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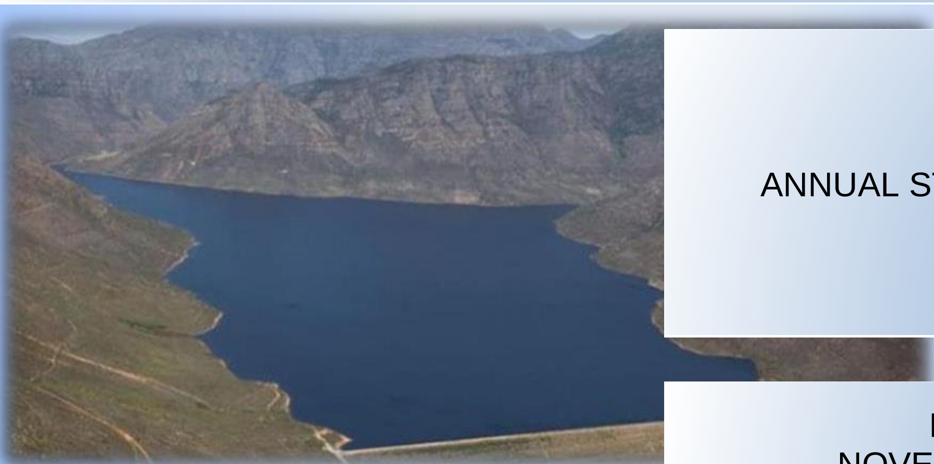
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

THE SUPPORT FOR THE IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR THE WESTERN CAPE WATER SUPPLY SYSTEM
WP11179



ANNUAL STATUS REPORT

FINAL
NOVEMBER 2018

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THE SUPPORT FOR THE IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR THE WESTERN CAPE WATER SUPPLY SYSTEM

ANNUAL STATUS REPORT

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Report to the Strategy Steering Committee

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This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa. 2018. Support for the Implementation and Maintenance of the Water Reconciliation Strategy for The Western Cape Water Supply System: Annual Status Report - November 2018. Prepared by NFM Multi Consulting/Tlou Consulting (Pty) Ltd Joint Venture in association with Aurecon South Africa (Pty) Ltd on behalf of the Directorate: National Water Resource Planning

DEPARTMENT OF WATER AND SANITATION

Directorate|: National Water Resource Planning

The Support for The Implementation and Maintenance of the Water Reconciliation Strategy for The Western Cape Water Supply System

APPROVAL

REPORT TITLE	:	Annual Status Update 2018
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REPORT STATUS:	:	Final
DATE:	:	November 2018

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DOCUMENT CONTROL							
Report title		Annual Status Update 2018					
Project number		WP 11179					
Client		Department of Water and Sanitation		**Client contact**	Mr TS Makombe		
Rev. No.	**Date**	**Revision Status**	**Revision details**	**Author**		**Verifier**	**Approver**
01	26 October 2018	Draft 1	Internal review	A Singh T Tlou		T Tlou	T Tlou
02	28 October 2018	Draft 2	Internal review	A Singh T Tlou E v/d Berg		T Tlou	T Tlou
03	14 November 2018	Draft 3	Incorporation of comments from ATSG #3 – 31 October 2018	A Singh T Tlou E v/d Berg		T Tlou	T Tlou
04	29 Jan 2019	Draft 3.1	Incorporation of comments from DWS – 24 Jan 2019	A Singh T Tlou E v/d Berg		T Tlou	T Tlou
05	2 May 2019	Final	Incorporation of comments from DWS – 2 May 2019	A Singh T Tlou E v/d Berg		T Tlou	T Tlou

APPROVAL			
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ACRONYMS	
AOA	Annual Operating Analysis
AsgiSA:	Accelerated and Shared Growth Initiative for South Africa
BGCMA	Breede-Gouritz Catchment Management Agency
BRBS	Breede River Basin Study
BRVAS	Berg River-Voëlvlei Augmentation Scheme
BWP	Berg Water Project
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CSAG	Climate Systems Analysis Group
CSIR	Council for Scientific and Industrial Research
EWR	Ecological Water Requirements
FSL	Full Supply Level
GAADD	Gross Average Annual Daily Demand
GFCF	Gross Fixed Capital Formation
HFY	Historical Firm Yield
IAP	Invasive Alien Plants
LTAS	Long-term Adaptation Scenarios
LTY	Long-Term Yield
MLD	Mega Litres per Day
PMZ	Pressure Management Zone
PwC	PriceWaterhouseCoopers
RI	Recurrence Interval
SIV	System Input Volume
SOF	Stakeholder Operating Forum
TCTA	Trans Caledon Tunnel Authority
TMG	Table Mountain Group

ACRONYMS	
URV	Unit Reference Value
WAAS	Water Availability Assessment Study
WC/WDM	Water Conservation and Water Demand Management
WCWSS	Western Cape Water Supply System
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WMD	Water Management Device
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works
WUA	Water User Association

EXECUTIVE SUMMARY

Introduction

The first reconciliation strategy for the Western Cape Water Supply System (WCWSS) was initiated by the Department of Water and Sanitation together with the City of Cape Town in 2005. The Reconciliation Study was aimed to facilitate the reconciliation of predicted future water requirements with available water in the WCWSS for a 25-year planning horizon. The Strategy is used as a decision support framework for making timeous and informed recommendations on water resource interventions that should be implemented to meet the future water requirements. The strategy has since that first study been regularly reviewed and updated to ensure its relevance in planning.

The 2017/2018 review and updating of the Water Reconciliation Strategy has been conducted and presented in this report.

Overview of the WCWSS

The WCWSS (Figure 1) is an integrated and collectively managed system of dams, pump stations, pipelines and tunnels. In addition to servicing Cape Town, the system supplies water to towns in the Overberg, West Coast and Cape Winelands District Municipalities as well as providing irrigation water for agriculture. The integrated system helps optimise the use of water resources in the region as it allows water to be transferred between dams and catchment systems to service various demand centres.

The major dams in the Supply System include the Theewaterskloof Dam in the Breede River catchment and the Voëlvlei, Berg River and Wemmershoek Dams in the Berg River catchment, and the Steenbras Upper and Lower Dams in the Steenbras River. In addition, there are a number of smaller dams and weirs, including the Department of Water and Sanitation's Kogelberg and Rockview Dams which serve Eskom's Palmiet Pumped Storage Scheme and the water transfer scheme to the Upper Steenbras Dam, Kleinplaas Dam on the delivery route of the Riviersonderend-Berg River Tunnel System in the Eerste River and Misverstand Weir on the lower Berg River.

Population Demographics and Socio-economic profile

The population in the WCWSS has grown over the ten-year period between the 2001 and 2011 census at an average annual growth rate of 2.7% per annum, declining to 1.7% per annum between 2011 and 2016. The City of Cape Town comprises 79.7% of the population, with the West Coast District Municipality and the Drakenstein Local Municipality contributing 6.3% and 5.6% of the total population respectively.

The socio-economic profile of the area was found to be the main motivating factor of mainstream migration, particularly to the City of Cape Town, while environmental factors contributed to the migration decision, particularly of migrants aged older than 50 years to the coastal areas. Approximately 31.3% of the in-migrants live in informal dwellings, thus potentially requiring formal housing and associated services such as water service provision.

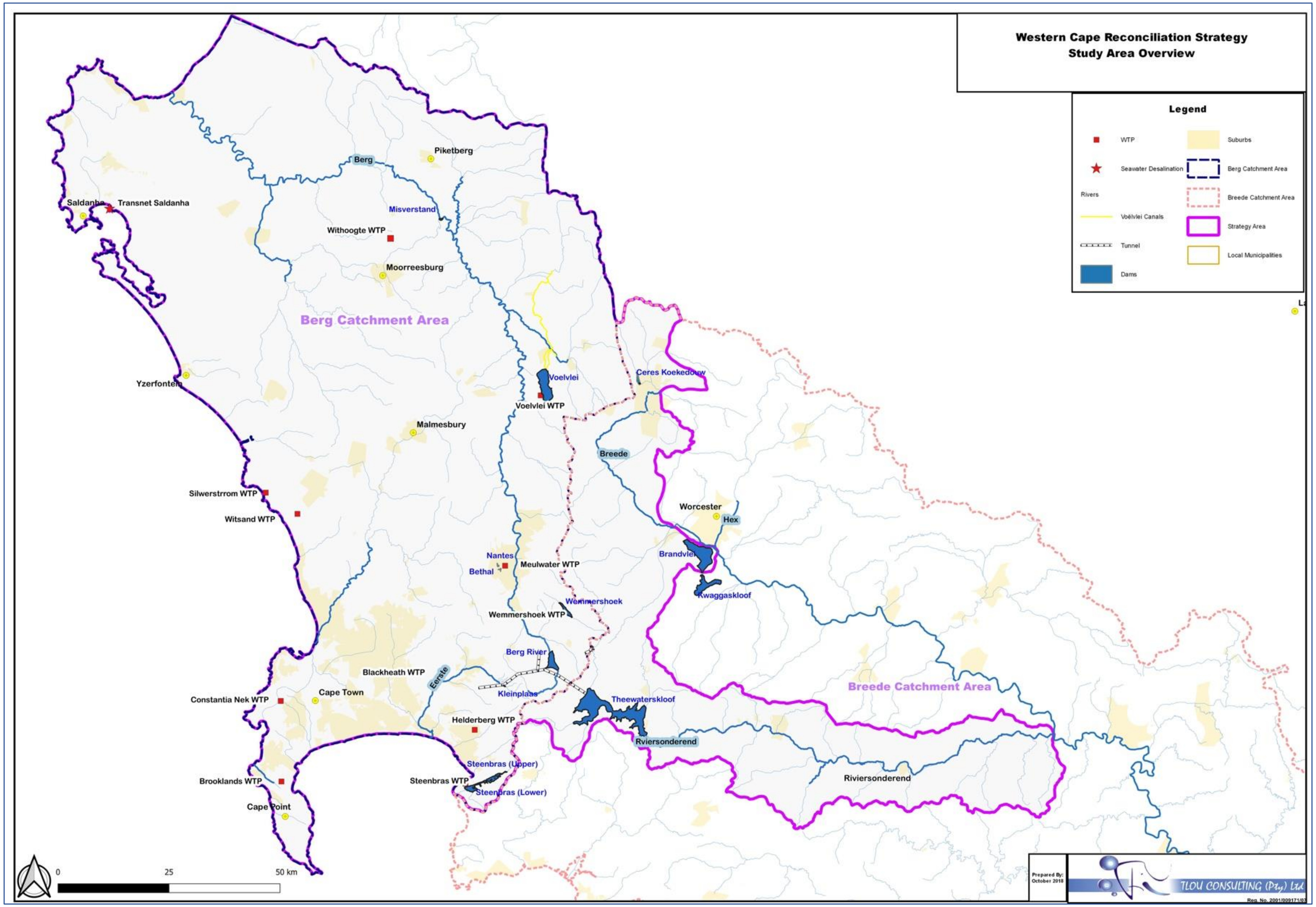

Figure 1. Map of WCWSS

The estimated population projection for the WCWSS is provided in Figure 2.

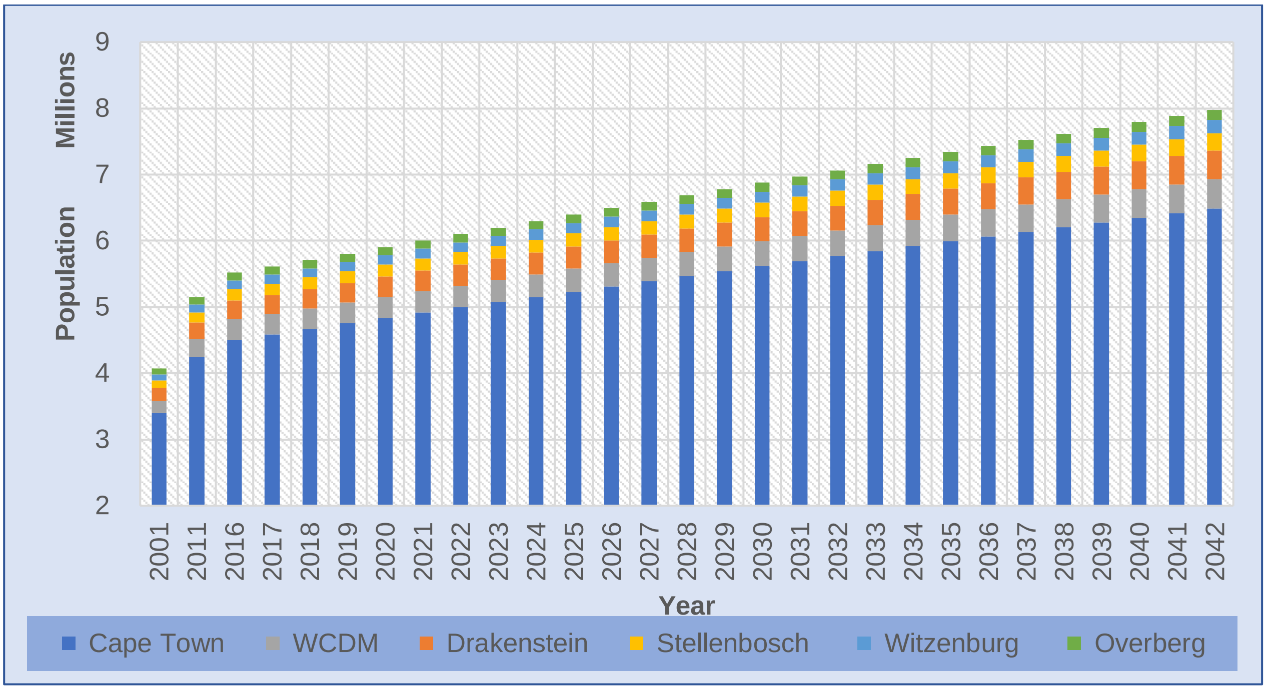

Figure 2. Population projection for the WCWSS

The projection, in the case of the City of Cape Town has been based on the study they have commissioned to update the population projections from 2017 to 2040. This study projects that the population will grow from 4 million in 2017 to 5.8 million in 2040, with an annual average population growth rate over the period of 1.7% per annum. The growth is envisaged to decline from 2.0% in 2017 to 1.2% per annum in 2040.

Growth in population in the West Coast District Municipality was premised on the population growth in the Saldanha Bay, Bergrivier and Swartland Local Municipalities, that was extracted from their Socio-Economic Profile and Integrated Development Plans. The population in the District is expected to grow from 0.3 million in 2017 to 0.4 million in 2042 at an average annual growth rate of 1.3%.

Population in the Drakenstein Local Municipality is expected to grow at an annual average growth rate of 1.7% per annum from 0.3 million in 2017 to 0.4 million in 2042, with the population centred in the major urban centres of Paarl and Wellington.

Population projection in the Stellenbosch Local Municipality was based on the annual reports of the Municipality. The population was projected at 1.84% per annum between 2016 and 2020, with a declining growth rate to 2042 and a total population of 0.3 million. The annual average growth rate for the period between 2016 and 2042 was 1.6%.

The growth in population for the Witzenberg Local Municipality was based on the Socio-Economic Profile and Integrated Development Plans 2018-2019. The population which is largely rural, is expected to grow from 0.1 million to 0.2 million in 2042, at an annual average growth rate of 1.6% per annum.

The population of Theewaterskloof is projected to growth at an average annual growth rate of 0.9% from 0.1 million in 2016 to 0.15 million in 2042.

Besides the population growth and changes in the socio-economic factors, the trends in the economic growth will have an impact on the future water requirements forecasting. Tourism, agri-processing and the oil and gas sectors are strategic priority areas for the WCWSS. The economic growth forecast for the high growth scenario was based on the Accelerated and Shared Growth Initiative for South Africa (AsgiSA) target of 6%, which remains an aspirational target, but one that has never been achieved. An economic growth forecast of 4.5% was applied to the WCWSS strategy update.

Historic and Current Water Use Requirements

The main source of supply in the WCWSS is the surface water resources. The extent of groundwater abstraction and use is not obvious as groundwater abstraction records are not readily available for many of the areas.

The largest user in the Supply System is the domestic sector followed by agriculture and industry.

Figure 3 provides a representation of the historical urban water use in the WCWSS. The City of Cape Town has the largest domestic water requirement at approximately 80% of total water requirement. Besides supplying users in the Metropolitan, the City is a major bulk water seller to the West Coast District and Stellenbosch and Drakenstein Municipalities.

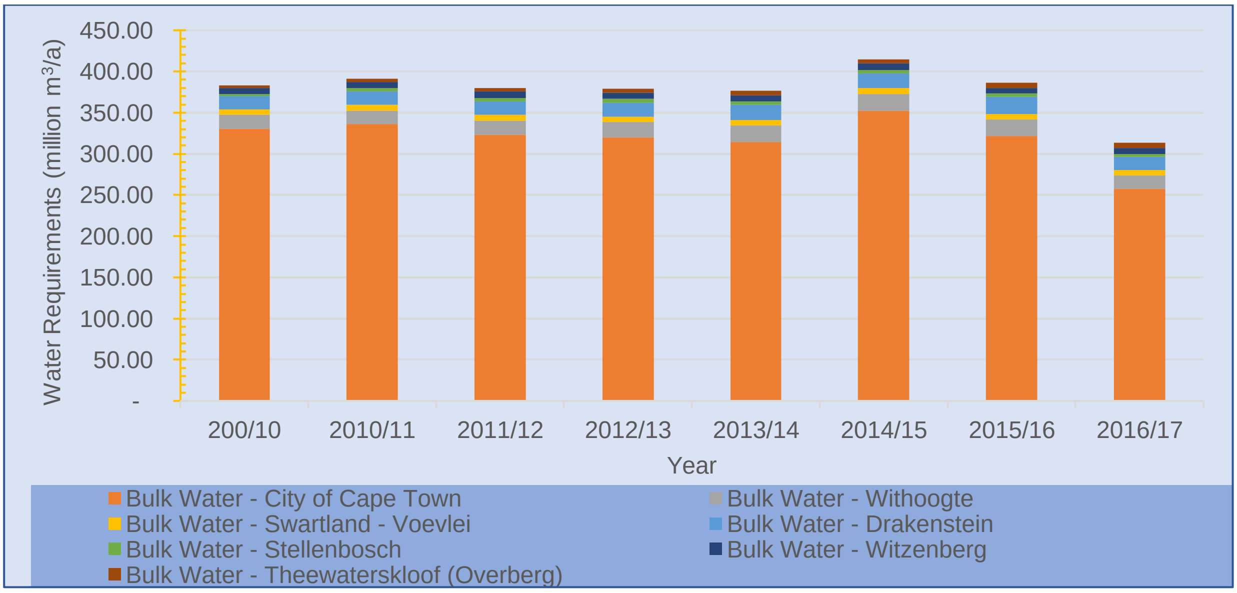

Figure 3. Historical urban water requirements

Although the total water requirements increased since 2007, the gross average per capita consumption decreased by 0.44% since 2010 to 227 l/c/d in 2015. This can be attributed to successful implementation of water conservation and water demand management (WC/WDM) measures.

Figure 4 illustrates the historic water use by the agricultural sector between 2010 and 2017. The total allocations to agriculture as set in the Raw Water Supply Agreement was 162 Mm^3/a. There has been no finalisation as to the actual total water allocation for irrigation agriculture. A discussion between the PSP, the irrigation sector and the Department of Water and Sanitation Western Cape Region will be held to try and achieve consensus on the water allocation to the irrigation sector. According to the irrigation agriculture sector, the total verified scheduled area for irrigation in the WCWSS is provided in Table 2. The sector has been allocated more water since the Raw Water Supply Agreement, with the current allocation approximately 193 Mm^3/a.

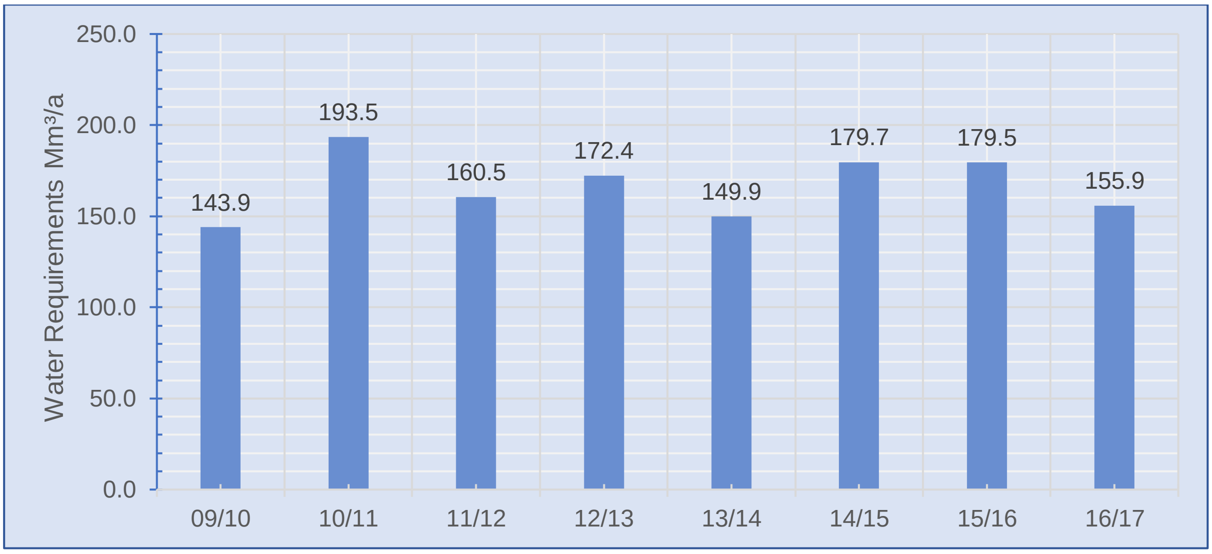

Figure 4. Historic agricultural water requirements

Table 1: Irrigation scheduled areas and irrigation quota

Resource	**Irrigation Board/ Water User Association**	**Verified water allocation**	**Quota m³/ha/a**	**Volume (m³/a)**
Berg	Berg River Subdistrict 1	3 571	4 000	14 285 200
	Berg River Subdistrict 2	4 227	5 000	21 134 500
	Berg River Subdistrict 3	3 003	6 000	18 019 200
	Suid-Agter Paarl	867	4 000	3 468 000
	Simondium	243	4 000	972 000
	Simonsberg	125	4 000	500 000
	Perdeberg	1 324	5 000	6 620 000
	Noord-Agter Paarl	970	5 000	4 848 500
	Groenberg Ward 1	211	5 000	1 056 000
	Groenberg Ward 2	119	5 000	597 000
	Riebeek Kasteel	224	6 000	1 344 000
	Riebeek West Ward 1	115	6 000	690 000

Resource	***Irrigation Board/ Water User Association***	***Verified water allocation***	***Quota m^3/ha/a***	***Volume (m^3/a)***
	Riebeek West Ward 2	*135*	*6 000*	*810 000*
	Lower Berg River	*3 657*	*5 000*	*18 283 000*
	Lower Berg River	*2 015*	*7 000*	*14 105 000*
Total Berg		*20 806*	*77 000*	*106 732 400*
Stellenbosch tunnel	*Wynland WUA*	*6 531*	*4 000*	*26 124 400*
Total Stellenbosch tunnel		*6 531*	*4 000*	*26 124 400*
Riviersonderend	*Zonderend*	*6 017*	*6 000*	*36 102 000*
	Vygeboom	*1 863*	*7 100*	*13 227 300*
Total Riviersonderend		*7 880*	*13 100*	*49 329 300*
Theewaterskloof Dam	*Theewaterskloof Dam*	*1 564*	*7 100*	*11 105 820*
Total Theewaterskloof		*1 564*	*7 100*	*11 105 820*

Future Water Requirements

Five future water requirement scenarios were developed for the domestic sector, based on various factors, such as population growth, socio-economic conditions and the economy as well as the current water restrictions. Furthermore, scenarios were also developed for the agricultural sector. Table 1 provides a description of the scenarios that were considered in establishing the future water requirements for the Western Cape Water Supply Scheme.

Table 2. Future water requirement scenarios

Scenario	*Scenario Description*	*Water Requirement by 2042 (million m^3/a)*
Domestic Sector		
Scenario 1	*2.0% growth rate at current per capita water use*	*661.44*
Scenario 2	*2.0% growth rate with additional water conservation and demand management*	*582.26*
Scenario 3	*Low growth scenario at 1.2% per annum*	*517.19*
Scenario 4	*Historical growth Scenario with an average annual growth rate of 1.73% per annum*	*603.33*
Scenario 5	*High growth scenario – initial growth rate of 2.65% per annum over the first 10 years*	*690.53*
Agricultural sector		
Scenario 1	*Agriculture growing to full allocation of 193 Mm^3/a in 5 years, thereafter remain capped*	*193**
Scenario 2	*Agriculture growing to full allocation of 193 Mm^3/a in 7 years, thereafter remain capped*	*193*
Scenario 3	*Agriculture growing to full allocation of 193 Mm^3/a in 10 years, thereafter remain capped*	*193*

** Agriculture allocation subject to validation and verification*

Figure 5 provides the total projected water requirements for the WCWSS based on the various scenarios for both the domestic and agricultural sectors.

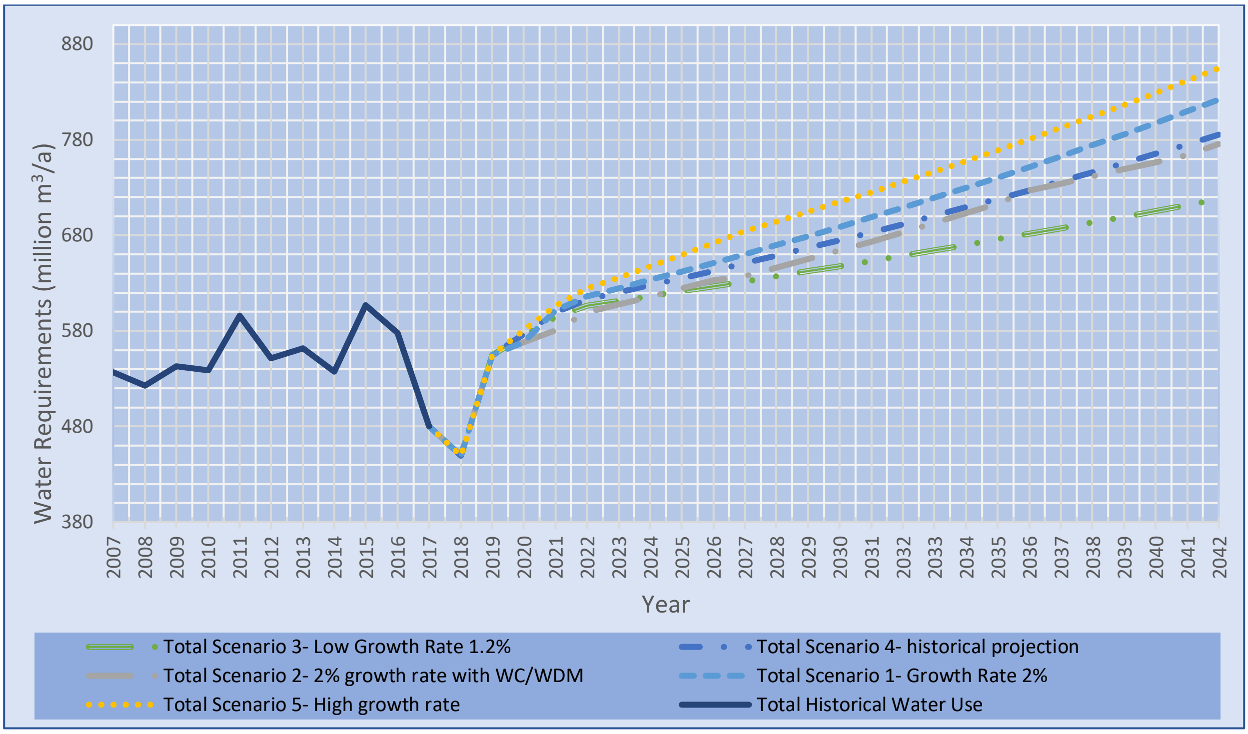

Figure 5. Project total water requirements for the WCWSS

Water Availability

The extension of the hydrology and updating of assumptions used to model the WCWSS has shown that the 1:50 year stochastic yield of the System has reduced by approximately 35 million m³/a to 545 million m³/a. The decrease in system yield has resulted in the System being over allocated. A significant contributor to the reduction in yield of the system was the spread of alien invasive plants, which if not managed could potentially lead to further reductions in the system yield.

Water Balance

Table 2 provides the description of the water balance assessment scenarios developed for the WCWSS and the anticipated future water requirement based on each scenario.

Table 3. Water balance assessment scenarios

Scenario	*Description of scenario*	*Future water requirement in 2042 (million m³/a)*
Scenario 1	*Future water requirements are based on a 2.0% growth rate.*	*821.67*
Scenario 2	*Future water requirements are based on 2.0% growth rate with the implementation of additional water conservation and demand management intervention options*	*775.26*
Scenario 3	*Future water requirements are based on a low growth scenario of 1.2% growth rate.*	*717.53*
Scenario 4	*Future water requirements are based on historical growth at 1.73%, with sustained 2015 water conservation and demand management levels.*	*785.05*

Scenario	*Description of scenario*	*Future water requirement in 2042 (million m^3/a)*
Scenario 5	*Future water requirements based on 2.65% growth rate, with sustained water conservation and demand management levels.*	*854.44*

The starting value for scenario projections have a very significant influence. Projecting from low annual water use values, as a result of drought conditions, can result in low projections that are often not realistic for longer-term planning. Following drought years, there tends to be a bounce-back of water use, which can vary depending on circumstances. To allow for this, the projected water requirement growth scenarios has a starting value in 2018 for projection that is equal to that of the 2015 water use to eliminate the constraining of projected demands as a result of water restrictions due to the recent drought. This also ensures that the level of water use efficiency in the Supply System as prevalent in 2015 is carried through into the projections.

2018 Reconciliation Strategy

For the planning of the future bulk water resource infrastructure requirements, Scenario 1 and Scenario 2 are considered the most realistic future water requirements.

Figure 6 and Figure 7 provide the reconciliation of water supply and requirements for the two scenarios.

In both of these scenarios, additional water resources will be required by 2021. This provides limited time to plan and implement major water resource infrastructure without fast tracking the programme.

Planning to meet the water requirements for this scenario requires the implementation of the following interventions:

- *Implementation of the Table Mountain Group Phase 1 and Cape Flats Aquifer Phase 2, by 2019/2020.*
- *Implementation of the Atlantis Aquifer to obtain first water towards the end of 2020.*
- *Implementation of the Invasive Alien Vegetation (IAP) removal to improve the yield of the system from 2020 onwards. This should be a continuous programme as follows:*
    - *Phase 1 is to stabilise the yield of the WCWSS*
    - *Phase 2 will be to improve the yield by removal of invasive alien plant.*
- *Optimise the management and operation of the WCWSS by refurbishing existing bulk infrastructure and improving the annual operating rules through the curtailment rules, in order to improve system yield.*
- *Development of the Berg River – Voëlvlei Augmentation Scheme (BRVAS) Phase 1 by 2022. If this intervention option is not implemented by then, there is a very high probability of water restrictions, even with normal rainfall in the system.*
- *The Breede-Berg River Transfer Scheme (BBTS) to provide first water by 2030.*

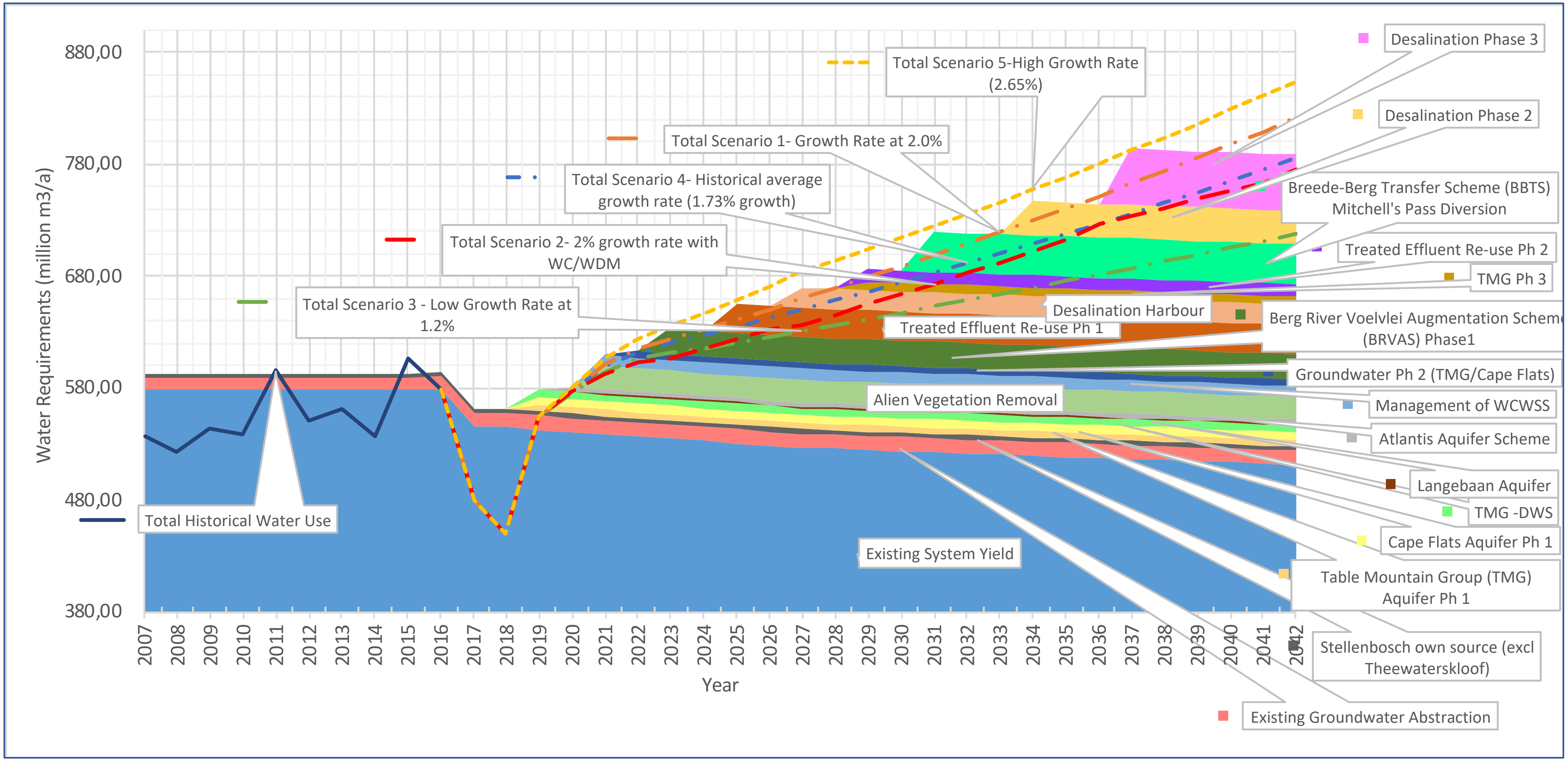

Figure 6. Reconciliation of water supply and requirement for Scenario 1 (2% growth rate)

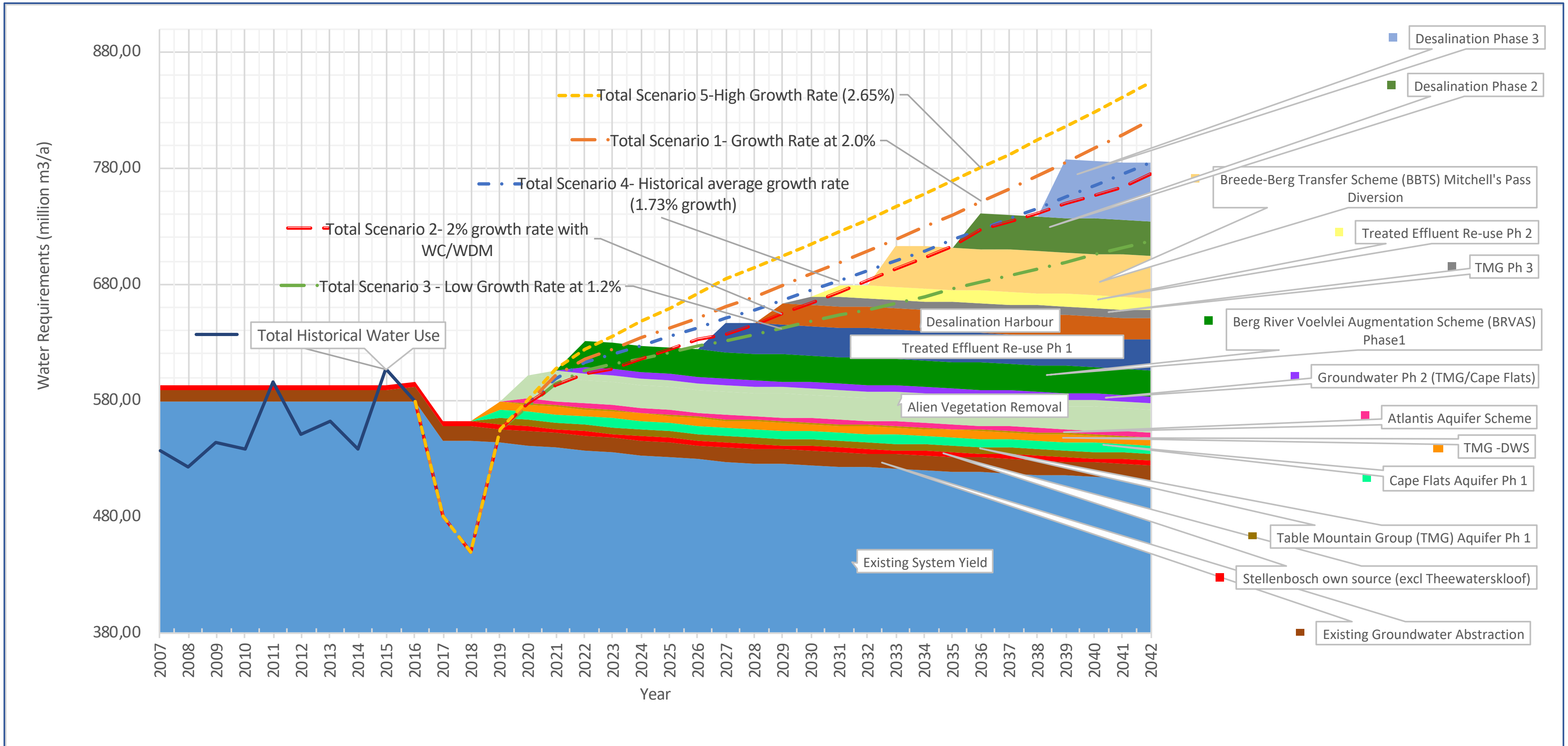

Figure 7. Reconciliation of water supply and requirement for Scenario 2 (2% growth rate with WC/WDM)

The following has been factored in the development of the potential implementation programme for Scenario 2:

- *Implementation of the Table Mountain Group Phase 1 and Cape Flats Aquifer Phase 2, by 2019/2020.*
- *Implementation of the Atlantis Aquifer to obtain first water towards the end of 2020.*
- *Implementation of the IAP removal to improve yield of the system from 2020. onwards. This should be a continuous programme as follows:*
    - *Phase 1 is to stabilise the yield of the WCWSS*
    - *Phase 2 will be to improve the yield by removal of invasive alien plant*
- *Optimise the management and operation of the WCWSS by refurbishing existing bulk infrastructure and improving the annual operating rules through the curtailment rules, in order to improve system yield.*
- *Development of the Berg River – Voëlvlei Augmentation Scheme (BRVAS) Phase 1 by 2022, even with implementation of WC/WDM interventions. If this intervention option is not implemented by then, there is a very high probability of water restrictions even with normal rainfall in the system.*
- *Implementation of further WC/WDM interventions will delay implementation of subsequent bulk water infrastructure options by between 3 to 5 years.*
- *The Breede-Berg River Transfer Scheme (BBTS) to provide first water by 2033.*

Conclusion

The available water supplies will be exceeded by 2019 under unconstrained demand. Based on currently available information, the only intervention that can move to immediate implementation is the Berg River-Voëlvlei Augmentation (BRVAS) (Phase 1). The earliest that implementation can be achieved is 2021, and therefore other interventions have to be identified to address the shortfall in the interim.

Identified short-term intervention measures include the following:

- *Development of the TMG and Cape Flats Aquifers to provide the current and future water requirements to the City of Cape Town. This must proceed as planned for implementation by 2019-2020.*
- *Development of the Langebaan Road Aquifer by Saldanha Bay Local Municipality to supplement the water by the West Coast District Municipality.*
- *Feasibility studies for the development of reuse systems which is currently being undertaken by the City of Cape Town.*

Decisions on the next series of augmentation options cannot be postponed further.

The identified interventions and programme for implementation will need to be regularly updated as more information becomes available, for example from feasibility studies and cost benefit analyses.

Recommendations

Table 3 provides the recommended intervention measures emanating from the Strategy Update and the responsible organisation to take the recommendation further.

Table 4. Programme for implementing recommended intervention measures

Recommendation	Responsible Organisation	Implementation Date
Address the current over-allocation in the WCWSS through either compulsory licensing or reviewing the curtailment rules	*Department of Water and Sanitation/SSC*	*Immediate*
Implementation of the Berg River-Voëlvlei Dam Augmentation project and appointment	*Department of Water and Sanitation*	*Immediate*

Recommendation	*Responsible Organisation*	*Implementation Date*
of a Professional Service Provider for the detailed design.		
Groundwater development from the Table Mountain Group Phase 1 and the Cape Flats Aquifer Phase 2.	*Department of Water and Sanitation and City of Cape Town*	*2019/2020*
Clearing of Invasive Alien Vegetation from the riparian zones of the Berg, Breede, Riviersonderend and Sandveld Rivers and their major tributaries.	*Department of Environmental Affairs*	*Immediate to stabilize the system and to thereafter improve yield*
Optimise the management and operation of the System by refurbishing the existing bulk infrastructure and improving the annual operating rules, through the curtailment rules, in order to improve the system yield.	*Department of Water and Sanitation and other Stakeholders*	*Immediate*
Breede – Berg River Transfer Scheme: Breede Water Availability Assessment Study.	*Department of Water and Sanitation*	*2018/2019*
Feasibility study of Phase 2 and 3 of the Voëlvlei Dam Augmentation.	*Department of Water and Sanitation*	
Feasibility and detailed studies on the development of water reuse systems.	*City of Cape Town; West Coast District Municipality; Drakenstein and Stellenbosch Local Municipalities.*	*To be completed by 2019*
Establishment of a pilot monitoring plan for desalination of seawater to determine the viability of desalination systems.	*City of Cape Town*	*To be completed by 2018*
Feasibility studies for intervention options such as the Lourens River Diversion, Palmiet Transfer Scheme, Molenaars Diversion and raising of Steenbras Lower Dam to be initiated.	*Department of Water and Sanitation*	*Immediate*
Implementation of approved and updated WC/WDM Plans	*City of Cape Town; West Coast District Municipality and the Local Municipalities; Irrigation Boards and Water User Associations*	*On-going*
Reconciliation Strategy must be regularly reviewed to ensure the objectives and targets set by the Strategy are achieved	*Strategy Steering Committee & Administrative and Technical Support Group*	*Ongoing*
The real-time monitoring system for the WCWSS must be fully utilized and regularly updated to improve the management of releases from the major dams and to also reduce potential losses incurred under previous operating rules.	*Department of Water and Sanitation*	*Ongoing*
The Yield Model should be calibrated to enable a definitive yield value as opposed to the preliminary value currently being used. The process will allow for the yield assessment of the individual dams in the WCWSS.	*Department of Water and Sanitation*	*Immediate*
Planning toward meeting the Resource Quality Objectives which are to be gazetted in the next few months, should begin without delay.	*Department of Water and Sanitation*	*Immediate*

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Appendix A – Intervention options identified in the 2007 Reconciliation Strategy

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1 BACKGROUND

The Department of Water and Sanitation initiated together with the City of Cape Town, the initial Reconciliation Strategy for the Western Cape Water Supply System (WCWSS) in early 2005. This study was aimed to facilitate the reconciliation of predicted future water requirements with available water in the WCWSS for a 25-year planning horizon. The Strategy is used as a decision support framework for making timeous and informed recommendations on water resource interventions that should be implemented to meet the future water requirements.

Since the first study the Reconciliation Strategy has been reviewed and regularly updated with the most recent update having being conducted in 2016.

2 OVERVIEW OF THE WCWSS

The WCWSS is an integrated and collectively managed system of dams, pump stations, pipelines and tunnels. In addition to servicing Cape Town, the system supplies water to towns in the Overberg, West Coast and Cape Winelands District Municipalities as well as providing irrigation water for agriculture. The integrated system helps optimise the use of water resources in the region as it allows water to be transferred between dams and catchment systems (City of Cape Town, 2018).

The geographical location of the WCWSS is outlined in

Figure 2-1.

The WCWSS supplies consumers and irrigators in the catchments of Riviersonderend, Berg and Eerste rivers from six (6) main dams. These include the Theewaterskloof Dam in the Sonderend River of the Breede River catchment and the Voëlvlei, Berg River and Wemmershoek dams in the Berg River catchment, and the Steenbras Upper and Lower Dams in the Steenbras River. In addition, there are a number of smaller dams and weirs including the Department of Water and Sanitation’s Kogelberg and Rockview Dams which serve Eskom's Palmiet Pumped Storage Scheme and the water transfer scheme to the Upper Steenbras Dam, Kleinplaas Dam in the Jonkershoek tributary of the Eerste River on the delivery route of the Riviersonderend-Berg River Tunnel System and Misverstand Weir on the lower Berg River.

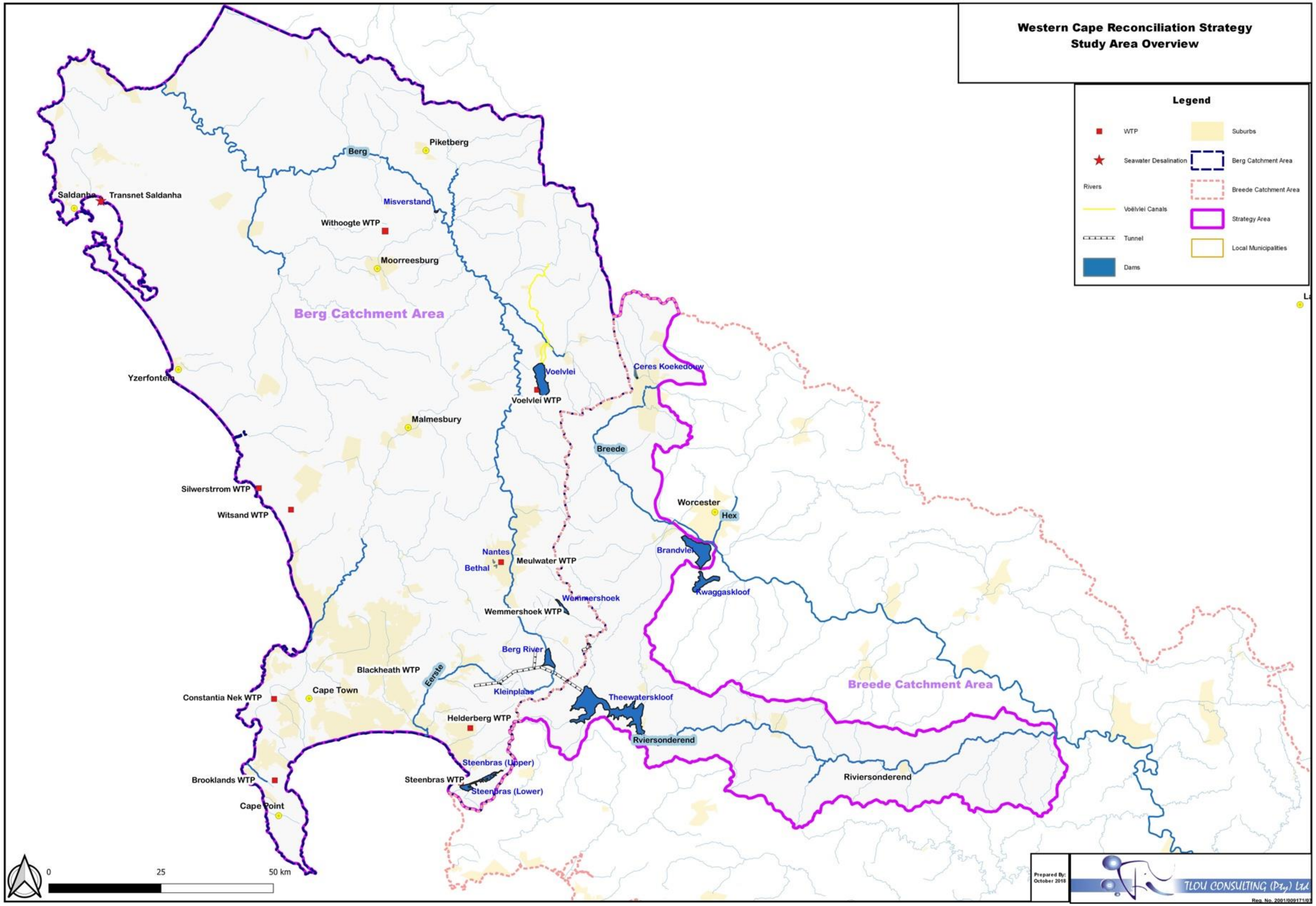

Figure 2-1. Geographical location of the WCWSS

Table 2-1 provides a summary of the large dams supplying the WCWSS.

These main dams are operated as an integrated system, so that the total storage of the system can be best utilised to maximise the yield and to minimise spillage. The integrated operation increases the firm yield of the system (effectively operating the System as a single dam). This optimisation of yield is mainly achieved through reducing the risk of spilling from individual dams. This is done by adjusting the demands on all dams, so as to achieve a similar likelihood of spillage occurring from each dam, i.e. by ensuring that the ratio of storage available to probable inflow for the balance of the winter months is similar.

Table 2-1. Summary of the main dams supplying the WCWSS (City of Cape Town, 2018)

Name	Location	Water source	Ownership	Completed	Capacity (million m3/a)
Theewaterskloof	Villiersdorp	Riviersonderend River	DWS	1978	480.25
Voëlvlei	Gouda	Klein Berg, Leeu and Twenty-Four rivers	DWS	1971	164.12
Berg River	Franschhoek	Berg River	DWS	2009	130.00
Wemmershoek	Franschhoek	Wemmers River	CCT	1957	58.64
Steenbras Lower	Gordon's Bay	Steenbras River	CCT	1921	33.52
Steenbras Upper	Gordon's Bay	Steenbras River	CCT	1977	31.77

2.1 Water Supply Schemes in the Water Supply System

The WCWSS currently comprises the schemes described below. The complex system of transfer schemes and pipelines providing water supply to the Supply System is provided in

Figure 2-2.

2.1.1 Riviersonderend – Berg River Government Water Scheme (Theewaterskloof and Kleinplaas Dams)

The largest component of the WCWSS is the Riviersonderend Government Water Scheme, which is a large inter-basin water transfer scheme that regulates the flow of the Riviersonderend, Berg and Eerste Rivers for urban, industrial and irrigation use. The Riviersonderend-Berg River Government Water Scheme comprises the Theewaterskloof Dam, the Riviersonderend-Berg River Tunnel system and the Kleinplaas Dam. The Scheme supplies irrigators in the Riviersonderend, Berg and Eerste River catchments and also the City of Cape Town, Stellenbosch and Overberg Water. A schematic of the Scheme is provided in Figure 2-3.

The Theewaterskloof Dam impounds water from the Riviersonderend River, while the much smaller Kleinplaas Dam helps balance releases from the tunnel and diverts waters from the Jonkershoek River to the City of Cape Town. During the winter months (April to September) water from the Banhoek and Wolwekloof Rivers, which are tributaries of the Berg River, is diverted down vertical shafts into the Riviersonderend Berg River Tunnel from where it can flow under gravity to either the Theewaterskloof Dam or the Kleinplaas Dam.

The Theewaterskloof Dam supplies consumers in its own catchment as well as consumers in the catchments of the Berg and Eerste Rivers and the City of Cape Town.

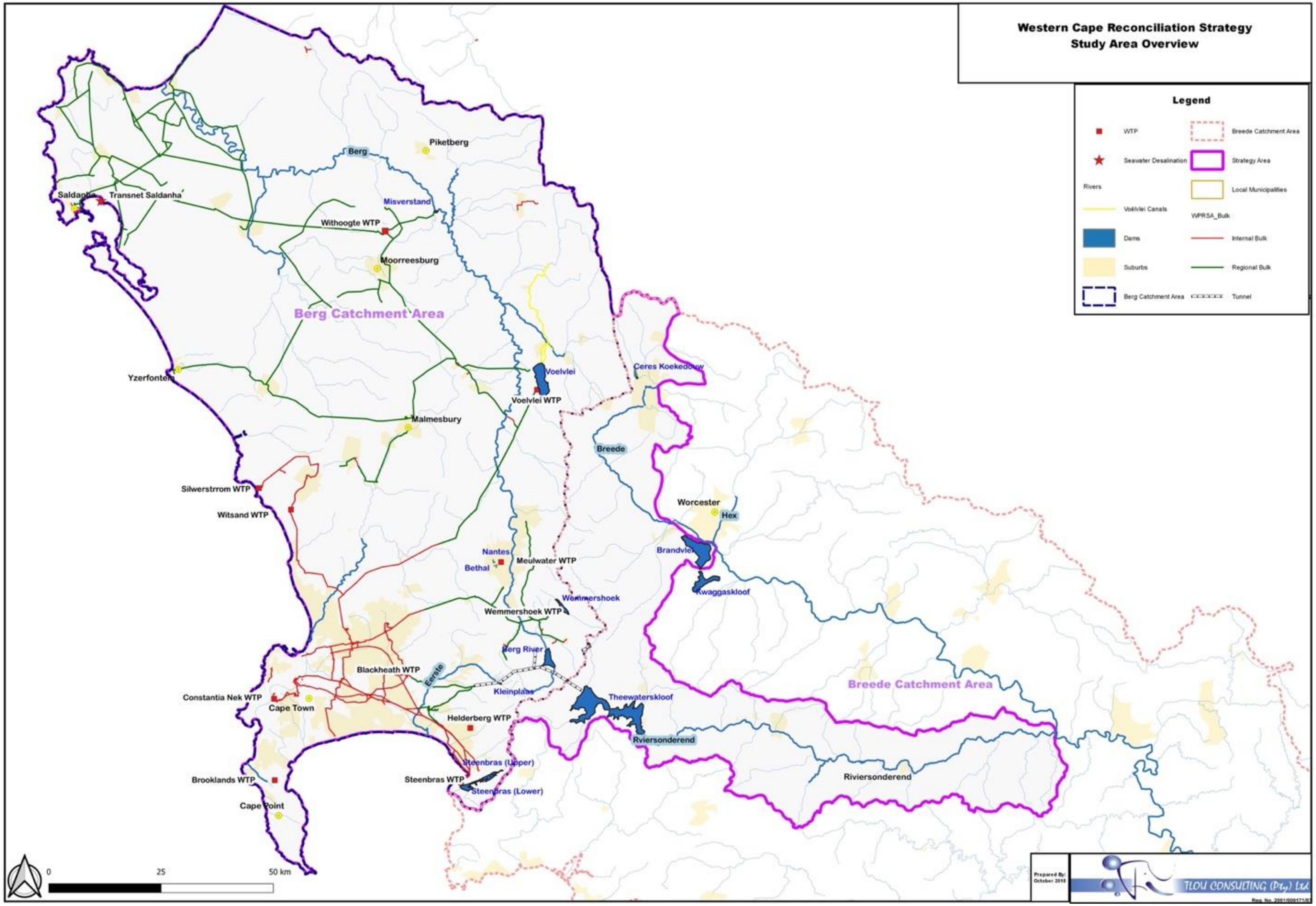

Figure 2-2. Overview of water supply in the WCWSS

Own Catchment

The following consumers are currently supplied from Theewaterskloof Dam:

- Direct abstractors. Vyeboom Irrigation Board currently supplied with 13.2 million m^3/a, other smaller irrigators who pump directly from the dam (currently 1.5 million m^3/a is measured though considerably more water could be supplied) and sports clubs.
- Riviersonderend Irrigation Board (currently supplied with 30.8 million m^3/a) and the Ruênsveld East and West stock watering and urban water supply schemes of Overberg Water is supplied by releases into the river downstream of the dam.

Berg River

The following consumers are also currently supplied from Theewaterskloof Dam via the Tunnel:

- Berg River Irrigators currently receive 48.6 million m^3/a of summer releases from Theewaterskloof into the Berg River, at the confluence with the Wemmershoek River, to augment the natural summer flow in the Berg River of about 16.5 million m^3/a, most of which is released from the Berg River Dam;
- The City of Cape Town via a pipeline to the Wemmershoek Water Treatment Works (WTW). Their supply varies from 0 to 23 million m^3/a;

The releases at the Berg River siphon are adjusted in response to the demands of irrigators so as to maintain a minimum summer flow of about 0,5 m3/s at Sonquasdrift in the lower Berg River.

The Banhoek Irrigation Board pumps water from the tunnel at the Banhoek shaft. They are currently supplied with 1.8 million m3/a.

Eerste River

In the Eerste River, water delivered by the Tunnel to Kleinplaas Dam is used to supply:

- City of Cape Town, via the Stellenboschberg Tunnel and the pipeline to the 500 Ml/day Faure and 400 Ml/day Blackheath WTW. The current supply is 118 million m^3/a.
- Helderberg Irrigation Board is currently supplied with 7.8 million m^3/a.
- Stellenbosch Irrigation Board is currently supplied with 9.7 million m^3/a.
- Riparian farmers around Stellenbosch and the lower Eerste River Irrigation Board via releases into the river of 2.8 million m^3/a.
- Stellenbosch Municipality via the Municipality's Paradyskloof WTW served from the outlet of Stellenboschberg Tunnel and via their diversion from upstream of Kleinplaas Dam and their Idas Valley Dam of 3 million m^3/a.

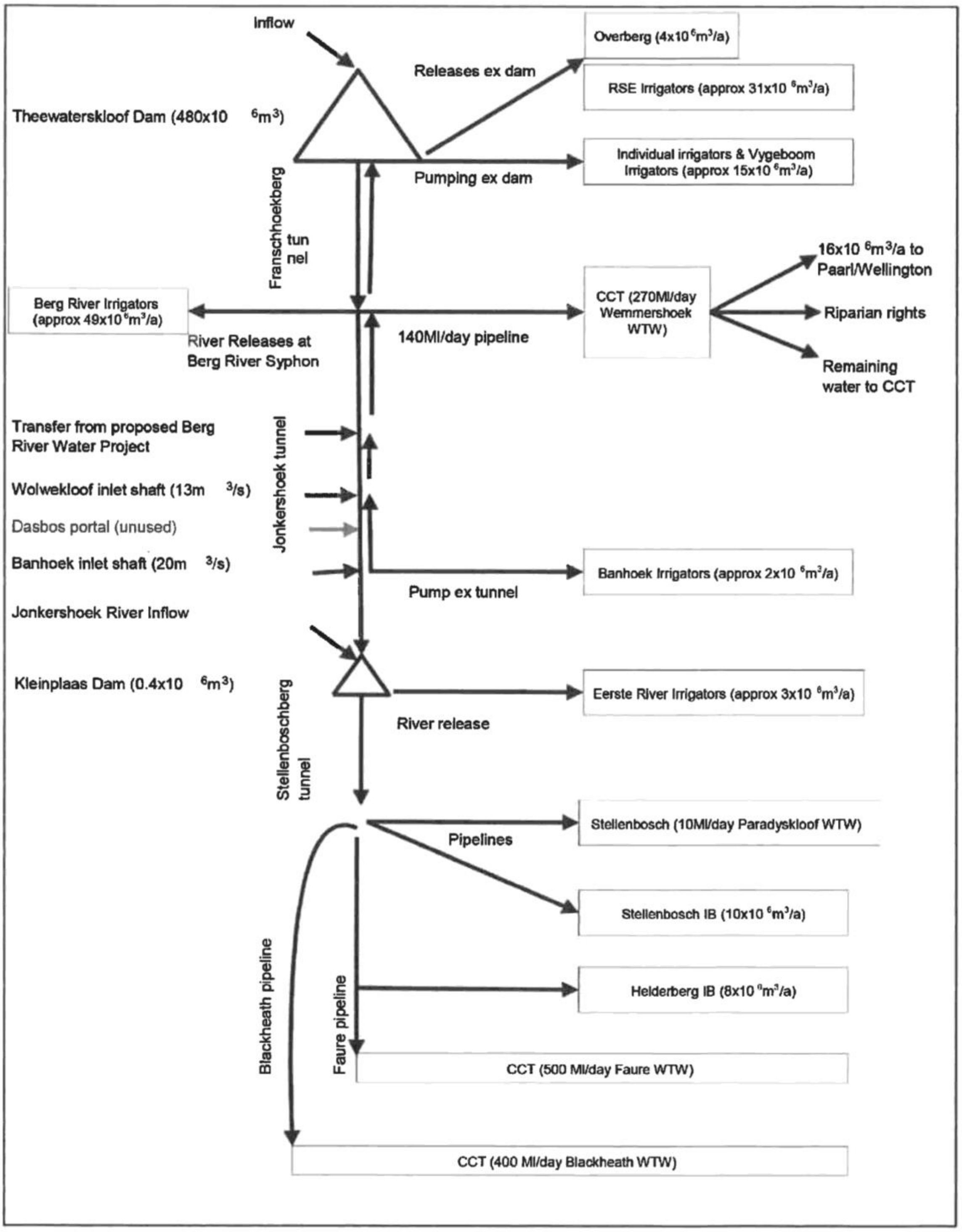

Figure 2-3. The Existing Berg River Government Water Scheme (prior to Berg Water Project) (extracted from DWAF, 2006)

The Kleinplaas Dam also receives unregulated inflow from the Jonkershoek tributary of the Eerste River. This water is used before the water is abstracted from the Riviersonderend Berg River Tunnel from Theewaterskloof Dam. However, if this unregulated inflow is insufficient to meet the demand and the water level drops to 0.8 m below the full supply level (FSL) of Kleinplaas Dam then releases are automatically made from the tunnel by three needle valves. If the water level drops to 6 m below full supply level (FSL) sediment will be withdrawn into the Stellenboschberg Tunnel and may affect the City of Cape Town's water treatment works at Blackheath and Faure. In winter, as the dam is not filled to its FSL, small floods in the Eerste River can be impounded.

When the releases from the Riviersonderend Berg River Tunnel into Kleinplaas Dam are smaller than the inflows at the Banhoek and Wolwekloof inlet shafts, some of this water flows into the Theewaterskloof Dam (Department of Water Affairs and Forestry, 2006).

2.1.2 Voëlvlei Government Water Scheme

The Voëlvlei Government Water Scheme is the second largest component of the WCWSS.

The Voëlvlei Dam is an off-channel dam supplied during the winter months (April to September) by diversions from the Klein Berg River into the Klein Berg Canal and from both the Twenty Fours Rivers and the Leeu River into the Twenty Four Rivers Canal. During the summer months,

releases are made from Voëlvlei Dam to supply consumers along the Lower Berg River, however during winter these consumers mainly abstract water from the unregulated flow in the Berg River. The schematic of the Voëlvlei Government Water Scheme is provided in Figure 2-4.

The quality of the water from the Klein Berg River was poor from time to time some years ago and contributed to the formation of algal blooms in Voëlvlei Dam, but there have been no algal blooms in recent years.

Voëlvlei Dam supplies some consumers directly from the dam while others are supplied via releases made into the Berg River. The Misverstand Weir, located downstream of Voëlvlei Dam, was intended to regulate abstractions from the Berg River (Department of Water Affairs and Forestry, 2006), however vortex formation at the Withoogte pumps currently limits drawdown and the utilisation of this storage. The Misverstand weir does not form part of the Voëlvlei Scheme, however its operation is directly linked to the releases from Voëlvlei Dam. The main purpose of the Misverstand weir is to divert water to the West Coast District Municipality's pump station which delivers water to the Withoogte WTW and onward to the Vredenberg/Saldanha area. The dam was also intended to provide some regulation of the summer releases from Voëlvlei Dam which are re-released at Misverstand to downstream irrigators (Department of Water Affairs and Forestry, 2006).

Direct Supply

The following consumers are supplied from Voëlvlei Dam:

- West Coast District Municipality has an allocation of 8.2 million m^3/a which supplies the towns of Gouda in Drakenstein LM, Riebeek West, Riebeek Kasteel, Malmesbury, including Chatsworth, Riverlands, Abbotsdale and Kabaskraal, Darling and Yzerfontein in Swartland LM via the Swartland WTW.

- City of Cape Town has an allocation of 70.4 million m^3/a via their own Water Treatment Works. Historically the City supplied 4 million m^3/a of their allocation to the Armscor site at Krantzkop, though this is not operational at present.

Supply via Berg River

The following consumers abstract releases made into the Berg River:

- West Coast District Municipality has an allocation of 23.04 million m^3/a from the Misverstand Dam to supply the towns of Velddrif and Dwarskersbos in the Berg River LM and Hopefield, Langebaan, Stompneus Bay, St Helena Bay, Jacobs Bay, Paternoster and Saldanha in the Saldanha LM and the towns of Moorreesburg and Koringberg in the Swartland LM via the Withoogte WTW.

- Lower Berg River Irrigators currently receive 18.1 million m^3/a via releases from Misverstand Weir.

- Berg River Estuary. In future, additional environmental releases may be required to meet the Reserve requirements of the Berg River Estuary, once the resource quality objectives have been gazetted and finalised.

The pumps at Withoogte currently limit the drawdown of Misverstand Weir to 300mm below FSL and it has been recommended that low lift pumps are installed to increase the utilisable storage.

Supply to Irrigators from the Twenty Four River Canal

The Twenty Fours Rivers Canal supplies approximately 20 million m^3/a to irrigators.

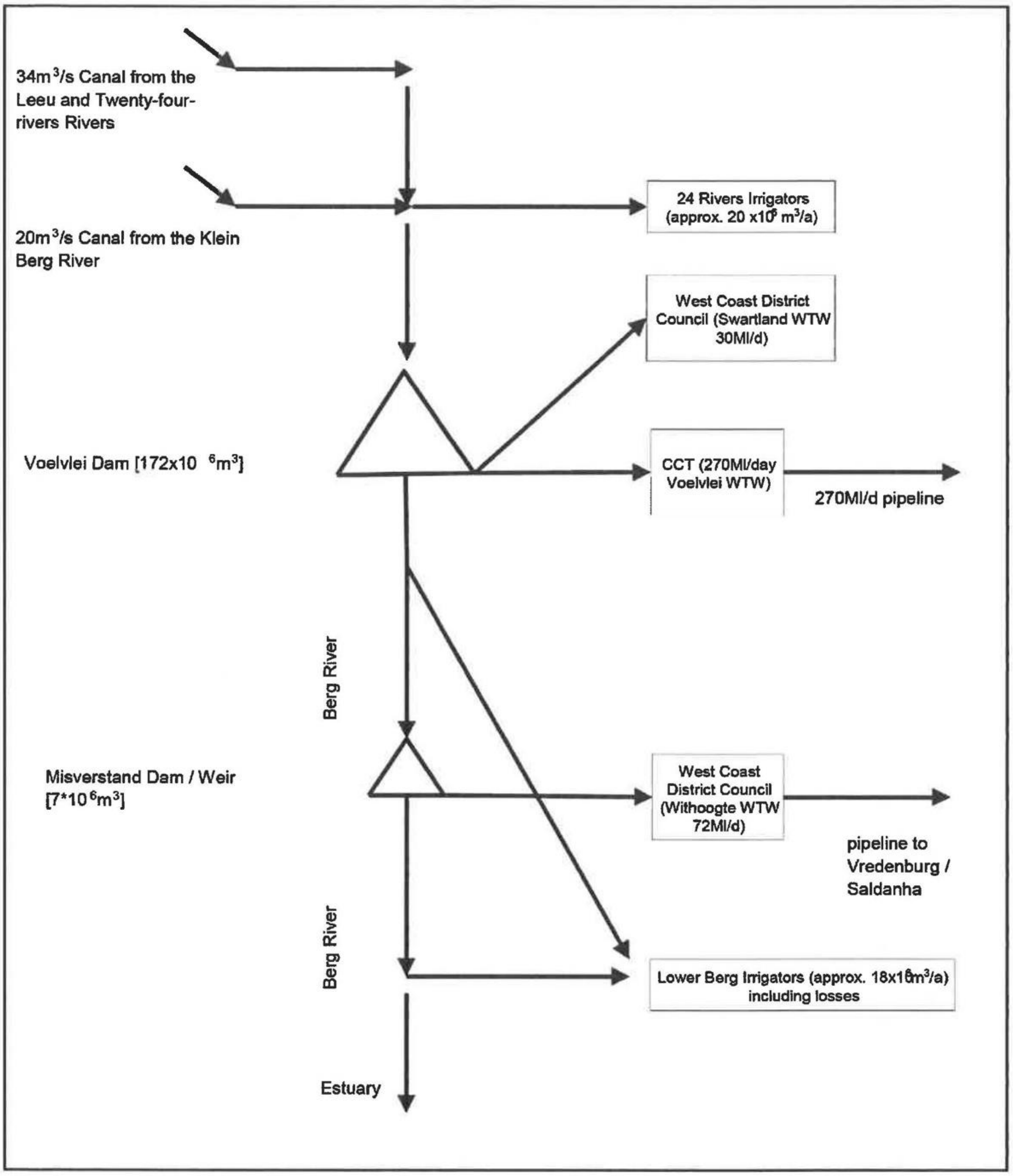

Figure 2-4. The Voëlvlei Government Water Scheme (extracted from DWAF, 2006)

2.1.3 Palmiet Transfer Scheme (Steenbras Dams)

The Steenbras dams impound water from the Steenbras River and receives transfers from the adjacent Palmiet River via Eskom's Palmiet Pumped Storage Scheme. The Steenbras dams and the Palmiet Transfer Scheme supply water to the City of Cape Town via the Steenbras WTW and the Faure WTW. The schematic of this scheme is provided in Figure 2-5.

Palmiet Transfer

Surplus water is transferred from the Kogelberg Dam on the Palmiet River to the Rockview Dam, which are the main components of the Palmiet Government Water Scheme, using the spare capacity in Eskom's Pumped Storage Hydropower Scheme. The Lower Palmiet River forms part of the Kogelberg Biosphere Reserve and the transfers to the Steenbras dams can only take place once the in-stream flow requirements of the river are satisfied.

Upper Steenbras Dam

The Upper Steenbras Dam can supply up to 300Ml/day to the Faure WTW (capacity 500 Ml/day) via the City's Pumped Storage Scheme and the Firlands pumpstation.

During the winter, water from the Upper Steenbras Dam usually spills into the Lower Steenbras Dam. The Upper Steenbras Dam, the Lower Steenbras Dam and transfers from the Palmiet River are operated in such a way as to minimise spillage from the Lower Steenbras Dam. This may have a negative impact on the ecosystem functioning particularly immediately downstream of the dam. The implementation of the RQOs of the Steenbras will impact on the yield from the Steenbras system. During the summer months water can be released from the Upper Dam into the Lower Dam to supplement the supply from the Lower Dam.

Lower Steenbras Dam

The Lower Steenbras Dam provides water to the 150Ml/day Steenbras WTW which is the main supply to some of the higher lying suburbs of Cape Town. Releases into Steenbras Dam are made from the Upper Dam during the late summer months, if required.

The combined yield of the Upper and Lower Steenbras Dams from their catchment area is about 40 million m^3/a, and about 62.5 million m^3/a including the Palmiet transfers. The Steenbras WTW treats about 30 million m^3/a from the Lower Steenbras Dam and the Faure WTW about 32.5 million m^3/a from the Upper Steenbras Dam, as well as water from Theewaterskloof Dam via Kleinplaas Dam (Department of Water Affairs and Forestry, 2006).

2.1.4 Wemmershoek Scheme

The Wemmershoek Dam impounds the Wemmershoek River and supplies water to:

- City of Cape Town: Wemmershoek Dam supplies the City of Cape Town's 270 Ml/day WTW at the dam with about 54 million m^3/a of which 38 million m^3/a is supplied to Cape Town via the City's Wemmershoek Pipelines.

- Paarl and Wellington: About 16 million m^3/a of the water treated at the Wemmershoek WTW is supplied via the offtake pipeline from the Wemmershoek Pipeline to Paarl and Wellington (Drakenstein Municipality).

- Compensation: A small volume is abstracted from the potable water Wemmershoek Pipeline as compensation to downstream farmers (3 million m^3/a) (Department of Water Affairs and Forestry, 2006).

The schematic is provided in Figure 2-6.

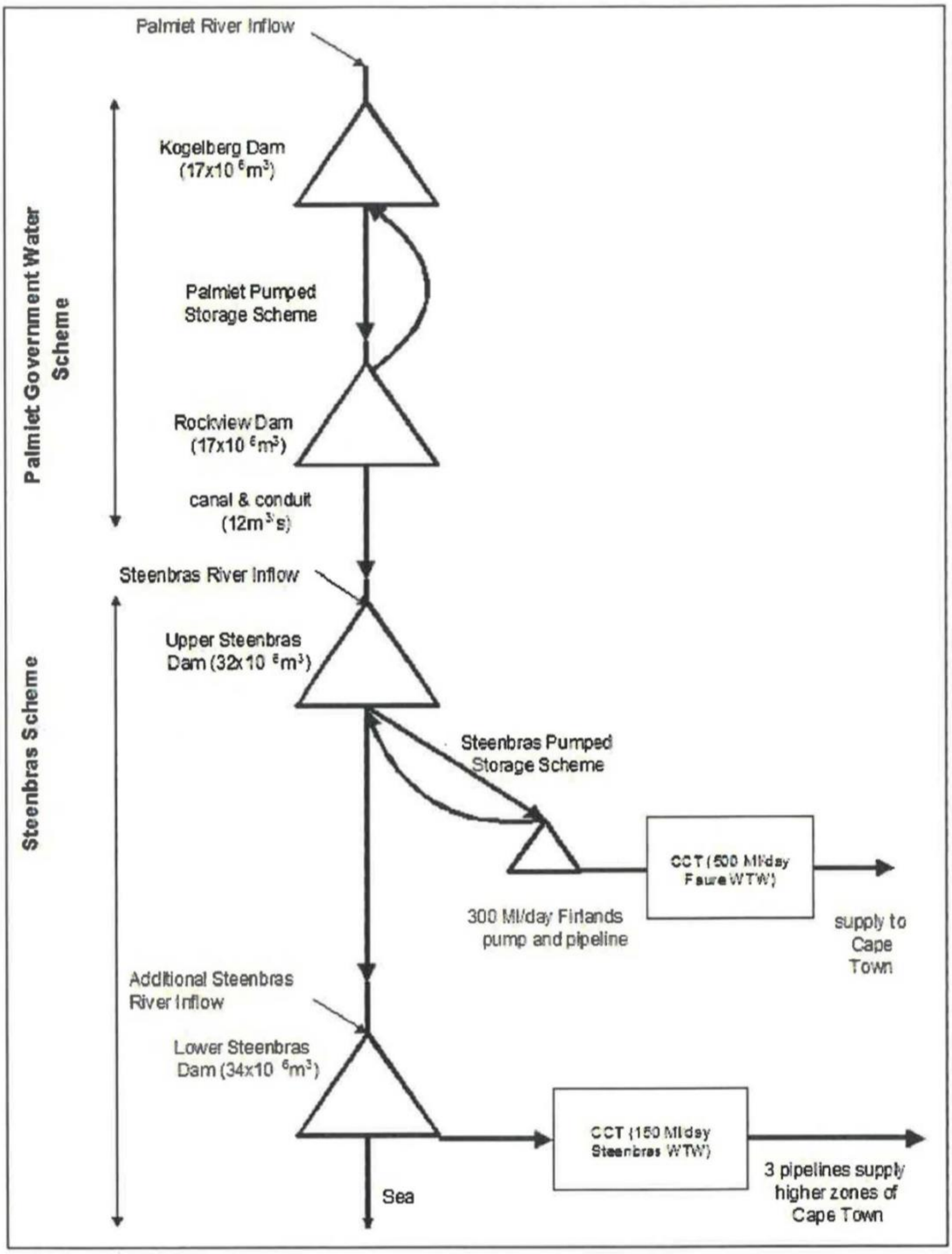

Figure 2-5. The Palmiet Government Water Scheme and the Steenbras Dams (extracted from DWAF, 2006)

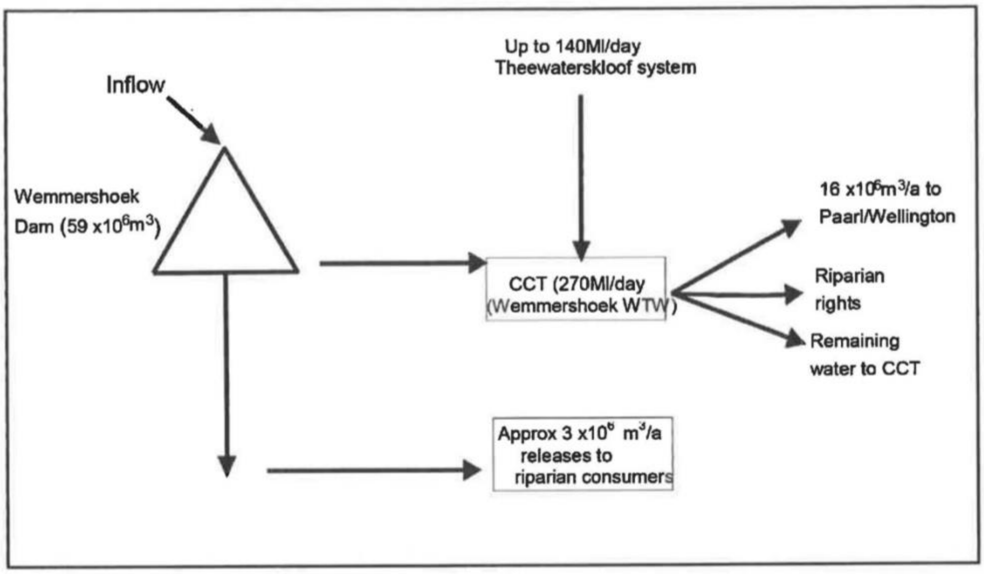

Figure 2-6. The Wemmershoek Scheme (extracted from DWAF, 2006)

2.1.5 Proposed Berg River Project

Berg River Dam

When required, water can be pumped from the Berg River Dam into the Theewaterskloof Dam via the Riviersonderend – Berg River tunnel system and water from Theewaterskloof Dam is released into the Berg River, below the Berg River Dam, as described in Section 2.1.1 above. A substantial proportion of the Theewaterskloof Dam storage serves to supply the demands on the system during serious droughts when the other dams are heavily drawn down. The schematic is provided in Figure 2-7.

During the wet winter months there will usually be a net transfer of water from the Berg River Dam into the tunnel system (from where the water can either be supplied to the City's Water Treatment Works (WTWs) at Faure or Blackheath or saved in Theewaterskloof Dam. Otherwise the Berg River Dam would tend to spill towards the end of the wet season. However, there is also a requirement to release environmental base flows throughout the year as well as a small flood in early winter, a medium flood and a large flood of 160 m^3/s during the winter months subject to such inflow floods occurring. Operating rules and software have been devised to facilitate this process.

During the winter months water is pumped from the Berg River Dam via the Tunnel System to Cape Town and to Theewaterskloof Dam.

Drakenstein Pumping Scheme

The Drakenstein Pumping Scheme comprises a low weir on the Berg River to enable water to be diverted into an excavated balancing basin. A pump station and delivery pipeline serves to deliver water into the Berg River Dam. The length of the pipeline is 8.7 km and the maximum pumping head at design flow is 130 m. The capacity of the system, 4 m^3/s, provides an incremental firm yield of 25 million m^3/a, however, up to 50 million m^3/a could be delivered into the Berg River Dam.

The Drakenstein Pumping Scheme (weir and pumping station) operates in the winter months from May to October and pumps water into the Berg River Dam whenever there is sufficient flow in the river in excess of the Reserve requirements, unless the Berg River Dam is likely to spill.

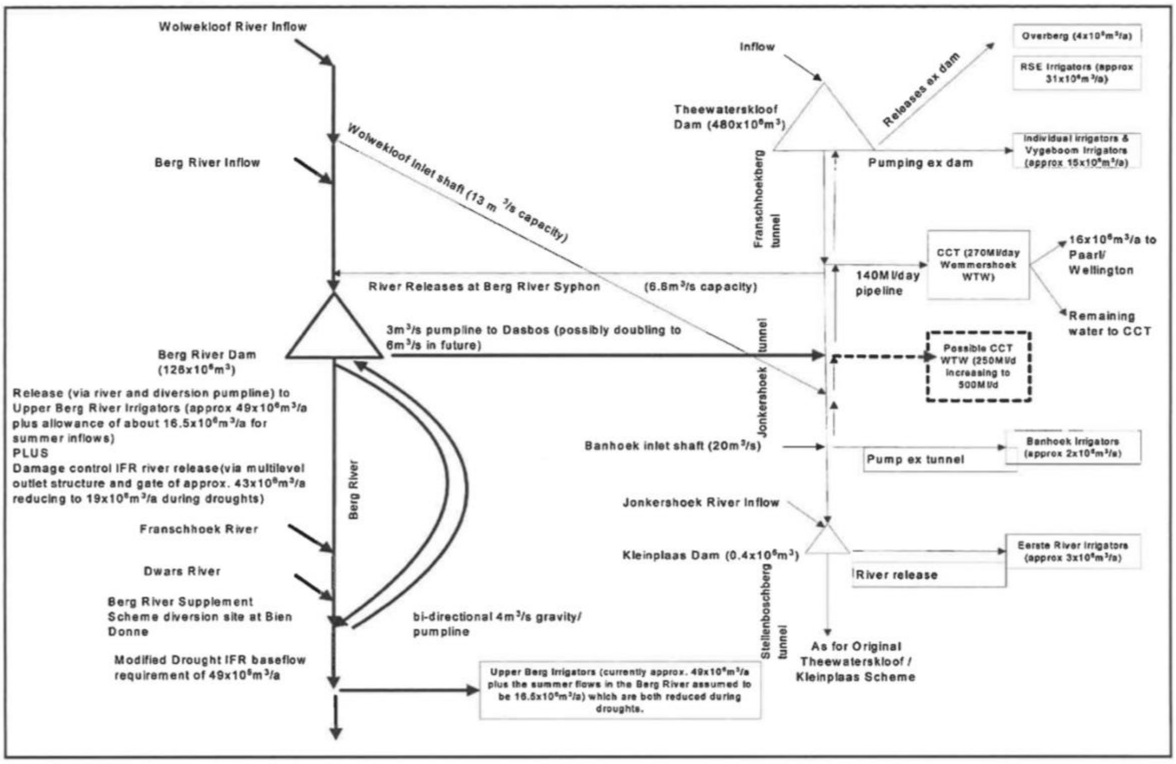

Figure 2-7. Proposed Berg Water Project (extracted from DWAF, 2006)

2.2 Local Schemes

In addition to the integrated main schemes of the Western Cape Water Supply Scheme, a number of minor schemes supply individual local authorities, limited areas of the City of Cape Town and irrigators (Department of Water Affairs and Forestry, 2006).

Table 2-2 shows those towns dependent on local supplies, some with partial dependence on the main schemes, while Table 2-3 highlights the minor schemes supplying small areas in the City of Cape Town.

Table 2-2. Minor Schemes in the WCWSS

Scheme Name	Local Schemes			Main Schemes	
	Raw Water Source	Areas Supplied	Scheme Capacity (million m^3/a)	Scheme	Capacity (million m^3/a)
Paarl	Nantes Dam Bethel Dam Berg River Pump Station	Paarl	2,8	Wemmershoek	17
Wellington	Antoniesvlei (supplementing supply from Wemmershoek)	Wellington	0,5		
Stellenbosch	Eerste River at Jonkershoek	Stellenbosch	5,5	RSE Berg	3
Piketberg	Voëlvlei Dam and Local Sources	7 750 people	1,0	Voëlvlei	

Scheme Name	Local Schemes			Main Schemes	
	Raw Water Source	Areas Supplied	Scheme Capacity (million m^3/a)	Scheme	Capacity (million m^3/a)
Saron	Twenty-four Rivers Canal	Saron	0,34	Voëlvlei	
Porterville	Local Sources	4 350 people	0,6		
Tulbagh	Local Sources	4 700 people	0,6		
Franschhoek	Local Sources	4 500 people	0,6		
Pniel	Local Sources	2 150 people	0,04		

From (Department of Water Affairs and Forestry, 2006)

Table 2-3. Minor Supply Schemes to the City of Cape Town

Scheme Name	Raw Water Source	Area Supplied	Scheme Capacity	
			million m^3/a	limiting factor
Table Mountain and Southern Peninsula Water Supply Scheme	Hely Hutchinson Dam De Villiers Dam Victoria Damn Alexandra Dam Woodhead Dam Albion Spring	Cape Metropolitan Area	5.0	Raw water yield
	Kleinplaas Dam Lewis Gay Dam	Simon's Town Simon's Town	1,8	Raw water yield
Atlantis	36 Boreholes	Atlantis Mamre	6,0	Raw water yield
Somerset West	Land-en-Zeezicht Dam 4 Boreholes	Somerset West	2,0	Raw water yield
Strand	Lourens River	Strand	0,8	Raw water yield

From (Department of Water Affairs and Forestry, 2006)

Irrigators in the Western Cape Water Supply area are supplied via the Main Schemes, Minor schemes and own storage. Table 2-4 indicates the sources of supply to irrigators in the Supply System.

Table 2-4. Sources of supply to irrigators in 2000

Water Management Area	River	Irrigators Reliant on Own Minor Schemes	Irrigators Entirely Reliant on or Partly Supplied by Main Schemes	Total Irrigation Requirements
		(million m^3/a)	(million m^3/a)	(million m^3/a)
Berg	Upper Berg	149	50	199
	Lower Berg	40	31	71
	Kuils, Eerste, Lourens, Sir Lowrys	21	20	41
Breede	Riviersonderend	12	44	56

Water Management Area	River	Irrigators Reliant on Own Minor Schemes	Irrigators Entirely Reliant on or Partly Supplied by Main Schemes	Total Irrigation Requirements
		(million m^3/a)	(million m^3/a)	(million m^3/a)
	Palmiet	56	-	56
TOTAL		278	145	423

From (Department of Water Affairs and Forestry, 2006)

3 POPULATION DEMOGRAPHICS AND SOCIO-ECONOMIC PROFILE

3.1 General

There has been a major time gap between the previous updating of the WCWSS Water Reconciliation Strategy. Therefore, in order to provide an update of the status and undertake a comprehensive updating of the reconciliation strategy, it was necessary that a review of the factors influencing the current and future water requirements of the system be undertaken. These factors include population and demographics, the socio-economy and the environmental factors of the WCWSS.

Because of various historical and political constraints, data on study area population and economic and environmental features have been difficult to collect and analyse in a common and consistent manner. Many of the quantitative data presented in this report have been contributed by committee members or extracted and modified from a recent report prepared for the Multilateral Working Group on Water Resources and funded by the German Government (CES Consulting Engineers and GTZ [Association for Technical Cooperation], 1996).

3.2 Population and Demographics

3.2.1 City of Cape Town historical population profile

The historical growth in population for the City of Cape Town between 2011 and 2017 was determined based on the data generated from Statistics South Africa (Stats SA). This is illustrated in **Table** 3-1. As illustrated in the table, population grew in the City's supply area at an annual rate of 2.6% between 2001 and 2011 and the population growth rate has declined between 2011 and 2016 according to the recently completed community survey undertaken by the Stats SA.

Of importance is that the rate of growth in the number of households has shown an increase of 3.23% per year between 2001 and 2011 and an increase of 3.43% per year between 2011 and 2016. This is an indication of the increase in access to formal housing and services in the City. According to the PDG report, one of the drivers of the increase in household growth in the City is due to an increase in housing development in a bid to address the increasing informal settlements and backyard dwellings taking place in the City (PDG,2018).

According to the Trends in Western Cape Urbanisation (van Ziel, 2017), the growth spots are the City of Cape Town, the West Coast and Cape Winelands Districts. This is where the in-migration into the province is being experienced.

Table 3-1. Historical population and growth rate – City of Cape Town

Population	2001	2011	2016
Cape Town	2 893 249	3 740 026	4 004 983
Historical growth rate		2.60%	1.38%
Households Cape Town	777 389	1 068 572	1 264 849
Historical growth rate		3.23%	3.43%

3.2.2 Historical population of the West Coast District Municipality

The West Coast District Municipality comprises five local municipalities, three of which fall in the WCWSS, namely the Swartland, Saldanha Bay and the Bergrivier Local Municipalities.

The historical population and growth rates of the three areas since the development of the WCWSS reconciliation strategy is illustrated in Table 3-2.

Table 3-2. Historical population and growth rate in the West Coast District Municipality

Description	2001	2011	2016
Swartland Local Municipality			
Swartland - Population	72 115	113 762	133 762
Historical growth rate		4.66%	3.29%
No of Households	17 403	29 324	39 139
		5.36%	5.94%
Bergrivier Local Municipality			
Bergrivier- Population	46 538	61 897	68 751
Historical growth rate		2.89%	2.12%
No of Households	11 766.00	16 275	19 072
		3.30%	3.22%
Saldanha Bay Local Municipality			
Saldanha Bay - Population	70 261	99 193	113 239
Historical growth rate		3.51%	2.68%
No of Households	18 663	28 835	35 550
		4.45%	4.28%
Total Population within the WCWSS	188 914	274 852	315 752
		3.82%	2.81%
Total No. Households within the WCWSS	47 832	74 434	93 761
		4.52%	4.72%

Based on Stats SA population census and the community survey data for 2016, the total population of the three municipalities between 2001 and 2016 has increased with the average growth rate of the area 3.48% per annum. However, this has been declining from 3.82% per annum between the 2001 and 2011 census records to 2.81% per annum between 2011 and 2016 according community survey conducted by Stats SA.

Swartland Municipality, which is supplied directly from the Voelvei Dam has the largest population which has been growing at a rate of 4.2% per year between 2001 and 2016. The population of the Saldanha Bay area has also been growing significantly at 3.23% per annum, which is centred around Saldanha Bay (Western Cape Government, 2017). Retirement property market is booming in Swartland and Saldanha resulting in a net migration into all three municipalities.

The increase in the total number of households in the three municipalities indicates that there is a significant increase in access to formal housing and services. This has been increasing at an annual average increase in the number of households of 4.72% per annum between 2011 and 2016.

3.2.3 Historical population of the Drakenstein Municipality

The Drakenstein Municipality forms part of the Cape Winelands District Municipality and is situated in the north east part of the WCWSS. Paarl and Wellington are the main urban centres in the municipality with smaller rural settlements at Saron and Gouda in the north and Hermon in the mid-west.

The historical population and growth rates of the Drakenstein Municipality since the development of the WCWSS reconciliation strategy is illustrated in Table 3-3.

Table 3-3. Historical population and growth rate in the Drakenstein Municipality

Description	2001	2011	2016
Drakenstein- Population	194 421	251 342	279 499
Historical growth rate		2.60%	2.15%
No of Households	44 410	59 774.00	71 686
		3.02%	3.70%

The historical growth in population of the municipality from 2001 to 2011 was 2.60% per annum. According to the SEP: Drakenstein, the population growth rate declined slightly between 2011 and 2016 due to changes in the migration patterns in the Western Cape. According to the Actuarial Society of Southern Africa (ASSA) model a further slowing of the population growth rate is expected in the long term. This has been factored into the future population growth in the Drakenstein Local Municipality.

3.2.4 Historical population of the Stellenbosch Municipality

Stellenbosch Local Municipality is located in the Cape Winelands District Municipality. The main towns in Stellenbosch Municipality include the student town of Stellenbosch, the picturesque Franschoek and the small towns of Klapmuts, Pniel and Raithby.

According to Table 3-4 population increased from 117 704 to 155 733 between the 2001 and 2011 census periods at an annual average growth rate of 2.84%. The Stats SA community survey conducted in 2016 indicated that the overall growth in population declined slightly to 2.54% per annum between 2011 and 2016.

Table 3-4. Historical population and growth rate in Stellenbosch Municipality

Description	2001	2011	2016
Stellenbosch- Population	117 704	155 733	176 523
Historical growth rate		2.84%	2.54%
No of Households	29 023	43 420.00	52 374
		4.11%	3.82%

3.2.5 Historical population of the Witzenburg Municipality

Witzenburg Municipality is responsible for service provision to the demarcated municipal area that includes the towns of Ceres, Tulbagh, Prince Alfred's Hamlet, Wolseley and Op-die-Berg. All though Ceres is in the Breede River catchment, the potential transfer of water through the Mitchell's Pass to Voelvlei Dam will have an impact on water supplies to the town. Hence its inclusion in the WCWSS.

From Table 3-5, the population of Witzenburg Municipality grew from 89 087 in 2001 to 115 946 in 2011 at an annual average growth rate of 2.67%. The population was estimated to have increased at 2.4% per annum from 2011 to 130 548 in 2016 based on the Stats SA Community survey conducted that year.

Table 3-5. Historical population and growth rate in Witzenburg Municipality

Description	2001	2011	2016
Witzenburg- Population	89 087	115 946	130 548
Historical growth rate		2.67%	2.40%
No of Households	20 651	27 419	35 976
		2.88%	5.58%

There was a significant increase in access to housing developments based on the 5.58% growth in number of households between 2011 and 2016.

3.2.6 Historical population in the Overberg Water Supply Area

Overberg Water supplies water to areas that are dependent on Theewaterskloof Dam which is a critical resource of the WCWSS. The main area supplied is the Theewaterskloof Local Municipality.

Theewaterskloof Municipality is responsible for service provision to the demarcated municipal area that includes the towns of Villiersdorp, Riviersonderend, Greyton, Grabouw and Genadendal.

The historical population and growth rates of the Theewaterskloof Municipality since the development of the WCWSS reconciliation strategy is illustrated in Table 3-6.

Table 3-6. Historical population and growth rate in the Overberg Water Supply area of Theewaterskloof Local Municipality

Description	2001	2011	2016
Overberg (Theewaterskloof)- Population	93 276	108 790	119 052
Historical growth rate		1.55%	1.82%
No of Households	23 044	28 884	33 097
		2.28%	2.76%

A comparison of the population growth rate between 2001 – 2011 and 2011-2016 indicates that historically, the population growth rate has been increasing in the Theewaterskloof Municipality. This is likely to continue to grow because of the net-migration taking place into the Western Cape particularly from the Eastern Cape and the Northern Cape (Jacobs, 2014).

3.2.7 Potential Implications of the historical population growth

The assessment of the population, as indicated in the previous sections, illustrates that the WCWSS population has grown over the ten-year period between the 2001 and 2011 census at an average annual growth rate of 2.7% per annum, declining to 1.7% per annum between 2011 and 2016.

The historical population growth patterns between 2001 and 2011 Stats SA census as well as the 2016 Community Survey has highlighted the following aspects and the potential implication of the growth patterns as it pertains to the strategic updating of the WCWSS Water Reconciliation Strategy:

1) That 79.7% of the population of the WCWSS is situated in the City of Cape Town, with West Coast District Municipality and Drakenstein Local Municipality contributing 6.3% and 5.6% of the total population respectively.

2) A study on the migration patterns of the Western Cape Province (Jacobs, 2014) highlighted the following:

    a. Strong migration patterns were found to existing between the municipalities in the Eastern Cape and the City of Cape Town region as well as coastal intermediate sized municipalities such as West Coast and Cape Winelands Districts.

    b. The socio-economic profile of the area was found to be the dominant motivating factor of mainstream migration, particularly to the City of Cape Town.

    c. Environmental factors also contributed in the migration decision particularly in the sub-stream of migrants aged older than 50 years who favoured coastal areas.

    d. Approximately 31.3% (Jacobs, 2014) of the in-migrants live in informal dwellings, thus potentially requiring formal housing and associated services such as water service provision.

3) The population growth and the migration patterns affect the allocation of the available resources to the municipalities in the WCWSS and service delivery outputs. This causes strain on the limited water resources resulting in competition for the resource if the irrigation sector and the environment are factored in.

3.2.8 Future population of the WCWSS

The City of Cape Town recently commissioned PDG in association (PwC) to undertake a study to update the population projections for the City from 2017 to 2040. This was based on the use of the Statistics South Africa 2016 Community Survey. In addition, the Integrated Development Plans of the municipalities in the WCWSS were used to update the population projections.

Figure 3-1 provides the estimated population projections of the municipalities in the WCWSS based on the above studies and data provided by the municipalities. The population projection for the City of Cape Town is as projected in the PDG report that was adopted by the City for future development planning and decision making. According to the report the population will grow from 4 087 318 in 2017 to 5 843 462 in 2040, with an annual average population growth rate over the period of 1.7% per annum. The annual population growth rate is envisaged to decline from 2.0% in 2017 to 1.2% per annum in 2040.

The West Coast District Municipality population growth, was premised on the population growth in the Saldanha Bay, Bergrivier and Swartland Local Municipalities. Information provided from the Socio Economic Profile of the three local municipalities was used in the population projections. The report had projected the population to 2023. This was then further projected based on the Integrated Development Plans of the three local municipalities as well as data received from the West Coast District Municipality. The population projection for the West Coast municipalities in the WCWSS is envisaged to grow from 306 959 in 2017 to 445 152 in 2042 at an average annual growth rate of 1.3%. The spatial distribution of this population will have an impact on the development of bulk water infrastructure in the area.

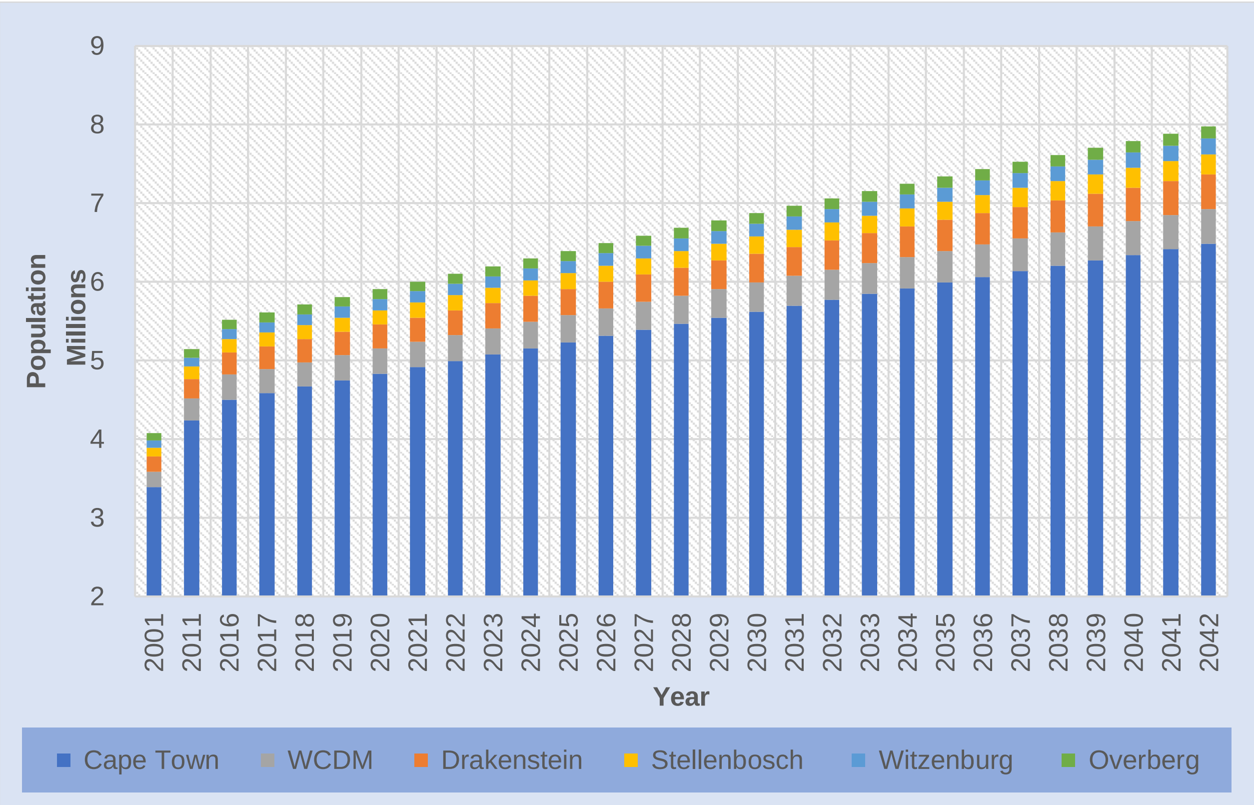

Figure 3-1. Population projection for the WCWSS

The population of the Drakenstein Municipality located in the WCWSS is expected to grow at an annual average growth rate of 1.7% per annum from 285 512 in 2017 to a total population of 435 980 in 2042, the planning horizon for the reconciliation strategy update. A large percentage of the population is located in the major urban centres of Paarl and Wellington.

Population projection for the Stellenbosch Local Municipality was based on the information from the annual reports of the municipality. This was projected at 1.84% per annum between 2016 and 2020. The population was projected at a declining growth rate (Stellenbosch Municipality, 2017), to 257 888 by 2042. The annual average growth rate for the period between 2016 and 2042 was 1.6%.

The growth in population for the Witzenburg Local Municipality was based on the Socio-Economic Profile of the Municipality as well as its Integrated Development Plan 2018-2019. The population which is largely rural, is expected to grow from 132 950 to 199 765 in 2042. This is an average annual growth rate of 1.6% per annum.

The population of Theewaterskloof Municipality was projected from a total population of 119 052 in 2016 to 151 624 at an average annual growth rate of 0.9%.

3.3 Economic profile of the WCWSS

3.3.1 Overview of key economic sectors

Besides the population growth and changes in the socio-economic factors of the WCWSS, the trends in the economic growth of the region will have an impact on the future water requirements forecasting.

Since 1996, the share of the services sector has increased in both the Western Cape and the rest of South Africa. The sector (excluding government services) now contributes more than 67% of the Gross Geographic Product of the Province. This is much higher than the services sector's contribution to the national economy which is just over 50%.

Through Project Khulisa, tourism (business and leisure tourism, and more specialised niches), agri-processing (value added activities in food and beverages, including its potential for domestic production and export) as well as the oil and gas sector (midstream services with immediate impact potential, such as rig repair) were identified as strategic priority areas for the Western Cape. Agri-processing are significant sectors in the WCWSS and are heavily to moderately dependent on water. Although tourism is not heavily dependent on the water sector, water is crucial to the tourism experiences such as swimming pools, sailing, canoeing, hiking, fishing and the aesthetic value of water resources such as the lagoons, rivers and estuaries. It has been determined that tourists can use between 3 to 8 times more water than the domestic sector (Becken, 2014).

3.3.2 Growth trends in the tourism sector

The tourism sector is crucial to the social and economic activity in the WCWSS and contributes to economic growth, job creation and improved household income. The current drought has had a negative impact on the quality of the tourism experience in the Water Supply System and has dented the growth in tourism between 2015 and to date, although there have been signs of recovery through technological changes in water usage in particular.

Efforts to promote the sector, improved tourist arrivals in the low season by 30% between 2013 and 2016, helping to mitigate the impact of seasonality and the current drought. This has made the Western Cape and in particular the WCWSS more viable for further investment in tourism. This will have an impact on the future water requirements although it is not a major consumer of water.

3.3.3 Growth trends in the agri-processing industry

The agri-processing industry is heavily dependent on the water sector, which is significant in the Western Cape and in particular the WCWSS.

In an expected environment of slower economic growth, exacerbated by the worst drought in the Western Cape's history, the food and agri-business sector are likely to face higher levels of competitiveness and challenges to remain profitable as illustrated by the fact that the global share of export has been flat since the 2011/12 season (see Figure 3-2). Grapes has lost a third of its market since 2003, although there has been growth in other fruit commodities.

The current drought will depress the economic growth of the industry as it is dependent on the primary sector, agriculture, which has been under severe water restriction since 2015. Direct investment in agriculture as well as agri-processing is a key driver for development and is essential for the long-term sustainability and competitiveness of the sector. The current drought has had an impact on on-farm investment decisions. According to the Bureau for Food and Agriculture Policy (BFAP, 2017), Gross Fixed Capital Formation (GFCF) in the Western Cape's agricultural sector has declined from its highest peak in 2013 of R4.8 billion, to around R3 billion in 2016 (Quantec, 2018d).

However, agriculture and agri-processing remain strategic sectors in terms of their contribution to economic growth, employment absorption and foreign earnings. It is envisaged that future water requirements for the WCWSS will be driven by the growth in the agri-processing sector and tourism in the long term.

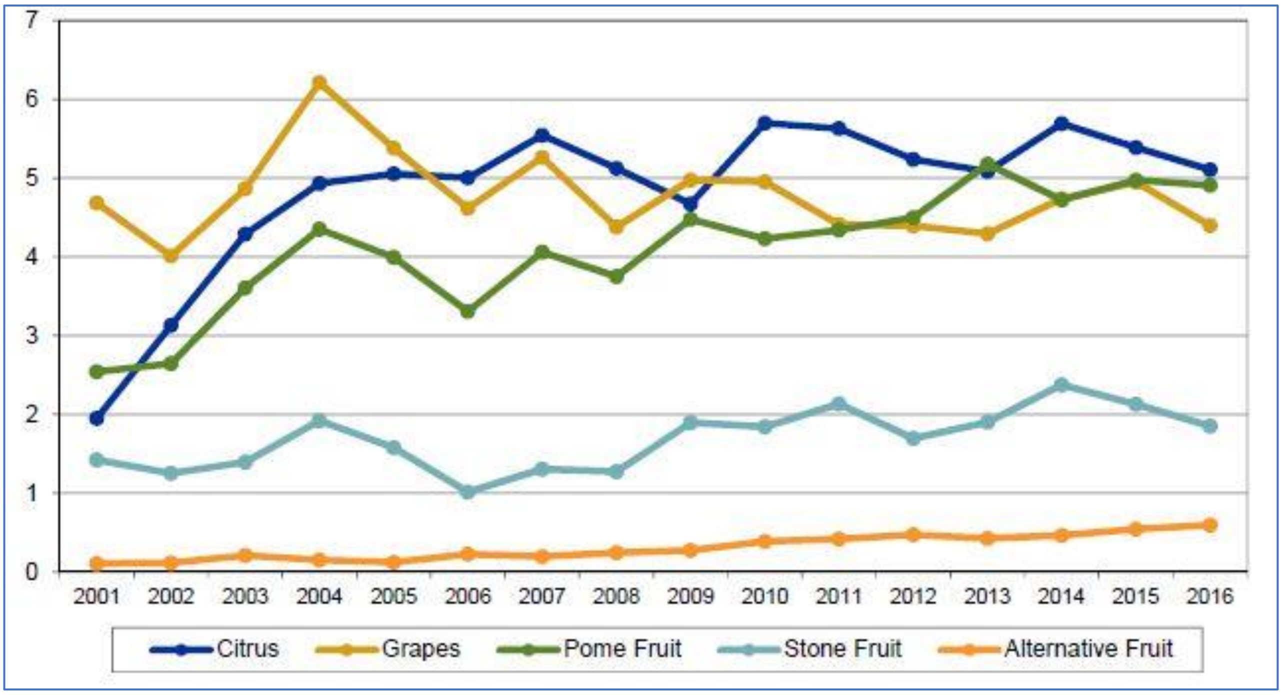

Figure 3-2 Western Cape share of world export value for specific fruit commodities, 2001 – 2016

Source: Quantec 2017, ITCS, 2017.

3.3.4 Comparison of economic growth forecast and actual growth up to 2016

In order to determine the likely future economic growth trend, which is a variable that will cause a response in the future water requirements, a comparison of the economic growth forecast in the 2007 strategy with the actual economic growth between 2006 and 2015 was conducted (see Table 3-7). The forecasted high economic growth scenario was clearly overstated when compared to how the economy actually grew in the period until 2015. The economic growth forecast for the high growth scenario was based on the Accelerated and Shared Growth Initiative for South Africa (AsgiSA) target of 6%, which remains an aspirational target but one that has never been achieved.

Table 3-7. Comparison of economic growth forecasts and actual economic growth rates

Water requirement scenario	Economic growth rate forecast (% per annum) (2007 strategy)		Actual Economic growth rate (% per annum)		
	2006-2010	2010-2030	2006 - 2015	2015-2022*	2022 - 2042
High	4.50	6.00	3.00	1.80	4.50
Low	4.00	4.00	3.00	1.00	2.50

Source: Determination of future water requirements, June 2007 / Provincial Economic Review and Outlook, 2017

4 UPDATING OF PREVIOUS WATER ABSTRACTIONS BY THE DOMESTIC SECTOR IN THE WCWSS

4.1 General

One of the drivers influencing the current and future water requirements of the WCWSS is the historic water use trends based on the water resource abstraction records and the changes in the unit consumption of the different domestic water users. The causal / structural econometric model to determine future water requirement growth rate forecast could then be developed from understanding these drivers: the population projections as discussed in the previous chapter, the socio-economy of the system, climate and weather on water use as these are encompassed in the historical unit consumption.

Comparisons between the changes in the population for the different sub-areas of the WCWSS were made with the historical water requirements and are discussed in the sections below. The changes in the unit consumption per capita per day in the different sub-areas were determined and the causes of the changes in the unit consumption are also discussed. They form the basis for the updating of the future water requirements forecasts of the different sub-areas of the WCWSS.

4.2 Historical Water Requirements and current allocations for the City of Cape Town

4.2.1 Water Allocations

The City of Cape Town is supplied by 14 dams with a collective capacity of approximately 900 million m^3/a. Most of this capacity is provided by six large dams: the Theewaterskloof, Voëlvlei, Berg River, Wemmershoek, and the Steenbras Upper and Lower dams.

The remaining dams are much smaller and only contribute 0.4% to total capacity. The three largest dams are owned or managed by the National Department of Water and Sanitation.

Groundwater is also an important water resource for the City of Cape Town. Drinking water is sourced from the Silverstroom springs at the Silverstroom weir, while Atlantis, on the West Coast, is supplied with drinking water extracted from the Atlantis Aquifer. This is pumped from boreholes at the Witsand and Silverstroom wellfields. The Cape Flats aquifer is an important source of irrigation water for vegetable farming in Philippi.

The Table Mountain Group Aquifer is being investigated as a potential future source of drinking water. It is a large aquifer, part of which extends under the mountain ranges to the east of the city, although not under Table Mountain itself. Many sports fields and other properties in Cape Town have private boreholes for irrigation. The practice is supported by the City of Cape Town as it helps to reduce the demand placed on the municipal drinking water supplies.

Many springs exist in Cape Town, especially in areas close to Table Mountain and in the Gordon's Bay and Atlantis areas. Many of these springs played an important historical role in providing drinking water. Albion Spring in Newlands is still in use today and water from this spring is pumped into the city's drinking water network. However, most springs are currently used for irrigation purposes (City of Cape Town, 2018).

The total allocation for the City of Cape Town from the WCWSS is 385.9 million m^3/a, according to information provided by the City. This **includes** the allocation of 81 million m^3/a from the Berg River Dam for which a licence has been applied for but has not been granted by the DWS. According to records of the Department of Water and Sanitation (DWS), the registration of allocations from the Departmental-owned infrastructure amounts to 210.9 million m^3/a, excluding the Berg River Dam, which is in line with the figures captured in the Berg Water Project (BWP) Agreement (see Table 4-1).

It is noted that the application for an allocation from the Berg River Dam is for 81 million m^3/a, while the yield of the dam was given as 80 million m^3/a prior to the Berg Water Availability Assessment Study. Currently the dam's total yield has been licenced to the TCTA, who was the implementing agent for the design and construction of the Berg River Dam.

Table 4-1. Registered/licensed water abstraction and allocations for the City of Cape Town's bulk distribution systems (kℓ/a)

Resource Name	Ownership	Agreement/Licence	Current Allocations
Berg River Dam	DWS owned	Licence pending	81 000 000
Berg River (Voëlvlei Dam)	DWS owned	BWP agreement*	70 400 000
Theewaterskloof Dam, fixed volume	DWS owned	BWP agreement	90 000 000
Theewaterskloof Dam, variable volume	DWS owned	BWP agreement	28 000 000
Palmiet River (Rockview & Kogelberg dams)	DWS owned	BWP agreement	22 500 000
Upper and Lower Steenbras Dam	CCT owned		40 000 000
Wemmershoek Dam	CCT owned		54 000 000
Total variable allocation for CCT from WCWSS			385 900 000
Small dams	CCT owned		6 300 000
Albion Spring	CCT owned		1 500 000
Atlantis Aquifer	CCT owned		5 000 000
Total allocation for CCT from own sources outside the WCWSS			12 800 000
Total variable allocation for CCT from all sources			398 700 000
Total fixed allocation for CCT from WCWSS			357 900 000

*Note: The BWP Agreement refers to the Raw Water Supply Agreement of April 2003 between the DWAF and CCT with respect to the Berg River Water Project (DWAF, 2003)

Clause 10.6 of the Raw Water Supply Agreement (DWAF, 2003) stated: *"Until such time as the full yield of the BWP is allocated, the City will be allocated all the water in the BWP that has not been allocated to other water users. An allocation to third party users will decrease the allocation to the City by the proportionate amount allocated to third party users."* Hence, a possible allocation to the West Coast District Municipality would reduce the City of Cape Town allocation.

The Agreement in Clause 5.2 requires that a licence application be submitted for the water that has been allocated from the BWP in terms of the Raw Water Supply Agreement. The City has submitted this licence application and is waiting for a decision by the Department of Water and Sanitation on the application.

An addendum to the Raw Water Supply Agreement between the Department of Water and Sanitation and the City of Cape Town was signed about 6 years ago, that changed the volume basis for the BWP Capital Charge from water bought from government water sources in the WCWSS, to:

CCT Requirements from Government Water Schemes + CCT own sources = Total CCT Requirements.

The charge by the TCTA to the City of Cape Town is therefore based on their total water use, which includes water from the City's dams which are part of the WCWSS (i.e. Steenbras dams and Wemmershoek Dam) plus the smaller dams such as those on Table Mountain and the Atlantis Wellfield.

The allocation from the Theewaterskloof Dam of 118 million m^3/a includes a temporary transfer of water use of 28 million m^3/a that was originally allocated to the agricultural sector, but not taken up at the time of the agreement (DWAF, 2003). The agreement stipulates that this additional allocation is variable depending upon the uptake by the agricultural sector, and might be reduced over time:

"CCT was also granted an additional temporary allocation by DWAF in 1989 based on that portion of the allocation to Agriculture, which was not being utilised, until such time as agriculture utilized such portion.

A part of the latter is considered as existing lawful water use in terms of the blanket declaration for Agriculture in terms of section 33 declaration by the minister for scheduled water use by irrigation boards and government water schemes. However, it also comprises existing lawful water use for CCT, to be utilized on a temporary basis, subject to water availability. This temporary yield allocation must be re-assessed on an annual basis."

However, current legal opinion indicates that the temporary allocation is not considered existing lawful use, until this has been confirmed through a verification and validation (V&V) process or compulsory licensing.

According to the BWP Agreement, the volume of 28 million m^3/a, temporarily allocated to the City, comprises an agricultural allocation of 17.6 million m^3/a, not utilised at the time of drawing up the agreement, and an irrigation surplus of 10.4 million m^3/a, which was meant to be available for additional allocation to the agricultural sector. Hence, the temporary allocation is not available as fixed allocation to the City. However, the full volume of 118 million m^3/a from the Theewaterskloof Dam is registered with the Department of Water and Sanitation to the City for billing purposes (i.e. 90 million m^3/a fixed allocation plus 28 million m^3/a temporary allocation). Since the conclusion of the BWP agreement a volume of 10.86 million m^3/a has been allocated as licences to the agricultural sector for 100% BEE projects, which relates to an additional water requirement of 14.5 million m^3/a from the system, including losses.

The temporary allocation could be made available to the City on application of a licence, if the volume is not allocated to other users at the time of compulsory licensing. The temporary allocation is an existing water use and the investment already made by the City can be used as motivation in the application for licences.

4.2.2 Historical water requirements

As indicated previously, the City of Cape Town is historically, by far the largest water user by volume of any sector, including irrigation agriculture, in the WCWSS. In 2015, the City accounted for 82.26% of the domestic water requirements. The raw water abstraction records from the surface water resources (i.e. City's own sources and raw water bulk purchase from Department of Water & Sanitation) and groundwater resources of the WCWSS for the City of Cape Town from 2010 to 2017 is illustrated in Table 4-2**.**

Table 4-2. Historical bulk water use of the City of Cape Town (million m³/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010-2017
Local Surface water abstraction	140.0	124.0	130.0	101.0	115.0	95.0	99.0	60.0	-7.46%	-11.4%
Run of River Abstraction	-	-	-	-	-	-	-			
Groundwater Abstraction	6.1	3.0	1.0	1.0	1.0	1.0	1.5	2.2	-30.4%	-13.6%
Water Reuse for Potable Supply	-	-	-	-	-	-	-			
Desalination (Sea Water)	-	-	-	-	-	-	-			
Other Raw Water Resource /Purchased	184.0	209.0	192.0	218.0	198.0	256.1	221.0	195.0	6.84%	0.8%
Subtotal	330.1	336.0	323.0	320.0	314.0	352.1	321.5	257.2	1.30%	-3.5%

The steep increase in water requirements in the 2014/15 can be attributed to the hot and dry summer, which resulted in water users increasing water consumption for gardening and showering. The total historical water requirements increased at an annual average growth rate of 1.3% per annum between 2009/10 and 2014/15. This declined to -3.5% per annum because of the severe water restrictions imposed on the Water Supply System due to the drought in 2016.

Due to the low storage levels in the dams of the WCWSS, the City of Cape Town voluntarily imposed Level 2 water restrictions with effect from 1 January 2016. This positively contributed to reducing the seasonal and peak water consumption over the summer period.

At the Stakeholder Operating Forum (SOF) meeting held on 16 November 2016 the committee members agreed to a 20% and 30% restriction on domestic/industrial and irrigation supply respectively, which was formally gazetted on 10 May 2017. This explains the drop in the water requirements for the year 2016/17.

A media statement released on 4 October 2017 increased the level of restrictions in this planning/operating year to a 40% and 50% restriction on domestic/industrial and irrigation supply respectively and as a result the projections for 2017/18 are to see a similar drop

Figure 4-1 provides a historic trend of the changes in unit consumption per capita for the City of Cape Town while **Figure** 4-2 illustrates the seasonal pattern of water use/requirements for the City. The unit consumption for the City was developed based on the historical raw water abstraction records and the population over the same period.

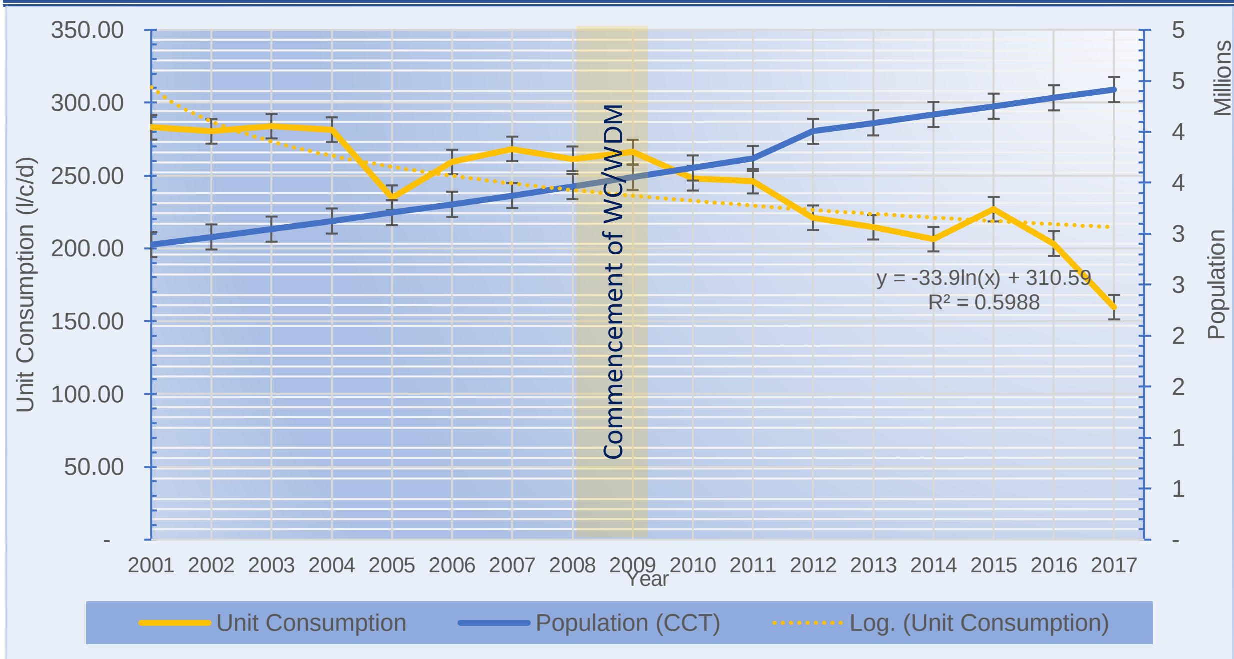

Figure 4-1: Change in unit consumption with change in population for the City of Cape Town

A review of the unit consumption per capita indicates that there has been a significant decrease in the average per capita consumption by the City from 2009 to 2015, at annual average abstraction rate of -2.6% per annum over the period. There has been a sharp decline in the unit consumption per capita/household from 266.06 l/c/d in 2009 to 226.91 l/c/d in 2015, a reduction of 15% in per capita water requirements based on the available information. Two issues that could attribute to the significant decline in the raw water abstraction, particularly between 2007 and 2015, are as follows:

- The most significant decrease in unit consumption started from around 2009 until 2014. This coincided with the period during which the City was involved in the implementation of a comprehensive Water Conservation and Demand Management (WC/WDM) intervention programme. The programme was aimed to reduce system losses (i.e. both physical and commercial losses) in its water supply network. The successful implementation of the comprehensive WC/WDM intervention programme which started to reflect a reduction by 2009 was not sufficiently accounted in the future water requirement growth forecast, resulting in overstating the additional water requirement of the City.

- Economic growth was hampered by external factors such as institutional, policy, uncertainty and governance issues, resulting in a lower than expected growth. The forecasting of the economic growth rate of 4.5% to 6% per annum was hence overstated in the previous water requirement growth fore.

Figure 4-2, indicates a very pronounced seasonal pattern to water use, with the bulk water abstraction in summer around 28% higher than winter. This is because the WCWSS is dependent on winter rainfall between May and September which reduces the abstraction from the dams in the system during normal rainfall season.

Given the extensive WC/WDM implemented since early 2007, the additional improvements in water efficiency will likely occur though capital expenditure on the water supply network (such as renewals) to maintain low leakage rates, and mandated levels of water efficiency for new and renovated houses. The extent of implementing additional interventions will be reviewed as part of the updating of the water reconciliation strategy for the WCWSS.

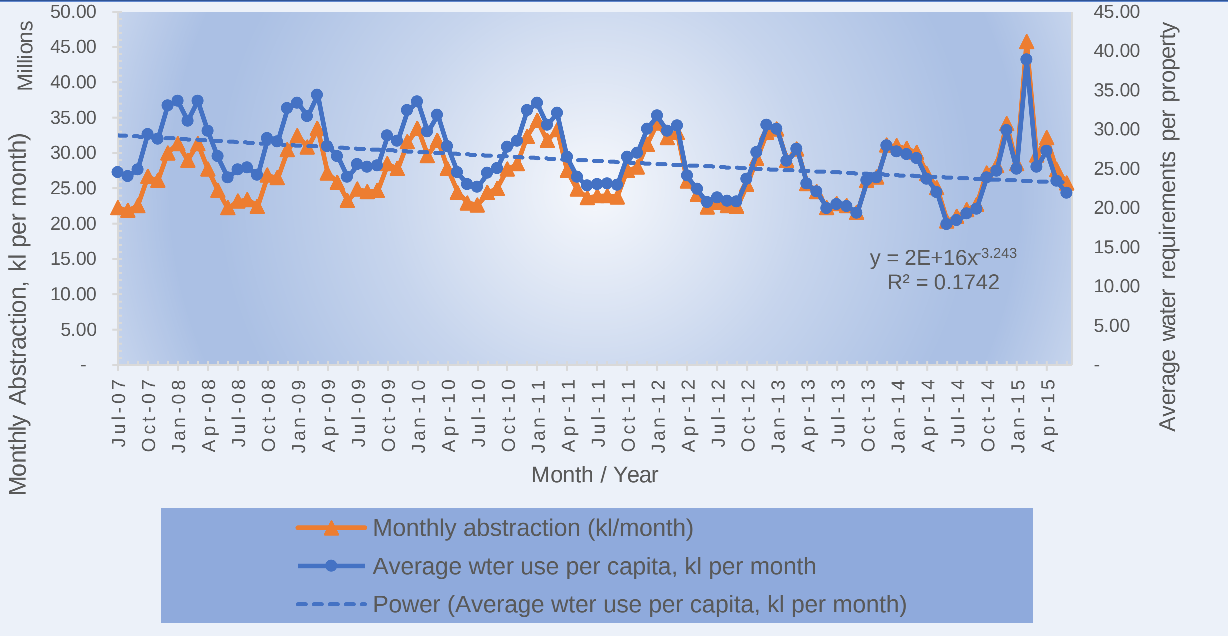

Figure 4-2: Average monthly water use, kl per month

4.3 Historical Water Requirement patterns and water allocation of the West Coast District Municipality

4.3.1 Water Allocations

The West Coast District Municipality is the bulk water services provider for the southern West Coast region through an extensive bulk distribution system.

The system consists of the Swartland Scheme in the south of the region, and the Management Scheme in the north. The Swartland Scheme supplies bulk water from the Voëlvlei Dam via the Voëlvlei WTW to the towns of Hermon and Gouda in the Drakenstein Municipal area, and to the towns of Riebeek West, Riebeek Kasteel, Malmesbury (including Chatsworth, Riverlands, Abbotsdale and Kalbaskraal), Darling, Yzerfontein, Moorreesburg and Koringberg in the Swartland Municipality.

The Misverstand Scheme supplies bulk water from the Misverstand weir via the Withoogte WTW to the towns of Velddrif and Dwarskersbos in the Berg River Municipality, and to Hopefield, Langebaan, Saldanha Bay, Vredenburg, Paternoster, St Helena Bay and Stompneusbaai in the Saldanha Bay Municipality. The Misverstand Scheme is augmented with extraction from the Langebaan Road aquifer at Langebaan Road.

The current raw water allocations from the various sources for the West Coast District Municipality's bulk distribution systems are given in **Table** 4-3.

Table 4-3. Allocations for the West Coast District Municipality's bulk distribution systems (kℓ/a)

Water use activity	Maximum volume (m^3/a)	Water Services Authority
Taking water from Berg River (Voelvlei Dam)	7 900 000	Swartland
Taking water from Berg River (Voelvlei Dam)	300 000	Drakenstein
Total: Voelvlei Dam	8 200 000	

Water use activity	Maximum volume (m^3/a)	Water Services Authority
Taking water from Berg River (Misverstand Dam)	20 427 000	Saldanha
Taking water from Berg River (Misverstand Dam)	1 573 600	Swartland
Taking water from Berg River (Misverstand Dam)	1 439 400	Berg River
Total: Misverstand Dam	23 440 000	
Total Allocation for West Coast DM from the surface water resources	31 640 000	
Groundwater allocation		
Langebaan Road Boreholes	1 500 000	
Hopefield Aquifer boreholes	160 000	
Total Groundwater	1 660 000	
Total water allocation	33 300 000	

The current licence allows the West Coast District Municipality to abstract a maximum of 23.4 million m^3/a from the Misverstand Weir. It is not clear whether the allocation includes the river losses between the Voëlvlei Dam and Misverstand Weir.

4.3.2 Historical water requirements

Table 4-4 provides the historical water requirements of the West Coast District Municipality from the 2009/10 hydrological year to the 2016/17 hydrological year.

The historical water requirements for the three municipalities in the District dependent on the WCWSS has been decreasing at an annual average growth rate of 0.4% per annum between 2010 and 2017. The growth in water requirements increased at 2.56% per annum between 2010 and 2015. However, the population growth rate was 3.15% per annum between 2010 and 2015 and 2.23% per annum between 2010 and 2017. The water requirements were growing at a lower rate than the growth in population in the West Coast District Municipality which is reflected in the decline in the unit consumption per capita over the same period (see **Figure** 4-3).

Table 4-4. Raw water abstraction by the West Coast DM including local resources (million m^3/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010-2017
West Coast towns- Withoogte	16.93	16.71	17.53	18.69	20.36	20.74	20.23	16.95	4.14%	0.0%
West Coast DM - Swartland	6.76	6.64	6.59	6.60	6.50	6.99	6.75	5.78	0.68%	-2.2%
West Coast DM - Groundwater	0.91	0.92	1.22	0.51	-	0.19	0.64	0.87	-26.8%	-0.8%
Saldanha Bay own source (Langebaan Aquifer)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50		
Saldanha Bay own source (Elandsfontein	-	-	-	-	-	-	-	-		

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010- 2017
Aquifer)										
Bergriver Own Source	-	-	-	-	-	-	-	-		
Swartland own source (emergency groundwater scheme)	-	-	-	-	-	0.20	0.20	0.20		
Groundwater (Elandsfontein Aquifer)										
Groundwater - Swartland emergency scheme					0.20		0.20			
Reuse										
Desalination										
Subtotal	26.11	25.76	26.83	27.30	28.56	29.62	29.52	25.30	2.56%	-0.4%

Figure 4-3 provides a historical water requirements trend based on the changes in unit consumption per capita for the municipalities in the West Coast District Municipality. Although the total historical water requirements in the sub-area has been increasing consistently with the increase in population, the average annual per capita consumption has not increased significantly over the same period.

The annual average per capita consumption declined from 271.98 l/c/d in 2010 to 264.3 l/c/d in 2015. During this period, the sub-area improved its water use efficiency as it was supplying more population. It is not very clear the relative contributions of implementing WC/WDM, regulations, greater urban density and other factors to the fall in consumption. When the current drought period of 2016 -17 is included in the historical unit consumption assessment the average per capita consumption decreases 219.19 l/c/d. This is not representative of the unit consumption under constraint.

From 2009 to 2015, West Coast District Municipality's per capita water consumption fell by -2.8%. Because of the 2016 – 2017 drought situation, the unit consumption significantly declined by -19.4 since 2010. It is not clear the extent to which the unit consumption will bounce back to during unconstraint demand. It is also not clear as to the extent of the deteriorating condition of the bulk water infrastructure, to the rise in consumption.

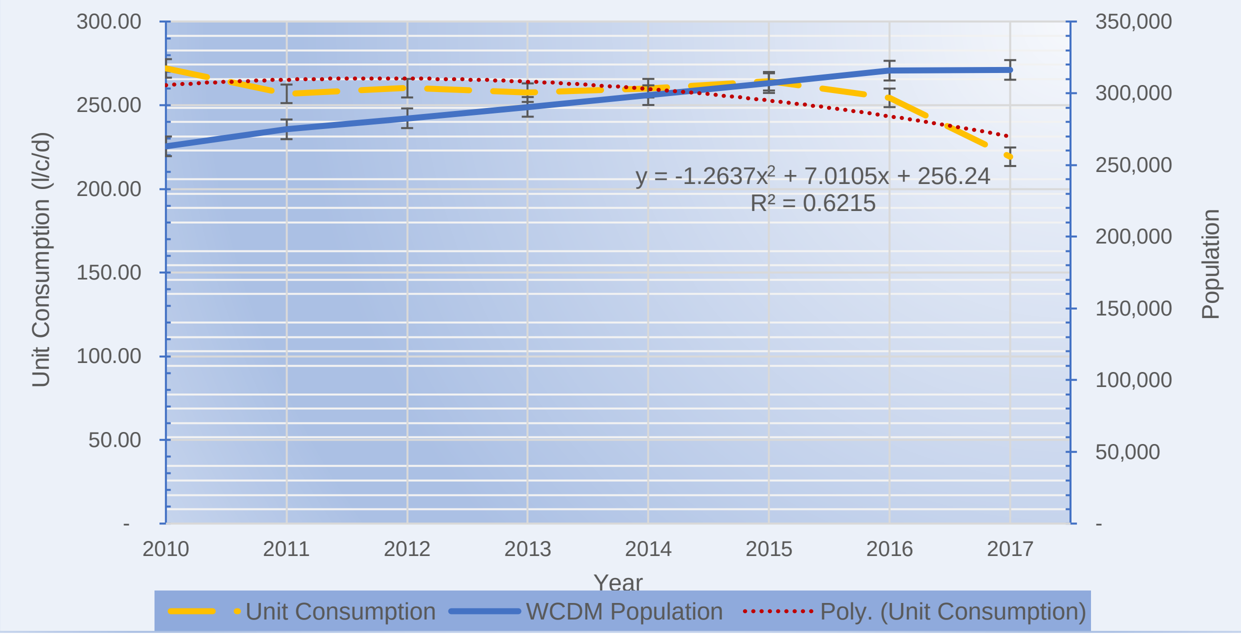

Figure 4-3: Change in unit consumption with change in population for the West Coast District Municipality

4.4 Historical water requirements and allocations of the Drakenstein Municipality

4.4.1 Water Allocations for Drakenstein Municipality

The Paarl and Wellington distribution system is an integrated system, with a large component of their potable water supply from the Wemmershoek Scheme and the balance from the Municipality's own sources, which include the Berg River, Bethel and Nantes dams and the Antoniesvlei. Saron and Bainskloof are also supplied with bulk raw water from the Municipality's own sources. Gouda is supplied with potable water by the West Coast District Municipality from their Swartland WTW. The current allocations for the towns in the Drakenstein Municipality's management area are given in **Table** 4-5.

The allocation for Paarl from the Berg River comprises two components; namely 1.17 million m^3/a during summer and 0.94 million m^3/a during winter. The summer water allocation is considered part of the WCWSS, as it would require releases from the Berg River Dam. The winter water allocation is not part of the Water Supply System requirements.

Table 4-5. Allocations for the towns in the Drakenstein Municipality (kℓ/a)

Town	Resource Name	WARMS Registration	Registered Volume
Paarl and Wellington	Wemmershoek	CCT Agreement	27 900 000
Paarl	Nantes and Bethel dams	No. 22058657	200 000
Paarl	Berg River	No. 22087162	2 109 000
Wellington	Antoniesvlei / Withoogte	No. 22058675	403 000

Town	Resource Name	WARMS Registration	Registered Volume
Saron	Leeu River (Klein Berg River)	No. 22075923	465 415
Total registered volume			31 077 415

4.4.2 Historical water requirements

Table 4-6 provides the historical water requirements of the Drakenstein Municipality from the 2009/10 hydrological year to the 2016/17 hydrological year. Drakenstein Municipality is the third largest domestic water user by volume historically in the WCWSS. In 2015, the total historical water requirements by the municipality including the bulk purchase of water from the City of Cape Town was 18.7 million m^3/a, which was 4.4% of the total domestic water requirements in the system.

Table 4-6. Raw water abstraction by the Drakenstein Municipality including local resources (million m^3/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010-2017
Paarl/Wellington local sources - Bethel & Nantes	-	-	-	-	-	-	-	-		
Paarl/Wellington Local source - Antoniesvlei Diversion	-	-	-	-	-	-	-	-		
Paarl/Wellington -CCT Bulk Purchase (Wemmershoek Dam)	-	-	-	-	-	-	-	-		
Sub-Total Raw water abstraction	16.01	16.65	16.82	17.11	18.41	17.82	20.54	16.40	2.17%	0.3%
Salon System- Raw water from Leeu River	0.39	0.59	0.56	0.57	0.62	0.68	0.61	0.61	11.6%	6.7%
Gouda System – WCDM Bulk purchase - Voelvlei	-	0.02	0.17	0.19	0.22	0.20	0.20	0.20		
Hermon System - CCT bulk purchase (Voelvlei Dam)	-	-	-	-	-	-	-	-		
Bainskloof System - RoR abstraction - Wit River	-	-	-	-	-	-	-	-		
Subtotal	16.40	17.26	17.55	17.87	19.25	18.70	21.36	17.22	2.7%	0.7%

Source: Page 62 of Drakenstein Municipality – Annual Report 2016/17

The historical water requirements increased significantly at 2.7% per annum between 2010 and 2015 while the population growth rate was 2.2% per annum over the same period. Because of the water restriction due to the 2016 -17 drought, the total water requirements shows a decrease to 0.7% from 2009/10 hydrological year. The water requirements were growing at a higher rate than the growth in population in the Drakenstein Municipality.

Figure 4-4 below provides a historic trend of the changes in unit consumption per capita for the schemes in the Drakenstein Municipality. It would appear that the unit consumption has been increasing at a higher rate than the growth in population since 2013.

The annual average per capita consumption has been declining between 2001 and 2015 at an average decrease of -1.65% per annum and with an increase between 2007 and 2015 at 0.11% per annum. The average per capita water use declined by -4.9% between 2010 and 2015 from 196.97 l/c/d to 187.24 l/c/d.

The extent and relative contributions of implementing WC/WDM, the municipality's plans to reduce the purchase of bulk water from the City of Cape Town, changes in regulations, greater urban density and other factors contributing to the decrease in the unit consumption is not clear.

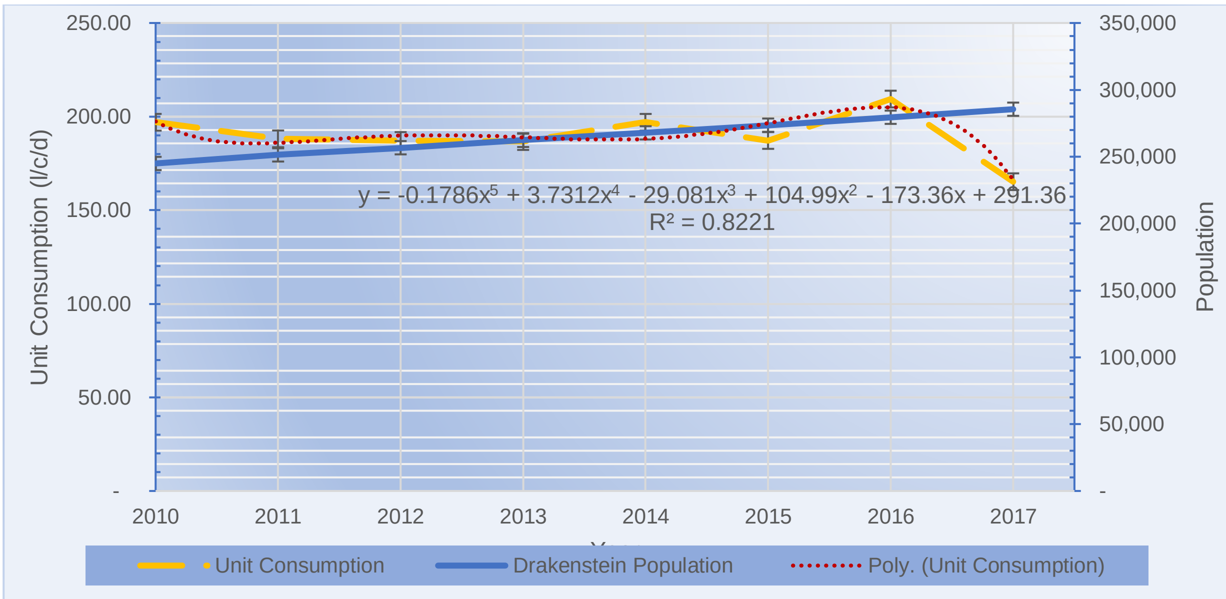

Figure 4-4: Change in unit consumption with change in population for the Drakenstein Municipality

4.5 Historical water requirements and water allocation of the Stellenbosch Municipality

4.5.1 Water Allocations

The Stellenbosch area is supplied with raw water through the following five water supply systems:

- Stellenbosch (Jonkershoek and Theewaterskloof tunnel);
- Franschoek;
- Wemmershoek (treated water imported from City of Cape Town);
- Blackheath (treated water imported from City of Cape Town);
- Faure (treated water imported from the City of Cape Town).

The WTW at Wemmershoek, Blackheath and Faure fall within the sphere of responsibility of the City of Cape Town. The City provided potable water of approximately 9.78 Ml/d during the financial year 2016/2017, ensuring a supply of approximately 34.21 Ml/d to the LM. Stellenbosch Municipality manages three water treatment works, namely Ida's Valley, Paradyskloof and Franschhoek. The potable water supply from these treatment works amounted to approximately 24.43 Ml/d in the 2016/2017 financial year (Stellenbosch Municipality, 2017).

The areas supplied from the Wemmershoek WTWs include half of Franschhoek town, La Motte, Wemmershoek, Pniel, Boschenda, Johannesdal, Kylemore, Lanquedoc, Klapmuts, Koelenhof, Elsenburg, Devon Valley and Muldersvlei. Areas supplied from Blackheath WTW include

Polkadraai, Spier and Vlottenburg. Areas supplied from Faure WTW are Faure, Jamestown, De Zalze, Raithby and Lynedoch. (Stellenbosch Municipality, 2017).

Water from the Eerste River in the Jonkershoek Valley is diverted by means of a weir and a gravity pipeline to two off-channel storage dams in Ida's Valley. The registered abstraction from this source is 7.224 million m³/a. During the summer water is being drawn from the Theewaterskloof scheme. This is obtained via a pipeline leading from the Stellenboschberg Tunnel outlet to the Paradyskloof WTW. A volume of 3 million m³/a is available from this source.

Franschhoek, which includes the smaller settlements of Groendal, La Motte, Wemmershoek and Robertsvlei is currently supplied with water from local sources in the catchments of the Mount Rochelle Nature Reserve and Perdekloof and with potable water via the City of Cape Town from the Wemmershoek Dam. Robertsvlei is supplied from a single borehole. The WARMS registrations for the perennial streams in the Mount Rochelle Nature Reserve is 0.221 million m³/a, for the Perdekloof Weir 0.577 million m³/a and for the Du Toits River 0.104 million m³/a (seeTable 4-7).

Table 4-7. WARMS registrations for the towns in Stellenbosch Municipality's management area (m^3/a)

Town	Source	WARMS Registration	Registered Volume
Franschhoek	Perdekloof Weir	22059237	576 648
	Mount Rochelle Fountain	22078305	220 752
	Du Toits River	22059433	103 680
	Wemmershoek (CCT)	CCT Agreement	Not fixed
Dwarsrivier	Wemmershoek (CCT)	CCT Agreement	Not fixed
Klapmuts	Wemmershoek (CCT)	CCT Agreement	Not fixed
Stellenbosch and Rural Areas	Theewaterskloof	22095527	3 000 000
	Jonkershoek	22059898	7 224 000
	Theewaterskloof and upper Steenbras (CCT)	CCT Agreement	Not fixed

The Dwarsrivier system includes Pniel, Kylemore, Lanquedoc, Johannesdal and Groot Drakenstein. These areas are supplied with potable water from the Wemmershoek Dam by the City of Cape Town. The local sources, which are currently not in use, include the Pniel Mountain Stream (0.053 million m³/a), Pniel Spring (0.025 million m³/a) and the Pniel Kloof Street Borehole (0.079 million m³/a).

4.5.2 Historical water requirements of Stellenbosch Municipality

Stellenbosch Municipality is the fourth largest domestic water user by volume historically in the WCWSS. In 2015, the total water requirements by the municipality including the bulk purchase of water from the City of Cape Town and its own bulk water supply systems was 13.75 million m^3/a, which was 3.22% of the total domestic water requirements in the system (see **Table** 4-8).

The growth in population between 2010 and 2015 was determined at 2.04% per annum increasing to 2.48% per annum between 2010 and 2017. The water requirements grew at an average annual growth rate of 5.4% between 2010 and 2015, but this declined to 1.1% between 2010 and 2017. This is attributed to the current drought which started in 2016.

Table 4-8. Historical water requirements of Stellenbosch Municipality (million m^3/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010-2017
Surface water - Bulk water purchase - CCT	2.94	3.92	4.05	4.26	4.29	4.20	4.17	3.49	7.37%	2.5%
Surface water - local sources	7.63	7.65	7.37	7.32	8.97	9.56	9.58	7.90	4.61%	0.5%
Groundwater	-	-	-	-	-	-	-	-		
Reuse										
Desalination										
Subtotal	10.57	11.57	11.41	11.58	13.26	13.75	13.75	11.39	5.41%	1.1%

Figure 4-5 below provides a historic trend of the changes in unit consumption per capita for the schemes in the Stellenbosch Municipality. It would appear that the unit consumption has been increasing at a higher rate than the growth in population since 2013. The annual average per capita consumption had been increasing between 2010 and 2015 at an average annual growth rate of 3.3% per annum from 191.21 l/c/d in 2010 to 224.87 l/c/d in 2015. The average per capita has been declining from 2015 at -1.38% 173.58 l/c/d in 2017. This can be attributed to the current drought in the Western Cape Province.

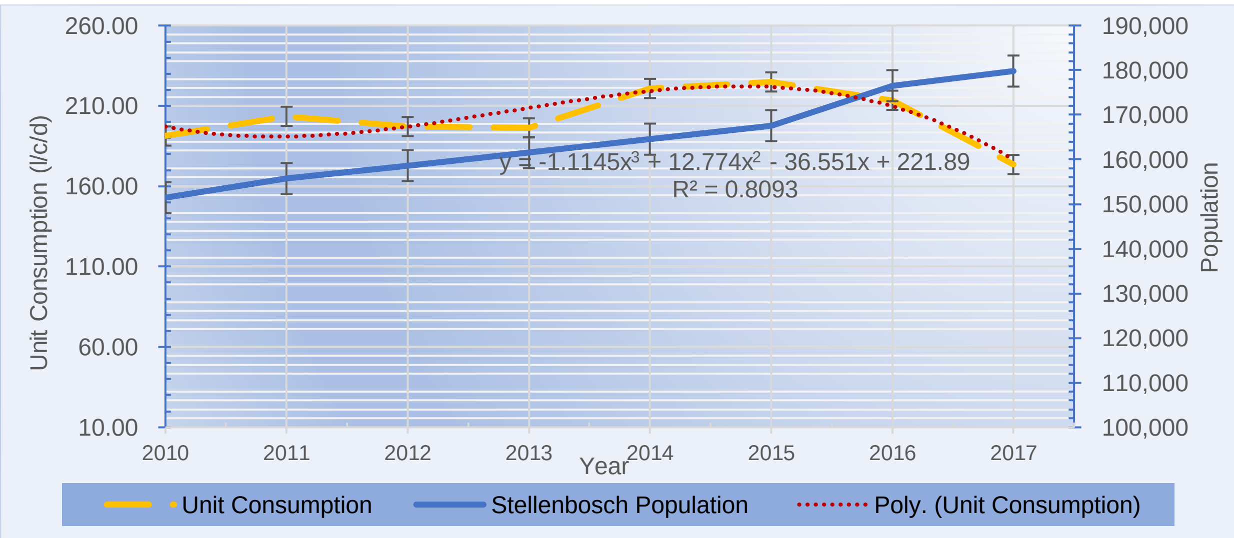

Figure 4-5: Change in unit consumption with change in population for the Stellenbosch Municipality

4.6 Historic and current water use/requirements of the Witzenberg Municipality

4.6.1 Water Allocations

Although a large part of Witzenberg Municipality is located in the Breede River catchment, there is a possibility that an identified future reconciliation strategy option is the development of a transfer scheme from the Breede to the Berg River system. This will impact on the supply of water to the Witzenberg Municipality.

All the towns in the Witzenberg municipal area are equipped with independent water services with their own resources, distribution systems and treatment works.

The main water source for Ceres is the Koekedouw Dam, Six (6) boreholes serve as a backup source of supply. The Klein Berg, Moordenaarskloff and Tierkloof serve as the main sources of water supply to Tulbagh. One borehole at Kruysvallei serves as a back-up emergency supply to Tulbagh. Wolseley receives it water supply from the Tierkloof weir. Prince Alfred's Hamlet has four water sources, namely the Wabooms River weir, a fountain, one borehole and a supply line from the Koekedouw Dam. Op-die Berg has three water sources, a fountain and two boreholes. (Witzenberg Municipality, 2017).

There was no data available on the water allocations for the Witzenberg Municipality, other than an allocation of 0.3 million m^3/a from the Voelvlei Dam, supplied by the West Coast District Municipality.

4.6.2 Historical Water Requirements of the Witzenberg Municipality

In 2015, the total water requirements by the municipality including the bulk purchase from the West Coast District Municipality and its own bulk water supply systems was 7.93 million m^3/a, which is 1.94% of the total domestic was in the system (see Table 4-9).

The growth in population between 2010 and 2015 was determined at 2.6% per annum but is slightly lower for the between 2010 and 2017 at 2.46% per annum. The historical water requirements grew at an average annual growth rate of 2.69% per annum between 2010 and 2015, but this declined to 0.7% per annum between 2010 and 2017. This is attributed to the current drought which started in 2016

Table 4-9. Historical water requirements of Witzenberg Municipality (million m^3/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010- 2017
From Berg River System										
From Breede River System - Koukebow Dam										
Groundwater										
Reuse										
Desalination										
Subtotal	6.94	7.12	7.47	7.60	7.67	7.93	7.05	7.29	2.69%	0.7%

Source: Witzenberg Municipality Annual Reports

Figure 4-6 provides the historic trend of the changes in unit consumption per capita for the schemes in the Witzenburg Municipality. Although the total water use increased at the same average rate as population growth of 2.69% per annum, the unit consumption per capita increased slightly at an average annual rate of 0.09% per annum over the 2010 - 2015 period. The average per capita water requirements increased from 169.6 l/c/d in 2010 to 170.39 l/c/d in 2015, with a significant decline in 2017 to 150.27 l/c/d as a result of water restrictions due to the drought.

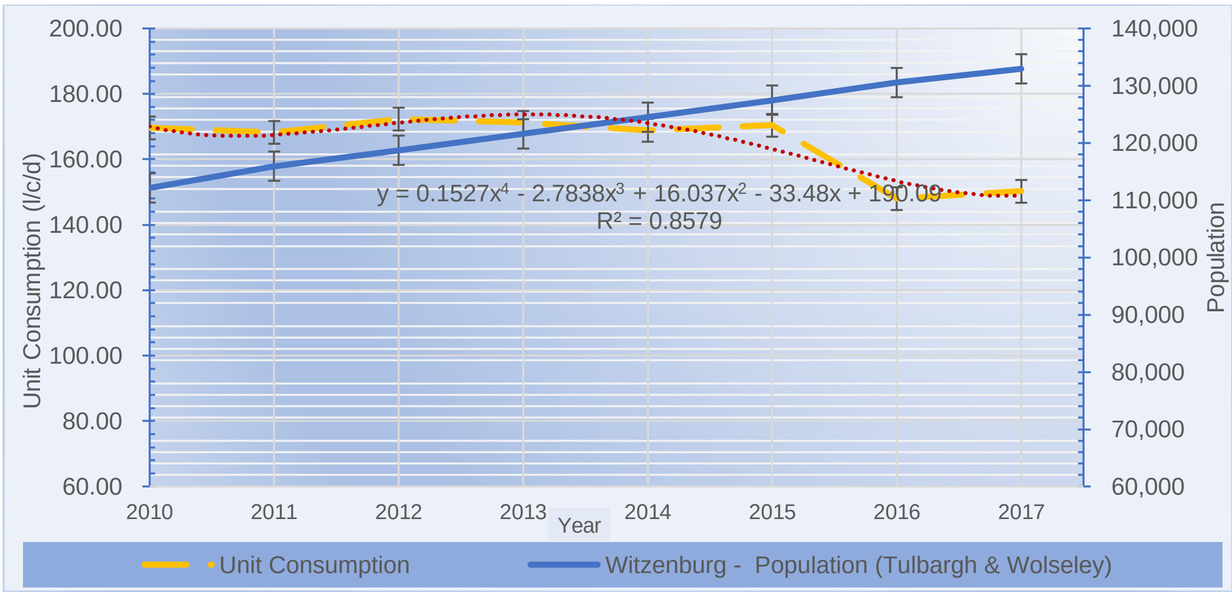

Figure 4-6: Change in unit consumption with change in population for the Witzenburg Municipality

4.7 Historic and current water use/requirements of the Overberg Water supply area

Overberg Water is the bulk service provider for the schemes in the Overberg District Municipality. Theewaterskloof Municipality, which falls in the Overberg District, is dependent on the Theewaterskloof Dam, which is a major dam in the WCWSS.

Based on the available data, the total historical water requirements of the Theewaterskloof Municipality was 5.14 million m^3/a, which was 1.2% of the total domestic water use in the system in 2015 (see **Table** 4-10**)**.

Table 4-10. Historical water requirements of Theewaterskloof Municipality (million m^3/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017	Growth Rate	
									2010 - 2015	2010-2017
Surface water (Overberg Water)	3.41	4.55	4.30	4.91	5.28	5.14	5.73	5.95	8.51%	8.2%
Subtotal	3.41	4.55	4.30	4.91	5.28	5.14	5.73	5.95	8.51%	8.2%

Figure 4-7 provides the historic trend of the changes in unit consumption per capita for the supply area in the Theewaterskloof Municipality. There was historical water use data from 2008 to current. The total historic water use in the sub-area increased at an annual growth rate of 3.6% per annum from 4.01 million m^3/a to 5.14 million m^3/a between 2008 and 2015. During the same period, population grew at a slower pace at 1.7% per annum and the unit consumption per capita increased at an average annual rate of 1.86% per annum. The average per capita water use increased by 13.78% between 2008 and 2015 from 105.76. l/c/d to 120.34 l/c/d.

It is not clear whether the significant increase in the average per capita consumption was due to the Municipality remedying the water service backlog in the area, improvement in levels of water service provision, changes in regulations, or other factors.

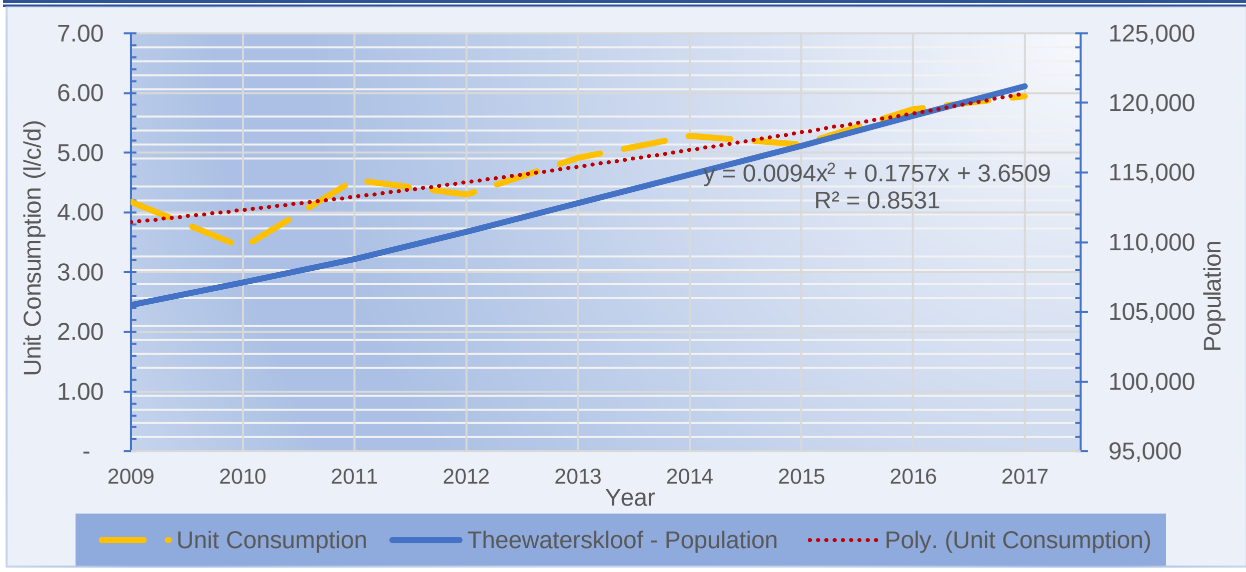

Figure 4-7: Change in unit consumption with change in population for the Witzenburg Municipality

4.8 Summary of the domestic water requirements

The total urban supply from the WCWSS is indicated in Table 4-11 and graphically represented in **Figure** 4-8**.** The data and information are not complete as there were no records of abstraction or use from some sources of supply. From the table it can be seen that:

- The City of Cape Town has the largest domestic water requirement in the Water Supply System, at approximately 80% of total water requirement. Besides supplying users in the Metropolitan, the City is a major bulk water seller to the Stellenbosch and Drakenstein Municipalities. This has been accounted for in the Stellenbosch and Drakenstein water use records and not in the City in order to avoid double counting.

- The main source of supply in the WCWSS is the surface water resources. The extent of groundwater abstraction and use is not obvious as groundwater abstraction records are not readily available for many supply areas in the Water Supply System.

- Although the total water requirements increased since 2007, the gross average per capita consumption for domestic water use in 2015 was 227 l/c/d. It is possible that this figure might be slightly higher if cognisance is taken of the limited abstraction records from local sources, particularly groundwater. It is important to note that the gross average per capita consumption declined by nearly 0.44% since 2010, when it was at 232.03 l/c/d in 2010, although population supplied by the WCWSS increased at an annual average growth rate of 2.05% per annum. The reasons for the decrease is discussed per Municipality in Chapter 3.

Table 4-11. Yearly raw water abstraction by Municipalities in the Western Cape Water Supply Area (million m³/a)

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017
Bulk Water - City of Cape Town	330.13	336.00	323.00	320.00	314.00	352.10	321.47	257.21
Bulk Water - Withoogte	16.93	16.71	17.53	18.69	20.36	20.74	20.23	16.95
Bulk Water - Swartland - Voevlei	6.76	6.64	6.59	6.60	6.50	6.99	6.75	5.78
Bulk Water - Drakenstein	16.01	16.65	16.82	17.11	18.41	17.82	20.54	16.40

Water Use Type	2010	2011	2012	2013	2014	2015	2016	2017
Bulk Water - Stellenbosch	2.94	3.92	4.05	4.26	4.29	4.20	4.17	3.49
Bulk Water - Witzenberg	6.94	7.12	7.47	7.60	7.67	7.93	7.05	7.29
Bulk Water - Theewaterskloof (Overberg)	3.41	4.55	4.30	4.91	5.28	5.14	5.73	5.95
Total Water Requirements WCWSS	383.13	391.58	379.75	379.17	376.52	414.91	385.94	313.07

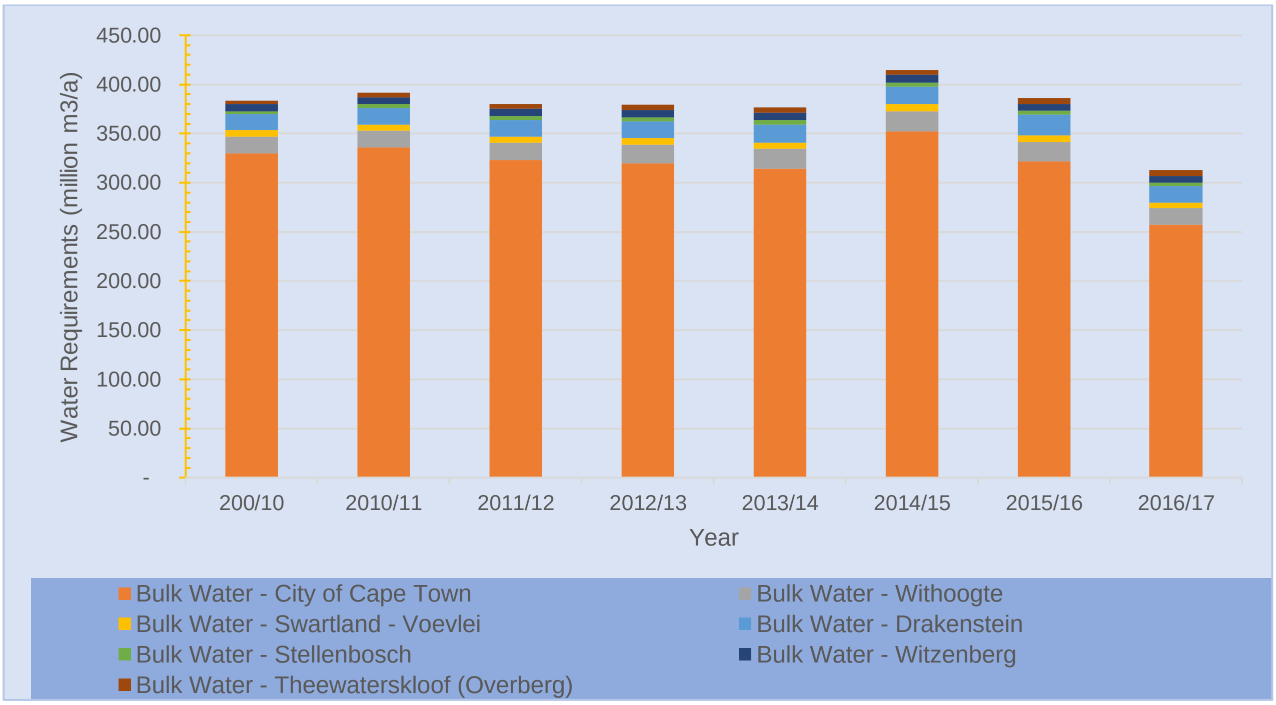

Figure 4-8: WCWSS historical urban water requirements

4.9 Industrial users

The Pretoria Portland Cement Company (PPC) has a registered allocation of 835 850 m^3/a to abstract water from the Berg River for industrial use at the PPC branch in Piketberg, as per the Authority for the Abstraction of Water No. 34/20/88 of 1 March 1988. The abstraction takes place from the Berg River near the N7 below the Misverstand Weir.

The Cape Portland Cement Company also has a permit for the abstraction of 850 000 m^3/a for industrial use in the area of Riebeek-Wes, to be taken directly from the Swartland Scheme pipeline (Authority No. 115/20/83). This allocation is considered to be in addition to the allocation to the West Coast District Municipality from the Swartland Scheme.

In addition to the scheduled agricultural water use within the Lower Berg River Irrigation Board, three other industrial users were registered with the Department of Water and Sanitation for abstraction from the Government Water Scheme with a total registered volume of 0.05 million m^3/a. These are Andre Serdyn, Lime Sales and Vogelvlei Yacht Club.

The Wynland Water User Association (WUA) has industrial water allocations of volumes equivalent to 32 ha and 229 ha for the Helderberg and Stellenbosch districts, respectively, which are now considered under domestic / industrial water use. This relates to a total allocation of 1.044 million m^3/a.

4.10 Irrigation Agriculture Water Requirement

4.10.1 Irrigation agriculture water users

The agricultural users within the Western Cape Water Supply Area, have been grouped into four areas, depending on source of water supply. The agricultural water users are provided in Table 4-12.

Table 4-12. Agricultural water users in the Western Cape Water Supply Area

Supply Zone	Irrigation Board/ Water User Association
Berg	Berg River Subdistrict 1, 2 and 3
	Suid-Agter Paarl
	Simondium
	Simonsberg
	Perdeberg
	Noord-Agter Paarl
	Groenberg Ward 1 and 2
	Riebeeck Kasteel
	Riebeek West Ward 1 and 2
	Lower Berg River
Stellenbosch tunnel	Wynland WUA
Riviersonderend	Zonderend
	Vygeboom
Theewaterskloof Dam	Theewaterskloof Dam

4.10.2 Water allocations

The capped allocation from the WCWSS for the agricultural sector (i.e. for irrigation and domestic use on the farms) was previously considered as 173.6 million m^3/a supplied at an assurance of 1:50 years. The total current agricultural allocations from the Water Supply Scheme are summarised in Table 4-13.

Table 4-13. Agricultural allocations (million m^3/a)

WUA / IB	BWP capped allocation	WRPM capped allocation	Registered volumes	WC WSS allocation	WC WSS requirement
Lower Berg IB	18.1	18.1	11.04	20.97	27.66
Additional approved licences	-	-	10.23	10.3	13.73
Upper Berg IB	58.6	58.6	73.63	73.09	58.60

<table>
<tr><th>WUA / IB</th><th>BWP capped allocation</th><th>WRPM capped allocation</th><th>Registered volumes</th><th>WC WSS allocation</th><th>WC WSS requirement</th></tr>
<tr><td>Additional approved licences</td><td>-</td><td>-</td><td>0.57</td><td>0.57</td><td>0.75</td></tr>
<tr><td>Compensation releases</td><td>-</td><td>16.5</td><td>-</td><td>-</td><td>16.50</td></tr>
<tr><td>Zonderend IB</td><td>31.5</td><td>31.5</td><td>35.92</td><td>36.11</td><td>41.46</td></tr>
<tr><td>Vyeboom IB</td><td>13.2</td><td>13.2</td><td>13.15</td><td rowspan="2">29.51</td><td rowspan="2">29.51</td></tr>
<tr><td>Pump from Theewaterskloof Dam</td><td>1.5</td><td>1.5</td><td>1.03</td></tr>
<tr><td>Banhoek IB and others</td><td>1.8</td><td>1.8</td><td>1.80</td><td>1.80</td><td>1.80</td></tr>
<tr><td>Users on Dasbos outlet</td><td>-</td><td>-</td><td>0.2</td><td>0.18</td><td>0.18</td></tr>
<tr><td>Wynland WUA: Stellenbosch District</td><td>12.0</td><td>12.0</td><td>12.04</td><td>11.91</td><td>11.91</td></tr>
<tr><td>Wynland WUA: Helderberg District</td><td>12.1</td><td>12.1</td><td>12.11</td><td>11.00</td><td>11.00</td></tr>
<tr><td>Wynland WUA: Eerste River District</td><td>3.1</td><td>4.3</td><td>1.65</td><td>3.15</td><td>3.15</td></tr>
<tr><td>Irrigation surplus</td><td>10.4</td><td>-</td><td>-</td><td></td><td>-</td></tr>
<tr><td>Overberg Water</td><td>-</td><td>4.0</td><td>-</td><td></td><td>-</td></tr>
<tr><td>Total</td><td>162.3</td><td>173.6</td><td>173.42</td><td>198.57</td><td>216.24</td></tr>
</table>

The allocations to the different agricultural users are defined at point of abstraction. If the flow in the river is not sufficient for abstracting, the irrigation boards and water user associations request the release of water from dams in the system. These releases are made and measured by the Department of Water and Sanitation. Most irrigation boards carry out their own measurements of the abstraction volume, which is then provided to the Department for billing purposes.

4.10.3 Agriculture Water Requirements

As part of the Raw Water Supply Agreement (DWAF CCT, 2003) concluded prior to the development of the Berg River Dam, the allocation to the agricultural sector allowed for growth in demand. The total allocation for agriculture was set in the Raw Water Supply Agreement at 162 Mm^3/a. Agriculture has subsequently been allocated more water with the total allocations currently at approximately 198.6 Mm^3/a (refer to Table 4-14). By 2015 most of the irrigation boards had grown into their allocations with only the Upper Berg, Heldeberg and Vyeboom Irrigation Boards not having reached their full allocation. **Figure** 4-9 illustrates the historic water use by the agricultural sector between 2010 and 2017.

Table 4-14. Agricultural use for the last three years (million m^3/a)

Water User Association / Irrigation Board	Allocation	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Berg River Scheme (Voëlvlei Dam & Misverstand Weir)									
Lower Berg IB	31.3	37.2	58.3	23.2	22.9	18.1	18.1	18.1	18.1
24 Rivers IB*		20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Riviersonderend / Berg River Scheme (Theewaterskloof Dam, Berg River Dam)									
Zonderend WUA	36.1	24.7	36.1	31.6	31.9	30.0	37.2	36.5	29.2
Vyeboom IB	13.5	9.6	10.8	8.4	8.9	8.0	9.3	10.0	8.8
Pump from Theewaterskloof Dam	16.0	1.5	1.5	1.5	1.5	1.5	1.8	7.5	7.5
Upper Berg IB	73.09	12.0	25.7	33.7	45.9	31.0	51.8	44.2	36.4
Banhoek IB / Dasbos	2.0	1.7	1.7	1.7	1.7	1.7	2.6	2.3	1.3
Helderberg IB + Stellenbosch IB	22.9	16.6	18.8	19.8	19.0	19.0	19.4	21.2	15.9
Wynlands WUA - Eerste River District	3.1	4.1	4.1	4.1	4.1	4.1	3.0	3.2	2.2
Compensation release		16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
Total	198.6	143.9	193.5	160.5	172.4	149.9	179.7	179.5	155.9

Note: Data on agricultural use prior to 2016/17 are not fully available

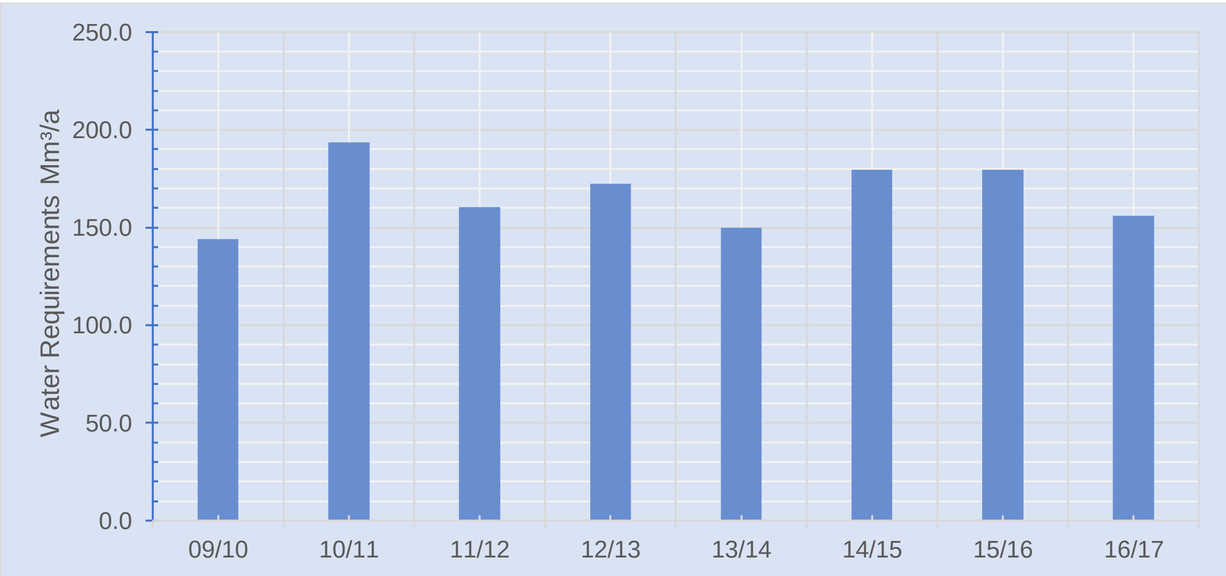

Figure 4-9: WCWSS historical agricultural water requirements

4.10.4 Environmental Factors

Environmental Factors, such as climatic conditions play a significant role in the irrigation agriculture sector of the WCWSS.

According to the 2016 strategy update the total water allocation for all agricultural water users was considered to be approximately 170 m^3/a but potentially growing to a maximum cap of 216.24 million m^3/a as per their full allocation. This has been revised downwards to a total allocation of 193 million m^3/a because of double counting of the winter allocation. Irrigation agriculture cannot use more than its total allocation which is still being confirmed. Growth in the sector will be as a result of improved irrigation efficiency and management levels.

- Changes in climatic conditions affecting agricultural water include:
    - Records of increased precipitation for summer rainfall is likely to reduce the demand for irrigation water, particularly in winter.
    - Countering the increased precipitation is an increase in temperatures and resultant increased evapotranspiration due to increasing solar radiation and moisture deficit on crops. This will increase the irrigation water demand.

There is a need to determine which of these two weather variables to be a significant determinant of demand.

5 FUTURE WATER REQUIREMENTS

5.1 Factors influencing future water requirement in the domestic sector

5.1.1 Comparison of actual water requirements and past forecasts

Since 2007, the high growth rate future water requirement forecasts for the WCWSS have been undertaken based on using the percentage determined for the 2007 reconciliation strategy with minor adjustments. This is illustrated in **Figure** 5-1.

The time factor of future water requirements growth rate forecast illustrates that if the factors and the weighting of the factors influencing future water requirement forecasts are not reviewed and updated frequently, there is a high probability that the forecast water requirement forecasts will either be under- or over-stated as illustrated in Figure 5-1.

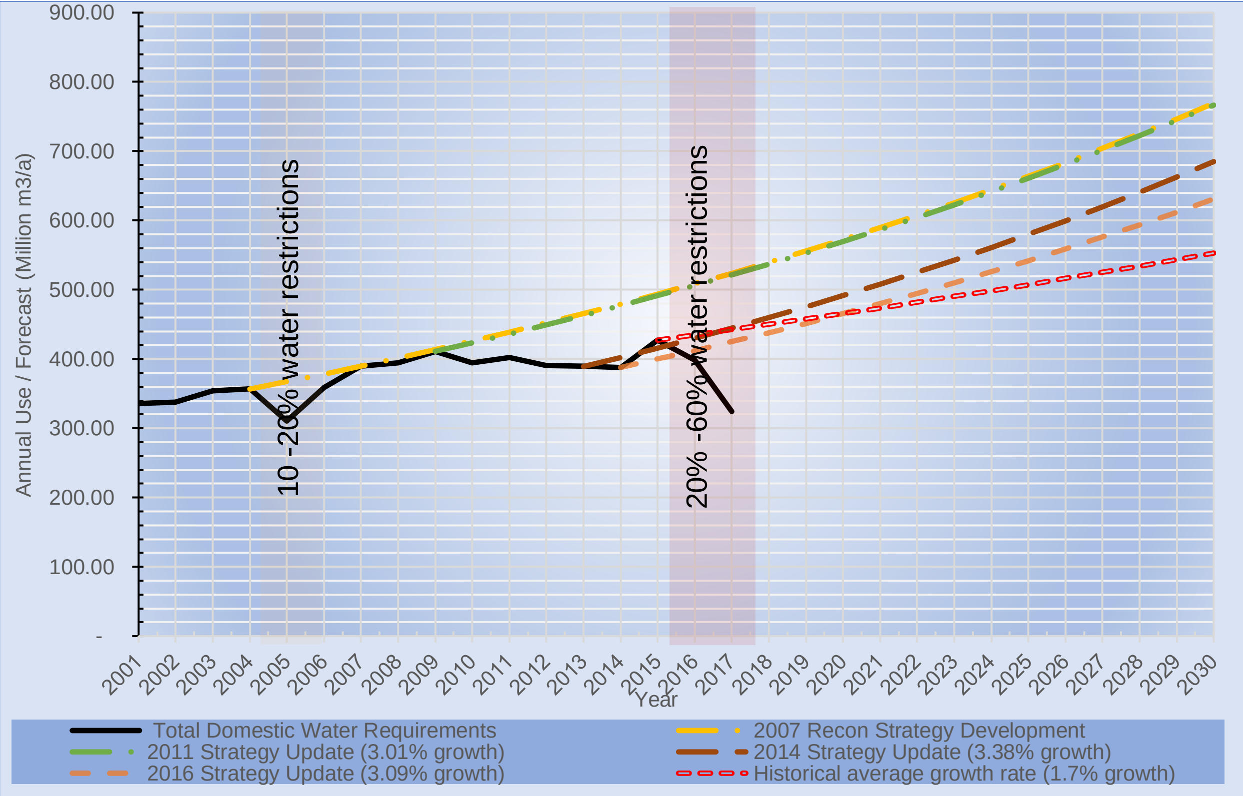

Figure 5-1: Actual Water Requirements and Past Forecasts

In the case of the WCWSS, adjustments were made in the previous reconciliation strategy updates. The 2015 water requirements factored the implementation of a significantly successful Water Conservation and Demand Management programme by the City of Cape Town. The assumption is that the programme will be sustained with the refurbishment of the bulk water infrastructure to reduce any growth in physical losses as a result of deteriorating conditions of the bulk water infrastructure.

5.1.2 Factors influencing the 2018 future water requirements forecasts

Although the factors that most directly affect water demand are difficult to predict, forecasts of demands and estimates that anticipate future water use patterns rather than simply extending old patterns, are extremely valuable in estimating the needs for water. In the case of the WCWSS, there have been changes to the following factors that will influence the future water requirements:

i. Changes in the population growth rate which is different from previous growth forecasts. As discussed in the previous chapter on the demographics, the population of the WCWSS has experienced net migration into the area (Jacobs, 2014). Based on the population projections undertaken by the different municipalities,

   a) Nearly 80% of the population of the WCWSS is situated in the City of Cape Metropolitan Area.

   b) The City of Cape has adopted the projections by PDG that population will grow from 4.0 million in 2016 (Stats SA, Community Survey 2016), to 5.84 million by 2040 at an annual average growth rate of 1.59% per annum. This is attributed to natural growth as well as net migration from outside the province.

   c) There are major economic developments in West Coast District Municipality, particularly in the Saldanha Bay area which will have an impact on population. In addition, environmental factors are also contributing in the migration decision, particularly in the sub-stream of migrants aged older than 50 years who favoured coastal areas such as the coastal towns of the West Coast District Municipality. The population in the West Coast District Municipality is expected to grow at an average population growth rate of 1.4% per annum from 2016.

   d) The total population of the WCWSS is envisaged to grow from 5.023 million in 2016 (based on the Stats SA Community Survey) to 7,475 million by 2042. This is an average annual growth rate of 1.54% per annum.

ii. The demographics assessment also highlighted the extent of informal settlements and backyard dwelling in the WCWSS. This will have an impact on water service provision and bulk water resources as formal housing development plans to address the informal and backyard dwelling is accelerated. This has been factored in the future water requirements forecast.

iii. Lower growth in economic and industrial activities in the WCWSS, particularly due to the current drought has impacted on the water requirements. The economic growth of the System is likely to improve once the current water restrictions are lifted.

iv. Water Conservation and Demand Management has had a major impact on the unit consumption per capita, which has been very pronounced since 2009.

   a) The average per capita consumption has been declining particularly in the City of Cape Town as well as the West Coast District Municipality and to a limited extent the Drakenstein and Stellenbosch municipalities.

   b) Based on the significant investment in implementing a successful water conservation and demand management programme, the improved level of water use efficiencies are likely to be sustained and have been factored in the future water requirement forecasts.

   c) Changes to the regulations to improve water use efficiency and the rate and tariff structures for the City of Cape Town are likely to impact the bounce back

v. The annual average growth rate in historical water requirements, from 2011 until 2015, was 1.46% per annum. This includes the effects of the implementation of WC/WDM in the WCWSS.

5.1.3 Implications of the current drought on future water requirements forecast

The ongoing drought has resulted in the Water Service Authorities undertaking a range of initiatives to further reduce the urban water requirements. These include, amongst others, various pressure management projects. The benefits from the pressure management projects are expected to result in long term savings. As a result, the current drought's impact on the long-term growth in demand is uncertain. While there will undoubtedly be a degree of recovery in demand (as restrictions are reduced), it is also likely that the recovery in demand will not be immediate, due to a range of factors including the increased use of water efficient devices. Additionally, a number of households and sectors of industry have invested in alternative water supply systems.

The current estimate of the recovery of urban demand scenarios have been based on a review of international literature (e.g. Beal et al., 2011; Beal & Stewart, 2011; Wittwer & Griffith, 2011; Giurco et al., 2013; Lindsay & Supski, 2017; Makki et al., 2013). **Figure** 5-2 below shows the experience in SEQ during the early 2000's. It indicates that as water restrictions are lifted, the demand does not recover immediately and remains suppressed. Recent per capita use from SEQ appears to vary through the year between 150-200 l/p/d. This is clearly well below the original water demand which exceeded 250 l/p/d.

The proposed high future water requirement forecast growth rate has been estimated at 2.65% per annum from the base year of 2015 requirements prior to the drought and will be factored in from the point of full recovery.

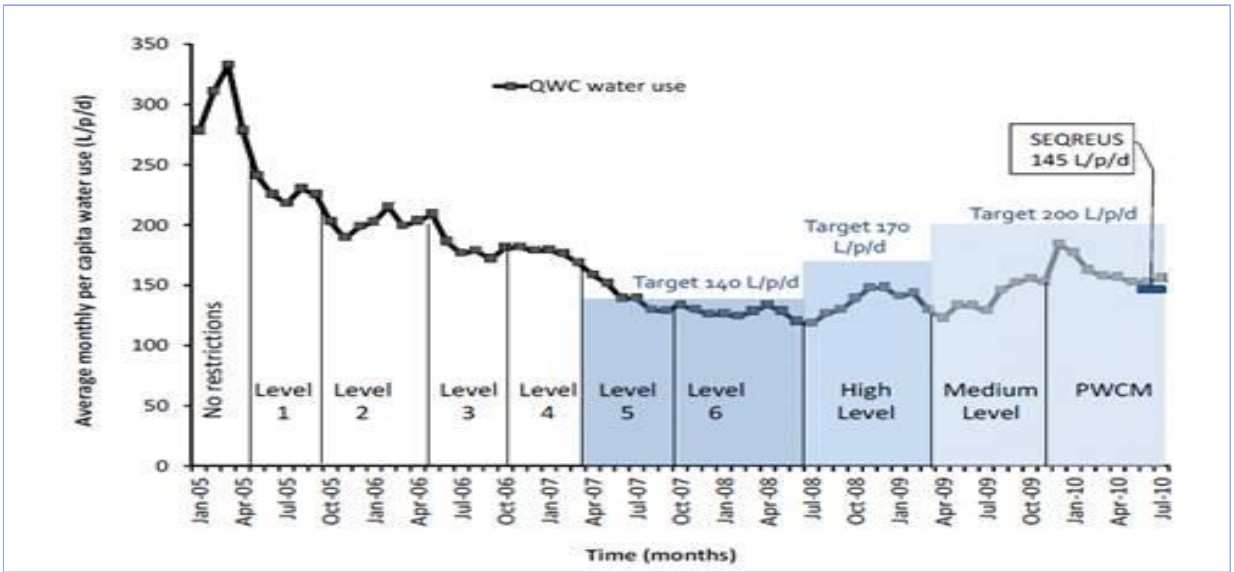

Figure 5-2: Comparison of all SEQ winter 2010 to SEQUES Total Average (Beal & Stewart, 2011)

5.2 Future water requirements forecast scenarios for the domestic sector

Based on the factors influencing water requirements, and the current water restrictions in the WCWSS, five future water requirements scenarios have been developed. These include the following:

a) *Scenario 1: 2.0% growth rate at current per capita water use* – This scenario is based on the growth rate of 2.0% per annum which the City of Cape Town has used in its projections. The projection was maintained because it constitutes 80% of the water requirements of the WCWSS. The future water requirements for this scenario for the domestic is 661.44 million m^3/a by 2042. Approximately 530 million m^3/a or 80% of the requirements is for the City of Cape Town

b) *Scenario 2: 2.0% growth rate with additional WC/WDM* – There has been significant changes to the unit consumption in the WCWSS due to the successful implementation of WC/WDM intervention programmes. In order to factor the improvement in water use efficiency, the major investments in water saving devices and technology and the implementation of a policy driven water efficiency management framework, the potential for implementation of further WC/WDM interventions was used in the development of the future water requirements scenario. The future water requirements for this scenario is 582.26 million m^3/a by 2042.

c) *Scenario 3: Low Growth Scenario* – This scenario is based on a low growth scenario of 1.2% per annum which is slightly higher than what the City of Cape Town is currently using. This was to factor in the other sub-areas of the WCWSS. The future water requirements for the low growth scenario is 517.19 million m^3/a in 2042.

d) *Scenario 4: Historical Growth Scenario* – This scenario is based on the extrapolation of the historic water requirements over a period of 15 years from 2001 to 2015. This extrapolation includes water restrictions of the 2005/06 hydrological years which are considered to be cyclical. However, the current water restrictions which have been in place since 2016 were excluded. This was considered to be an extreme event which is not likely to occur over the 25-year planning period of the reconciliation strategy update. An average annual growth rate of 1.73% per annum was used for the historical growth scenario. The future water requirements for this scenario is 603.33. million m^3/a by 2042.

e) *Scenario 5*: *High growth scenario* – This scenario has assumed that post the current water restrictions, there will be a significant drive for the WCWSS economy to catch up lost ground. *The accelerated economic growth* will have an impact particularly on the agri-processing industries which are medium to heavily dependent on the water resources. An initial growth rate of 2.65% per annum over the first 10 years and the 2.01% per annum for the rest of the planning period was used. This was premised on the City of Cape Town demand forecast and adjusted to reflect growth in the other sub-areas of the system. The future water requirements for this scenario is 690.53 million m^3/a by 2042.

Figure 5-3 provides an illustration of the future domestic water requirements forecast scenarios for 2017 to 2042. These have been used together with the irrigation agricultural water requirements in comparison with the available system yield of the WCWSS in the updating of the water reconciliation strategy options.

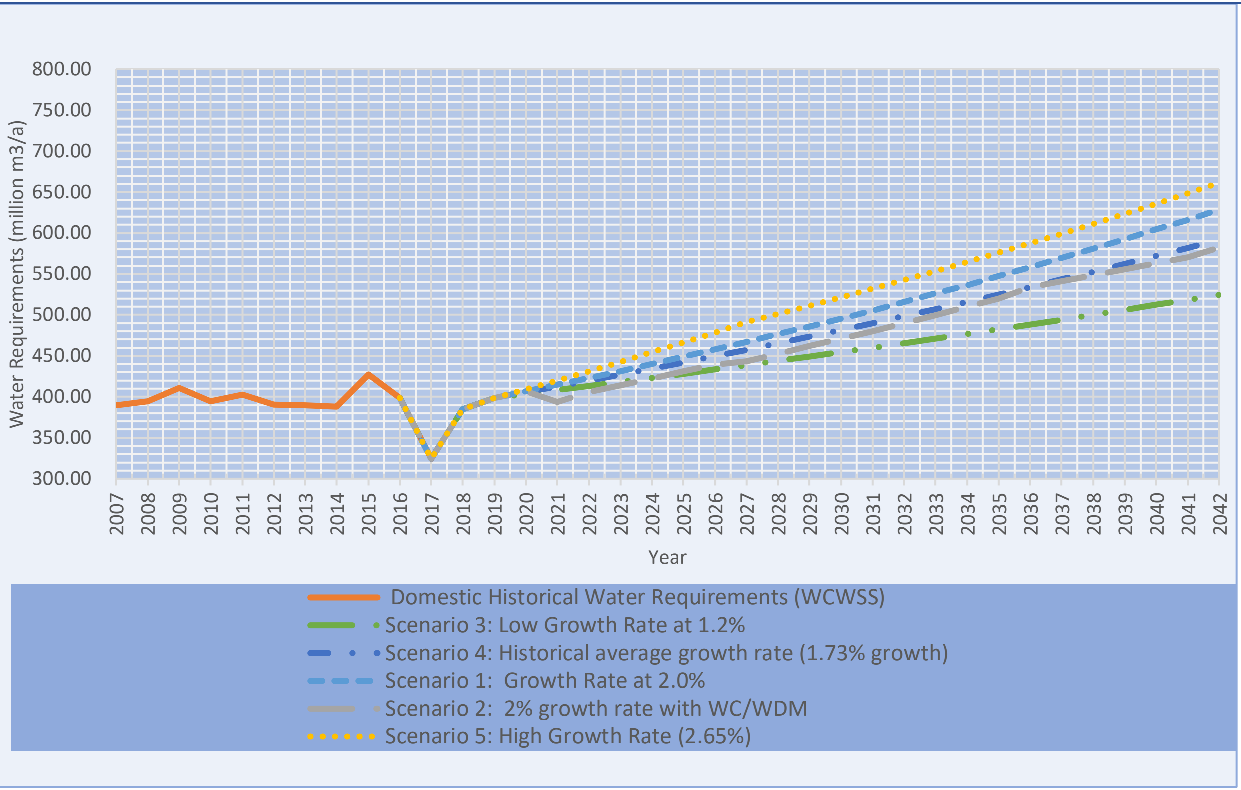

Figure 5-3: Future water Requirements Scenarios for the WCWSS domestic water use

5.3 Agricultural Water Requirements

As part of the Raw Water Supply Agreement (DWAF CCT, 2003) concluded prior to the development of the Berg River Dam, agriculture's allocation allowed for growth in demand. The total allocation for agriculture was set in the Raw Water Supply Agreement at 162 Mm^3/a. However the scheduled area (see **Table 5.1** below) indicates that agriculture has subsequently been allocated more water with total allocations currently at 193 million m^3/a. This is in accordance with the irrigation agriculture sector. The total allocation for irrigation agriculture still needs to be confirmed as the figure is more than what is in the raw water supply agreement at 162 million m^3/a.

Table 5-1: Irrigation Agriculture Allocation based on scheduled areas

Resource	Irrigation Board/ Water User Association	Verified water allocation	Quota m3/ha/a	Volume (m3/a)
Berg	Berg River Subdistrict 1	3 571	4 000	14 285 200
	Berg River Subdistrict 2	4 227	5 000	21 134 500
	Berg River Subdistrict 3	3 003	6 000	18 019 200
	Suid-Agter Paarl	867	4 000	3 468 000
	Simondium	243	4 000	972 000
	Simonsberg	125	4 000	500 000
	Perdeberg	1 324	5 000	6 620 000

Resource	Irrigation Board/ Water User Association	Verified water allocation	Quota m3/ha/a	Volume (m3/a)
	Noord-Agter Paarl	970	5 000	4 848 500
	Groenberg Ward 1	211	5 000	1 056 000
	Groenberg Ward 2	119	5 000	597 000
	Riebeek Kasteel	224	6 000	1 344 000
	Riebeek West Ward 1	115	6 000	690 000
	Riebeek West Ward 2	135	6 000	810 000
	Lower Berg River	3 657	5 000	18 283 000
	Lower Berg River	2 015	7 000	14 105 000
Stellenbosch tunnel	Wynland WUA	6 531	4 000	26 124 400
Riviersenderend	Zonderend	6 017	6 000	36 102 000
	Vygeboom	1 863	7 100	13 227 300
Theewaterskloof Dam	Theewaterskloof Dam	1 564	7 100	11 105 820

By 2015 most of the irrigation boards (IB's) had grown into their allocations with only the Upper Berg, Heldeberg and Vyeboom Irrigation Boards, not having reached their full allocation. Of concern is that the Lower Berg Irrigation Board, who have recently received additional allocations (Department of Water and Sanitation, 2015) have consistently, since 2013/2014, exceeded their capped allocation.

Due to the current restrictions imposed in the WCWSS, the agricultural sector has already reached and exceeded their quota in the 2017/18 hydrological cycle of 58.57 million m³/a. The agricultural sector unlike the urban sector is more likely to rebound quickly to the pre – restricted requirements and then gradually grow to its full allocation. The scenarios which were adopted in the last WCWSS update are as follows.

- Agriculture growing to full allocation of 193 Mm³/a in 5 years and thereafter remain capped;
- Agriculture growing to full allocation of 193 Mm³/a in 7 years and thereafter remain capped;
- Agriculture growing to full allocation of 193 Mm³/a in 10 years and thereafter remain capped.

Figure 5-4 provides the future water requirement forecast for the irrigation agriculture in the WCWSS.

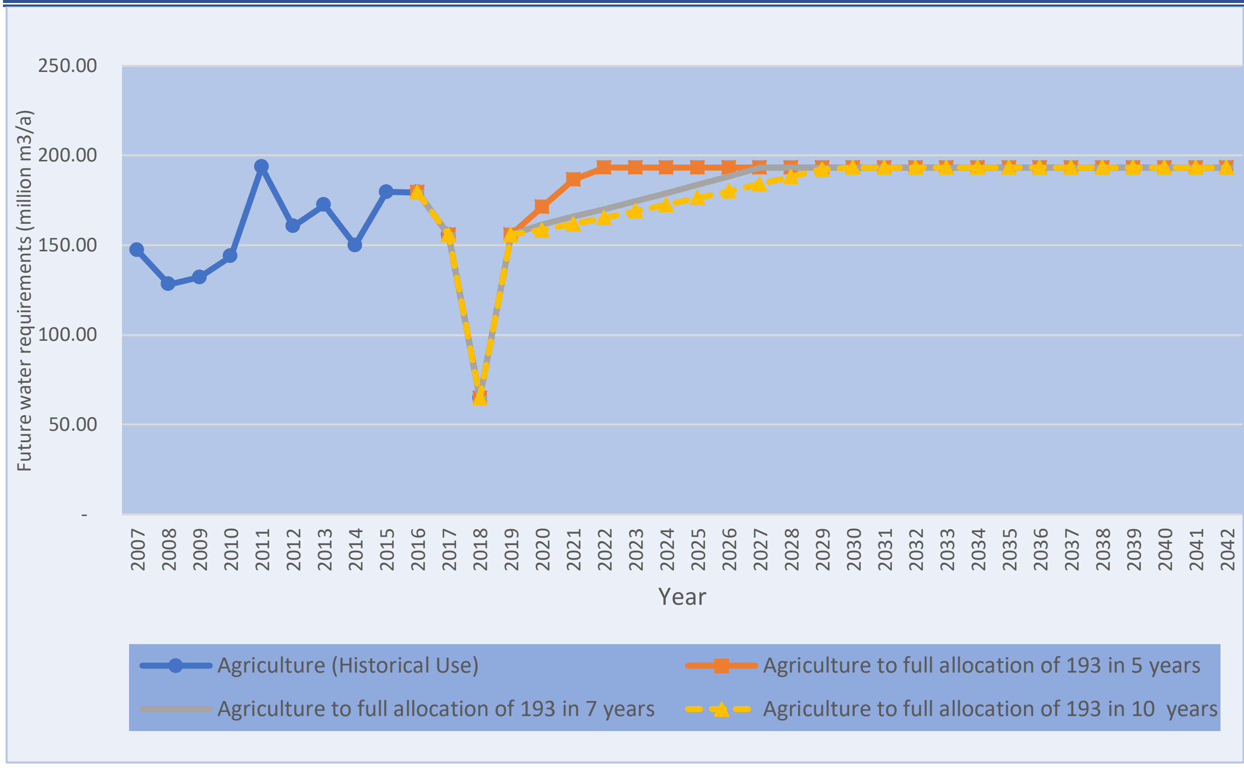

Figure 5-4: Projected Agricultural water requirements

5.4 Future water requirements for the WCWSS

The total projected water requirements for the WCWSS is indicated in Figure 5-5**.**

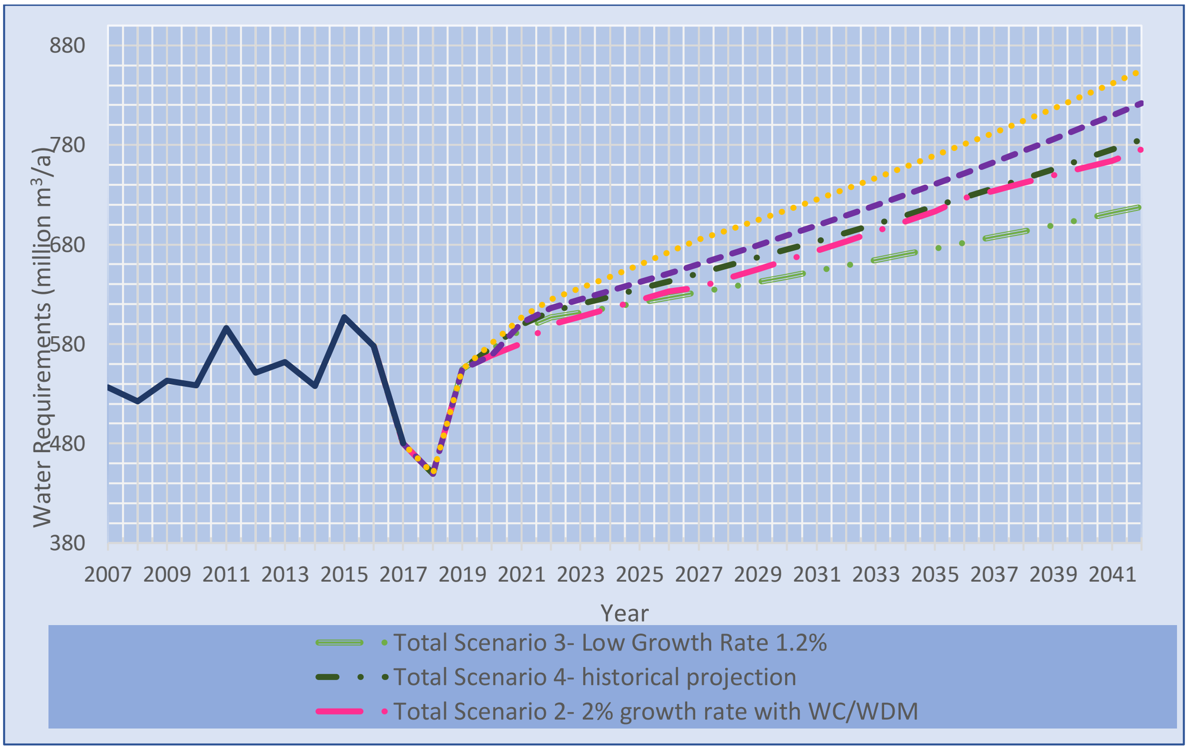

Figure 5-5: Projected Total Water Requirements for WCWSS

6 WATER AVAILABILITY IN THE WCWSS

6.1 Introduction

The hydrology adopted in Water Resource Yield Model (WRYM) and Water Resource Planning Model (WRPM) analyses of the WCWSS, since 2005, spanned a 77-year (hydrological) record period, i.e. 1928/1929 to 2004/2005. The Department of Water and Sanitation commissioned Aurecon as part of the 2017/18 Annual Operating Analysis of the WCWSS to extend the hydrology to the 2016/2017 hydrological year and then incorporate that hydrology into the modelling of the system.

The extended hydrology was used to *inter-alia* determine the updated 1:50 year yield of the WCWSS.

6.2 Existing hydrology incorporated in the current WRYM

The naturalised streamflow input sequences in the current WRYM and WRPM configurations of the WCWSS are based on WRSM/Pitman rainfall-runoff catchment model calibrations conducted during the Berg Water Availability Assessment Study (DWAF, 2008), generally known as the Berg WAAS. These calibrations were conducted against 33 individual monthly streamflow records relevant to the WCWSS. The calibration periods for the various gauged sub-catchments in the WCWSS ended in hydrological year 2004/05 or earlier, depending on the final dates of individual streamflow records.

The Berg WAAS included comprehensive updates of urban water use, areas under irrigation, areas under commercial timber plantations, areas under invasive alien plant (IAPs) and farm dam volumes. The raw data used for the WAAS updates of areas under irrigation, commercial plantations and IAPs and of farm dam volumes had been digitised from 1: 10,000 aerial photography, flown during 2001 and 2002. These calibrated WRSM/Pitman configurations were used to generate input files of natural monthly streamflow sequences for all the incremental catchment nodes in the WRYM and WRPM configurations of the WCWSS.

Until 2016, all WRYM and WRPM analyses of the WCWSS since the completion of the Berg WAAS, incorporated the WAAS hydrology, which spanned the 77-year period of 1928/29 to 2004/05. However, for the 2017/18 Annual Operating Analysis (AOA) Study, the Department of Water and Sanitation determined that, given the unusual rainfall-runoff patterns experienced within the WCWSS since 2014/15, it was necessary to extend the hydrology to the 2016/17 hydrological year and then incorporate the extended hydrology into the current modelling of the WCWSS (DWS, 2018).

The post-2005 rainfall records for all rainfall stations used in WRSM/Pitman calibrations during WAAS were sourced and checked for reliability and missing values. Because of the pressure of time, only a basic level of statistical patching of missing values could be completed. The WAAS monthly rainfall input files for the WRSM/Pitman configurations were then extended to September 2017 to enable the WAAS-calibrated WRSM/Pitman rainfall-runoff model to be used to generate natural monthly stream flows for the extended period.

Note: This exercise did not include re-calibration of the WRSM/Pitman model parameters.

6.3 Validation of WRYM Modelling

Given the severity of the recent few years of deficient inflows into the six major WCWSS dams since 2014/15, it was deemed important for the credibility of WRYM-supported augmentation planning for the WCWSS, to validate the WRYM-simulated drawdown by comparison with the observed combined drawdown of the six major dams within the WCWSS, i.e. the Theewaterskloof, Vöelvlei, Wemmershoek, Berg River, Upper Steenbras and Lower Steenbras dams.

To this end, the extended hydrology to 2016/17 was incorporated in the WRYM to simulate the combined drawdown of the WCWSS's six major dams since 2014/15. The simulated drawdown was then compared with the actual system drawdown over the period 2014/15 to 2016/17, which indicated (Department of Water and Sanitation, 2018) that there were some inconsistencies that required further investigation before the extended hydrology could be utilised. After further investigation, it was determined that several WRYM modelling assumptions needed revision, as follows:

- **Irrigation from Theewaterskloof Dam:** Farmers pumping directly from Theewaterskloof Dam have an allocation of 1.5 million m³/a. However, based on data received from Department of Water and Sanitation it is estimated that in some years they utilised an additional 6.9 million m³/a of water.

- **City of Cape Town local sources:** The local sources supplying the City have been yielding an estimated 10 million m³/a less than what was previously assumed. This assumption appears not to have been revised since 2004, but based on experience through the recent drought, it is estimated that the City's existing local sources can be relied upon for only about 5 million m³/a.

- **Current state of IAPs:** The WAAS modelling (as agreed at the time) assumed that stakeholders would curtail the spread of IAPs. It appears that the spread of IAPs has not been managed to the degree envisaged in the WAAS modelling and, as a result, the spread of IAPs has significantly increased (which has been confirmed by the CSIR). This would have led to a significant reduction in streamflow upstream of the major dams. Therefore, the updated WCWSS modelling required incorporating streamflow reductions according to the latest available estimate of the spread of IAPs done by the CSIR in 2016.

- **Updated dam evaporation values:** In line with analyses conducted as part of the 2017/18 WCWSS Annual Operating Analysis (AOA), monthly evaporation values for the Berg River, Misverstand, Theewaterskloof and Voëlvlei dams were updated.

Operational issues experienced in the WCWSS over the period 2014 to 2017:

Berg River Supplement Scheme: During the 2014/2015 operating year, the Berg River Supplement Scheme was not functioning at all (16.5 million m³/a not transferred to Berg River Dam). During the 2015/2016 operating year this scheme was operational for only 8 hours per day (19.6 million m³/a not transferred to Berg River Dam). In the 2016/2017 operating year the scheme was fully operational again.

Inflow canals at Voëlvlei Dam: During the 2015/2016 operating year, the inflow canals silted up and an estimated 7.5 million m³/a (estimated by the Provincial Government) of inflow to Voëlvlei Dam was 'lost' due to this. The canals were cleared by the Provincial Government in the following year and the inflows returned to normal during the 2016/2017 operating year.

The above revised modelling assumptions were incorporated in the WRYM and the drawdown of the WCWSS's combined storage during the current drought simulated. The results of this investigation verified that the WRYM of the WCWSS can be credibly utilised for further investigations. It was therefore determined that the extended hydrology (i.e. 1928/1929 – 2016/2017) should be used in all WRYM and WRPM analyses going forward.

6.4 Impacts of Invasive Alien Plants

As stated, the CSIR has confirmed that the spread of IAPs has markedly increased since the 1: 10,000 aerial photography compiled during 2001 and 2002, that underlies the WAAS estimates of areas under IAPs. Therefore, the updated WCWSS modelling required incorporating streamflow reductions according to the latest available estimate of the spread of IAPs done by the CSIR in 2016.

An updated (2018) coverage of areas under IAPs, in which data sets from the Working for Water Programme and the CSIR have been combined, have recently been made available.

A cursory review of this coverage indicates particularly significant increases since the WAAS study, in areas under IAPs, upstream of Theewaterskloof, Berg River, Wemmershoek and Voëlvlei dams. Figure 6-1 provides a summary of an assessment of the impacts of IAPs on the yield of the WCWSS, undertaken jointly for the Working for Water Programme and the CSIR (Aurecon, 2016).

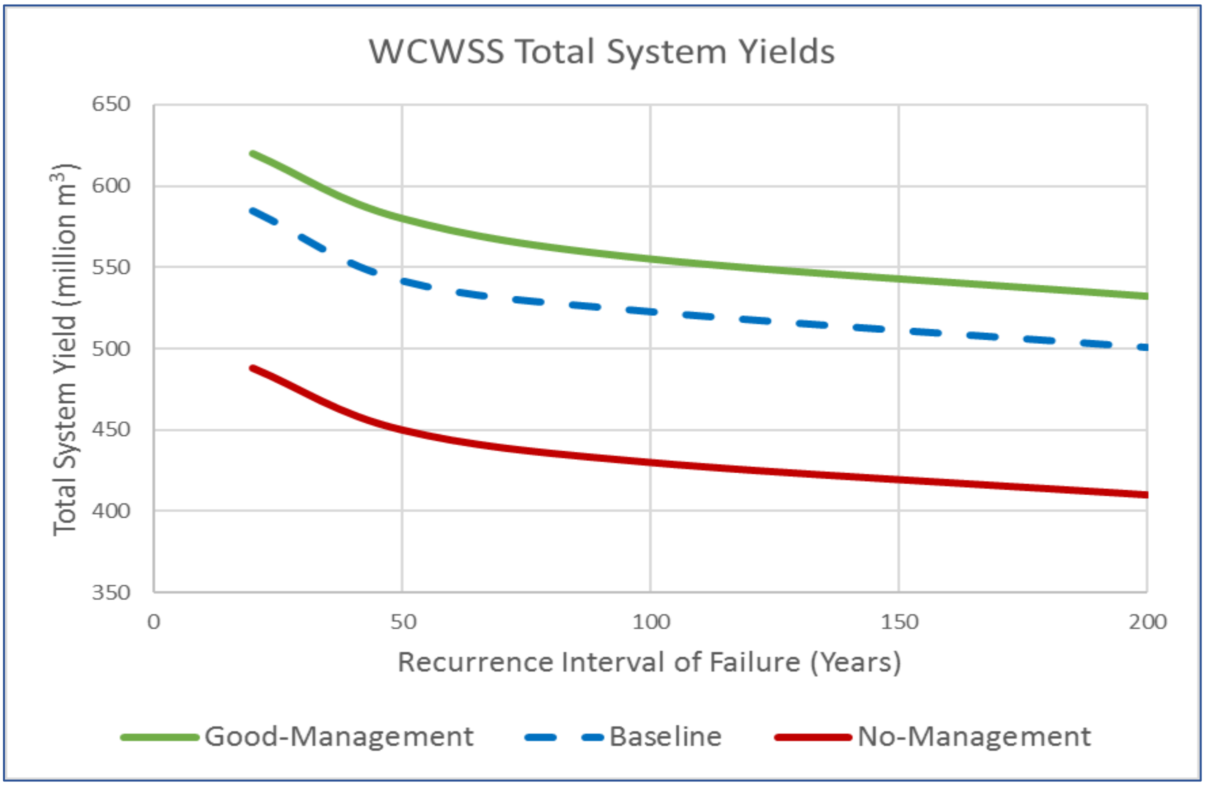

Figure 6-1. Impacts of IAPs on the yield of the Western Cape Water Supply

6.5 Climate Change

Aurecon and the Climate Systems Analysis Group (CSAG) conducted a planning session during May 2018 to unpack the details of the climate change scenarios required for super-imposition on the extended hydrology in the WRYM and WRPM configurations. The CSAG team has made sound progress and it is expected that Aurecon will be able to undertake the climate change scenario modelling with the WRYM and WRPM soon. The WRYM modelling will allow quantification of the potential range of climate change impacts on the WCWSS yield. This will then inform the longer-term planning/phasing of large schemes such as BRVAS, re-use, desalination, the Table Mountain Group Aquifer (TMG), etc. The climate change hydrology will also be incorporated into the WRPM so that the Reconciliation support graphs can include climate change impacts.

The potential range of climate change impacts on runoff from South African catchments was investigated in a recent study commissioned by the Department of Environment Affairs as part of the Long-term Adaptation Scenarios Programme (LTAS) (DEA, 2015).

6.6 Preliminary revised system yield

The WRYM was utilised by the City of Cape Town (Aurecon, 2018) to analyse the impact of the extended hydrology and updated assumptions on the availability of water in the WCWSS. The analysis included determining a preliminary revised historical firm yield (HFY) and stochastic long-term yields (LTYs). It is important to note that a single combined yield was determined for the major water resources within the WCWSS, i.e. Voëlvlei Dam, Berg River Dam, Wemmershoek Dam, Theewaterskloof Dam, Lower Steenbras Dam, and Upper Steenbras Dam. For Secondary Catchments G1–G4, relevant to the WCWSS, all evaluated climate futures indicate a reduction in runoff.

6.6.1 Historical firm yield (HFY)

The extension of the hydrology, and updating of the assumptions in the WCWSS model (Section 6.2) have resulted in the historical firm yield (HFY) reducing by 21 million m^3/a (see no. 4 vs no. 5 in Table 6-1).

It is important to note that the 4-year-long 1970s drought remains the critical drought when determining the HFY.

Table 6-1: Historical firm yield (HFY) of the WCWSS

No.	Description	System Yield
		(million m^3/a)
1	Legacy HFY (DWA, 2011)	549
2	Legacy HFY after introduction of EWR nodes and refinements	548
3	Legacy HFY + EWR nodes and refinements + Theewaterskloof and Kleinplaas changes	532
4	HFY of updated system and WAAS naturalised streamflow – without BVRAS	529
5	HFY of updated extended hydrology (1928 – 2016)	508

6.6.2 Stochastic yields

A stochastic streamflow analysis using the extended hydrology spanning an 89-year period was undertaken to determine the stochastic yield of the WCWSS (Aurecon, 2018). This required the development of stochastic parameters and the generation of a PARAM.dat file which is used in both the WRYM and the WRPM to generate stochastic flow sequences.

6.7 Stochastic long-term firm yield

The long-term firm yield (LTY) curves for the WCWSS were developed using a total of 201 stochastically generated flow sequences. The results of the LTY analysis are summarised in Table 6-2 and Table 6-3**.** The DWS typically utilise the 1:50-year RI yield (Table 6-3) for long-term planning purposes. Table 6-3 shows a reduction of approximately 35 million m^3/a in 1:50-year RI yield compared with the most recent prior estimate. The reduction in the yield of the system means that the WCWSS is likely further over-allocated than what was reported in DWS (2015).

Table 6-2: Stochastic long-term firm yields for the WCWSS, using the extended hydrology stem

Recurrence interval	1:20-year	1:50-year	1:100-year	1:200-year
Annual probability of supply failure	5%	2%	1%	0.5%
Yield (million m³/a)	580	545	519	495

Table 6-3: 1:50-year stochastic long-term firm yield of the WCWSS

No.	Description	System Yield (million m³/a)
1	Legacy 1:50-year stochastic yield (DWA, 2011)	570
2	Legacy 1:50-year stochastic yield + Theewaterskloof and Kleinplaas changes	553
3	1:50-year stochastic yield of updated system and WAAS naturalised streamflow – without BVRAS	579
4	1:50-year stochastic yield of updated extended hydrology (1928/29 – 2016/17)	545

6.8 Further required modelling

6.8.1 Background

As explained, the naturalised streamflow input sequences in the current WRYM yield model configuration of the WCWSS are based on WRSM/Pitman rainfall-runoff catchment model calibrations conducted during the Berg WAAS study (DWAF, 2008).

Until 2016, all WRYM and WRPM analyses of the WCWSS since the completion of the Berg WAAS, incorporated the Berg WAAS hydrology, which spanned the 77-year period of 1928/29 to 2004/05. However, for the 2017/18 Annual Operating Analysis (AOA) Study, DWS determined that, given the unusual rainfall-runoff patterns experienced in the WCWSS since 2014/15, it was necessary to extend the WAAS-based hydrology to the 2016/17 hydrological year and then incorporate the extended hydrology into the current modelling of the WCWSS. Hence, the WCWSS rainfall and natural streamflow input sequences were extended from 2005/06 to 2016/17. Because of the pressure of time, only a basic level of statistical patching of missing values could be completed. The WAAS monthly rainfall input files for the WRSM/Pitman configurations were then extended to September 2017 to enable the WAAS-calibrated WRSM/Pitman rainfall-runoff model to be used to generate natural monthly stream flows for the extended period. However, for long-term use in the WCWSS planning process, these provisional extensions of the WCWSS need to be overhauled.

6.9 Augmentation Schemes

6.9.1 Vöelvlei Augmentation Scheme

The Berg River Voëlvlei Augmentation Scheme is an augmentation scheme being planned by the DWS. It involves the pumped abstraction of winter water from the Berg River, once the ecological water requirements (EWRs) of the river and the estuary have been met. The ecological Reserve commensurate with a Category D River has been allowed for in the system modelling of the scheme.

According to the DWA (2012) the required stream flow into the Berg River Estuary during the summer months should vary between 0.6 and 0.9 m^3/s. To provide the required Reserve inflows to the Estuary would require that additional – to current – releases of between 0.3 m^3/s and 0.6 m^3/s should be made from Voëlvlei Dam, particularly during the four summer months from December to March. Therefore, the conservative assumption has been made in the system modelling of the proposed scheme that an additional release of 0.5 m^3/s should be made from Voëlvlei Dam for the six summer months. Based on these, and other assumptions detailed in DWA (2012), two scheme options were investigated, namely:

- Option 1: 4 m^3/s pump station with a stepped-pump operating rule providing 23 million m^3/a.
- Option 2: 6 m^3/s pump station with variable speed drives providing 20 million m^3/a.

The DWS is currently taking this scheme forward.

6.9.2 City of Cape Town Build Programme

The City releases monthly updates in the form of a 'Water Outlook' report which, along with engagements with the City, form the basis of this section.

The City of Cape Town's 'Build Programme' has continued to evolve as the City has sought to optimise the programmes scale and composition. Initially, the 'required Build Programme' was estimated to be in the region of 500Ml/d. This has reduced over the course of the last few months to approximately 350Ml/d – which is currently the basis of the City's planning. The City's Build programme aims not only to provide additional water to meet demand but also increase the resilience of the City's supply of water and is thus composed of various water resources. The long term 'Build Programme' comprises the following planned water supply augmentation schemes (summarised in Figure 6-2):

- Groundwater – ±137MLD
  - Cape Flats aquifer ±55MLD sustainable yield
  - Atlantis aquifer, ±32MLD final yield
  - TMG aquifer ±50 MLD year-round yield
- Permanent Desalination – 120-150MLD
  - The City is currently determining the optimum size, location, phasing of the development of a permanent desalination scheme. Currently it would appear that the City is considering a permanent desalination scheme of between 120 – 150MLD to be developed at a single site.
  - It is expected that the scheme will become operational around 2021
- Permanent Re-use – 70-90MLD
  - The City currently aims to 'maximise value' by developing re-use facilities.
  - Over and above the requirements for recharging the Cape Flats Aquifer, the City currently intends developing a water re-use scheme of between 70 – 90MLD
  - This should be online by 2020.

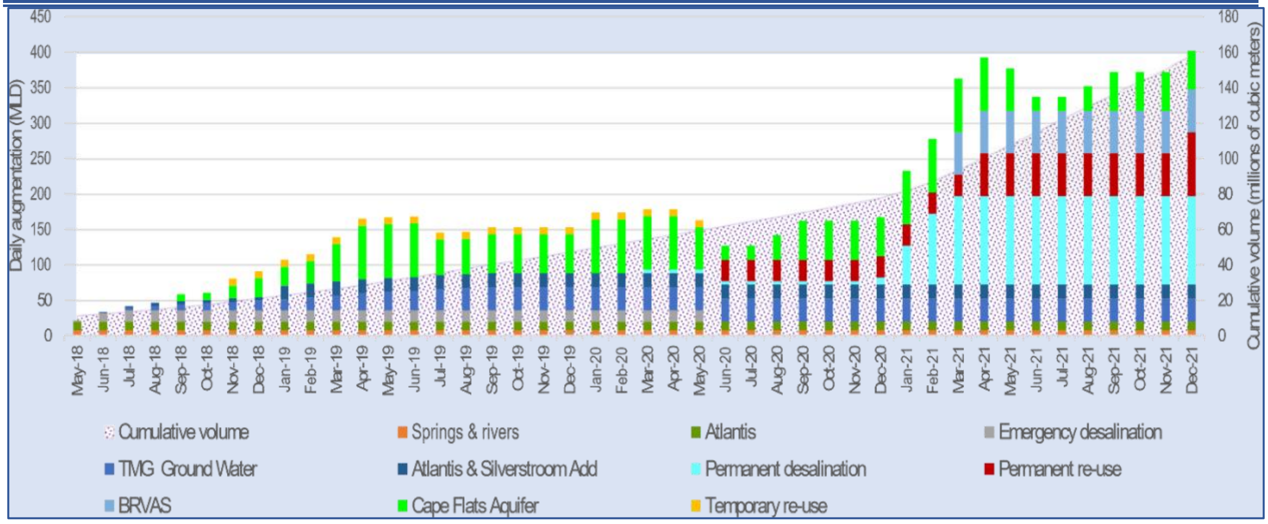

Figure 6-2 Provisional Future Augmentation Programme May 2018 -December 2021

6.10 Summary of proposed schemes

Currently, there is planning for approximately an additional 370MLD from various sources. Of this the City of Cape Town is responsible for planning approximately 310 MLD. While the City of Cape Town's 'Build Programme' will likely ensure adequate water availability for the City for the next 5-10 years there is a need to manage the impacts of the reduced yield and the water security of all sectors in the WCWSS.

6.11 Motivation for a Water Availability Assessment Study (WAAS) for the Breede River Basin

6.11.1 Background

At the time of the commissioning of the Berg WAAS, various possible diversion schemes to transfer water from the Upper Breede River to the Berg River catchment, as future augmentation options for the WCWSS, had already been identified in previous studies. Consequently, DWA included the update of the hydrology and water use of the Upper Breede River Catchment (upstream of Brandvlei Dam) in the Berg WAAS, with the intention that future feasibility assessments of these schemes could be based on up-to-date information. This update was successfully completed for all main-stem and tributary incremental sub-catchments of the Upper Breede, except for the incremental main-stem sub-catchment between Michell's Pass and the next downstream flow-gauging station, H4H006, in the vicinity of Brandvlei Dam. The poor quality of the streamflow record at this point made it impossible to close a water balance for the complete Upper Breede River catchment. The agreed limits to the scope of work of the Berg WAAS, as well as its delivery deadlines, precluded continuation of the update process downstream of H4H006.

The preliminary findings of three subsequent Projects – the Western Cape Pre-/Feasibility Studies, development of a Catchment Management Strategy (CMS) (CMS) for the Breede-Overberg CMA (2009) and the development of a CMS for the Breede-Gouritz CMA (BGCMA) (2017) - have both indicated an urgent need for a WAAS for the whole Breede River Basin. These developments and their implications for the Breede River Basin's planning and management are outlined below.

6.11.2 Western Cape Pre-/Feasibility Studies

During the DWA Project, "Feasibility and Pre-Feasibility Studies for the Augmentation of the WCWSS by Means of Further Surface Water Developments" (DWA, 2012), two augmentation options were selected for full Feasibility assessments. The first of these is the BRVA diversion scheme to transfer winter flows from the Berg River at Lorelei into the existing off-channel Voëlvlei Dam. The second selected option is a transfer of winter flows from the Upper Breede River at Michell's Pass into Voëlvlei Dam via the Klein Berg River.

The Michell's Pass diversion would reduce the winter flows in the Breede River at the Papenkuils Pump Station at Brandvlei Dam, which would, in turn, reduce the firm yield of Brandvlei Dam, as well as the availability of EWRs in the Middle and Lower Breede River main-stem. The analyses currently being undertaken towards the optimisation of the Michell's Pass diversion scheme include the assessment of the potential benefits and draw-backs of various physical and operational measures required to off-set the flow reduction impacts in the Middle and Lower Breede River main-stem.

The current analyses of the impacts of the Michell's Pass diversion and of its various potential mitigation options along the complete main-stem of the Breede River to its estuary are being conducted by means of the WRYM system model, using the naturalised flow sequences and water demands prepared for the Breede River Basin Study (BRBS), completed in 2003. As indicated in the previous Section, due to the poor quality of the H4H006 flow record, the water balance for the Upper Breede sub-system could not be closed during the 2007 Berg WAAS update of the hydrology and water use of this sub-system. In the light of this dilemma and, given that the BRBS comprises the most recently integrated update of the hydrology and water use across all of the Upper, Middle and Lower Breede sub-systems, it was decided that it would be prudent to use the BRBS hydrology and water use information for the feasibility assessment of the Michell's Pass scheme.

If in the future the commencement of the implementation of the Michell's Pass scheme were to be considered, a prerequisite for that would be that the WAAS for the whole Breede catchment first be completed. This would ensure that the impacts of the Michell's Pass diversion and of its various potential mitigation options along the complete main-stem of the Breede River to its estuary may be quantified with sound, up-to-date streamflow sequences.

6.11.3 Breede River Basin CMS

The practical implementation of the latest Catchment Strategy prepared by BGCMA. (2017) will only be feasible with sound, up-to-date streamflow sequences for the Breede River main-stem as well as all its tributaries, which will be the result of a Basin-wide WAAS study.

6.12 Conclusions and Recommendations

The extension of the hydrology and updating of assumptions used to model the WCWSS has shown that the 1:50-year stochastic yield of the WCWSS has reduced by approximately 35 million m^3/a. The decrease in system yield has resulted in the WCWSS currently being over allocated. A significant contributor to the reduction in the yield of the system was the spread of alien invasive plants, which if not managed could potentially lead to further reductions in the system yield. Based on these findings the following recommendations are made:

- Urgent action is required to prevent the further spread of alien invasive plants in the catchments of the WCWSS.
- As a result of the reduction in system yield, the current over allocation of the WCWSS needs to be addressed.

- Monitoring of the potential impacts of climate change should be a priority and should include regularly updating the hydrology:
    - Every 10 years for 'average' conditions
    - Every 5 years during / following drought conditions.
- The WCWSS hydrology needs to be urgently updated through a re-calibration of the WRSM/Pitman rainfall-runoff catchment model to incorporate the impacts of the current drought on the Pitman model parameters.
- A Water Availability Assessment Study (WAAS) for the Breede River Basin is urgently needed to precede any further planning relating to Breede River support to the WCWSS, as well as for any potential re-allocations in the Breede Basin.

7 PROGRESS WITH IMPLEMENTATION OF WATER RECONCILIATION STRATEGIES

7.1 Interventions identified in the previous reconciliation strategies

The initial WCWSS Reconciliation Strategy was completed in 2007.

A number of augmentation options were recommended for further consideration or investigation and these are provided in Appendix A.

7.2 Progression of water Interventions

The Reconciliation Strategy Committee, during the 2007 Reconciliation Strategy project made the decision that the Department of Water and Sanitation would investigate the surface water augmentation options while the City of Cape Town would investigate other options.

7.2.1 Interventions by the Department of Water and Sanitation

7.2.1.1 Augmentation of Voëlvlei Dam

The Department of Water and Sanitation commissioned feasibility studies for two surface water development options, namely the:

- Berg River – Voëlvlei Augmentation Scheme (BRVAS); and
- Breede-Berg (Mitchell's Pass) Water Transfer Scheme (BBTS)

Both schemes rely on the utilisation of the existing storage capacity in the Voëlvlei Dam, and on the existing capacity of the City of Cape Town's pipeline, from their WTW at the dam, to their Plattekloof reservoir in Cape Town.

Berg River – Voëlvlei Augmentation Scheme (BRVAS)

This Scheme would involve the pumped abstraction of winter water from the Berg River, once environmental water requirements are met.

The EIA for the Scheme was completed early last year. An appeal process was entered into and the DWS responded to both appeals with an amicable settlement. The final EIA decision was issued in February 2018. The scheme has been declared a Government Water Scheme and will obtain funding assistance and support from National Treasury. The project has been handed over to the TCTA to seek approval for funding from National Treasury and meeting with the City of Cape Town and other users to finalise offtake agreements. At the time of writing this report, funding had not yet been secured.

Breede-Berg (Mitchell's Pass) Water Transfer Scheme (BBTS)

The DWS is developing a TOR for a bridging study for the Mitchell's Pass Diversion in the 2018/19 financial year and that they hope to obtain funding for this. The DWS could not undertake a feasibility study for the Lower Steenbras due to budgetary constraints.

The BRVAS would involve the pumped abstraction of winter water from the Breede River, once the EWRs of the river and estuary have been met. The scheme will only be able to augment the WCWSS by about 2-3 years. This scheme would increase the 1 in 50 year yield of the WCWSS by about 23 million m^3/a to enable the system to meet the future growth in the water requirements (Department of Water Affairs, South Africa, 2012).

The BBTS would involve the diversion of winter water from the upper Breede River at the same location as that of the current Artois canal diversion. The scheme would involve upgrading the existing diversion weir and the conveyance of the diverted water under gravity, via a pressure pipeline of 2000 mm diameter across the catchment divide into the adjacent catchment of the Klein Berg River. The proposed BBTS would augment the supply of the WCWSS by 36 million m^3/a to enable the system to meet the future growth in the water demands (Department of Water Affairs, 2012).

7.2.1.2 Groundwater interventions

The Theewaterskloof TMG Groundwater Project was borne out of augmenting the City of Cape Town's groundwater exploration projects. Exploratory drilling at target sites is currently underway.

7.2.2 City of Cape Town Interventions

The persistent drought has led to fast-tracking of several projects with the aim of augmenting supply as quickly as possible.

7.2.2.1 Groundwater Development Options

Atlantis aquifer

The Atlantis aquifer system is currently operating off-grid (separately from the wider WCWSS) at approximately 12MLD. The aquifer is the sole source of supply to Atlantis. The aquifer consists of unconsolidated dune sand with an average thickness of 25m, natural recharge is augmented by artificial recharge through storm water runoff and treated waste water. Planning and design on the additional yield is underway to determine the infrastructure requirements to absorb the additional water into the system. This additional abstraction is to be distributed to areas south of Atlantis. See Figure 7-1 for the implementation programme.

Cape Flats aquifer

The water use license allows for an abstraction limit of 20Mm^3 per annum in phase 1 (and 25, and 30 Mm^3 per annum in phases 2 and 3 respectively). 20 Mm^3 translates to a daily yield of 55 MLD spread over the year, but infrastructure is designed to provide a peak yield of ~80MLD to allow for higher abstraction over the summer months during periods of drought.

Figure 7-1 provides the implementation programme and anticipated abstraction volumes from the CFA. Extraction volumes will be managed within the 20Mm^3 per annum required by license conditions. It is expected that lower volumes will be abstracted during the winter months and peak volumes during summer. Actual volumes will be adjusted according to prevailing water requirements.

The license condition further provides for an annual recharge requirement of 12Mm^3 which forms part of the re-use projects (City of Cape Town, 20 May 2018).

TMG Aquifer

The license for abstraction from the TMG aquifer covers a variety of different sites. The City is prioritising sites to minimise environmental impact while optimising yield. Current planning includes Steenbras, Wemmershoek, Berg River and Theewaterskloof while Cape Peninsula and Helderberg are being reassessed.

In terms of the licence conditions, the allowable annual extraction for Phase 1 is shown in

Table 7-1. Artificial recharge of the aquifer is not a condition of the license.

Table 7-1. Allowable annual extraction from TMG Aquifer in Phase 1

Site	Phase 1 (Mm^3/a)	Phase 2 (Mm^3/a)	Phase 3 (Mm^3/a)
Cape Peninsula	8	12	14
Helderberg Basin	3.6	5.5	7.3
Berg River Valley	3.6	5.5	7.3
Steenbras	12	20	35
Theewaterskloof	10	31	56
Wemmershoek	2	3	4
Voëlvlei	3	5	6
TOTAL	42.2	82	129.6

From (City of Cape Town, ATSG, 8 March 2018) & (City of Cape Town, 20 May 2018)

Steenbras has been prioritised as the Steenbras Dams are owned and operated by the City, and drilling is proceeding in the utility zone. The $12Mm^3$ translates to a sustainable daily extraction of 33MLD, however this abstraction depends on resolution on environmental matters.

The national DWS has commenced drilling at Theewaterskloof (which falls under their control). Steenbras in combination with Theewaterskloof would provide a possible yield of 50MLD.

7.2.2.2 Wastewater Reclamation

Direct Reuse Faure New Water Scheme

Detailed design work is proceeding on a 70MLD wastewater reuse plant to be sited at Faure Treatment Works, taking water from Zandvliet WWTW and potentially from Macassar to scale to 90MLD. Planned reclamation is from Zandvliet WWTW at 10Ml/day and Zandvliet/Macassar WWTW at 50Ml/day and 20Ml/day, respectively (City of Cape Town, ATSG, 8 March 2018).

Concept designs have been developed for water reuse from Athlone (75MLD), although this is unlikely to be triggered in the medium term (City of Cape Town, 20 May 2018).

CFA managed aquifer recharge project

Work is proceeding on options for recharge of the Cape Flats aquifer. Phase 1 requires $12Mm^3$ or 33MLD while Phase 3 requires $25Mm^3$ or 68MLD. Recharge is planned from wastewater treatment works at Cape Flats, Mitchell's Plain and Borcherd's Quarry. Recharge is not immediately required for the aquifer to remain sustainable but is planned to be fully operational within 24 months (City of Cape Town, 20 May 2018).

The implementation programme for the treated effluent reuse is provided in Figure 7-1.

7.2.2.3 Desalination: Koeberg / Atlantis

Permanent desalination

The optimum site for a permanent desalination plant is being explored and a pilot plant at Koeberg (5-20MLD) (City of Cape Town, ATSG, 8 March 2018) is being implemented which will inform the design for a potential larger desalination plant at that site in the future (City of Cape Town, 20 May 2018).

	Base Case Scenario Augmentation Plan												
	1	2	3	4	5	6	7	8	9	10	11	12	
Augmentation Schemes	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	**Ml/d / Mm3/a**
Table Mountain Group P1	X X	X											15 / 5.5
Cape Flats Aquifer P1	X X	X											20 / 7.3
Alien Vegetation													55 / 20.0
Atlantis Aquifer		X X	X										10 / 3.65
Management of WCWSS													27 / 9.9
Berg River Augmentation			X X	X X	X								40 / 14.6
Groundwater Ph2 (TMG / Cape Flats)			X	X X	X								15 / 5.5
Treated Effluent Re-Use P1					X X	X X	X						70 / 25.6
Desalination Harbour							X X	X X	X				50 / 18.3
Table Mountain Group P3									X X	X			20 / 7.3
Treated Effluent Re-Use P2										X X	X		30 / 10.9

Figure 7-1. City of Cape Town's Implementation Programme (November 2018)

8 STATUS OF WC/WDM INTERVENTIONS

8.1 Overview

One of the management interventions in the WCWSS, particularly in the City of Cape Town, and other municipalities, was the development and implementation of a comprehensive WC/WDM programme in the system. The delay in the implementation of the Berg River Dam has prompted the need to manage the demand side of the bulk water supply system.

8.1.1 Rationale for implementing a WC/WDM intervention programme

In the WCWSS, the need to improve water use efficiency by reducing water losses and managing consumer demand for water had become a major imperative by 2007. This led to the development of a WC/WDM strategy document by the City of Cape Town which had indicated that implementing the programme was an effective means of managing the limited water resources of the Water Supply System. Municipalities that have implemented WC/WDM measures are beginning to:

- Realise the financial benefits of delaying the need for costly new bulk water infrastructure;
- Extend the life of their infrastructure by reducing the burst frequency and infrastructure fatigue;
- Save money on the running costs of the bulk water supply systems;
- Improve on the natural and aquatic environment.

8.2 WC/WDM Interventions by the City of Cape Town

8.2.1 Interventions implemented until the 2015 strategy update

Several WC/WDM intervention programmes have been and are still being implemented in the WCWSS. Significant water loss reduction and consumer demand management has been implemented and the results of these programmes were clearly illustrated in Chapter 3 on the reduction in the average per capita consumption in most of the municipalities.

8.2.2 Current WC/WDM interventions

Since 2015, a number of additional WC/WDM intervention measures were identified for implementation. The onset of the severe water restrictions in the WCWSS necessitated a more detailed and aggressive water conservation programme. These included the following:

8.2.2.1 Establishment of Pressure Management Zones and District Metered areas and installation of flow and time modulated controllers

With the implementation of pressure management in the previous intervention programme, it was identified that there was scope in further reduction of the City of Cape Town's average system pressures for the different supply zones and District Metered Areas, that were being established in the previous implementation plan. According to the City of Cape Town the following interventions have been implemented:

(i). A total of 212 Pressure Managed Zones (PMZ's) were identified which is an increase from the original 116 PMZ. Of these 212, to date 109 are currently confirmed and various pressure management systems ranging from simple fixed PRVs to advance pressure management systems have been installed. However, 10 of the PMZ have been breached when zero pressure tested.

(ii). Currently installation of flow and time modulated controllers on the PRVs was undertaken on 86 of the 99 PMZs that were established across the City since the implementation of the WC/WDM intervention programme.

(iii). Where the controllers have been installed, significant pressure reduction as much as 1.0 bar downstream in 10 of the pressure management zones has been set, while only 9 zones have more than 1.5 bar downstream pressure. Although the pressure settings are likely to be temporary and will be increased once water restrictions are lifted, the impact of the pressure reduction has resulted in the following:

a) Reduction in the background leakage, and the night flow in particular;

b) Reduce the repair and maintenance of the infrastructure in these zones;

c) Continued to provide continuous water supply into the town without introducing intermittent water supply. The problems of intermittent water supply system include (i) contamination in pipelines especially when negative pressures result in the entry of pathogens via leaking pipes, (ii) transient pressures due to filling and emptying of the pipelines reducing the life cycle of the infrastructure;

d) Reduction in the system input volume and therefore reduction in the raw water abstraction by the City of Cape Town. This indirectly improved the assurance of supply of the WCWSS.

8.2.2.2 Implementation of an active leakage detection and repair programme

The City of Cape Town established an Active Leakage Detection and Repair unit to physical identify and repair leaks in the City's network. Approximately 6 400 km of the network was surveyed with leak detection equipment. Approximately 2 914 leaks were located since 2015 and 2 537 leaks repaired on pipelines larger than 50 mm diameter.

On the consumer demand management side, the City of Cape Town undertook an inspection of indigent households (approximately 29 833 of the 40 320 households). The leak repair unit located 7 633 leaks and repaired 1 787.

8.2.2.3 Installation of water management devices

Since September 2017, water management devices which replaced the standard water meters and are programmed to provide a daily allocation of water on a property were installed on 59 836 properties across the City of Cape Town. These have had a major impact on consumer use reduction during the current severe water restrictions that was imposed on the water users in the WCWSS. A total of 9.5 Ml/d to 11.9 Ml/d has been saved depending on the number of water management devices working.

8.2.2.4 Additional WC/WDM interventions to address severe water restrictions

In order to address the severe water restrictions due to the current drought experienced in the WCWSS, a number of additional interventions were identified by the City of Cape Town. These include the following:

(i). Installation of Treated Effluent Draw Off Points;

(ii). Approval of Water Services Intermediaries;

(iii). Retrofit of Council Infrastructure with Water Saving Fittings;

(iv). Use of Treated Effluent to Flush Toilets at Businesses, schools and Council Infrastructure.

8.2.3 Impact of the current WC/WDM Interventions

The implementation of the WC/WDM intervention programme has had a significant impact in reducing both the system water losses as well as the consumer demand as illustrated in **Table 8.1** below.

Table 8-1: Impact of the WC/WDM Intervention measures up to October 2018 – City of Cape Town

Pressure Management KPI	Achievement for Week Ending 5 October 2018	% Target
Recommissioning existing Pressure Managed Zones (PMZ's)	1 279 kl/day	15%
Optimising existing PMZ's	2 702 kl/day	56%
Advanced pressure management	29 696 kl/day	693%
Creation of new PMZ's	1150 kl/day	34%
"Big hitter" areas (Khayelitsha, Mitchells Plain, Gugulethu/Nyanga, Langa)	27 785 kl/day	257%
Reticulation leak repair	3 980 kl/day	92%
Internal leak repair	858 kl/day	10%
Top Consumer Engagement	- 1000 kl/day	21%
Total Average Weekly Demand Reduction	66 450 kl/day	135%

Source: City of Cape Town – WMD 2018

The City of Cape Town has successfully reduced the water use by 66.5 Ml/d over the period which is 7.6% of the system input volume. The above interventions are likely to be sustained after the severe water restrictions are lifted. Given the highly successful advanced pressure management intervention which was achieved on 40.5% of the Pressure Management Zones, there is significant scope for further reduction on water losses though pressure management. An additional 50 Ml/d can be achieved if all the Pressure Management Zones are installed with advanced pressure management systems.

8.2.4 Implications of the current severe water restrictions

Figure 8.1 below illustrates the decline in the system input volume. Between 2015 and the start of the 2016/17 hydrological year, the average system input volume declined from 980.75 Ml/d, when level 1 water restrictions were in place to 596 Ml/d.

As the water restrictions are lifted when the dam levels have picked up, it is likely there will be a bounce back in the gross average annual daily demand (GAADD) for the City of Cape Town.

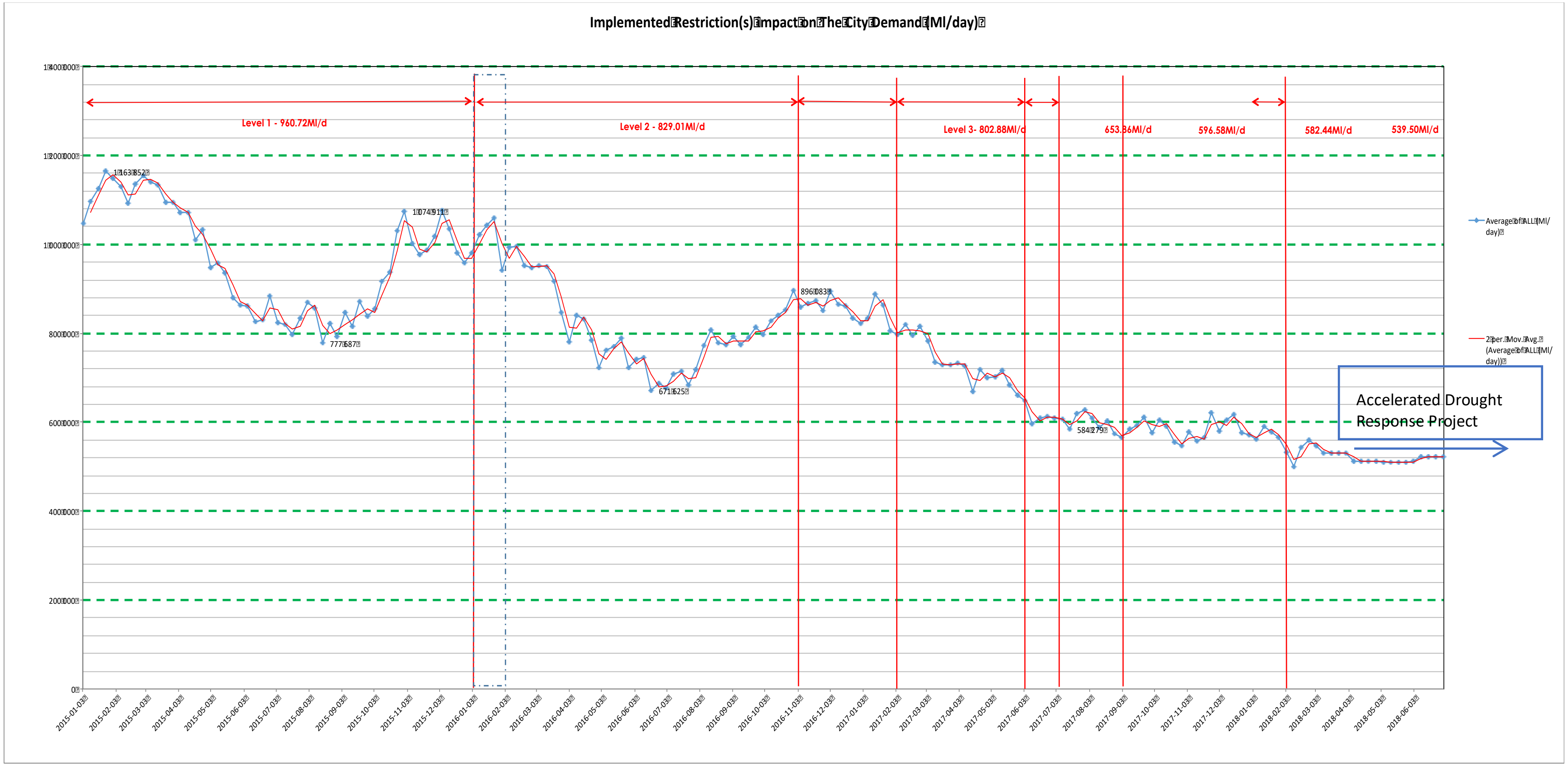

Figure 8-1: Impact of current interventions on the City of Cape Town water supply system

9 RECONCILIATION STRATEGY UPDATE – OCTOBER 2018

9.1 Updating of the reconciliation strategy

9.1.1 General

The development and the subsequent updating of the WCWSS water reconciliation strategy identified key criteria that are important in addressing the region's problems:

(i). *Regional review to the update* – Determining the water quantity and quality issues need to be addressed from a regional perspective defined by hydrologic rather than political boundaries will provide critical insight into sustainable water resource management.

(ii). *Accounting for welfare of both present and future needs* - Determining the needs of the present and future water requirements and the status of the environment have been considered as a matter of equity.

(iii). *Consider all options for balancing water resources and water requirements*. The reconciliation strategy options have been and will be developed to be flexible and robust enough to deal with the uncertainties inherent in the hydrology, future water requirements forecast and long-term climatic changes. This will require building reliance in the strategy options.

(iv). *Ensure the maintenance of ecosystem service to sustain water supplies in the Western Cape Water Supply Scheme through integrated planning.* The impact of the environmental water requirements (EWR) on the yield of the WCWSS will be determined, considered and allocated to maintain and enhance environmental quality and biodiversity of the region.

(v). *Recognise the mutual dependence of water quality and quantity. The adequacy of the water supplies inherently involves issues of water quality.*

This chapter focuses on identifying the gaps between the current and future water requirements and available water supplies in the context of the volume, the reliability of supply and the quality of the water resource fit for use. These estimates of future water requirement scenarios are based on different levels of service and growth projections.

Based on the size and timing of this gap, measures and actions are then identified to close the gap and bring supplies into balance with the expected demands at the different assurance levels of supply.

9.2 Updating of the water balance

9.2.1 General

The water supply demand balance of the WCWSS for the water year ending September 2017 has been undertaken. The following were considered in the determination of the water supply-requirements balance for the system:

- The available recently updated system yield of the WCWSS.
- The available groundwater abstraction based on information provided by the water users in the WCWSS.
- The updated water requirements based on information presented by the municipalities in the WCWSS and used to update the current and future water requirement scenarios. This has been undertaken as discussed in the previous chapters.

9.2.2 Uncertainties in the development of the supply demand balance

Uncertainty in the supply demand balance falls into six broad categories:

(i). Natural variability in the hydrological/hydrogeological conditions that affect the output available from sources. This uncertainty was accounted for in the long-term yield of the system based on the assurance of supply of different water use sectors and extended hydrological record that took into account the recent drought record. It has also factored in the growth in alien vegetation which affect the stream flow.

(ii). Uncertainty in the operational availability of supplies from sources. These are typically specified risks that are considered in short term yield on an annual basis;

(iii). Variability in the magnitude of forecast demands depending on the assumptions made. This variability has been considered through scenario analysis with the high growth future water requirements scenario used to determine the options to address the supply demand gaps.

(iv). Specified uncertainties affecting the supply side and the demand side values used in the supply demand balance. These uncertainties are taken into account in the headroom allowance;

(v). Uncertainty in whether and/or when any given demand side or supply side option can in fact be delivered. This form of uncertainty, which includes planning and other permission uncertainties, is generally treated deterministically by including an assumed lead time into the option selection process; and

(vi). Uncertainty due to legislation/regulations such as the implementation of EWRs.

The above uncertainties have been factored into the updating of the water supply demand balance for the WCWSS.

9.2.3 Available water resources

9.2.3.1 Available yield from the surface water resources

The updated long-term yield assessment for the WCWSS was undertaken based on the hydrology extended to include the 2016/17 drought records. The system was determined to be 545 million m^3/a based on the 1:50 year stochastic yield.

The updated yield assessment of the WCWSS has highlighted that with the inclusion of the latest drought in the long-term assessment, the available system yield has reduced by 35 million m^3/a. The decline in the system yield was taken from the end of the 2016/17 water cycle. In addition to the decrease in the system yield, the alien vegetation growth will have an impact on the yield if this is not addressed. If the working for water programme is not implemented, this will have a 2 million m^3/a reduction in yield impact on the WCWSS. A scenario with stream flow reduction due to alien vegetation has been developed in the water balance assessment.

The impact of the EWRs (EWR) on the long-term system yield of the WCWSS was factored in the updated yield assessment.

There is the climate changes scenario which has not been developed as there is limited information on the extent and likely impact of climate change on the long-term stochastic yield of the Water Supply System. This is still being developed and has not been included in this strategy update.

9.2.4 Updated current and future water requirements

The historical and future water requirements of the WCWSS were updated as discussed in the previous chapters. Meetings were held with the City of Cape Town as well as with the West Coast District Municipality to confirm the historical consumption records given the interventions such as WC/WDM.

The historical water use since the 2015/16 water year were excluded in the future water requirements projections. This was done in order to factor in that the average per capita consumption will increase back to a level of consumption which may be up to before the drought. However, the extent of the bounce back is difficult to quantify at this stage.

The base date for the projected future water requirements high growth scenario was taken as the year prior to the drought, namely the 2014/15 hydrological year. There was general acceptance by the stakeholders with the proposed approach to determining the high growth future water requirements scenario.

9.3 Water Balance Scenarios

9.3.1 General

Five water balance assessment scenarios have been developed for the WCWSS. These include the following:

(i). Scenario 1: Future water requirements are based on a 2.0% growth rate. This is considered the most realistic scenario based on the drivers of future water requirements as discussed in the previous chapters.

(ii). Scenario 2: Future water requirements are based on a 2% growth rate with the implementation of additional WC/WDM intervention options.

(iii). Scenario 3: Future water requirements are based on a low growth scenario of 1.2% growth rate.

(iv). Scenario 4: Future water requirements are based on historical growth, at 1.73%, with sustained 2015 water conservation and demand management levels.

(v). Scenario 5: Future water requirements are based on a 2.65% growth rate, with sustained 2015 WC/WDM levels.

The focus of the water balance scenarios has been on Scenario 1 and Scenario 2 in the updating of the WCWSS Water Reconciliation Strategy. For planning of the future bulk water resource infrastructure requirements these are considered the most realistic future water requirements. These are discussed in the following sections.

9.3.2 Scenario 1: Future water requirements based on 2.0% per annum growth rate

This scenario looks at future water requirements based on a projected growth rate of 2.0% per annum. This is considered the most realistic base scenario without additional water conservation and demand management interventions. Table 9-1 provides the possible intervention implementation programme.

The planned year of first water is based on information provided by stakeholders according to their current planning. These have been revised based on when the next augmentation option is required according to the water requirement scenario. The yields are also based on the studies undertaken by the different institutions indicated in Table 9-1. It is important to note that the phasing of the implementation of the potential interventions should be based on the least cost approach using the unit refence value (URV) for the development of the options. This will be provided in the next update of the annual report.

Table 9-1. Potential Intervention Programme for the 2.0% per annum growth rate

No	Intervention	Institution	Planned Year First Water	Revised Year of First Water	Yield (million m^3/a)	Status
1	Groundwater Resource Development Options					
1.1	Table Mountain Group (TMG) Aquifer Ph 1	CCT		2019	5.50	Implementation
1.2	Cape Flats Aquifer Ph 1	CCT		2019	7.30	Implementation
1.3	Atlantis Aquifer	CCT		2020	3.65	Implementation
1.4	Groundwater Ph 2 (TMG/Cape Flats)	CCT		2022	5.50	Planning
1.5	TMG -DWS	DWS		2019	6.21	Implementation
1.6	TMG Ph 3	CCT	2027	2029	7.30	Pre-Feasibility
1.7	Langebaan Road Aquifer Scheme	SDB		2020	1.35	Feasibility
2	Management of the WCWSS					
2.1	Alien Vegetation Clearing	WfW			20.10	Over 10 years
2.2	System Improvements	DWS		2019	9.90	
3	Water Reuse					
3.1	Treated Effluent Re-use Ph 1	CCT	2020	2024	25.60	Feasibility
3.2	Treated Effluent Re-use Ph 2	CCT	2020	2028	10.90	Pre-Feasibility
3.3	Saldanha Bay Water Reuse					
4	Surface Water Resource Options					
4.1	Berg River Voelvlei Augmentation Scheme (BRVAS) Phase1	DWS / TCTA	2023	2022	23.00	Procurement Stage- Risk of financing
4.2	Breede-Berg Transfer Scheme (BBTS) Mitchell's Pass Diversion	DWS	N/A	2031	36.00	Pre-Feasibility Study
5	Desalination (Sea water)					
5.1	Desalination Harbour	CCT	2026	2026	18.30	Pre-Feasibility
5.5	Saldanha Bay desalination plant (IDZ)	CCT			3.65	
5.6	Desalination Phase 3	CCT	2033	2034	50.00	Pre-Feasibility
5.7	Desalination Phase 4	CCT	2035	2036	50.00	Pre-Feasibility
	Total Yield				284.26	

In this scenario the following have been factored in the development of the potential intervention implementation programme:

a. The implementation of Table Mountain Group Phase 1 and the Cape Flats Aquifer Phase 2 which are under implementation and will be completed in 2019/2020.

b. The Atlantis Aquifer development is planned to get the first water towards the end of 2020.

- The implementation of the IAP removal will be critically important to address the short-term water requirements of the WCWSS. The results of the programme which should be implemented as a project by all stakeholders through the Working for Water programme should be undertaken to achieve the following from 2020. This should be a continuous programme as follows:
    - Phase 1 is to stabilise the yield of the WCWSS
    - Phase 2 will be to improve the yield by removal of invasive alien plant

c. The management and operation of the WCWSS can be optimised by refurbishing some of the existing bulk infrastructure and improving the annual operating rules through the curtailment rules. This will improve the system yield.

d. The development of the Berg River - Voëlvlei Augmentation Scheme (BRVAS) Phase 1 will be required in 2022. If not implemented by then, there is a very high probability of water restrictions even with normal rainfall in the system.

e. The Breede - Berg River Transfer Scheme (BBTS) known as the Mitchell's Pass Diversion has been included as one of the long-term intervention options. The first water would be required in 2030. Given the long lead time of such projects, planning of the scheme should commence soon.

Figure 9-1 provides the comparison between the water requirements for the historical growth scenario with the potential reconciliation options over a 25-year period.

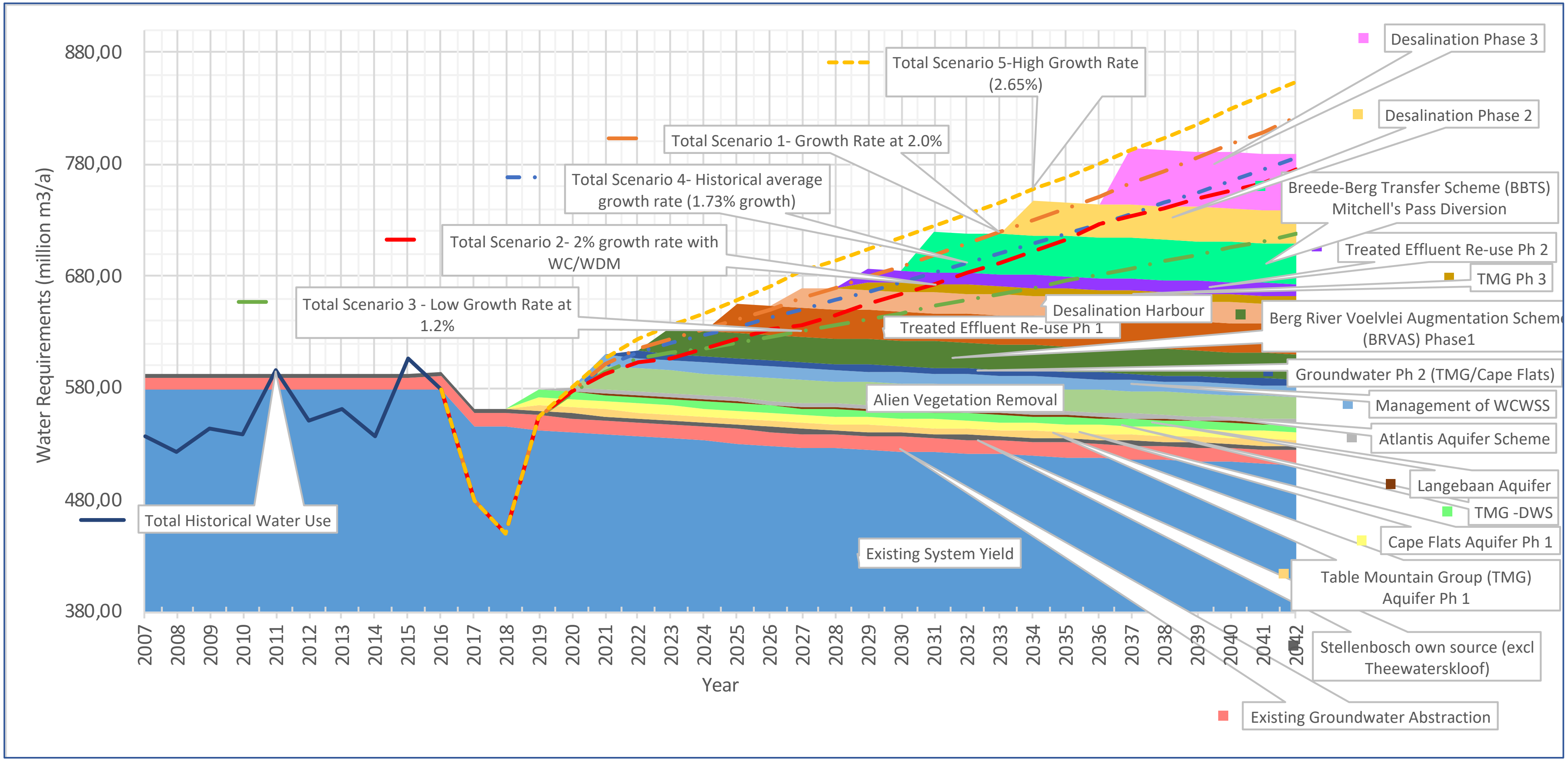

Figure 9-1: Reconciliation of **water supply and requirement for the 2.0% growth rate**

9.3.3 Scenario 2: Future water requirements based 2% growth rate with additional WC/WDM

In this scenario the future water requirements are based on the implementation of additional water conservation and demand management interventions. These are based on the current interventions, which have yielded significant water loss reduction, such as advanced pressure management. It has been estimated that future water requirements in 2042 will be reduced from 821.7 million m^3/a to 774.04 million m^3/a. This averages a saving of approximately 20 million m^3/a from 2021 or 47.7 million m^3/a in 2042. Table 9-2 provides the possible intervention implementation programme.

Table 9-2. Potential Intervention Programme for the realistic future water requirements with WC/WDM

No	Intervention	Institution	Planned Year First Water	Revised Year of First Water	Yield (million m^3/a)	Status
1	Groundwater Resource Development Options					
1.1	Table Mountain Group (TMG) Aquifer Ph 1	CCT		2019	5.50	Implementation
1.2	Cape Flats Aquifer Ph 1	CCT		2019	7.30	Implementation
1.3	Atlantis Aquifer	CCT		2020	3.65	Implementation
1.4	Groundwater Ph 2 (TMG/Cape Flats)	CCT		2022	5.50	Planning
1.5	TMG -DWS	DWS		2019	6.21	Implementation
1.6	TMG Ph 3	CCT	2027	2029	7.30	Pre-Feasibility
1.7	Langebaan Road Aquifer Scheme	SDB		2020	1.35	Feasibility
2	Management of the WCWSS					
2.1	Alien Vegetation Clearing	WfW			20.10	Over 10 years
2.2	System Improvements	DWS		2019	9.90	
3	Water Reuse					
3.1	Treated Effluent Re-use Ph 1	CCT	2020	2026	25.60	Feasibility
3.2	Treated Effluent Re-use Ph 2	CCT	2020	2031	10.90	Pre-Feasibility
3.3	Saldanha Bay Water Reuse					
4	Surface Water Resource Options					
4.1	Berg River Voelvlei Augmentation Scheme (BRVAS) Phase1	DWS / TCTA	2023	2022	23.00	Procurement Stage- Risk of financing
4.2	Breede-Berg Transfer Scheme (BBTS) Mitchell's Pass Diversion	DWS	N/A	2033	36.00	Pre-Feasibility Study
5	Desalination (Sea water)					
5.1	Desalination Harbour	CCT	2026	2029	18.30	Pre-Feasibility
5.5	Saldanha Bay desalination plant (IDZ)	CCT			3.65	

No	Intervention	Institution	Planned Year First Water	Revised Year of First Water	Yield (million m^3/a)	Status
5.6	Desalination Phase 2	CCT	2033	2036	30.00	Pre-Feasibility
5.7	Desalination Phase 3	CCT	2035	2039	50.00	Pre-Feasibility
	Total Yield				264.26	

In this scenario the following has been factored in the development of the potential intervention implementation programme:

a. The implementation of Table Mountain Group Phase 1 and the Cape Flats Aquifer Phase 2 which are under implementation and will be completed in 2019/2020.

b. The Atlantis Aquifer development is planned to get the first water towards the end of 2020.

c. The implementation of the IAP removal will be critically important in addressing the short-term water requirements of the Western Cape Water Supply Scheme. The results of the programme which should be implemented as a project by all stakeholders through the Working for Water programme should be undertaken as a continuous programme to achieve the following:

   - Phase 1 is to stabilise the yield of the WCWSS
   - Phase 2 will be to improve the yield from 2020 by removal of invasive alien plant

- The management and operation of the Western Cape Water Supply Scheme can be optimised by refurbishing some of the existing bulk infrastructure and improving the annual operating rules through the curtailment rules. This will improve the system yield.

d. The development of the Berg River - Voëlvlei Augmentation Scheme (BRVAS) will be required in 2022 even with the implementation of WC/WDM interventions. If not implemented by then, there is a very high probability of water restrictions even with normal rainfall in the system.

e. The implementation of further WC/WDM interventions will delay the implementation of the subsequent bulk water infrastructure options by between 3 and 5 years as indicated in Table 9.2 above.

f. The Breede - Berg River Transfer Scheme (BBTS) known as the Mitchell's Pass Diversion has been included as one of the long-term intervention options. The first water would be required in 2033, a delay of 3 years due to the implementation of WC/WDM interventions. Given the long lead time of such projects, planning of the scheme should commence soon.

The planned year of first water is based on information provided by stakeholders according to their current planning. These have been revised based on when the next augmentation option is required for a 2% growth and sustained water conservation and demand management interventions water requirement scenario. The yields are also based on the studies undertaken by the different institutions indicated in the **Table** 9-2. It is important to note that the phasing of the implementation of the potential interventions should be based on the least cost approach using the unit reference value (URV) for the development of the options. This will be provided in the next update of the annual report.

Figure 9-2 provides the comparison between the water requirements for the per capita use with sustained water use efficiency and the potential reconciliation options over a 25-year period.

9.3.4 Other scenarios

Three other scenarios were also evaluated. The low growth scenario will delay implementation of the bulk water infrastructure reconciliation options. This may however have an impact on the economic growth of the WCWSS.

The historical growth scenario generally is in line with Scenario 2 (2% growth rate with WC/WDM).

The worst-case scenario is based on the case where the economy of the WCWSS grows at a much faster pace. Given the previous water requirements scenario projections since 2007, the average growth rate was found to be less than 2.5% per annum. Although this scenario is unlikely, if this occurs it means the future bulk water requirements infrastructure will be required much earlier than the base case scenario of 2.0% growth rate without additional WC/WDM intervention measures.

9.4 Summary

The water balance assessment for the WCWSS has highlighted the following:

- The reduction in the system yield by nearly 35 million m^3/a has had a significant impact in bringing the supply deficit earlier than was previously envisaged.

- The working for water programme in the WCWSS has not been effective in reducing the alien vegetation in the system. This has contributed to reduction in the system yield of the Water Supply System. This is likely to impact on the annual stream flow reduction which will affect the system yield on an annual basis.

- The projected water requirements growth scenarios were taken at the base date of 2015 to remove the constrained demands because of water restrictions due to the current drought. This also ensured that the level of water use efficiency in the City of Cape and other municipalities as at 2015 was carried through into the projections. Intensified WC/WDM measures implemented in the Water Supply System in 2016 and 2017, was not taken forward in the projections.

- Additional water resources are required by 2021 for the planning scenarios of 2% per annum growth rate with and without WC/WDM interventions measures but with different time frames. This provides limited time to plan and implement major water resources infrastructure without fast tracking the programme. The development of the Berg River - Voëlvlei Augmentation Scheme – Phase 1 cannot be delayed.

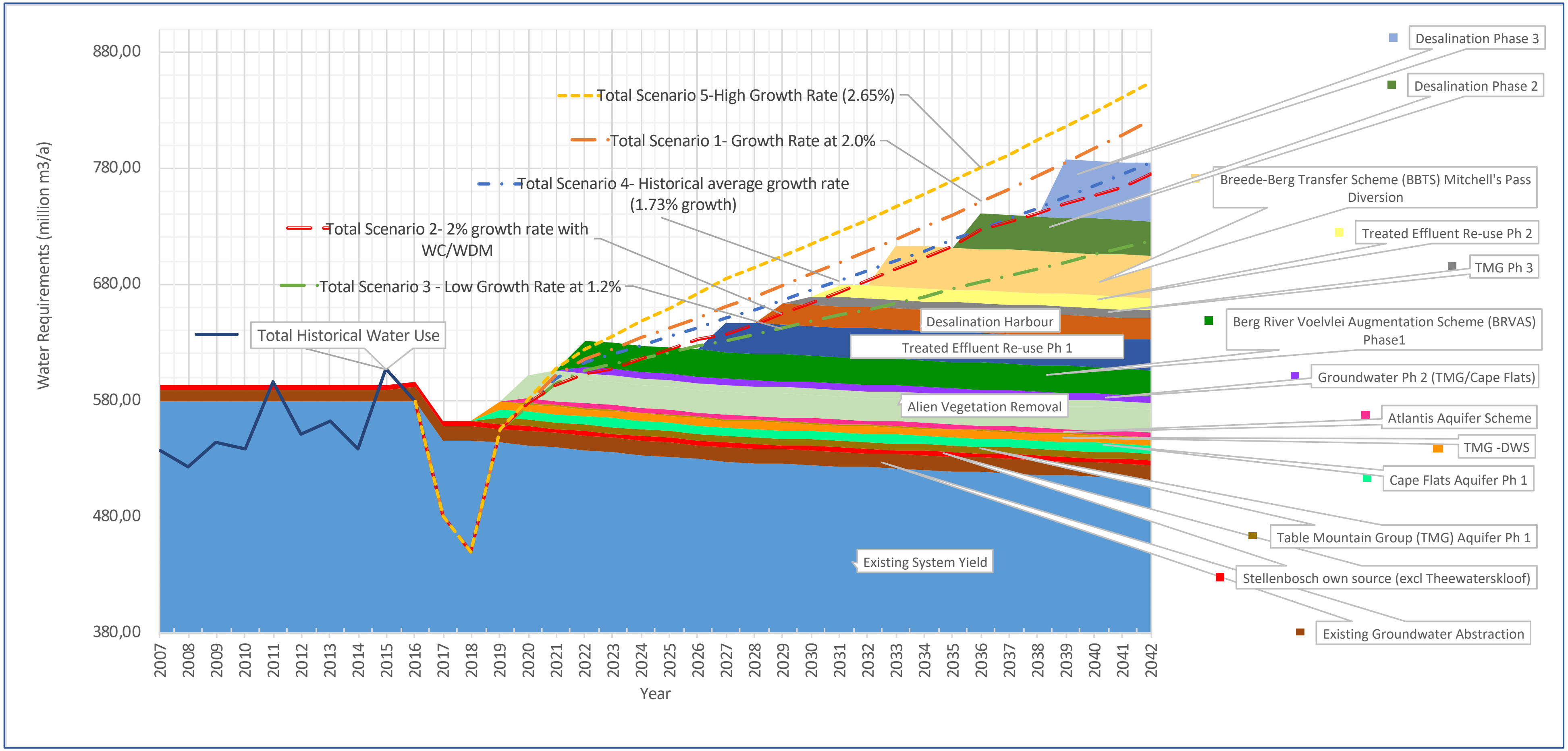

Figure 9-2: Reconciliation of water supply and requirement for 2% growth rate with WC/WDM

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusion

The 2017/18 review and updating the of Water Reconciliation Strategy of the WCWSS has indicated the following:

1. The historical annual average per capita consumption for the Supply System has declined significantly due to the successful implementation of WC/WDM by all users in the System. Therefore, the successful implementation of WC/WDM has been critical in the sustainable provision of bulk water supply in the system.

    a. The average per capita consumption for the City of Cape Town declined from 268 l/c/d in 2007 to 240 l/c/d in 2015, although population increased at

    b. 2.05% per annum. The City achieved a reduction in bulk water abstraction of approximately 40.0 million m^3 over the same period. The City's success in implementing their WC/WDM Strategy is constantly monitored.

    c. The West Coast District Municipality's average per capita consumption also declined from 287.07 l/c/d in 2007 to 264.32 l/c/d in 2015, while population increased by 3.38% over the same period. The implementation of the WC/WDM interventions by the West Coast District Municipality contributed to a reduction in abstraction of 2.6 million m^3. At the time the District was abstracting more than its authorised water use allocation.

    d. In the case of Drakenstein Municipality, the average per capita consumption declined from 196.97 l/c/d in 2010 to 187.24 l/c/d in 2015, while population increased by 2.24% over the same period. The implementation of a WC/WDM intervention programme in the Drakenstein Municipality contributed to a reduction in bulk water abstraction and purchase of 0.97 million m^3 over the same period. This was not as significant as in the City of Cape Town.

2. The surface water resource assessment for the WCWSS has highlighted the following:

    a. The reduction in the system yield by nearly 35 million m^3/a has had a significant impact in bringing the supply deficit earlier than was previously envisaged.

    b. IAP has had a significant impact in the reduction of the WCWSS yield. The working for water programme in the Water Supply System has not been effective in reducing the alien vegetation in the system. This is likely to impact on the annual stream flow reduction which will affect the system yield on an annual basis.

3. The revised water allocation in the WCWSS was determined to be 593.05 million m^3/a, allocated as follows:

    a. The domestic sector has a total water allocation of 399.75 million m^3/a, with the City of Cape Town having a total allocation of 357.9 million m^3/a or 89.5% of the water allocated.

    b. Irrigation Agriculture, which had not taken up its full water allocation, has a total water allocation of 193 million m^3/a.

4. A comparison of the revised water allocation to the available system yield illustrates that the system is over-allocated by 48.04 million m^3/a. This is double the yield of the Berg River Voelvlei Augmentation Scheme (BRVAS) Phase 1.

5. Although five future water requirements scenarios were developed, two planning scenarios were prepared for the strategy update namely the following:

   a. Scenario 1 was for the projected future water requirement scenario of 2.0% per annum growth rate. The base date of 2015 was used in order to remove the constrained demands because of water restrictions due to the current drought. This also ensured that the level of water use efficiency in the City of Cape and other municipalities as at 2015 was carried through into the projections. The future water requirements in 2042 were determined to be 821.67 million m^3/a.

   b. Scenario 2 was for the future water requirement of 2.0% per annum growth rate with water conservation and demand management interventions. The future water requirements in 2042 were determined to be 775.26 million m^3/a.

6. The available water supplies will be exceeded by 2019 under unconstrained demand. Based on currently available information, the only intervention that can move to immediate implementation is the BRVAS (Phase 1). The earliest date that this can be implemented is by 2021. Therefore, other interventions had to be identified to address the shortfall before the BRVAS Phase 1.

7. Implementation of the short-term intervention measures to address the current water restrictions include the following:

   a. Development of the TMG and Cape Flats Aquifers to provide the current and future water requirements of the City of Cape Town. This is planned to be implemented between 2019 and 2020.

   b. Development of the Langebaan Road Aquifer by Saldanha Bay to supplement the water supply from the WCDM, which is currently being implemented.

   c. Feasibility studies for the development of water reuse systems are being undertaken by the City of Cape Town.

8. The decision on the next augmentation intervention cannot be postponed any further and will depend on the intervention which can be implemented the soonest. It is important to continue with the feasibility studies for other interventions to enable informed decisions on the succession of implementation measures.

9. The identified interventions and programme for implementation will need to be regularly updated as more information becomes available, for example from feasibility studies and cost benefit analyses.

10.2 Recommendations

The following recommendations follow from the assessment of the current water requirements and updated scenario planning:

1. The Department of Water and Sanitation must immediately commence with the implementation of the Berg River-Voëlvlei Dam (Phase 1) Augmentation project and appoint a PSP for the detail design – Responsibility Department of Water and Sanitation.

   a. The detail design or a parallel study should also revisit the location and design of the proposed abstraction point, as observations made during the drought indicated potentially better suited abstraction points to increase the flexibility of operation during emergency situations.

2. The implementation of developing groundwater from the Table Mountain Group Phase 1 and the Cape Flats Aquifer Phase 2, including the drilling of boreholes in the Theewaterskloof basin by the Department of Water and Sanitation must be undertaken to be completed in 2019/2020. – Responsibility City of Cape Town and Department of Water and Sanitation.

3. The implementation of the IAP removal will be critically important in addressing the short-term water requirements of the WCWSS. The results of the programme which should be implemented as a project by all stakeholders through the Working for Water programme should commence as a matter of urgency in order to improve the yield of the System by 2020. The clearing of invasive alien vegetation must be significantly increased, especially in the riparian zones of the Berg, Breede, Riviersonderend and Sandveld rivers and their major tributaries – Responsibility Department of Environmental Affairs.

4. The management and operation of the WCWSS can be optimised by refurbishing some of the existing bulk infrastructure and improving the annual operating rules through the curtailment rules. This will improve the system yield – Responsibility Department of Water and Sanitation and Stakeholders.

5. The following feasibility studies were identified in the 2007 Reconciliation Strategy Study and the 2015 Scenario Planning update. These studies need to continue and be concluded soonest, namely:

    a. Mitchell's Pass Diversion Scheme – The Department of Water and Sanitation to commence with the Breede Water Availability Assessment Study urgently in the 2018/2019 financial year to confirm water availability.

    b. Phases 2 and 3 of the Voëlvlei Dam Augmentation – The Department of Water and Sanitation to commence with the feasibility study.

    c. The feasibility and detailed studies on the development of water reuse systems should be completed in 2019 – Responsibility City of Cape Town, West Coast District Municipality, Drakenstein and Stellenbosch Municipalities.

    d. The establishment of a pilot monitoring plant for desalination of seawater should be concluded in 2018 in order to determine the viability of desalination systems – Responsibility City of Cape Town.

    e. The feasibility studies for the previous reconciliation strategy options such as Lourens River Diversion, Palmiet Transfer Scheme, Molenaars Diversion and raising of Steenbras Lower Dam should be undertaken urgently – Responsibility Department of Water and Sanitation.

6. The City of Cape Town, other municipalities and the agricultural sector must actively continue with the implementation of their approved and updated WC/WDM Plans.

    a. Sustaining the gains in WC/WDM is critical to the system.

    b. All water users must implement, measure & report on their programme, including the irrigation agriculture sector.

    c. Responsibility of City of Cape Town, West Coast District Municipality, and relevant Local Municipalities as well as Irrigation Boards and Water User Associations.

7. Regular reviews of the Reconciliation Strategy should continue in order to ensure the objectives and targets set by the Strategy are achieved – Responsibility Strategy Steering Committee and Administrative and Technical Support Group.

a. Alignment to the City of Cape Town's build programme and other interventions by municipalities need to be reported at the Administrative and Technical Support Group meetings.

b. The proof of existing water allocations should be provided to the Administrative and Technical Support Group to enable the validation of the water allocations in the WCWSS.

8. The Decision Support System which is currently being implemented for the WCWSS includes a real-time monitoring system which must be fully utilised and regularly updated to improve the management of releases from the major dams and to also reduce potential losses incurred under previous operating rules.

9. The Yield Model should be calibrated to enable a definitive yield value as opposed to the preliminary value currently being used. The process will allow for the yield assessment of the individual dams in the WCWSS.

10. Planning toward meeting the Resource Quality Objectives which are to be gazetted in the next few months, should begin without delay.

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APPENDIX A: INTERVENTION OPTIONS IDENTIFIED IN THE 2007 RECONCILIATION STRATEGY

Identified Augmentation Options (DWS, 2007)

OPTION	DESCRIPTION
A. Agricultural Water Conservation and Demand Management	
A1.1 - River Release Management	Releases from dams for uptake by irrigation users could be more efficiently timed and managed. Examples include the releases from Voëlvlei Dam to Misverstand Dam, from Theewaterskloof and Greater Brandvlei dams and from the future Berg River Dam. Freshening releases (notably 22 Mm3/a from Greater Brandvlei Dam) for salinity management in the middle and lower Breede River could be reduced through the use of interceptor drains to trap highly saline return flows. Decision support systems should be considered to assist water control officers and dam operators.
A1.3 - Irrigation Canal Losses	No significant water conservation and demand management (WC/DM) measures have been applied to conveyance systems, river losses and canals. Concrete lined irrigation canals in the Breede WMA are extensive. Some are as old as 100 years and losses from weakened canals are high. Refurbishment is expensive and may not be affordable by the irrigators. A possible option is for the urban sector to refurbish the canals, in return for a portion of the water traded out of irrigation.
A1.4 - Farm Dam Losses	Over 40% of the total irrigation demand in the Berg WMA is from farmers' own sources. The lining of farm dams could offer water savings of about 6%. However, this is likely to be prohibitively expensive for farmers.
A1.7 - Metering	Very limited metering of irrigation usage currently takes place. Metering from source to point of abstraction and then to field application is necessary to properly understand the extent of utilization and losses. This would help to define the potential benefits of WC/DM, to control abstractions and usage by irrigators, and to bill for water actually used.
B: Water Trading	
B1.1. Theewaterskloof and Upper Berg	During the periods investigated, less than 60% of the allocated water from the system was being used by the Zonderend and Upper Berg River Irrigation Boards. This equated to some 57 Mm3/a not being utilised by irrigators.
B1.2 Eikenhof Dam	Approximately 4,5 Mm3/ a is allocated but unutilised from Eikenhof Dam. This volume of water could potentially be integrated into the WCWSS via the existing Palmiet Pumped Storage Scheme.
B1.3 Koekedouw Dam	Approximately 3 Mm3/a is allocated but unutilised from the Ceres-Koekedouw Dam. This volume of water could potentially be integrated into the WCWSS via the potential Michell's Pass Diversion Scheme.
C: Changes in Land Use	
C1 - Removal of Invasive Alien Plants	In the Berg WMA, an area of approximately 137 000 ha of dense invasive alien plant (IAP) infestation occurs. Most of this is in the Lower Berg catchment. High concentrations occur in the riparian zones and result in a reduction in surface water runoff of some 87 Mm3/a. Clearing efforts are currently focused on a 30 m strip on either side of the river channel and on light infestations in high mountain areas (reduction in seed spread).
C2 - Removal of Commercial Forestry	Mountain-to-Ocean (25% SAFCOL and 75% Cape Timber Resources) is currently phasing out operations in the Western Cape. In the Berg WMA, 11 900 ha of forestry reduces surface water runoff by about 26 Mm3/a. In the Upper Breede and Riviersonderend catchments, about 3 600 ha of forestry occurs, reducing surface water runoff by some 8 Mm3/a. In the Upper Palmiet and Kogelberg catchments some 5 400 ha of forestry exists, with roughly 3 100 ha being phased out. The current reduction of surface water runoff is calculated at 11 Mm3/a.
D: Re-use of Treated Effluent	
D1. Treated for Local Irrigation (and Industrial) Use	Entails the treatment of wastewater for the irrigation of public open spaces and sports fields and also for agricultural and industrial purposes. The scheme entails reticulation via a separate treated wastewater distribution network from 13 Wastewater Treatment Works (WWTW). Treatment for this option assumes further filtration only.
D2 – Treated for Commercial Irrigation (Exchange for Irrigation Allocations)	Entails the exchange of treated domestic effluent with untreated fresh water (currently supplied to farmers). The untreated fresh water would then be treated to potable standards. There is potential to supply the Eerste River irrigators from the Zandvliet and Macassar WWTW during summer. A 45km pipeline and 0,5Mm3 balancing dam near Stellenboschberg Tunnel Outlet would be required.
D3 – Treated for Potable Use	Entails the use of wastewater treated to potable standards for year-round use. Further treatment than conventional would be undertaken with a 1:4 blending ratio (four parts treated fresh water to one part treated wastewater). Cape Flats, Mitchell's Plain, Zandvliet and Macassar WWTW are proposed with treatment/blending at Faure WTW.
D4 – Dual Reticulation	Entails conveyance of treated effluent via a separate network to domestic users for

OPTION	DESCRIPTION
Networks	gardening and toilet flushing purposes. This option must be considered conjunctively with other WC/DM initiatives which target the same users (private boreholes, grey water, rain tanks, etc.)
E: Urban Water Conservation and Demand Management	
E2 – Leakage Detection and Repair	This scheme is based on the assumption that unaccounted for water cannot economically be reduced to below 15% of the average annual daily demand. The target is therefore the difference between the unaccounted-for water and 15% of average annual daily demand. CCT investigations indicate a potential saving of 15,6 Mm3/a.
E3 – Domestic Leakage Repair (Low Income Households)	Repair of domestic plumbing leaks (toilets, taps, etc.). The target area is lower income households, unable to afford regular maintenance and repair.
E4 – Pressure Management	During periods of low demand (typically at night), reticulation systems experience high pressure. This increases the rate of leakage and pipe bursts. By reducing the pressure during low demand periods, the volume of water wasted through leakage can be reduced.
E5 – Use of Water Efficient Fittings	This option involves the use of water-efficient fittings for toilets, showers and hand basin taps/mixers. Opportunity exists amongst commercial, municipal and industrial users, both for new developments and retro-fitting of existing developments.
E6 – Elimination of Automatic Flush Urinals	Entails the replacement of automatic flush urinals with user-activated or waterless urinals. Opportunity with public office buildings, railway stations, schools, private hotels, bars and restaurants. Malfunctioning automatic flush urinals use substantially more water than functioning AFUs.
E7 – Adjustment of Water Tariffs, Metering and Credit Control	This option makes use of adjustment of tariffs, improved metering and more effective credit control. The overall impact is one of awareness of the cost of water with an assumed 30% tariff increase providing potential savings of up to 6%.
E8 – User Education	Focuses on making consumers aware of their responsibility to use water more efficiently. Initiatives include inter alia informative billing, media marketing, water user forums and outreach programmes.
E9 – Promotion of Grey Water Use	Interception of water from baths, showers and basins for gardening purposes. Kitchen sinks and washing machines are excluded due to solids content and chemical concentrations in the wastewater.
E11 – Promotion of Private Boreholes and Wellpoints	This is an augmentation option involving the installation of private wellpoints (up to 8m deep) or boreholes (deeper than 8m). Wellpoints have lower yields but are cheaper to install.
F: Groundwater Development Options	
F1: TMG Aquifer. TSA W7 - Wemmershoek	Pilot phase development of 13 production boreholes and several monitoring boreholes, located 3 km northwest of the Wemmershoek Dam wall. Abstracted water would be piped under gravity to the Wemmershoek Dam.
F2: TMG Aquifer – TSA H8 - Steenbras	Pilot phase development of 13 production boreholes and several monitoring boreholes, located 3 km south east of the Upper Steenbras Dam wall. Abstracted water would be piped under gravity to the Upper Steenbras Dam.
F3 – TMG Aquifer. TSA T4 - Theewaterskloof	Pilot phase development of 13 production boreholes and several monitoring boreholes, located approximately 6 km west of Vygeboom. Abstracted water would be piped under gravity to the Theewaterskloof Dam.
F4 - Cape Flats Aquifer	Establishment of production and monitoring boreholes, a lime-dosing facility and a 25 Ml buffer reservoir. Boreholes would be sited within public open spaces, parks and school grounds in Mitchell's Plain, sufficiently far away from existing WWTW and solid waste sites.
F5 - West Coast Aquifers	Adamboerskraal Aquifer, adjacent to Berg River estuary. Langebaan Road Aquifer, between Berg River, Langebaan, Darling and Hopefield. Elandsfontein Aquifer, between Berg River, Langebaan, Darling and Hopefield, and Grootwater Aquifer, between Yzerfontein and the Modder River to the south. The Atlantis Aquifer, between Atlantis and Mamre is fully allocated.
F6 - Newlands Aquifer	Potential to install boreholes and abstract additional groundwater up to a safe yield of about 3,5 Mm3/a.
F7 - Conjunctive Use	The scheme involves injecting surplus surface water into aquifers in winter, for use in summer. Also involves pumping groundwater into surface water storage facilities, to supplement surface water supplies during periods of shortfall. Opportunity exists primarily in the West Coast Aquifers and in the Breede River Valley alluvium.
G: Surface Water Development Options	
G1 - Raising Lower Streenbras Dam	24 m raising of the Lower Steenbras Dam to the same full supply level (FSL) as the Upper Steenbras Dam. The scheme includes existing and potential transfers from the Palmiet River and runoff from within Steenbras Dam's catchment.
G2a - Upper Campanula	Alternative 1 - Construction of a 50 Mm3 dam on the lower Palmiet River, and

OPTION	DESCRIPTION
Dam	a pipeline and canal to the existing Kogelberg Dam. Water transferred to a raised Lower Steenbras Dam via the existing Palmiet Pumped Storage Scheme.
G2b - Upper Campanula Dam	Alternative 2 - As for option G2a above but with a weir 1 km upstream of the Palmiet Estuary. Water transfer from the weir via a tunnel into Upper Campanula Dam, then into a raised Lower Steenbras Dam.
G3 - Lourens River Diversion	The scheme involves the construction of a weir on the Lourens River diverting winter water directly into the Steenbras - Faure pipeline.
G4 - Eerste River Diversion	The scheme involves the construction of 4 m high (35 000 m3 capacity) weir on the Eerste River, with pumping into a new off-channel balancing dam and on to the Faure WTW. A bypass pipeline would be required from Stellenbosch due to water quality concerns.
G5 – Berg River – Voëlvlei Augmentation: Phase 1	The scheme requires a 1 m high weir and intake on the Berg River near Spes Bona. Winter water (3 m^3/s) would be pumped over 5 km to the Voëlvlei WTW. Treatment would be for direct delivery to Cape Town or alternatively, pre-treatment for storing water in Voëlvlei Dam. The scheme would optimise spare capacity in the existing WTW and in the pipeline to Cape Town (total 20 million m3/a). Balance to supply other users reliant on Voëlvlei Dam.
G6 - Voëlvlei Augmentation : Phases 2 and 3	This option takes the Berg River Project into account. Phase 2 involves a 9 m raising of Voëlvlei Dam. Phase 3 involves a 7.5 m high (4 Mm3 capacity) weir on the Berg River and a rising main to the Voëlvlei Dam, with a diversion capacity of 20 m3/s. A 1.5 m dia. steel pipeline to Cape Town would also be required.
G7 - A new dam at Misverstand	This option involves the construction of a 27 m high dam (280 Mm3 capacity) on the Berg River in close proximity to the existing weir. The option could be used to satisfy West Coast demands or be integrated with the Voëlvlei Dam by pumping water to the Twenty-Four Rivers canal, which feeds the Voëlvlei Dam.
G8 - Twenty-Four Rivers Dam	This scheme involves the construction of a 21 m high rockfill dam at the existing diversion weir site on the Twenty-four Rivers. The potential dam would act as a balancing dam to improve the efficiency of diversions into Voëlvlei Dam.
G9 - Watervals River Dam	The dam would be located in the catchment adjacent to Voëlvlei Dam. A 14 m high rockfill dam (12 Mm3 capacity) would feed water via a tunnel into the Voëlvlei Dam.
G10 - Upper Molenaars Diversion	Involves the construction of a pumping sump in the Molenaars River. Winter flows would be pumped at 5 m3/s through the Huguenot Tunnel (existing 1.2 m dia. pipe), before being gravity fed to either the Berg River Dam or the Wemmershoek Dam via 26 km of new pipeline.
G11 - Muldersvlei Optimisation Scheme	This is a cost saving initiative by the CCT. The scheme involves a new 500 Ml/d WTW at Muldersvlei to treat Berg River Dam and Supplement Scheme water (± 81 Mm3/a) to potable standards, rather than Theewaterskloof Dam water, which is of a lower quality.
G12 - Wemmershoek Dam and Pipeline	This option would connect the Wemmershoek Dam to the Berg River Dam. Surplus water from Wemmershoek Dam catchment could be transferred to the Berg River Dam, either by flow reversal in the Wemmershoek pipeline or via a new pipeline.
G13 - Michell's Pass Diversion	This option entails the construction of a 10 m high weir on the Dwars River diverting winter water via a 9 km canal into the Klein Berg River, and then to the Voëlvlei Dam. Diversion capacities of 4, 8 and 12 m3/s have been investigated.
G14 – Brandvlei to Theewaterskloof Transfer	This option entails the augmentation of the Greater Brandvlei Dam by increased Papenkuils abstraction with direct pumping into the Greater Brandvlei Dam. Water would then be transferred by pipeline, canal and tunnel to the Theewaterskloof Dam.
G15 - Raising Theewaterskloof Dam	This option only has a benefit if developed in conjunction with scheme G14. There is little yield benefit from runoff from its own catchment and high evaporation is an issue.
G16- Lower Wit River Dam	This scheme entails the construction of a 28 m high (24 Mm3 capacity) rockfill dam at the bottom of Bain's Kloof on the Lower Wit River. Winter water (1.2 m3/s) would be pumped across the catchment divide, then gravity fed to the Klein Berg River and into the Voëlvlei Dam.
G18 - Upper Wit River Diversion	Entails a diversion weir on the Wit River and a tunnel under Bain's Kloof Pass into the Kromme River catchment. A new dam on the Kromme River (Doolhof Farm) would be constructed. The water would be treated and pumped to Wellington and back to Paarl (reverse use of Paarl-Wellington pipeline). Water could also be reversed into the Wemmershoek-Cape Town pipeline.
H: Desalination	
H1 - Koeberg Site	This option utilises water from the outlet structure at the Koeberg Nuclear Power Station to provide seawater to a reverse osmosis desalination plant. Therefore, no inlet or outlet structures are required. There are cost-saving benefits in using

OPTION	DESCRIPTION
	this heated seawater, as well as operating benefits associated with using water of a relatively constant temperature. A 60 Ml/d plant has been assumed.
H2- Melkbos Site	At this site, seawater for the reverse osmosis desalination plant would be drawn directly from the sea, and therefore would require an inlet and outlet works.

APPENDIX B: MINUTES OF ATSG NO 3. – 31 OCTOBER 2018

SUPPORT FOR THE IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR THE WESTERN CAPE WATER SUPPLY SYSTEM

ADMINISTRATIVE AND TECHNICAL SUPPORT GROUP MEETING #3

DATE: 31 October 2018 **TIME:** 10H00 – 15H00
VENUE: WC DWS Regional Office, Bellville. Spectrum Building - 2nd floor Boardroom
52 Voortrekker Road, Bellville
CHAIR: DWS

PURPOSE OF MEETING: To provide technical support and feedback to the implementation and maintenance of the Western Cape WSS Reconciliation Strategy

MINUTES :

ITEM	DETAIL	ACTION
1	**Welcome and Introduction**	
	Mr Daniels chaired the meeting on behalf of the National DWS Office, who could not attend due to factors beyond their control. He welcomed all role-players to the 3rd ATSG meeting on the WCWSS Reconciliation Strategy.	
2	**Attendance and Apologies**	
	The attendance register is provided in Appendix A. Apologies were received from the following: • Tendayi Makombe • Patrick Mlilo • Jenny Pashkin • Fanus Fourie • Pamlah Shikwambana • Michael Webster • Nicolette Vermaak • Gisela Kaiser • Ashton van Niekerk • Melissa Lintnaar-Strauss • Peter Flower (will join the meeting a bit later)	
3	**Additions/Changes to the Agenda**	
	The agenda was adopted with no changes.	
4	**Minutes of Previous ATSG (Meeting No 2 – 19 June 2018)**	
4.1	Approval of minutes The minutes were adopted with the following corrections: • Point 2 - Correct Ms Bila to read Ms Bila-Mupariwa	

ITEM	DETAIL	ACTION
	• Correct the spelling of Voëlvlei Dam in point 6.2.3; 6.2.5; 6.3.7 and 6.7. • Point 6.2.3, bullet 2 – correct to read *Mr du Buisson* indicated that one cannot draw down Voëlvlei to the real outlet. • Page 8 – bullet 1, correct Swartberg to Swartland.	
4.2	Matters arising	
	The following items still need to be actioned: • Mr Makombe to provide the PSP with the contact person for climate change discussions. • Ms Singh to distribute the communication strategy to the ATSG members. • Ms Singh to include Working for Water and Working for Wetlands to the ATSG distribution list. • Mr Shand to distribute a report on possible options to the ATSG. Outstanding matters to be actioned by the 15th November 2018.	
5	**Presentation of the Draft Annual Status Report**	
5.1	Discussion	
	Mr Tlou and Mr van der Berg presented the draft annual status report (Appendix B). The following discussions emanated from the presentation.	
	Allocation figures	
	It was explained that the study team was not able to obtain all water use licences to support the domestic allocation figures. Information was sourced from the White Papers, Bulk Water Service Agreements and in the case of the West Coast, the latest water use authorization was obtained.	
	Mr Roberts indicated that the Region has all the documentation regarding the water use authorisations and will provide to the Study Team. He indicated that the additional allocation to the West Coast depended on an additional 4 million m^3/a from Voëlvlei and 6 million m^3/a from Misverstand. He did not agree with the baseline allocation to West Coast of 22.8 million m^3/a. He indicated that their initial allocation was 17.44 million m^3/a from Misverstand and 4.2 million m^3/a from Voëlvlei.	J Roberts
	Mr Roberts explained that the Drakenstein LM gets water from Voëlvlei and they have an allocation and new licence from Voëlvlei, but also get water from Cape Town through the Voëlvlei line.	Note to PSP
	The study team to collate the water use licences and have them available on the project.	PSP
	Mr Enright highlighted that water use licences were only allocated after 2000. Figures prior to this come from White Papers. He indicated that the temporary allocations are illegal water use and should be removed from the allocation considerations in the supply system. These temporary allocations lead to double counting as this is contained in the agricultural allocations already.	PSP
	Mrs Petersen queried the availability of the allocation figures from the validation and verification process as that would have all the supporting documents. This is the most recent information available and should be used in this process. She indicated that a final schedule was compiled about three months ago.	PSP to obtain from Region
	Mr van Zyl indicated that the authorisations are available on paper, however the system is overallocated based on the yield of the system. He mentioned that the yield of Theewaterskloof has been revisited on numerous occasions and at each time the yield decreased. The annual operating model is being run and it was requested that both this study and the figures used in the model should relate.	Note to PSP

ITEM	DETAIL	ACTION
	Mr Roberts confirmed that there have been allocations made to West Coast and to the City of Cape Town from the Berg River Dam through new licences.	
	He indicated there are two different processes: the validation and verification for agriculture and the validation and verification for the domestic sector. The Section 56-3's have not been incorporated in many cases in the V&V project, which are now being added to the list of river sections / systems. This will help the management of the system in deciding from which source the water is taken.	
	Mr Roberts further mentioned that the allocation to West Coast of 22.8 million m^3/a quoted on the presentation comprises allocation from groundwater of 1.35 million m^3/a. Under the new licence, water is only allocated from the system and the groundwater allocation has been taken away and provided to Saldanha Bay LM under a new licence.	Note to PSP
	The PSP to confirm if the figure used in the allocation table for the West Coast DM includes the authorization for groundwater.	PSP
	Mr Killick highlighted that the Raw Water Supply Agreement allows for a reduction in allocations, so if the yield of the system has dropped then all users should be reduced prorata. Overallocation should not be addressed by introducing restrictions.	
	He further indicated that the yield of the individual dams against which allocations are made was last determined in the 1990's. An update of the yield of these dams need to be done as a matter of urgency. The Voëlvlei Dam, is potentially overallocated by 80 million m^3/a.	Note to DWS
	Mr Daniels indicated that there are mechanisms to control the overallocation, however the issue is in having the correct information on hand to make sure you implement the right mechanism of control.	
	It was noted that that care must be taken not to confuse restrictions, which is a punitive measure to reduce demands during droughts, as a mechanism to reduce the overallocation. It is also a short-term measure.	
	Mr Daniels responded to this by saying there is a need to have long-term planning of augmentation schemes to reduce the limitations imposed on users and to get their full allocation from the system. The limitation will be short-term.	
	Mr Enright highlighted that the only way allocations can be reduced is through compulsory licensing, and that is only for implementation of the Reserve and Black Economic Empowerment. The option available is to put in permanent restrictions, which is not unusual. He recommended that the reduced yield be put into the model and it would probably result in reaching restrictions quicker or more often.	
	It was suggested that the discussion on the tariffs to be paid by the West Coast DM based on their new licence be handled outside of this meeting.	
	Agricultural allocation	
	It was noted that the figures used in the study was based on figures submitted by the Agricultural sector on their verified areas. According to Mr Enright this is the Schedule 63 list.	
	Mr van Zyl queried the allocation of 193 million m^3/a. He feels the figure should be closer to 163 million m^3/a. This was supported by Mr Roberts who indicated it should be 167.5 million m^3/a. Mr Roberts further indicated that the table presented includes meter scheduling which is not released through the system, for example through the Lower Berg. The figures the DWS has from the V&V perspective are slightly larger on the summer allocation, but the quota is different. The DWS is not applying a 5000 quota as yet. They are presently only supplying a 3000 quota from Voëlvlei Dam. It was written up in the	

ITEM	DETAIL	ACTION
	documentation as what should be considered but it has not been applied. He indicated that the Theewaterskloof allocation from direct abstraction was far more than the 1.5 and 7.5 million m^3/a allocated last year. They now have a validation figure of 11 million m^3/a. The 220 million m^3/a comes from the 2015 status report, which according to Mr Killick had inaccuracies. Mr Daniels requested that the DWS verify the figure for agriculture with the Agricultural sector. The list needs to reflect what is released from the system. Mr Daniels indicated that it is important to involve the PSP in all the separate discussions being held. Mr Enright indicated that they cannot continue underplanning on the system. He explained that the allocation from Theewaterskloof includes the irrigators on the river feeding into the Dam. It was recommended that upstream users are identified and considered in the system allocation. ***Effect of Ecological Water Requirements in the future forecasting*** Mr Flower queried how the EWR will be effected and its affect on future forecasting and yield of the system. Mr van der Berg responded to the query by indicating that all legal EWRs have been taken into consideration in the recent yield modelling. This includes the Berg River Dam and releases to the estuary. This was only assessed in terms of quantity and not quality. Many of the dams do not have release mechanisms so it was modelled under constraints of existing infrastructure. Mr Daniels stated that an additional 17 million m^3/a maybe required to give effect to the Reserve and queried how one incorporated this into an already stressed system, bearing in mind the RQOs is a statutory requirement. Mr Shand responded by indicating that on the Berg River Dam, the environmental releases are not included in the current modelling conducted. Mr van der Berg indicated that there are some recommendations that are more operational, where all the dams are operated together in order to get some flows through the system. This however means that even the private dams will need to be operated together. Operationally this means that the lowest dam effectively has to be kept full and would need to overflow to get flows into the river. It is not a legal requirement as such, but rather a strong recommendation as part of the RQOs, which will likely be published soon. Once the RQOS are published it becomes a legal issue which can be put back into the model. Mr Shands explained that when the Voëlvlei Pumping Scheme was looked at, the estuary water requirement was a key consideration of how the scheme would be operated. But this is the only direct operational intervention apart from the Berg River Dam which has an environmental release. Mr Roberts indicated that to make an environmental release from the future Berg River - Voëlvlei Augmentation Scheme, would have a bottleneck at Misverstand. The weir would need to be operated at a very high level for spills to take place. Management of the water downstream of the dam would be necessary to ensure the required volume reaches the estuary. The necessity of the gauging station becomes very important. It was noted that future planning will need to align to meet the EWR. ***Water Resource Availability*** Mrs Kloppers indicated that the Climate Change Directorate at the Western Cape Provincial Office has conducted a number of studies with UCT. There are a number of good studies and projections that can be brought into this. She	J Roberts/W Enright J Roberts/W Enright J Roberts / W Enright

ITEM	DETAIL	ACTION
	suggested the study team speak to Marlene de Ross and Y. Isaacs for information.	E van der Berg
	It was also noted that the Region together with specialists from the National DWS Office are planning a climate change workshop. Mrs Bila-Mupariwa to invite the CCT to this meeting.	Bila-Mupariwa
	Mr Killick indicated that the preliminary yield now quoted is based on extension of hydrology and did not include a recalibration of the model. He urged that the Committee recommend that the yield model be recalibrated, as a definitive yield value is required. This would look at the individual yield of the dams as well.	DWS
	The updating of the WAAS for the Breede catchment came out of the recommendation of the 2007 Reconciliation Study and to date this has not been done. This recommendation needs to be carried forward in this study and should include the Berg River catchment as well.	DWS
	Climate change projections need to be included in the longer term planning.	
	Mrs Kloppers indicated that the previous recommendation was to not to have a separate climate change scenario, but rather climate change should be superimposed on all scenarios.	E van der Berg
	Mr Enright explained that previously climate changes was taken into account by a 15% reduction over 25-30 years, this was later reduced to 10%. Climate change will benefit the dams as a result of floods, but the prolonged droughts will be problematic. Mr van der Berg responded saying that the 10% reduction is very simplistic and something more sophisticated is required and this needs to be investigated.	
	Water Balance Scenarios	
	Mr Tlou explained that that the Gini effect was factored in through the per capita water use.	
	The CCT indicated that they were comfortable with the 2% growth rate projection.	Note to team
	Intervention Options	
	Mr Roberts indicated the need to look at long term support to take smaller Municipalities off the WCWSS and be dependent on local sources.	Note to team
	Mr Roberts indicated that Saldanha Bay LM water reuse will not happen. Augmentation options earmarked for Saldanha Bay LM includes Langebaan Road Aquifer Phase 2 which is licensed and Langebaan Phase 3 and 4, which is recharged with the reuse component from the Langebaan WWTW. The Saldanha Bay WWTW is fully allocated to Mittal Steel. The other options include the Elandsfontein aquifer and the desalination plant at Danger Bay, which is supported by National Treasury. The desalination plant will start at 10Ml and progress to a 30Ml Works.	Note to team
	Mr Daniels has requested that information received from the Municipalities be passed through the Regional Office, to ensure there is similar understanding before presentations are made at the next meeting.	Note to Team
	Mr Killick highlighted that money will be spent to reclaim yield through removal of alien vegetation. The process will not immediately release water, so the first phase will not increase the yield, but rather stabilize the situation. Team to update the scenario to reflect this.	
	Mr van der Berg indicated that he will provide the team information he has available regarding the groundwater developments throughout the Municipalities in response to the drought situation, that have been conducted through	E van der Berg

ITEM	DETAIL	ACTION
	Province. However, he requested that before use this be checked with the Regional Office.	Note to team
	Mr Shands highlighted the following intervention options: • a small scheme proposed at Misverstand that would increase the yield with 4 million m^3/a, which is worth including into the study; • Accessibility of the 10% storage in the Berg River Dam, once the Berg River pumping scheme is built. This option should be considered as part of the TCTA Berg-Voëlvlei Augmentation Scheme to allow water to drain toe the outlet works of the Voëlvlei Dam.	Note to team
	Further options highlighted by the Irrigation Board included: • Voëlvlei pump scheme – upgrading of pumping capacity into the dam. This can allow the pumping of floods from the Berg River into the Voëlvlei Dam. This intervention has been identified as an option for a very long time. • Raising of the Voëlvlei Dam should be implemented urgently. The irrigation sector would like to see implementation of these intervention measures immediately. The lack of funds should not prevent the implementation and if necessary funds should be raised for this purpose.	Note to team
	Mr Daniels indicated that he will speak to Mr Menard regarding the progress on these two intervention options.	D Daniels
	Mr van Zyl highlighted the option of: • Molenaars Diversion – pressure by Drakenstein LM for the DWS to revisit this scheme. He noted that if the DWS does not implement this, the LM might be interested in pursuing this option.	Note to team
	Mr Roberts indicated that other options that should be considered include: • Having Drakenstein come off the WCWSS and develop their own schemes. • Storage within the Palmiet, but closer to the estuary. Currently, 160 million m^3/a flows into sea, after the users are provided their allocations. It is the highest yielding catchment in the Cape. An EWR of 60 million m^3/a is required for the estuary. It was noted that there are sensitivities around the biosphere in this catchment that need to be considered.	Note to team
	Mr Tlou highlighted that the unit reference value of the various options have not been investigated as yet and will be addressed in subsequent updates of the report.	
	Mr Wood clarified that the reduction in yield is now being recovered by augmentation, which is largely within the control of Cape Town. The system is overallocated and to balance the system all users must take a cut. He highlighted that the programme presented at this meeting is essentially the CCT funding the recovery of the yield of the system. There are other users that are investing and their augmentation options should be brought in to this programme. The CCT is planning by assuming a certain loss in yield or availability in the system and they are planning to recover that and cater for their growth. All users must do the same. Otherwise this is cross subsidization.	Note to DWS & Project Team
	Mr Wood questioned whether the curtailments to meet the available yield will be	

ITEM	DETAIL	ACTION
	imposed through the Annual Operating Analysis or is the option to bring allocations down to the yield of the system. He indicated that this is a key point that needs to be resolved urgently. Mr Wood referred to the March ATSG meeting where the City mentioned that the 1:200 year assurance is more appropriate for the urban sector. The City is currently using this assurance level in their planning. However, this also depends on how the public takes to this as there are cost implications. The reason for this is that the City is concerned about their ability to restrict in the future. They do not believe they can achieve more than a 30% restriction, as there are many savings that will stay, as many people have made water wise alterations. They will want lesser restrictions and believe they can plan for this with a higher level of assurance. He requested for a view of this from DWS, as it might also require a different operation of the system and different curtailments. He indicated that correspondence regarding this was provided to the DWS Head Office. Mr Daniels indicated that this discussion can take place at the SOF meeting on the 19 November.	DWS Note to team DWS
6	**Relevant projects and initiatives undertaken in WCWSS**	
6.1	DWS Studies	
	System augmentation	
	Discussed in item 5.	
	WCWSS operation and monitoring	
	Discussed in item 5	
	Update on dam levels and water restriction	
	Mr van Zyl provided a presentation on the monitoring of system performance (Appendix C). He thanked the CCT and the irrigators on managing the restrictions well, that have now resulted in an increase in dam levels. He noted that the Steenbras Upper reduced in level and explained that was as a result of releasing water into Steenbras Lower. The CCT was able to shift their demand accordingly which enabled the WCWSS to get through the dry period. The City together with the irrigators were able to make water available for the emergency schemes required during this period. He mentioned that the new water year starts on the 1 November and as the rivers are dry, releases will be made from tomorrow (1st Nov) until the 19th Nov. The exact level of restriction imposed is not known at this stage. The irrigation season also starts from the 1 November. Mr Roberts cautioned the irrigators in applying for their quotas. They should not apply for a lot now and find themselves short once the model has been run. Mr Shands cautioned how the information is provided as it can be miscommunicated via the press. The message being conveyed through these discussions is that the restrictions are still in place, and the users / irrigators can use the water at their own risk within the restrictions. It was recommended that a notice to this affect be issued. Mr Bourbon-Leftley indicated that they have an allocation which is through releases from the dams as well as from natural river flow. As the rivers are dry they are not able to use the allocation through river flow. The allocation from	Note to irrigators DWS Region

ITEM	DETAIL	ACTION
	dam releases is 58 million m^3/a, however based on calculations done in previous years, this is reduced to 44 million m^3/a. The restrictions that are being posed are based on the 44 million m^3/a, the hectares are also restricted and furthermore they need to take river losses into account. River losses years ago was taken as 25%, however recent metering has indicated losses to be in the region of 40-50%. He emphasized that it is very unlikely that good quality fruit can be produced under these conditions, in particular export quality fruit, such as table grapes, plums, nectarines, citrus. At least 6000 $m^3/ha/a$ is required to produce export fruit. He elaborated that the Irrigation Board cannot be restricted based on 5 wet years, when they did not take much from the dams. It has a major impact on the particular board. Mr Roberts and Mr van Zyl, indicated that the annual operating analysis modelling will be run based on the allocations this year, not on weighted average. Mrs Petersen requested the DWS to seriously consider the request from the agricultural sector, not to impose restrictions, as they do not have much resilience and to limit restrictions on the domestic sector. She further requested the CCT to reconsider the way in which they look at restrictions and perhaps assist by adjusting the tariff structure, if the same restrictions are to be imposed. Mr Daniels emphasized that the objective of having restrictions was not to curtail agriculture but a way to have water for a longer period of time. It was requested that the issues around restrictions be handled at the SOF meeting on the 19 Nov. The management of the system by all role-players to prevent failure during the drought was commended.	Note to DWS Note to DWS & CCT All stakeholders
	Validation Verification	
	Report back will be made at the next meeting.	
	Classification and RQOs	
	Mr Daniels noted that on the 6 November the Project Steering Committee for the Resource Quality Objectives will be held. He will forward the invitation to members that have not received it as yet.	D Daniels
	Groundwater interventions	
	Mr van Niekerk and Mr Zenzile provided the following written input for the minutes. Groundwater interventions • This project was borne out of augmenting and assisting the CCT with their groundwater exploration projects as per the reconciliation strategies, however due to the delays in finalizing an MOU the project was commissioned by DDG WP&I and NWRI. • Due to many studies being conducted in the Theewaterskloof TMG Sandstones and the urgency of the project, desktop studies and in-the-field geological mapping was conducted to select sites for groundwater exploration in the Theewaterskloof basin. • NWRI has provided a cost benefit analysis for the project.	

ITEM	DETAIL	ACTION
	• An EMP exists for the groundwater component of the project of which is a living document and is updated as new information becomes available. • The project is currently in exploratory phase with 3 targets drilled thus far. • The project came to a halt due to financial constraints – whilst the project was commissioned it was operating on an operational budget from Sub-directorate Geohydrology WC. • Submissions were compiled for drought funding in order to complete the project – this funding has been granted in kind to a total of R28.9 million. • The project personnel have consulted stakeholders such as Cape Nature, Environmental Affairs, Department of Environmental Affairs and Development Planning, who are assisting with the project and quarterly project meetings are held to address issues and share knowledge.	
6.2	City of Cape Town Studies • Current and future demands • Current and Planned Water savings and demand management initiatives • Progress on Accelerated Augmentation Projects • Planned Build Programme • Current system operation	
	Current and Planned Water savings and demand management initiatives	
	Mr Mabadiro provided a presentation on the Water Demand Management Progress and Plan on behalf of the CCT (Appendix D). Discussions emanating from the presentation included the following: Mr Roberts indicated that the intention from Province is to move most of the larger users off-grid, such as Coca-Cola and Clover. They have their own plants and distribution systems and would like to continue using them at their full potential. Mr Mabadiro explained that these discussions are on-going. Mrs Petersen indicated that with the current restrictions, the CCT is over the restricted allocation by 20%, similar to other Municipalities. Mr Wood responded by highlighting that they put forward a motivation for the progressive easing of the water restrictions in August. Unfortunately they did not receive any response from the National Department. Given that the dams are recovering in a certain way there was scope to amend restrictions and indeed possible to amend restrictions for all users and progressively reduce them. When the dams are at 75%, which is where they are now, you cannot have a scenario where you go from a 45% restriction to a 10-15% restriction, because the CCT needs to manage their own consumer usage of water as it could become out of control. They are not sure how they are going to have the progressive lifting of the restrictions. From the point of view of the CCT they have tried to put forward a rational approach. Furthermore, while the CCT might have missed their target by 15 million m^3, (41% saving), the fact that they can integrate their dams through the conveyance system has a yield of more than this. They can manipulate the system together with the DWS team to actually prevent a failure. Mr Wood emphasized it should not only be looked at from an actual saving, as the CCT in effect, through altering the demands on the dams and the way it was done	

ITEM	DETAIL	ACTION
	when it started raining – by puting all demands on Steenbras and Wemmershoek - to prevent spillage, the CCT used their very expensive infrastructure to manipulate the draw on the dams for the benefit of the other users as well.	
	CCT water plans	
	Mr Wood gave a brief overview of the CCT Water Strategy which will be released in the next few weeks. It considers both the supply side and demand management in a water sensitive City and addresses environmental issues as well. It is a sensitive document and they would want alignment with what is presented in the Recon strategy when it goes out for public comment. Given the decline in the yield and the loss in the 28 million m^3/a from the Theewaterskloof Dam and given the alien infestation, the CCT has taken the water they believe is allocated to them at a 200-year assurance of supply from the system and put together a pragmatic demand curve to this. It is a little different to what was presented today. They assumed for example a permanent saving of 30% on garden irrigation. The City cannot get to below 40%, especially with all the inbuilt savings, water services intermediaries, to get below 30% is going to be very difficult. The overall build programme is around 300MLD over the next 10 years. Their intention is to proceed with the following intervention options: TMG Phase 1 – Steenbras, Cape Flats Aquifer, alien vegetation removal, the small reuse plant and then moving on to bigger plants such as the Faure Reuse being phased. They are looking into unit reference values, to target the cheaper water first. Their plan is to develop a management system and will be speaking to the Department in terms of collaboration, however they would want their own system. Surface water resources will be targeted down the line as these schemes cannot be rushed. These include Campanula Dam, Steenbras raising, Molenaars, etc. They will not list these specific actions in the public domain. Mr Wood to provide this detail to the Study Team. Mr Daniels requested that the CCT make this presentation at the SSC. Depending on whether it has gone out for public comment, they will present in a lite format or the detailed strategy. They will not compromise the public participation process. It was queried whether the CCT considered desalination and smaller decentralized augmentation options. Mr Wood indicated that desalination is in the plan as well as decentralized augmentation schemes, however the latter depends on how demand grows. The plan is an adaptive plan, so they would be able to shift options around. They have tested these against various assurances of supply. It is a R10 billion investment programme over the next 10 years. Mr Wood highlighted that this plan will recover their portion of the loss of yield, but it cannot be done for everyone in the WSS. It will also change how they are restricted, for example, they cannot be restricted on a desalination plant as it is not part of the system.	B Wood B Wood
6.3	West Coast DM	
	West Coast DM was not in attendance.	
6.4	Breede-Gouritz CMA	
	Mr Daniels indicated that he has not received any news on the CMAs. Should he receive information he will forward to all members.	

ITEM	DETAIL	ACTION
6.5	Berg-Olifants CMA	
	Mr Daniels indicated that he has not received any news on the CMAs. Should he receive information he will forward to all members.	
6.6	Agricultural sector	
	Mr Enright provided feedback on the agricultural sector and provided the following written notes for the minutes. *Current and Future water demands* Water demands of the agricultural water users are limited to the scheduled water entitlements at the relevant quotas. These scheduled water use entitlement have been declared by the Minister as Existing Lawful Water Use even if not used in full. This data was provided to the PSP and discussed at the meeting. It is accepted that fine tuning and confirming of these figures must be done. The total uptake of these water use rights is predicted to be earlier than indicated in the graphs. *Current and planned water savings and demand management initiatives.* The water uses in the Upper Berg River, Lower Berg River, Wynland, Banhoek, Vyeboom and Riviersonderend are all metered. These are organised under Irrigation Boards and Water User Associations. There are some meters on pumps on the river running into and pumping from the Theewaterskloof Dam. These are managed by DWS. The meter systems in the upper Berg River Main Irrigation Board are all connected with a telemetry system with data transferred connected to the central office. Pumps can be remotely switched off when relevant restricted allocation are reached. Losses in the river system are of main concern. In average flow conditions it is estimated at 25%, but much higher during low river flows. With the metering systems in place, a better indication will be reached. It must be understood that with a zero restriction, the river water users are already restricted with 25% on their water use right. With 25% restrictions, the actual restriction is thus 50% or more. The volume of treated effluent from municipalities discharged to the rivers are important and part of the water use to reduce the river losses. The Berg Main Irrigation Board is active in supporting alien clearing of invasive alien plants and also eradicate aquatic water weeds on their own initiative. Involved in River maintenance management plan to manage flood protection works. Decision dates for possible restrictions must be brought forward to assist in planning by water users. Restrictions must be done on water entitlements and not water use of some previous years – this must be changed in the model as well.	

ITEM	DETAIL	ACTION
	The importance of Agriculture must be understood to ensure a higher assurance of supply. Discussions emanating from his feedback included: • The need of a table which will provide guidance on the level of restriction based on level of dam storage. In this case the model does not have to be run each time, but can be checked against the model. In this case all users are aware of the restrictions that will be imposed.	
7	**Preparation for the SSC Meeting**	
	The Study Team will update the Draft Annual Status Report based on comments and discussions from this meeting as well as focused information from various stakeholders. The report will be circulated prior to the SSC meeting.	
8	**Communication**	
	An official media release will be prepared after approval of the Status Report.	
9	**General**	
	Gauging station on the Lower Berg River: Mr van Zyl, explained that the investigations conducted indicate that a gauging station at the sites investigated will be a very expensive undertaking and suggested that this be considered in the Voëlvlei Augmentation Programme. The gauging station is necessary to adequately manage the system, in terms of users and requirements for the estuary.	DWS / TCTA
	Alien vegetation clearing It was recommended that alien vegetation clearing be a programme identified on the WCWSS reconciliation strategy as an augmentation option. This was supported by DWS and WC Province.	Note to team
	Mr Daniels to try and have a standing member from the Working for Water Programme on this committee to provide feedback on the status of the programme. Mr van Zyl indicated that during the drought the Region had identified many projects that were handed to the Environmental Department - Working for Water for implementation. These projects were to create jobs for the farm workers that were laid off. Some of these projects were to be initiated in November 2018. Mrs Petersen queried as to how stakeholders can invest in alien clearing. She indicated that the Department of Environmental Affairs as well as the Department of Agriculture received once-off funding for clearing across the Province. Without all stakeholders collectively prioritizing their funding, the effective utilisation will not be significant. Mrs Petersen indicated that she is arranging a session with all stakeholders, including Working for Water to enable this prioritization to take place. The second issue raised was how does the Department of Water and Sanitation contribute toward alien clearing and can this be included in the water management charge. It was indicated that the DWS have identified priorities on the government water schemes and have begun with implementation.	D Daniels
	All stakeholders will be invited to the next tariff meeting. The CCT indicated that they also have a programme to address alien vegetation and are making a concerted effort to involve all role-players,	D Daniels

ITEM	DETAIL	ACTION
	including Cape Nature. Their focus is on the Western Cape Water Supply catchment area. They feel that a considerable amount of water is being lost through alien vegetation and are focused in dealing with this issue. It was indicated that the CCT pays a large amount toward catchment management and this fee should be used toward clearing alien invasive plants. They also highlighted that they are pursuing this as a formal augmentation option with their own funding and would therefore want the additional yield made available.	Note to DWS
	Mr Daniels indicated that he will arrange a meeting with all role-players to discuss and find a way forward on the alien plant clearing.	D Daniels
	Mrs Kloppers indicated that even though meetings take place amongst role-players, having alien vegetation clearing as a formal augmentation measure, will allow it to be elevated to the level of the Reconciliation Project and this Committee. Mr Daniels indicated that alien vegetation clearing will be a standing item on the agenda and the lead organization in this respect being Working for Water will be requested to provide feedback at this meeting.	D Daniels / A Singh
	It was noted that Working for Water is responsible for ongoing maintenance of alien vegetation and a separate focused intervention to deal with the infestation as it is today and to arrest the alien spread is necessary. The CCT is of the opinion that a special intervention project should be created with specialist input as much of the alien vegetation is in high altitude areas.	
	Mr van der Berg indicated that a responsible person needs to be tasked with the responsibility of driving this intervention, and while the WfW will do the work, it is up to the Committee to define the priorities and motivate for them extremely well.	
	It was also noted that a Freshwater Forum has been established, that comprises many of the roleplayers and that should be brought into the discussion.	D Daniels / A Singh
10	**Next meetings Proposed** SSC Meeting #2: 27 November 2018 Possible venues for the meeting include the CCT and the DWS. The possibility of involving the DWS Head Office through Skype or Video Conferencing will be investigated. ATSG Meeting #4: March 2019	
11	**Closure** Mr Daniels thanked all attendees for their attendance and participation at the meeting. The meeting closed at 15H00.	

APPENDIX A: ATTENDANCE REGISTER

SUPPORT FOR THE IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR THE WESTERN CAPE WATER SUPPLY SYSTEM
ADMINISTRATIVE AND TECHNICAL GROUP MEETING #3
DATE: 31 OCTOBER 2018 AT 10H00
VENUE: DWS WC REGIONAL OFFICE, SPECTRUM BUILDING - 2ND FLOOR, 52 VOORTREKKER ROAD, BELLVILLE

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