1 Impact of institutional capacity on performance

> "Current performance of water services in South Africa, particularly in terms of reliability and quality is indicative of a decline in local government capacity to manage infrastructure and sustain water services."

The current performance of water services in South Africa, particularly in terms of reliability and quality, is indicative of a decline in local government capacity to manage infrastructure and sustain water services, as a result of more general governance failure. Shortcomings in municipal capacity are not universal, as a third of municipalities are performing adequately. Performance is also uneven across the infrastructure provision process: access to services has increased in the sense that infrastructure is in place; but the lack of capacity to operate and maintain the resulting infrastructure has resulted in excessive system failure, partly because the assets are left to deteriorate, partly because of inadequate operational systems, and partly because of weak management of operational activities.

6.7.2 Municipal technical capacity

The capacity challenges in South African municipalities stretch across several disciplines, from executive management to planning to engineering, and broader systemic difficulties. One of the recognised issues in the sector is the lack of adequate technical skills in the public sector, and in particular the low number of engineers managing water services in municipalities. While there are some gains in technical capacity, primarily in smaller local municipalities, **the low numbers of professional engineers in most local governments remains a serious constraint in the provision of water and sanitation services.** The South African Institution of Civil Engineering (SAICE) surveys of 2005 and 2015, show a decline in the ratio of municipally employed engineering professionals per 10,000 population in metros, small gains in local municipalities, and alarmingly low numbers in district municipalities (Figure 30). On the other hand, the ratios for employed technicians and technologists are shown to be increasing[37].

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[37] An Engineer is a university graduate with a four-year Bachelor of Engineering Degree, a technologist is a graduate of a technical university with a three-year Bachelor of Technology Degree and a technician has a two-year National Diploma in Engineering, plus one year of practical experience.

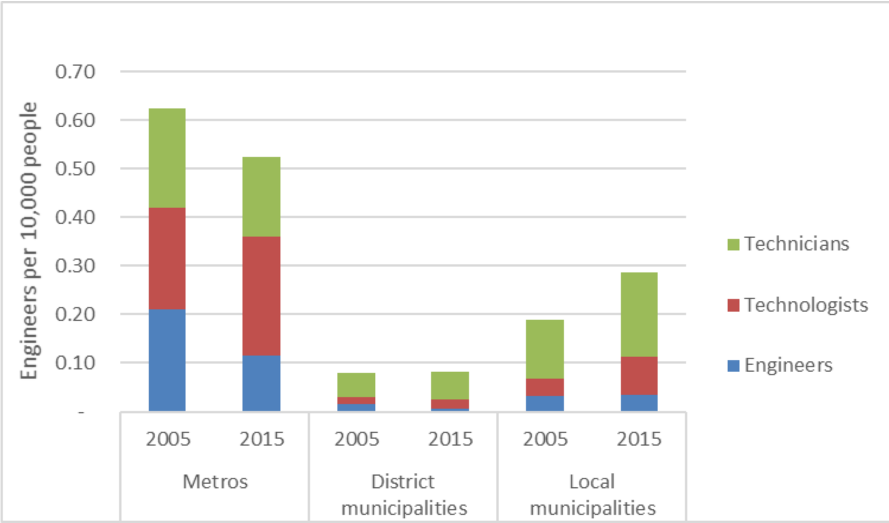

Figure 30: Results of SAICE survey of engineering professionals 2005-2015

Although the data presented above is for employed professionals and does not include engineers that are contracted to undertake specific projects within municipalities, it is still necessary for municipalities to employ suitably qualified professionals to manage the day-to-day operations and provide oversight of municipal infrastructure projects.

Statutory reports submitted by municipalities to National Treasury do not track engineers as a profession, but do track the numbers of 'professionals' which are assumed to be university and university of technology graduates. This data is submitted by municipal service. The data shows similar trends to the SAICE data - that over the past five years there has been an ongoing loss of water services professionals from metros, presumably mostly engineers. On the other hand, there are gains in water services professionals in local municipalities. In C2 districts there have been increases in water services professionals, but off a low base.

The Municipal Demarcation Board (MDB) undertakes irregular capacity surveys of municipalities, excluding metros, with most recent surveys undertaken in 2011 and 2018. The MDB data shows significant increases in professional engineers in all but B1 and C1 municipalities. The gains by local municipalities combined is consistent with the findings from other surveys. In the case of districts, the data also shows again the very low numbers of engineers in C2 districts which are responsible for large scale water supply and sanitation assets. The greater increases in numbers of technologists across all municipal categories is also notable. Figure 31 below shows the average number of engineering staff per municipality with professional registration, by municipal type.

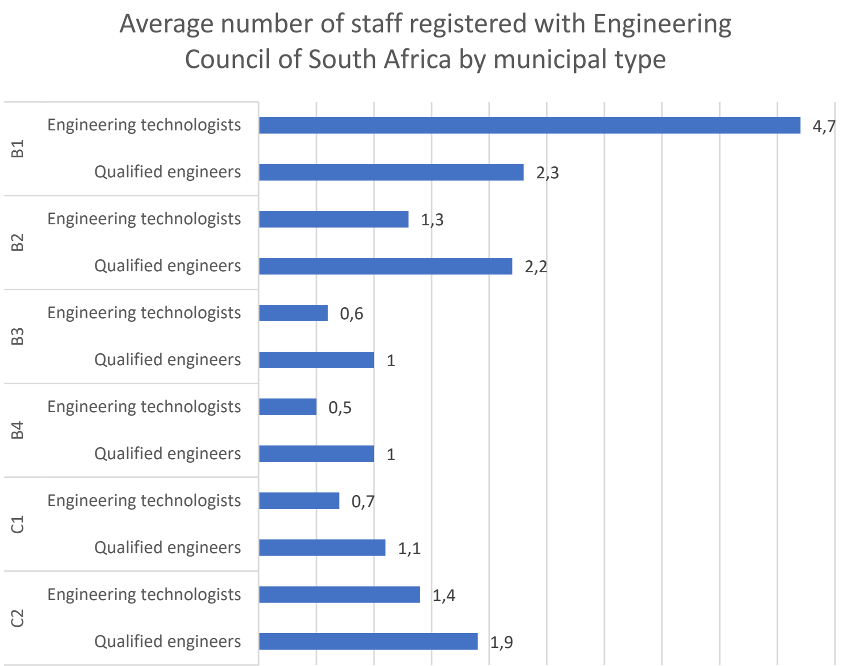

Figure 31: Average number of engineering staff per municipality with professional registration, by municipal type. Source: Municipal Demarcation Board, 2018

It is evident that the shortage of engineering professionals in municipalities is not due to a shortage of engineers in the country, rather it is due to conditions specific to those in municipalities which do not attract existing or new professionals to the public sector. For example, a survey conducted in 2019 by SAICE found: *'amongst 1367 of its members, 932 (68%) of the surveyed engineering professionals indicated willingness to work in the public sector. There are specific issues however, that prevent engineering professionals from joining the public sector. These include an over-politicisation of infrastructure departments, the diminished decision-making roles of technocrats, the lack of systems, processes and structures for efficient administration, lack of training, development and career paths, and unwarranted interference of HR and Finance divisions in the work of infrastructure engineering professionals'* (SAICE, 2019).

With municipal water and sanitation departments lacking skilled and experienced professionals, systems will continue to fail, and renewal efforts will not succeed. The most obvious evidence of this is the increase in intermittent water supply (Box 9), particularly in rural areas, and the failure of wastewater treatment plants in urban areas (Box 6), leading to poor quality effluent discharged into water bodies. The use of management contracts to bring in private sector expertise to supplement senior municipal technical capacity has been proposed and debated (Palmer, 2020).

Box 9: Intermittent water supply in South Africa

The causes of intermittent water supply (IWS) include deteriorating infrastructure due to poor maintenance, increased demand due to population growth and urbanisation, water scarcity due to drought, and the growth of the demand beyond the network design limit due to poor forward planning and poor water demand management. Apart from physical water shortages, the most common cause of IWS in developing countries is poor planning, shortcomings in the management of the water distribution system, and ageing infrastructure (Klingel, 2012; Loubser et al., 2020). Poorly planned supply systems are complex to operate and maintain. The planning, analysis, and operation of water systems requires a detailed knowledge of the water supply network infrastructure and condition. This is possible only when there is proper data collection and data management. A lack in proper data management, therefore, can lead to poor performing supply systems and unsatisfactory levels of service to the consumers.

Water shortages in South Africa are not necessarily caused by inadequate water resources but are often due to deteriorating water supply infrastructure and management and planning shortcomings (Commonwealth Governance, 2018). For example, Mopani District Municipality has not been able to sustainably provide water in most of its towns due to several challenges that have incapacitated the municipality. These challenges include inadequate water resources, ageing infrastructure, limited capacity in municipalities, the non-payment of water services by the consumers, and poor planning (Maake and Holtzhausen, 2015). Hoffman and Nkadimeng (2016) investigated water supply in Motetema settlement, situated within the Elias Motsoaledi Local Municipality in Limpopo Province, and found that dilapidated and fragile infrastructure led to severe water supply interruptions. In addition, municipal responses to breakages were reportedly very slow. Water quality was also reported to be poor, indicating that reliability and quality issues can be related and experienced simultaneously.

Solutions to IWS include external approaches, like governance improvement and changing social behaviour that are outside the control of the utility, and those within the control of the utility, such as technical, management, operations and maintenance interventions and the effective use of tools such as data collection tools (flow meters, pressure loggers etc.), hydraulic data modelling tools (EPANET, WaterGEMS etc.), and GIS software for spatial data analysis (den Dekker, 2020).

6.7.3 Governance and leadership

Achieving efficient, accountable governance systems and executive and political leadership pose important capacity challenges. At local government level, there is evidence of malfeasance in the awarding of contracts to politically connected contractors (Muller, 2020), and a "lack of attention" paid to water and sanitation infrastructure (Auditor-General South Africa, 2019). The Auditor-General (2019) also found that there was inadequate monitoring and oversight of contractors, planning, and poor quality of workmanship leading to unnecessary project delays.

At the national government level, the Department of Water and Sanitation is responsible for setting the policy direction for the delivery of water and sanitation services. The apex non-political position is that of a Director-General (DG). In the period 2009-2017, the average tenure of a DG was 11 months, with nine incumbents over the period, with five of these in acting positions (Auditor-General South Africa, 2018). This indicates **management instability in the Department of Water and Sanitation which is likely to have impacted on water services policy and regulation.** Examples of this include the delays in establishing Catchment Management Agencies, delays in setting up the Independent Economic Regulator, delays in rationalizing water boards, and delays in reviewing the water sector legislation. Regulation of municipal water tariffs has not been occurring and regulation of water board tariffs has been erratic. The delay in finalising the Draft Revised Water Pricing Strategy means that raw water has been under-priced for many years.

6.7.4 Programmatic responses to capacity building

Although there are government programmes to provide technical support to municipalities (such as the Municipal Infrastructure Support Agent (MISA)), or supplemental technical capacity where there is little or none (such as the Cuban engineers brought to South Africa), **there is currently no comprehensive capacity building programme for water and sanitation services specifically**, and thus such an intervention is difficult to cost. However, a capacity building intervention, based on a few existing initiatives, has been proposed and costed as part of all the modelled scenarios. Thus, no metric is used for building adequate institutional capacity. Only inputs are considered that may contribute toward achieving this objective. Reliance has been placed on national departments and agencies to 'build capacity' through various national departments and agencies, most importantly the DWS, MISA and the Government Technical Advisory Centre (GTAC) within National Treasury. But current technical capacity building efforts, whether these are funded by national or international partners, have been too small in scale, inadequately designed, or uncoordinated and, therefore, not sufficiently effective. Partly this is because these national-scale organisations lack sufficient infrastructure management capacity themselves, whether this be to set up programmes, provide direct advice, or set up partnerships with private sector providers. **Where short- to medium-term capacity gaps exist in municipalities, capacity can be provided through a range of private sector partnership types, including concessions, leases and management contracts.**

Although there is no national capacity building strategy in place, there was a strategy developed by sector stakeholders in February 2020. This strategy was led by the South African Local Government Association (SALGA) and with some adaptation, it includes six primary interventions, two in the form of 'supporting the supporters' and four in the form of infrastructure support programmes (Palmer, 2020):

- Provide **technical assistance to the Public-Private Partnership unit in GTAC** to increase its capacity to develop partnerships with a 'supply driven' approach and including management contracts and operating contracts.
- Provide **technical assistance to MISA** to turn around the current situation where it has a serious lack of professional engineers.
- For **metros**: Increase the capability of the existing **City Support Programme** to focus on water supply and sanitation services and facilitate partnerships with private sector organisations, including management contracts.
- For **Intermediate City Municipalities (ICMs)**: Implement the currently conceived ICM Support Programme but with an increased emphasis on technical capacity building for water and sanitation services and the related establishment of partnerships, where appropriate.
- For **Towns and Rural Local Municipalities**: Establish a new support programme with specific roles for MISA and Provinces and framework contracts for private partnerships focused on specific types of infrastructure, with wastewater treatment works being an important example.
- For **Rural District Municipalities:** The 21 district municipalities which are water services authorities for mostly rural areas have the biggest technical capacity constraints associated with water supply and sanitation service provision. A programme to set up regional management support contracts for these district municipalities was conceived and accepted

by government in 2015 but was improperly implemented by MISA. It is essential that this is re-established and applied according to the approved business plan.

An assessment of the costs of these support initiatives is difficult, as most of them are only at concept stage. However, high-level costs have been estimated including provision for the following: professional staff and overheads for all six interventions; transaction costs for private partnerships, including management and operating contracts; costs of specialist consultants to supplement 'in house' capacity; and actual management contractor costs for the rural districts programme. The total amount is estimated at R1.0 billion a year which amounts to 0.6% of the total capital and operating expenditure on water and sanitation in the country.

6.8 Performance of scenarios against defined metrics

The outputs of the modelling for each of the 24 water services scenarios have been discussed in the preceding section. Some of the scenarios perform better according to certain metrics than others. A graphical summary of the performance of each of the scenarios against the performance metrics identified in Section 4 is provided in Table 12.

Table 12: Metrics used to quantify achievement of sector objectives

🟥 Not achieved by 2030
🟩 Fully achieved by 2030

		Objective 1: Basic Servicing												Objective 2: Achieving SDGs											
		Full conv.			Low cost			Alternative			WCDM			Full conv.			Low cost			Alternative			WCDM		
Objective	**Metric**	Baseline	Urban	Rural	Baseline	Urban	Rural	Baseline	Urban	Rural	Baseline	Urban	Rural	Baseline	Urban	Rural	Baseline	Urban	Rural	Baseline	Urban	Rural	Baseline	Urban	Rural
SDG 6.1 and 6.2: Universal access to safe and reliable water services	Proportion of population using safely managed drinking water services	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	Proportion of population using safely managed sanitation services	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	Proportion of population using a hand-washing facility with soap & water	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Universal basic services	Proportion of population with a basic water supply	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	Proportion of population with limited sanitation.	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Financially sustainable water services	Average annual total cost (capital and operating costs over 10 years) expressed as a percentage of GDP	🟨	🟨	🟨	🟩	🟨	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟥	🟥	🟥	🟧	🟧	🟧	🟧	🟧	🟧	🟨	🟨	🟨
Reduced demand on freshwater resources	System input volume divided by population	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟥	🟥	🟧	🟥	🟥	🟧	🟧	🟧	🟧	🟨	🟨	🟨
	NRW as a percentage of system input volume	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Minimising environmental impact	Change in the annual tonnes of CO_2 equivalent emitted by the sector	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟧	🟧	🟧	🟧	🟧	🟧	🟨	🟨	🟨

Table 12 indicates that **the scenario that satisfies the SDG targets and performs the best against other metrics is the WCDM scenario**. There is negligible difference between the Baseline, Urban and Rural demographic scenarios, although, external to this study, the Baseline scenario produces the highest economic growth rate, which is positive for affordability of water and closing the funding gap.

However, while the findings show that none of the scenarios are affordable, the SDG achievement scenarios are the least affordable. Therefore, to achieve universal basic servicing at the least cost by 2030, the country would need to follow the WCDM scenario.

The WCDM technology option is based on a mix of alternative technologies, including maximum use of on-site water and sanitation options, including Next Generation Sanitation and biochar treatment of pit waste[38], and decentralised wastewater treatment for a percentage of waterborne sewage. In addition to the alternative technologies, technical losses have been reduced to 20% through aggressive technical and non-technical interventions. The WCDM scenarios include a number of assumptions:

- That on-site water and sanitation options are going to be acceptable at scale
- That Next Generation Sanitation (NGS) options can be produced at scale at the costs assumed (this is currently uncertain)
- That municipalities have the capacity to:
    - Roll out the provision of services at scale (applicable to all scenarios)
    - Provide and maintain on-site and Next Generation technologies
    - Operate and maintain decentralised wastewater treatment works
    - Implement the aggressive WCDM measures and keep technical losses at this level.

The above assumptions imply that steps need to be taken to prove and implement alternative technologies at scale, and the municipal capacity, particularly technical capacity, is improved above current levels.

[38] Next Generation Sanitation and biochar treatment of pit waste refer to non-sewered off-grid sanitation solutions that treat human waste at source

6.9 Summary of findings

A summary of the findings in the preceding sections is provided below.

Universal access to safe and reliable water and hygiene services

- Achieving SDG 6 is not only about the provision of new infrastructure; addressing inadequate management of existing systems is one of the major interventions required.
- For water, 48% of the 'gap' to achieving SDG 6.1 is due to quality and reliability issues.
- For sanitation, 44% of the 'gap' to achieving SDG 6.2 is due to faecal sludge management.
- There is a lack of awareness or knowledge by households and even service providers around how to manage faecal sludge safely.
- There is a lack of clarity around who should pay for faecal sludge management services (pit and septic tank emptying) in rural areas.

Affordable financially sustainable water services

- The total average annual cost (capital and operating) to achieve the SDG water and sanitation access targets varies between 2.3% and 2.7% of 2020 GDP or between R121 billion and R131 billion (Real 2021 Rands).
- The lowest cost scenarios are those that include extensive Water Conservation and Demand Management, and do not provide individual services to all users.
- Capital expenditure need is dominated by renewal of existing infrastructure.
- Hygiene expenditure, for both operating and capital costs, is very low compared to water and sanitation.
- There are affordability issues in providing the individual services required by the SDGs in urban informal areas.
- The largest capital investments are required in metros and intermediate city municipalities, followed by B4 rural municipalities.
- The greatest expenditure is required in dense urban areas, where the cost per household is also the lowest, indicating an efficient use of resources.
- The funding gap to achieve the SDGs varies between 27% and 32% of the required expenditure between the various scenarios, amounting to between R34 billion and R38 billion per annum.
- Without either an increase in the water tariff level or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 targets by 2030.

Reduced demand on freshwater resources

- The increase in demand through providing higher levels of service can be offset through savings in NRW.
- Aggressive Water Conservation and Demand Management means that universal basic servicing can be achieved without a significant increase in total water demand above current levels.
- The cost of water conservation and demand management is approximately 1% of the total cost of achieving the SDGs (approximately R1.15 billion per annum) but has a significant impact on the environmental impact of the water service.
- South Africa will not achieve the desired water use efficiency targets without drastically influencing technology and behaviours adopted by all water users.

Increased water resilience

- The allocation of water between users is obviously a key policy choice which has a significant impact on urban water security, particularly in those Water Management Areas where the urban allocations are small.
- The additional capital and operating expenditure required to augment the raw water supply to meet the modelled water services scenarios ranges from around R8.7 billion per annum to R14.4 billion per annum, which represents between 6% and 11% of the overall cost.
- Climate scenarios and the levels of IAP infestation have a large impact on water availability and thus on raw water costs.

Minimising or reducing the environmental impact of service delivery

- Reducing demand through aggressive Water Conservation and Demand Management reduces the greenhouse gas emissions in year 10 by to up to 6% below the baseline.
- Scenarios with the highest cost also have the worst environmental outcomes in terms of carbon emissions.

Building adequate institutional capacity

- Current performance of water services in South Africa, particularly in terms of reliability and quality is indicative of a decline in local government capacity to manage infrastructure and sustain water services.

- Low numbers of professional engineers in most local governments remains a serious constraint in the provision of water and sanitation services.
- Management instability in the Department of Water and Sanitation is likely to have impacted on water services policy and regulation.
- There is no nationally developed strategy to develop technical capability of municipalities across all categories of municipalities. The implementation of such a strategy would cost approximately R1 billion per annum, 0.6% of the total operating and capital cost of achieving the SDGs.
- Where short- to medium-term capacity gaps exist in municipalities, capacity can be provided through a range of private sector partnership types, including concessions, leases and management contracts.

7 Policy choices and implications

What does South Africa's constitutional principle of "water as a basic right" mean for water investment priorities, technological choices, and costs? And how does it translate into an actionable objective? The right to water is achieved through the provision of new infrastructure to increase access and the constant provision of sustainable services. Investment of effort and money is required in a number of different areas – infrastructure, systems, institutions, and regulation – in order to achieve the SDG 6. In a resource-constrained environment, not every intervention can be funded, and these need to be prioritized. Some policy choices seem clear, while others are less straight forward and trade off against each other. This section describes some of the main policy trade-offs in pursuit of South Africa's SDG and climate change ambitions.

7.1 Cost recovery versus user affordability

In light of the funding gap, **municipalities must make a difficult trade-off between increasing water tariffs and decreasing affordability for customers and its subsequent impact on municipal revenue**. However, to aid with affordability, tariffs can be restructured into inclining block tariffs (if not structured this way already) to charge higher unit charges for larger water consumers who are assumed to be able to afford the charges. Another obvious policy choice is to improve metering and billing and to limit consumption where water is being charged below cost or provided free of charge. Flow limiting is a possible alternative or additional solution which has been applied successfully in eThekwini Metro, but it requires considerable political will to implement. Other means to tighter regulate consumption and secure political support for a culture of payment for services are essential.

In the absence of an ability to increase tariffs, local government could lobby national government to increase the portion of the Equitable Share to local government. Alternatively, national government could require local government to ring-fence, or at least report on the amounts of Equitable Share allocated to water services.

7.2 Individual versus shared services in urban informal areas

Policy makers must decide between individual services, which meet the SDG requirement of 'safely managed,' or basic services, which do not meet the 'safely managed' requirement. This research has focussed on the attainment of the SDGs as a target, but has presented 'basic servicing' as an alternative, even if this service level does not achieve the SDGs. The decision on the different service levels is not a purely technical decision and has implications for the financial sustainability and political acceptability of the water and sanitation services. The National Norms and Standards (Water Services Act) should reflect these policy choices. The trade-offs are summarised in Table 13 below.

Table 13: Key trade-off: individual, safely managed services vs more affordable basic services

	Individual, safely managed services	***Universal basic services***
Advantages	Sustainable, safe access to the highest level of service.	More affordable and easier to implement in the short term for universal access.
Disadvantages	More costly because of greater numbers of physical units and networked infrastructure and require high levels of management capacity to implement and maintain. Space is often an issue in dense informal settlements	Services may not be safe or financially and socially sustainable.

A funding gap exists for even the lowest cost technical option, and given the current fiscal constraints, the lowest total cost options may be more realistic. However, the global *Beyond the Gap* Study showed that if achievement of individual, safely managed services is the goal, as it should be, then basic services as an intermediate step towards a full service level is more costly overall (Rozenberg & Fay, 2019). The cost difference between the lowest cost SDG Achievement Scenario and the lowest cost Basic Servicing scenario was only 0.2% of GDP. This may lead one to think that with such a small cost difference, achieving the SDGs is an obvious strategy. However, there are also other factors to consider beyond a relatively small cost difference, such as the capacity to deliver and maintain individual services.

7.3 Improved access through new infrastructure versus improved services through better management

Access statistics show that while there still needs to be an improvement in access through infrastructure provision, the biggest issue in the water and sanitation sectors is not the lack of access, but the quality and, more importantly, the continuity of service. **Policy needs to adequately allocate resources between increased access to unserved households and improved management to households with access.** Access, however, cannot be ignored and both access to new services and management of existing services need to be addressed concurrently. The trade-offs between providing new infrastructure, and the improved management of existing services are shown in Table 14 below.

Table 14: Key trade-off: focus on increased access or improved management

	Increased access to unserved households	***Improved management of services to households with access***
Advantages	More equitable access – everyone on at least a basic level.	Reduces overall costs and has the potential to increase revenue.
Disadvantages	Diminishing marginal returns and increased cost in servicing the last unserved households.	Inequitable if serviced households are prioritised.

7.4 New water resource development versus improved catchment management and regulation

While the additional investment in water resources needed to improve potable water security is relatively small in relation to the investment needed in water services, the total investments in water resources overall (including to supply non-potable demand) are substantial and lumpy. These large investments in water resources infrastructure can be deferred or avoided through improved catchment management and regulation, but this requires significant investment in institutional capability and capacity. The key trade-off is between a focus on new water resource development and improved catchment management and regulation (Table 15).

Table 15: Key trade-off: new water resource development vs improved catchment management and regulation

	New water resource development	***Improved catchment management and regulation***
Advantages	Improved water security and supportive of economic growth	Save the cost of new water resources. More equitable allocations.
Disadvantages	Costly, requires institutional capacity, and options are diminishing.	Requires considerable state capacity (at all spheres), new funding models and improved inter-governmental relations.

Again, these are not binary trade-offs and both strategies will need to be pursued. However, improved catchment management and regulation will be required for both new and existing water resources and thus needs to be urgently developed in the short term. South Africa's limited surface water availability will also require consideration for alternative supply options and a greater focus on supporting a transition to more water sensitive cities. South Africa is starting to make investments in the clearing of IAPs through, especially, the ***Working for Water*** programme under the Department of Forestry Fisheries and Environment, but also through other initiatives supported by LandCare, World Wildlife Fund, the South African National Biodiversity Institute and, increasingly, through private sector involvement such as the Greater Cape Town Water Fund. Increased investment in alternative supply options will require increased collaboration and co-operation between different spheres of government as well as consideration for more diversified and integrated water supply options. Improvements in WCDM are also critical to reducing the demand on water resources, as is continued improvement in the operation and maintenance of existing bulk water supply systems.

8 Conclusion

The SDGs are deliberately more ambitious and challenging to achieve than the MDGs because the focus is no longer only on improved access, but also the quality, reliability and safety of the water, sanitation and hygiene services. Access statistics show that South Africa's performance is not good and there is a long way to go to achieving the SDGs. What is more concerning is that the financial modelling shows, that in the current fiscal context, South Africa cannot afford to implement the necessary interventions before 2030 to achieve these targets without a significant increase in either the fiscal transfers to local government and/or an increase in tariff levels. The existence of a funding gap has been highlighted in previous studies and confirmed in this one. The South African government will need to make explicit policy choices to minimise cost and to increase the funding through user charges, development charges and national fiscal transfers. All of these interventions speak to placing a greater societal value on the availability and sustainable management of water and sanitation.

The modelling of a number of scenarios has shown that technical options do not have a major impact on cost but do make a big difference to environmental outcomes. It is encouraging to be able to show that alternative options, both for water service provision and water resources, can increase water resilience and decrease greenhouse gas emissions below that of the status quo. The largest investments are needed in large urban centres and in sparse rural municipalities, with the former having greater impact per unit expenditure, and the latter having more opportunity for technical innovation to reduce unit costs.

While technical choices need to make sense in terms of affordability, appropriateness to context, and more urgently on their environmental impact, there are other, more fundamental systemic issues, that need to be resolved. The recurring constraint in the system is the capacity of both local government Water Services Authorities and national government to fulfil their water-related mandates. Lack of capacity is having an impact on the rate of roll-out of new infrastructure and the maintenance of existing services. Poor asset management results in poor service delivery and environmental outcomes. Capacity development and supplementation is critical to achieving the SDGs and for addressing the chronic issues around non-revenue water. The analysis has found that the improvement of water conservation and demand management can have a positive impact on all SDG 6 performance indicators considered in the study, including overall lifecycle cost. However, additional measures to address behaviour change and water use efficiency will be needed to reach the water consumption target of 175 l/c/d.

Key policy trade-offs relate to balancing difficult decisions that impact on consumers in the short-term in relation to access and cost of water services, versus ensuring the longer-term sustainability of the services for all consumers. Given that the greatest barrier to achievement of the SDGs is probably the provision of individual sanitation facilities in dense, urban informal settlements, more pragmatic solutions than individual, sewered or on-site facilities, may need to be found. While short-term solutions need to be robust, affordable, and provide a basic level of service, longer-term solutions may have to be sought in the systemic approach to informal settlements and their upgrading, rather than from the water sector alone. Policy needs to include a blend of increasing access to services and improved management of existing services, but what is an appropriate mix, and how can it be monitored? The evidence suggests that interventions focussing on management may have more of an impact on the SDG targets than interventions focussing only on access. Indicators that provide information on system performance (such as Blue Drop, Green Drop and No Drop) should be carefully monitored and given as much political attention as access figures. Improved catchment management, including the review and management of allocations, and the clearing of IAPs, is necessary and urgent and requires improved capacity, particularly at national government level.

9 Recommendations[39]

The recommendations for the attainment of the SDG 6.1 and 6.2 targets are listed below in order of priority, and are classified according to the departments/entities or designated official that should be responsible for their implementation. The entities with secondary responsibilities are also listed.

9.1 Implement a nationally coordinated capacity building and institutional strengthening strategy

Given that a large portion of the current backlog in service access relates to the management of services, and that the preferred scenarios emphasize the use of alternative technologies and aggressive WCDM, increased institutional capacity is essential. It is proposed here as the priority, given the limited amount of funding that it requires, approximately R1 billion per annum, in relation to the

[39] A table linking recommendations to findings and institutional responsibility is provided in Annexure F.

potential benefits. Fundamental to increasing municipal capacity is to have clearly defined programmes to manage the way funding for capacity building programmes is applied at national level. This funding is needed to build technical capacity and to set up partnerships with private sector to provide services through a range of contracting styles. The success of these programmes will, in turn, depend on building the capacity of the national departments and agencies supporting municipalities.

The institutional capacity building required, includes building sector leadership and improved governance at national and local spheres of government, and increasing technical capacity at local government level along six strands:

- Stabilize the DWS and introduce mechanisms to ensure accountability for implementing the NWSMP.
- Improve governance of water through more coherent regulation, for example through water allocations, tariff regulation and reporting on procurement and capital expenditure.
- Increase performance incentives for municipal good governance through peer-to-peer learning and incentive grants.
- Focus on technical capacity in municipalities, but also of national government and support agencies by implementing the capacity building strategy developed by SALGA.
- Develop mechanisms and refine incentives to facilitate partnerships with the private sector to supplement public sector capacity.
- Investigate and develop measures to improve the attractiveness of the municipal environment for qualified technical personnel.

Technical capacity interventions should help ensure that local political leadership is held accountable for the governance of infrastructure development and services in their municipalities.

9.2 Prioritise WCDM

WCDM is the next priority as it makes the best use of existing infrastructure while, at the same time, increasing revenue to municipalities. The results indicate the numerous benefits of WCDM, which contribute to the objectives of 1) universal access (through reducing intermittent water supply); 2) financial sustainability (through lower total costs and reducing non-revenue water); 3) resource efficiency (less wastage); 4) increased water resilience (through lower overall consumption); and 5) reducing environmental impact (through lower GHG emissions). Technical options that promote WCDM have the lowest costs and best environmental outcomes. However, alternative technology options and a comprehensive WCDM programme will require both capital and operating expenditure to be dedicated to achieving the desired reductions. There has been very limited success in prioritising these options to date (DWS, 2018). The capital and operating costs of WCDM represent between 0.8% and 1.3% of total cost (R1.1 billion per annum to R1.5 billion per annum). Implementing aggressive WCDM would require government to:

- Prioritise and incentivize WCDM through regulation. WCDM initiatives have largely been left to local government to manage, but there is scope for the DWS to impose strict WCDM targets on municipalities, potentially with penalties for not meeting these targets.
- Allocate dedicated funding to WCDM initiatives, either as an incentive grant or as a ring-fenced portion of one of the existing water sector grants.
- As per the Minister of Water and Sanitation's 10-point plan, initiate the DWS 'No Drop' monitoring programme to collect data and report transparently on the levels of non-revenue water in each municipality.
- Implement the recommendations made in the Final Report on the Status of Water Losses in the 8 Large Water Supply Systems (DWS, 2019).
- Address non-revenue water through focusing on unmetered, unbilled connections, particularly in rural areas, through the installation of meters and flow limiters. This will require political buy-in from councilors and traditional leaders to support measures that may restrict flow but increase assurance of supply and revenue to municipalities.

9.3 Improve economic regulation of water services to address chronic revenue shortages

The expenditure required to achieve the SDGs by 2030 is between 2.3% and 2.7% of 2020 GDP or between R121 billion and R131 billion (Real 2021 Rands), but the current available funding is between 27% and 32% less than this, leading to an annual shortfall of between R34 billion and R38 billion. Without either an increase in the water tariff level or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 targets by 2030. Recommended measures to address this are:

- Establish an independent economic regulator to review and regulate water and sanitation tariffs.
- Undertake water audits to ensure that all connections that are intended to be billed are metered.
- Investigate municipalities with poor cost recovery and provide capacity support to set cost reflective tariffs.

- Undertake a nationwide campaign to address non-payment for water services.

9.4 Incentivise proper integrated asset management

The findings around universal access to services have shown that asset management is a critical component of maintaining current levels of services (not to allow these to decline) and maintain revenue, as well as to address quality and reliability issues that form a large portion of current service backlogs. The total capital expenditure required annually to eradicate the backlog and renew existing and new infrastructure is approximately R21 billion per annum. The capital investment requirement is dominated by the need for asset renewal, which represents approximately R15 billion of the R21 billion required to ensure sound asset management, on the capital account. Measures to address integrated asset management are as follows:

- Incentivise expenditure on operations and maintenance and integrated asset management by re-establishing and sustaining the Blue Drop and Green Drop monitoring programmes, as stated by the Minister of Water and Sanitation in his 10-point plan.
- Increase monitoring of water quality downstream of water treatment works to detect non-compliance with effluent discharge standards early.

9.5 Make appropriate service level choices

The findings show that South Africa cannot afford to achieve even the universal basic servicing targets, let alone the SDG targets by 2030, without radical revision to tariff levels and/or fiscal allocations. Hard choices need to be made to spend on the highest impact solutions with the lowest cost. Measures to increase value for money of expenditure are as follows:

- Avoid the continuation of low capital cost, high operating cost service options introduced as 'interim' or 'emergency' services. For instance, wherever water tankering is taking place or portable chemical toilets are in use, municipalities must be supported by the DWS or relevant province to investigate and propose more long-term, permanent solutions with a lower lifecycle cost.
- Alternative technology options, particularly for sanitation should be used where they are acceptable and can be delivered at scale. Support the research and development efforts in this field. This is currently taking place within the DWS and the WRC and this research and development work should continue to be supported. South Africa could engage more systematically with global research initiatives, such as those conducted by the Gates Foundation, and under the World Bank's Citywide Inclusive Sanitation initiative.

- Clarify the national policy position on housing provision and the servicing of informal settlements, including service level standards (shared vs individual).

9.6 Initiate a national faecal sludge management programme

The access figures for sanitation are difficult to determine accurately because of a lack of data around faecal sludge management, particularly in rural areas, as well as unclear policy guidance as to what constitutes safe faecal sludge management. The DWS is in the process of developing a National Faecal Sludge Management Strategy, to be finalised in 2022. An effective means to radically improve sanitation service levels in rural areas is to make use of the current on-site sanitation facilities and focus on supporting households to manage faecal waste safely, preferably with on-site beneficiation. This will not entail a standardised method but may include any one of: safe manual emptying with on-site burial or composting; manual vacuum pump emptying and disposal; or mechanical emptying by tanker for centralised disposal, either by the municipality or private service providers. The recommended actions are to:

- Include in the National Faecal Sludge Management Strategy a clear policy position on who is responsible for the costs of faecal sludge management in rural areas.
- Undertake faecal sludge management campaigns, clarifying what constitutes safe FSM, that should progressively replace a focus on toilet provision in rural areas.

9.7 Better manage water resource allocations

Ensuring adequate water for competing uses requires clear allocations of water in each Water Management Area and the regulation thereof. To this end, DWS, and its Catchment Management Agencies, should:

- Review water allocations, particularly the urban agriculture split for systems serving large urban centres.
- Better regulate the abstraction of raw water.

9.8 Coordinate national efforts on IAP clearing

The water resources modelling shows that additional infestation of IAPs can reduce water availability, while clearing can increase available surface water resources. The modelling estimates this to require approximately R650 million per annum. DWS, in collaboration with other sector stakeholders, should:

- Identify priority areas for IAP clearing and develop catchment protection plans, including IAP management planning at a catchment level, focused on those catchments or sub-catchments that are either at highest risk of reduction due to infestation, or the highest potential increase in yield through clearing.
- Clarify institutional responsibility (probably catchment management agencies) and funding model for IAP clearing.

10 References

Auditor-General South Africa, 2018. Report of the auditor-general to the joint committee of inquiry into the functioning of the Department of Water and Sanitation. Challenges facing the water and sanitation portfolio. 23 March 2018.

Auditor-General South Africa, 2018. Municipal Financial Management Act: Auditor-general flags lack of accountability as the major cause of poor local government audit results. Available at https://www.agsa.co.za/Portals/0/Reports/MFMA/2019.06.25/2019%20MFMA%20Media%20Release.pdf. Accesses 10 November 2021.

Beraki, AF., Le Roux, A. & Ludick, C. 2019. Green Book. The impact of climate change on drought. Pretoria: CSIR.

Loubser, C., Basson, S. & Jacobs, HE. 2020. A conceptual index for benchmarking intermittent water supply in a water distribution system zone. Water SA, 46(1 January). https://doi.org/10.17159/wsa/2020.v46.i1.7873.

Commonwealth Governance. 2018. Utilities in South Africa. Available at: https://www.commonwealthgovernance.org/countries/africa/south_africa/utilities/. Accessed: 28 June 2021.

CSIR, 2019. Green Book: Adapting South African settlements to climate change. Available at: www.greenbook.co.za.

Cullis J, Alton T, Arndt C, Cartwright A, Chang A, Gabriel S, Gebretsadik Y, Hartley F, De Jager G, Makrelov K, Robertson G, Schlosser A, Strzepek K, & Thurlow J. 2015. An uncertainty approach to modelling climate change risk in South Africa. United Nations University World Institute for Development Economics Research. WIDER Working Paper 2015/045.

Cullis J.D.S., Görgens A.H.M. & Marais C. 2007. A Strategic Study of the Impact of Invasive Alien Plants in the High Rainfall Catchments and Riparian Zones of South Africa on Total Surface Water Yield. Water SA Vol. 33 No. 1. January 2007.

Cullis, J. & Phillips, M. 2019. Green Book. Surface Water Supply. Water supply climate risk narrative for South Africa. Pretoria: Aurecon & CSIR. Available at: https://pta-gis-2-web1.csir.co.za/portal/apps/GBCascade/index.html?appid=74fc5a7337f34460b7a09242d0770229.

den Dekker, P. 2020. Strategy to transition from an intermittent to a continuous water supply using a district metering area approach (Thesis). Delft University of Technology.

Department of Planning, Monitoring and Evaluation. 2019. Medium-Term Strategic Framework. DPME: Pretoria.

Department of Water and Sanitation (DWS). 2012. National water resources strategy 2. DWS: Pretoria

Department of Water and Sanitation (DWS). 2015. Metropolitan Municipality Water Balance Assessment. DWS: Pretoria.

Department of Water and Sanitation (DWS). 2016. National sanitation policy 2016. DWS: Pretoria

Department of Water and Sanitation (DWS). 2017a. National water investment framework – Executive summary. Sept. 2017. Unpublished departmental report. DWS: Pretoria.

Department of Water and Sanitation (DWS). 2017b. National norms and standards for domestic water and sanitation services Version 3- Final. DWS: Pretoria.

Department of Water and Sanitation (DWS). 2018. National Water and Sanitation Master Plan (NWSMP). DWS: Pretoria.

Department of Water and Sanitation (DWS). 2019. Final Report on the Status of Water Losses in the 8 Large Water Supply Systems. DWS: Pretoria.

ENCA. 2018. ENCA, 2018. Available at: https://www.enca.com/south-africa/cape-town-gets-10bn-litres-of-water. Accessed 12 November 2021.

Engelbrecht, F., Le Roux, A., Arnold, K. & Malherbe, J. 2019. Green Book. Detailed projections of future climate change over South Africa. Pretoria: CSIR.

Gosling, M. 2018. Western Cape farmers call for easing of water restrictions to repair drought damage. News24 Media Report. Available at: https://www.news24.com/news24/SouthAfrica/News/western-cape-farmers-call-for-easing-of-water-restrictions-to-repair-drought-damage-20180917. Accessed on 12 November 2021.

Hoffman DJ and Nkadimeng LM. 2016. Investigating water supply challenges in the Elias Motsoaledi municipality of Limpopo Province. UPSpace, University of Pretoria.

Intergovernmental Panel on Climate Change. 2007. Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, And Response Strategies Technical Summary. IPCC Expert Meeting Report. 19–21 September, 2007. Noordwijkerhout: The Netherlands.

Johannessen, Å., & C. Wamsler. 2017. What does resilience mean for urban water services? Ecology and Society 22(1):1. https://doi.org/10.5751/ES-08870-220101.

Klingel, P. 2012. Technical causes and impacts of intermittent water distribution. Water Science and Technology: Water Supply, 12(4): 504–512.

Le Maitre, D., Forsyth, G., Dzikiti, S & Gush, M. 2013. Estimates of the impacts of invasive alien plants on water flows in South Africa. Report No. CSIR/NRE/ECO/ER/2013/0067/B, Natural Resources and the Environment, CSIR, Stellenbosch.

Lawless, A. 2005. Numbers and Needs: Addressing imbalances in the Civil Engineering profession. SAICE: Midrand.

Maake MT & Holtzhausen N. 2015. Factors affecting the provision of sustainable water services in the Mopani District Municipality, Limpopo Province. Admin. Public. 23 (4) 248-271.

Matikinca, P., Ziervogel, G. & Enqvist, J. 2020. Drought response impacts on household water use practices in Cape Town, South Africa. *Water Policy*. 22(3): 483-500.

McKenzie, R. 2014. Guidelines for Reducing Water Losses in South African Municipalities: Report to the Water Research Commission. TT 595/14: Pretoria.

Moolman, S. 2021. The Price of Water and Electricity in South Africa: A Tale of Two Tragedies. Available at: https://www.poweroptimal.com/the-price-of-water-and-electricity-in-south-africa-a-tale-of-two-tragedies/ . Accessed: 30 June, 2021.

Muller, Mike. 2020. Money Down the Drain: Corruption in South Africa's Water Sector: A Water Integrity Network / Corruption Watch report.

Municipal Demarcation Board (2018) Municipal Capacity Assessment. Available at: https://www.demarcation.org.za/capacity-assessment/. Accessed: 28 July 2021.

National Planning Commission. 2013. National Development Plan: Vision for 2030. Department of the Presidency: Pretoria.

Palmer, I. 2020. Technical capacity building workshop, 28 February 2020 - Report from workshop, including recommendations. Report from workshop held at DBSA Vulindlela Academy, 13 March 2020. Unpublished.

Partners in Development. 2020. Amathole Water and Sanitation Indaba: Appropriate on-site sanitation technologies. 7 February 2020.

PDG. 2017. A review of the challenges and constraints associated with the provision of sanitation services in urban informal settlements. Report ref K5/2486 to the Water Research Commission. WRC: Pretoria.

Roma, E., Buckley, C., Mbatha, S., Sibiya, L., & Gounden, T. 2010. Community ablution blocks with sewers or infiltration, eThekwini (Durban), South Africa – Case study of sustainable sanitation projects. Available at: https://www.susana.org/en/knowledge-hub/resources-and-publications/case-studies/details/792. Accessed 12 November 2021.

Rozenberg, J., & Fay, M. 2019. Beyond the Gap: How Countries Can Afford the Infrastructure They Need while Protecting the Planet. Sustainable Infrastructure. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31291 License: CC BY 3.0 IGO.

SALGA. 2021. Report on the Deferral of Asset Maintenance in South African Municipalities. Authored by PDG. Unpublished.

SAICE. 2019. South African Institution of Civil Engineering. South African Engineers are Leaving in Alarming Numbers and it's Hurting the Economy. Available at https://saice.org.za/south-african-engineers-are-leaving-in-alarming-numbers-and-its-hurting-the-economy. Accessed 8 November 2021.

StatsSA. 2019. General Household Survey 2019. Statistical Release P0318. Statistics South Africa: Pretoria.

StatsSA, 2016. Community Survey 2016. Statistical Release P0301. Statistics South Africa: Pretoria.

Still, D. 2020. Appropriate on-site sanitation technologies. Presentation to the Amathole Water and Sanitation Indaba, 7 February, 2020. Unpublished.

The International Benchmarking Network for Water and Sanitation Utilities (IBNET). 2021. Water supply tariff database. Available at: https://tariffs.ib-net.org/. Accessed: 28 July 2021.

Thompson, B., Palmer, I. & Eberhard, R. 1996. Financial modelling of municipal services in South African towns. Development Southern Africa. 13(5) pp. 745-758.

United Nations. 2015. Sustainable Development Goals. Communication Materials. Available at https://www.un.org/sustainabledevelopment/news/communications-material/. Accessed 8 November 2021.

Water Integrity Network. 2020. Money Down the Drain: Corruption in South Africa's water sector. Available at: https://www.waterintegritynetwork.net/?docs=16984. Accessed: 28 July 2021.

World Bank. 2021. Going beyond the infrastructure funding gap: a South African perspective – population and gross domestic product projections as inputs to the infrastructure demand scenarios. Unpublished report prepared for the DBSA. World Bank: Washington DC.

Ziervogel, G. 2019. Unpacking The Cape Town Drought: Lessons Learned. Report for Cities Support Programme. Undertaken by African Centre for Cities. Available at: https://www.blueeconomyfuture.org.za/gallery/ziervogel-2019-lessons-from-cape-town-drought_a.pdf. Accessed 12 November 2021.

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Annexure A: Description of water services and water resource models

Water services model

The water services model is a modified version of the municipal services financial model, which was developed by PDG over the best part of a decade. This model is designed to assist local government in the development of infrastructure investment plans, and undertake national analyses of infrastructure investment requirements. The water services model concept is shown in Figure A1.

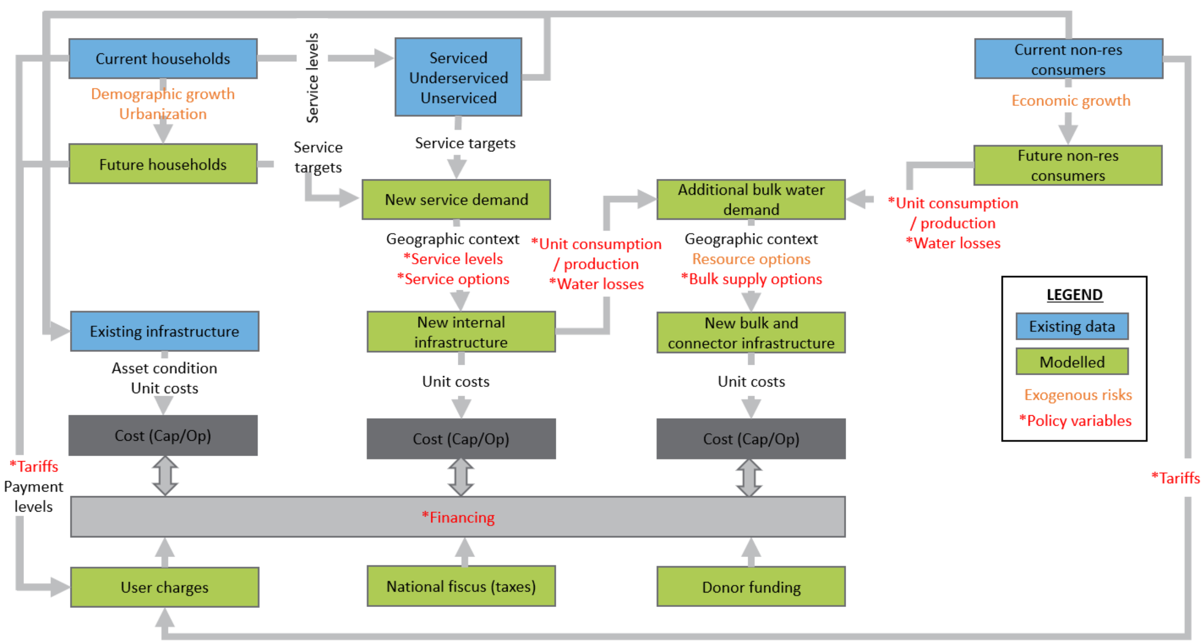


Figure A1: Water services model concept

The model projects the full operating and capital accounts associated with infrastructure provision in a municipal area over 10 years. The user can choose to model all infrastructure provision (by municipal and external service providers) or to model provision by the municipality only. In this case, only the water and sanitation services were modelled, for all actors (including private sector concessions and water boards that supply potable bulk water to municipalities).

The model uses a unit-cost approach to determine infrastructure investment need. The unit costs used in the model have been developed by a consulting engineering firm, and represent an average cost of providing infrastructure, and adequately maintaining this service (see costs in Annexure D). The starting point for the model is a projection of the number of consumers in a municipality, based on household and economic growth rates. A user-defined service delivery programme is then used to determine the numbers of consumers that have different levels of service in each year of the model run, as well as the numbers of consumers that are provided with different levels of service in each year. Once the service delivery programme is known, the model estimates operating expenditure and capital expenditure required using unit consumptions, operating costs per consumer and capital costs per new consumer connected for each level of service.

The model also projects the financing of the capital account (and its corresponding impact on the operating account), but this was not considered for the SDG 6 analysis, as the focus of the study is on the funding that is required to achieve SDG 6.

The following operating costs are included in this total cost:

- Operations and maintenance costs of existing water services;
- Operations and maintenance costs of new water services;
- Operations and maintenance costs of water resources (pro rata for potable water only);
- Operating expenditure on WCDM; and
- Operating expenditure on capacity building.

On the capital side, the total costs include the following capital expenditure:

- Capital costs of new internal, connector and bulk water services infrastructure;
- Renewal of existing water services assets;
- Renewal backlog on existing water services assets;
- Capital costs of new water resources infrastructure (pro rata for potable water only); and
- Capital costs of WCDM.

The funding sources included in the analysis are the following:

- User charges: Municipal water and sanitation revenue, less bad debt;
- Development charges: Capital contributions by developers to municipalities for new bulk services (either in cash or in kind), estimated as at 60% of the capital cost

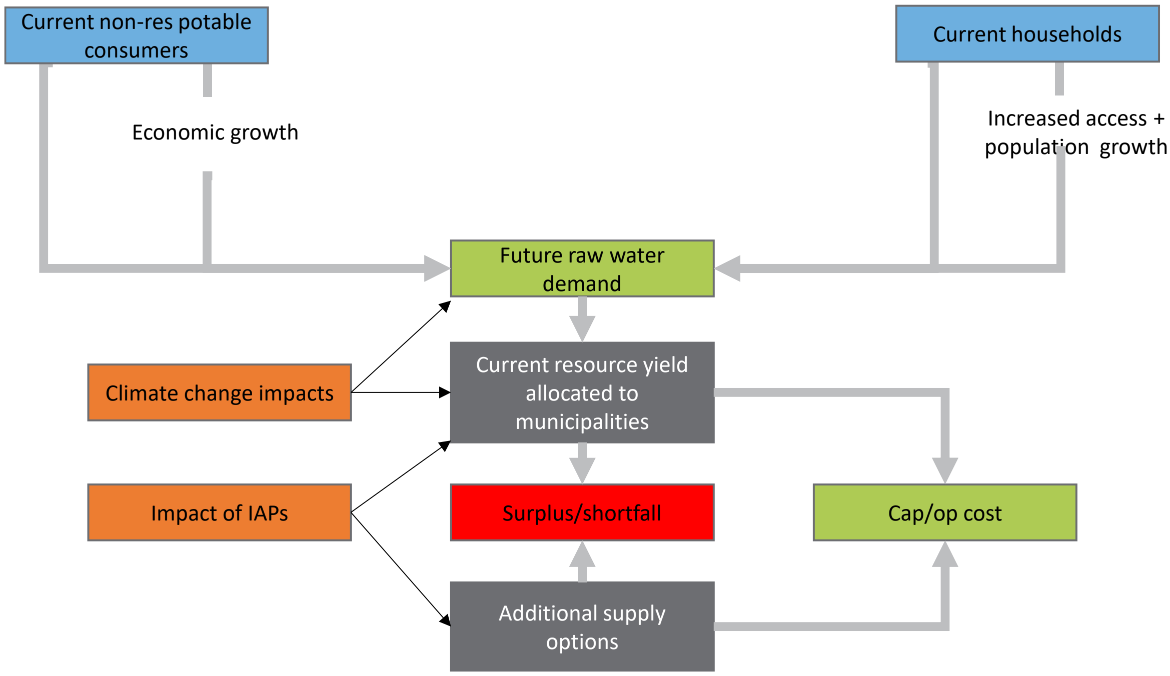
of bulk and connector infrastructure attributed to high income residential and non-residential customers;

- Equitable share: an unconditional transfer from the national fiscus to local government, calculated as the difference between reported municipal expenditure on water services and user charges revenue;
- Capital grants: from national to local government, including portions of the Urban Settlements Development Grant, the Integrated Urban Development Grant, the Municipal Infrastructure Grant, the Regional Bulk Infrastructure Grant, the Human Settlements Development Grant, and the Water Services Improvement Grant;
- National government capital expenditure directly from the fiscus by DWS and its agencies (for water resources), with 40% of the current capital expenditure of R2.1 billion per annum assumed to be for potable; i.e., approximately R860 million per annum[40].

Water resources model

The water resource model is a bespoke tool developed specifically for this project. The model concept is shown in Figure A2.

[40] National government operational funding from the fiscus has not been included due to a lack of clarity on the direct operating costs of water resources for potable supply and the proportion of these costs that are covered by raw water tariffs.



Note: IAP stands for invasive alien plants.

Figure A2: Water resources model concept

The model classifies the municipalities in South Africa to the 9 water supply areas, with municipalities outside of this allocated to the 'rest of country' water supply area. These water supply areas provide an amount of water to these municipalities, known as their 'potable yield.' The proportion of the yield that is provided to non-potable uses (primarily agriculture and large-scale industrial use such as electricity generation) is assumed to remain constant over time. The yield of the water supply areas are affected by the prevalence of invasive alien plants, and the impacts of climate change. For each of the water service areas, the Department of Water and Sanitation has identified a pipeline of projects that can be used to augment the supply of water in advance of an anticipated shortfall.

The water services model projects an overall potable water demand by geography type (Urban-Formal, Urban-Informal, Rural-Traditional and Rural-Farms) which is disaggregated to municipalities, and reaggregated to water service areas based on the location of the municipalities, with a factor to increase demand based on the increased temperature due to climate change, and a further factor to account for technical losses in the raw water systems (primarily leaking pipes during the conveyance of raw water). It is known what proportion of demand for each municipality is surface water, with this demand deducted from the yield available from the water service area. The groundwater demand is allocated to the 'rest of country' water service area.

The water resources model will then deduct demand from the available supply (the 'potable yield'). If there is no shortfall, then no intervention is required to increase the available yield. If there is a shortfall, the model will calculate the extent of the shortfall, and identify the next project (or projects) that should be implemented to satisfy the shortfall. For the 'rest of country' water service area, the marginal costs of new interventions are applied to eradicate the shortfall. The interventions are assumed to be fully implemented in a single year, and implemented in their entirety, which results is most likely to result in a surplus for the following years.

This process is repeated annually for the 10-year period of analysis. The operating and capital costs of these interventions are then fed back into the water services model and aggregated with the cost of water services to determine the total cost of achieving SDG 6.1 and 6.2.

Annexure B: Data sources

Access data: General Household Survey 2019, Community Survey 2016

Cost data: Municipal Infrastructure Investment Framework, DWS Cost Benchmark for water services projects (2016), previous PDG work, cost of alternative treatments from various research papers and Gates Foundation research. National Water and Sanitation Masterplan.

Tariffs:

National Treasury database of municipal tariffs

IBNET database.

Finance data:

National Treasury Local Government Municipal Reporting Reforms Database.

Infrastructure and performance data:

DWS National Integrated Water Information System (NIWIS)

DWS Integrated Regulatory Information System (IRIS)

StatsSA GHS

Water resource data:

DWS reconciliation studies

DWS Ultimate Marginal Cost study

DWS All Towns Study

Governance data:

Lawless, A (2005): Numbers and Needs: Addressing imbalances in the Civil Engineering profession

Municipal Demarcation Board (2018) Municipal Capacity Assessment.

National Treasury Local Government Municipal Reporting Reforms Database – SA24 tables

Annexure C: Alignment of JMP and StatsSA categories

The mapping of the JMP and StatsSA categories for water access is shown in Table C1 below.

Table C1: Alignment of JMP facility types and StatsSA reporting categories

SDG/JMP classification	StatsSA classification
Improved	All piped water
All piped	Piped (tap) water on site or in yard Piped (tap) water in dwelling Neighbour's tap Public/communal tap Borehole on site Borehole in yard Rain-water tank on site Rainwater tank in yard
Non-piped	Other Well Spring Water vendor Borehole outside yard Water-carrier/tanker
Surface water	Flowing water/stream/river Stagnant water/dam/pool

The JMP also assesses access against the JMP drinking water ladder. The alignment of the reporting categories in shown in Table C2 below, indicating which StatsSA classifications are included in the definition of 'safely managed' required in the SDG target.

Table C2: Alignment of JMP drinking water ladder and StatsSA reporting categories
(Source: South Africa SDG Country Report, StatsSA:2019)

SDG/JMP classification	StatsSA classification	Data source
Safely managed	**The lower of the following two options:** -Piped (tap) water in dwelling -Piped (tap) water on site or in yard	StatsSA GHS Blue Drop

SDG/JMP classification	StatsSA classification	Data source
	-Borehole on site -Borehole in yard -Rain-water tank on site AND No water interruptions, or a water interruption has been repaired, in the previous two days **OR** Water from the following water sources that has been determined safe to drink: -Piped (tap) water in dwelling -Piped (tap) water on site or in yard -Borehole on site -Borehole in yard -Rain-water tank on site	
Basic service	-Borehole outside yard <200m away -Neighbour's tap <200m away -Public/communal tap <200m away MINUS The proportion of the population using safely managed water sources (i.e., the lower of the two items mentioned above)	StatsSA GHS
No service/ Inadequate service	-Flowing water/stream/river -Stagnant water/dam/pool -Other -Spring -Well -Water vendor -Water-carrier/tanker -Improved sources >200m away	StatsSA GHS

The alignment of the JMP sanitation categories to the StatsSA reporting categories is shown in Table C3.

Table C3: Alignment of JMP sanitation water ladder and StatsSA reporting categories

SDG/JMP classification	StatsSA classification	Data source
Open defecation	-Other -Unspecified -None -Open defecation (e.g., no facilities; field; bush)	StatsSA GHS
Unimproved sanitation	-Pit latrine/toilet without ventilation pipe -Bucket toilet (collected by municipality) -Bucket toilet (emptied by household)	StatsSA GHS
Limited sanitation	-Flush toilet connected to a public sewerage system -Pit latrine/toilet with ventilation pipe -Flush toilet connected to a septic tank or conservancy tank -Pour bucket-flush toilet connected to a septic tank (or septage pit) -Ecological sanitation system (e.g., composting toilet) -Chemical toilet/portable toilet AND Facilities are shared between two or more households	StatsSA GHS
JMP basic sanitation	-Flush toilet connected to a public sewerage system -Pit latrine/toilet with ventilation pipe -Flush toilet connected to a septic tank or conservancy tank -Pour bucket-flush toilet connected to a septic tank (or septage pit) -Ecological sanitation system (e.g., composting toilet) -Chemical toilet/portable toilet AND Facilities are not shared	StatsSA GHS

The metrics for the measurement of a quality water service are contained in the Blue Drop System, which measures services against the SANS 241 drinking standard and the National Norms and Standards for Domestic Water and Sanitation Services (DWS, 2017b). The Blue Drop reports have not been issued since 2014, although it is set to be revitalised in 2022. In the 2014 Blue Drop assessment, 86% of WSAs achieved good or excellent status for microbiological water quality compliance, but only 70% achieved good or excellent status for water quality operational compliance. Data from municipalities are still reported into the DWS's integrated regulation information system (IRIS) system, which has been used in the analysis for this report to estimate the expenditure required to upgrade water treatment works to produce water of the required quality. The NWSMP indicates that 44% of the 962 water treatment works are in poor or critical condition.

The General Household Survey (GHS) collects data on the reliability of water supply, asking whether there have been interruptions to water supply in the prior 12 months that have lasted two days or more. Overall, 25.8% of households in the country have experienced intermittent water supply (IWS). Notably, in metropolitan areas, only 12.2% of households have experienced water supply interruptions, indicating a significant disparity in the reliability of services between metropolitan areas and secondary cities and rural areas.

Annexure D: Unit capital and Operating costs

Unit capital and operating costs were derived for the provision of new bulk and connector infrastructure, as well as the renewal and rehabilitation of the existing infrastructure. Unit capital costs were also introduced for the upgrading of existing bulk infrastructure to achieve the SDGs (Table D1).

Table D1: Unit capital and operating costs for bulk and connector infrastructure

Infrastructure type	Capital cost	Operating cost
Water treatment works	R2.97 mil to R34.69 mil Per Megalitre per day of new capacity (depending on geography)	R2.13 to R7.19 per cubic metre of water treated (depending on geography)
Sanitation treatment works	R12.79 mil to R31.98 mil Per Megalitre per day of new capacity (depending on geography)	R0.96 to R2.81 per cubic metre of water treated (depending on geography)

Unit capital and operating costs were also developed for the user-end technology (Table D2). The incidence of this cost (i.e., who pays for the technology) varies by household income. It is assumed that middle- and high-income, and non-residential customers will pay the capital cost for their own end-user technology, but the capital cost of technology for low-income households will be paid for by the State through a number for fiscal transfers made to local government for this purpose.

Table D2: Unit capital and operating costs for end-user technology

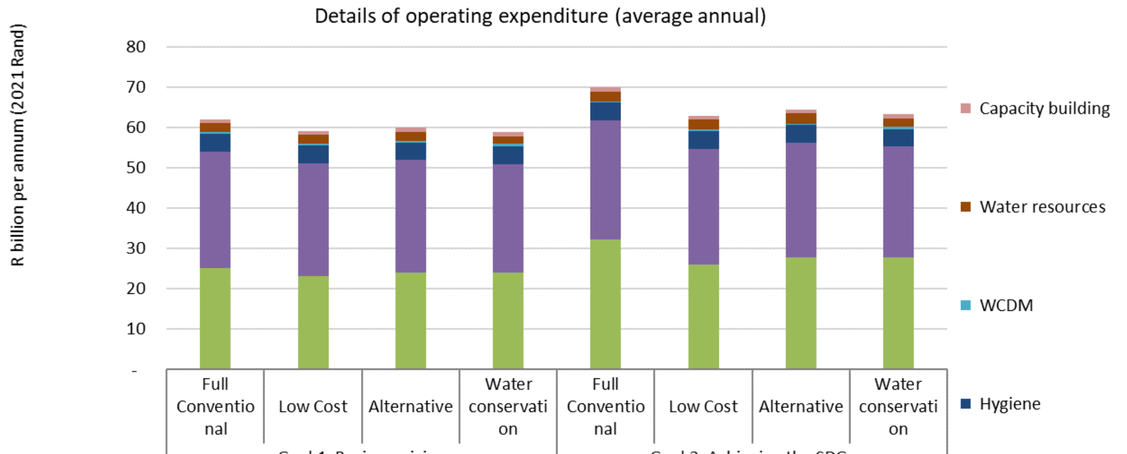
End-user technology	Capital cost (R/dwelling unit)	Operating cost (R/month/dwelling unit)
WATER		
Metered household from municipal supply	R10 058,33	R53,19
Onsite supply from own borehole	R50 000,00	R32,80
Onsite supply from well/spring	R3 000,00	R4,37
Metered yard tap from municipal supply	R5 466,49	R53,19
Roof tank from municipal supply (i.e. regulated supply)	R24 598,09	R30,00
Public/communal standpipes from municipal supply	R2 733,24	R10,45
SANITATION		
Full flush system, connected to sewer	R11 450,10	R57,99
Full flush system, connected to decentralised treatment	R11 450,10	R57,99

End-user technology	Capital cost (R/dwelling unit)	Operating cost (R/month/dwelling unit)
WATER		
Full flush system, connected to septic tank	R23 959,61	R29,44
Pour flush system, connected to sewer	R10 305,09	R42,92
Pour flush system, connected to septic tank	R23 400,00	R29,44
Pour flush with soakaway/leech pit	R9 522,62	R16,93
VIP with emptying and treatment	R10 000,00	R20,00
VIP double pit (i.e. no emptying and treatment)	R18 000,00	R10,00
Dry pit with biochar treatment	R22 060,36	R0,34
Containerised (chemical, container) i.e., requiring offsite treatment	R10 714,29	R1 756,94
No water, onsite treatment (e.g. composting, UD toilets,)	R12 000,00	R41,67
Water, onsite treatment within unit (most likely NGS)	R12 235,00	R20,00
Water, onsite treatment (Biodigester/biogas systems)	R5 141,00	R57,00

Note that the model used to calculate the cost of achieving the SDGs applies a factor to some of these costs to account for whether they are in urban or rural areas, the centralised wastewater treatment technology types (for example, extended aeration plants in urban areas versus oxidation ponds in rural areas), water treatment type (large scale treatment from surface water versus small scale treatment from boreholes) and infrastructure length (rural areas typically require longer connector infrastructure).

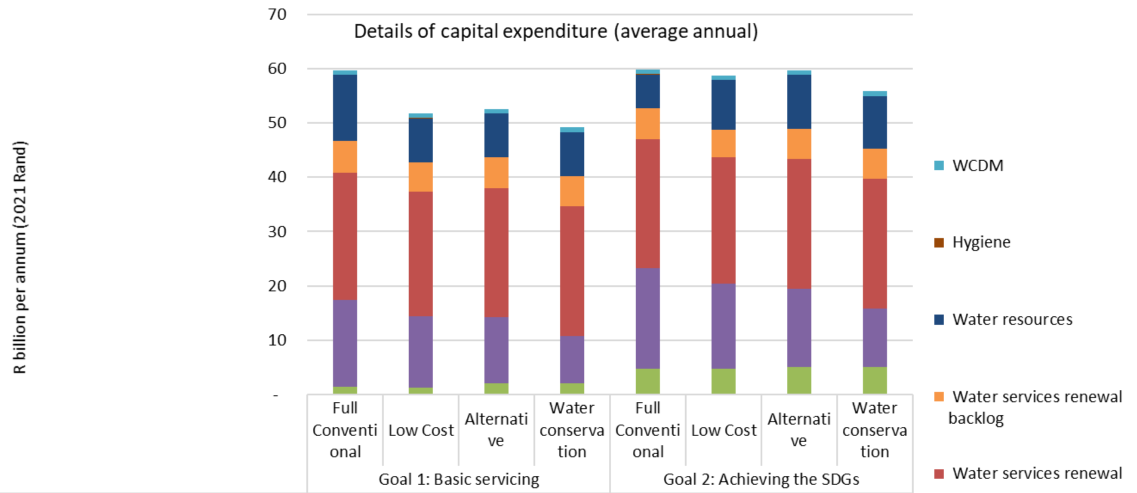
Annexure E: Details of graphs in report

This annexure presents the data that make up the graphs in the main body of the report.



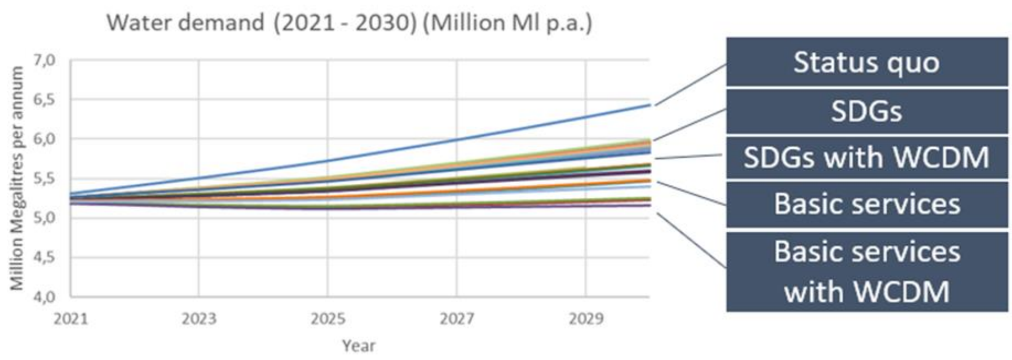
	Goal 1: Basic servicing				Goal 2: Achieving the SDGs			
	Full Conventional	Low Cost	Alternative	Water conservation	Full Conventional	Low Cost	Alternative	Water conservation
Capacity building	1	1	1	1	1	1	1	1
Water resources	2	2	2	2	2	2	2	2
WCDM	0,35	0,35	0,35	0,54	0,36	0,36	0,36	0,56
Hygiene	4	4	4	4	4	4	4	4
Bulk	29	28	28	27	29	29	28	27
Distribution	25	23	24	24	32	26	28	28

Figure E1: Details of operating expenditure breakdown per scenario



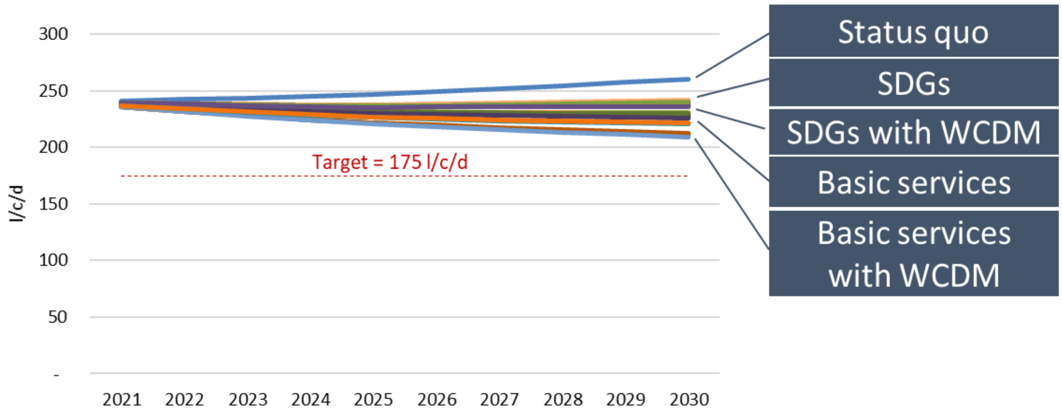
	Goal 1: Basic servicing				Goal 2: Achieving the SDGs			
	Full Conventional	Low Cost	Alternative	Water conservation	Full Conventional	Low Cost	Alternative	Water conservation
WCDM	1	1	1	1	1	1	1	1
Hygiene	0	0	0	0	0	0	0	0
Water resources	12	8	8	8	6	9	10	10
Water services renewal backlog	6	5	6	6	6	5	6	6
Water services renewal	23	23	24	24	24	23	24	24
New bulk and connector infrastructure	16	13	12	9	19	16	14	11
New internal infrastructure	1	1	2	2	5	5	5	5

Figure E2: Details of capital expenditure breakdown per scenario



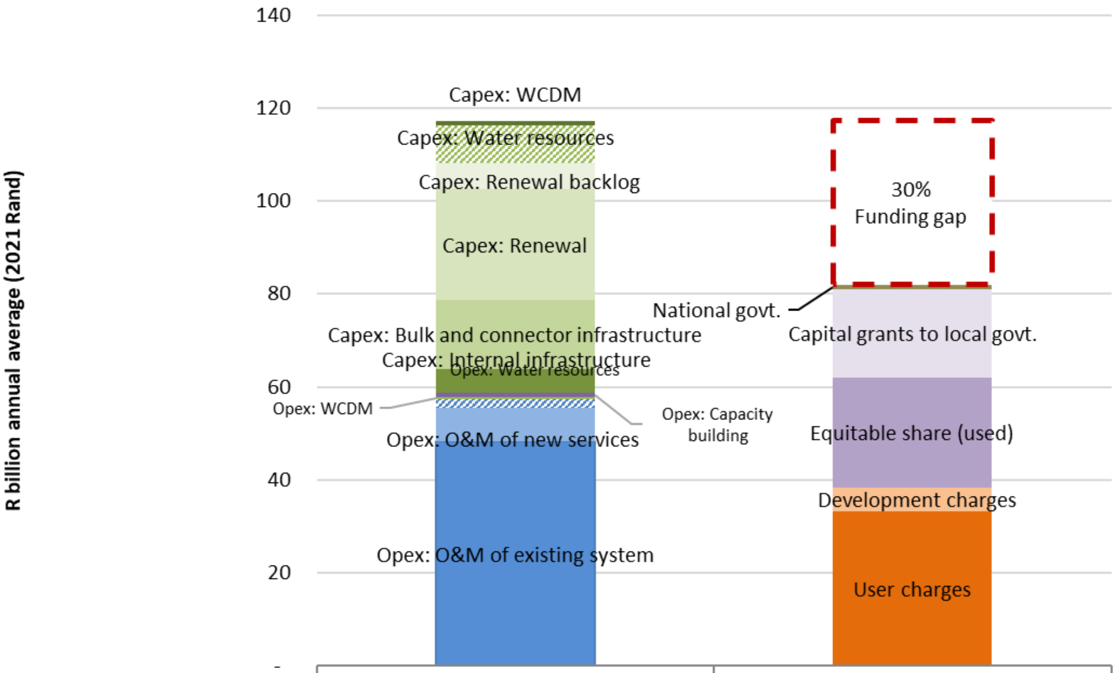
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0SQ		5,14	5,31	5,41	5,51	5,61	5,72	5,86	5,99	6,13	6,28	6,43
1BF		5,14	5,24	5,27	5,30	5,33	5,37	5,43	5,48	5,55	5,61	5,68
1UF		5,14	5,24	5,27	5,31	5,34	5,38	5,44	5,50	5,57	5,63	5,70
1RF		5,14	5,23	5,26	5,29	5,32	5,35	5,41	5,46	5,51	5,56	5,61
1BL		5,14	5,23	5,26	5,29	5,32	5,36	5,42	5,47	5,53	5,60	5,66
1UL		5,14	5,24	5,27	5,30	5,34	5,37	5,43	5,49	5,56	5,62	5,68
1RL		5,14	5,23	5,26	5,28	5,31	5,35	5,40	5,45	5,50	5,54	5,59
1BA		5,14	5,23	5,26	5,29	5,32	5,36	5,41	5,47	5,53	5,59	5,65
1UA		5,14	5,24	5,27	5,30	5,33	5,37	5,43	5,49	5,55	5,61	5,67
1RA		5,14	5,23	5,26	5,28	5,31	5,34	5,39	5,44	5,49	5,53	5,58
1BW		5,14	5,19	5,17	5,15	5,14	5,13	5,15	5,16	5,18	5,20	5,23
1UW		5,14	5,19	5,17	5,16	5,15	5,15	5,16	5,18	5,20	5,22	5,25
1RW		5,14	5,18	5,17	5,14	5,13	5,12	5,13	5,14	5,15	5,15	5,16
2BF		5,14	5,26	5,32	5,37	5,43	5,49	5,57	5,66	5,74	5,84	5,93
2UF		5,14	5,26	5,32	5,38	5,44	5,50	5,59	5,68	5,77	5,86	5,95
2RF		5,14	5,26	5,31	5,36	5,42	5,48	5,55	5,63	5,71	5,79	5,86
2BL		5,14	5,26	5,32	5,38	5,44	5,50	5,59	5,67	5,77	5,86	5,96
2UL		5,14	5,26	5,33	5,39	5,45	5,52	5,60	5,70	5,79	5,89	5,98
2RL		5,14	5,26	5,32	5,37	5,43	5,49	5,57	5,65	5,73	5,81	5,89
2BA		5,14	5,26	5,31	5,36	5,42	5,48	5,56	5,64	5,72	5,81	5,91
2UA		5,14	5,26	5,32	5,37	5,43	5,49	5,57	5,66	5,75	5,84	5,93
2RA		5,14	5,26	5,31	5,35	5,41	5,46	5,54	5,61	5,69	5,76	5,83
2BW		5,14	5,21	5,22	5,22	5,23	5,25	5,29	5,33	5,37	5,41	5,46
2UW		5,14	5,21	5,22	5,23	5,25	5,26	5,30	5,34	5,39	5,43	5,48
2RW		5,14	5,21	5,22	5,22	5,22	5,24	5,27	5,30	5,33	5,36	5,40

Figure E3: Details of potable water demand projections (million Ml pa)



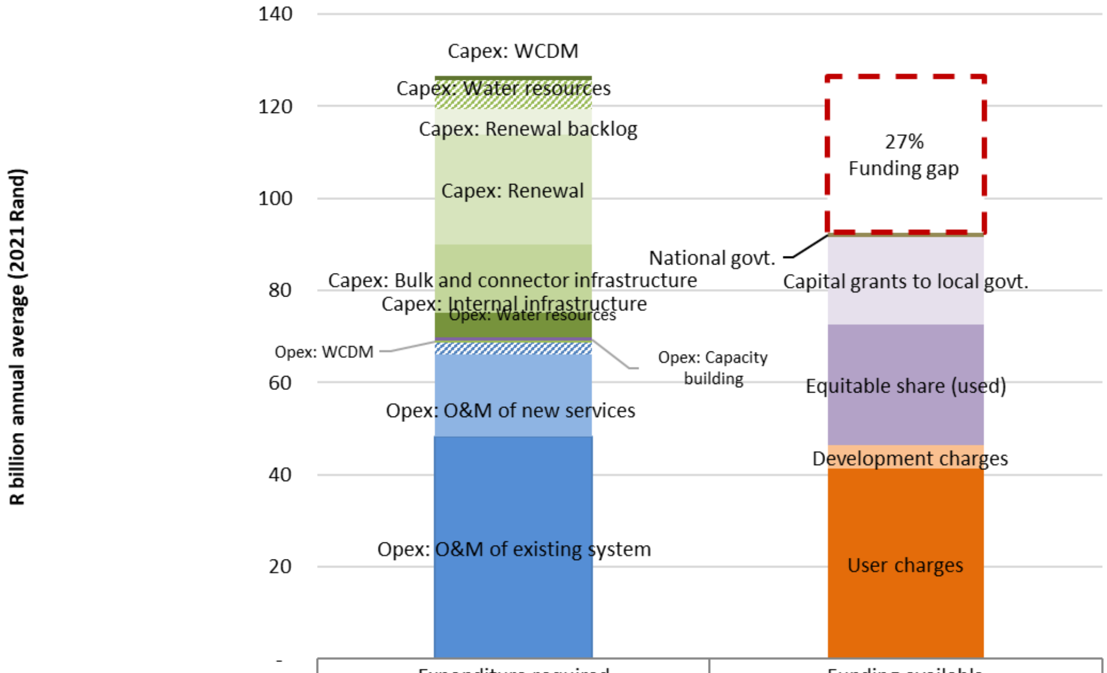
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1BF	241,1	242,3	243,5	244,9	246,6	249,1	251,6	254,3	257,2	260,3
1UF	237,8	236,0	234,2	232,6	231,3	230,8	230,3	230,0	229,8	229,8
1RF	238,0	236,3	234,6	233,1	231,8	231,4	231,1	230,8	230,7	230,5
1BL	237,8	236,0	233,9	232,2	230,7	229,9	229,2	228,5	227,7	226,9
1UL	237,8	235,9	234,0	232,3	230,9	230,4	229,8	229,4	229,2	229,1
1RL	237,9	236,1	234,4	232,9	231,5	231,0	230,7	230,4	230,2	230,0
1BA	237,7	235,8	233,6	231,9	230,3	229,5	228,7	227,9	227,1	226,2
1UA	237,7	235,8	233,9	232,2	230,7	230,2	229,5	229,1	228,9	228,7
1RA	237,9	236,0	234,3	232,7	231,3	230,8	230,4	230,0	229,8	229,5
1BW	237,7	235,7	233,5	231,7	230,0	229,2	228,4	227,5	226,7	225,7
1UW	235,6	231,6	227,8	224,3	221,2	219,0	216,8	214,8	213,1	211,5
1RW	235,7	231,9	228,2	224,8	221,8	219,6	217,6	215,7	214,0	212,3
2BF	235,5	231,6	227,4	223,9	220,5	218,0	215,7	213,4	211,1	208,8
2UF	238,9	238,2	237,5	236,9	236,5	237,1	237,5	238,2	239,1	240,0
2RF	239,1	238,5	237,9	237,4	237,0	237,6	238,3	239,1	239,9	240,7
2BL	238,9	238,2	237,1	236,4	235,9	236,2	236,5	236,8	237,0	237,2
2UL	239,0	238,4	237,8	237,3	237,0	237,7	238,3	239,1	240,0	241,1
2RL	239,2	238,7	238,2	237,8	237,6	238,3	239,2	240,1	241,1	242,0
2BA	239,0	238,4	237,4	236,8	236,4	236,8	237,2	237,6	237,9	238,2
2UA	238,9	238,0	237,2	236,5	236,0	236,4	236,8	237,4	238,1	238,9
2RA	239,0	238,3	237,6	237,0	236,6	237,0	237,6	238,3	239,0	239,8
2BW	238,8	238,0	236,8	236,0	235,3	235,4	235,7	235,8	236,0	236,0
2UW	236,7	233,8	231,0	228,5	226,2	224,9	223,6	222,6	221,7	221,0
2RW	236,9	234,1	231,4	229,0	226,8	225,5	224,4	223,4	222,6	221,8

Figure E4: Details of potable water demand projections (litres/capita/day)



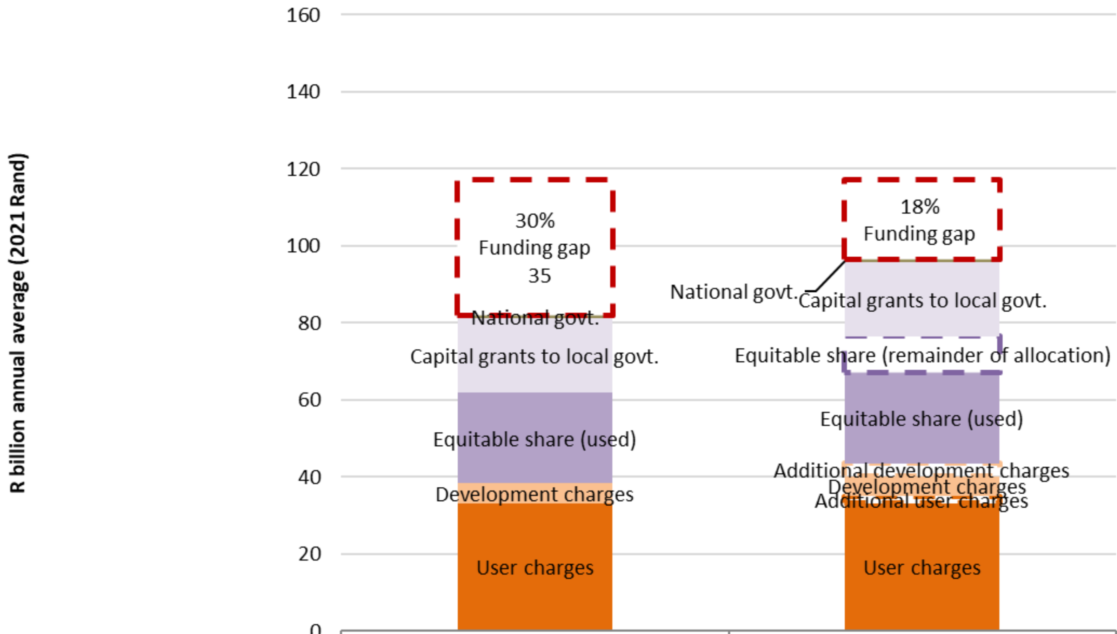
	Expenditure required	Funding available
Funding gap		35
National govt.		1
Capital grants to local govt.		19
Equitable share (used)		24
Development charges		5
User charges		33
Capex: WCDM	1	
Capex: Water resources	8	
Capex: Renewal backlog	6	
Capex: Renewal	24	
Capex: Bulk and connector infrastructure	15	
Capex: Internal infrastructure	5	
Opex: Capacity building	0,9	
Opex: WCDM	0,54	
Opex: Water resources	2	
Opex: O&M of new services	7	
Opex: O&M of existing system	48	

Figure E5: Details of funding gap for achievement of basic servicing with aggressive WCDM



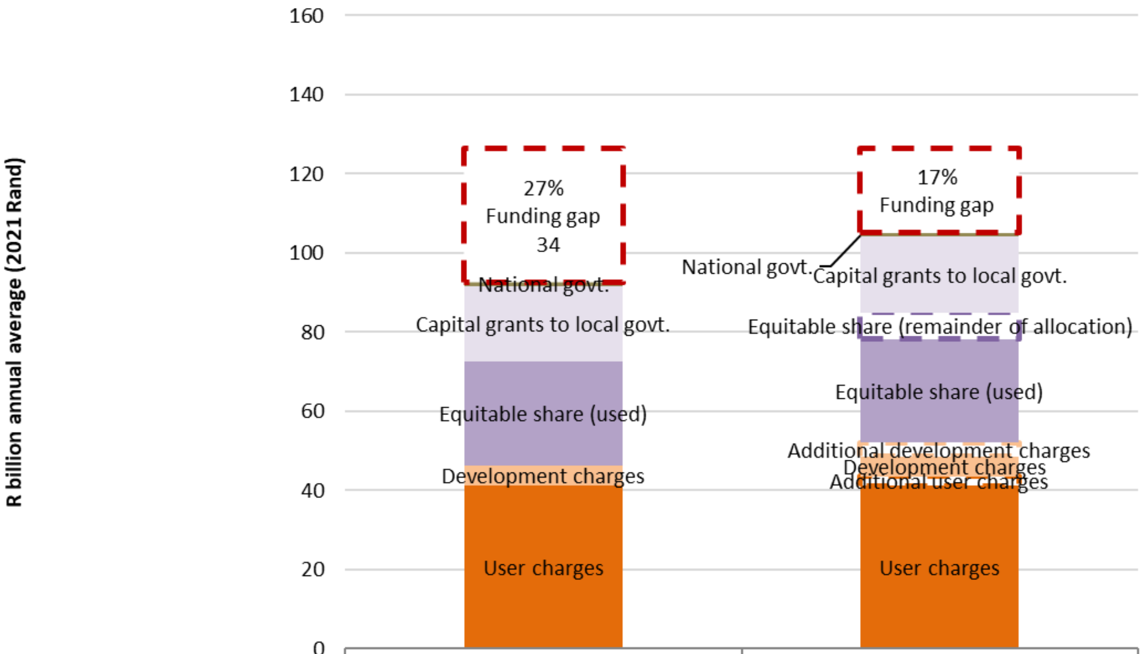
	Expenditure required	Funding available
Funding gap		34
National govt.		1
Capital grants to local govt.		19
Equitable share (used)		26
Development charges		5
User charges		41
Capex: WCDM	1	
Capex: Water resources	6	
Capex: Renewal backlog	6	
Capex: Renewal	24	
Capex: Bulk and connector infrastructure	15	
Capex: Internal infrastructure	5	
Opex: Capacity building	0,9	
Opex: WCDM	0,36	
Opex: Water resources	2	
Opex: O&M of new services	18	
Opex: O&M of existing system	48	

Figure E6: Details of funding gap for achievement of the SDGs with full conventional services



	Funding available	Potential funding available
Funding gap	35	21
National govt.	1	1
Capital grants to local govt.	19	19
Equitable share (remainder of allocation)		9
Equitable share (used)	24	24
Additional development charges		3
Development charges	5	5
Additional user charges		2
User charges	33	33

Figure E7: Details of potential increase in funding to close the funding gap for the Basic Servicing scenario with aggressive WCDM



	Funding available	Potential funding available
Funding gap	34	22
National govt.	1	1
Capital grants to local govt.	19	19
Equitable share (remainder of allocation)		7
Equitable share (used)	26	26
Additional development charges		3
Development charges	5	5
Additional user charges		2
User charges	41	41

Figure E8: Details of potential increase in funding to close the funding gap for the achievement of the SDGs with full conventional servicing

Annexure F: Linking Findings and Recommendations

Finding	Recommendation	Primary responsibility	Secondary responsibility
Implement a nationally coordinated strategy for capacity building and institutional strengthening in the water sector			
Management instability in the Department of Water and Sanitation is likely to have impacted on water services policy and regulation.	Stabilize the DWS and introduce mechanisms to ensure accountability for implementing the NWSMP.	Minister of Water and Sanitation	DWS
Without either an increase in the water tariff level or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 targets by 2030.	Improve governance of water through more coherent regulation, for example through water allocations, tariff regulation and reporting on procurement and capital expenditure.	DWS	Municipalities/ NT
For water, 48% of the 'gap' to achieving SDG 6.1 is due to quality and reliability issues.	Increase performance incentives for municipal good governance through peer-to-peer learning and incentive grants.	DWS & National Treasury	SALGA Municipalities
Current performance of water services in South Africa, particularly in terms of reliability and quality is indicative of a decline in local government capacity to manage infrastructure and sustain water services. There is no nationally developed strategy to develop technical capability of municipalities across all categories of municipalities. The implementation of such a strategy would cost approximately R1 billion per annum, 0.6% of the total operating and capital cost of achieving the SDGs.	Focus on technical capacity in municipalities, but also of national government and support agencies by implementing the capacity building strategy developed by SALGA.	DCOG	SALGA NT (GTAC) MISA NT (CSP) Municipalities

Finding	Recommendation	Primary responsibility	Secondary responsibility
Where short- to medium-term capacity gaps exist in municipalities, capacity can be provided through a range of private sector partnership types, including concessions, leases and management contracts.	Develop mechanisms and refine incentives to facilitate partnerships with the private sector to supplement public sector capacity.	NT (GTAC)	DWS/ NWP (DBSA)
Low numbers of professional engineers in most local governments remains a serious constraint in the provision of water and sanitation services.	Investigate and develop measures to improve the attractiveness of the municipal environment for qualified technical personnel.	DCOG	MISA
Prioritise Water Conservation Demand Management (WCDM)			
The lowest cost scenarios are those that include extensive Water Conservation and Demand Management. The increase in demand through providing higher levels of service can be offset through savings in NRW. Aggressive Water Conservation and Demand Management means that universal basic servicing can be achieved without a significant increase in total water demand above current levels. The cost of water conservation and demand management is approximately 1% of the total cost of achieving the SDGs (approximately R1.15 billion per annum) but has a significant impact on the environmental impact of the water service.	Prioritise and incentivize WCDM through regulation, including through strict WCDM targets, potentially with penalties for not meeting these targets.	DWS	NT/ NWP (DBSA)
	Allocate dedicated funding to WCDM initiatives, either as an incentive grant or as a ring-fenced portion of one of the existing water sector grants.	DWS & NT	NWP (DBSA)
	As per the Minister of Water and Sanitation's 10-point plan, initiate the DWS 'No Drop' monitoring programme to collect data and report transparently on the levels of non-revenue water in each municipality.	DWS	Municipalities
	Implement the recommendations made in the Final Report on the Status of Water Losses in the 8 Large Water Supply Systems	DWS	Municipalities

Finding	Recommendation	Primary responsibility	Secondary responsibility
Reducing demand through aggressive Water Conservation and Demand Management reduces the greenhouse gas emissions in year 10 by to up to 6% below the baseline. Reducing demand through aggressive Water Conservation and Demand Management reduces the greenhouse gas emissions in Year 10 by to up to 6% below the baseline.	Address non-revenue water through focusing on unmetered, unbilled connections, particularly in rural areas, through the installation of meters and flow limiters. This will require political buy-in from councillors and traditional leaders to support measures that may restrict flow but increase assurance of supply and revenue to municipalities.	Municipalities	SALGA/ NWP (DBSA)
	Invest in bulk and zonal meters, including in areas that are intended to be unbilled (e.g. informal settlements)	Municipalities	SALGA/ NWP (DBSA)
Improve economic regulation of water services to address chronic revenue shortages			
The expenditure required to achieve the SDGs by 2030 is between 2.3% and 2.7% of 2020 GDP or between R121 billion and R131 billion (Real 2021 Rands). The funding gap to achieve the SDGs varies between 27% and 32% of the required expenditure between the various scenarios, amounting to between R34 billion and R38 billion per annum. Without either an increase in the water tariff level or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 targets by 2030.	Establish an independent economic regulator to review and regulate water and sanitation tariffs	DWS	NT
	Undertake water audits to ensure that all connections that are intended to be billed are metered.	Municipalities	SALGA / DWS
	Investigate municipalities with poor cost recovery and provide capacity support to set cost reflective tariffs	DCOG	MISA/ NT/ DWS
	Undertake a nationwide campaign to address non-payment for water services	SALGA & DWS	Municipalities
Incentivise proper integrated asset management			

Finding	Recommendation	Primary responsibility	Secondary responsibility
Achieving SDG 6 is not only about the provision of new infrastructure; addressing inadequate management of existing systems is one of the major interventions required. Capital expenditure need is dominated by renewal of existing infrastructure.	Incentivise expenditure on operations and maintenance and integrated asset management by re-establishing and sustaining the Blue Drop and Green Drop monitoring programmes, as stated by the Minister of Water and Sanitation in his 10-point plan.	DWS	NT
For sanitation, 44% of the 'gap' to achieving SDG 6.2 is due to faecal sludge management.	Increase monitoring of water quality downstream of water treatment works to detect non-compliance with effluent discharge standards early.	Municipalities & CMAs	DWS/ DFFE
Make appropriate service level choices			
Without either an increase in the water tariff level or an increased allocation from the national fiscus, South Africa will be unable to afford to reach the SDG 6 goals by 2030.	Avoid the continuation of low capital cost, high operating cost service options introduced as 'interim' or 'emergency' services. Wherever water tankering is taking place or portable chemical toilets are in use, municipalities must be supported by the DWS or relevant province to investigate and propose more long-term, permanent solutions with a lower life cycle cost.	Municipalities	DWS
South Africa will not achieve the desired water use efficiency targets without drastically influencing technology and behaviours adopted by all water users.	Alternative technology options, particularly for sanitation should be used where they are acceptable and can be delivered at scale. Support the research and development efforts in this field. This is currently taking place within the DWS and the WRC and this research and development work should continue to be supported.	DWS	WRC/ NWP (DBSA)

Finding	Recommendation	Primary responsibility	Secondary responsibility
The lowest cost scenarios are those that do not provide individual services to all users. There are affordability issues in providing the individual services required by the SDGs in urban informal areas.	Clarify the national policy position on housing provision and the servicing of informal settlements, including service level standards (shared vs individual).	DHS	DWS
Initiate a national faecal sludge management programme			
For sanitation, 44% of the 'gap' to achieving SDG 6.2 is due to faecal sludge management. There is a lack of clarity around who should pay for faecal sludge management services (pit and septic tank emptying) in rural areas.	Include in the National Faecal Sludge Management Strategy a clear policy position on who is responsible for the costs of faecal sludge management in rural areas.	DWS	SALGA
There is a lack of awareness or knowledge by households and even service providers around how to manage faecal sludge safely.	Undertake faecal sludge management campaigns, clarifying what constitutes safe FSM, should progressively replace a focus on toilet provision in rural areas.	DWS	Municipalities
Better manage water resource allocations			
The allocation of water between users is obviously a key policy choice which has a significant impact on urban water security, particularly in those Water Management Areas where the urban allocations are small.	Review water allocations, particularly the urban agriculture split for systems serving large urban centres.	DWS / CMAs	
	Better regulate the abstraction of raw water.	DWS / CMAs	

Finding	Recommendation	Primary responsibility	Secondary responsibility
Coordinate national efforts on IAP clearing			
Climate scenarios and the levels of IAP infestation have a large impact on water availability and thus on raw water costs.	Identify priority areas for IAP clearing and develop catchment protection plans, including invasive alien plant management planning at a catchment level, focused on those catchments or sub-catchments that are either at highest risk of reduction due to infestation, or the highest potential increase in yield through clearing.	DWS / CMAs	
	Clarify institutional responsibility (probably catchment management agencies) and funding model for IAP clearing.	DWS	