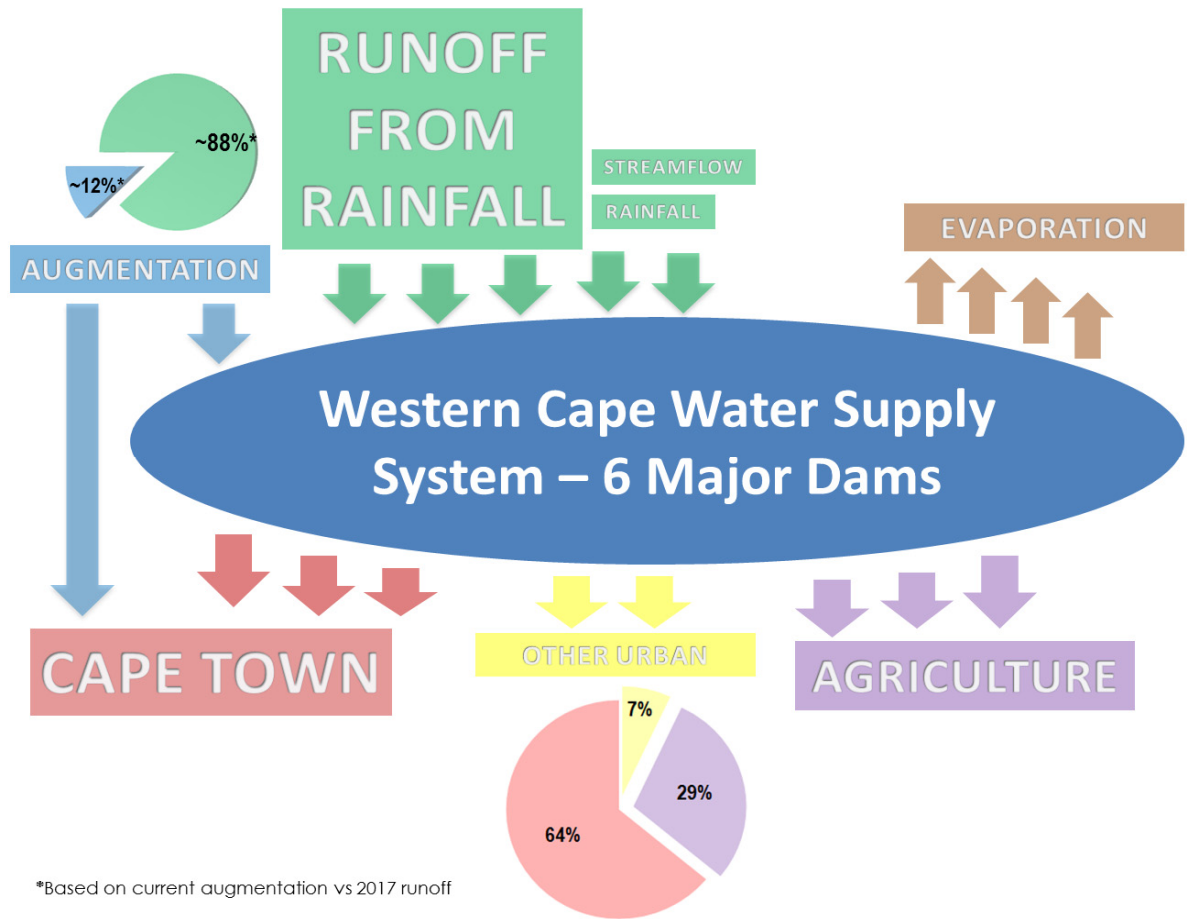


The City of Cape Town is part of the Western Cape Water Supply System, which gets its water from a system of dams that supply agriculture and other urban areas. The current system is heavily dependent on rainfall. The National Department of Water and Sanitation (NDWS) is responsible for planning and implementing water resources schemes to meet water demand for cities, industries, mining and agriculture. The Department plans at a 1 in 50 year level of assurance. This means that during droughts with a severity of 1:50 years or more, restrictions need to be imposed to reduce demand.



To get through the drought we want to ensure that dam levels do not fall below 15%, although we can extract water to 10%, and with more difficulty, even lower.

Dam levels rise principally from runoff from rainfall in catchment areas, and to a far lesser degree from streams flowing into the dams, and rainfall over the dams. Some augmentation will enter the system (such as groundwater from aquifers).

With climate change, worldwide weather patterns have changed and our catchment area has seen the worst drought on record. The current drought is much more severe than a 1 in 50 drought event. The best estimate of the return interval of the meteorological drought in the region of WCWSS dams is 311 years, with 90% confidence that it actually falls between 105 and 1280 years. The existing augmentation schemes will provide only about 12% of total available supply during 2018 while the poor rainfall of 2017 contributed 88%.

The next augmentation scheme for Cape Town was planned for 2022/3 and is being accelerated by the national Department. This scheme (augmentation of Voelvlei Dam) is unlikely to be ready before 2021.

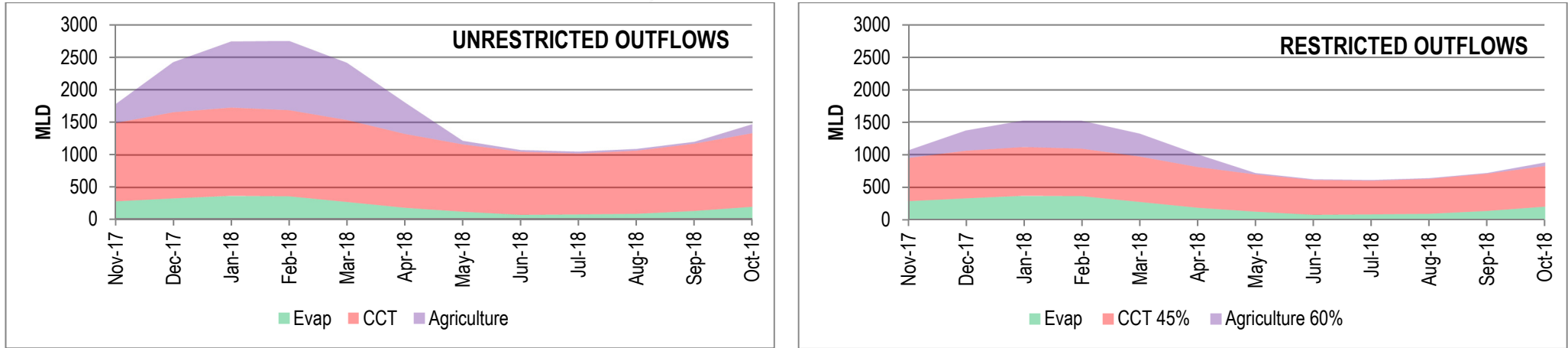
Global climate models are in agreement, that while simulations have very different outcomes, that it is not reasonable to plan for a scenario in which it does not rain in the future or in which it only rains at 2017 levels.

DAM LEVELS

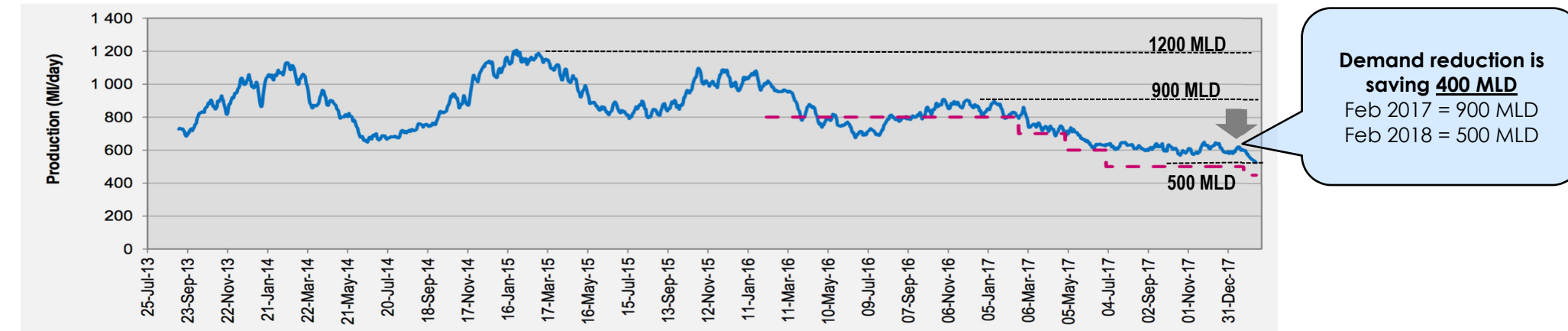
Dam behaviour is thus modelled conservatively on 2017 runoff data. Dam levels drop from use by Agricultural, City of Cape Town, other municipalities, and through evaporation. Although we have progressed exceedingly well in curtailing our urban consumption and fast-tracking augmentation schemes, the poor rainfall of 2017 leaves us exposed to dams emptying too quickly.

The City, together with DWS monitors dam levels, and publishes change in dam levels and consumption every week. Tracking urban and agriculture demand against allocations has been included on the City's water dashboard. Decisions around further restrictions will be made based on how dam levels are tracking against the anticipated behaviour, and we will have early warning if we are not on track. Note that every day the 450 MLD target is exceeded means less water in the dams, which needs to be recovered by future reduced demand, while we are tracking augmentation projects to further reduce drawdown.

- Important principles:
- Getting through the drought in 2018 requires that demand be reduced;
  - Augmentation alone will not add sufficient water to the system before the next rainy season but will be critical in 2019 if 2018 winter rainfall is poor;
  - City of Cape Town (CCT) cannot reasonably go off-grid from the Western Cape Water Supply System (WCWSS);
  - Out-flows from the system are shown below (maximum calculated evaporation, Cape Town and Agricultural allocations). Unrestricted, the system demand peaks in summer at over 2,500 million litres a day (MLD). Under the current restrictions the seasonal peak is at approximately 1,500MLD.



- Urban restriction currently at 45%;
- WCWSS covers West Coast district municipality and local municipalities of Drakenstein, Stellenbosch and Witzenberg;
- CCT provides water to parts of Stellenbosch and Drakenstein municipalities;
- CCT also manages some of the dams in the WCWSS – Steenbras and Wemmershoek;
- CCT has a number of small dams in its control, with storage capacity of ~4.4Mm<sup>3</sup> (as compared to the WCWSS capacity of 900Mm<sup>3</sup>);
- Domestic use ~ 70% of CCT use;
- Informal settlement use ~4% of water for approximately 15% of households.



### DEMAND MANAGEMENT

To manage daily demand requires that each person should use no more than the defined volume per day, whether they are home, at work or elsewhere. Reaching the overall demand target is only possible if individual use is curtailed.

#### What the City is doing:

- **Restriction Level 6B:** Level 6 was enforced from 1 January 2018, and 6B from 1 February 2018. The target has to be reduced to 450MLD. Daily individual consumption must be limited to a maximum of 50 litres per person per day (pppd) to be aligned with Level 6 tariffs. 4 million people at 50 litres per day = 200MLD. Approximately 150MLD is consumed by industry, commerce, government etc. This results in 100MLD less than the daily target of 450MLD. The inability to adhere to restrictions thus far means that a stretch target is appropriate to ensure that the 450MLD target is reached
- **Communication campaigns:** Every person in the city to realise that this is a crisis. The city has launched numerous communication campaigns to assist people in reducing their consumption, such as household leak detection & repair and how to use 50 litres, and continues to use radio, print and social media to reach every citizen and mobilise to reduce consumption to 450MLD, aligned with 6B restrictions.
- **Pressure reduction:** Pressure reduction was initiated more than a decade ago and has been accelerated to automate zones across the city to optimise the system and reduce demand - especially the impact of leaks. Pressure zones will be used to force down consumption by throttling zones to the extent of partial supply in an effort to adhere to the daily water budget.
- **Household flow regulators:** The city has been installing water management devices to manage debt for many years. The programme has been dramatically ramped up to households who have not reduced consumption to restrict daily household consumption and safeguard against the impact of leaks. In many cases this was due to undetected leaks, but under level 6 restrictions, the city will install these where consumption is higher than 10.5kl/month. A household of 4, each person using 50 litres pppd results in a monthly consumption of 6,000 litres per household. The allowance is per day, whether at home, work or school. Note also that the average household size in Cape Town is 3.2 people. While 6B restricts to 50l pppd, devices will only be fitted above 10.5kl, targeting highest users.
- **Punitive tariffs:** restrictions go hand-in-hand with stepped tariffs, charging more for water use at higher volumes. More punitive tariffs have been introduced on inclining blocks so that higher use of volumes come at an increased cost. Level 6 tariff was introduced on 1 February 2018 where punitive tariff applies to all use over 50 litres per person per day (pppd). Level 6 tariffs are in force from 1 February 2018. Water is still cheap compared to other goods and services, and is supplied to every household. Level 5, 6 & 7 restriction tariffs have been approved by Council in-year thanks to special dispensation from the Minister of Finance.
- **Adaptation:** The city has engaged with large and small business with possible solutions and is working to incentivise reduced consumption. Avenues still to be evolved include usage of private boreholes in the system.
- **Information to drive behaviour change:** we are embarking on making visually available household consumption data to incentivise all households to stay within usage limits (red & green dots).

#### What is happening with Agriculture?

- **Agricultural restriction:** This is currently set at 60%. At the rate of abstraction, agriculture had used 90% of their allocation at 31 January 2018;
- The National Department of Water and Sanitation (NDWS) is responsible for regulating and controlling use, including releasing water for agriculture;
- City of Cape Town has been working with NDWS and the Western Cape Provincial Government to ensure that releases are controlled – as at the end of January, NDWS has stopped releases to those irrigation boards who have reached their allocation increasing confidence that the agricultural restriction target will be met;

#### And other urban areas?

- Similarly to managing agriculture, NDWS is responsible for managing other urban use. The outflow to other urban is relatively small. Cumulatively other urban centres are meeting restrictions even though both Swartland and Overberg are currently exceeding their targeted consumption.

**Both urban and agriculture restrictions must be adhered to - Day Zero will impact on both.**

### EVOLUTION OF THE WATER AUGMENTATION PROGRAM

#### WHERE HAVE WE COME FROM?

##### The Water Resilience Programme

The Water Resilience Program developed in 2017 was based on the assumption that it would not rain again and had a goal of providing 500MLD as fast as possible, without a budget constraint. The project list as at 24 October 2017, shown below, comprised 12 desalination projects, 4 ground water and 6 wastewater reclamation projects.

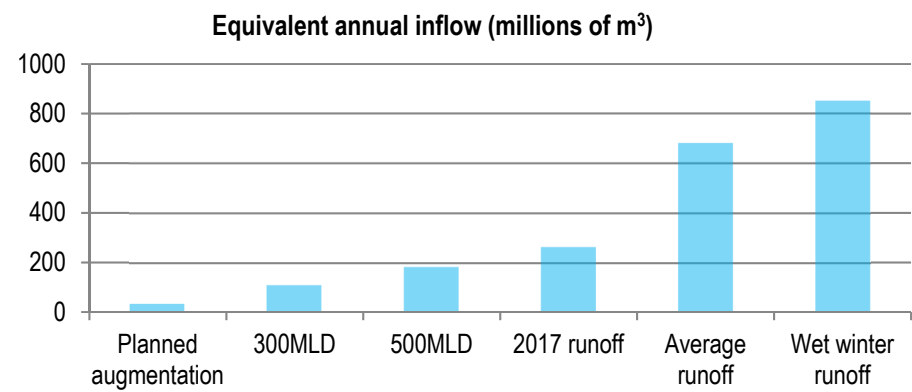
##### Budget constraints and international review

Following a number of Budget strategy meetings within the City in September, October and November 2017, and after the first bids were received for temporary desalination projects in November, the full implications of the programme on the water tariff became more apparent. These meetings coincided with an international review of the program facilitated by National Treasury's Cities Support Programme, undertaken during November. The review advised the following:

Tranche	Solution Type	Sites	Supply (MI)	Solution Total (MI)	Tranche Total (MI)	Total (MI)	
Immediate	Desalination	Hout Bay	4	82	92	504	
	Desalination	Granger Bay	8				
	Desalination	Red Hill/Dido Valley	2				
	Desalination	Strandfontein	4				
	Desalination	Monwabisi	4				
	Desalination	Harmony Park	1				
	Desalination	Cape Town Harbour	50				
	Water Reclamation	Zandvliet WWTW	10				
Tranche 1	Desalination	Cape Town Harbour (Barge)	50	110			
	Ground Water	Atlantis & Silverstroom Aquifer	25				
	Ground Water	Cape Flats Aquifer	25				
	Water Reclamation	Fisantekraal WWTW	10				
Tranche 2	Desalination	Universal Site	20	22	102		
	Desalination	Maide Cove	2				
	Ground Water	Cape Peninsula Aquifer	20	40			
	Ground Water	Matte Mats Holland Aquifer	20				
	Water Reclamation	Peppercorn WWTW	10	40			
	Water Reclamation	Cape Flats WWTW	10				
	Water Reclamation	Bellville WWTW	10				
	Water Reclamation	Macassar WWTW	10				
Extreme	Desalination	Gordons Bay Ship/Barge	150	200	200		
	Desalination	Cape Town Harbour (Ship)	50				

- **Manage demand and dam draw-down.** Assuming it will not rain again is not realistic. Augmentation will not make a significant difference to dam levels this summer and there is therefore no alternative but to ensure effective demand management during this summer. Ensuring agriculture is restricted is very important and the city should also pursue opportunities for water transfers from agriculture. The critical point for dam levels is June 2019 if there is poor rain in the winter of 2018.
- **Prioritise ground water.** Ground water is much quicker to exploit and is cheaper. There is a large resource available. It is possible to over-exploit the groundwater resource in the short-run as part of the emergency, taking future recharge into account.
- **Do not pursue temporary desalination and reuse.** Temporary desalination and reuse is very expensive. Multiple small plants are logistically complex, and are not sustainable. Providing temporary desalination at scale is not a quick solution, It will take longer than planned and anticipated.
- **Do not use ship or barge-based marine desalination plants.** Current experience shows that such plants are very costly and have a poor track record of producing target fresh water quantity due to the source seawater challenges when the plant is docked in ports located in an urbanized or industrial area.
- **Re-use is cheaper than desalination and may be faster to execute.** Pursue the most promising opportunities for re-use in a cost-effective and time-effective way, in parallel to permanent desalination.
- **Pursue permanent desalination at optimal scale.** Plan and execute permanent desalination at a optimum scale, at a plant size or in modules of 120-150 MI/day. Do not build desalination plants of capacity larger than 200 MLD.
- **Procure time and cost-effectively.** A competitively bid turnkey approach for reuse and desalination, using the private sector and with a water purchase agreement, will yield the lowest cost per unit of water compared to the alternatives and be quicker to implement provided regulatory processes are fast-tracked as part of the emergency.
- **Make decisions on the long term now and implement.** Do not delay decisions on permanent reuse and desalination, and implementation.





**REVISED BUDGET AND PROJECT LIST**

Following a request from the City, the Minister of Finance granted an exemption on 27 October 2017 from the provisions of regulation 72(c) of the Municipal Budget and Reporting Regulations and section 28(6) of the MFMA. The exemption applies to the capital needs of the municipality and the associated tariff adjustments in the 2017/18 financial year to allow for the implementation of the water resilience measures to address the short-term drought challenges. The municipality must ensure compliance with all other related processes, including the supply chain management, the adjustment budget processes and the re-prioritisation of capital projects for the 2017/18 and 2018/19 financial years to ensure that the municipality remains within affordable spending levels and service delivery is not compromised. In light of this, Council approved a Section 29 report at its December meeting providing funding for 7 of the 19 augmentation projects out of citywide savings.

Three small temporary desalination projects were retained. A placeholder for a larger scale (120 MI/day) permanent desalination plant was included (detailed plans for this had not been developed at that stage). Budget was provided for 50 MI/day of groundwater from the Cape Flats and Atlantis/Silverstroom aquifers. The total estimated yields at the time of signing the report was 196 MLD with a provision for a further 40 MLD from water trading.

- Of the **12 projects not funded** in the Section 29 report, the status at the beginning of February 2018 is as follows:
- **3** Temporary containerised desalination projects **on hold** – Hout Bay, Granger Bay & Dido Valley;
  - **2** Temporary desalination/reuse projects from the Universal sites tender - **investigating options** to increase yield in the short term at affordable rates;
  - **3** Barge & ship projects (Gordon's Bay and CT harbour) – **not to be further pursued** due to specialist advice;
  - **2** Wastewater re-use projects **which are continuing** but to be funded by the Water & Sanitation budget (Macassar and Cape Flats WWTW);
  - **2** TMG ground water projects **which are continuing** but to be funded by the Water & Sanitation budget (Cape Peninsula and Helderberg).

**WHERE ARE WE GOING? (THE NEW WATER PROGRAMME)**  
**Greater resilience through diversification of water sources**

World class water utilities aim to increase their resilience by diversifying their supply to include a suitable mix of surface, desalinated, re-used and ground water. Supply diversification has been under consideration for a number of years in the City. Ground water is extracted from aquifers that can be managed as underground storage reservoirs. While aquifers are also affected by drought, it is possible to over-extract from aquifers during dry years with recharge during wet years, thus increasing the sustainable yield. The groundwater infrastructure is constructed to accommodate the maximum yield and, with very little cost impact, it is possible to extract significantly larger volumes of water when required. Treated wastewater is used both as a source of potable water (treated to a suitable potable standard) and/or to recharge aquifers. The latter may be a less costly option. Desalinated water offers the only truly new water within the water cycle and, arguably, offers an unlimited supply. Desalination is more energy intensive than reuse and therefore more costly. Because the capital costs of building a desalination plant and the associated infrastructure is very high, it is more cost-effective to run a desalination plant continuously.

**What are forward looking utilities doing?**

1. Desalination – 25% of Water Portfolio
2. Water Reuse – 25 % of Water Portfolio
3. Groundwater Extraction – 25% of Water Portfolio
4. Surface/Dam Water – 25% of Water Portfolio
5. Recharge of Aquifers & Reservoirs by Reclaimed and Desalinated Water in Wet Years
6. Over-pumping of Aquifers During Dry Years

In the past, the Western Cape Water Supply System has relied almost exclusively on surface water sources stored in dams because these are much less expensive than the alternatives (see insert). However, in the context of a highly variable and unpredictable climate, it is not prudent to be so heavily dependent on a single source of water. To become more resilient, both the WCWSS and Cape Town should diversify its sources of water in line with the principles and approach outlined above.

Western Cape Water System Yield	Unconstrained Allocation Mm³	Unconstrained daily demand MLD	Restricted allocation Mm³	Average restricted daily demand MLD
Cape Town	324	888	178	488
Agriculture	144	395	58	158
Other Urban	23	63	13	35
Total	570	1,346	248	681

**Indicative target volumes from diverse sources**

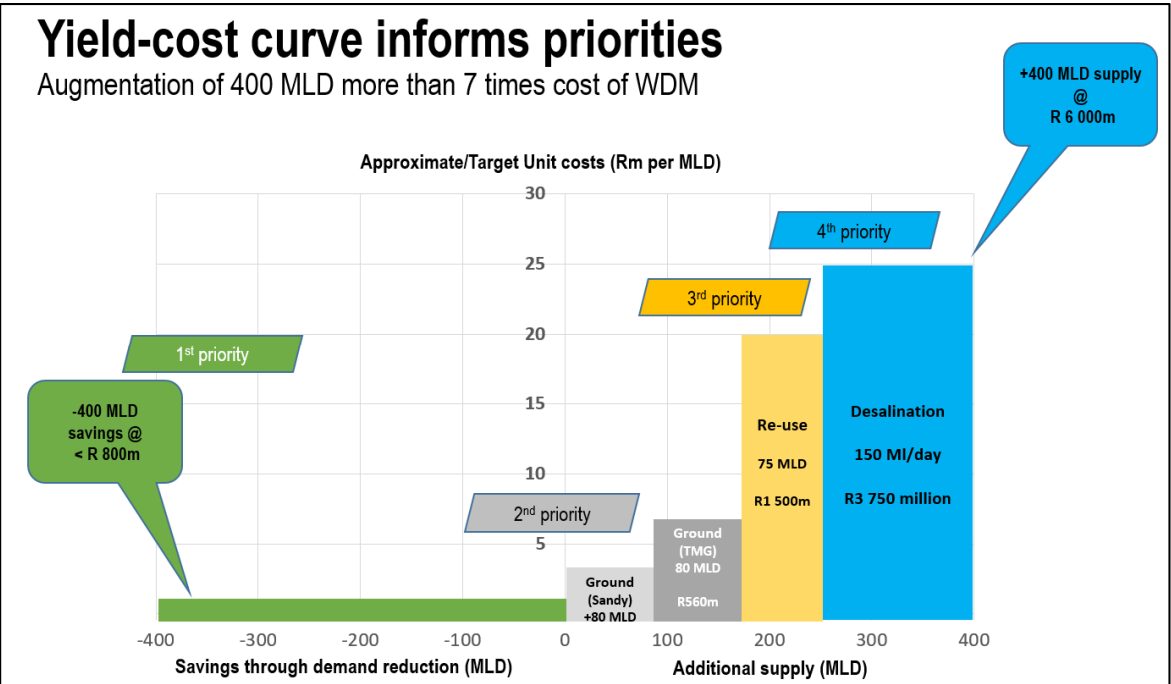
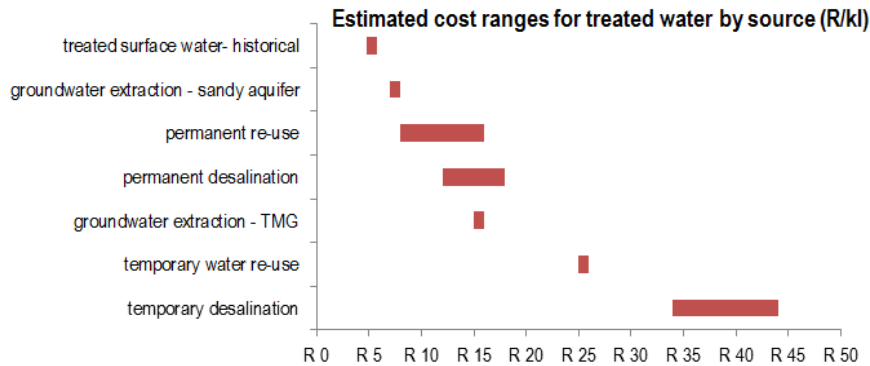
The hydrology informing the system yield from the Western Cape Water Supply System is in the process of being updated. In addition, the Department of Water and Sanitation (DWS), is implementing the Bergriver Voelvrei Augmentation Scheme which is expected to add 23 Mm³ (60MLD) into the WCWSS in 2021. These processes will inform the calculation of the yield from surface water together with the level of assurance. In turn, this information can be used to inform the calculation of the appropriate level of augmentation from groundwater (with recharge), re-use and desalination to provide Cape Town with a much more dependable level of water supply. The City is currently in the process of optimising the extent of the build programme and the figures in the table above are subject to change:

Source	Sustainable yield MLD	Peak yield MLD	Notes
Ground	150	225	About 75 MLD from sandy aquifers (including recharge) and 75 MLD from TMG (no recharge). Over-abstraction from sandy aquifers up to 150 MLD in dry years.
Re-use	75	75	One large re-use reclamation plant (economies of scale)
Desalination	120-150	120-150	Optimal scale for desalination is 120-150 MLD
TOTAL	345-75	420-450	Representing 42% (51% at peak) of unconstrained demand, and 77% (92% at peak) of constrained demand respectively.

Increasing the yield from the diverse sources will also increase the cost of water. An appropriate balance between assurance of supply and the cost of water will have to be found.

**AUGMENTATION**

Non-surface water augmentation schemes are a much more expensive source of water compared to rain-fed dams. Even under very poor rainfall conditions such as that experienced in 2017, the volume of water added to the dams was the equivalent of ~720MLD. For practical reasons Cape Town will continue to rely significantly on surface water dams supplied by rainfall. Reliability of the system will be increased by adding ground water, re-use and desalination. The costs of these schemes (see below) can be compared to the cost of water from dams which is **R5.20/kl**.



Current projects

A list of current augmentation projects is given in the insert. Although the planned scale of ground water abstraction is large, these projects will not materially affect dam levels through to June/July 2018.

Future projects

Water demand in Cape Town will continue to grow as a result of population and economic growth. Providing water from diverse sources in the region of 300 to 450 MLD will increase the city's resilience to periods of drought at the same time as provide for future growth. The greater resilience provided from these diverse sources, with the ability to extract more from aquifers during droughts and to re-charge with other water sources during wet periods, is significant. The impact of climate variability will be continuously assessed and the planned augmentation volume may be increased in future years, in consultation with DWS.

Work is proceeding on a number of water re-use options including Cape Flats (75 MLD), Athlone (75 MLD), Zandvliet (50 MLD) and Macassar (20 MLD). Options for recharge of the Cape Flats aquifer are also being explored.

The optimum site for a 120-150 MLD permanent desalination plant is being explored and a pilot plant at Koeberg (20 MLD) is being constructed which will inform the design for a larger desalination plant at that site in the future.

CAPE TOWN'S CURRENT AUGMENTATION PROJECTS

Projects under construction or completed:

- Groundwater (~150MLD)**
- Cape Flats aquifer (~80 MLD) underway (incremental);
  - Atlantis aquifer, 5MLD refurbished and ±20MLD underway;
  - TMG aquifer (~80 MLD) underway (incremental).

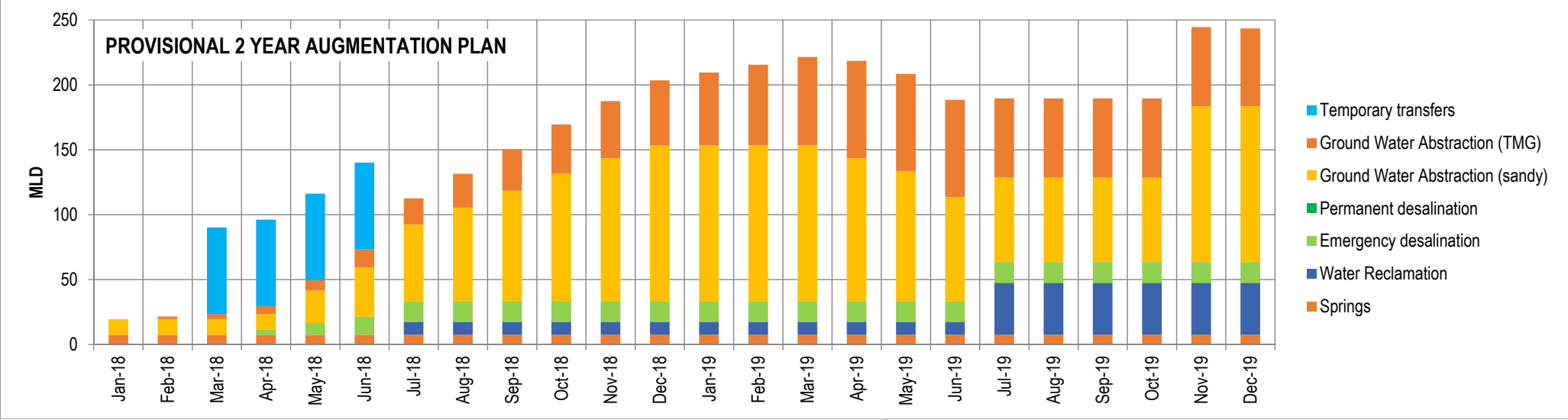
- Water transfers (60 MLD over four months)**
- 8 Mm³ from Groenland Water User Association, on track;
  - Future transfers will be investigated.

- Temporary desalination (16MLD)**
- Strandfontein, 7MLD, full production in May 2018;
  - Monwabisi, 7MLD, full production in May 2018;
  - V&A, 2MLD, full production in March 2018.

- Water re-use (10 MLD)**
- Zandvliet, temporary, full production in June 2019.

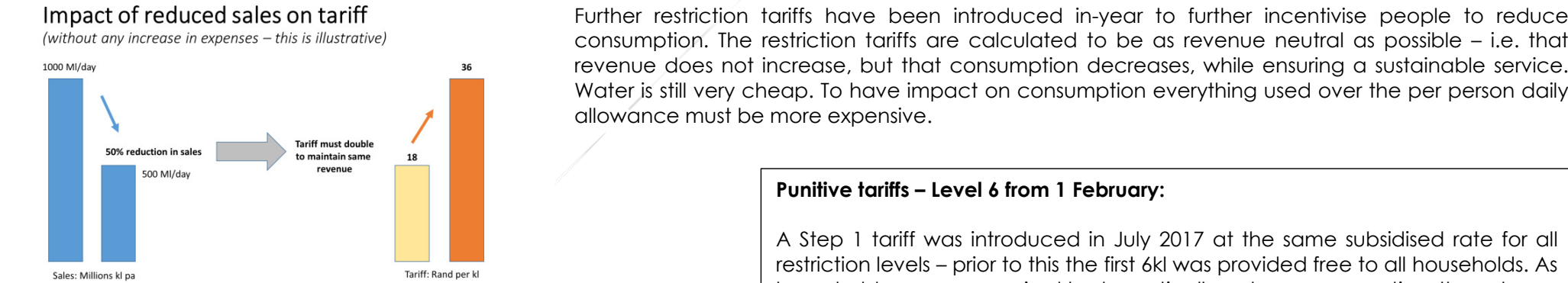
- Springs (4 MLD)**
- Newlands – Albion spring in operation at ~3MLD. We aim to add all feasible springs into the reticulation system which will increase the volume;
  - Oranjezicht – routed 1MLD into the system, looking at other springs.

For the reasons above, the augmentation programme for the next 2 years is shown below:



FINANCE

As the cost of raw water is low, the cost of providing the service remains virtually the same despite the dramatic drop in volume/sales and concomitant drop in revenue. Water & Sanitation should operate as a trading service, i.e. revenue should cover the cost of providing the service. A drought charge was proposed to cover the shortfall in revenue to fund the operations of providing reticulated water and sanitation to customers.



Existing Restriction tariffs (Water)						
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Step 1 [0-6kl]	4.00	4.00	4.00	4.00	18.75	26.25
Step 2 [6-10.5kl]	15.57	15.57	15.57	15.57	26.25	46.00
Step 3 [10.5-20kl]	18.22	20.04	21.87	22.78	46.00	100.00
Step 4 [20-35kl]	26.99	32.65	36.43	38.32	100.00	300.00
Step 5 [35-50kl]	33.33	45.00	61.66	99.99	300.00	800.00
Step 6 [+50kl]	43.97	97.71	209.29	265.12	800.00	800.00
Commercial	19.63	21.59	23.55	24.54	37.50	50.00

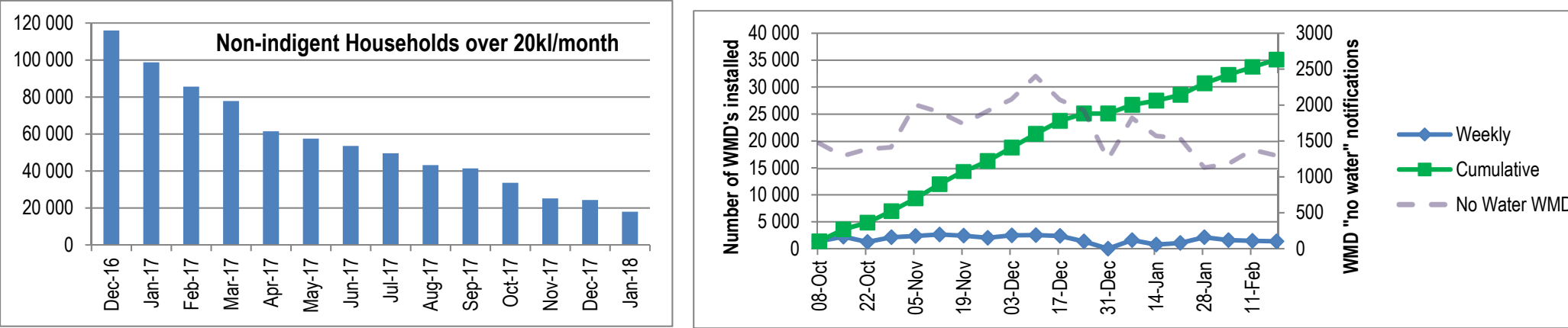
Punitive tariffs – Level 6 from 1 February:

A Step 1 tariff was introduced in July 2017 at the same subsidised rate for all restriction levels – prior to this the first 6kl was provided free to all households. As households are now required to dramatically reduce consumption, the volumes in higher usage steps have shrunk considerably.

Level 6 tariff is designed on 50l pppd to reach overall demand below 450MLD, for a household of 4, all water above 6kl is significantly more expensive. Step 1 & 2 (up to 10.5kl per month) will still be provided as free service to indigent households at Level 6.

Level 7 tariffs will be applicable only once points of distribution (PODs) are operational.

**CONSUMPTION CONTROL:** the city would have been able to manage household consumption through smart metering – similar to electricity, where one could use pre-paid metering or remote monitoring and controlling. The reality is that water has always been too cheap for this to be viable, and although the city has installed approximately 240,000 water management devices over the past decade, the programme has not been without problems. Household demand has declined significantly with just over 18,000 non-indigent households exceeding 20kl/month at end January (based on actual meter readings). Since acceleration in installation from beginning October 2017, we have installed approximately 2,000/week, and dealt with a concomitant increase in no water service requests.

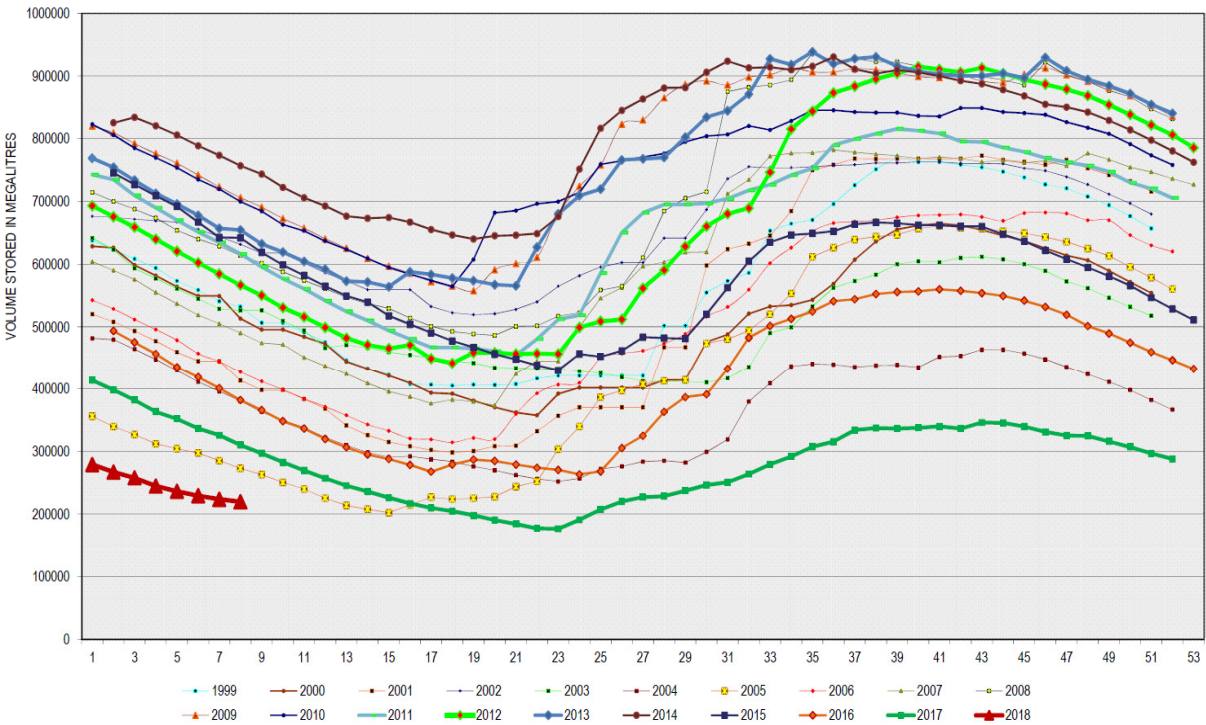




DAM MODEL

Dam levels have been tracked for many years – for the first months of the year (summer), levels drop, and increase again once the rainy season starts. The 2017 dam behaviour can be seen plotted against that of the past 20 years. We continue tracking dam levels by measuring the actual levels, and forecasting future dam levels by subtracting evaporation, agricultural and urban use. As we are not expecting any rain between now and May 2018, we can confidently predict dam levels at various stages of the coming months if we adhere to the restrictions. If we don't adhere, then dam levels will drop too quickly and we will not reach the rainy season. Currently, levels are dropping at below 1% per week. In January 2017 this peaked at 1.7% per week, in January 2018, at 1.4%. We simply cannot afford such a rapid drop in level.

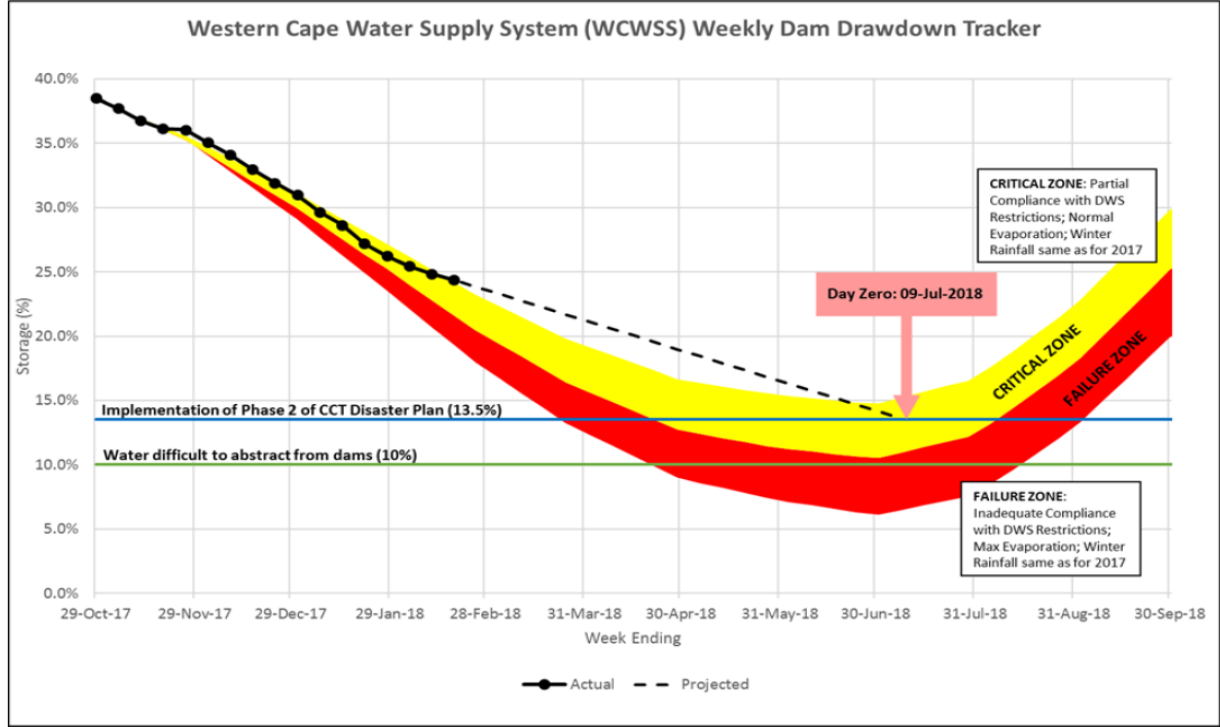
Assumptions in dam behaviour are conservative and assume extreme evaporation, and rainfall mirroring that of 2017. Rainfall was exceptionally low - and late. By varying the anticipated demands of agriculture and urban use, the percentage reached before the impact of the rainy season is evident can be seen below.



In simple terms some sample calculations are shown below, based on dam levels at the start of the hydrological year, 1 November 2017:

Starting volume 1 Nov = percentage x total volume  
= 38.4% x 900,000 Million cubic metres  
= 345,600 Mm<sup>3</sup>

Starting volume 1 Dec = actual starting volume 35.6% of 900,000 Mm<sup>3</sup>  
= 345,600 – Agricultural use – urban use – evaporation + rainfall + streamflow + runoff  
= 320,400 Mm<sup>3</sup>



Providing additional water is part of the emergency, medium and long term planning, but the only way to protect the supply scheme from running dry at this stage is reducing demand.

To this end, the NDWS imposes restrictions. The current restrictions, if adhered to, will result in the dams reaching a minimum of 15% before the rainy season. Outflow is seasonal given that more water is used in the agricultural growing season, and in summer for evaporation and urban. As we do not know when the rainy season will start, or how much rain is likely to fall in the catchment areas, we must use even less water than the restriction levels demand.

It is evident that failure will occur unless demand is consistently curtailed to meet the overall restrictions. Day Zero is tracked and updated weekly as shown on the left. The modelling is conservative given the lack of direct control that the City has over the variables which affect dam levels.

As agricultural releases have in large part ceased, it appears that the agricultural restriction will be met. The graph below tracks Cape Town demand. The yellow line is an extrapolation of year to date use which achieves 39% savings. While we are not quite meeting the usage target 4 months into the hydrological year, with the current demand management measures in place, the 45% restriction will be met by the end of the year (as shown by the green dotted line).

NEXT STEPS

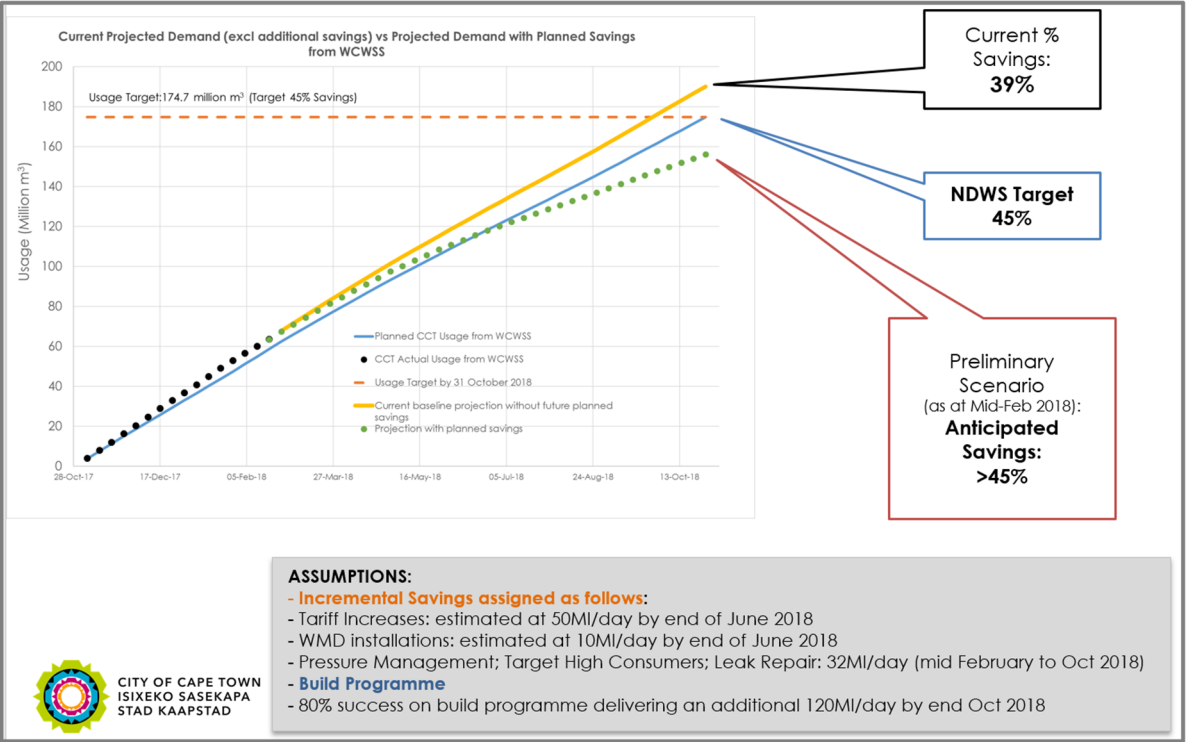
1. Decisions under consideration by the City on:

- Optimal approach to adding re-use capacity + decision + implementation;
- Location of 120-150 MI/day desalination plant + decision + implementation;
- Procurement model to be used & possible use of external capacity to assist with procurement and contract management;

2. It is imperative that some re-use and desalination is brought on line at a suitable scale quickly. This will require continued fast tracking of procurement and regulatory processes as part of the drought emergency;

3. Financial impacts in future are still uncertain, but will be substantial as a result of reduced & uncertain future sales combined with increased costs;

4. Improved coordination and strong leadership within and between spheres of government is needed, particularly to fast-track regulatory and procurement processes.



We must make up the shortfall immediately by limiting consumption to 50l pppd under Level 6B restrictions, while we continue physically restricting above 10.5kl/household. We need to publish, track and adhere to our water budget to meet our restriction target. While it requires every individual, household and business to make up the shortfall, the City will progressively reduce pressure in zones which will result in water not being available at all households all the time. We have fast-tracked automating pressure control and obtaining integrity of all zones which will enable such reduction, and will reduce aggressively as each zone allows.

Limiting individual and household consumption is far preferable than the Day 0 scenario of households collecting water from PODs and risk failure of the sewerage network. The department remains committed to ensuring that demand is driven down sufficiently to ensure that Day zero is not triggered during this summer.