Cape Town Water Strategy
– our shared water future –

DRAFT FOR COMMENT

Version 1.6
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FIVE COMMITMENTS

Commitment: a willingness to give our time and energy to something that we believe in, a promise, a firm decision to do something.

1. **Safe access to water and sanitation**. The City of Cape Town metropolitan municipality[1] will work hard to provide and facilitate safe access to water and sanitation for all of its residents in terms of well-defined minimum standards. In particular, the City will work with communities in informal settlements and with other stakeholders to improve the daily experience of access to water and sanitation, with an emphasis on building trust and increasing safety within these communities through this process.

2. **Wise use**. The City will promote the wise use of water by all water users. This will include (a) pricing water based on the cost of providing additional supply, while retaining the commitment to provide a basic amount of water for free for those not able to afford this; (b) revising by-laws and building codes, and using other incentives to support water efficiency and the treatment and reuse of wastewater; (c) supporting active citizenship by substantially improving customer management and engagement; and (d) managing the water network effectively to reduce losses and non-revenue water.

3. **Sufficient, reliable water from diverse sources**. The City will develop new diverse supplies of water – which could include groundwater, water reuse and desalinated water, cost-effectively and timeously to increase resilience[2] and substantially reduce the likelihood of severe water restrictions in future. The City is committed to increasing available supply by approximately 300 million litres per day over the next ten years, and in suitable increments thereafter, in a way that is adaptable and robust to changes in circumstances.

4. **Shared benefits from regional water resources**. The City will work with key stakeholders and partners, including other urban and agriculture water users, and other spheres of government, to make the most of the opportunities to optimise the economic, social and ecological benefits of regional[3] water resources, and to reduce the risks. The City will do this through collaborative processes.

5. **A water sensitive city[4]**. The City will actively facilitate the transformation of Cape Town over time into a water sensitive city that makes optimal use of stormwater and urban waterways for the purposes of flood control, aquifer recharge, water reuse and recreation, and is based on sound ecological principles This will be done through new incentives and regulatory mechanisms as well as through the way the City invests in new infrastructure.

The City's commitments in the context of a whole-of-society approach

This strategy sets out the commitments of the City of Cape Town metropolitan municipality in relation to its constitutionally mandated responsibilities to provide water services and to manage the urban water environment. However, the attainment of the strategic vision, namely a water sensitive city with wise water use, will depend on the actions of all people and institutions living in the city. The City will therefore adopt a collaborative approach in implementing this strategy. Collaborative relationships are based on trust, and trust is built where there is transparency and mutual accountability, and where stated intentions of all partners are consistently translated into actions.

THE RELIABILITY OF CAPE TOWN'S WATER – WHAT YOU NEED TO KNOW

As a customer, resident, employee, business-owner, investor or political representative, here are eight points you need to know about the reliability of Cape Town's water supply:

1. **Cape Town will continue to rely on rainfed dams in the Western Cape Water Supply System for most of its water**. 95% of Cape Town's water comes from a regional, integrated surface water system managed by the national Department of Water and Sanitation. Water from rainfed dams is much cheaper than the alternatives – groundwater, reuse and desalination. It is much more affordable for the City to continue to rely on rainfed dams for most of its water. Even though the City will invest in alternative sources of water, rainfed dams will still supply over three-quarters of the water to Cape Town in ten years' time.

2. **The City commits to increasing available supply by more than 300 million litres per day in the next 10 years**. Based on scenario analysis, the City will commit to increasing available supply by over 300 million litres per day over the next ten years at a cost of approximately R5.4 billion (2018 Rands). This program is adaptable and is robust when tested against the different scenarios (including a step change in rainfall). Both the timing and composition of the committed program are subject to review as new information and circumstances come to light. Further investments will be necessary thereafter as water demand increases due to population and economic growth.

3. **The build program will reduce the likelihood of severe water restrictions in future**. The build program is based on a higher reliability standard (99.5%) than has been used in the past (98%). This will substantially reduce the likelihood of severe water restrictions in future unless there is a step change in rainfall due to climate change. If this turns out to be the case, the program will be both accelerated and expanded.

4. **The cost of more reliable water is affordable**. The investment in new and diverse sources of water, including groundwater, wastewater reuse and desalination will increase the cost of water. The cost of the insurance premium to move to a higher reliability of supply (moving from 98% to 99.5% reliability) is 20% of this new build cost, that is, R1.2 billion over ten years. This works out to about R2.50 per month per person living in Cape Town, much less than the cost of single bottle of water or cool drink.[5]

5. **The new infrastructure may not be used all of the time, but the investment would not have been wasted**. All water schemes provide insurance against periods of low rainfall. Periods of low rainfall may become more frequent and more severe as a result of climate change. But it is also possible, and even likely, that the additional more expensive supplies of water (such as reuse and desalination) will not be used all of the time. This will not have been wasteful expenditure. The future is uncertain and the cost of very severe restrictions is much higher than the cost of insuring against this likelihood by providing additional water supply capacity.

6. **Desalination will become an important part of Cape Town's water future**. New surface water resources are limited. In future, a greater proportion of Cape Town's water supplies will be met from alternative sources including groundwater, reuse and desalination. In the medium and longer term, desalination is very likely to become an increasingly significant share of the mix because it is scalable and not dependent on rainfall. The committed program includes water from all three sources – ground, reuse and surface – because of the importance of early learning. This early learning is likely to substantially improve the cost-effectiveness of the medium and long term program. The City will also aim to prepare sites allowing for rapid deployment of desalination if needed (See Annexure C).

7. **Cape Town will proactively address regional water risks** in partnership with other users and key stakeholders through a collaborative approach. (See Commitment 4.)

8. **Our collective relationship with water will change**. Whilst the City will continue to ensure an adequate supply of water, at the right quality, to meet the needs of all users, the reality of being in a water-scarce region will mean that we all need to continue to use water wisely. The water tariff structure will help to ensure that water is affordably available for use, whilst waste will be discouraged.

PREFACE

This strategy was developed in the context of a severe three-year drought in the period 2015 to 2017. Cape Town was able to get through the drought and avoid 'Day Zero'[6] by successfully reducing water use by more than 40%, a remarkable achievement. The lessons learned in this process, about what works well and what needs to be improved, have informed this strategy.

The strategy provides a roadmap for the creation of a future in which there will be sufficient water for all, a future in which Cape Town will be more resilient to climate and other shocks. It takes into account the important yet complex relationships between water, people, the economy and the environment.

Supporting the life of the city

Cape Town residents were reminded during the recent drought that having enough water makes the city's life possible. Without it, quality of life is put at risk for everyone. The City understands that it has a central role in ensuring that this fundamental need is met. This strategy puts quality of life for everybody in the city as the first priority. Poverty and poor living conditions are a daily reality for many households living in Cape Town. This strategy supports poverty reduction and improved living conditions by outlining practical steps to improve the quantity and quality of water and sanitation services provided to all people, particularly those living in informal settlements. Better management of stormwater, rivers and waterways in the city will reduce flood risk. Cost-effective, secure water provision provides an essential foundation for economic growth and job creation.

The effective implementation of the water strategy is *necessary* for the achievement of Cape Town's other development goals – undoing the spatial legacy of apartheid, eradicating crime and violence, improving living conditions and enabling work opportunities. This strategy can therefore be regarded as a *foundational* and *enabling* strategy for the city and its people.

Climate uncertainty

Cape Town and its surrounds have always experienced a high degree of climate variability and uncertainty. Rainfall patterns are highly variable between years, and between places, and droughts and localised floods are common. Changes in temperature and wind also affect water availability. The development and management of surface water schemes in South Africa take these uncertainties into account. Planning was based on the probability of the occurrence of low rainfall years. Dams and the related systems supplying water to urban areas in South Africa are generally designed on a 98% probability that water from rainfall would be sufficient to meet the anticipated or planned water requirements in any particular year. In other words, any significant restriction of water supply would only occur in one in every 50 years. The three-year drought in Cape Town was a 1 in 590-year event based on historical rainfall records. The additional uncertainties associated with climate change now need to be included in planning for the future, including changes in rainfall, temperature and wind, and a likely increase in the intensity and frequency of extreme weather events. Nobody is able to accurately predict the future climate and water availability. Cape Town needs to make plans that are robust in the context of this uncertainty.

Creating a more diverse water supply system for Cape Town

In the past, Cape Town was almost exclusively reliant on rain-fed dams for its water supply. Cape Town's water supply will become more resilient through the development of diverse water sources including groundwater, water reuse and desalination. In combination, a mix of sources will be more reliable and more resilient in the context of climate change.

Vision, principles, commitments and action

The strategy, informed by a long-term vision and set of principles, is centred around five core commitments made by the City to the citizens of Cape Town that, taken together, will meet citizens' needs, support improved living conditions, protect the environment and enable and support a growing economy. The steps necessary to translate the strategy into action are set out in the last section, including the strengthening of institutions, financial resourcing and building trust.

CONTENTS

VISION AND PRINCIPLES

Our vision: Cape Town will be a water sensitive city by 2040 that optimizes and integrates the management of water resources to improve resilience, competitiveness[7] and liveability for the prosperity of its people.

Ten principles informing the strategy:

Value water
Our water resources are precious and scarce. Water is the basis of all life. Not only is it essential for basic human needs, vital for productive and resilient natural ecosystems and central to food, energy and economic security, it is also an important part of the spiritual, cultural and recreational life of communities. The strategy recognises that different people hold multiple and diverse views of water and value it in different ways.[8]

Grow inclusivity and trust
Water will be managed in a way that is equitable, transparent and inclusive. Although trade-offs are inevitable, especially because water is scarce, the strategy will seek to share benefits and costs in an fair way. Inaction is likely to increase costs and result in more difficult trade-offs. For changes to be supported, they need to be seen to be necessary, effective and fair. The strategy will promote measures that are both proactive and adaptive in the face of change.[9]

Build capability
Our water system is complex. Effective management requires skilled practitioners with adaptive abilities, working within and across institutions and among multiple stakeholders collaboratively and with a learning mind-set. The strategy will support the development of the necessary capabilities across these systems.

Work together and across boundaries
Water catchment boundaries do not coincide with political and administrative boundaries and water is also transferred between catchments. A collaborative and partnering approach across neighbourhood, catchment, physical, economic and political boundaries is necessary to build a more resilient future, and to address the challenges at the appropriate scale — whether local, regional or national.

Design for adaptation
While change is certain, we are unable to predict with any confidence the pace of change and sometimes even the direction of change. Changes in population size and composition, climate, the economy and technology will influence both water use and availability. The strategy will support an adaptive approach to the management of water, increasing resilience.

Live with water
Water flows through the urban environment, but it is often channelled, hidden and polluted. The strategy will support the rehabilitation of urban waterways and increase their value and use for recreation, flood management and water supply.

Work with nature
The natural environment, within and beyond the urban environment, filters and stores water. The strategy will support the protection of these natural environments and the integration of these natural processes with the built environment to enhance the function, beauty, and resilience of the region's water infrastructure and landscape.

When it rains, slow, store and repurpose
Fast-moving stormwater is hard to manage. The strategy will support approaches that increase the permeability of surfaces, reduce pollution and increase local storage. The management of stormwater will be integrated with the management of waterways and groundwater, and the repurposing of rainwater for appropriate uses will be encouraged.

Ready for shocks
Water-related shocks including droughts and floods, are likely to become more frequent and intense. The strategy will develop greater urban resilience by improving the City's preparedness and response to these shock events.

Stimulate the green economy
New economic opportunities can emerge out of an environment where the value of water as a scarce resource is appreciated. The decisions we take to secure our water future can enable local design of water-related products and services, and can stimulate increased demand for these products across our economy, supporting the creation of enterprises and jobs.

COMMITMENT 1: SAFE ACCESS TO WATER AND SANITATION

The City will work hard to provide and facilitate safe access to water and sanitation for all of its residents in terms of well-defined minimum standards. In particular, the City will work with communities in informal settlements and with other stakeholders to improve the daily experience of access to water and sanitation, with an emphasis on building trust and increasing safety within these communities through this process.

THE CHALLENGES

The core business of Cape Town Water (the current City of Cape Town Department of Water and Sanitation)[10] is to facilitate access to safe water and sanitation services. It is the responsibility of the City to provide *reliable*, *convenient* and *safe*[11] water and sanitation services, and the processes used to do this need to be *transparent*, *financially sustainable*, and *responsive* to citizens. Water quality needs to be assured and wastewater and faecal sludge need to be collected, treated and discharged appropriately and in line with the relevant standards.

Within a developing city context, the City performs relatively well on most of these measures and for a large majority of its residents. The City will continue to provide these services and will aim for steady and incremental improvements in all domains of performance. There is, however, one area of service provision that is much more challenging than the others. This is the provision of sanitation services in informal settlements. Although households living in informal settlements express the need for safety and jobs as their top priorities[12], improvement in water and sanitation provision is also very important.

For the approximately half a million people living in informal settlements (about one in every eight persons living in Cape Town), the drought did not have a significant direct impact in terms of water supply. Water is supplied through public taps at no cost at a ratio of approximately 25 households or less per tap and water use averages at about 50 litres per person per day. Water use in informal settlements accounts for only 5% of the total use in the city as a whole. Supplies to informal settlements were maintained throughout the drought. Apart from some instances where aggressive pressure management interrupted supplies, water supplies to informal households were not affected. As noted above, safety is a significant concern for people living in informal settlements. The large majority of households must share a sanitation facility with others, and hence sanitation services are also associated with the safety concerns of residents, especially when shared facilities are used during the night. Maintaining clean shared facilities is also a significant challenge. Improving sanitation is thus a much higher priority compared to water supply and other services in informal settlements.

While the City is committed to becoming a safe and caring city[13], human dignity and respect is compromised when communities living in informal settlements experience water and sanitation services to be insufficient. At the same time, the number of people living in informal settlements is increasing, and so is the size of the challenge.

ACHIEVING BETTER OUTCOMES THROUGH BUILDING TRUST

The City makes significant efforts to improve living conditions for people living in informal settlements. The impediments to improved services are numerous and multifaceted. Unplanned high densities usually make it impossible to construct and operate permanent infrastructure without relocation. Many settlements are located on land that is unsuitable for residential development or on privately-owned land, constraining the ability of the City to provide permanent infrastructure. Alternative sanitation solutions are continually assessed and tested, and mechanisms to improve drainage around communal taps and flood mitigation measures are explored. Every settlement is unique and successful interventions can only be determined with intensive, time-consuming and complex citizen engagement. There are no easy answers to these difficult challenges. The fundamental challenge is not a technical one, but is rather social and political in nature. Nevertheless, the City commits itself to finding better ways to provide safe water and sanitation services, through *processes that build dignity, trust and social cohesion*. This will require multidisciplinary approaches that extend beyond the scope and mandate of Cape Town Water on its own.

COMMITMENT 2: WISE USE

The City will promote the wise use of water by all water users.[14] This will include (a) pricing water based on the cost of providing additional supply, while retaining the commitment to provide a basic amount of water for free for those not able to afford this; (b) revising by-laws and building codes, and using other incentives to support water efficiency and the treatment and reuse of wastewater; (c) supporting active citizenship by substantially improving customer management and engagement; and (d) managing the water network effectively to reduce losses and non-revenue water.

CAPE TOWN HAS BECOME A WATER-WISE CITY, BUT NEEDS TO SUSTAIN THIS

Cape Town has become a progressively water-wise city through repeated drought responses. Overall water use (including all[15] uses and water losses) had reduced from 330 litres per person per day in 1998 to 220 litres per person per day in 2014. In 2018, total water use was restricted down to below 135 litres per person per day, a reduction of nearly 60% compared to 1998 (Figure 1). The low usage during the most recent drought, far below the average per person use in the other metros in South Africa, has caused a level of personal and economic hardship that is not sustainable, and usage will increase when restrictions are lifted. However, many of the changes in water use are likely to be permanent. During the drought households, businesses and institutions invested in alternative sources of supply (such as groundwater, rainwater tanks and reuse). They replaced lawns and water-sensitive plants with alternatives requiring less water, and they invested in water saving devices such as low-flow taps, water-saving shower heads, smaller toilet cisterns etc. Other behaviours such as shorter showers and using shower water to flush toilets are likely to change over time, but not to pre-drought norms. The drought has changed Cape Town's relationship with water. Cape Town's challenge is to reach a sustainable level of wise water use.

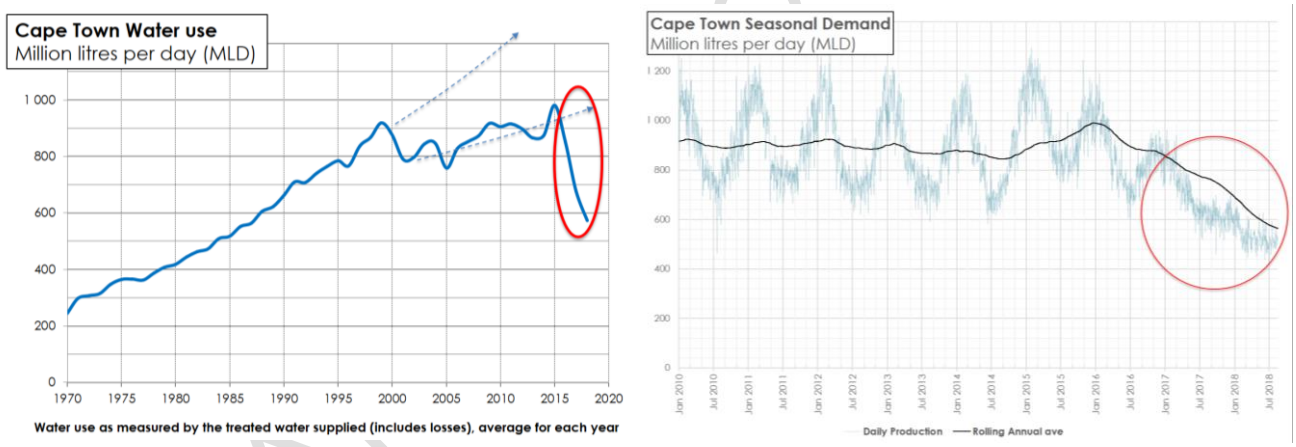


Figure 1: Total water use[16] in Cape Town since 1970, and seasonal variation in million litres per day

How much water do we need and use?

According to the World Health Organisation we need at least 50 litres of water per person each day to satisfy our basic needs – drinking, cooking, washing (ourselves and our clothes), flushing the toilet and for other basic uses of water.[17] A typical household bucket contains about 7 litres of water, so for daily use we need 7 buckets of water a day.

Cape Town currently supplies free water to about half a million people living in informal settlements. Actual water use is less, on average, than the basic need amount – water is heavy to carry and a household of four would need to carry 28 buckets of water every day to use 50 litres per person. Total usage in informal settlements, including all types of use and losses is about 50 litres per person per day (7 buckets), and only 5% of total usage in the city.

Cape Town also supplies free water to a further approximately one million people in formal households (about one in every four persons living in the city) living in properties with a municipal valuation of R400 000 or less.[18] This free amount is limited to 87 litres per person per day (12 buckets). In practice, many households living in these properties use more water than this and so the average use for this category is higher. Although this additional water is billed, most of this water is not paid for.

The remaining population (a little more than two and a half million people) have in the past used much more water – about 220 litres per person per day (30 buckets) on average. During the drought this use was reduced to about 120 litres per person per day (15 buckets), a reduction of nearly 50%.

PRICING

The City will price water based on the cost of providing additional supply, while retaining the commitment to provide a basic amount of water for free for those not able to afford this.

Every person needs access to at least a basic amount of water every day. This is a human right and the City provides this for free for those who cannot afford to pay for it (about 1.5 million people making up more than a third of the total population in the city). Beyond this, households are required to pay for water. Other users (for example, businesses) are required to pay for all of the water they use. When water is priced correctly, including the cost of adding new supplies and including the full environmental costs, then households and other users can decide for themselves how much water they want to use. With enforcement of relevant environmental laws, resources will be allocated efficiently and the environment will be protected and rejuvenated. Beyond the social policy of ensuring that a basic amount of water is affordable for everybody, the price of water will promote wise and responsible use. The correct price to ensure this is the long-run marginal cost, also known as the *incremental average cost*.[19] The City will set the price of water at the average incremental cost at the same time as ensuring basic needs are met. (See "Translating the strategy into action".)

OTHER INCENTIVES TO PROMOTE WISE WATER USE

The City will revise by-laws and building codes, and use other incentives to support water efficiency and the treatment and reuse of wastewater with public participation.

In addition to using price to promote efficient water use, the City will also continue to review and improve its by-laws, regulatory mechanisms and other incentives to promote water efficiency and the treatment and reuse of groundwater, stormwater and wastewater. This will be in support of the City's Municipal Spatial Development Framework which seeks to improve the efficiency of the urban form through densification. Regulations and other incentives will be subject to a cost-benefit analysis to ensure that the benefits of regulation exceed the costs. Key areas include: low-flush toilets, low-flow taps and showers (aerators and other devices to reduce the flow rate), management and uses of grey water, night-flow monitoring for large users and decentralized treatment. (See also "Commitment 5: A water sensitive city".). The City will aim for stability and predictability in the revision and implementation of these regulatory mechanisms and incentives, drawing on international best practice. See Annexure D (Water conservation and demand management.)

SUPPORTING ACTIVE CITIZENSHIP THROUGH CUSTOMER ENGAGEMENT

The City will support active citizenship by substantially improving customer management and engagement.

During the drought, many households were inconvenienced by low pressures and various matters associated with meter reading and water management devices. To assist with water management, and to avoid unaffordable water bills, about 220 000 water management devices have been installed by the City. These devices automatically cut off the water after the daily allocation has been reached. The installation of these devices was accelerated during the drought to households who contravened the limits for households – initially 20 kl/month and later 10.5 kl/month. This, together with a lack of understanding of how the devices worked, and very high bills where limits had not been implemented, contributed to a high number of complaints to the City. Aggressive pressure management also contributed to no water being available, sometimes for several hours, increasing the number of complaints. Response times were slow due to the increased number of complaints.

The City will continue to improve the services it provides and will significantly enhance the customer management function within Cape Town Water, including response times to calls and the time to resolve complaints and will adhere to a core set of service levels and response times. Changes will be made in the way services are provided and paid for to increase the level of responsibility taken by citizens and to increase citizen engagement. (See "Translating the strategy into action.")

EFFECTIVE WATER NETWORK MANAGEMENT

The City will continue to manage and reduce water demand through improved network management, including the isolation of pressure management zones, pressure management, night-flow monitoring, water leak detection and reducing non-revenue water.

Cape Town has a well-managed water network. Before the drought, non-revenue water[20] was just 15%, much lower than in other cities in South Africa[21]. This was achieved through a water demand management program initiated during the drought in 2000 and continued since then. Activities included proactive leak detection, pipe and meter replacement informed by a sophisticated asset management strategy. The time from leak alert to completion of a repair was also substantially improved through a first responder system.

During the drought significant investments were made to increase the ability of the City to manage water pressures on a zone by zone basis, using smart pressure controllers. At the time of the development of this strategy, 102 zones had been isolated and optimised using pressure management, resulting in a saving of over 50 Ml per day. Pressure management, together with a large increase in the price of water, was a significant contributor to the reduction in demand achieved in February 2018, from 600 Ml per day down to 550 Ml/day. Other water management reduction activities such as leak detection and repairs were also intensified.

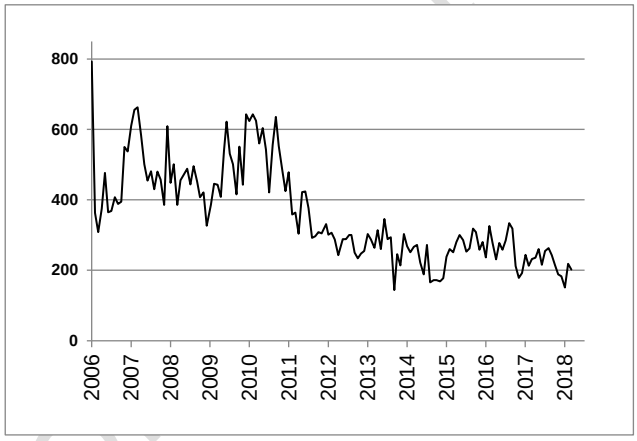


Figure 2: Water pipe bursts per month

The City will continue to invest in continuous improvement in the management of the network including the optimisation of pressures in the network taking long term effects into account.

COMMITMENT 3: SUFFICIENT, RELIABLE WATER

The City will develop new diverse supplies of water – including groundwater, water reuse and desalinated water, cost-effectively and timeously to increase resilience[22] and substantially reduce the likelihood of severe water restrictions in future. The City is committed to building affordable new capacity of approximately 300 million litres per day over the next ten years, and in suitable increments thereafter, in a way that is adaptable and robust to changes in circumstances.

EXCLUSIVE RELIANCE ON RAINWATER IS NO LONGER WISE

The primary cause of the Cape Town water crisis was low rainfall. The combined inflow for the years 2015, 2016 and 2017 was lower than for any other consecutive three-year period in the 90-year record and has been calculated as a 1 in 590 year event[23].

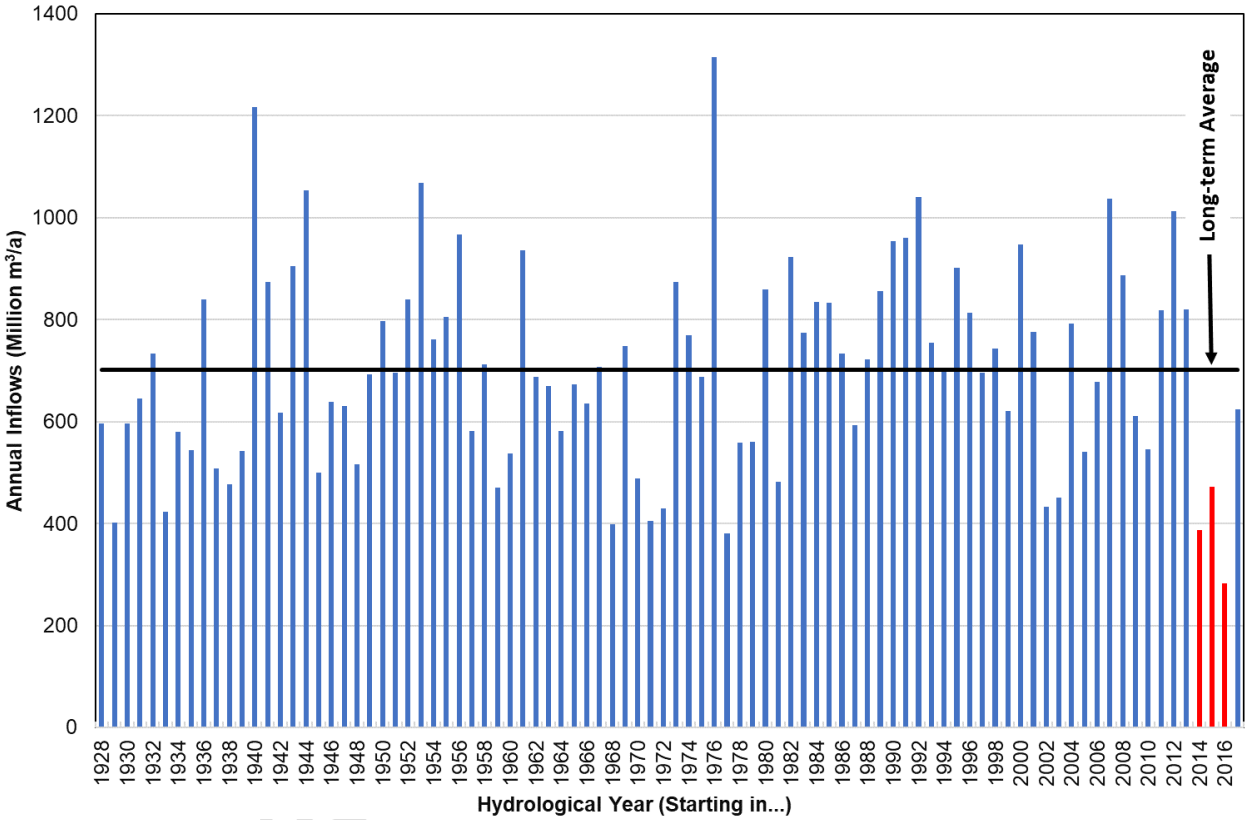


Figure 3: Annual inflow into Cape Town's dams over 90 years from 1928 to 2018

The majority of global climate models predict lower rainfall in the future for the Cape Town region, with an increasing frequency of low rainfall years. Water availability is affected by rainfall, as well as temperature and wind.[24] It is also possible that Cape Town could experience (or may already have experienced) a step change in water availability from climate change (Annexure A).

DOING NOTHING IS NOT AN OPTION

If the City does nothing, Cape Town would continue to be fully exposed to the risks that resulted in the drought. These risks, including climate change and alien vegetation growth, are likely to increase. In addition, population and economic growth will increase water use and the City would experience severe water stress with permanent stringent water restrictions within a few years. The risk of another severe drought would be much higher than in the past. There is therefore a significant economic cost to not investing. In addition, the people of Cape Town are very unlikely to want to experience severe restrictions again. Therefore, doing nothing is not an option.

APPROACH

Planning in the context of uncertainty. In the context of high levels of uncertainty, the City will adopt a scenario planning approach to ensuring sufficient and reliable water availability.

New build program. Cape Town will undertake a responsible build program, with a diverse range of sources, to increase water security for Cape Town and to increase resilience. This will build on Cape Town's past experience of investing in water supplies as well as new learning, ensuring that the most cost effective approach is followed.

New and diverse sources of water, linked to an integrated surface system. A key shift is that Cape Town will be developing diverse sources of water at scale, including groundwater, water reuse and desalination, and these schemes will be developed alongside and integrated with the existing surface water system which provides water to different users – both urban and agriculture.

We are committed to maximizing the re-use of wastewater in line with the National Water Resource Strategy (2013) to meet current and future water demand. At present some 8% of treated wastewater is used for industrial, commercial and landscaping purposes. A very small volume is also used in combination with stormwater to recharge the Atlantis Aquifer and maintain the sea water intrusion barriers associated with the groundwater scheme. Future plans, which form part of the 10 year committed programme, include use of treated wastewater to recharge the Cape Flats Aquifer and as a direct source of drinking water to be blended with water supplied from the Faure Water Treatment Plant which serves a large part of the municipal area. This is in keeping with our objective of creating a water sensitive city which seeks to maximize integration of the urban water cycle to build resilience and protect our sensitive natural ecosystems. This approach is successfully implemented elsewhere.

Insurance against low rainfall and climate change. The build program is necessary to provide insurance in case of periods of low rainfall or lower water availability. Periods of low rainfall may become more frequent and more severe as a result of climate change. It is possible, and even likely, that the additional more expensive supplies of water (such as reuse and desalination) will not be used all of the time. This will not have been wasteful expenditure. The future is uncertain and the cost of very severe restrictions is much higher than the cost of insuring against this likelihood by providing additional water supply capacity.

Three complementary programs. The City's build program complements its activities to promote water wise use and actively manage demand, to increase opportunities from the integrated surface water supply system and to transform the city to become water sensitive. All are necessary.

PLANNING IN THE CONTEXT OF UNCERTAINTY

The two key planning variables for investing in new water supply are future water demand and future water availability. Unfortunately, there is a high degree of uncertainty associated with each of these two variables:

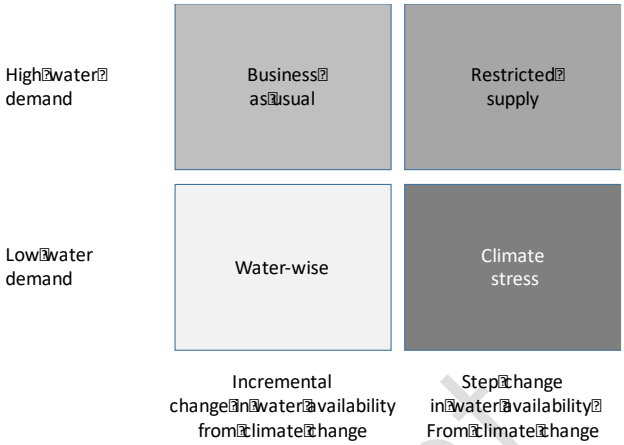
- **Future water demand** is uncertain because of the very disruptive effect of the drought. It is not known, within any certainty, how future demand will be affected by the drought in the short and longer term as a result of significant changes in behaviour, the price of water and because of investments made (in the past or the future) in water efficiency or alternative sources of water by water users.
- **Future water availability** from rainfall is uncertain because of climate change. The effect of climate change on future water availability is highly uncertain.

The very high degree of uncertainty in these two variables far exceed the effect of any other variables on future demand and supply. Further details are given in Annexure A.

SCENARIOS

In light of the significant uncertainties, it is prudent to plan on the basis of scenarios. The key variables *outside of the City's control* are future water demand (without restrictions) and future changes to water availability (climate change affecting rainfall, temperature and wind). While Cape Town can influence demand through the imposition of restrictions, Cape Town aims to supply sufficient water to meet *unrestricted* water-wise demand. (See Commitment 2.)

The four scenarios that a plan needs to be tested against are shown in the figure to the right.



Where does Cape Town get its water from and how will this change?

Cape Town's existing primary source of water

Cape Town gets almost all of its water from the Western Cape Water Supply System (WCWSS). This is an integrated system providing water for both urban and agricultural use. In a normal year, Cape Town uses about 60% of the available water, and agriculture uses about 30%.

Supply to Cape Town is dominated by surface water sources. The bulk of the water supplied in the supply area is from surface water sources, dependent on winter rains. Rainfall varies significantly across the area and between years.

The surface water system comprises six large dams and a number of smaller dams. Cape Town owns three of the six large dams. The other dams are owned by the national government. Total storage of the six large dams is approximately 900 million kl.

The WCWSS is managed by the national Department of Water and Sanitation (DWS) in partnership with the City of Cape Town. DWS is responsible for water resources regulation (making allocations and monitoring abstractions) and for water resources planning. DWS and the City of Cape Town manage the operation of the complex and inter-connected system of dams, pipelines, tunnels and related infrastructure jointly. (The City owns three of the six dams that form part of the system.)

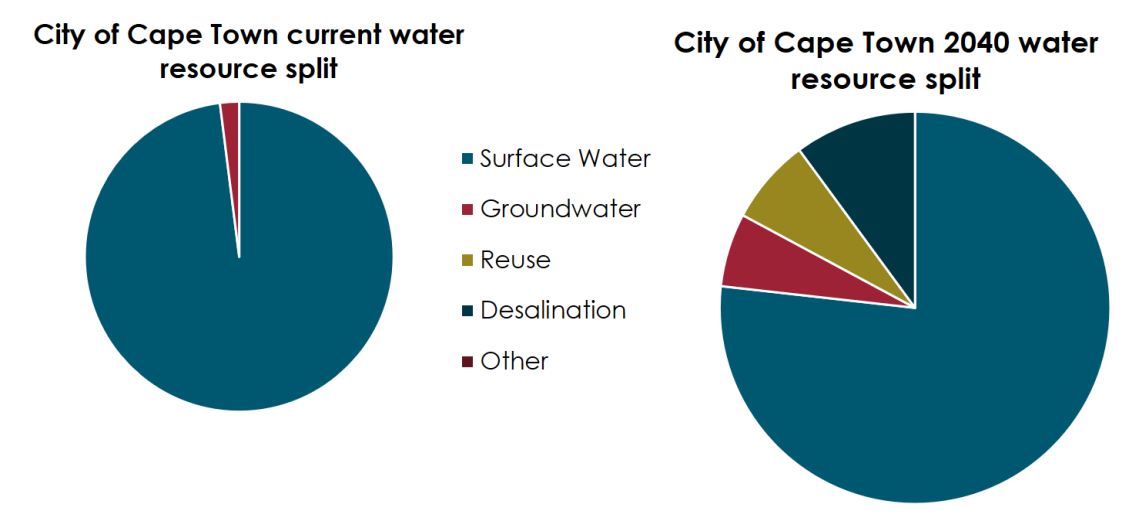
A WCWSS **water resource reconciliation study** was completed in 2007. This study looks at future water demand and supply and proposes interventions to ensure supply exceeds demand. DWS produces annual status updates, the most recent being 2016. (The 2018 update is in progress.)

An annual operating analysis informs operating rules and restrictions. The hydrological year ends on 30 October and a decision on operating rules for the system, including any applicable restrictions, is made by DWS for the forthcoming hydrological year.

The WCWSS steering committee makes recommendations. The committee, comprising the water users, meets annually to review the status (and other) reports submitted and to make recommendations on interventions including, for example, new supply schemes and restrictions.

Additional supply was planned for 2022. The next water augmentation scheme was the Lower Berg River Augmentation Scheme. The scheme would add 23 million cubic metres per year into the WCWSS and was due for completion in 2022 (Status Report May 2016).

How Cape Town's water supply system will change



AN INCREASE IN THE SECURITY OF SUPPLY

Cape Town gets most of its water from rain-fed dams (see Text Box). The security of this supply is based on the probability of having to restrict water use when rainfall is low. Up until now, Cape Town's water supply systems were based on a 98% level of assurance (using historical rainfall records). That is, sufficient water would be available for 49 out of every 50 years without the need for any severe restrictions.

There are two reasons why this approach needs to change.

In the context of climate change, a security of supply at this level and that is backward looking (looking at past rainfall patterns to estimate future water availability), is unlikely to be adequate to reliably meet Cape Town's water needs going forward.

In addition, if Cape Town continues on a water-wise path, the ability of the city to restrict supply without substantial economic harm will be significantly reduced. This is a second and important reason to increase the security of supply.

Only in the case where climate change is not a significant factor, and where demand returns to pre-drought levels, would be it sensible to maintain the current level of assurance of supply.

	No climate change Future rainfall the same as in the past	**Climate change** Lower rainfall, more frequent droughts (but quantum of changes not known)
Low water demand (Water-wise with efficient water use)	**An increase in the assurance of supply is prudent** because more difficult to restrict demand without economic cost.	**An increase in assurance of supply is prudent** because probabilities based on past are not predictive of the future.
High water demand Water demand returns to pre-drought levels	**Current level of assurance can be maintained**.	**Not applicable** (high water demand cannot be met affordably in this scenario)

Figure 4: Scenarios and the appropriate choice of security of supply

The City therefore will increase the level of assurance to 99.5% (based on historical rainfall records), that is, sufficient water available for 199 out of every out of 200 years. This is a prudent approach in the present circumstances.

Building for a higher reliability of supply (99.5%) means that the City will implement the water augmentation infrastructure sooner that would be the case using a lower reliability standard (98%). The cost of this is approximately R2.7 billion (2018 Rands) over the planning period to 2040, a cost premium of approximately 20% of the total build program.[25]

THE NEW WATER PROGRAM

The plan to ensure sufficient water is based on a set of assumptions that are considered to be most likely to occur. This is called the base case plan. This plan was then tested against four scenarios that are described in Annexure A. These scenarios consider the alternative possible futures for key variables outside the control of the city, namely future climate (and related water availability in the dams) and future demand. The augmentation plan developed for this base case is shown to be robust and adaptable in the event that the future differs from the base case assumptions.

The base-case plan was developed using the following four assumptions (see Annexure A):

1. **Climate change**. A gradual change in climate resulting in reduced water availability from rain-fed dams over time.[26]
2. **Assurance of supply**. An increase in the assurance of supply from 49 in 50 years (98%) to 199 in 200 years (99.5%) without severe restrictions as discussed above, resulting in a reduced assured availability of water from the WCWSS.
3. **Management of the WCWSS**. Decrease in runoff as a result of alien vegetation, changes in water allocations (including to the ecological reserves) and inefficiencies in the management of the existing integrated system. Steps to address the management of the integrated system incorporated into the plan and are discussed further in Commitment 4.
4. **Water use**. A moderate rebound of water use after the drought restrictions are lifted.

The programme to ensure sufficient water availability was designed for the base case planning assumptions and tested for robustness and adaptability against the other scenarios (Annexure B).

The selection of projects in the new water program took the following into account:

1. **Cost**. Low-cost interventions, including water demand management, the control and eradication of alien vegetation and improvements to the management and effectiveness of the integrated surface water system are prioritised.
2. **Existing funding commitments**. Schemes where funding has already been committed will be completed unless compelling reasons not to do so emerge.
3. **Timing**. Schemes that can provide water sooner will be prioritised until the desired reliability standard has been reached.
4. **Diversification and early learning**. Diverse water sources, with relatively uncorrelated risks, are developed to allow for learning about how previously undeveloped resources perform. This will support the achievement of increased resilience through introducing different sources of water. Where new sources of water are likely to become an important part of the future water supply mix (for example, desalination), the City will bring forward projects and implement these at a more modest scale to obtain earlier learning. This will enable future larger-scale projects to be implemented more quickly and more cost-effectively, an important benefit.
5. **Adaptability and scalability**. Sources of water than can be scaled and where timing of implementation is adaptable (can be speeded up is necessary) will be prioritised in light of the significant uncertainties related to both future rainfall and demand.
6. **Earlier than needed**. The City will implement future supply schemes five years in advance of when they are required to account for uncertainty, specifically for the following: current uncertainty regarding allocations and assurances of supply within the WCWSS, inherent uncertainty regarding impact of climate change on the yield of the system, uncertainty regarding effectiveness of WCWDM[27] programme, challenges of maintaining alien invasive plant clearance programmes outside of the control of the City and project implementation risks.
7. **Phasing**. The program is also structured in two-phases: committed projects and an adaptable program that can be brought forward and/or scaled as necessary and as new circumstances emerge.

The overall timing and scale of the interventions in the New Water Program are show in Figure 5.

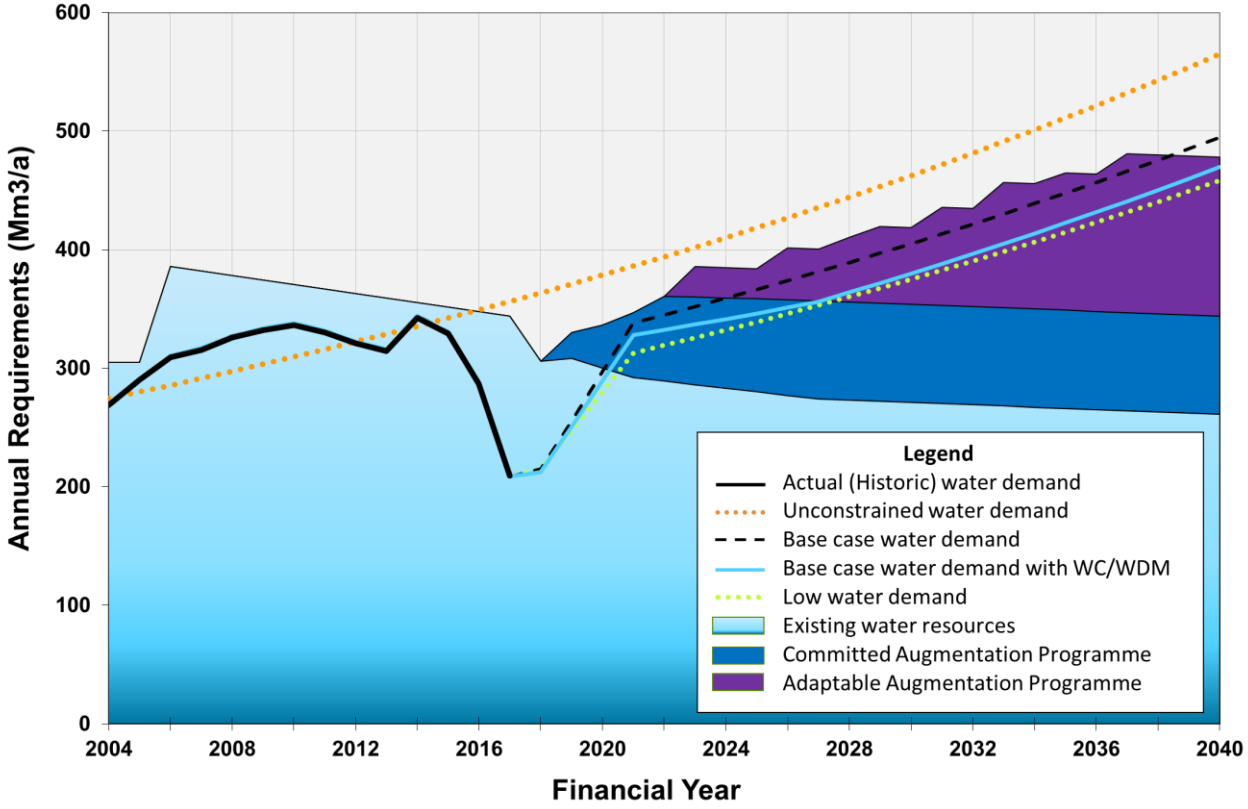


Figure 5: The scale and timing of the new water program in million kl per year

The reasons for the decrease in the yield from the WCWSS from 2006 to 2018 are discussed in Annexure A.

The committed program will deliver more than 300 million litres per day of new capacity over 10 years and a saving of approximately 70 million litres for day from demand management. The adaptable program will deliver a further approximately 250 million litres per day of new capacity up to 2040.

HOW DID THE CITY DECIDE HOW MUCH NEW CAPACITY TO BUILD?

There is a trade-off between the reliability of water supply and how much it costs. Rainfall is not reliable – in some years it rains a lot and in other years it only rains a little. When rainfall is low, the water flow into the dams is not enough to meet the city's needs. It is possible to increase the reliability of water from these dams by building more dam storage capacity and developing other sources of water. Both option costs more money.

Rainfall is likely to become less reliable in future. There is now substantial evidence at the global level that climate change is resulting in increased temperatures and to changes to weather patterns. Cape Town's rainfed water supply is vulnerable to climate change. The City will make plans based on an assumption that rainfall will become less reliable in future.

Doing nothing is not an option. If the City did nothing, Cape Town would continue to be fully exposed to the risks of insufficient water. These risks are likely to increase as a result of climate change. In addition, population and economic growth will increase water use and it is likely that the City will experience water stress with permanent and severe water restrictions within a few years.

New and diverse supplies will increase reliability. Investment in new and diverse supplies of water – surface water, ground water, reuse and desalination – will reduce the risk of severe water restrictions in future.

The City will plan for a higher level of reliability. In the past, water planning for Cape Town was based on reliability standard of 98%, that is, for any one year, there was a 98% probability (98 out of 100 years) that there would be sufficient water without requiring any significant restrictions, based on historical records of water flows into the dams. Because of the risk of climate change, this reliability standard is no longer appropriate. The City will plan for its water supply based on a reliability standard of 99.5%. That is, for any one year, there will be a 99.5%

probability (199 out of 200 years) that there would be sufficient water without requiring any significant restrictions, based on historical records. The intention of the new reliability standard is to substantially reduce the risk of severe water restrictions in future.

The city will adopt scenario planning with annual reviews. In the context of high levels of uncertainty, the City will adopt a scenario planning approach, with annual reviews, to ensure sufficient and reliable water availability.

The committed program balances risk and cost. The committed program is designed to balance risk and cost. If less capacity is built, then the risk of severe water restrictions will increase. If more capacity is built, then risk is further reduced but the cost increases. The proposed program reduces risk at an affordable price.

Committed program

The purpose of the committed program is to build now to achieve the desired reliability of supply as soon as possible subject to the conditions set out above. The committed interventions that are part of the New Water Program over the next ten years are shown in Table 1. They comprise management interventions, groundwater abstraction, reuse and desalination, as well as additional surface water supply.

Table 1: Committed new water programme over ten years – provision costs

Intervention +	**First Water**	**Effective yield**		**Total Capex**	**Unit Capex** ++	**Operating cost** +++
		Ml/day	*Million kl pa*	R million	Rm /MLD	R/kl
Demand management	2019	*70*	26	410	6	3
Alien vegetation clearing	2019	55	20			~20-40 m pa
Management of WCWSS	N/A	27	10			~2-5 m pa
Cape Flats Aquifer P1	2019	20	7.3	610	31	5
Table Mountain Group P1	2019	15	5.5	375	25	5
Cape Flats Aquifer P2	2020	25	9.1	450	18	5
Atlantis Aquifer	2021	10	4	290	29	8
Table Mountain Group P2	2021	15	5.5	335	23	5
Table Mountain Group P3	2021	20	7.3	326	16	2
Berg River Augmentation	2022	40	15			~3-5
Water Re-Use P1	2023	70	26	1360	20	5
Desalination Phase 1	2026	50	18	1650	33 - 40	9
Total including WDM		417	154	5806		
Total new supply		347	128	5396		

Notes: + Timing, and the capital and operating costs are best available engineering estimates. All schemes subject to outcomes of ongoing investigations (to determine optimal yield, siting and timing) and relevant approvals. ++ Rounded to nearest million Rand. +++ Rounded to nearest Rand.

The risk in committing to certain schemes is that may not all be needed – for instance, if demand rebound is lower and slower. However, the cost is capped by the requirement that the committed program includes schemes that are highly likely to be needed in the next 15 years regardless, so the cost is one of incurring costs early, but not incurring them unnecessarily. On the other hand, the benefit is that commitment now is required if the reliability of supply level is to be achieved as rapidly as possible – or put another way, the risk of severe restrictions in the future would be higher than the target level if this commitment is not made. If demand is lower than predicted in the base scenario, it will also be possible to delay implementation of some of the schemes.

Further, the committed program will help the City to gain experience of costs, procurement, and operation of all the technologies that the City will need in the next decade.

Desalination – which is endlessly scalable, least dependent on rainfall, and likely least socially and environmentally challenging – is an important option to develop and learn about. Desalination can ensure reliable supply with certainty when no other options are available.

In view of the significant risks of another drought, the City will implement one or more 'desalination parks', that are permitted and 'ready to go' should the need arise to implement permanent

desalination capacity more quickly. See the Climate Stress scenario and "Increasing robustness and adaptability" below.

Adaptable program

The purpose of the adaptable program is to plan schemes that will be needed in the future, but for which an immediate decision to implement is not needed. Based on emerging information on demand bounce back and rainfall, the City would be able to shift the adaptable program forward or backward. The further adaptable interventions that are part of the New Water Program are shown in Table 2. They comprise further groundwater abstraction, reuse and desalination, as well as additional surface water augmentation.

Table 2: Adaptable new water programme with indicative supply volumes

Intervention	Supply *Ml/day*
Ground water (further phases)	50
Reuse schemes (2nd phase)	30
Desalination (further phases)	100
Surface water (new schemes)	100
Total	250

Note: Volumes are subject to change.

Preparatory work for the schemes under the adaptable program—for instance, securing and permitting sites, and preparing designs and bid documents—will be done in advance, so the City can quickly implement the schemes once needed. (See "Increasing robustness and adaptability" below.)

Stress testing for robustness and adaptability

In light of the significant uncertainty in three areas – rainfall, future water use and institutional effectiveness – the new water program has been 'stress tested' to see if the program and outcomes are robust if the future turns out to be different than anticipated for the base case planning scenario. The conclusions of the stress tests (shown in Annexure B) are as follows:

Business as usual (high demand). Demand rebounds to pre-drought levels and rainfall patterns in the near future largely reflect the past distribution of rainfall (gradual climate change, only a small reduction in rainfall). In this scenario, supply can be met through the planned program at a 1 in 50 year (98%) level of assurance. This is acceptable because the ability to restrict demand will not have been reduced as a result of the drought.

Water-wise. Demand remains low after the drought, while rainfall patterns in the near future largely reflect the past distribution of rainfall (gradual climate change, only a small reduction in rainfall). In this scenario, components of the planned program can be delayed because supply will exceed demand if the program is implemented as planned.

Climate stress. There is a step change in the climate (low rainfall) and demand remains low after the drought. In this case, the planned program will only be able to meet the City's basic needs in the early years, requiring significant restrictions. In this scenario, the program will be accelerated. (See increasing robustness and adaptability below.)

Increasing robustness and adaptability

Measures to increase the robustness and adaptability of the new water program are set out in Annexure C. In particular, the measures enable and support the acceleration of the build program if this is needed (climate stress scenario). This includes development of permitted desalination parks to allow for the rapid deployment of desalination capacity at scale if needed.

WHAT IMPACT WILL THE NEW WATER PROGRAM HAVE ONE ON TARIFFS?

Water and sanitation tariffs will change. Both the structure and the level of water and sanitation tariffs will change over time to better reflect actual costs and to provide appropriate signals for efficient water use and investments in additional supplies. The fixed charge will increase to cover the fixed costs of managing and maintaining the distribution network. The volumetric tariff will be set at the cost of providing new water supplies or wastewater treatment. In the long term, the volumetric tariff will be set at the cost of adding new desalinated water supply.

Cape Town water tariffs will decrease from the very high levels imposed during restrictions in early 2018. Future tariffs will be lower than those experienced during the drought tariffs and the volumetric tariff will settle at the cost of providing additional desalinated water. The cost of desalinated water is expected to be in the region of R15 to R25 per kl depending on how efficiently it is procured. (The volumetric water tariff is currently higher than this.)

Poor households will continue to receive subsidies. Every person needs access to at least a basic amount of water every day. This is a human right and the City provides this for free for those who cannot afford to pay for it (about 1.5 million people making up more than a third of the total population in the city). Subsidies will be used to keep the water and sanitation services for basic needs affordable for poor households.

See "Translating the strategy into action".

WATER RESTRICTIONS

Will there be water restrictions in future?

Because the majority of Cape Town's water will continue to come from rain-fed dams over the next ten years and more, it will still be necessary for Cape Town to implement restrictions during drought periods when rainfall is low. If the New Water Plan is successfully implemented (Commitment 3), and if the other commitments are also implemented (Commitments 2, 4 and 5), then the frequency and severity of restrictions will be much less than has been experienced in the recent past. This is a key objective of this strategy. Nevertheless, restrictions are still likely to be necessary to some extent. Feedback from residents and stakeholders is that they clearly understood the need for water restrictions but found the many levels of water restrictions implemented by the City in the past confusing. This system will be simplified going forward.

The difference between water restrictions and demand management

Water restrictions are usually punitive in nature and focus on demand reduction in the short-term, often with significant impacts on the consumer. On the other hand, water conservation and water demand management focuses on the sustained reduction and minimisation of wasteful use of water and the efficient and fit-for-purpose use of water over the medium to long-term. These measures should not negatively affect water users and have been discussed in Commitment 2.

Three restriction levels

The City plans to implement three restriction levels (Table 3 and Figure 6) with an emergency response if needed. When recovering from a drought, the approach to lifting restrictions will be more conservative than the rules for implementing higher level restrictions. These restriction levels will be reviewed annually.

Table 3: Indicative dam levels for implementation of restriction levels at beginning of hydrological year

Restrictions	**Dam level** at 1 November
No restriction	Above 80%
Level 1	Below 80%
Level 2	Below 70%
Level 3	Below 60%
Emergency response	Below 45%

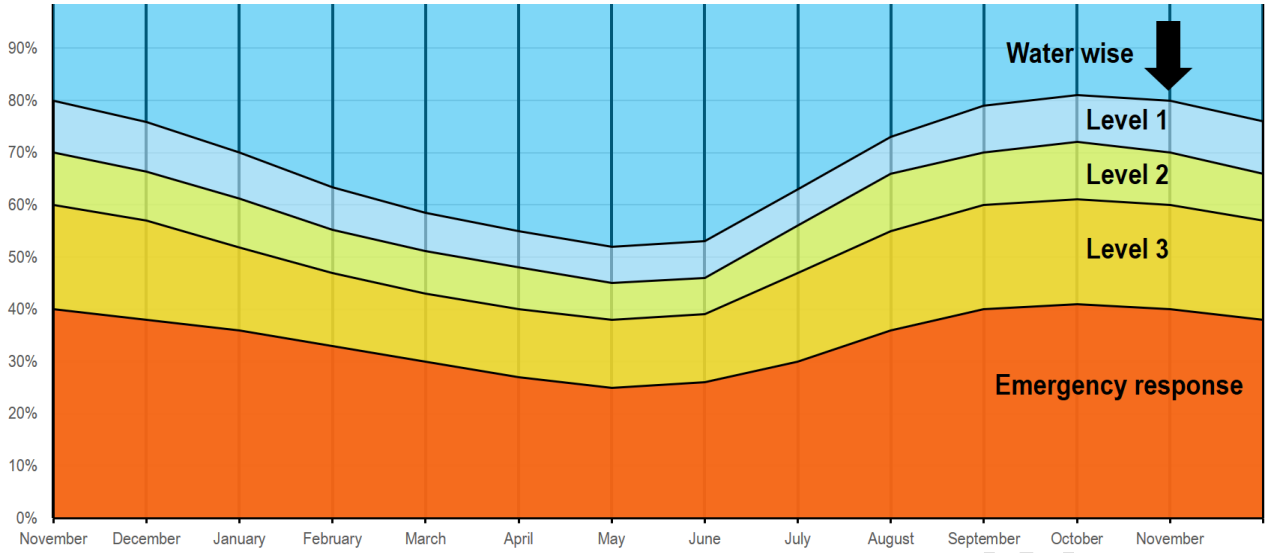


Figure 6: Illustrative dam levels for urban water restriction levels to be imposed (subject to change)

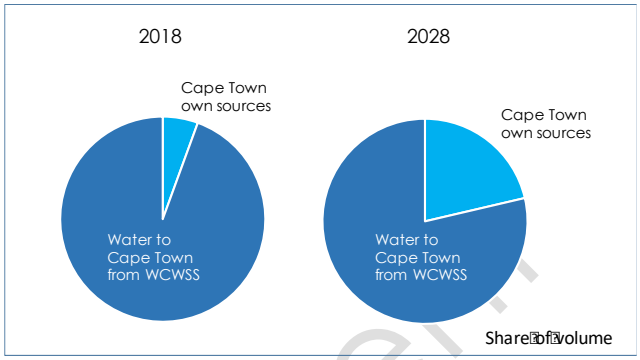
Dam levels will trigger different level restrictions depending on the time of year. The city will aim for transparency and predictability in the implementation and management of restrictions levels.

COMMITMENT 4: SHARED BENEFITS FROM REGIONAL WATER RESOURCES

The City will work with key stakeholders and partners, including other urban and agriculture water users, and other spheres of government, to make the most of the opportunities to optimise the economic, social and ecological benefits of regional[28] water resources, and to reduce the risks. The City will do this through collaborative processes.

A SHARED RESOURCE THAT IS CHANGING

Cape Town receives, and will continue to receive, a significant share of its water from an integrated surface water system, the Western Cape Water Supply System (WCWSS). This system is shared with other urban users (7%) and with agriculture (29%).



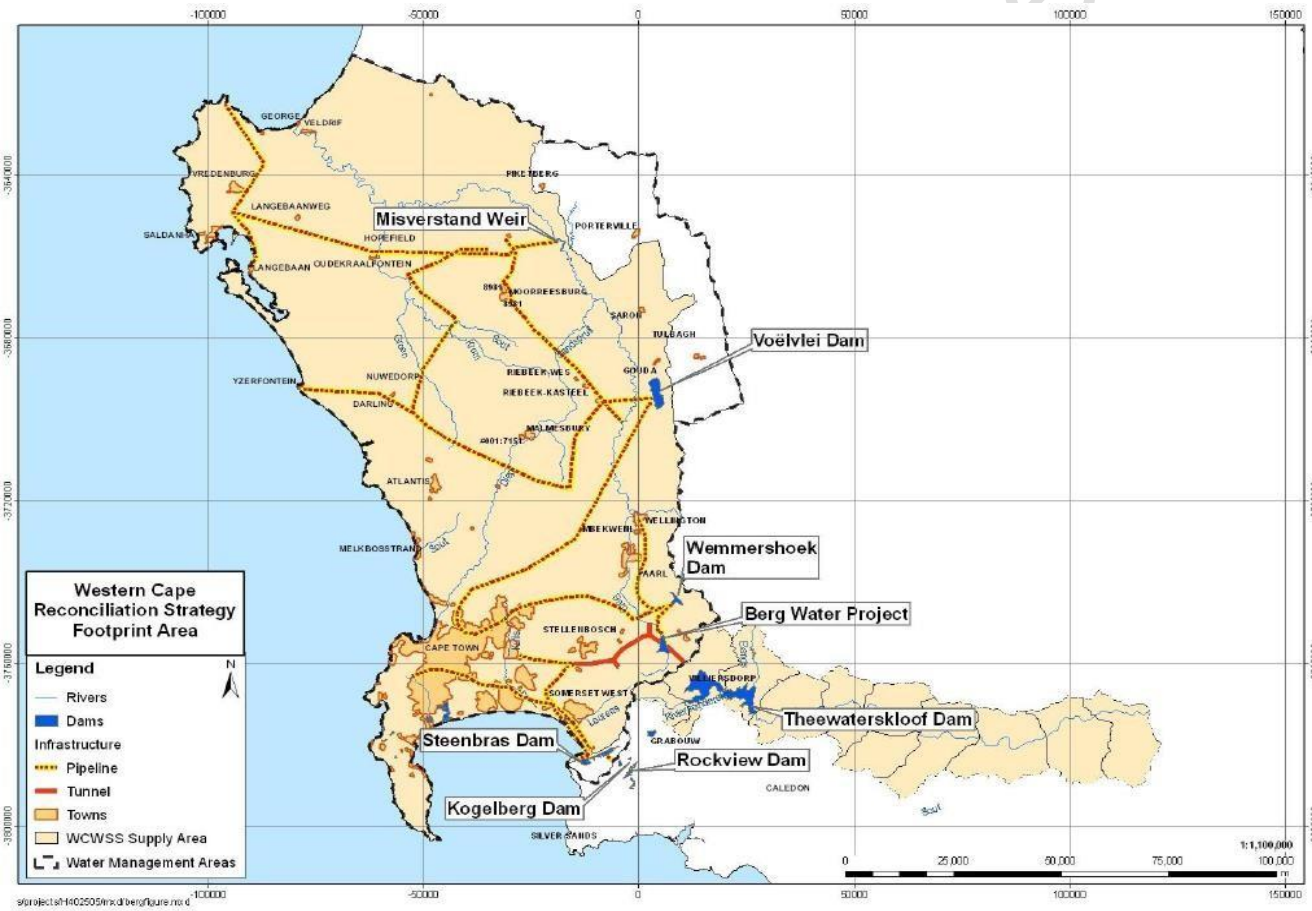


Figure 7: The geographic extent of the Western Cape Water Supply System

However, the relationship between water users in the WCWSS will change. The City of Cape Town, the system's largest water user, will build substantial water supply schemes of its own, as opposed to relying almost entirely on the WCWSS. Moreover, water schemes with very different costs and technical characteristics (for example, desalination plants and aquifer recharge) now need to be considered for the first time.

Given the changes in technologies, costs, and relationships between users, it is necessary to consider what arrangements would be best suited to manage the WCWSS and its interface with other bulk water production and storage systems, such as those that the City plans to build, in the future.

SHARED BENEFITS

Water benefits people, the economy and the environment in multiple ways. Water supports all life. Sufficient water is necessary for households to support basic needs and to enhance quality of life. Water is necessary to support commerce and industry, and for agriculture. Water supports the natural environment and riverine and wetland eco-systems. All users of the system stand to benefit collectively to the extent that the opportunities to maximise the benefits of water are realised.[29]

The economic and social costs of severe water restrictions imposed in the WCWSS system were very high. Job losses in agriculture were very significant, as was reduced investments and tourism, also leading to job losses.

SHARED RISKS

Risks related to the sub-optimal management of the WCWSS include:

- The spread of alien vegetation (reducing run-off into the dams);
- Delays in providing additional surface water supplies;
- Reduced water availability (lower dam levels) as a result of inadequate maintenance of the infrastructure (pump stations, canal cleaning etc.);
- Reduced water availability (lower dam levels) as a result of sub-optimal operation of the system timing of transfers and releases etc.);
- Over-allocations and/or insecure allocation reducing availability of water and affecting investments and job creation, and
- Implementing restrictions fairly and effectively.

From the City's perspective, another risk is that the WCWSS could be operated to transfer the benefits of the City's increased reliability to other users of the system. This could happen if the City's security of supply from the WCWSS was reduced under the expectation that the City would operate its own facilities to make up for any shortfall. If this were to happen, the costs of supply in Cape Town would rise, as more expensive plants would have to be run to make up for loss of supply from WCWSS. At the same time, Cape Town's security of supply would fall below planned levels, since the planning being undertaken assumes that the WCWSS water is available to Cape Town in accordance with past agreements and practices.

All the users of the system have an interest in a predictable and secure set of water rights that they can depend on, and to know that the allocation of water rights is managed in a transparent and fair way, including adherence to existing legal agreements.

The experience of the drought showed that insufficient water hurt the whole region and the economic impact was also experienced at a national level.

The risks therefore hurt everybody. In future, all stakeholders will benefit if the regional water management and supply area is governed in a more integrated and collaborative way.

OPTIONS FOR THE FUTURE

Options for consideration with other users and stakeholder include:

- Amending existing legal agreements and developing new legal agreements specifying water rights in the system in clearer and more enforceable terms;
- Promoting not just better information on management of the system, but also the sharing of that information with all users and the public;
- Ensuring adequate funding for the effective operation of the system;
- Professionalising the management of the operation of the system; and,
- Creating a more inclusive and robust governance structure for the WCWSS, with greater representation of water-rights holders (users) in decision-making.

A COLLABORATIVE APPROACH

As the biggest water user in the system, in terms of both water allocation and infrastructure, the City will work collaboratively with stakeholders and partners in order to:

- Improve the analytical information-base for water resource management decisions and to include, more explicitly, economic factors into these considerations;
- Build stronger relationships between the key stakeholders through the process of sharing expertise, information, infrastructure, and finances to ensure better planning and cost-effective investments;
- Optimise the overall economic and social benefit of water;
- Improve water resource management approaches and practices to ensure resilient outcomes; and,
- Evolve institutional and governance arrangements between the users (urban and agriculture) and the Department of Water and Sanitation, and to ensure more robust and transparent management of water resources.

COMMITMENT 5: A WATER SENSITIVE CITY

The City will actively facilitate the transformation of Cape Town over time into a water sensitive city that makes optimal use of stormwater and urban waterways for the purposes of flood control, aquifer recharge, water reuse and recreation, and is based on sound ecological principles This will be done through new incentives and regulatory mechanisms as well as through the way the City invests in new infrastructure.

THE CHALLENGES

Stormwater and urban water ways are often considered to be a costly problem – water is polluted and the adjourning areas are often unsafe and remain unused. However, they also present an opportunity. Stormwater can be managed to reduce the threat of flooding, and can also be a resource that can be used, for example, to recharge the aquifer.

Water sensitive cities – a process and a destination
In its broadest context, water sensitive urban design (WSUD) encompasses all aspects of integrated urban water cycle management, including water supply, sewerage and stormwater management. It represents a significant shift in the way water and related environmental resources and water infrastructure are considered in the planning and design of cities and towns, at all scales and densities. WSUD is now often used in parallel with the term water sensitive cities. However, there is a subtle but important distinction between these two terms; water sensitive city describes the destination (the objective), while WSUD describes the process" (Fletcher et al., 2014).

This strategy sets out the principles and approaches for an integrated urban water management approach that will, over time, transform the city into a water sensitive city, that makes use of the opportunities presented by storm water and urban water ways.

Cape Town is home to an extensive network of rivers and wetlands. These freshwater systems fulfil a dual function – as havens for plant and animal life, and as natural infrastructure networks for the management, treatment and conveyance of stormwater and treated wastewater effluent. The 'built' stormwater infrastructure - comprising roadside gutters, kerb inlets and pipes – interfaces directly with Cape Town's receiving freshwater and coastal environments. An integrated understanding of and management approach to managing these connected systems is essential for the protection of the receiving environment. The ongoing organic and inorganic pollution and the littering of the city's stormwater and freshwater systems poses a threat to both biodiversity and human health.

Improved stormwater management is vital for protecting the citizens of Cape Town from localised and more widespread flooding. It is notable that citizens living in informal settlements face the brunt of localised flooding. They have the least means to prepare and recover from such events. The City has a particular duty to ensure the safety of the most vulnerable people in the city. There is also an opportunity capture and store stormwater for productive use, including the recharging of aquifers.

The health of our urban water ecosystems tells part of the story of rivers and wetlands. They are generally not suitable for recreation, and in places are unsightly and hence are undesirable as public spaces for people to come together. Another part of the story of our rivers and wetlands is that they are in places regarded as unsafe due to criminality. The current state of urban water ecosystems is a missed opportunity for Cape Town. They are largely ignored by Capetonians. Yet they are rich with possibility.

VISION

The overarching vision informing this strategy is that Cape Town will become a water sensitive city by 2040 that optimizes and integrates the management of water resources to improve resilience, competitiveness and liveability for the prosperity of the people of Cape Town.

This multi-dimensional and complex process is illustrated in Figure 8. The City will model the future form of the built and natural environment in order to inform its plans, using a scenario-based approach.

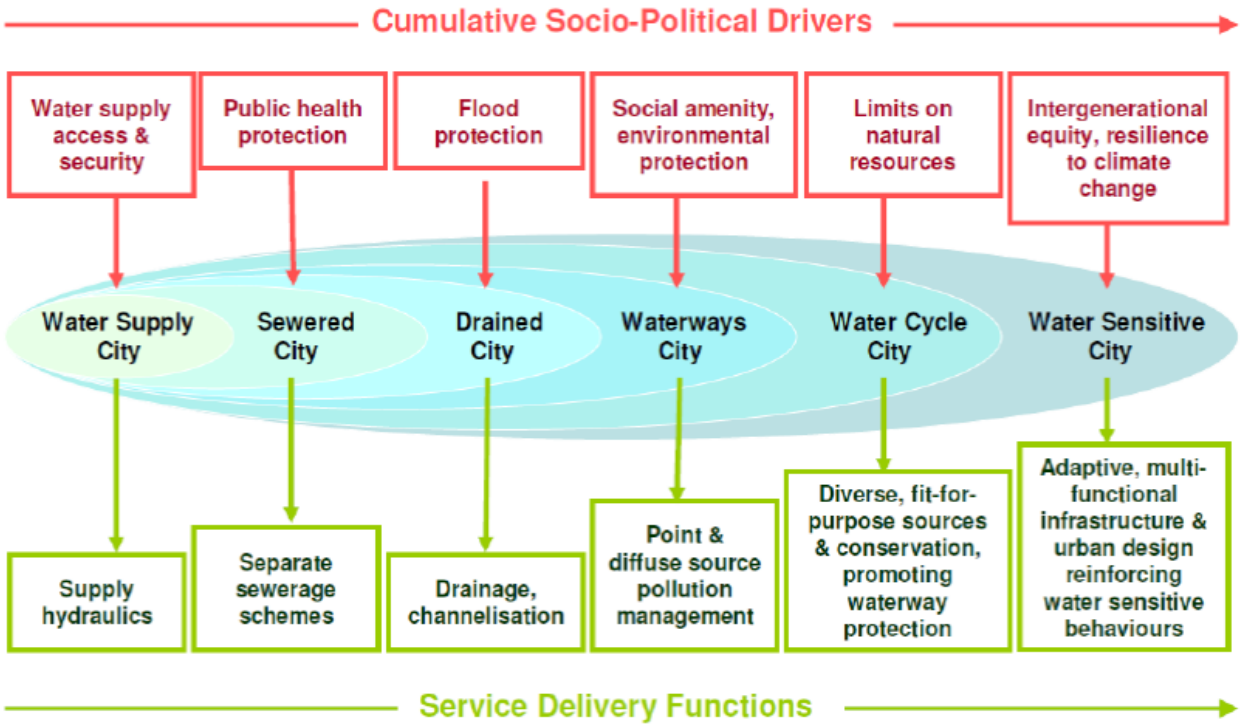


Figure 8: The transitions from a water supply city to a water sensitive city[30]

Cape Town has largely met the water supply challenge. It also manages a sewer network and treats the wastewater for almost all formalised properties. Nevertheless, some significant service challenges still exist as discussed in Commitment 1. Cape Town also experiences serious challenges with respect to flood management on the Cape Flats and many of its waterways are heavily polluted. The transformation of the city into a water sensitive city will be challenging and is a medium term objective.

PRINCIPLES AND APPROACH

The principles informing water sensitive urban design are set out in the text box.

The City has three primary tools to promote a transition of Cape Town towards a water sensitive city:

- **Economic and financial incentives** – the way the city levels taxes and service charges.
- **Regulatory mechanisms** – changing the rules of the game through, for example, land-use permissions and building codes.
- **Direct investments in infrastructure**.

In all three areas, the City will ensure that the benefits of any initiative to develop a water sensitive city will exceed the costs.

Principles of Water Sensitive Urban Design

Protect natural systems. Protect and enhance natural water systems.

Protect water quality. Improve the quality of water draining from urban area.

Integrate stormwater treatment into the landscape. Use stormwater treatment systems in the landscape for multiple uses and with multiple benefits such as water quality treatment, wildlife habitat, public open space, recreational and visual amenity.

Reduce runoff and peak flows. Reduce peak flows by on-site temporary storage measures (with potential for reuse) and minimise impervious areas.

Add value while minimising development costs. Minimise the drainage infrastructure cost of development.

Reduce potable water demand. Use stormwater as a resource through capture and reuse for non-potable purposes (toilet flushing, garden irrigation, laundry etc.).

Source: Melbourne Water

TRANSLATING THE STRATEGY INTO ACTION

INCREASING CAPABILITY

The lion's share of the City's commitments set out in this strategy will be undertaken by Cape Town Water[31], in partnership and collaboration with other directorates in the City and other stakeholders.

A fit-for-purpose modern water provider. Cape Town Water is undergoing a transition from a municipal engineering department to a modern, professional water services provider, consistent with international best practice. This transition cuts across all aspects of the organisation with a focus on customer service, efficiency and effectiveness. A **Cape Town Water transition plan** will be developed and implemented to achieve this transformation. Key components of the transition plan, subject to refinement, are set out below, building on existing strengths.

i. **Putting customers first**. Cape Town Water will make every effort to ensure that customers are happy with the services they receive. The City will make its operations and performance more transparent and accountable to customers. The City will adopt a proactive approach to its customers. This will involve establishing a Customer Services Branch that is suitably structured and staffed, and managed by a customer relations management specialist. The customer relations management policy for water and sanitation will be reviewed and improved. As much attention will be given to listening to customers' needs and perspectives as to communicating to customers. More use will be made of multiple and multi-language media platforms including radio phone-ins. The annual customer surveys will be improved and the published results made more accessible. The customer service charter is at the heart of the agreement with the customer and Cape Town Water will review the charter to ensure it is both more visible and credible, including clear and measurable commitments to realistic standards of service. Call-centre performance will be substantially improved, including the time to answer the phone, the call experience, and timely resolution of queries. Problem resolution tracking and work flows will be improved to improve effectiveness and reduce time to problem resolution. All front-line staff will be selected for customer service aptitude and skills, and be specifically trained in customer service best practice. Cape Town Water will improve the service provided to key customers by establishing a key customer unit to better manage the complex demands of customers with a large number of meters and large sales volumes. The meter replacement programs will be accelerated. Complaints related to sewer blockages and overflows outnumbered the number of complaints related to water, even during the drought. In addition to its ongoing program to replace sewer pipes, Cape Town Water will embark on a concerted campaign to improve customer awareness of the causes of sewer blockages and how these can be avoided, and continue to attend to timely sewer upgrading and replacements.

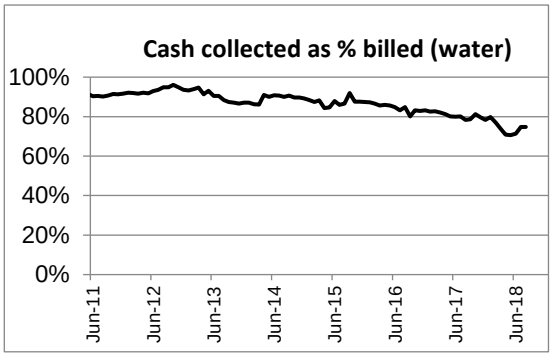
ii. **Improving water and sanitation outcomes in informal settlements**. The significant challenges involved in improving water and sanitation services in the many informal settlements have been described in Commitment 1. The City is committed to finding better ways to provide safe water and sanitation services, through processes that build dignity, trust and social cohesion. This will require multidisciplinary approaches that extend beyond the scope and mandate of Cape Town Water on its own. The challenges are as much social and political in nature as they are technical. In this light, Cape Town Water will develop a multidisciplinary and learning-orientated approach to service provision in informal settlements. The City will seek to leverage available and relevant know-how and resources, both within and beyond the city. This will be complemented with an ongoing action learning research agenda in collaboration with relevant stakeholders and partners to improve the effectiveness and impact of the City's efforts to improve water and sanitation services in informal settlements.

iii. **Investing in people**. The most important resource available to Cape Town Water is its people. Cape Town Water will build an organisational culture based on the values of integrity, excellence in execution and diversity. The organisational structure will be revised to ensure it is fit for purpose, with regular reviews thereafter. The best person for each job will be appointed, paying particular attention to the skills required to implement this strategy and embracing the employment equity targets that support the value of diversity and enable it to better reflect its customer profile. This will be done in partnership with organised labour. Emphasis will be placed on increasing fluidity and

speed of execution within the organisation, particularly with respect to decision making, appointments and procurement. The time taken to make appointments and vacancy rates will be substantially reduced. Procurement processes will be optimised, paying attention to value for money, and time-taken to contract. Standard Operating Procedures will be reviewed and improved to retain institutional memory and ensure effective training. Emphasis will be placed on talent management for succession planning and staff development. The working environment will be improved. The headquarters of Cape Town Water has recently been completed, provisionally rated as a 5-star Green Building, leading the way for the City's sustainability agenda. Cape Town Water has 63 depots which will be systematically upgraded to ensure a consistently good standard throughout the organisation.

Figure 9: New Water headquarters

iv. **Improving cash collection**. Cash collections have declined from over 90% in 2012/13 to a low of 70% during 2017/18. Although exceptional circumstances during this last financial year contributed to poor performance, there is a need to turn performance around in order to achieve 95% or more over the next three years. This will require substantially reducing the number of estimated meter readings, improving billing accuracy, making bills easier to understand, making it easier for customers to pay, and resolving account queries speedily.



v. **Improving operational efficiency and effectiveness of network management**. A key function of Cape Town Water is to manage the water and sewer networks comprising over 20 000 km of pipes. Attention will be paid to ongoing operational improvements in effectiveness and efficiency in line with international best practice.

vi. **Expanding and managing bulk water and wastewater infrastructure.** Cape Town water is embarking on a substantial new build program (Commitment 3), in addition to upgrading and expanding existing wastewater treatment works (to ensure compliance with the license conditions and to cater for increasing demand) and managing a substantial bulk infrastructure. Attention will be paid to efficient capital expenditure, timely commissioning of projects and operational efficiency in line with the master plan, network modelling and international best practice.

vii. **Maximising benefits and reducing risks of shared regional water resources**. Cape Town Water will ensure is it suitably staffed and resourced to be able to work effectively and collaboratively with stakeholders and partners in order to improve the information base and understanding, build stronger relationships between the key stakeholders, optimise the overall economic and social benefit of water, improve water resource management approaches and practices to ensure resilient outcomes and to reduce risks, and to evolve institutional and governance arrangements between the users (urban and agriculture) and the National Department of Water and Sanitation, and to ensure more robust and transparent management of water resources.

viii. **Supporting the transition to a water sensitive city**. In order to realise the vision of a water-sensitive city, the relationship between the residents of Cape Town and water will have to change. All forms of water in the city – rain, stormwater, grey and black water, canals and rivers – need to be managed in an integrated way that make best and sustainable use of water, a scarce resource, and reduces the risk and impact of flooding. As part of this transition, the responsibility for stormwater management has already been moved across from the roads departments to Cape Town Water. The mechanisms at the disposal of the City to facilitate and influence this transition are city taxes and service charges, land-use permissions, building codes and by-laws, and through direct investments in infrastructure. Cape Town Water will ensure is it suitably staffed and resourced to be able to work effectively, collaboratively and through a multidisciplinary and learning-orientated approach to implementing the water sensitive city vision. The City will seek to leverage available and relevant know-how and resources, both within and beyond the city. This will be complemented with an ongoing action learning research agenda in collaboration with relevant stakeholders and partners to improve the effectiveness and impact of the City's efforts to facilitate a transition to a water sensitive city.

Cape Town Water

Source to tap. Cape Town Water has a proud tradition of providing quality water and sanitation services from source to tap. This involves many diverse responsibilities ranging from the management of water catchments areas and water storage to the treatment of wastewater and its safe disposal back into the environment.

Effective drought response. Before the drought, Cape Town Water supplied about 900 million litres of water to customers daily. This is the average for the year. Peak summer use was about 1200 million litres of water per day. Following the successful implementation of water demand management, and as a result of the water saving efforts of Cape Town's residents, water supply reduced to about 550 million litres of water per day in the first half of 2018. The effective response in managing down water demand, together with active cooperation on the part of Cape Town's citizens, businesses and institutions, revealed a capable institution with many strengths.

Staff and customers. Cape Town Water, with a staff complement of a little more than 4000 people, provides water and sanitation services to 660 000 customers with water connections, 645 000 customers with sewer connections, and 204 informal settlements, serving about 4.2 million people in total.

Infrastructure. The City owns twelve water treatment plants with a combined capacity of 1600 million litres per day, 24 reservoirs holding treated water with 48-hour storage capacity and 11 000 km of water pipes. The city maintains 9 000 km of sewers and operates 17 wastewater treatment works and six smaller facilities with a combined capacity of close to 740 million litres per day. 603 pump stations are maintained throughout the reticulation system. About 11% of the treated wastewater, 49 million litres per day, is sold for reuse to 184 customers amounting.

Asset management and quality assurance. The City's water and sanitation asset base is valued at R75 billion, and is managed through with an asset management system and department-wide processes with ISO 9001 quality certification. The operating budget is over R7 billion and the capital budget over the next 10 years is approximately R40 billion.

Supply to other municipalities. The City sells treated water to neighbouring Drakenstein (Paarl) and Winelands (Stellenbosch) municipalities.

Water quality. Every year, around 16 000 drinking water samples are drawn from approximately 300 designated sampling points and are laboratory tested to ensure compliance with stringent water quality standards (SANS 241). High levels of compliance with SANS 241 drinking water quality standards are attained and these have been rated in the excellent category. A well-functioning SANAS ISO 17025 accredited laboratory and well established research facility support the attainment of these results.

Services in informal settlements. Approximately 165 000 informal households in 204 informal settlements throughout the city are served by approximately 6 500 communal taps and 50 000 toilets.

Industry is a small water user in Cape Town, accounting for only about 4% of water consumption, and **commercial use** accounts for about 12% of total water use by customers.

Wastewater treatment works upgrades. The City is in the process of doing major upgrades to several wastewater treatment works, including Zandvliet, Cape Flats and Athlone wastewater treatment works, and is constructing a state-of-the-art regional sludge treatment facility.

Source: Water Services and the Cape Town Urban Water Cycle (November 2017)

FINANCING CAPITAL COSTS AND SETTING TARIFFS

Creating a sustainable water and sanitation service

The water and sanitation services are not sustainable at present. Expenditure is insufficient to maintain and replace existing infrastructure. As a result, the existing assets are becoming less reliable and revenues do not translate into sufficient cash to meet expenses due to low cash collections.

In order to achieve sustainability, each of the following components are necessary, and need to work together as an integrated whole:

- An **investment plan** with the required capital expenditure to meet growing needs and to sustain the service by continually upgrading and or replacing assets as they reach the end of their useful life.
- **Efficient, cost-effective spending** of the capital budget and on operations and maintenance, with incremental and ongoing improvements in service performance and service efficiency.
- **A revenue model** comprising tariff revenues, grants and other sources of revenue to meet the revenue requirements.
- A **tariff model** that is able to generate the necessary revenue from tariffs.
- **Efficient cash collection** to meet the cash requirements of the water provider so that it can pay for all of its expenses, including repayment of the capital costs.

Collectively these contribute to the business plan for the service provider that is part of the Water Services Development Plan required by law.

Financing the capital budget

The committed new water program (Commitment 3) will require capital expenditure of approximately R5.7 billion over ten years (including water conservation and demand management related initiatives). The total capital budget for the water and sanitation service (including the new water programme) over that period is four times that amount.

Financial modelling shows that this budget can be financed by the City cost-effectively based on its balance sheet and from its sources of rates and tariff income. Capital grants will be used to prioritise access to basic services. The City is able to achieve efficient financing of capex through a pooled city financing strategy. Projects can also be financed through project finance which will be considered for new plant if it is shown to offer greater value for money overall through, for example, the reduction of construction and operating risk and more efficient delivery methods.

Subsidies for poor households

Subsidies will be used to keep the water and sanitation services for basic needs affordable for poor households. In the first instance, this subsidy will come from an appropriate share of the national government grant, the equitable share. If this is insufficient, then the cost of providing this water will be cross-subsidised from the rates account for from other water and sanitation users.

Tariff principles

In terms of the law[32], tariffs need to reflect the cost of providing the service, and promote the economical, efficient and effective use of resources. Tariffs also need to be transparent and fair. Fixed charges can be used to recover the fixed-cost component of a service. At the same time, fixed charge also increase the predictability of revenue and the ability to sustain revenue during droughts. Tariffs should also promote water demand management and conservation. Tariffs should be easily understood and not be administratively complex nor expensive to administer.

Cape Town water tariff policies

The City will adopt the following key water tariff policies:

1. **Residential customers who have been classified as indigent** (by property value or other means[33]) will receive a first allocation of water for basic water use each month for free. Thereafter, these customers will have the same tariff as other residential customers except no fixed charge will be paid.

2. **Other residential customers** will be charge a multipart tariff as follows: a fixed charge and a three-tier volumetric tariff. In general, basic usage will be charged at historic cost and higher usage at average incremental cost[34] or at conservation tariff levels.
3. **Non-residential customers** will be charged a two-part tariff with a fixed charge and a flat-rate volumetric tariff. All categories of non-residential customers will have the same tariff. This tariff will recover the full cost of providing water. The volumetric tariff will be set at the average incremental cost of the service.
4. The **fixed charges** will be set with a view, over time, to recover the fixed costs of the water reticulation business.[35]
5. **Revenue neutral during restrictions**. The tariffs will be designed to be revenue neutral during periods of restrictions. Three restriction tariffs will be developed. Separate arrangements will be made for payment for services in the case of an emergency.
6. **Tariff stabilisation**. Tariff stabilisation mechanisms will be investigated. (See text box.)

A rainless day fund?

The City's current policy of staying revenue neutral while drought restrictions are imposed has placed a financial burden on its customers. Under the Level 6B tariffs put into effect in February 2018, the first block in the residential tariff band increased by more than six times to R30/kl.

Looking forward, it may be more reasonable for the City (instead of its residents) to manage the financial risk of future drought-imposed restrictions because the City has better access to credit and ability to save than most residents. The City could do this by designing a 'rainless day' fund, in which reserves are set aside for the City's use in 'rainless' years, so that the entire burden does not need to be passed onto customers. Such funds are adopted by utilities in the United States. [+]

[+] American Water Works Association, 'Cash Reserve Policy Guidelines'.

Cape Town sanitation tariff policies

Alternative methods of charging for sanitation are being investigated. It is intended that the sanitation charges will follow the water tariff policies through the implementation of fixed charges and a volumetric tariff. The water volume to which the sanitation charge will be applied will be capped for residential customers.

Future water tariffs levels

The City imposed high tariffs during the drought to create strong incentives to reduce and save water. Cape Town's future water tariffs will vary during periods of water restrictions but will yield, in total, the current level of revenues, adjusted for normal inflation in costs and the increased capital budget. **Cape Town water tariffs will decrease from the very high levels imposed during restrictions in early 2018**. The cost of desalinated water is estimated to be between R15 and R25 per kl.[36] and to this must be added the costs of managing the water network.[37] Costs and tariffs are likely to become more predictable over the next two to three years, when demand has rebounded and cost data is more certain. Great tariff certainty will be provided during the development of the Cape Town Water transition plan (see Implementing below.

Future wastewater tariffs

Future wastewater tariffs will also increase in real terms, but not to the same extent as the water tariff.

The cost of becoming a water sensitive city

It has taken Singapore over fifty years to reach a stage where it can be considered to be a water sensitive city in a context where water security and integrated urban water management were top political priorities, with a world class water provider leading the way and where available financial resources are ten times greater than those available in South Africa.[38] It is therefore not realistic for Cape Town to be transformed into a water sensitive city through public investments in infrastructure and natural eco-systems in a short period of time. Rather, this transformation will take place over many years and primarily through changing the incentives that influence the nature and location of both public and private investments in the built infrastructure making up the city.

SUPPLYING YOUR OWN WATER

Cape Town Water has a constitutional obligation to provide safe drinking water to its residents, and is the legally mandated Water Service Authority. During the drought, customers were encouraged to construct their own alternative water supply – such as rainwater tanks and boreholes – to supplement municipal supply. This investment by individual customers was helpful in mitigating the risks of the drought, but does not take away the City's legal obligations. Customers that wish to continue to use alternative supplies for potable purposes will need to sign a Water Service Intermediary Agreement with Cape Town Water. This agreement will include details on the time-fame, the nature of the supply, quality assurance and financial arrangements, including an availability charge related to the cost of maintaining the water distribution network.

BUILDING RESILIENCE THROUGH PARTNERING AND COLLABORATION

The successful translation of the City's commitments in this strategy into meaningful outcomes requires a 'whole-of-government' and 'whole-of-society' approach. The City has made clear commitments in this water strategy but cannot transition to a water resilient city on its own.

The City recognises that collaborative relationships need to be built and maintained at many different levels of the Cape Town water system, including:

- Between citizens and the City government
- Between customers and the service provider
- Between citizens and political leadership
- Between officials and politicians
- Between different City departments
- Between different spheres of government
- Between business and the City
- Between the City and the scientific community
- Between the City and other users of the WCWSS

Collaborative relationships are based on trust, and trust is built where there is transparency and mutual accountability, and where stated intentions of all partners are consistently translated into actions.

Based on the intensive experiences of engagement during the drought, and learning from these, the City will promote and facilitate the building of trust in the following tangible ways:

Engaging citizens and civil society. The City will endeavour to create an enabling environment in order to be responsive to citizen-led water initiatives. The City will continue to work with social partners and collaborative intermediary organisations. The City will undertake regular social surveys to better understand the needs and perceptions of citizens, and work with research institutions, NGOs and neighbourhood organisations that have established processes for documenting community water use and needs, perceptions, and attitudes.

Engaging business. The City will continue to work with collaborative intermediary organisations such as Wesgro, GreenCape and WWF to better understand business needs and perceptions and to improve communications.

Engaging government. The City will continue to work with collaborative intermediaries such as the Western Cape Economic Development Partnership and National Treasury's City Support Programme to facilitate productive relationships with other spheres of government including the Western Cape Government and various national government departments.

Engaging labour. The City will continue to work with organised labour as a key partner in service delivery to ensure that the rights of workers are protected.

Engaging researchers. The City will continue to engage with research working groups such as the Freshwater Forum, Cape Higher Education Consortium (CHEC), Water Research Group, Water

Research Commission and the Water Hub to develop and pursue applied research and evidence-based decision-making to assist the City to better fulfil its mandate and to implement this strategy. The City will also explore a transdisciplinary research approach and partner with researchers to co-design research agendas and projects for the City.

Engaging key customers. The City will set up a key customers unit to be more responsive to the needs of key customers.

Engaging international expertise and experience. The City will enhance existing and develop new knowledge sharing partnerships with national and international bodies able to share relevant knowledge and experience to enable more effective implementation of this strategy. Where appropriate, the City will make use of collaborative intermediates to support this effort. In addition, the City is committed to sharing its own experiences with these institutions in order to contribute to the global community of practice.

Effective partnering

A partnering approach enables joint problem-identification, co-design and co-implementation of solutions, joint monitoring and evaluation, and shared learning and adaptation. When developing partnerships, the City, working with its partners, will ensure that there are clear mandates, a suitable convenor, the right people in the room to make decisions, regular meetings for effective communication and mutual accountability for implementation, with consequences for non-performance.

COMMUNICATING

Clear communication is critical to building a water resilient city, both within the City itself as well as externally with the public.

At least three components are important: communicating and educating people about the value of water; educating people about climate futures, the need to plan for extremes, and how this affects communities; and communications around behaviour changes.

The City will identify key communication partners, use and develop existing communications channels, harness the power of social media, practice creative storytelling, and develop adaptive messaging based on different needs and situations.

LEARNING

Institutional learning ensures that different types and sources of knowledge are valued and considered when developing solutions. This is needed to experiment and take risks. Learning by doing is required to test alternative approaches and reflect on them, which is central to building a resilient approach. During the drought, the City was able to create and/or participate in some spaces for learning but the practice of learning is not well institutionalized. To adapt to a rapidly changing world, skills to facilitate a learning approach and to institutionalize this are needed.[39]

The City will seek ways to develop a learning culture within the organisation and to institutionalise this as it implements this strategy. In doing so it will explore different learning streams and communities of practice.[40]

The City will support and encourage learning through: [41]

- Supporting long-term monitoring of key social and ecological components;
- Providing opportunities for interaction that enable extended engagement between participants;
- Engage a variety of participants;
- Promote ways to share knowledge;
- Ensure sufficient resources to enable learning processes to take place; and
- Enable people to network and create communities of practice.

In summary, learning ensures that different types and sources of knowledge are valued and considered when developing solutions, and this leads to greater willingness to experiment and take risks.

IMPLEMENTING

The strategy will be translated into action through **three implementation plans**:

A **Cape Town Water transition plan** will be developed and implemented to achieve the transformation of Cape Town water into a modern fit-for purpose water service provider that will lead key elements of the implementation of this strategy.

The **water services development plan** will incorporate the augmentation plan and all formal planning-related aspects of the water and sanitation business. This forms part of the City's Integrated Development Plan and is the City's legal planning instrument. All of the City's water-related capital projects are included in the IDP. The water services development plan is revised every five years and reviewed and updated annually.

The **collaborative resilience action plan** will create a multi-stakeholder platform to coordinate efforts and improve governance and decision making during any period of crisis. This plan will build on the Section 80 Water Resilience Advisory Committee established by the City during the drought crisis. The platform will be support the City during strategy implementation, with monitoring and adapted. The whole-of-society approach of this initiative is based on fundamentals of sustainability and resilience, reinstates the critical importance and value of partnerships, communication and cooperation, and also speaks directly to the UN Sustainable Development Goals (SDGs).

MONITORING IMPLEMENTATION AND REVIEWING THE STRATEGY

The Cape Town Water Strategy will be reviewed regularly as part of the formal water services development plan annual review process.

The implementation of the strategy will be monitored through the three plans described above.

ANNEXURE A: SCENARIOS

RAINFALL UNCERTAINTY

It is wise to consider the possibility of a step change in rainfall for Cape Town

A step change in rainfall was experienced around 1976 in Perth, also situated on the south-western corner of a continent but just three degrees further north.[42]

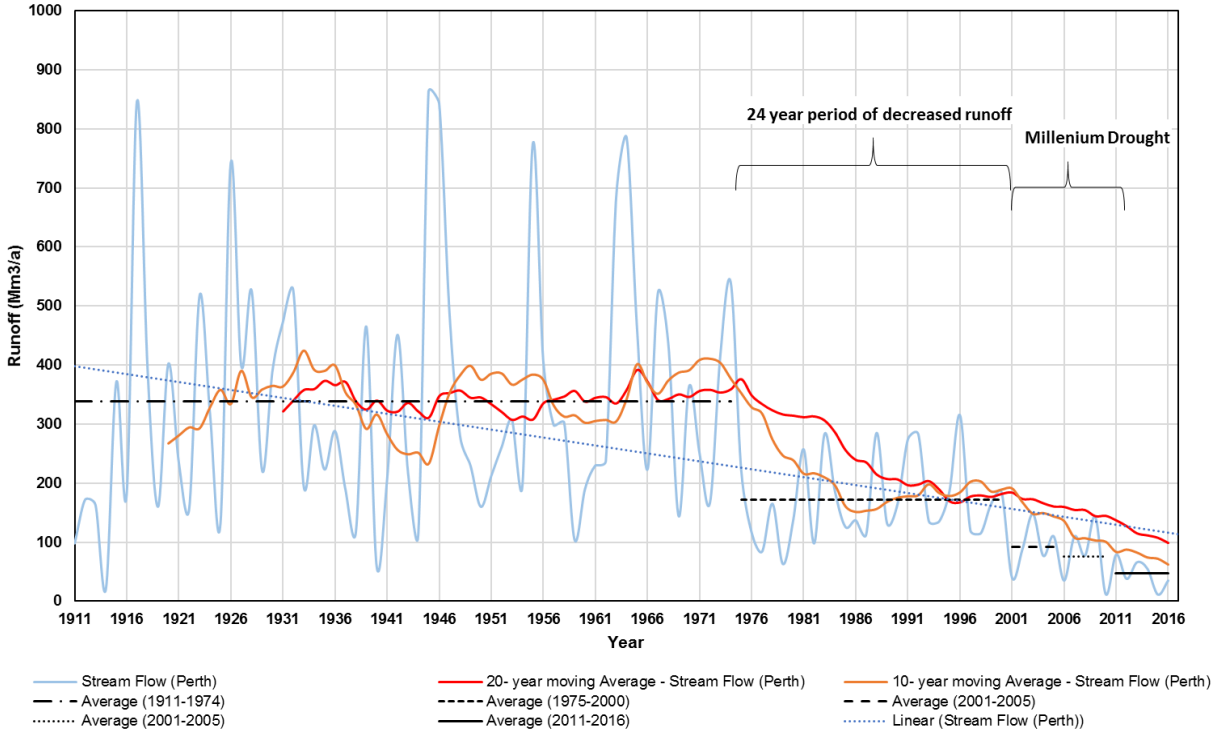


Figure A1: Perth's historical stream flows

While a historical analysis for the WCWSS does not show a step change in runoff this does not rule out the possibility that the WCWSS has recently experienced a 'step change' in climate. While the impact of climate change is uncertain, it is prudent for Cape Town to develop plans that take this uncertainty into account. This requires a scenario-based planning approach because the climate is outside of the control of the City.

DEMAND UNCERTAINTY

During 2015 to 2017, water use was reduced by over 40%. At the same time, both the population and the economy continued to grow. Water has also become much more expensive and this affects use. The combined impact of these factors on future water use is not known with any certainty. In the past, water use has not returned to previous levels after a drought. However, the extent of the demand reduction experienced by Cape Town is unprecedented. While demand can be influenced by City actions, the behavioural choices of users are outside of the direct control of the City and there is a high degree of uncertainty as to what the cumulative effect of these choices will be going forward (Figure A2). The band of the uncertainty is very significant, approximately 300 Ml per day, on average for the year, which is close to 40% of the lower use band.

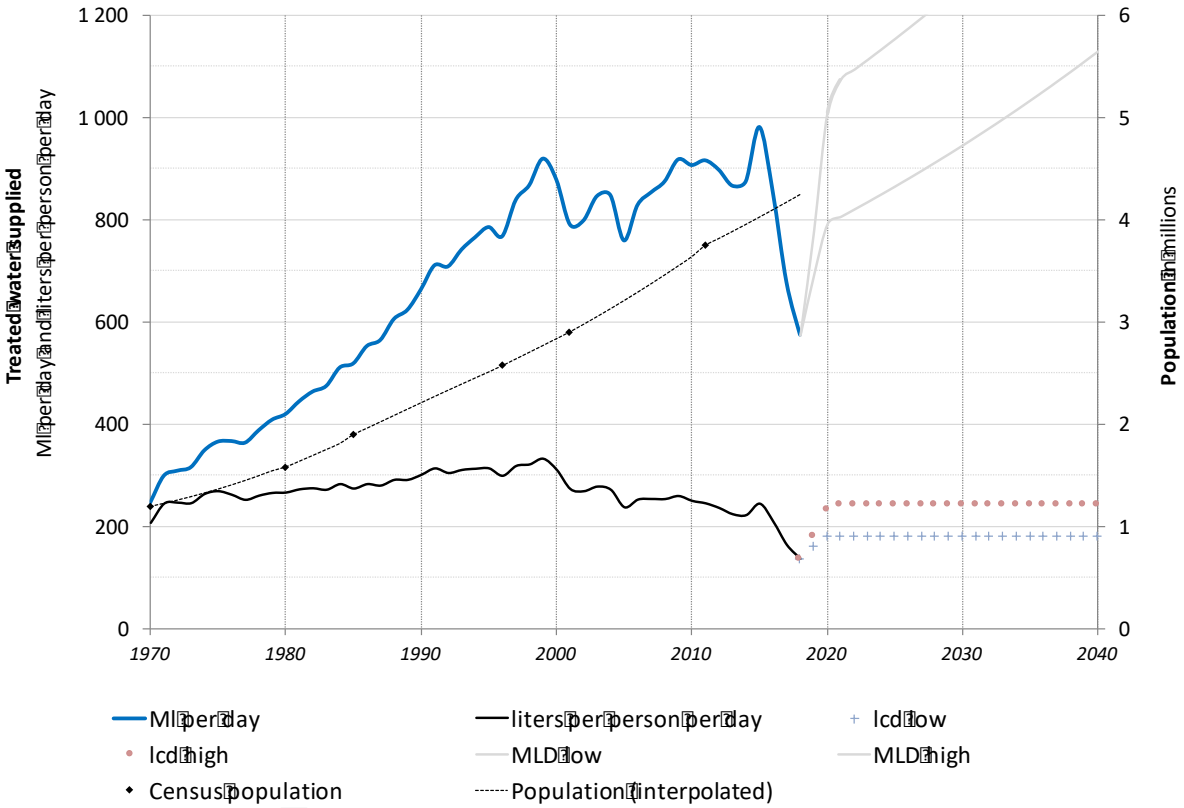


Figure A2: Future water demand is highly uncertain

THE DO NOTHING OPTION WITH A 99.5% ASSURANCE OF SUPPLY

The relationship between water availability and demand is shown in Figure A3. Water availability increased in 2006 as a result of the commissioning of the Berg River Dam. Since then water availability has declined as a result of the growth in alien vegetation, sub-optimal management of the system, a reduction in Cape Town's water allocation and an increase in the reliability of supply standard.

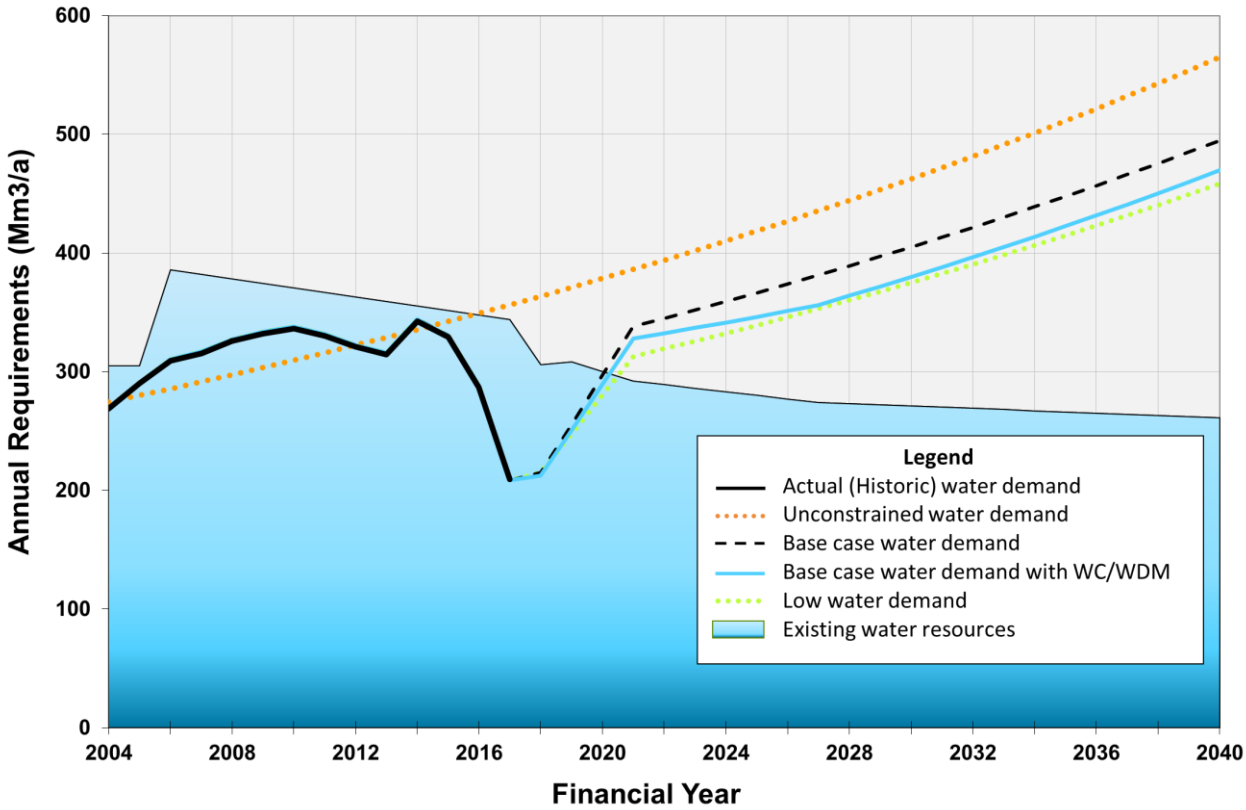


Figure A3: Base case planning scenario with declining water availability and moderate demand

ANNEXURE B: STRESS TESTS

BUSINESS AS USUAL – HIGH WATER DEMAND AND GRADUAL CLIMATE CHANGE

In this scenario the City's ability to curtail water requirements would not decrease as is expected for the base case scenario augmentation plan. Therefore, it would still be reasonable to supply water at the current level of assurance (1 in 50 years) and not increase the assurance to a 1 in 200 year as is planned for the base case. Figure shows that the planned augmentation programme would be able to meet demand under an unconstrained demand growth scenario at the current assurance of supply. Should this scenario become reality the City would then have the option to accelerate the implementation of augmentation schemes to increase the assurance of supply and resilience of the system if desired.

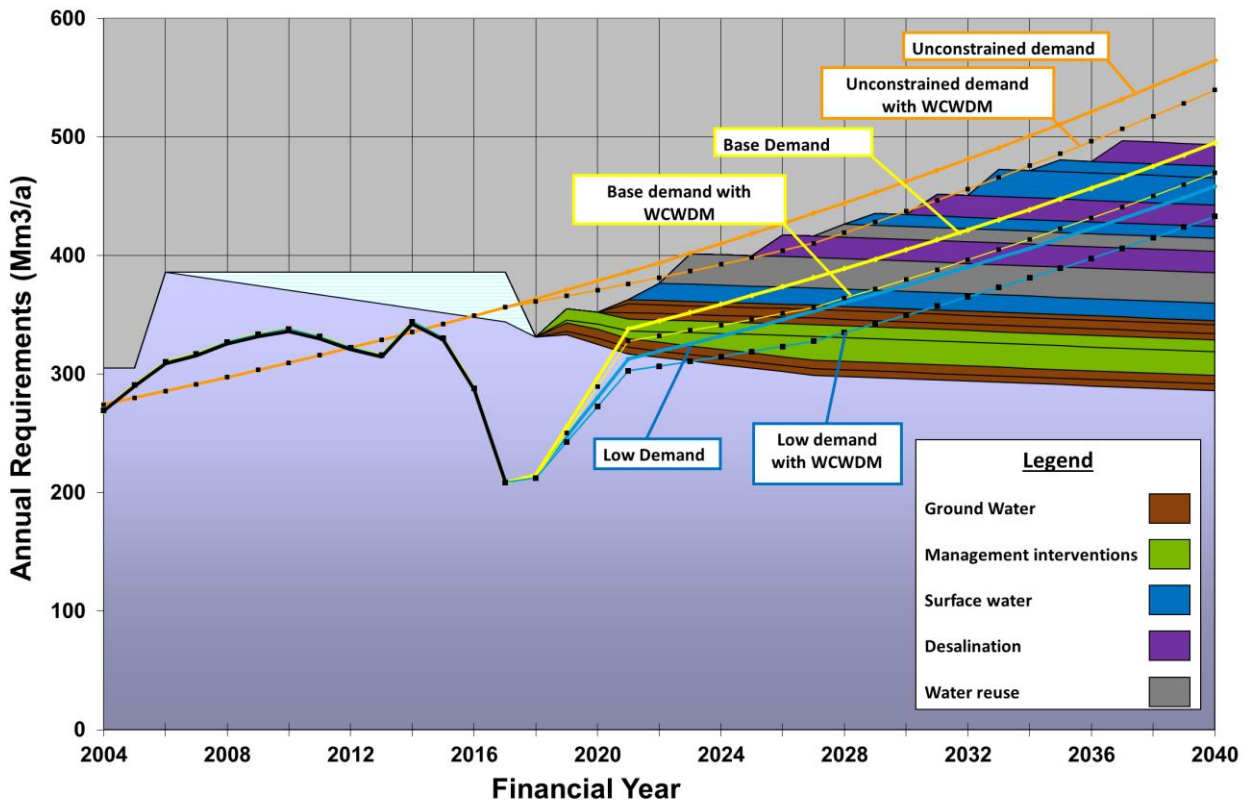


Figure B1: Business as usual stress test – high demand & gradual climate change with 1:50 security of supply

LOW DEMAND WITH GRADUAL CLIMATE CHANGE

In the case of a lower water demand the City would, if it followed an implementation programme based on the base case scenario augmentation plan, have a surplus of supply as is clear from Figure B1. Should this scenario emerge the City would be able to delay the implementation of additional augmentation, for which a commitment has not already been made, by 3 years as shown in Figure B2.

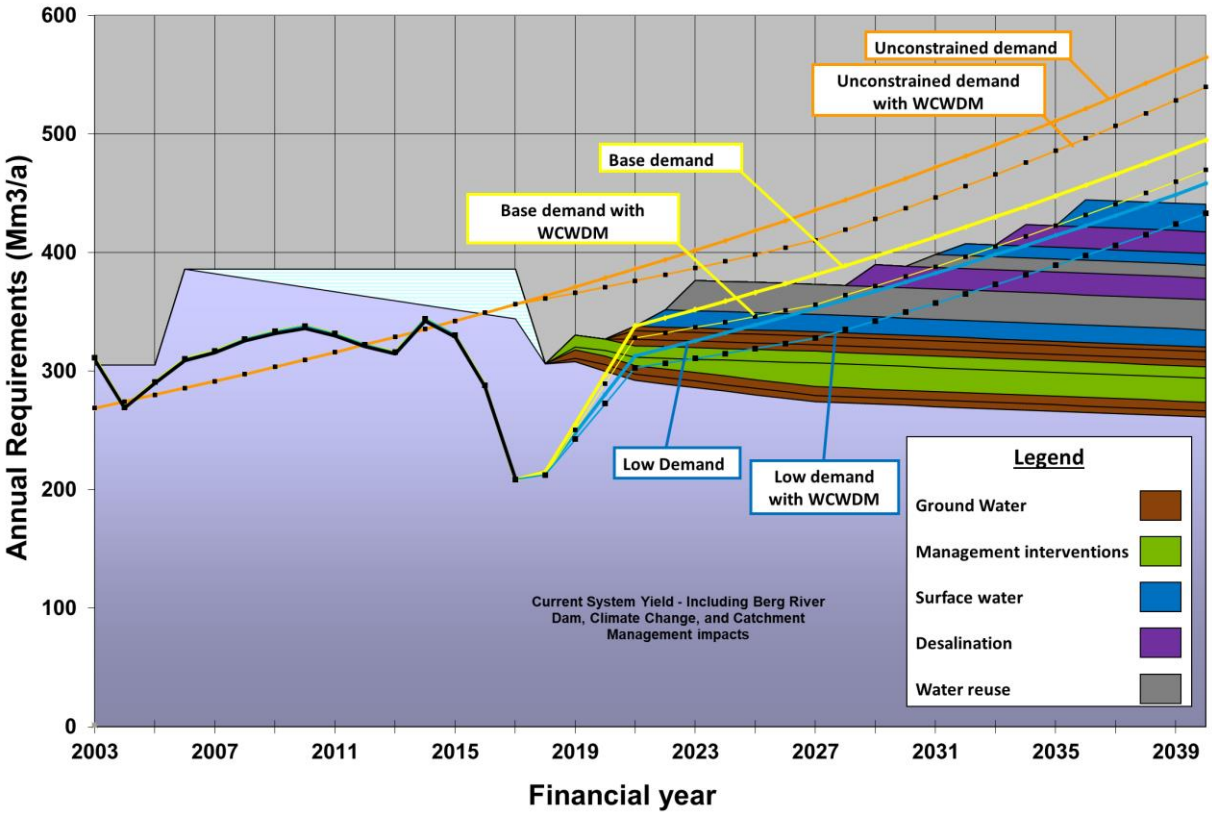


Figure B2: Low demand stress test – low demand rebound and gradual climate change

CLIMATE STRESS – STEP CHANGE IN CLIMATE WITH LOW DEMAND

A step change down in rainfall means that inflows to the six major dams of the WCWSS (before accounting for the growth of invasive alien plant species) will be similar to the inflows in the last 3 years, on average. While climate scientists do not see evidence that there has been a step change in rainfall, they also cannot be sure that there has not been a step change in rainfall. As such, it is worthwhile to stress-test the base scenario augmentation plan against an alternate scenario that assumes low rainfall in the future, to see how far forward the adaptable program would need to be moved to meet the City's desired reliability of supply.

If there was a step change in climate, with the rainfall of the past three years repeated continuously going forward, then the planned augmentation program would only be able to meet the City's basic water needs (Figure 3C). In other words, significant restrictions would have to stay in place until planned augmentation exceeds the growth in demand. In this scenario, the City will accelerate the implementation of augmentation schemes. In view of the risks posed by this scenario, the City will implement measures to increase the robustness and adaptability of the program as set out in Annexure C. This will include the establishment of permitted desalination parks to allow for the rapid deployment of desalination capacity at scale if needed.

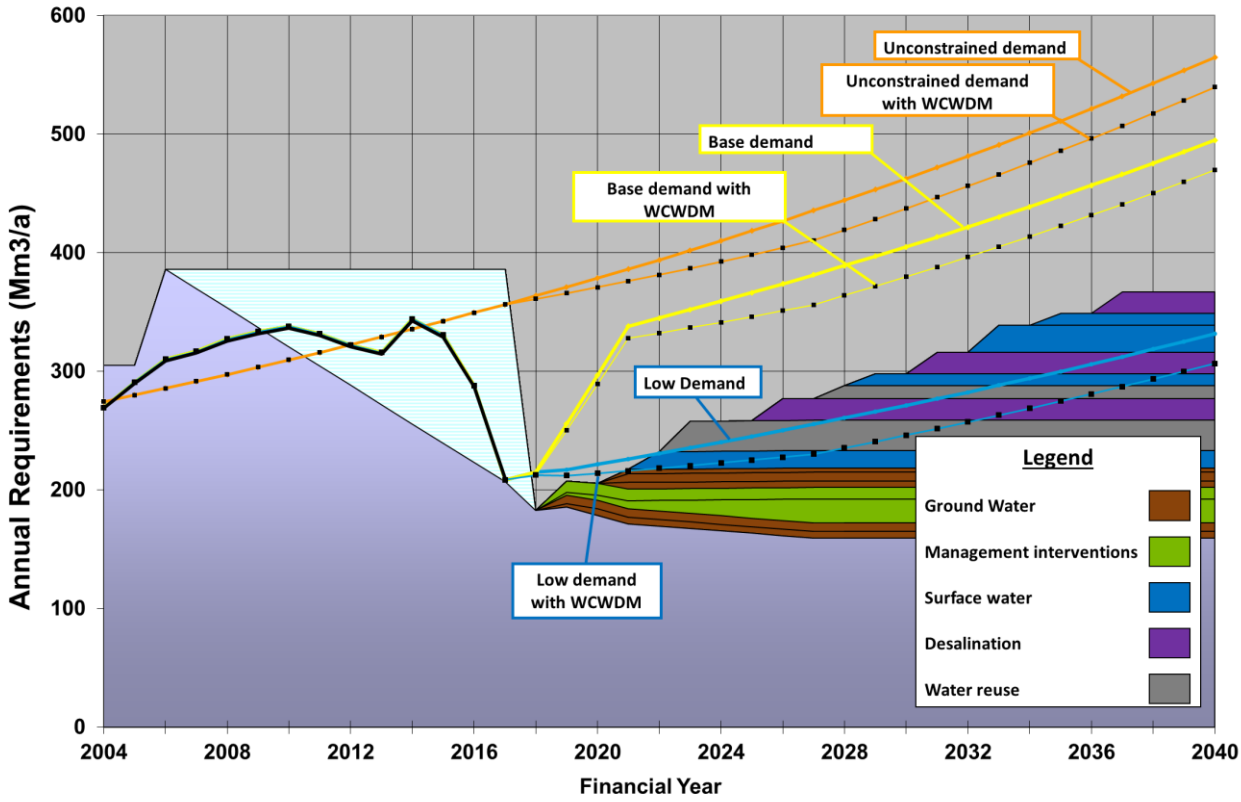


Figure B3: Stress test of the planned augmentation scheme against a climatic step change

ANNEXURE C: MEASURES TO INCREASE ROBUSTNESS AND ADAPTABILITY

The City will implement the following measures to increase the robustness and adaptability of the program.

1. **Monitor**. The City will monitor rainfall and water demand data carefully.
2. **Update demand and supply reconciliations**. The City will regularly update the water demand and supply availability data, and refine demand and supply reconciliations accordingly.
3. **Learn by doing**. Where the City knows which augmentation options are cheapest, it will maximise the supply to be made available from these options. However, cost data for schemes is still uncertain in many cases. In this context, learning by doing and diversification to increase resilience are reasons to do multiple projects of each supply option.
4. **Increase adaptability** through the ability to advance or delay projects as appropriate to the circumstances. As a general principle, projects will be conceived, designed and contracted in such a way as to enable projects to be implemented more rapidly or to be delayed in light of emerging circumstances. Some specific measures are set out below.
5. **Undertake project preparation in advance**. The City will proceed with project preparation well in advance of when projects may be needed in case projects need to be accelerated. Project preparation will include feasibility studies as well as the necessary regulatory permissions such as water use licenses, environmental impact assessments etc.
6. **Include desalination as part of the supply mix**. Desalination, which is endlessly scalable, least dependent on rainfall, and likely to be less socially and environmentally challenging than a number of the other options, is an important technology to develop and learn about. Desalination can ensure reliable supply with certainty when no other options are available.
7. **Investigate merits of a desalination park**. The City will establish one or more desalination parks[43] that are permitted and would allow for the rapid deployment of desalination capacity if required in an emergency.
8. **Mitigate social risks**. Outside of an emergency situation, direct reuse of wastewater for drinking water may face strong social resistance. The City will embark on a proactive process to engage citizens on the benefits and risks of direct wastewater re-use and will also consider non-direct reuse options, learning from the experience of other countries in the process.
9. **Mitigate environmental risks**. The City will ensure that the environmental risks associated with new water supplies are considered holistically. Surface water, groundwater, wastewater reuse and desalination all have different risk profiles, and there are cost and other trade-offs associated with the choice between water sources. The reality is that the City will come to depend on all of these sources of water over time. It is often the case that the fear is greater than the lived experience. The City will learn by doing and mitigate environmental risks as appropriate in the process.
10. **Mitigate procurement and implementation risks**. Public procurement of large infrastructure is time consuming and transaction intensive in the South African regulatory context. Procurement delays pose a significant risk to the program. The City will mitigate these risks by pursuing a range of procurement strategies, including the use of private sector capacity for project management and implementation, and will engage with stakeholders to improve the environment in which procurement takes place, with the aim of timely, cost-effective and corruption-free procurement and project implementation.
11. **Risk-based dispatch**. The City will plan for a 99.5 percent reliability of supply. When rainfall is average or high (or even below average) the City may not need some or all of the planned augmentations. The City's desire to provide sufficient water for responsible use with a higher reliability of supply mean that risk-based dispatch will be necessary. In the past the operating cost of an additional unit of rain-fed water was low (about R5 per m^3 including treatment), in the future operating costs of new plants will be higher (R10 per m^3 or more). Therefore, it makes sense in periods with normal or plentiful rainfall to largely rely on dam water, while avoiding the operating costs of the most expensive alternative plants. On the other hand, as dam levels start to fall,

progressively more expensive alternative sources should be operated to preserve the security of supply provided by adequate storage levels in the dams. The City will learn from risk-based dispatch regimes adopted in other cities such as Sydney in Australia and Barcelona in Spain. See text box.

12. **Mitigating Tariff Impact on Customers**. The City will continue to seek full recovery of the cost of delivering the service through tariffs. Financing required for implementing projects will be planned in advance to allow for tariff certainty, but will only be built into the tariff at the point of raising such finance (at implementation of projects/programmes).

Risk-Based Dispatch and Restrictions

The City's future operations will need risk-based 'dispatch' of plants and implementation of restrictions. This is because, in normal rainfall years, the City will have much more water production capacity than it needs.

The reason for this is linked to the reliability of supply standard. If the City plans for a 99.5 percent reliability of supply, then almost 99.5 percent of the time the City will have more than enough water available to meet its needs. When rainfall is average, when rainfall is high, and even when rainfall is below average—just not so low that City's allocations from the WCWSS dams cannot be met—the City will not need some or all of the planned augmentations

In contrast, if the reliability of supply was set lower—say, 60 percent—then in normal years, the City would need most or all of its available resources to be producing. In years where rainfall was below normal, the City would soon need to impose restrictions.

Given the City's desire to provide water in abundance for responsible use, a higher reliability of supply is required, meaning the risk-based dispatch will be necessary. While in the past the operating cost of an additional unit of water was low (R5/m^3), since it was fed from the dams, in the future operating costs of many plants will be higher (R10/m^3 or more).

Therefore, it makes sense in periods with normal or plentiful rainfall to largely rely on dam water, while avoiding the operating costs of the most expensive alternative plants. On the other hand, as dam levels start to fall, progressively more expensive alternative sources should be operated to preserve the security of supply provided by adequate storage levels in the dams. As needed, restrictions should also be imposed.

The City can learn from similar risk-based dispatch regimes adopted in Sydney, Australia and Barcelona, Spain, as described below.

Sydney, Australia

Sydney has 5 years of available water supply in dams located in the Blue Mountains, similar to Cape Town's WCWSS. During the Millennium Drought, low rainfall meant that dam levels fell continuously, prompting fears that Sydney would run out of water. To forestall that risk, Sydney built a desalination plant, which it committed to just as dam levels approached the 30 percent of storage mark, on the basis that this would allow the plant to come on stream in time to avert a crisis. The desalination plant was designed as a risk management instrument, to be run when needed, not continuously.

Other risk management instruments include transfers from another dam (Shoalhaven) and construction of additional desalination capacity, as well as demand restriction measures. The regime for implementing these risk management measures has been tightly specified.

Because the drought broke soon after construction of the desalination plant started, Sydney's plant has never run. Nevertheless, it serves a useful purpose as an insurance policy against future drought. Because the desalination plant cannot supply all of Sydney's demand, it starts to operate when dams reach 60 percent, to slow the rate of draw down on storage and buy time for the rain to fall, or, ultimately, for the construction of additional desalination capacity.

The desalination plant has significant start-up and shut-down costs. This is why, once started (at 60 percent), it is not shut down once dam levels go back above 60 percent, but continues running until dams reach 70 percent.

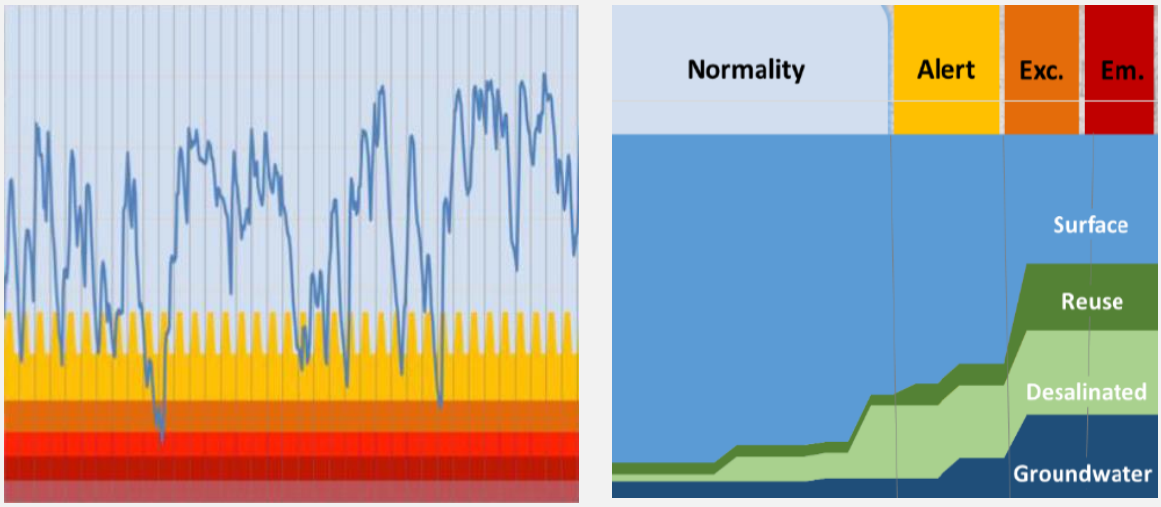
Barcelona, Spain

Like Sydney, Barcelona experienced a severe drought in 2008, which necessitated demand restrictions, and import of drinking water by ship from France.

The City responded through integrated management of underground and surface water sources, modernization plans to promote the efficient use of water, improved detection of spillage and illegal water extraction, wastewater reuse, and the rainwater management.

In addition, the city introduced a clear set of triggers for use of additional water sources as storage levels in dams fell. As illustrated in Figure C1, triggers would lead to progressive increase in use of desalination water, ground water, and wastewater reuse, to curtail demands on water in the dams.

Figure C1: Barcelona Drought Response Thresholds



Source: Manuel Mariño, Cape Town Water Crisis 2017 Analysis from International Experience Presentation.

Cape Town's dispatch and restrictions plan could look similar to these models, with plants being commissioned in order of unit operating cost (where the plant with the lowest operating cost per m^3 is commissioned first).

ANNEXURE D: WATER CONSERVATION AND WATER DEMAND MANAGEMENT

As early as 1995, City of Cape Town committed itself to a 10% saving on the historical demand growth of 4 % per annum. An Integrated Water Resource Planning (IWRP) study carried out in 2001 indicated that various Water Demand Management and Water Conservation (WC/WDM) initiatives are the most feasible water augmentation options to meet the growing water demand for the City.

In 2001 CCT developed a WC/WDM policy and strategy based on the outcome of the IWRP study. Several WC/WDM projects were implemented and some of the projects such as the Khayelitsha Pressure management project were very successful and received widespread recognition. The implementation of the strategy was however not sustainable and due to numerous institutional challenges, the initial commitment and resources to WC/WDM were significantly reduced during 2003, 2004 and again during 2006. The City then developed a comprehensive 10-year WC/WDM Strategy and the programme was approved by the Mayoral Committee in May 2007. The WC/WDM Strategy targeted water savings of approximately 90 million m^3/a by 2016/2017. The strategy detailed the interventions required to ensure the demand is maintained below the Low Water Demand Curve as set out in the CCT/DWS Raw Water Supply Agreement which is agreement between DWS and CCT. Progress, against the planned water savings targets and Low Water Demand Curve is reviewed annually and submitted to DWS.

The CCT reviewed the strategy in 2010 and 2011 with the aim of assessing the progress against the initial planned savings and setting new targets for the next 10 years with a revised cumulative targeted savings of 120 million m^3 by 2021/22 (includes proposed savings set in 2007/08).

In 2017, during the drought, the interventions and associated savings were reviewed for the next 10 years. The revised WC/WDM programme, if all the objectives are met, assumes a potential saving of 184 Ml/d over a 10-year period from 2017 to 2027. One of the biggest interventions, the "Recycling of treated effluent" assumes a potential "saving" of 66 Ml/d. It is estimated that only 30% of this "saving" replaces potable water use which means that the total potential saving from all the WC/WDM interventions is 138 Ml/d. Given the uncertainty around the implementation and effectiveness of all the WC/WDM measures, for the purposes of this strategy it is been assumed that the WC/WDM programme will achieve 50% of the targeted savings over the 10-year period. The translates to a saving of 69 Ml/d.

ANNEXURE E: THE WATER RESILIENCE COLLABORATION LABORATORY OUTCOMES

Some possible solutions

Mobile Co-Design Lab: Small co-labs elicit participation in informal settlements, providing more inclusive and proactive governance while working with communities on designs for critical infrastructure at community and household level. With community involvement early on, stakeholders are more accountable in the design and implementation of projects. Co-labs will draw on International best practice to promote creative and safe spaces that address pressing resilience challenges such as flooding, inadequate sanitation, lack of social cohesion and trauma. See Commitment 1.

Community Generated Data: With organized groups in informal settlements already collecting a wide range of quantitative and qualitative data on their communities, this initiative offers a pathway for comprehensive data collected by the City of Cape Town and by communities to be combined, enabling better decisions on interventions in informal settlements. Forums for reflection and discussion will be created to assess data and provide critical inputs into City budgeting and planning cycles.

Livable Waterways: Local water corridors are largely unlivable, yet if transformed – with interventions such as a series of bio-filters and a networks of canals controlled by communities – these green-blue corridors can be invaluable for cooling the city and cleaning riverways. This initiative will engage citizens and building social cohesion. See Commitment 5.

Business Water Collaborative: Hit hard by punitive tariffs and restrictions during the drought, water-intense industries significantly augmented their supply with groundwater (having a reverberating impact on municipal revenue and groundwater resources). In order to minimize future water shocks and aiming to improve the competitiveness of Cape Town industry as well as enhancing resilience while at the same time reducing the reliance on groundwater, this initiative proposes a City-managed, diversified water portfolio for certain economic nodes. Private sector investment can be utilized to establish shared infrastructure to meet collective (alternative) water needs; supply would follow a holistic water resource model leaning heavily on alternative sources (i.e. rainwater, treated effluent, seawater, in addition to groundwater and municipal supply).

Source: 100RC Water CoLab, Cape Town, September 2018

ANNEXURE F: FURTHER READING AND RELATED REFERENCES

National policies, plans and legislation

- Disaster Management Act, 2002 (Act 57 of 2002, as amended 2015)
- Integrated Resource Plan for Electricity (IRP) 2010 - 2030: Update Report (DoE, 2013)
- Integrated Resource Plan Update: Assumptions, Base case and observations, Draft (DoE, 2016)
- National Adaptation Strategy
- National Climate Change Bill, 2018
- National Climate Change Response White Paper (2011)
- National Desalination Strategy (DWS, 2011)
- National Environmental Management Act, 1998 (Act 107 of 1998)
- National Environmental Management: Biodiversity Act (Act 10 of 2004)
- National Sanitation Policy (DWS, 2016)
- National Water Act, 1998 (Act 36 of 1998)
- National Water Resource Strategy (version 2)
- National Water Resources Strategy (DWS, 2014)
- The Water and Sanitation Master Plan (DWS, 2017)
- Water Services Act, 1997 (Act 108 of 1997)

City of Cape Town

- City of Cape Town Climate Change Policy, 2017
- City of Cape Town Data Strategy, 2017
- City of Cape Town Environmental Strategy, 2017
- City of Cape Town Floodplain and River Corridor Management Policy, 2009
- City of Cape Town Inland & Coastal Water Quality Improvement Strategy & Implementation Plan, 2012
- City of Cape Town Integrated Development Plan, 2017-2022
- City of Cape Town Management of Urban Stormwater Impacts Policy, 2009
- City of Cape Town Preliminary Resilience Assessment, 2018
- City of Cape Town Stormwater By-law, 2005
- City of Cape Town Water By-law, 2010
- City of Cape Town Water Conservation & Water Demand Management Programme / Strategy, 2007, updated 2014/15
- City of Cape Town Water Demand Management and Strategy Review, 2015/16
- City of Cape Town Water Services Development Plan, 2017/18 – 2021/22

Relevant International Programmes

- Sustainable Development Goals, notably Goal 6 and 11

A note for the reader – making meaning of water volumes and costs

Newspaper articles and reports refer to various volumes of water – litres, kilolitres, cubic meters, megaliters, million cubic meters – and it is hard to keep track of these terms and understand what they meaning in different contexts. This is a short guide to water volumes and other terms and concepts used in this strategy.

What is a cubic meter?

A cubic meter is 1000 litres. A cubic meter (1000 litres) is also the same as 1 kilolitre (kl).

How much is a megaliter?

A megalitre (Ml) is one million litres.

How much water does the city use? (megalitres or millions of litres)

Before the drought, in the year 2014/15, Cape Town used 980 million litres of water per day (980 megalitres) on average. During the drought water use was reduce to a little about 500 million litres per day (500 megaliters).

How much water do we use? (litres per person per day and kl per month)

Total water use for the city as a whole was about 230 litres per person before the drought. This was reduced to about 130 litres per person per day during the drought. Total use incudes all uses and includes losses. At a household level, at least 50 litres or water is necessary per person every day for basic needs. Households can maintain a good standard of living using 100 litres per person per day. This is the typical household use for many European cities.

A household of four people using 100 litres per person per day will use 12 000 litres in a month (12kl or 12 cubic metres).

How did water resources develop serving Cape Town?

Cape town's water history. Cape Town's recorded water history starts in 1834, when the growing city was served by 36 free flowing fountains. The first reservoirs were constructed in 1850, to make better use of spring and surface water. Every time demand exceeded supply, more storage capacity was conceived. Small dams were constructed on Table Mountain, but the additional yields provided could not keep pace with demand. So the 6 large dams that provide the water to the Western Cape Water Supply System (WCWSS) were constructed between 1920 (Steenbras) and 2006 (Berg River dam).

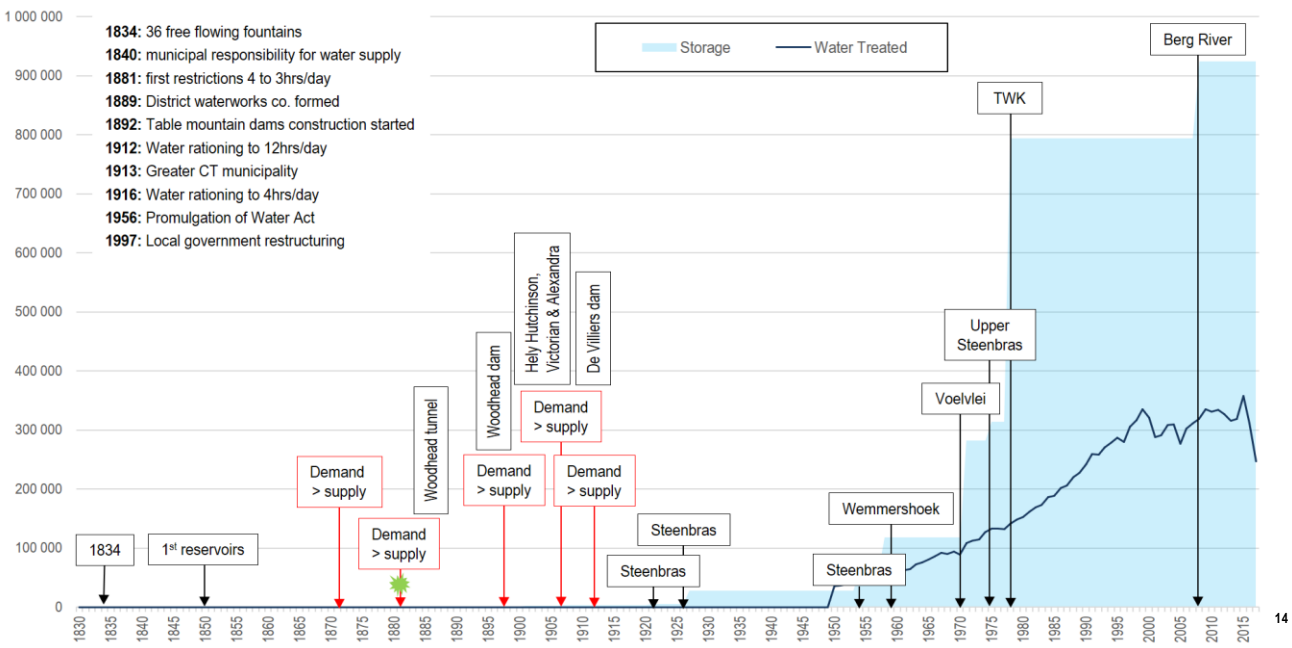


Figure 9: Cape Town's water supply history 1834 – 2016

The dams have a combined yield of ~900 million cubic meters per year (MCM/yr) which is reliant on winter rainfall. For nearly 170 years, Cape Town and surrounds relied on surface water as the source.

Historically rainfall has been variable year on year, as well as across the catchments. The supply system stretches from Voelvlei dam in the north to Theewaterskloof in the east. Typically, within a season, better rainfall is experienced in some areas than others. Theewaterskloof is the largest dam and catchment, and usually takes two years to fill with average rainfall, while the balance of the dams fills in a single season.

How big are our dams?

The six large dams supplying the city of Cape Town hold 900 000 million litres (900 000 megalitres). When the numbers are large like this, the preferred unit is million cubic meters. 1 million cubic meters is the same as 1000 megalitres. So the volume of the dams is also 900 million cubic meters.

How long can the water in the dams last?

If the water in the dams was used by the City only, and if there were no evaporation losses, then a full dam would last for 1000 days (less than 3 years) at a use of 900 million litres per day, and 1800 days at 500 million litres per day. But the dams lose over 200 million litres per day on hot summer days from evaporation and about a third of the water is used by agriculture. Also, it is difficult to use water from the dams when they at low (below 10%). In practice, then, the time that the full dams can last is less than two years for normal unrestricted usage. It should be noted that some cities, for example, Sydney, have storage dams that contain five years of normal water use.

DEFINITIONS

Alien vegetation	Invasive alien vegetation refers to plants brought to South Africa from other countries, both intentionally and unintentionally, that cause human, environmental or economic harm.
Aquifer	An aquifer system is a group of formations that contain sufficient saturated permeable material to yield economic quantities of water to boreholes and springs.
Aquifer recharge	Managed aquifer recharge is the intentional recharge of water to suitable aquifers for subsequent recovery or to achieve environmental benefits; the managed process assures adequate protection of human health and the environment.
Collaborative intermediary organisation	Organisations that create platforms for deliberation and collaboration between diverse stakeholders.
Desalination	Removal of salt (sodium chloride) and other minerals from the water (usually sea water) to make it suitable for human consumption and/or industrial use
Groundwater	Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers.
Resilience	The capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.
Social cohesion	Social cohesion is linked to more stable and participatory democracies, greater economic productivity and growth, inclusivity and tolerance, effective conflict management and resolution, and a generally better quality of life for people.
Stormwater	Surface water in abnormal quantity resulting from heavy falls of rain or snow.
Wastewater	Spent or used water with dissolved or suspended solids, discharged from homes, commercial establishments, farms, and industries.
Water catchment	A catchment is an area where water is collected by the natural landscape
Water conservation	Water conservation is the practice of using water efficiently to reduce unnecessary water usage.
Water reuse	Water reuse is the use of treated wastewater for beneficial purposes, which increases a community's available water supply. Water can be re-used directly by injecting water treated to potable standards into the bulk water supply system, or indirectly, to recharge aquifers. Current reuse in Cape Town consists of treated effluent supplied for industrial use, construction and irrigation.
Water sensitive city	The destination of water sensitive urban design (see below).
Water sensitive urban design	Encompasses all aspects of integrated urban water cycle management, including water supply, sewerage and stormwater management. It represents a significant shift in the way water and related environmental resources and water infrastructure are considered in the planning and design of cities and towns, at all scales and densities. Fletcher et al., (2014)

ACRONYMS

DWS	Department of Water and Sanitation (national government)
IWRP	Integrated Water Resource Planning
kl	Kilolitre = one thousand litres = 1 m^3
lcd	Litres per person per day
m^3	Cubic metre = one thousand litres = 1 kl
MLD	Million litres per day
Ml	Million litres
SDG	Sustainable Development Goal
WC	Water Conservation
WCWDM	Water Conservation and Water Demand Management
WCWSS	Western Cape Water Supply System
WDM	Water Demand Management
WSUD	Water Sensitive Urban Design

ENDNOTES

[1] Referred to as "the City" in the strategy.

[2] "*Urban resilience* is the capacity of individuals, communities, institutions, businesses and systems in a city to survive, overcome, adapt and grow no matter what kind of chronic stresses and acute shocks they experience." (Cape Town Integrated Development Plan 2017-22)

[3] Regional refers to the region served by the WCWSS,

[4] "Water is integral to almost every feature of an urban landscape. Our cities and towns are complex, ever evolving places, and the way we interact with other people constantly changes too. In a water sensitive city, we interact with the urban water (hydrological) cycle in ways that:

- provide the water security essential for economic prosperity through efficient use of diverse available resources;
- enhance and protect the health of waterways and wetlands, the river basins that surround them, and the coast and bays;
- mitigate flood risk and damage; and
- create public spaces that collect, clean, and recycle water."

https://watersensitivecities.org.au/what-is-a-water-sensitive-city/

[5] All costs in this Strategy are subject to revision as new information comes to light and as circumstances change.

[6] Day Zero was set at total dam level in the supply system reaching 13.5% of storage capacity, which would have provided an allocation of 25 lcd to 4 million people of Cape Town for 3 months before dam levels reached 10%, at which point extraction from dams would have been progressively more challenging.

[7] Competitiveness refers to economic competitiveness of the city to attract investment, to stimulate job creation and to encourage tourism.

[8] Adapted from the UN High Level Panel on Water Outcome Document, "Making every drop count: An agenda for water action" (2018).

[9] Ibid.

[10] Currently known as the City of Cape Town Water and Sanitation Department.

[11] Safe water is defined in the national quality standard SANS 241: 2015 (drinking water).

[12] Resilient Cape Town - Preliminary Resilience Assessment report available at http://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/CCT%20PreliminaryResilienceAssessment.pdf

[13] Cape Town Integrated Development Plan 2017-22 available at http://resource.capetown.gov.za/documentcentre/Documents/City%20strategies%2c%20plans%20and%20frameworks/IDP%202017-2022.pdf

[14] Wise water use refers to all types of water use including potable and non-potable use, and including water reuse.

[15] All uses include both domestic and non-domestic use such as commerce and industry.

[16] Total water use is the total treated water supplied to Cape Town, and includes water sold to other small municipalities. This includes all water uses – domestic, commercial and industrial – and water losses.

[17] www.un.org/waterforlifedecade/pdf/human_right_to_water_and_sanitation_media_brief.pdf

[18] Households who live in properties with a current municipal value greater than R400 000 and who are registered as indigent also receive this free allocation of water.

[19] The average incremental cost is the average of the future costs incurred in adding additional supplies and can be calculated by dividing the discounted value of future supply costs by the (similarly discounted) amount of additional water to be produced (Bahl and Linn, 1992).

[20] Non-revenue water (NRW) is water that has been supplied into the water network but has not been provided to customers as either free water (in terms of Cape Town's free water policy) or billed. Non-revenue water includes physical water losses and apparent losses (for example through unauthorised connections or due to metering inaccuracies).

[21] Data from DWS.

[22] "*Urban resilience* is the capacity of individuals, communities, institutions, businesses and systems in a city to survive, overcome, adapt and grow no matter what kind of chronic stresses and acute shocks they experience." (City IDP 2017-22)

[23] Unpublished report commissioned by the city.

[24] The level of rainfall is the primary driver of water availability in the dams. However, temperature and wind also impact on evaporation from dams and on the relationship between rain and run-off.

[25] The Net present value would be approximately R14 Billion at 98% assurance compared to R16.7 Billion at 99.5% assurance.

[26] The 2040 yield of the WCWSS was estimated assuming a 10% reduction in the runoff from the WCWSS's catchments. This will result in an average decrease in water availability to the City of 1 million m^3 per year. See Annexure A.

[27] City of Cape Town WCWDM Strategy.

[28] Regional refers to the region served by the WCWSS.

[29] Various initiatives are underway or have been undertaken to better understand water use in the region. Any proposed studies will build on existing work.

[30] Source: BROWN, R., KEATH, N. & WONG, T. 2008. Transitioning to water sensitive cities: Historical, current and future transition states. In: Proceedings of the 11th International Conference on Urban Drainage, 31 August-5 September 2008, Edinburgh International Conference Centre, Scotland. Edinburgh: IAHR/IWA

[31] The City's Department of Water and Sanitation.

[32] Tariff principles for municipal services are set out in the Municipal Systems Act and for water and sanitation services in the Water Services Act.

[33] As per the City's Indigent Tariff Policy.

[34] The average incremental cost is the average of the future costs incurred in adding additional supplies and can be calculated by dividing the discounted value of future supply costs by the (similarly discounted) amount of additional water to be produced (Bahl and Linn, 1992).

[35] Fully recovering all fixed costs through fixed charges may make water services unaffordable for poor and middle-class residential customers. The City may wish to set fixed charges below total fixed costs and set volumetric charges (except the lowest block) above the average incremental cost. The City will explore this trade-off as it develops its plan for financial stability.

[36] The cost of desalinated water depends on a number of factors not least of which is the cost-effectiveness of procurement, that is, the extent to which competitive procurement processes are able to deliver internationally competitive prices.

[37] To the extent that a fixed charge recovers the cost of the water network, then the volumetric water tariff is likely to be in the lower range of the estimated band.

[38] Singapore has a per capita GDP of $52906 compared to South Africa's of $5273 (2016) according to the World Bank.

[39] Gina Ziervogel, pers comm. 2018.

[40] Source: Applying resilience thinking Seven principles for building resilience in social-ecological systems. www.stockholmresilience.org.

[41] Ibid.

[42] Perth is at a latitude of 31 degrees South and Cape Town is at 34 degrees South. See Smith and Scott. Past and future changes to inflows into Perth (Western Australia) dams. *Journal of Hydrology: Regional Studies* Volume 2, November 2014, Pages 84-96. Data source for graph: Water Corporation, 2018.

[43] Desalination parks are sites prepared specifically for desalination plants to be developed rapidly if additional supply is required. Common infrastructure can be constructed upfront while plants can be added in modules in the region of 50MLD.