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Volume 3 of 7

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

Directorate: National Water Resource Planning

WESTERN CAPE WATER SUPPLY SYSTEM: RECONCILIATION STRATEGY STUDY

Scenario Planning for Reconciliation of Water Supply and Requirement

FINAL

June 2007

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

Submitted by:
Ninham Shand (Pty) Ltd in Association with
UWP Consulting (Pty) Ltd

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UWP CONSULTING

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

WESTERN CAPE WATER SUPPLY SYSTEM
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CLIENT	**:**	**Department of Water Affairs and Forestry**
PROJECT NAME	**:**	**Western Cape Water Supply System : Reconciliation Strategy**
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WESTERN CAPE RECONCILIATION STRATEGY STUDY

VOLUME NUMBER	REPORT TITLE	
1	Reconciliation Strategy	
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THE WESTERN CAPE WATER SUPPLY SYSTEM RECONCILIATION STRATEGY

EXECUTIVE SUMMARY

Background

The Department of Water Affairs and Forestry (DWAF) commissioned the Western Cape Reconciliation Strategy Study, to facilitate the reconciliation of predicted future water requirement scenarios with supply from the Western Cape Water Supply System (WCWSS) for a 25 year planning horizon. The Study seeks to provide a decision support framework to facilitate timeous decision making of appropriate water resource interventions necessary to ensure that the future water requirement can be met on a sustainable basis.

One of the main objectives of the Western Cape Water Supply System Reconciliation Strategy Study is to provide a defendable documented process for the selection of interventions to ensure reconciliation until 2030, taking account of the uncertainties concerning the growth in the future requirements, as well as uncertainties regarding the available and future yield of the existing water resources. A Study Selection Process was developed to identify the most favourable interventions or groups of interventions to meet the water requirements, when these exceed the existing available supplies. The outcome of the Study Selection Process would be a list of which interventions should be immediately implemented or studied further to enable implementation at a later point in time when the water requirement exceeded the available supply.

The Study Selection Process

The objective of the Study Selection Process is to identify the most favourable interventions or groups of interventions to meet the water requirement when this exceeds available supply. The proposed steps in the process for the selection of interventions for further study are listed below:

Step 1: Identify interventions
Step 2: Screen interventions
Step 3: Public review of selected interventions
Step 4: Scenario planning process
Step 5: Review of selected intervention scenarios by water institutions, authorities and local political representatives
Step 6: Obtain public feedback on scenarios
Step 7: Initiate studies

The Study Selection Process was initiated during the WCRSS. To date, Steps 1 - 4 have been completed and the remainder of the steps will be completed before the end of the study. Figure E1 provides an overview of the process to date and proposed future steps, with specific emphasis on how the public is engaged in the process. This report details Step 4 of the Study Selection Process.

Final Selection Process

Once interventions have been studied and the level of information on the interventions is comparable, the Department of Water Affairs and Forestry (DWAF) and the City of Cape Town (CCT), in dialogue with other stakeholders, will take a decision on which intervention to implement first. This process to select interventions for implementation, called the Final Selection Process, will be determined by the future Strategy Steering Committee and will include the following key components:

1. Stakeholder input will be included in various parts of the process including the criteria against which the interventions will be evaluated and compared. (Reconciliation Strategy: Appendix C provides an example of the criteria that could be used).

2. Public participation will constitute a key part of the legal EIA processes required to implement the interventions.
3. The Reconciliation Planning Support Tool (RPST) will be used to assist in the decision-making process. To make sure that decisions are based on the best available data, information obtained through the feasibility studies should be continuously incorporated into the RPST.
4. The outcome of important technical decisions will be communicated to the public through public meetings.
5. The Strategy Steering Committee will make recommendations to the Minister of the DWAF on the next supply-side intervention to be implemented.
6. Information obtained from the studies will be communicated to the public as appropriate.
7. The final decision on the next intervention will be made by the Minister.

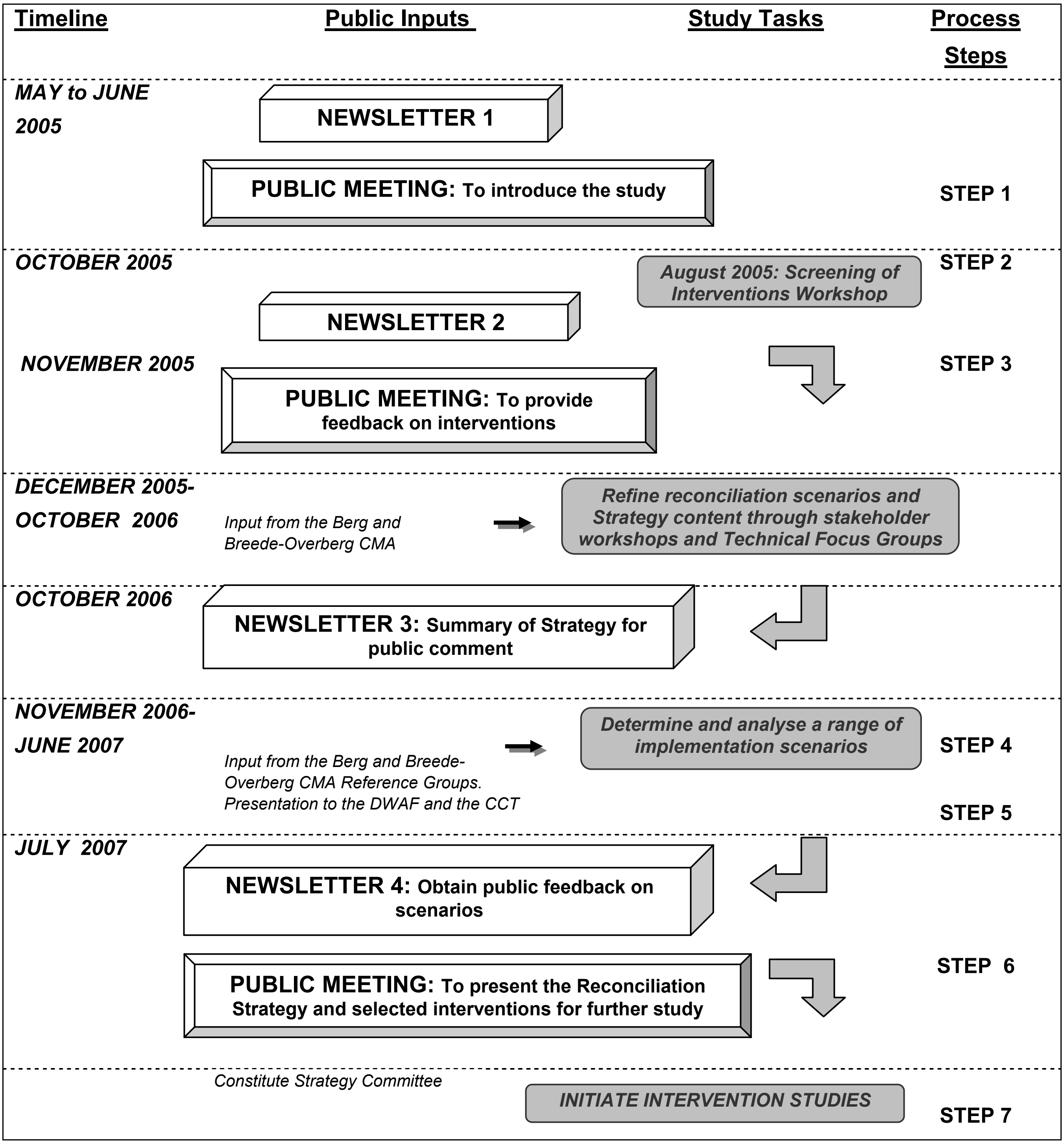

Figure E1 Overview of the Study Selection Process undertaken during the WCRSS

Scenario Planning Process

The objective of the Scenario Planning Process (Step 4) is to identify, evaluate and assess alternative groupings and phasing of interventions so as to determine the most appropriate combination of interventions that should be implemented to reconcile water supply and requirement in the WCWSS, up to 2030. The combination of interventions selected to meet the requirement, is termed a scenario. The scenario planning process considers a range of possible scenarios to reconcile water supply and requirement. The objective is not to select one "favourable scenario" but to identify which interventions should be studied to allow consideration of a range of possible scenarios. This will allow the DWAF and the CCT, and other stakeholders, the maximum amount of flexibility in making informed decision on which intervention to implement after the Berg Water Project (BWP), and beyond. The outcome of the process will be a list of interventions that should be studied to feasibility level, by specific dates, so as to facilitate the implementation of a range of reconciliation scenarios.

As outlined in Figure E1, the 56 interventions considered in the scenario planning process were screened at a Screening of Interventions Workshop, attended by a wide range of stakeholders, including identified DWAF staff, the consultant team and supporting specialists, CCT officials, representatives from National and Provincial Government Departments, representatives from the Berg and Breede WMAs identified through the public participation process, and Study Steering Committee members. The outcomes of this workshop are documented in Appendix C. It must be emphasised that before being implemented, supply-side interventions will still have to go through the EIA process, including the required legal public participation. During this process, the socio-economic implications and ecological impacts will be investigated and evaluated in greater detail.

The Reconciliation Planning Support Tool

The Scenario Planning Process involved the use of a graphical support tool called the Reconciliation Planning Support Tool (RPST). The WCWSS RPST is a graphical tool, to provide support for the selection process. The tool allows the user to compare potential interventions with one another, and with one or more selected future water requirements scenarios. Appendix D provides greater detail on the functionality of the RPST. The eleven scenarios analysed in the process are summarised in Table E1 below.

Conclusions

It is imperative that the CCT implement its 8-year WC/WDM Strategy as well as investigate additional longer term WC/WDM interventions, as the long lead times required to implement a supply-side intervention precludes the selection of a supply side intervention prior to 2013 under the High Water Requirement (HWR) Curve. Should the CCT be successful in implementing its WC/WDM strategy and programme and all additional WC/WDM interventions, a new supply-side intervention will only be required in approximately 2019. Should the actual water requirements follow the low water requirement curve, a new water source will only be required in 2025.

If the CCT is unsuccessful in implementing its WC/WDM strategy and programme, and assuming that the HWR Curve is followed, then the requirement will exceed the supply in 2011 and the City will face an increased possibility of having to impose water restrictions on its consumers. Under these circumstances, the Table Mountain Group (TMG) Aquifer Scheme and/or other supply-side interventions will have to be "fast tracked" or the implementation lead time of certain interventions will have to be reduced.

Table E1 The scenarios evaluated in the scenario planning process

SCENARIO	DESCRIPTION
Scenario 1 (illustrative)	No WC/WDM. All supply-side interventions can be implemented
	Objective: To determine the impact of not implementing WC/WDM
Scenario 2 (illustrative)	CCT WC/WDM strategy and programme implemented: all supply-side interventions can be implemented
	Objective: To determine the impact of implementing the CCT's WC/WDM strategy and programme
Scenario 3 (illustrative)	CCT WC/WDM strategy and programme implemented, as well as additional IWC/WDM interventions. All supply-side interventions can be implemented
	Objective: To determine the impact of implementing all WC/WDM interventions
Scenario 4 (illustrative)	CCT WC/WDM strategy and programme implemented: only groundwater interventions can be implemented
	Objective: To determine how groundwater interventions could meet the future requirement
Scenario 5 (a and b) (illustrative)	CCT WC/WDM strategy and programme implemented: Only effluent re-use interventions can be implemented
	Objective: To determine how effluent re-use interventions could meet the future requirement
Scenario 6 (illustrative)	CCT WC/WDM strategy and programme implemented: Only desalination implemented
	Objective: To determine how desalination interventions could meet the future requirement
Scenario 7 (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection of interventions based on URV (both WC/WDM and supply-side interventions)
	Objective: To determine the impact of selecting interventions based on lowest URV
Scenario 8 (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on URV (Scenario 7) with the ecological Reserve being phased in for existing water resources
	Objective: To determine how the implementation of the ecological Reserve will impact on the selection of interventions
Scenario 9 (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on URV (Scenario 7) with the potential for climate change being considered
	Objective: To determine how climate change could impact on the selection of interventions
Scenario 10 (a) (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on a “conservative portfolio” of interventions
	Objective: To determine the impact of selecting a “conservative portfolio”
Scenario 10 (b) (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on a conservative portfolio of interventions, including potential impacts of the ecological Reserve and climate change
	Objective: To determine how the implementation of the ecological Reserve and the potential for climate change could impact on the selection of interventions
Scenario 10 (c) (reconciliation)	All WC/WDM interventions implemented (as per Scenario 7): Thereafter selection based on a conservative portfolio of interventions, including potential impacts of the ecological Reserve and climate change
	Objective: To determine how the implementation of longer-term WC/WDM interventions impact on Scenario 10(b)
Scenario 11 (reconciliation)	The LWR Curve formed the basis of this analysis: CCT WC/WDM strategy and programme implemented: Thereafter selection based on URV (Scenario 7)
	Objective: To determine how the LWR Curve and the least URV selection criteria could impact on the selection of interventions

A number of requirement and supply-side interventions should be considered for further studies should DWAF and the CCT want to ensure the reconciliation of water supply and requirement over the next 25 years. It is also imperative that a number of the studies commence in 2007 as the lead time to implement certain supply-side interventions is approximately 10 years.

Recommendations

In order to ensure the reconciliation of water supply and requirement within the WCWSS, it is recommended that:

1) A Strategy Steering Committee should be formed in order to make recommendations, on an annual basis, on long term planning activities required to ensure reconciliation of requirement and available supply in the WCWSS area.
2) The CCT's 8-year WC/WDM strategy and programme should be implemented in order to ensure that no shortage of supply exists prior to the implementation of the next intervention.
3) The CCT should initiate a feasibility study to determine the potential of additional longer term WC/WDM interventions to be implemented beyond the existing eight year strategy. Table E2 contains a summary of the intervention study start dates and identifies the responsible organizations for initiating the studies.

Table E2 Summary WC/WDM Intervention study start dates

Intervention	Date Study Required	Study Level Required	Responsibility
CCT 8-year WC/WDM Strategy and Programme	2007	To be implemented	CCT
LONGER TERM WC/WDM INTERVENTIONS			
WC/DM: Adjustment of water tariffs, metering and credit control	2007	Feasibility (yields to be updated)	CCT
WC/DM: Eliminate auto-flush urinals	2007	Feasibility (yields to be updated)	CCT
WC/DM: Leakage detection and repair	2007	Feasibility (yields to be updated)	CCT
WC/DM: Promotion of private boreholes and wells	2007	Feasibility (yields to be updated)	CCT
WC/DM: Use of water efficient fittings	2007	Feasibility (yields to be updated)	CCT
WC/DM: User education	2007	Feasibility (yields to be updated)	CCT

4) Studies at an appropriate level of detail should be carried out for all the supply-side interventions listed in Table 5.2, in order to ensure the reconciliation of water supply and requirement.
5) The CCT should proceed with the TMG Aquifer feasibility study and pilot project, as the TMG Aquifer has been identified as a potentially significant water source for future development.
6) The CCT should proceed with the implementation of a pilot sea water desalination plant in order to learn lessons for the implementation of large-scale desalination. It is important to understand the pre- and post-treatment processes, obtain a better understanding of the actual operating and capital costs associated with desalination, as well as any potential environmental impacts. The CCT should also monitor sea water quality along the Western Cape Coastline in order to develop a database of the varying sea water qualities.
7) The CCT and all other WSAs in the WCWSS should develop integrated effluent re-use policies for their areas of jurisdiction and also initiate feasibility studies to determine the full future potential for effluent re-use in their respective areas. There should be close collaboration and integration between all the WSAs in this regard where appropriate. This would include the conceptual design of various effluent re-use interventions, and a comprehensive EIA.
8) The DWAF should initiate an integrated WCWSS effluent re-use study, which would include interventions such as the exchange of Berg River irrigation water.
9) The Strategy Steering Committee should monitor the progress of the CCT's TMG Aquifer Feasibility Study and Pilot Project and after considering the outcomes, takes a decision regarding further feasibility studies on the TMG Aquifer Scheme.

Table E3 Summary of Supply Intervention study start dates

Intervention	Date Study to Start	Study Level Required	Responsibility
EXISTING FEASIBILITY STUDIES			
TMG Aquifer Feasibility Study	Ongoing	Feasibility	CCT
Pilot Desalination Plant	Ongoing	Feasibility	CCT
TMG Regional Monitoring	Ongoing	Monitoring	DWAF
Invasive Alien Plant Clearance	Ongoing	Ongoing	DWAF
PLANNED FUTURE STUDIES			
Voëlvlei Phase 1 (Note 1)	2007	Update feasibility	DWAF
Michell's Pass Diversion	2007	Pre-feasibility/Feasibility (Note 2)	DWAF
Newlands Aquifer	2007	Pre-feasibility	CCT
Cape Flats Aquifer	2007	Feasibility	CCT
West Coast Aquifer Recharge (Langebaan)	2007	Pre feasibility	DWAF
Upper Wit River Diversion	2007	Pre-feasibility	DWAF
Raising Steenbras Lower Dam (including pre-feasibility of Upper Campanula Dam)	2007	Pre-feasibility	DWAF/CCT
Lourens River Diversion Scheme	2007	Update Pre-feasibility (as linked to Raising Steenbras Lower)	CCT/DWAF
Upper Molenaars Diversion	2007	Pre-feasibility	DWAF
Effluent Re-use (policy, effluent treated to potable standards, effluent treated for irrigation/industry)	2007	Pre-feasibility	CCT and all WSAs
WCWSS Effluent Treatment Re-use Study	2007	Pre-feasibility	DWAF

Notes :
1. This would include a pre-feasibility study of the Voëlvlei Phase 2 Scheme.
2. Michell's Pass Diversion may have to be carried out at Feasibility in order to make a comparison with Voëlvlei Phase 1.

10) All interventions where very little data exists (specifically in terms of yield and cost) should be studied at reconnaissance level, so that a comparative evaluation can be made in the future. These interventions are listed in Table 5.3.
11) A study should be undertaken by the DWAF to investigate and assess the implications and costs of implementing the Ecological Reserve on existing water resources schemes.
12) The capacity of the Voëlvlei pipeline should urgently be assessed by the CCT, as the condition of this pipeline may impact on the viability of implementing either the Voëlvlei Phase 1 Scheme or the Michell's Pass Diversion Scheme. The cost implications on other supply-side interventions, utilising an additional pipeline from Voëlvlei to the CCT should be assessed.

Table E4 Summary of intervention where insufficient information is available

Intervention	Timing	Responsibility
Groundwater		
Conjunctive use	To be determined by Strategy Steering Committee	DWAF
Artificial Recharge (ASR)	To be determined by Strategy Steering Committee	DWAF
Artificial Recharge: Breede River Alluvium	To be determined by Strategy Steering Committee	DWAF
Maximise existing infrastructure		
Steenbras Pumped Storage Scheme Intake	2007	CCT
Possible additional off- channel raw water storage at Misverstand Dam	To be determined by Strategy Steering Committee	DWAF
Maximise WCWSS yield		
Operation of Kleinplaas Dam	2007	CCT
Improve Operation of Atlantis Aquifer (see Note 1)	2007	CCT
Other		
Implications of implementing Ecological Reserve on existing water resources	To be determined by Strategy Steering Committee	DWAF
Water Trading	As soon as possible	All WSAs
Non-flow Related Interventions	To be determined by Strategy Steering Committee	DWAF
Integrated Catchment Management	To be determined by Strategy Steering Committee	DWAF
Integrated WSWSS Re-use Study (including Berg River water exchange)	2007	DWAF
Note 1: Improved management and operation of the Atlantis Aquifer will reduce the reliance placed on Voëlvlei Dam		

13) Owing to the potential impact of climate change on the reconciliation of water supply and requirement, the DWAF should initiate an impact assessment study in this regard.
14) The Scenario Planning process should be updated on a regular basis to cater for:

- Revised future water requirement projections.
- Updated information on the implementation of the ecological Reserve and the potential for climate change.
- Updated information from recently completed studies (reconnaissance level, pre-feasibility level and feasibility level) for WC/WDM and supply-side interventions.
- Any other change to the input data.
- Revision to the CCT's 8-year WC/WDM strategy.

15) The Strategy Steering Committee must ensure that the following monitoring is undertaken in order to be able to ensure the reconciliation of water supply and requirement over the longer term:

- The success of the WC/WDM interventions implemented. This is of particular importance as the volume and implementation date of anticipated water-saving interventions have a significant impact on future supply intervention study start and scheme implementation dates.
- Actual water use (agricultural and urban)
- Population growth and economic growth rate figures in order to be able to develop a better understanding of future water requirements
- Hydrological and geo-hydrological monitoring
- Water quality monitoring

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ABBREVIATIONS AND ACRONYMS

AFU	Automatic Flush Urinals
ASR	Aquifer Storage Recovery
BRTS	Berg River Tunnel System
BWP	Berg Water Project
CCT	City of Cape Town
CMC	Cape Metropolitan Council
DWAF	National Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
HWR	High Water Requirement
I&AP	Interested and Affected Parties
LWR	Low Water Requirement
NPV	Net Present Value
NWA	National Water Act
O&M	Operation and Maintenance
BRTS	Berg River Tunnel System
RDM	Resource Directed Measures
RO	Regional Office of DWAF
RPST	Reconciliation Planning Support Tool
RQO	Resource Quality Objectives
TCTA	Trans Caledon Tunnel Authority
TMG	Table Mountain Group
TOR	Terms of Reference
TWK Dam	Tweewaterskloof Dam
UAW	Unaccounted for Water
URV	Unit Reference Value
WC/WDM	Water conservation and water demand management
WCRSS	Western Cape Reconciliation Strategy Study
WCWSS	Western Cape Water Supply System
WDM	Water Demand Management
WMA	Water Management Area
WMS	Water Management System
WRU	Water Re-use
WSA	Water Services Authorities
WTW	Water Treatment Works
WUA	Water User Association
WUE	Water Use Efficiency
WWTW	Waste Water Treatment Works

Terms Used

Longer-term WC/WDM interventions	Longer-term WC/WDM interventions that are not included in the CCT WC/WDM strategy and programme. The information was based on the Integrated Water Resource Planning Study, which was completed in 2001.
CCT's 8-year WC/WDM strategy and programme	WC/WDM interventions contained in the CCT's WC/WDM strategy and 8-year programme. The CCT's WC/WDM strategy and programme is in draft format and still requires formal acceptance and adoption by the CCT. Appendix F summarises these WC/WDM interventions.
Feasibility Studies	A detailed study including engineering, economic and other aspects. The Study will include a full EIA process. The Study is aimed at enabling a final decision regarding the viability of implementing the intervention to be made.
Implementation programme	The time required to implement each intervention taking consideration of the various approval processes required.
Intervention	A supply scheme, operational measure, or WC/WDM option that provides addition yield to the system or reduces the water requirement of the system.
Net Present Value (NPV)	The costs associated with the implementation of an intervention.
Pre-feasibility Study	A study required to evaluate a number of alternative options (for the implementation of a specific intervention) in more detail, so that sufficient information is made available to make a reliable selection between options.
Reconciliation Planning Support Tool	A graphical planning support tool used to assist in making decisions on how best to meet the future water requirement. The tool allows the user to compare potential interventions with one another, and with one or more selected future water requirement scenarios. The tool should not be seen as means of solving the complex decisions inherent in these processes but simply assist decision-makers in understanding and communicating the implications of certain decisions (see Appendix D for more information).
Reconnaissance Study	Required to provide sufficient information to assess whether an intervention should be considered for further study. A Reconnaissance Study is therefore normally required before an intervention can be meaningfully compared in the Reconciliation Planning Support Tool.
Scenario	A combination of interventions that are selected to meet the growing water supply requirement of the system.
Study start date	The date on which a study should be initiated in order for the intervention to be ready for implementation.
Supply-side interventions	Interventions that provide additional yield to the WCWSS
Water Conservation and Water Demand Management (WC/WDM)	Water Conservation focuses on the protection and efficient use of water resources. Water Demand Management focuses on achieving the most beneficial and efficient solution to water services from various perspectives, including social and financial

1. INTRODUCTION

1.1 The Reconciliation Strategy Study

One of the main objectives of the Western Cape Reconciliation Strategy Study (WCRSS) is to provide a defendable, documented process for selecting interventions to meet the water requirement of the WCWSS until 2030. The process should take account of the uncertainties concerning the growth in future requirement, as well as uncertainties regarding the availability and future yield of existing water resources. The objective of the Study Selection Process, described in Section 1.2, is to identify the most favourable interventions or groups of interventions to meet the water requirement when this exceeds available supply. The Study Selection Process was initiated during the WCRSS. To date, Steps 1 - 4 have been completed and the remainder of the steps will be completed before the end of the study (i.e. by June 2007). This report details Step 4 of the Study Selection Process. Figure 1 provides an overview of the process to date and proposed future steps, with specific emphasis on how the public is engaged in the process.

Once interventions have been studied and the level of information on the intervention is comparable, the Department of Water Affairs and Forestry (DWAF) and the City of Cape Town (CCT), in dialogue with other stakeholders, will take a decision on which intervention to implement first. This process to select interventions for implementation, called the Final Selection Process, will be determined by the future Strategy Steering Committee. A possible Final Selection Process is described in Section 1.4.

1.2 Overview of the Study Selection Process

The Study Selection Process, to identify those interventions that should be studied to meet the future water requirements, is summarised below. It is envisaged that a multi-disciplinary team of specialists would undertake the selection process, with the assistance of the owners, operators and main bulk users of the WCWSS. Public participation and input should be considered throughout the process.

Specialists who should be included in the study selection process include:

- Water Resources Engineer/Hydrologist (surface water),
- Geo-hydrologist (Groundwater),
- Environmental Scientist (Aquatic Scientist),
- Social Scientist/Resource Economist (with water expertise), and
- Authority representatives involved in system operation and impacted on by the operation of the WCWSS.

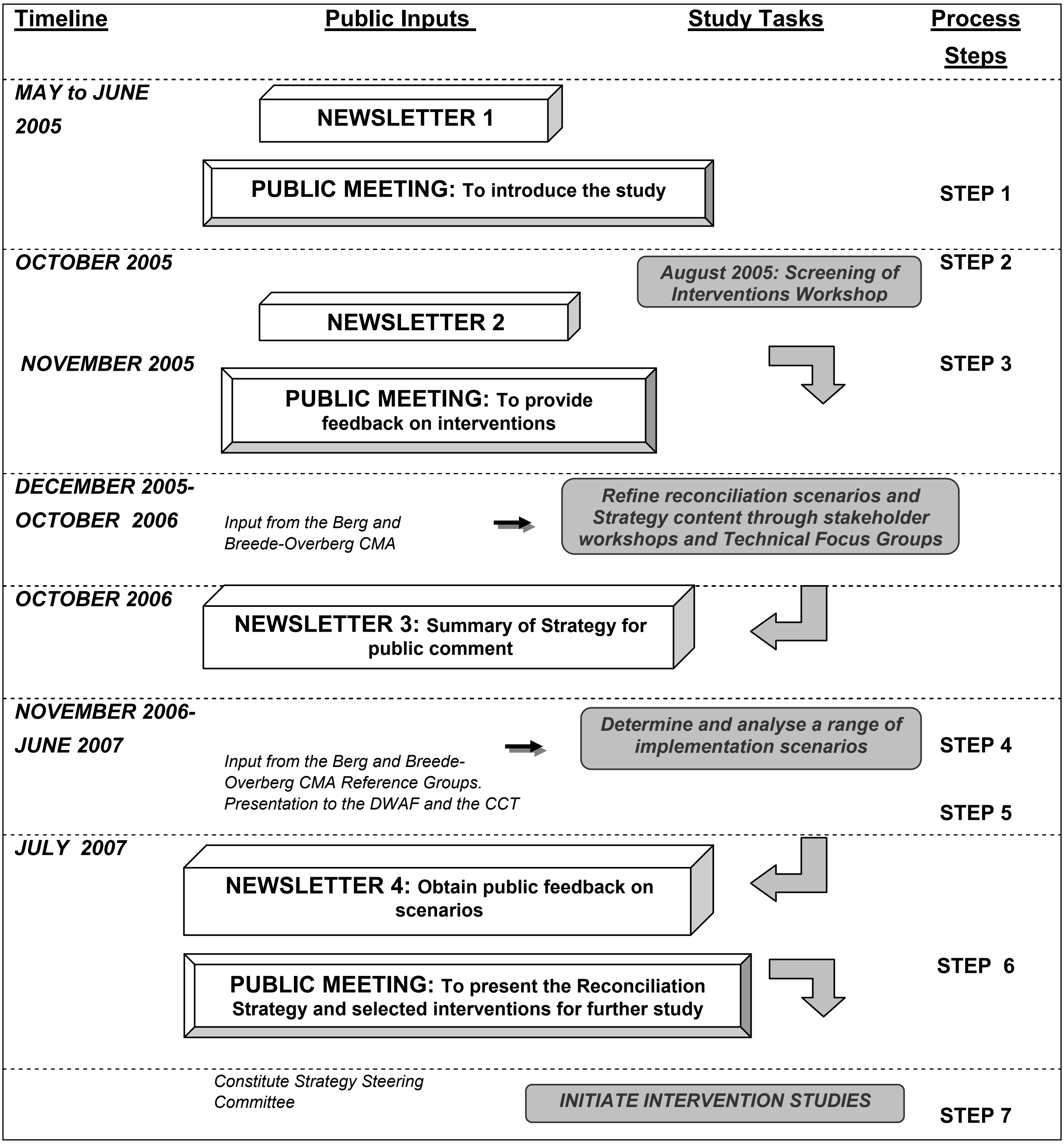


Figure 1.1: **Overview of the study selection process undertaken during the WCRSS**

As illustrated in Figure 1.1, the study selection process includes the following seven steps:

Step 1: Identify interventions

A. List and document all possible interventions to a common base of information.

B. Obtain public input on additional interventions and amend proposed list.

C. Consider the time required to implement each intervention and recommend a likely implementation programme for each intervention.

Step 2: Screen interventions

A. Identify a representative multi-stakeholder group to assist in the screening process.

B. Use agreed criteria to screen interventions that have fatal flaws (The criteria used in the Selection of Interventions Workshop are included in the Reconciliation Strategy: Appendix C).

C. Maintain a record of screened interventions which could be considered if additional information or technology becomes available.

D. Update the implementation programmes taking into account further input.

Step 3: Public Review of Selected Interventions

A. Obtain public feedback on the screening process.

B. Update the programme and list of interventions.

Step 4: Scenario Planning Process

A. Identify a range of possible implementation scenarios using the Reconciliation Planning Support Tool (RPST).

B. Analyse the scenarios and document the outcomes.

Step 5: Review of selected intervention scenarios by Water Institutions, Authorities and local political representatives

A. Obtain feedback on the scenarios from a multi-stakeholder group, including water institutions, local authorities.

B. Revise implementation scenarios, programmes and actions to be taken.

Step 6: Obtain public feedback on scenarios

A. Obtain public feedback on the proposed scenario for further study.

B. Update the scenarios accordingly.

Step 7: Initiate studies

A. Strategy Steering Committee recommends studies to the DWAF and CCT and communicates decisions to the public.

Once the Study Selection Process is complete, DWAF and CCT will be responsible for implementing the identified actions and studies.

1.3 Application of the Study Selection Process in the WCWRSS

The following section describes how the Study Selection Process was undertaken during the WCRSS. Currently only Steps 1 to 4 have been completed.

Step 1A to 1C: Identify Interventions

Step 1 comprised a review of all existing information and water resource investigations carried out to date within the WCWSS

The following sources were utilised:

- The Western Cape Systems Analysis (DWAF)
- Voëlvlei Phase 1 Feasibility Study (DWAF)
- The Integrated Water Resource Planning Study (CCT)
- The Bulk Water Supply Study (CCT)
- The Breede River Basin Study (DWAF)
- TMG Aquifer Feasibility Study and Pilot Project (CCT)
- The West Coast Study (DWAF)
- The CCT’s draft WC/WDM Strategy

In May 2005, Newsletter 1 was sent out to interested and affected parties (I&AP) inviting them to comment on the initial list of Water Conservation and Water Demand Management (WC/WDM) interventions and supply-side interventions to be considered in the WCRSS. Following the Newsletter, three public meetings were held, from 31 May 2005 to 2 June 2005, to obtain further public input. After obtaining public input, the Study Team compiled an extensive list of possible interventions, and existing information on each intervention was documented as background information for a Screening of Interventions Workshop, held on 4 August 2005.

Steps 2A to 2C: Screen Interventions

A Screening of Interventions Workshop was attended by a wide range of stakeholders, including identified DWAF staff, the consultant team and supporting specialists, CCT officials, representatives from National and Provincial Government Departments, representatives from the Berg and Breede WMAs, identified through the public participation process, and Study Steering Committee members.

The objectives of the Screening of Interventions Workshop were to:

- Identify schemes that require no further evaluation in this study;
- Utilise existing information to assess the acceptability of the various options identified in previous studies in terms of technical, financial, environmental and social criteria; and
- Augment the existing information with specialist inputs from key stakeholders.

Each of the interventions was considered in isolation during the workshop, however it was stressed that other issues, such as those listed below, would be important in formulating the best scenario for reconciling supply and requirement:

- The importance of additional storage and improving system assurance of supply;
- The speed and cost of implementing a large intervention versus a number of smaller interventions;
- The ability of the WCWSS users to accommodate the additional yields that would be made available through a new supply-side intervention;
- The need for diversification of sources;
- The need to lower the risks associated with system failure;
- Health risks; and
- The ability to incrementally implement interventions.

This screening of interventions was based on a number of criteria, namely:

- Potential scheme yields, inclusive of the impact of the ecological Reserve;
- Updated financial cost estimates and unit reference values (URVs);
- Socio-economic implications; and
- Ecological impact.

The socio-economic implications and ecological impacts documented at the Screening Workshop assisted in screening out certain interventions, which were not considered further in the study (See Appendix A). However, it must be emphasised that before being implemented, supply-side interventions will still have to go through the EIA process, including the required legal public participation. During this process, the socio-economic implications and ecological impacts will be investigated and evaluated in greater detail.

Table 1.1 lists the interventions that were discussed and ranked at the workshop. Based on the information available, the workshop attendees agreed on the ranking for each of the criteria. Overall, 66 interventions were discussed and the participants agreed to screen out 19 interventions. The ranks for each of the criteria were discussed and agreed to by participants at the workshop. Appendix A provides the reason for screening out each of the interventions. A copy of the starter document used for the Screening Workshop is included as Appendix B.

Table 1.1 Summary of the results of the Screening of Interventions Workshop

Option	URV (R/m^3)	Socio - Economic	Ecological	Outcome
	1- Favourable 2- Moderately favourable 3- Unfavourable			
A - AGRICULTURAL WATER CONSERVATION AND DEMAND MANAGEMENT				
A1 - River Release Management	1	1	1	
A2 - Irrigation Practices	3	3	3	Screened out
A3 - Irrigation Canal Losses	3	2	2	
A4 - Farm Dam Losses	3	3	3	Screened out
A5 - Crop Selection	3	3	3	Screened out
A6 - Crop Deficit Irrigation	3	3	3	Screened out
A7 - Metering	1	1	1	
B - WATER TRADING				
B1 - Water Trading	1	1	2	
C - CHANGES IN LANDUSE				
C1 - Removal of Invasive Alien Plants	1	1	1	
C2 - Removal of Commercial Forestry	1	2	1	
D - RE-USE OF TREATED EFFLUENT				
D1 - Treated for Local Irrigation (and Industrial) Use	1	1	1	
D2 - Treated for Commercial Irrigation (Exchange for Irrigation Allocations)	1	1	1	
D3 - Treated for Potable Use	2	2	1	
D4 - Dual Reticulation Networks	1	1	1	
E - URBAN WATER CONSERVATION AND DEMAND MANAGEMENT				
E2 - Leakage Detection and Repair	1	1	1	
E3 - Domestic Leakage Repair (Low Income Households)	1	1	1	
E4 - Pressure Management	1	1	1	
E5 - Use of Water Efficient Fittings	1	1	1	
E6 - Elimination of Automatic Flush Urinals	1	1	1	
E7 – Adjustment: Water Tariffs, Metering and Credit Control	1	2	1	
E8 - User Education	1	1	1	
E9 - Promotion of Grey Water Use	2	3	2	
E10 - Rainwater Tanks	3	1	1	Screened out
E11 - Promotion of Private Boreholes and Wellpoints	1	1	2	
F - GROUNDWATER DEVELOPMENT OPTIONS				
F1 - TMG Aquifer. TSA W7 - Wemmershoek	1	2	2	
F2 - TMG Aquifer. TSA H8 - Steenbras	1	2	2	
F3 - TMG Aquifer. TSA T4 - Theewaterskloof	1	2	2	
F4 - Cape Flats Aquifer	1	1	2	
F5 - West Coast Aquifers	2	2	2	
F6 - Newlands Aquifer	1	1	2	
F7 - Conjunctive Use	1	1	1	
F8- Aquifer Storage Recovery				
G - SURFACE WATER DEVELOPMENT OPTIONS				
G1 - Raising Lower Streenbras Dam	1	1	2	
G2a - Upper Campanula Dam only	1	2	3	
G2b - Upper Campanula Dam and supplement	3	3	3	Screened out
G3 - Lourens River Diversion	1	1	1	
G4 - Eerste River Diversion	1	2	1	
G5 - Voëlvlei Augmentation : Phase 1	1	1	2	
G6 - Voëlvlei Augmentation : Phases 2 and 3	2	2	3	
G7 - A new dam at Misverstand	2	1	2	
G8 - Twenty-four Rivers Dam	1	1	2	
G9 - Watervals River Dam		1	3	Screened out
G10 - Upper Molenaars Diversion	1	2	1	

G11 - Muldersvlei Optimisation Scheme				
G12 - Wemmershoek Dam and Pipeline	1	1	1	
G13 - Michell's Pass Diversion	1	2	2	
G14 - Brandvlei to Theewaterskloof Transfer	1	2	2	
G15 - Raising Theewaterskloof Dam	3	2	2	Screened out
G16 - Lower Wit River Dam	1	2	3	
G17 - Upper Wit River Dam	1	2	3	Screened out
G18 - Upper Wit River Diversion	1	1	2	
G19 - Olifants River Diversion	3	2	3	Screened out
G20 Dam on the Kuils River (from public meetings)				Screened out
G 21 Dredging of existing dams (from public meetings)				Screened out
G 22 Raised Nuweberg Dam Palmiet River (from public meetings)				Screened out
H - DESALINATION				
H1 - Koeberg Site	3	1	2	
H2- Melkbos Site	3	1	2	
I - OTHER INTERVENTIONS				
I1 Water transfers from the Congo River				Screened out
I2 Water transfers from the Orange River				Screened out
I3 Towing of icebergs				Screened out
I4 Non-flow related interventions (added at workshop)				
I6 Rainfall, mist and dew harvesting (added at workshop)				Screened out
I7 Utilisation of urban storm water (added at workshop)				Screened out
I8 Cloud seeding (suggested at public meetings)				Screened out
Note: Several interventions were added at the workshop and so certain information on these interventions, such as URV, socio-economic implications and ecological impact, was not available for ranking.				

Steps 3a to 3b: Obtain Public Feedback

Newsletter 2 was sent out to I&APs in October 2005. The Newsletter provided an opportunity for public feedback on the outcomes of the Selection of Interventions Workshop. In addition to the newsletter, further feedback was invited at a public meeting held on the 24 November 2005.

Technical workshop to integrate public comments and refine the intervention list

On 27 February 2006, the study team and specialists met for a further workshop to integrate public comments and review the list of interventions. In preparing for the workshop, additional information was obtained from various studies, which resulted in amendments to the list of interventions. The following interventions were added:

- Maximise existing infrastructure
- Breede River Alluvium
- Maximise WCWSS yield
- Re-use/Berg River Water Exchange
- Integrated Catchment Management
- CCT: Desalination Pilot Scheme

Based on additional information obtained, several interventions were screened from the process. These are listed in Table 1.2.

Table 1.2 The following 4 interventions were screened out during Step 3 of the process

Interventions	Reason for Screening Out
A7 Metering of agricultural water use	No additional water will be made available for the system as water savings will be utilised on farms.
A3 Irrigation canal losses	No additional water will made available for the system as water savings will be utilised on farms.
C2 Commercial Forestry	Mountain to Ocean took a policy decision not to remove the commercial forestry that could have had an influence on the yield of the WCWSS.
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 Mm^3/a) to potable standards, rather than Theewaterskloof Dam water, which is of a lower quality. CCT is currently undertaking a pilot study to implement this intervention and so it does not require further evaluation for implementation.

Step 4: Scenario Planning Process

Appendix C briefly describes the 56 interventions that were taken forward for analysis in the Scenario Planning Process. This Step involves the use of the WCWSS RPST to evaluate reconciliation scenarios. The WCWSS RPST is a graphical tool, to provide support for the selection process. The tool allows the user to compare potential interventions with one another, and with one or more selected future water requirements scenarios. Appendix D provides greater detail on the functionality of the RPST. In preparing input data for the tool, minor changes to how the interventions were grouped and described were required. The changes enhanced the functionality of the tool and are described below:

- "B1a Theewaterskloof and Upper Berg", "B1b Eikenhof Dam" and "B1c Koekedouw Dam" were combined into one intervention called Water Trading.
- "D3 Treated for potable use" was split into three interventions, each with different quantities of yield.
- In terms of the TMG Aquifer, the size of the yield, rather than the geographic location, was seen as an important factor in evaluating the interventions. The three geographically specific interventions were therefore split into three generic interventions with different quantities of yield. Each TMG Aquifer intervention also has an option to fast track the implementation if required.
- In terms of desalinisation, it was recognised that any intervention would be gradually increased in stages and that this was more important to consider than the geographic location of the interventions. "H1 Koeberg Desalinisation Site" and "H2 Melkbos Desalination sites" were therefore split into three geographically generic interventions each with similar yields.
- G13 Michell's Pass diversion was split into three different interventions: Michell's Pass diversion yielding 8 m^3/s, Michell's Pass diversion yielding 4 m^3/s and Michell's Pass diversion yielding 8 m^3/s which included provision for a pipe line to the CCT.
- An additional intervention for Voëlvlei Phases 2 and 3 was added which included a pipeline to the CCT.
- The WC/WDM interventions that are currently included in the draft CCT WC/WDM draft strategy were included in the RPST (these are listed in Appendix F).

The remainder of this Report details with how the tool was applied to determine and analyse a range of implementation scenarios and to then select interventions that require additional study.

Steps 5 to 7: Future Steps in the process

As illustrated in Figure 1, the next step in the process will involve a review of the selected interventions by water institutions, authorities and local political representatives. The scenarios will also be reviewed based on public feedback. The final step involves recommending studies to DWAF and CCT and communicating the final study selection to the public.

1.4 Final Selection Process

The Final Selection Process will guide the process of determining which interventions are ultimately selected for implementation after the BWP, and thereafter. It must be noted that the Minister of the DWAF does not have to approve the implementation of WC/WDM interventions. For that reason, the Final Selection Process, described below, does not include consideration of WC/WDM but applies specifically to supply-side interventions. The selection process for implementation of interventions will be finalised by the Strategy Steering Committee and will include the following key components:

1. Stakeholder input will be included in various parts of the process including the criteria against which the interventions will be evaluated and compared. (Reconciliation Strategy: Appendix C provides an example of the criteria that could be used).
2. Public participation will constitute a key part of the legal EIA processes required to implement the interventions.
3. The RPST will be used to assist in the decision-making process. To make sure that decisions are based on the best available data, information obtained through the feasibility studies should be continuously incorporated into the RPST.
4. The outcome of important technical decisions will be communicated to the public through public meetings.
5. The Strategy Steering Committee will make recommendations to the Minister of the DWAF on the next supply-side intervention to be implemented.
6. Information obtained from the studies will be communicated to the public as appropriate.
7. The final decision on the next intervention will be made by the Minister.

2. STEP 4: SCENARIO PLANNING PROCESS

2.1 Objective

The objective of the Scenario Planning Process (Step 4) is to identify, evaluate and assess alternative groupings and phasing of interventions so as to determine the most appropriate combination of interventions that should be implemented to reconcile water supply and requirement in the WCWSS, up to 2030. The combination of interventions selected to meet the requirement, is termed a scenario. Due to the lead times required for feasibility studies, interventions need to be identified well in advance so that they are ready for implementation within the required time frame. While conducting the feasibility studies, some interventions may be found not to be suitable for implementation. For that reason, the scenario planning process considers a range of possible scenarios to reconcile water supply and requirement. The objective is not to select one "favourable scenario" but to identify which interventions should be studied to allow consideration of a range of possible scenarios. This will allow the DWAF and the CCT, and other stakeholders, the maximum amount of flexibility in making informed decision on which interventions to implement after the BWP, and beyond. The outcome of the process will be a list of interventions that should be studied, by specific dates, so as to facilitate the implementation of a range of reconciliation scenarios.

2.2 Identification of Scenarios

During the Scenario Planning Process 11 scenarios where considered. A range of scenarios was utilised to assess inter alia the following:

a) the benefits of implementing WC/WDM;
b) the reconciliation and supply implications of implementing the ecological Reserve for existing water resources
c) the reconciliation and supply implication arising from climate change.

Scenarios 1 - 6 were selected to "illustrate" how different scenarios impacted on the reconciliation process and were not selected as viable reconciliation options. For example, Scenario 1 was developed to consider the implications of not implementing any WC/WDM interventions. Scenarios 7-11 are reconciliation scenarios that represent possible combinations of interventions that could be implemented to meet the requirement of the WCWSS. Table 2.1 illustrates the comparison between "illustrative scenarios" and "reconciliation scenarios".

Table 2.1 Comparison between the two main approaches used to analyse groupings of interventions in the planning process

	Illustrative Scenarios	Reconciliation Scenarios
Scenarios	1-6	7-11
Objective	To illustrate how a particular type of intervention (i.e. WC/WDM, groundwater) impacts on the reconciliation process	To select a possible combination of interventions that could be implemented to achieve reconciliation of water supply and requirement
End supply date	No common end supply data selected	2029/30
Financial analysis	None (except for scenario 6)	NPV for all scenarios
Reconciliation Curve	High Water Requirement Curve	High Water Requirement Curve, except Scenario 11 where the Low Water Requirement Curve was used.
Outcome	Information on how certain interventions effect the reconciliation process	Identification of interventions that should be studied to facilitate reconciliation

The scenarios, which were evaluated, are listed in Table 2.2. Each scenario has a specific objective, which may impact on the possible studies required, as well as the date when the DWAF and/or the CCT should commence the implementation process.

The evaluation of each scenario is described in Section 3 of this Report. As summarised in Table 2.2, in considering each scenario the following broad distinctions should be taken into account:

- Scenarios 1 to 3 illustrate the impact of WC/WDM on timing for implementation of supply-side interventions.
- Scenarios 4 to 6 illustrate the impact of developing groundwater interventions, effluent re-use interventions and desalination in lieu of considering surface water interventions.
- Scenarios 7 to 9 illustrate a least cost per unit volume of water approach (URV) for the selection of interventions and also considers the impact of implementing the ecological Reserve and the potential impact of climate change on the implementation timing of supply-side interventions.
- Scenario 10 illustrates a conservative portfolio, which was selected by those with an understanding of how the system operates. For operational reasons, certain interventions with low URVs were not selected. The selection also considers the impact of implementing the ecological Reserve and the potential impact of climate change on the implementation and timing of supply-side interventions.
- Scenario 11 illustrates the impact of the LWR Curve of Scenario 7.

Table 2.2 Intervention scenarios analysed in the scenario planning process

SCENARIO	DESCRIPTION
Scenario 1 (illustrative)	No WC/WDM. All supply-side interventions can be implemented
	Objective: To determine the impact of not implementing WC/WDM
Scenario 2 (illustrative)	CCT WC/WDM strategy and programme implemented: all supply-side interventions can be implemented
	Objective: To determine the impact of implementing the CCT's WC/WDM strategy and programme
Scenario 3 (illustrative)	CCT WC/WDM strategy and programme implemented, as well as additional IWC/WDM interventions. All supply-side interventions can be implemented
	Objective: To determine the impact of implementing all WC/WDM interventions
Scenario 4 (illustrative)	CCT WC/WDM strategy and programme implemented: only groundwater interventions can be implemented
	Objective: To determine how groundwater interventions could meet the future requirement
Scenario 5 (a and b) (illustrative)	CCT WC/WDM strategy and programme implemented: Only effluent re-use interventions can be implemented
	Objective: To determine how effluent re-use interventions could meet the future requirement
Scenario 6 (illustrative)	CCT WC/WDM strategy and programme implemented: Only desalination implemented
	Objective: To determine how desalination interventions could meet the future requirement
Scenario 7 (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection of interventions based on URV (both WC/WDM and supply-side interventions)
	Objective: To determine the impact of selecting interventions based on lowest URV
Scenario 8 (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on URV (Scenario 7) with the ecological Reserve being phased in for existing water resources
	Objective: To determine how the implementation of the ecological Reserve will impact on the selection of interventions
Scenario 9 (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on URV (Scenario 7) with the potential for climate change being considered
	Objective: To determine how climate change could impact on the selection of interventions
Scenario 10 (a) (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on a “conservative portfolio” of interventions
	Objective: To determine the impact of selecting a “conservative portfolio”

SCENARIO	DESCRIPTION
Scenario 10 (b) (reconciliation)	CCT WC/WDM strategy and programme implemented: Thereafter selection based on a conservative portfolio of interventions, including potential impacts of the ecological Reserve and climate change
	Objective: To determine how the implementation of the ecological Reserve and the potential for climate change could impact on the selection of interventions
Scenario 10 (c) (reconciliation)	All WC/WDM interventions implemented (as per Scenario 7): Thereafter selection based on a conservative portfolio of interventions, including potential impacts of the ecological Reserve and climate change
	Objective: To determine how the implementation of longer-term WC/WDM interventions impacts on Scenario 10(b)
Scenario 11 (reconciliation)	The LWR Curve formed the basis of this analysis: CCT WC/WDM strategy and programme implemented: Thereafter selection based on URV (Scenario 7)
	Objective: To determine how the LWR Curve and the least URV selection criteria could impact on the selection of interventions

It is important to note that the scenarios were also chosen with the following in mind:

- Scenarios 1 to 5 illustrate which interventions have sufficiently short lead times to allow implementation to meet the High Water Requirement (HWR) Curve. No financial analyses were undertaken as no common end supply date was selected.
- Scenarios 6 to 10 show the cash flow and present value cost of various selections of scenarios, based on URV of water and availability for implementation for supplying the HWR Curve until 2029.
- Scenario 11 shows to what extent the Low Water Requirement (LWR) Curve might reduce the financial costs and delay the need for implementing additional WC/WDM and/or supply-side interventions.

2.3 Assumptions for Scenarios

The selection of interventions included in the various scenarios was based on the following assumptions:

1. All WC/WDM interventions are shown as a reduction in the requirement curve and not as additional system yield.
2. All WC/WDM interventions already implemented have been accounted for in both the LWR and HWR curves
3. Unless otherwise specified, each scenario was evaluated against the HWR Curve. This assumes a high population growth and a high economic growth. The HWR gives the most conservative approach to intervention implementation start dates.
4. Additional WC/WDM are longer-term interventions that are not included in the CCT's draft WC/WDM strategy and programme.
5. At the Screening of Interventions Workshop, each of the interventions was ranked according to potential socio-economic implications, ecological impacts and health risks. Schemes with fatal flaws were eliminated. The ranking was based on preliminary information and so only provides an indication of potential impacts and risks. It is therefore assumed that socio-economic implications, ecological impacts and health risks will be carefully considered during the feasibility studies. The information gathered during the studies will then inform the Final Selection Process.
6. Unless otherwise stated, the selection of supply-side interventions was based on lowest URV.
7. Schemes which rely upon the same spare capacity of downstream infrastructure will not be selected for the purpose of the water balance. These schemes (sometimes referred to as mutually exclusive schemes) are defined as follows: schemes, which if implemented together, would exceed the capacity of the commonly needed infrastructure, the second phase of a scheme or schemes impacting too severely on other existing water resource developments, such as those on the Breede River.
8. When it could be avoided, two TMG Aquifer Schemes were not selected consecutively as it may be necessary to understand the potential impact of the first scheme (from an environmental impact perspective and from a well field operation perspective), before proceeding with the second scheme.

2.4 Input Data Used

The data on which the scenarios were determined and analysed was considered to be the best data available at the time. It is important to note the following with respect to the data:

a) The interventions, budgets and savings contained in the CCT's draft WC/WDM strategy and programme were preliminary and are currently in the process of being revised and updated by the CCT. The CCT's WC/WDM strategy and programme was in draft format and still requires formal acceptance and adoption by the CCT (see Appendix F for a summary of these WC/WDM interventions).
b) The information for the additional WC/WDM interventions was taken from the CCT's Integrated Water Resource Planning Study, which was completed in 1999.
c) The capital costs, yields and URVs for the various interventions were collated from previous studies and escalated to 2005 price levels. These have been determined at various levels of detail, depending on the scope of studies previously undertaken for specific interventions. It was not the purpose of this Strategy Study to refine the Unit Reference Values (URVs) for all the interventions.
d) Preliminary costing and URV estimates for some of the options not previously studied (such as effluent re-use) were determined during the course of this study.

As information becomes available, it is important to review and update the scenarios investigated. This is of particular importance with regard to the WC/WDM interventions, as the yield and implementation dates of anticipated water savings interventions has a significant impact on the study and implementation programme for further interventions.

2.5 Determining the Implementation Programme

In order to determine and analyse scenarios, the Intervention Data Sheet in the RPST needs to be completed. A key parameter in the sheet is the implementation programme required (i.e. time to implement each intervention taking consideration of the various approval processes required), with the duration in years (or parts of years to the nearest 0.25 years). The preliminary assessment of the programmes for the implementation of each intervention was determined by utilising the judgement of the study team. Appendix E lists the implementation times used in the Intervention Data Sheet.

The time to implement an intervention is determined by the various processes and procedures that must be undertaken, with estimates of possible lag times (or delays) that might occur in the process. Based on the existing level of information for each intervention, different studies or processes are required (i.e. Level 1: Reconnaissance Study, Level 2: Pre-feasibility Study, Level 3: Feasibility Studies and **Level 4**: Construction or Implementation). The processes for the various interventions depends on the amount of information gathered by previous studies as well as the likely duration to complete further studies and to obtain the necessary approvals for implementation. The processes that may be necessary to complete a study and implement an intervention are discussed below:

Level 1: Reconnaissance Study, Reconnaissance Study

A Reconnaissance Study is required to provide sufficient information to assess whether an intervention should be considered for further study. The RPST requires information on yield, financial parameters (URV, capital cost and operating cost); and information on various other criteria (such as environmental impact and social-economic implication). A Reconnaissance Study is therefore normally required before an intervention can be meaningfully compared in the RPST.

The various reconnaissance processes identified are:

- The lag time that arises on account of the need to budget well in advance for the Reconnaissance Study.
- The development of Terms of Reference for the appointment of a Consultant (or Professional Service Provider) and the tender and appointment process.

- The time that it would take the Consultant to undertake the Reconnaissance Study.

Certain interventions were identified for Reconnaissance Studies because there was not sufficient information available to compare them within the RPST. These interventions are listed in Table 2.3.

Table 2.3 Summary of intervention where insufficient information is available

Intervention
Wemmershoek BWP Pipeline
Conjunctive use
Aquifer Storage Recovery (ASR)
ASR: Breede River Alluvium
Maximise existing infrastructure
Maximise WCWSS yield
Water Trading
Non-Flow Related Interventions
Integrated Catchment Management
Re-use - Berg River Water Exchange

Level 2: Pre-feasibility Study

A Pre-feasibility Study may be needed to evaluate a number of options in more detail so that sufficient information is available to make a reliable selection between options. For example, the proposed pre-feasibility by the Directorate: Options Analysis (D: OA) of DWAF will identify which interventions should be selected for feasibility studies. The various pre-feasibility processes identified are virtually identical to those for the Reconnaissance Study as described above.

Level 3: Feasibility Studies

Feasibility Studies will initially be conducted on those selected by the Pre-Feasibility Study of the D: OA and on a number of other potential interventions for which Pre-Feasibility or Feasibility Studies have previously been undertaken. A full Feasibility Study is usually required before implementation. Feasibility Studies are likely to be conducted on a number of interventions and will comprise the following processes:

- The lag time for budgeting and the process of appointing a consultant as outlined above for the Reconnaissance Study.
- The Feasibility Study and EIA are processes that are usually undertaken together.
- As the DWAF is responsible for determining the ecological Reserve this has been shown as a separate process but taking place concurrently with the Feasibility Study and EIA. It has been assumed that the programme will be dictated by the longer of these two processes, i.e. the Feasibility and EIA process and the ecological Reserve processes.

Level 4: Construction or Implementation

The Construction or Implementation of an intervention will involve a number of processes as follows:

- The lag time for budgeting and the process of appointing a consultant is the same as outlined above for the Reconnaissance and Pre-Feasibility Studies.
- Detailed design, preparation of the construction tender, calling for and preparing tenders, tender evaluation and award.
- Construction implementation period or bylaw enacted by Council.
- Warm-up or first filling, E.G. filling of a dam.

2.6 Future Water Requirements

Two future water requirement curves for the CCT were derived as part of the Reconciliation Strategy, namely a HWR Curve and a LWR Curve. The assumptions for the two curves are listed in Table 2.4. Additional information on the requirement curves is provided in the Reconciliation Strategy.

Table 2.4 Water requirement curves

Water Requirement Curve	Population Growth	Economic Growth
High Water Requirement	HIGH	HIGH
Low Water Requirement	LOW	LOW

The two water requirement curves which were developed are shown in Figure 2.1. The CCT's actual historic water requirement, unconstrained growth curve and Low Water Demand Curve are also shown on the same graph for comparison purposes.

For illustrative purposes, Figure 2.2 shows CCT's low water requirement. This is CCT's commitment to DWAF in accordance with the 2001 WDM strategy (the curve therefore includes WC/WDM interventions).

The Low Water Demand Curve is the CCT's commitment to DWAF with regard to WC/WDM when the "Raw Water Supply Agreement" between the DWAF and CCT was signed. The Low Water Demand Curve includes the impact of implementing WC/WDM measures, whilst the HWR Curve and LWR Curve exclude the impact of WC/WDM interventions.

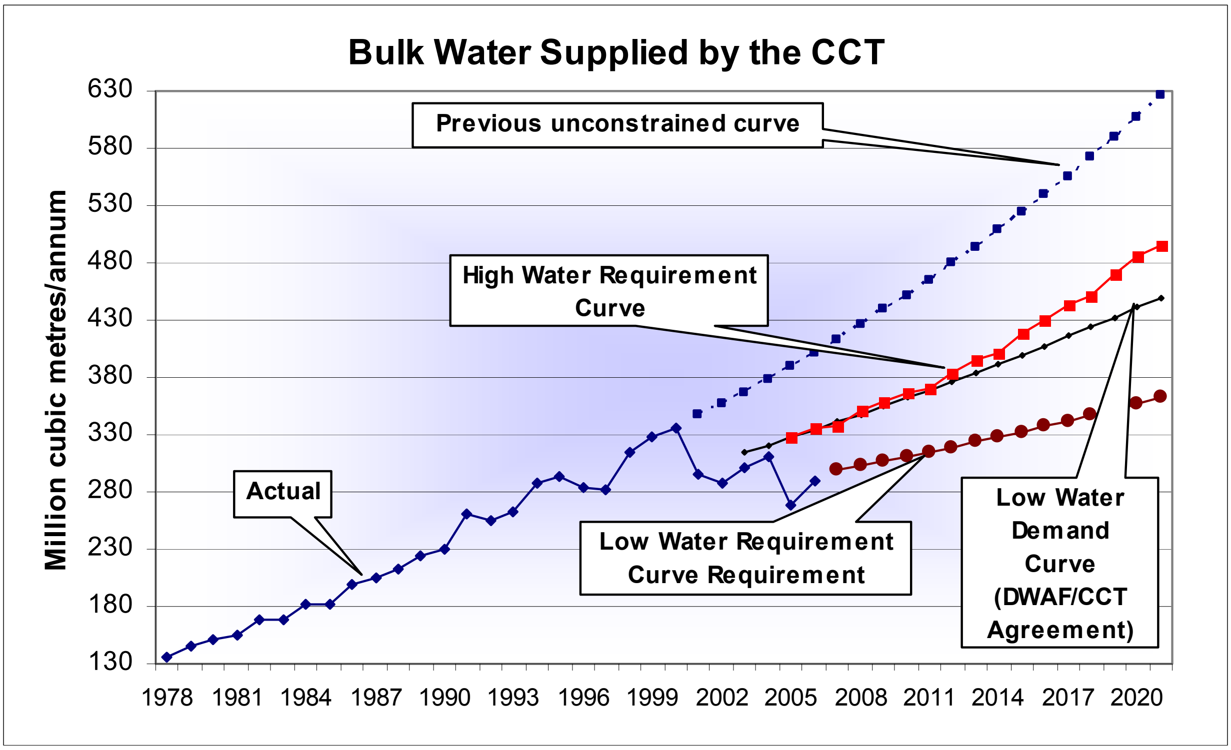


Figure 2.1 Water requirement curves

Note: The Low Water Demand Curve represents the CCT's commitment to implementing WC/WDM as contained in the Raw Water Supply Agreement between the CCT and the DWAF.

Further assumptions include:

- Towns along the Cape West Coast, utilising water from the WCWSS, would have a growth in water consumption of 6% per annum.
- Stellenbosch's water requirement from the WCWSS would grow at 2% per annum, up to a maximum of 3 million m^3 per annum.
- The agricultural sector would grow at a rate of 2% per annum up to a capped value of 174 million m^3 per annum. Please refer to the "Raw Water Supply Agreement" between the Department of Water Affairs and Forestry and the City of Cape Town for more information in this regard (see Appendix A of the Reconciliation Strategy).

Figure 2.2 shows the combined requirement of the WCWSS including both the urban and agricultural sectors, and the available supply.

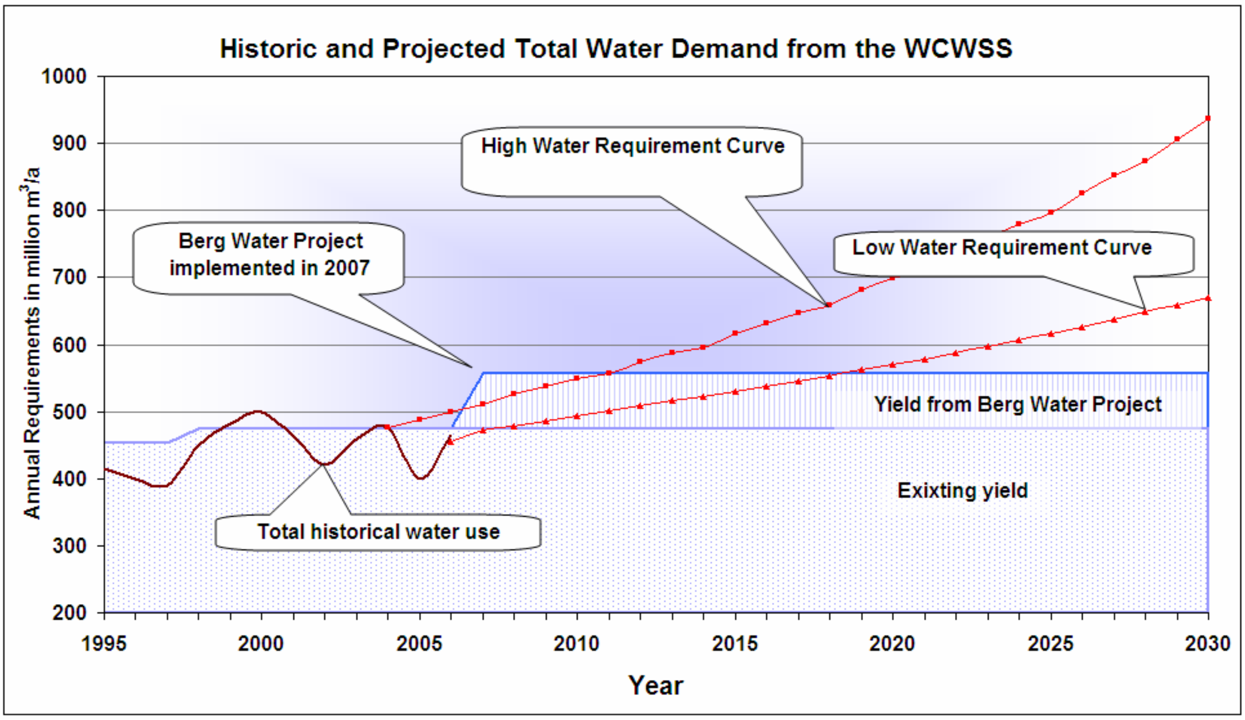


Figure 2.2 Historic and projected total water requirements from the WCWSS

3. DISCUSSION OF PLANNING SCENARIOS

3.1 Scenario 1: No WC/WDM. All Supply-Side Interventions can be Implemented

Objective: To determine the impact of not implementing WC/WDM

Scenario 1 was developed primarily to consider the impact of not implementing any WC/WDM interventions on the required study start dates for the available supply-side side interventions. Should no additional WC/WDM be implemented by the CCT, and utilising the HWR Curve, a supply-side intervention would be required in 2011. This intervention would be required after the BWP. However, due to the long lead times associated with the implementation of supply-side interventions, the earliest possible start date to initiate the process of implementing a supply-side intervention is 2014 and therefore a shortfall would occur between 2011 and 2013 as shown on Figure 3.1. The interventions giving this earliest start date are ground water interventions, including a "fast tracked" TMG Aquifer Scheme. Table 3.1 and Figure 3.1 indicate the interventions which make up Scenario 1. No interventions have been selected after 2018, as

Table 3.1 No WC/WDM and all supply-side interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	Cape Flats Aquifer	2014	18	7	2007		1
2	West Coast Aquifers	2014	13.8	6.5	2007.5		1
3	TMG Aquifer Scheme 1 (after CCT exploratory phase)	2014	20	6.5	2007.5	Yes	1
4	Newlands Aquifer	2015	7	8	2007		0
5	TMG Aquifer Scheme 2 (after CCT exploratory phase)	2016	50	8.5	2007.5	Yes	3

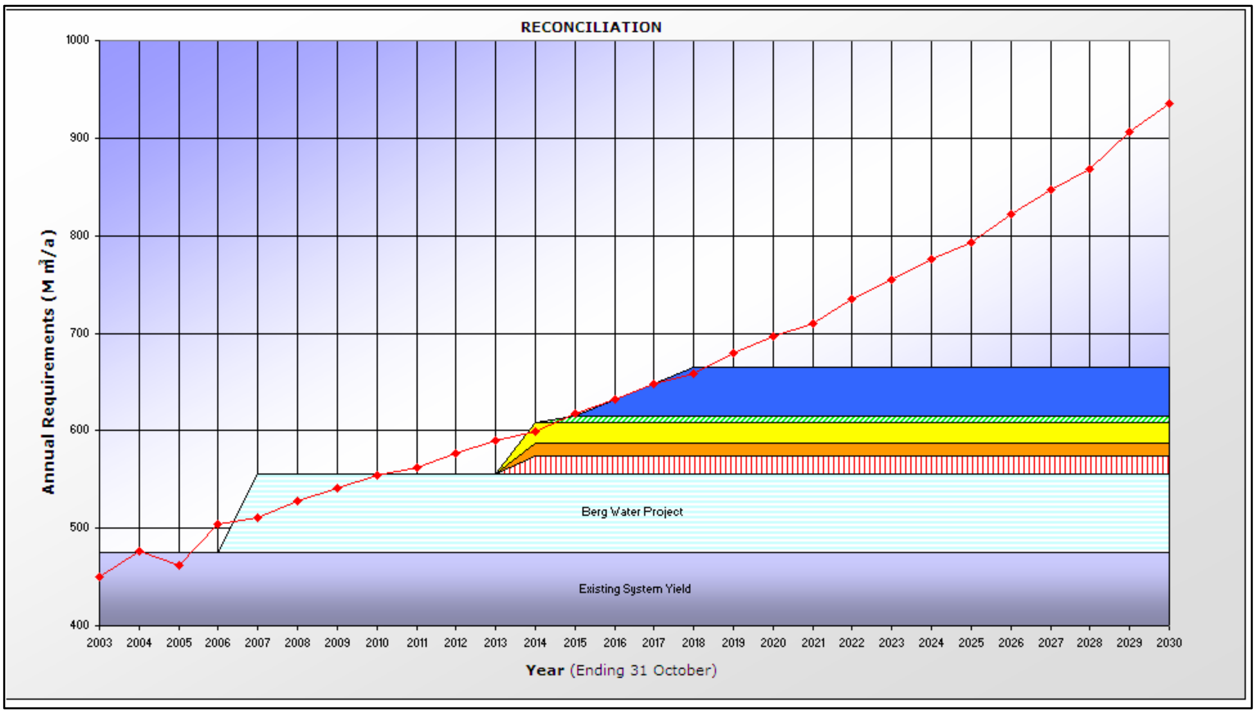


Figure 3.1 Scenario 1: No WC/WDM and all supply-side interventions

3.2 Scenario 2: CCT WC/WDM Strategy and Programme Implemented. All Supply-Side Interventions can be Implemented

Objective: To determine the impact of implementing the CCT's WC/WDM strategy and programme

Scenario 2 was developed in order to determine what the required intervention study start dates would be if the CCT successfully implemented its WC/WDM strategy and programme. This scenario assumed that no additional WC/WDM would be carried out beyond the CCT's current 8-year WC/WDM strategy. The outcome of this scenario was that the first supply-side intervention would be required in 2015. It illustrates that the implementation of the CCT's current WC/WDM strategy and programme would delay the implementation of a supply-side intervention by 4 years. The only supply-side interventions, which were available for selection based on their lead times, were groundwater interventions. The first supply-side intervention, selected on available lead time, was the Newlands Aquifer Scheme. The successful implementation of the CCT's current WC/WDM strategy and programme would allow for a number of supply-side interventions to be implemented without "fast-tracking" any interventions and without having to reduce the normal lead time for implementation of interventions. This would also result in no shortfall in the supply. Table 3.2 and Figure 3.2 indicate the interventions which make up Scenario 2.

Table 3.2 Scenario 2 : No longer-term WC/WDM and all supply-side interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	Newlands Aquifer	2015	7.0	8	2007		1
3	Cape Flats Aquifer	2015	18.0	7	2008		1
4	West Coast Aquifers	2016	13.8	6.5	2009.5		1
5	Upper Wit River Diversion	2017	10.0	10.5	2006.5		1

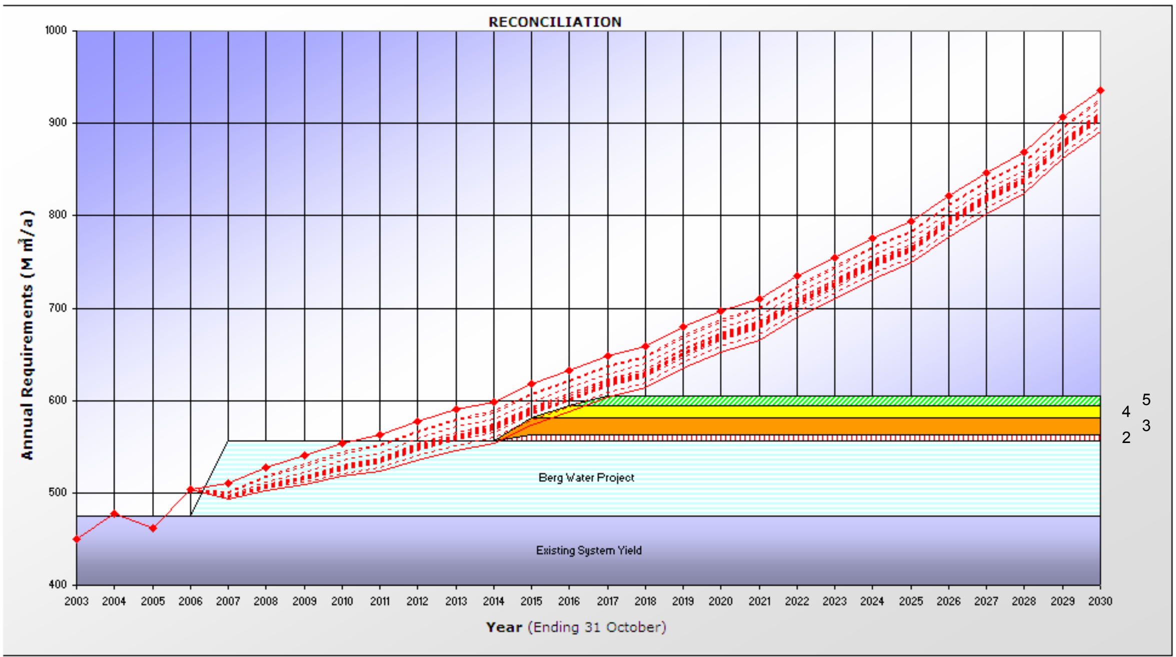


Figure 3.2 Scenario 2: No additional WC/WDM interventions and all supply-side interventions

3.3 Scenario 3: CCT WC/WDM Strategy and Programme Implemented as well as Additional WC/WDM Interventions. All Supply-side Interventions can be Implemented

Objective: To determine the impact of implementing all WC/WDM interventions

Scenario 3 was developed in order to determine what the required intervention study start dates would be if the CCT successfully implemented its 8-year WC/WDM strategy and programme, as well as additional longer term WC/WDM initiatives, which were identified as part of the CCT's earlier Integrated Water Resource Planning Study. The outcome of this scenario was that the first supply-side intervention would be required in 2019. Comprehensive WC/WDM, if successfully implemented, could potentially effect a saving of approximately 100 million m^3 of water per annum by 2019. The implementation of additional longer-term WC/WDM interventions could delay the implementation of a supply-side intervention by 8 years. Owing to the later implementation date for a supply-side intervention, there would then be fewer limitations on the choice of interventions that could be implemented. It would therefore be possible to select a number of alternate supply-side interventions for implementation in 2019, as indicated in Table 3.3 and Figure 3.3.

Table 3.3 Scenario 3: All WC/WDM and all supply-side interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	WC/DM: Adjustment of water tariffs, metering and credit control	2015	20.0	4	2011		4
3	WC/DM: Eliminate auto-flush urinals	2015	4.2	3.5	2011.5		1
4	WC/DM: Leakage detection and repair	2015	15.6	7.5	2007.5		2
5	WC/DM: Promotion of private boreholes and wells	2016	3.6	0.5	2015.5		3
6	WC/DM: Use of Water Efficient Fittings	2016	7.9	3.5	2012.5		3
7	WC/DM: User Education	2017	10.0	1.5	2015.5		3
8	Voëlvlei Phase 1	2019	35	11.5	2007.5		1
9	Newlands Aquifer	2021	7	8	2013		1
10	Upper Wit River Diversion	2021	10	10.5	2010.5		1
11	Cape Flats Aquifer	2022	18	7	2015		1
12	West Coast Aquifer	2023	13.8	6.5	2016.5		1
13	TMG Aquifer Scheme 1 (1 year into CCT pilot monitoring)	2023	20	10.5	2012.5		1

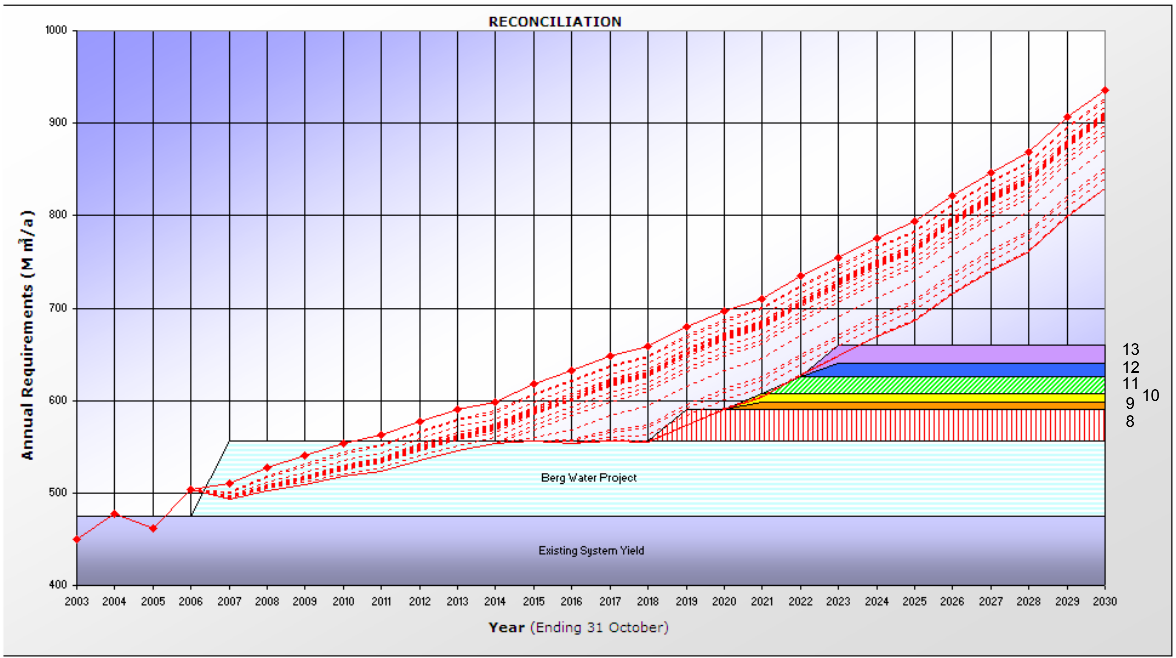


Figure 3.3 Scenario 3: All WC/WDM and all supply-side interventions

3.4 Scenario 4: CCT WC/WDM Strategy and Programme Implemented. Only Groundwater Interventions can be Implemented

Objective: To determine how groundwater interventions could meet the future requirement

Scenario 4 was developed in order to determine what the required intervention study start dates would be if the CCT successfully implemented its 8-year WC/WDM strategy and programme, and thereafter only had groundwater interventions to choose from. The scenario assumed that no additional WC/WDM interventions were carried out beyond the CCT's current 8 year WC/WDM strategy and programme. The outcome of this scenario was that the first groundwater supply-side intervention would be required in 2015. Due to the anticipated shorter lead times associated with the implementation of primary aquifers, namely the Cape Flats Aquifer, Newlands Aquifer and the West Coast Aquifers, these interventions were selected first. In 2017, it was possible to select the TMG Aquifer as the next intervention to be implemented. Under this scenario, there was no requirement to "fast-track" the implementation of the TMG Aquifer Scheme. Should one of the Cape Flats Aquifer, Newlands Aquifer or the West Coast Aquifers not be implemented, or should the aquifers have a yield less than anticipated, there would be a requirement to "fast track" the implementation of the TMG Aquifer.

There is some concern regarding "fast tracking" of the TMG Aquifer, as the purpose of the feasibility study and pilot project, which the CCT initiated, is an incremental learning approach. This approach is aimed at gaining a better understanding of the aquifer and the associated potential environmental impacts prior to investing in production wellfields, should the outcome of the feasibility study and pilot project be favourable. By "fast tracking" the TMG Aquifer Scheme, one could reduce the implementation time by approximately 4 to 5 years. Any "fast tracking" of the TMG Aquifer Scheme should take these abovementioned concerns into account.

Table 3.4 and Figure 3.4 indicate the interventions which make up Scenario 4.

Table 3.4 Scenario 4 : CCT WC/WDM strategy and all groundwater interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	Newlands Aquifer	2015	7.0	8	2007		1
3	Cape Flats Aquifer	2015	18.0	7	2008		1
4	West Coast Aquifer	2016	13.8	6.5	2009.5		1
5	TMG Aquifer Scheme 1 (1 year into CCT pilot monitoring)	2017	20	10.5	2006.5		1
6	TMG Aquifer Scheme 2 (1 year into CCT pilot monitoring)	2019	50	12.5	2006.5		2
7	TMG Aquifer Scheme 3 (1 year into CCT pilot monitoring)	2021	70	14	2007		4

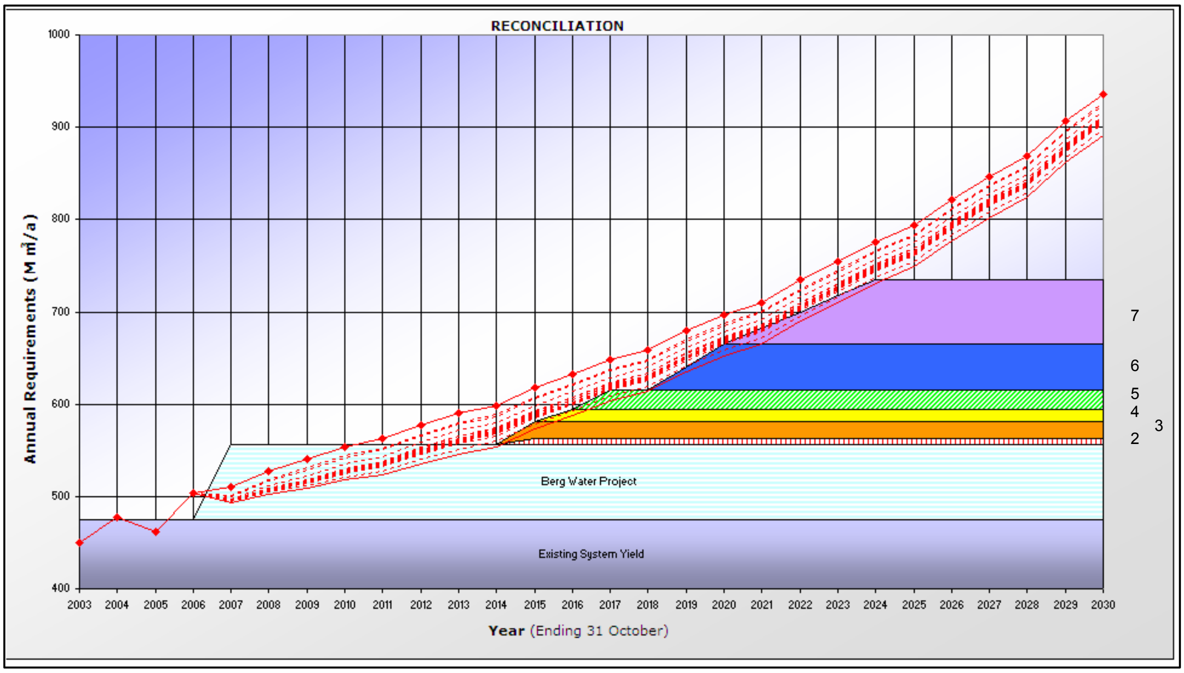


Figure 3.4 Scenario 4 : CCT WC/WDM strategy and all groundwater interventions

3.5 Scenario 5 (a and b): CCT WC/WDM Strategy and Programme Implemented. Only Effluent Re-use Interventions can be Implemented

Objective: To determine how effluent re-use interventions could meet the future requirement

Scenario 5 (a and b) were developed in order to determine what the required intervention study start dates would be if the CCT successfully implemented its WC/WDM strategy and programme and thereafter only had effluent re-use interventions to choose from. The scenarios assumed that no additional WC/WDM interventions were implemented, beyond the CCT's current 8-year WC/WDM strategy and programme. The CCT would first have to focus on treated effluent re-use for irrigation and industry, dual reticulation systems and treated effluent re-use and commercial irrigation exchange from 2015 to 2018. Due to the implementation lead times, interventions to treat effluent to potable standards would not be possible as there would be a shortfall in supply for 1 year in 2019. Although not graphically shown, Scenario 5 (a) illustrated the shortfall in supply in 2019.

A water balance could only be achieved by reducing the implementation lead times of interventions to allow treated effluent to potable standards to be implemented within a reduced time period. Scenario 5(b) illustrates the water balance that was achieved by fast-tracking the implementation of potable re-use.

Table 3.5 and Figure 3.5 indicate the interventions which make up Scenario 5 (b).

Table 3.5 Scenario 5 (b): CCT WC/WDM Strategy and all effluent re-use interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	Re-use- Irrig/Industrial	2015	20.0	8	2007		1
3	Re-use - dual reticulation	2016	28.0	8	2008		2
4	Re-use - Commercial Irrigation	2018	5.0	11.5	2006.5		1
5	Re-use - potable (UWP Study Option 1)*	2018	150.0*	8	2010		8

* Generic combination re-use scheme with total yield of 150 Mm^3/a

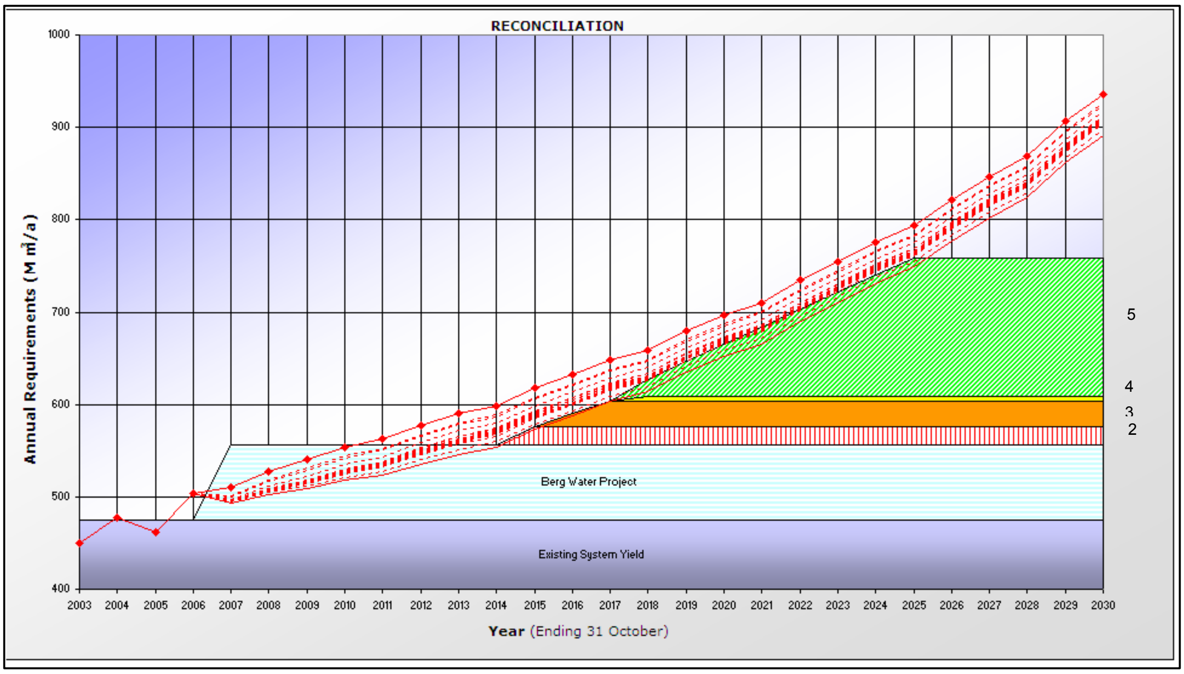


Figure 3.5 Scenario 5 (b): CCT WC/WDM strategy and all effluent re-use interventions

3.6 Scenario 6: CCT WC/WDM Strategy and Programme Implemented. Only Desalination Implemented

Objective: To determine how desalination interventions could meet the future requirement

Scenario 6 was developed in order to determine what the required intervention study start dates would be if the CCT successfully implemented its WC/WDM strategy and programme and thereafter could only implement a desalination intervention. The scenario assumed that no additional longer-term WC/WDM interventions were implemented beyond the CCT's current 8-year WC/WDM strategy and programme. The outcome of Scenario 6 is that, due to the implementation lead-time, there will be a deficit in supply for a 3-year period, from 2013 to 2016, prior to water being available from a large-scale desalination plant. The time frame for the implementation of the desalination plant is based on the shortened lead times. All the additional needs of the water users from the WCWSS could be supplied from desalination thereafter. As desalination is still considerably more expensive than other supply-side interventions, this option would significantly increase the cost of water to the end user.

It may be possible to "fast-track" a desalination plant (as was the case in Perth, Western Australia) and implement a desalination plant by 2013.

Table 3.6 and Figure 3.6 indicate the interventions, which make up Scenario 6. Figure 3.7 shows the cash flow requirement (based on a desalination cost of R6/m^3) for this Scenario.

Table 3.6 Scenario 6 : CCT WC/WDM strategy and desalination

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	Desalination 1 Generic	2017	100.0	9.5	2007.5		3
3	Desalination 2 Generic	2021	100.0	9.5	2011.5		5
4	Desalination 3 Generic	2026	100.0	9.5	2016.5		4

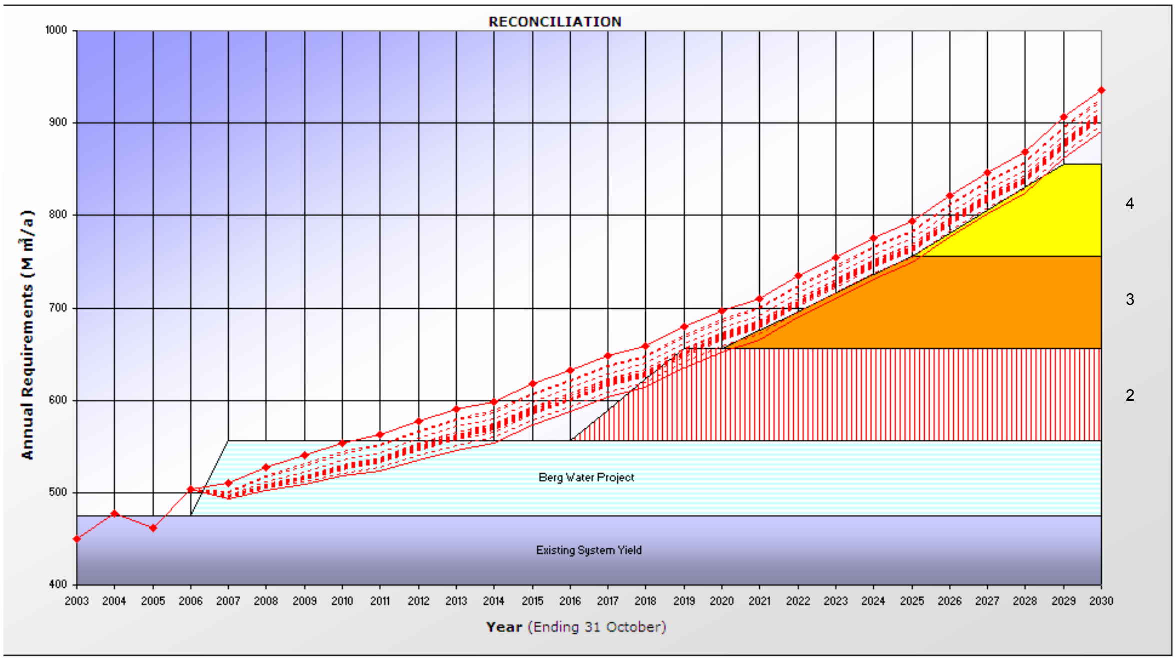


Figure 3.6 Scenario 6: CCT WC/WDM strategy and desalination

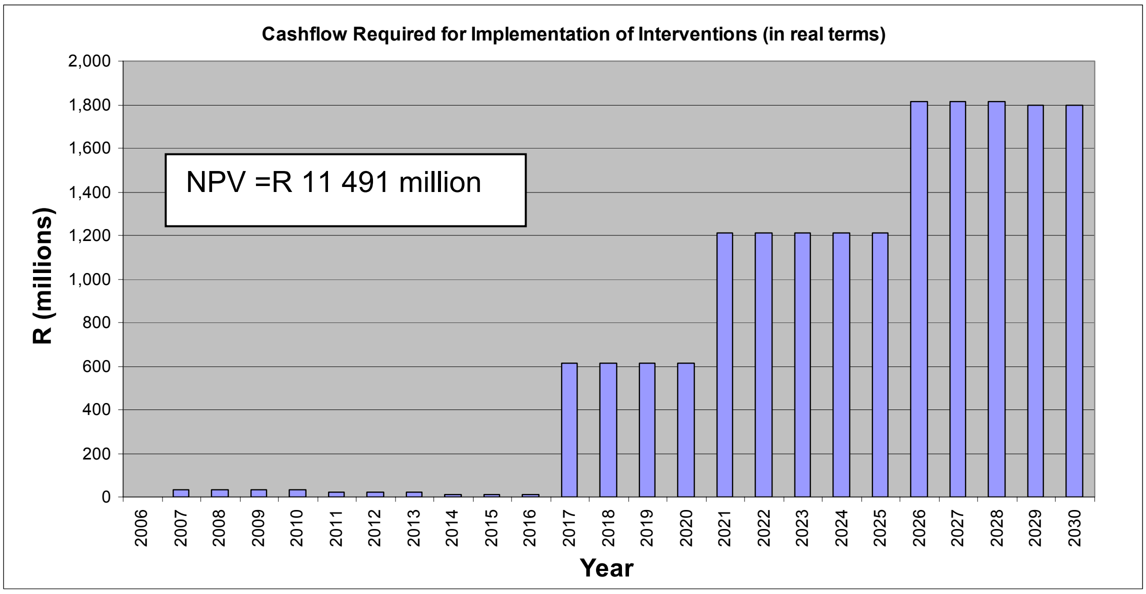


Figure 3.7 Scenario 6: Annual cash flow requirements

The Net Present Value (NPV) of this scenario is R11 491 million. The significant NPV indicates that desalination as an option is still significantly more expensive than implementing other WC/WDM and supply-side interventions.

3.7 Scenario 7: CCT WC/WDM Strategy and Programme Implemented. Thereafter Selection of Interventions based on URV (both WC/WDM and Supply-side Interventions)

Objective: To determine the impact of selecting interventions based on lowest URV

Scenario 7 was developed in order to determine what the required intervention study start dates would be if the CCT successfully implemented its WC/WDM strategy and programme and thereafter implemented interventions based on lowest URV. The scenario assumed that both supply-side and additional WC/WDM interventions could be carried out beyond the CCT's current 8-year WC/WDM strategy. The first interventions to be selected, based on the lowest URV after 2013, were additional WC/WDM interventions. Thereafter, a mix of surface water and groundwater interventions became available for selection. It was not necessary to "fast track" or reduce the implementation lead time for any of the interventions.

The following assumptions underlie the selection:

- The Michell's Pass Diversion intervention cannot be selected if the Voëlvlei Phase 1 Scheme is selected, until additional conveyance capacity is provided between the Voëlvlei Dam and the general Blaauwberg area, within the Cape Metropolitan Area.
- Owing to the uncertainty regarding the feasibility of Voëlvlei Phase 1 and the fact that the Michell's Pass Diversion Scheme has not been studied to the same level of detail as the Voëlvlei Phase 1 Scheme (feasibility level), it would be prudent to also study the Michell's Pass Diversion Scheme at pre-feasibility level in order to make a realistic comparative assessment of the URV, socio-economic and ecological impacts with those of the Voëlvlei Phase 1 Scheme.
- Should the actual water requirement be lower than that for the HWR Curve, or should WC/WDM be more successful than envisaged, then the Michell's Pass Diversion Scheme may be a preferable option to implement rather than the Voëlvlei Scheme, owing to its lower URV.
- The Lourens River Scheme could not initially be selected, as the winter requirement for water at the Faure Water Treatment Plant is not high enough to utilise the full yield of the Lourens River Scheme, without prejudicing the yield from Kleinplaas Dam and the Palmiet Scheme.
- The Lourens River Scheme could be fully utilised should additional storage be made available through the raising of the Steenbras Lower Dam.

Table 3.7 and Figure 3.8 indicate the interventions, which make up Scenario 7. Figure 3.9 shows the cash-flow requirement for this Scenario.

Table 3.7 Scenario 7: CCT WC/WDM strategy and lowest URV supply-side and additional WC/WDM interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006	8
2	WC/WDM: Adjustment of water tariffs, metering and credit control	2015	20.0	4	2011	4
3	WC/WDM: Eliminate auto-flush urinals	2015	4.2	3.5	2011.5	1
4	WC/WDM: Leakage detection and repair	2015	15.6	7.5	2007.5	2
5	WC/WDM: Promotion of private boreholes and wells	2016	3.6	0.5	2015.5	3
6	Newlands Aquifer	2016	7.0	8	2008	0
7	Upper Wit River Diversion	2017	10.0	10.5	2006.5	1
8	Voëlvlei Phase 1	2019	35.0	11.5	2007.5	1
9	Re-use- Irrig/Industrial	2021	20.0	8	2013	1
10	Cape Flats Aquifer	2022	18.0	7	2015	1
11	WC/WDM: Use of Water Efficient Fittings	2022	7.9	3.5	2018.5	3
12	West Coast Aquifer	2023	13.8	6.5	2016.5	1
13	24 Rivers Dam	2023	1.8	8.5	2014.5	1
14	TMG Aquifer Scheme 3 (1 year into CCT pilot monitoring)	2024	70.0	14	2010	3
15	WC/WDM: User Education	2027	10.0	1.5	2025.5	3
16	TMG Aquifer Scheme 2 (1 year into CCT pilot monitoring)	2027	50.0	12.5	2014.5	2
17	TMG Aquifer Scheme 1 (1 year into CCT pilot monitoring)	2029	20.0	10.5	2018.5	1

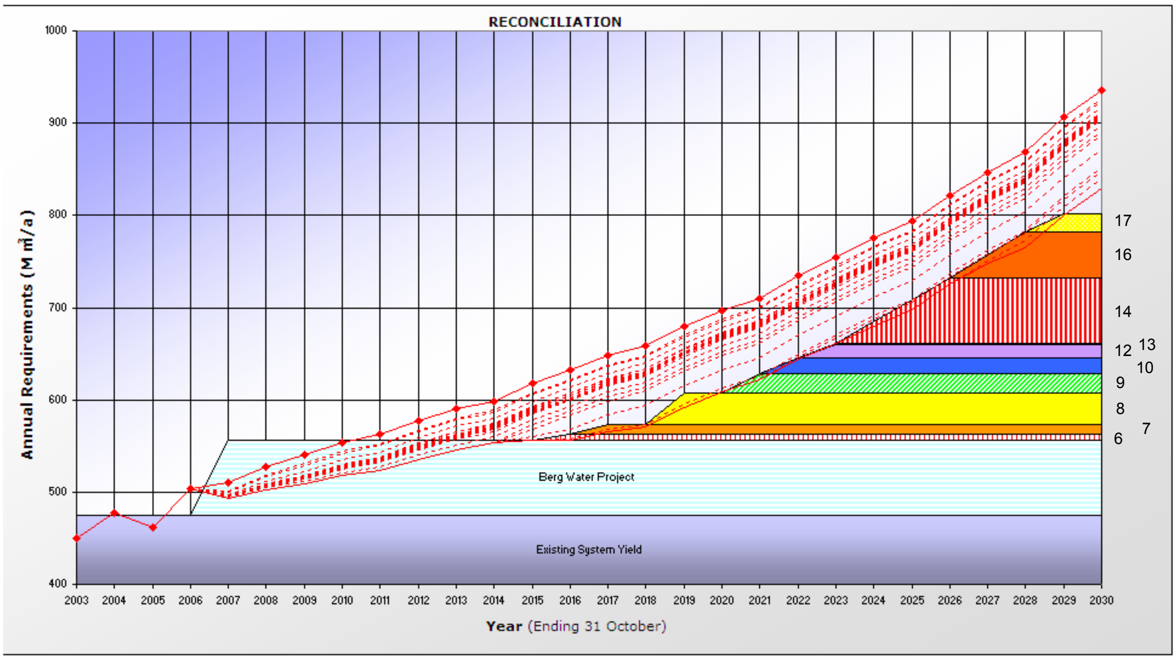


Figure 3.8 Scenario 7: CCT WC/WDM strategy and lowest URV supply-side and WC/WDM interventions

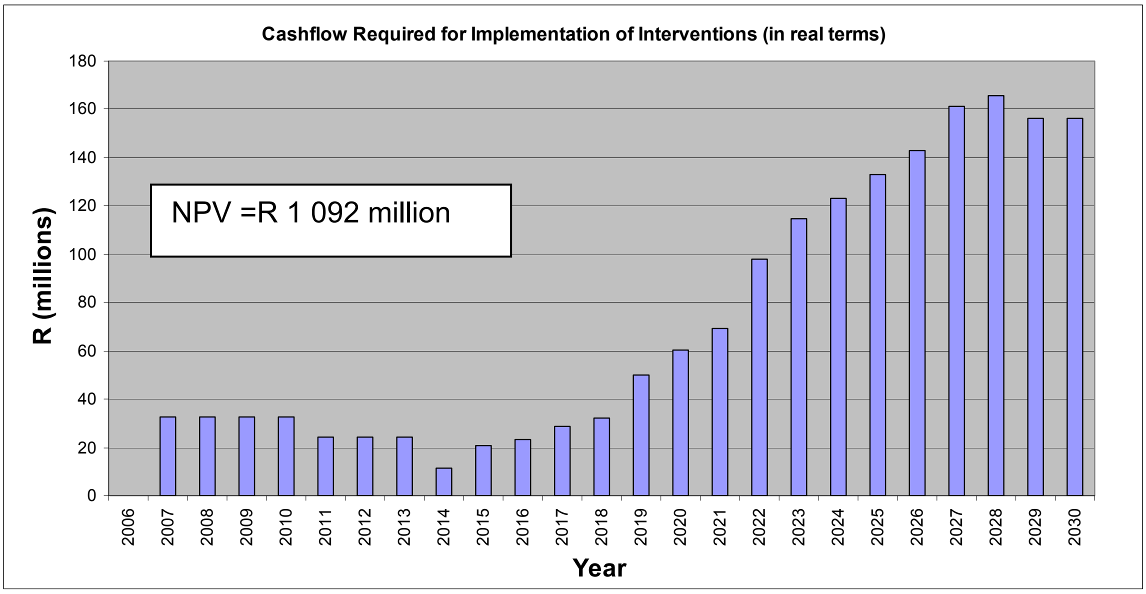


Figure 3.9 Scenario 7: annual cash-flow requirements

The NPV of implementing Scenario 7 is R1 092 million. The relatively low cash flow requirements between 2007 and 2018 are due to the implementation of WC/WDM interventions prior to the implementation of other supply-side interventions.

3.8 Scenario 8: CCT WC/WDM Strategy and Programme Implemented. Thereafter Selection Based on URV (Scenario 7) with the Ecological Reserve being Phased-in for Existing Water Resources

Objective: To determine how the implementation of the ecological Reserve will impact on the selection of interventions

Scenario 8 is similar to Scenario 7, but assumes that the ecological Reserve for existing water resources, namely Theewaterskloof Dam, Steenbras Upper and Lower Dam and Wemmershoek Dam are phased in over a 2 to 3 year period, starting in approximately 2016. The impact of the ecological Reserve on the yield for this scenario were taken as 10% of the yield of the existing water resources. This scenario assumes that additional longer-term WC/WDM interventions are available for selection after the implementation of the CCT's WC/WDM strategy and programme. The first interventions to be selected based on lowest URV after 2013 were additional WC/WDM interventions.

Table 3.8 and Figure 3.10 indicate the interventions, which make up Scenario 8. Figure 3.11 shows the cash flow requirement for this scenario.

Table 3.8 Scenario 8: CCT WC/WDM strategy and lowest URV intervention and ecological reserve implemented

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	WC/WDM: Adjustment of water tariffs, metering and credit control	2015	20.0	4	2011		4
3	WC/WDM: Eliminate auto-flush urinals	2015	4.2	3.5	2011.5		1
4	WC/WDM: Leakage detection and repair	2015	15.6	7.5	2007.5		2
5	WC/WDM: Promotion of private boreholes and wells	2016	3.6	0.5	2015.5		3
6	Newlands Aquifer	2016	7.0	8	2008		0
7	Upper Wit River Diversion	2017	10.0	10.5	2006.5		1
8	Cape Flats Aquifer	2017	18.0	7	2010		1
9	Re-use- Irrig/Industrial	2018	20.0	8	2010		3
10	Voëlvlei Phase 1	2019	35.0	11.5	2007.5		1
11	WC/WDM: Use of Water Efficient Fittings	2020	7.9	3.5	2016.5		3
12	West Coast Aquifer	2020	13.8	6.5	2013.5		1
13	24 Rivers Dam	2021	1.8	8.5	2012.5		1
14	TMG Aquifer Scheme 3 (1 year into CCT pilot monitoring)	2021	70.0	14	2007		4
15	WC/WDM: User Education	2025	10.0	1.5	2023.5		3
16	TMG Aquifer Scheme 2 (1 year into CCT pilot monitoring)	2025	50.0	12.5	2012.5		2
17	TMG Aquifer Scheme 1 (1 year into CCT pilot monitoring)	2027	20.0	10.5	2016.5		1
18	Raise Lower Steenbras Dam	2028	25.0	15.5	2012.5		1
19	Lourens River Dam	2029	19.0	9.5	2019.5		1

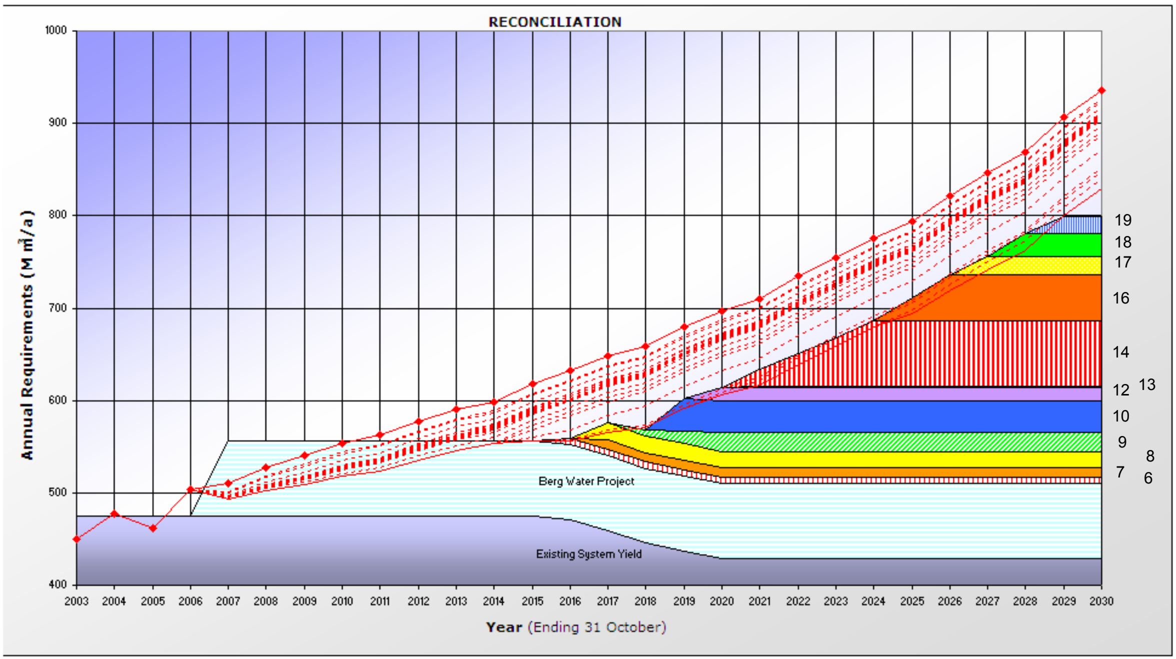


Figure 3.10 Scenario 8: CCT WC/WDM strategy and lowest URV intervention and the ecological reserve

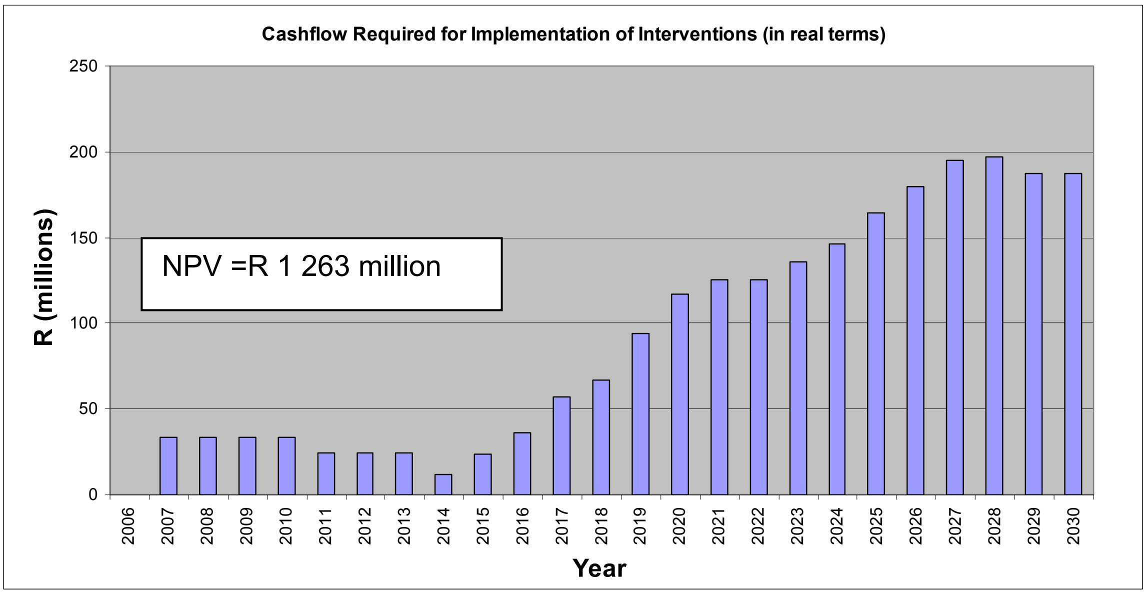


Figure 3.11 Scenario 8: Annual cash-flow requirement

The Net Present Value of implementing Scenario 8 is R1 263 million, based on the cash flow as shown in Figure 14. The cost of implementing the ecological Reserve of existing water resources, in terms of loss in yield, is the difference in the NPVs between Scenario 7 and Scenario 8. This amounts to a current-day present value of R171 million. This additional R171 million is illustrated by the increased cash flow requirement from 2016 onwards. This NPV excludes the infrastructure costs associated with enabling the ecological Reserve releases.

3.9 Scenario 9: CCT WC/WDM Strategy and Programme Implemented. Thereafter Selection Based on URV (Scenario 7) with the Impact from Climate Change being Factored In

Objective: To determine how climate change could impact on the selection of interventions

Scenario 9 is similar to Scenario 7, but assumes that the yield from current and future rainfall-dependent supply-side interventions would decrease as a result of climate change. It was assumed that climate change would negatively impact on the available yield from future surface water source interventions by 15% and from groundwater interventions by 5%. It was also assumed that the yield of existing water resources would decrease gradually by approximately 15% over the next 25 years. This translates into an approximate reduction in existing system yield of 3 million m^3 per annum for the next 25 years, and a total reduction in yield (including new supply-side interventions) of approximately 107 million m^3 per annum. This scenario assumes that additional WC/WDM interventions are also available for selection after the implementation of the CCT's WC/WDM strategy and programme. The first interventions to be selected based on lowest URV after 2013 were additional WC/WDM interventions. Thereafter, a mix of effluent re-use, surface water interventions and groundwater interventions were available for selection.

Table 3.9 and Figure 3.12 indicate the interventions which make up Scenario 9. Figure 3.13 shows the annual cash flow requirements.

Table 3.9 Scenario 9: CCT 8 year WC/WDM strategy and program and lowest URV intervention and climate change

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	WC/DM: Adjustment of water tariffs, metering and credit control	2013	20.0	4	2009		4
3	WC/WDM: Eliminate auto-flush urinals	2013	4.2	3.5	2009.5		1
4	WC/WDM: Promotion of private boreholes and wells	2013	3.5	0.5	2012.5		3
5	WC/WDM: Leakage detection and repair	2014	15.6	7.5	2006.5		2
6	Newlands Aquifer	2015	6.7	8	2007		0
7	Cape Flats Aquifer	2016	17.1	7	2009		1
8	Re-use- Irrig/Industrial	2017	20.0	8	2009		3
9	Voëlvlei Phase 1	2018	29.8	11.5	2006.5		1
10	Upper Wit River Diversion	2019	8.5	10.5	2008.5		1
11	WC/DM: Use of Water Efficient Fittings	2020	7.9	3.5	2016.5		3
12	West Coast Aquifer	2020	13.1	6.5	2013.5		1
13	24 Rivers Dam	2021	1.5	8.5	2012.5		1
14	TMG Aquifer Scheme 3 (1 year into CCT pilot)	2021	66.5	14	2007		3
15	WC/WDM: User Education	2024	10.0	1.5	2022.5		3
16	TMG Aquifer Scheme 2 (1 year into CCT pilot)	2024	47.5	12.5	2011.5		2
17	TMG Aquifer Scheme 1 (1 year into CCT pilot)	2026	19.0	10.5	2015.5		1
18	Raise Lower Steenbras Dam	2027	21.3	15.5	2011.5		1
19	Lourens River Diversion	2028	16.2	9.5	2018.5		1
20	Lower Wit River Dam	2028	25.1	17	2011		1
21	Eerste	2029	7.1	9.5	2019.5		1
22	Re-use - dual reticulation	2029	28.0	8	2021		3

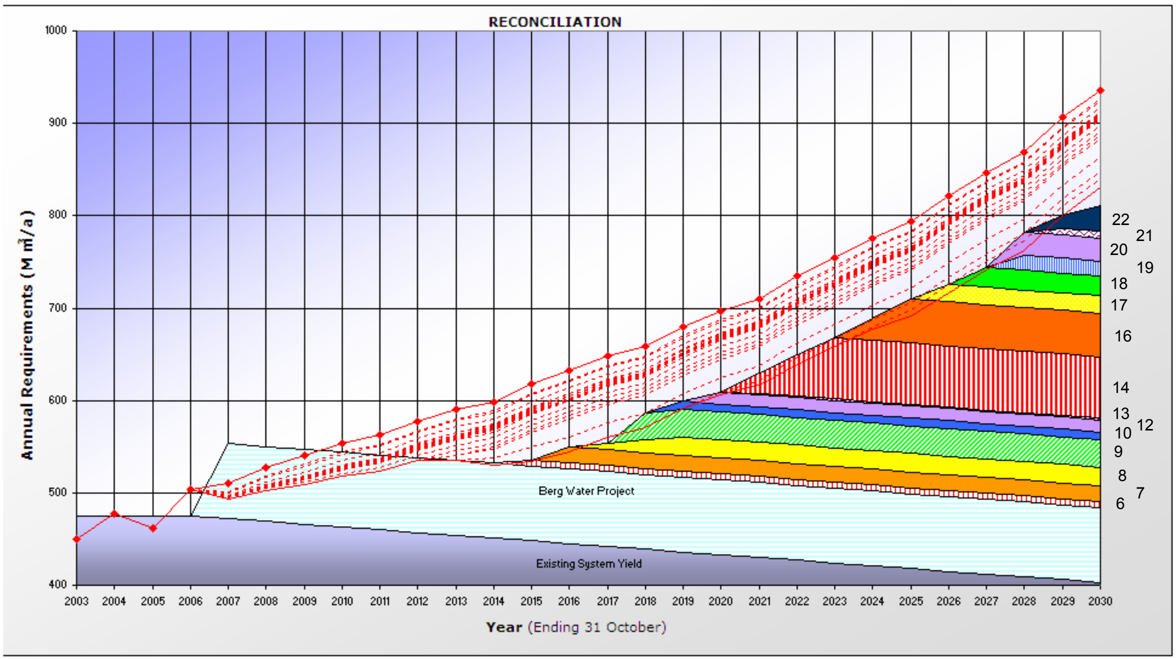


Figure 3.12 Scenario 9: CCT WC/WDM strategy and lowest URV intervention and climate change

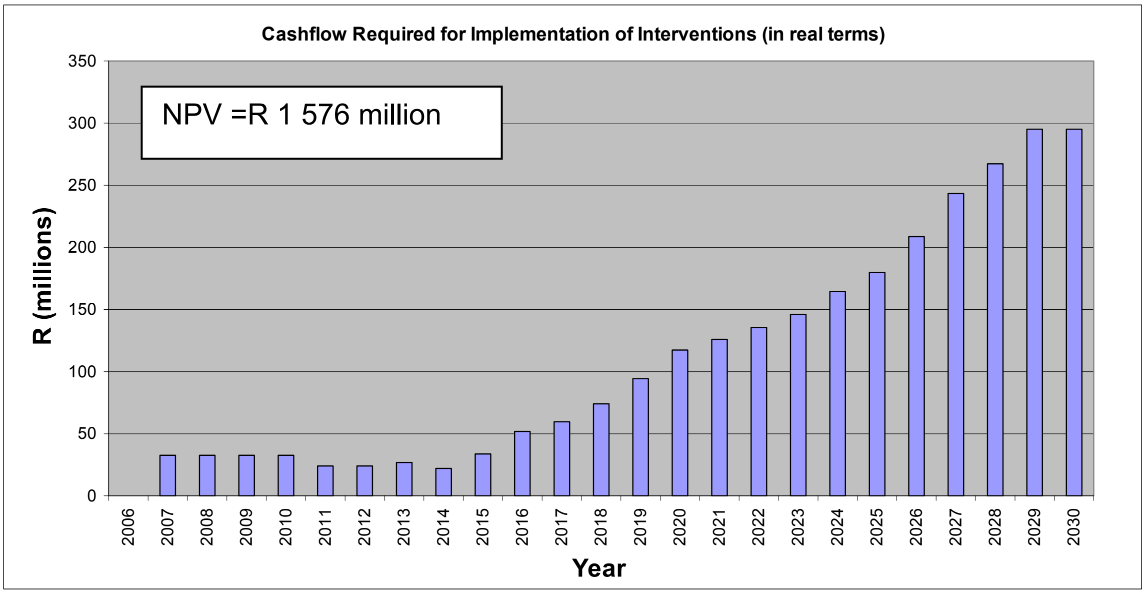


Figure 3.13 Scenario 9: Annual cash-flow requirements

The NPV of implementing Scenario 9 is R1 576 million. The cost associated with implementing additional interventions, in order to offset the impacts associated with climate change, is equal to the difference in the NPVs of Scenario 7 and Scenario 9. This amounts to a present day value of approximately R474 million. This additional R474 million illustrated by the significant increase in cash flow requirement beyond 2016.

3.10 Scenario 10(a): CCT WC/WDM Strategy and Programme Implemented. Thereafter a Conservative Portfolio was Selected

Objective: To use local understanding of how the WCWSS operates to select a "conservative portfolio"

The "conservative portfolio" was identified by the DWAF and the consulting team based on, their knowledge of the WCWSS, the supply schemes available for selection and on the practicality of implementing some of the interventions. The portfolio presumes that only CCT's WC/WDM strategy and programme was implemented, and none of the additional WC/WDM. This represents approximately 50% of the overall potential for WC/WDM. The interventions were analysed by those familiar with the system, on lowest URV, and on the availability of the intervention with regard to implementation lead times.

Based on their understanding of the system, certain interventions were excluded, which include, *inter alia*:

- Newlands Aquifer (because yield is small and likely to impact on river flow and existing users);
- the Cape Flats Aquifer (on account of the perceived O&M problem of operating numerous boreholes in a relatively low income urban area); and
- the Upper Wit River diversion scheme (because of potential difficulties of obtaining environmental approvals).

This scenario assisted in identifying any other interventions, not identified in the previous scenarios, which should be studied at pre-feasibility or feasibility level.

Treated effluent re-use for irrigation and industry was considered the first major intervention, which should be implemented. Thereafter, it would be a requirement to "fast-track" the TMG Aquifer Scheme and to reduce the lead time of other supply-side interventions, in order to be able to reconcile supply and requirement until 2030. Due to the need for additional storage, the Lourens River Diversion scheme, although having a low URV, could only be selected after Steenbras Lower Dam was raised.

Table 3.10 and Figure 3.14 indicate the interventions making up Scenario 10(a). Figure 3.15 shows the annual cash flow.

Table 3.10 Scenario 10(a) : CCT WC/WDM strategy and conservative supply-side interventions

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	TMG Aquifer Scheme 1 (after CCT exploratory phase)	2015	20.0	6.5	2008.5	Yes	1
3	Voëlvlei Phase 1	2017	35.0	9.5	2007.5	Yes	1
4	Re-use- Irrig/Industrial	2018	20.0	8	2010		2
5	Raise Lower Steenbras Dam	2020	25.0	10.5	2009.5	Yes	1
6	Lourens River Diversion	2021	19.0	9.5	2011.5		1
7	TMG Aquifer Scheme 2	2022	50.0	8.5	2013.5		3
8	Upper Molenaars Diversion (To Berg River Dam)	2025	27	14	2011		1
9	Re-use - potable UWP Study Option 1	2026	120	13	2013		4

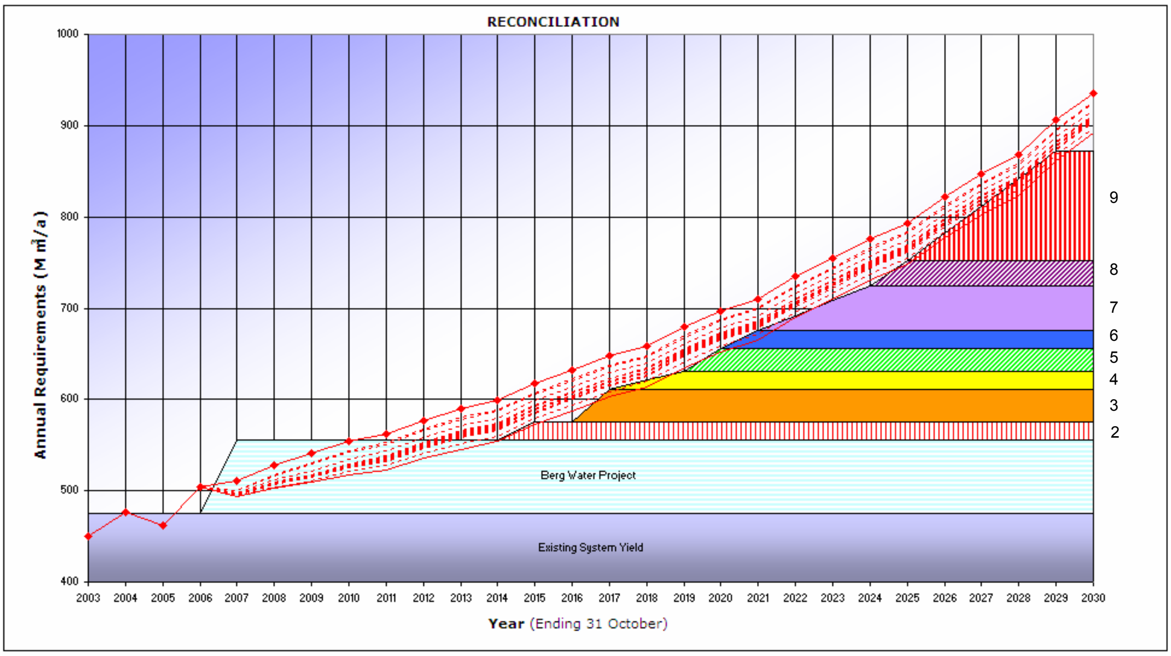


Figure 3.14 Scenario 10(a): CCT WC/WDM strategy and conservative supply-side interventions

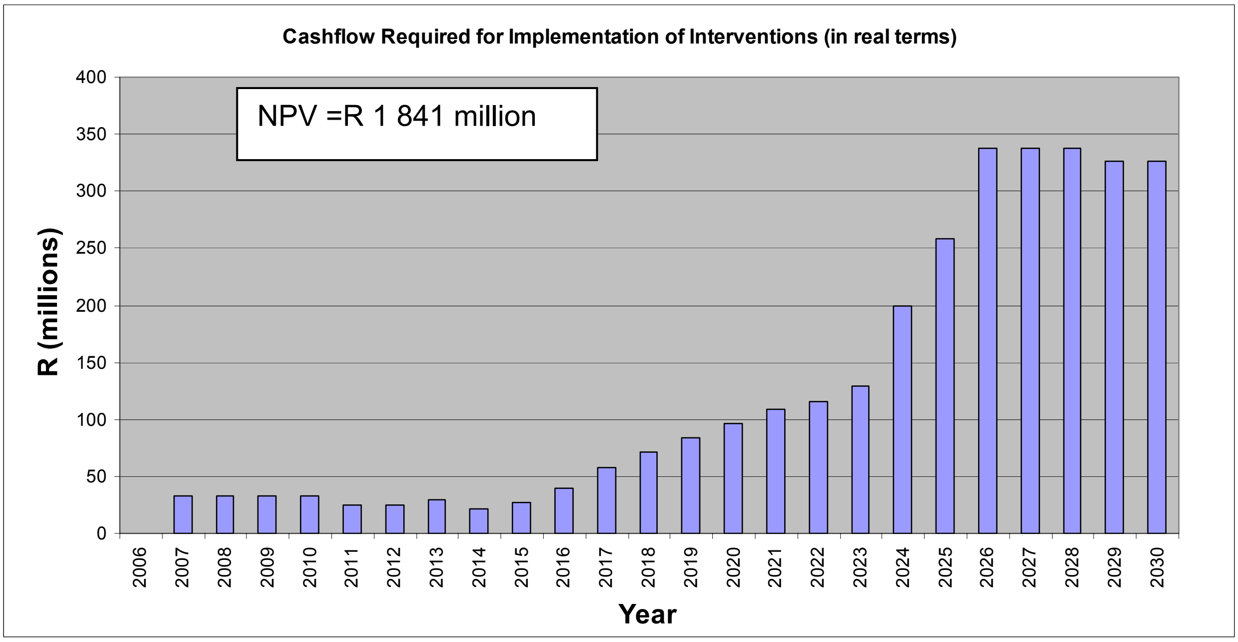


Figure 3.15 Scenario 10(a): Annual cash-flow requirement

The NPV of implementing Scenario 10(a) is R1 841 million. The cost for this Scenario is approximately R749 million higher than the least-cost option, which was evaluated as Scenario 7. This difference can be ascribed to the following two factors:

1) The fact that only approx. 50% of the WC/WDM modeled potential was implemented, and
2) The fact that, as a result of implementation practicalities and issues of sustainability, certain cost effective interventions were replaced with more expensive interventions.

3.11 Scenario 10(b): Selection Based on "Conservative Portfolio" and Considering Potential Impacts of Ecological Reserve and Climate Change

Objective: To determine how the implementation of the ecological Reserve and the potential for climate change could impact on the selection of interventions

Scenario 10(b) was developed in order to determine what the required intervention study start dates would be if only the CCT's 8-year WC/WDM strategy and programme was implemented (represents approximately 50% of the total modelled potential for WC/WDM) and thereafter the "conservative portfolio" was implemented and cognisance was taken of the implementation of the ecological Reserve and the potential impact of climate change. The selection of interventions was based on lowest URV and on the availability of the intervention with regard to implementation time. It was assumed that climate change would negatively impact on the available yield of future surface water interventions by 15% and groundwater interventions by 5%. It was also assumed that the yield of existing water resources would decrease by approximately 15% over the next 25 years. This would result in a reduction in yield of approximately 3 million m^3 per annum over the next 25 years, (a total of approximately 75 million m^3). The conservative portfolio was identified by the DWAF and the consulting team, based on their knowledge of the area, the schemes available for selection, on available lead time, and on the practicality of implementing some of the interventions available for selection. The purpose of this "conservative" scenario was to see how the cumulative potential impact of the implementation of the ecological Reserve and the potential for climate change could impact on the selection of schemes for further studies.

The "fast-tracked" TMG Aquifer Scheme was considered the first major intervention, which should be implemented. Thereafter, there would be a requirement to utilise treated effluent re-use for irrigation and industry and to reduce the lead time of other supply-side interventions in order to be able to reconcile supply and requirement until 2030. Due to the requirement for additional storage, the Lourens River Diversion scheme, although having a low URV, could only be selected after Steenbras Lower Dam was raised as explained in the third paragraph of Section 3.7.

Table 3.11 and Figure 3.16 indicate the interventions, which make up Scenario 10(b). Figure 3.17 shows the annual cash flow requirement for Scenario 10(b).

Table 3.11 Scenario 10(b): CCT WC/WDM strategy (50% of total WC/WDM potential) and conservative supply-side interventions and ecological reserve and climate change

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	TMG Aquifer Scheme 1 (after CCT exploratory phase)	2013	19.0	6.5	2006.5	Yes	1
3	Re-use- Irrig/Industrial	2014	20.0	6	2008	Yes	2
4	Voëlvlei Phase 1	2016	29.8	9.5	2006.5	Yes	1
5	Lourens River Diversion	2017	16.2	9.5	2007.5		1
6	Raise Lower Steenbras Dam	2017	21.3	10.5	2006.5	Yes	1
7	TMG Aquifer Scheme 2 (after CCT exploratory phase)	2018	47.5	8.5	2009.5	Yes	2
8	Upper Molenaars Diversion (To Berg River Dam)	2020	23	14	2006		1
9	Re-use - potable (Note 1)	2020	180	13	2007		8
10	Desalination 1 Generic (Note 2)	2028	66	16.5	2011.5		2

Notes
1. Generic combination re-use to potable standards intervention with total yield of 180 Mm^3/a
2. Yield of desalination intervention provides supply balance till 2030

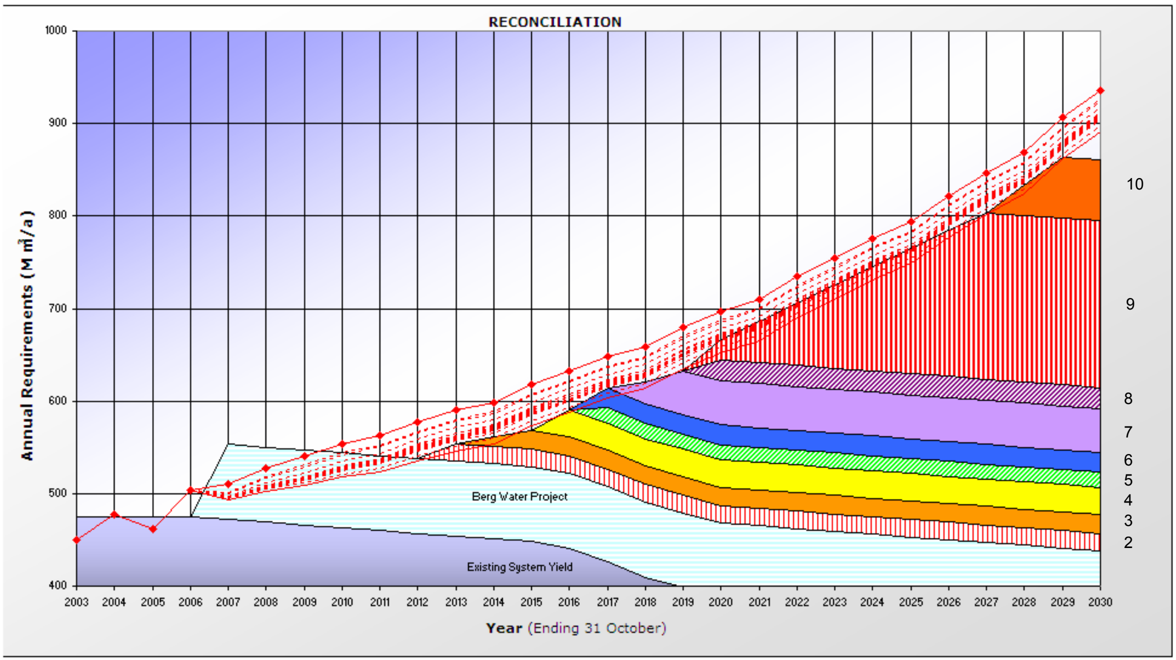


Figure 3.16 Scenario 10(b): CCT WC/WDM strategy and conservative supply-side interventions, ecological reserve and climate change

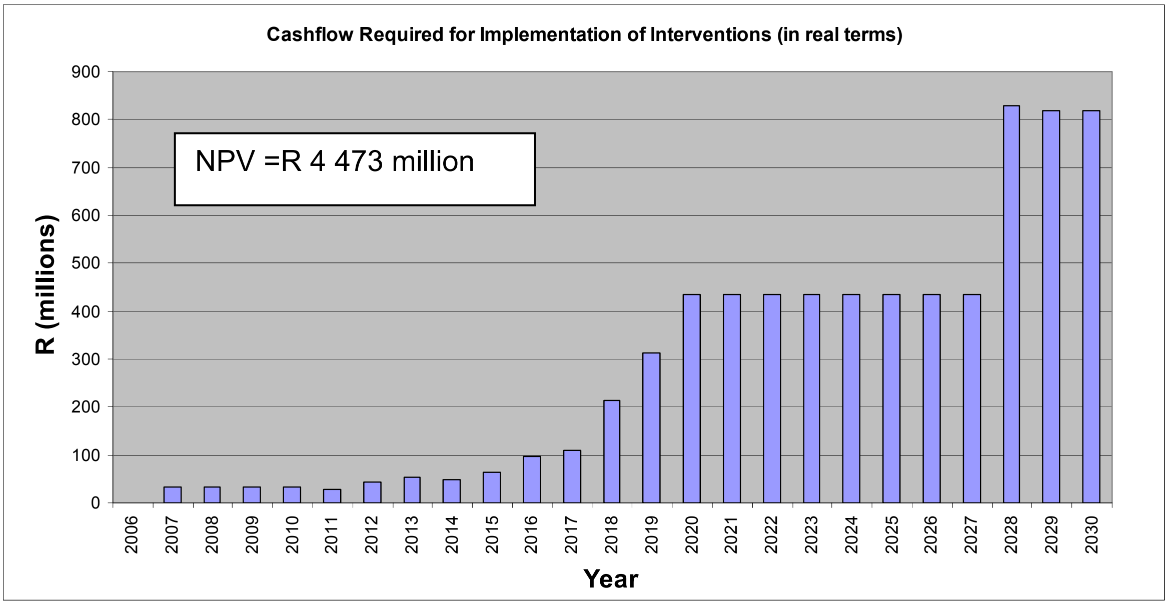


Figure 3.17 Scenario 10(b): Annual cash-flow requirement

The NPV of implementing Scenario 10(b) is R4 473 million. The cost for this scenario is approximately R2 629 million higher than the cost of Scenario 10(a). This is evident on the cash flow diagram and is primarily as a result of implementing a treated effluent re-use to potable standards intervention and the desalination intervention from 2020 onwards, in order to offset the system yield lost to both the ecological Reserve requirement and the potential impact of climate change.

3.12 Scenario 10(c): CCT WC/WDM Strategy and Programme Implemented. Thereafter Selection Based on a Conservative Selection of Interventions Including Additional Longer-term WC/WDM Interventions, Potential Impacts of Ecological Reserve and Climate Change

Objective: To determine how the implementation of additional longer-term WC/WDM interventions impacts on Scenario 10(b)

Scenario 10(c) was developed in order to determine what the required intervention study start dates would be if the CCT's WC/WDM strategy and programme was successfully implemented and thereafter additional longer-term WC/WDM interventions were implemented together with a "conservative portfolio" of supply-side interventions. Cognisance was taken of the implementation of the ecological Reserve and the potential impact of climate change.

Table 3.12 and Figure 3.18 indicate the interventions, which make up Scenario 10(c). Figure 3.19 shows the annual cash flow requirement for Scenario 10(c).

Table 3.12 Scenario 10(c): All WC/WDM interventions and conservative supply-side interventions and ecological reserve and climate change

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	WC/DM: Adjustment of water tariffs, metering and credit control	2013	20	4	2009		4
3	WC/WDM: Promotion of private boreholes and wells	2013	3.6	0.5	2012.5		3
4	WC/WDM: Eliminate auto-flush urinals	2013	4.2	3.5	2009.5		1
5	WC/WDM: Leakage detection and repair	2014	15.6	7.5	2006.5		2
6	Re-use- Irrig/Industrial	2015	20	8	2007		3
7	WC/WDM: Use of Water Efficient Fittings	2016	7.9	3.5	2012.5		3
8	WC/WDM: User Education	2016	10	1.5	2014.5		3
9	TMG Aquifer Scheme 1 (after CCT exploratory phase)	2017	19.0	10.5	2006.5		1
10	Voëlvlei Phase 1	2018	29.8	11.5	2006.5		1
11	Raise Lower Steenbras Dam	2019	21.3	10.5	2008.5	Yes	1
12	Lourens River Diversion	2020	16.2	9.5	2010.5		1
13	TMG Aquifer Scheme 2 (after CCT exploratory phase)	2020	47.5	12.5	2007.5		2
14	Upper Molenaars (Diversion Berg River Dam)	2022	23	14	2008		1
15	Re-use - potable UWP Study Option 1 (Note 1)	2023	180	13	2010		7

Note 1: Generic re-use option used in RPST utilising the full potential of treated effluent

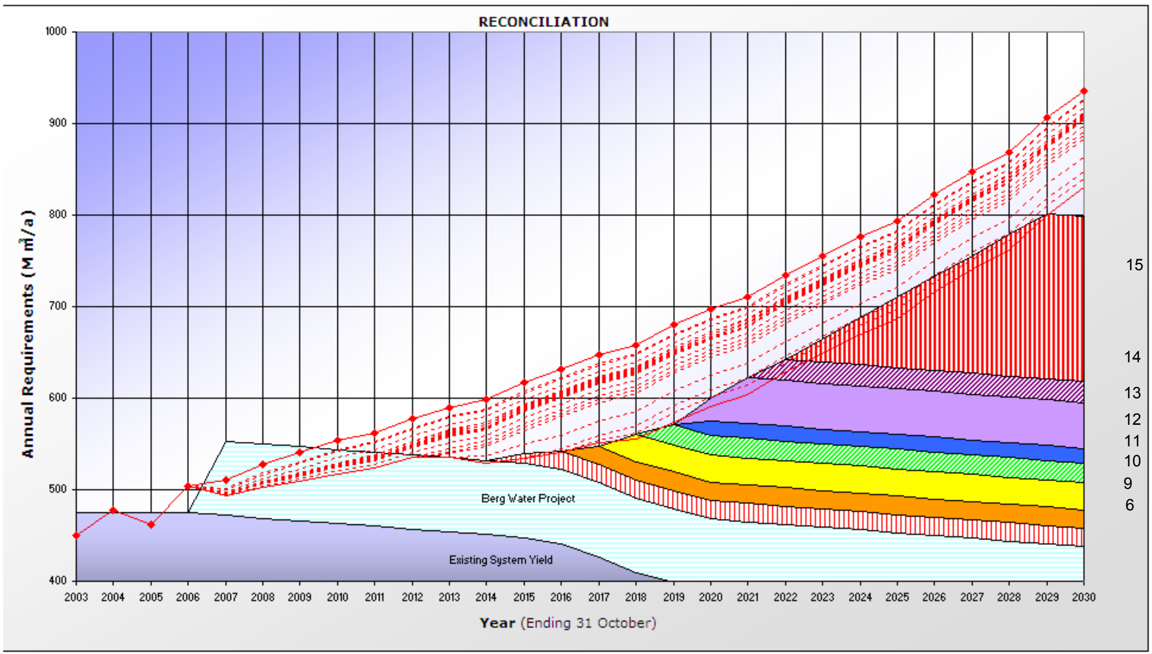


Figure 3.18 Scenario 10(c): All WC/WDM interventions and conservative supply-side interventions, ecological reserve and climate change

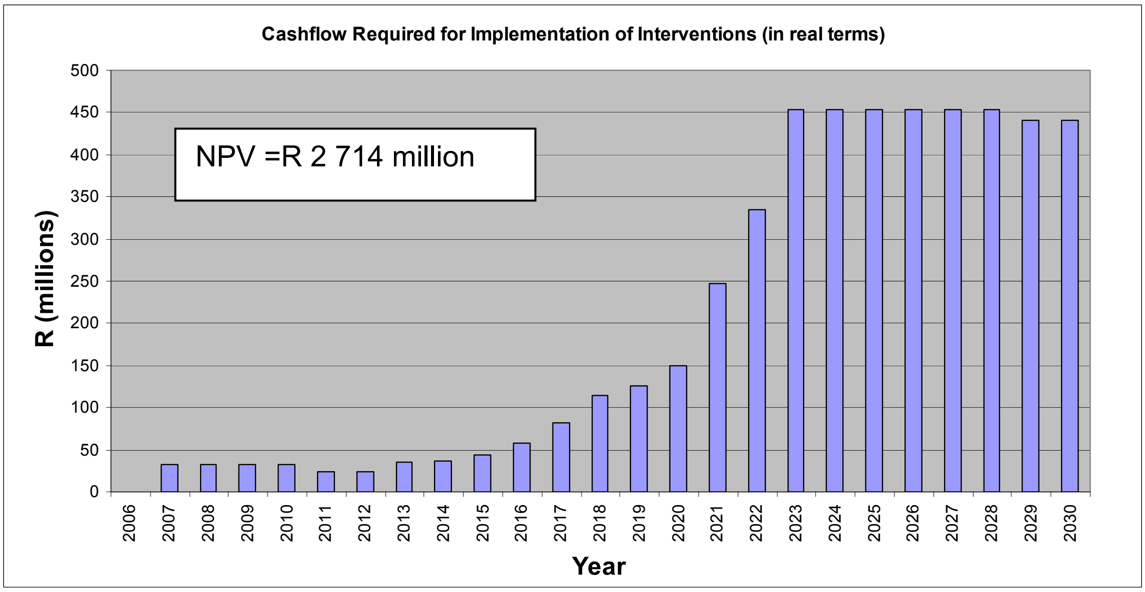


Figure 3.19 Scenario 10(c): Annual cash-flow requirement

If WC/WDM interventions were successfully implemented as per Scenario 7, then the NPV of the Scenario 10(c) would be R2 714 million. The cost for this scenario, due to the implementation of additional longer-term WC/WDM interventions, is approximately R1 759 million lower than the cost for Scenario 10 (b). This cost difference can be attributed to the fact that a desalination intervention was required in Scenario 10(b), but not in Scenario 10(c). The cost for Scenario 10(c) is approximately R873 million higher than Scenario 10(a). This difference can be attributed to the costs associated with implementing additional interventions in order to offset the loss of yield associated with the implementation of the ecological reserve and possible impacts of climate change.

3.13 Scenario 11: The IWR Curve formed the Basis for this Analysis. CCT WC/WDM Strategy and Programme Implemented. Thereafter Selection based on URV (Scenario 7)

Objective: To determine how the LWR Curve and the least URV selection criteria could impact on the selection of interventions

Scenario 11 is similar to Scenario 7 with the exception that the LWR Curve was used. The LWR Curve assumes low economic growth and low population growth parameters. With the LWR in place, and assuming that the CCT successfully implements its WC/WDM strategy and programme, requirement would only exceed available supply in 2024, thereafter additional WC/WDM interventions could be implemented. The first supply-side scheme to be implemented, based on lowest URV, was assumed to be the Michell's Pass Diversion Scheme, which would need to be implemented by 2025.

Table 3.13 and Figure 3.20 below indicate the interventions which make up Scenario 11. Figure 3.21 shows the annual cash flow implication.

Table 3.13 LWR Curve with the CCT WC/WDM strategy and lowest URV intervention

No	Intervention	Year of First Water or Saving	Yield million m^3/a	Total Lead Time	Study Start Date	Fast-tracked	Time to Full Yield/Saving
1	CCT WC/WDM Strategy and Programme	2007	44.8	1	2006		8
2	WC/WDM: Adjustment of water tariffs, metering and credit control	2024	20.0	4	2020		4
3	Michell's Pass Diversion ($4m^3/s$)	2025	35.7	13.5	2011.5		1
4	A WC/WDM: Eliminate auto-flush urinals	2029	4.2	3.5	2025.5		1

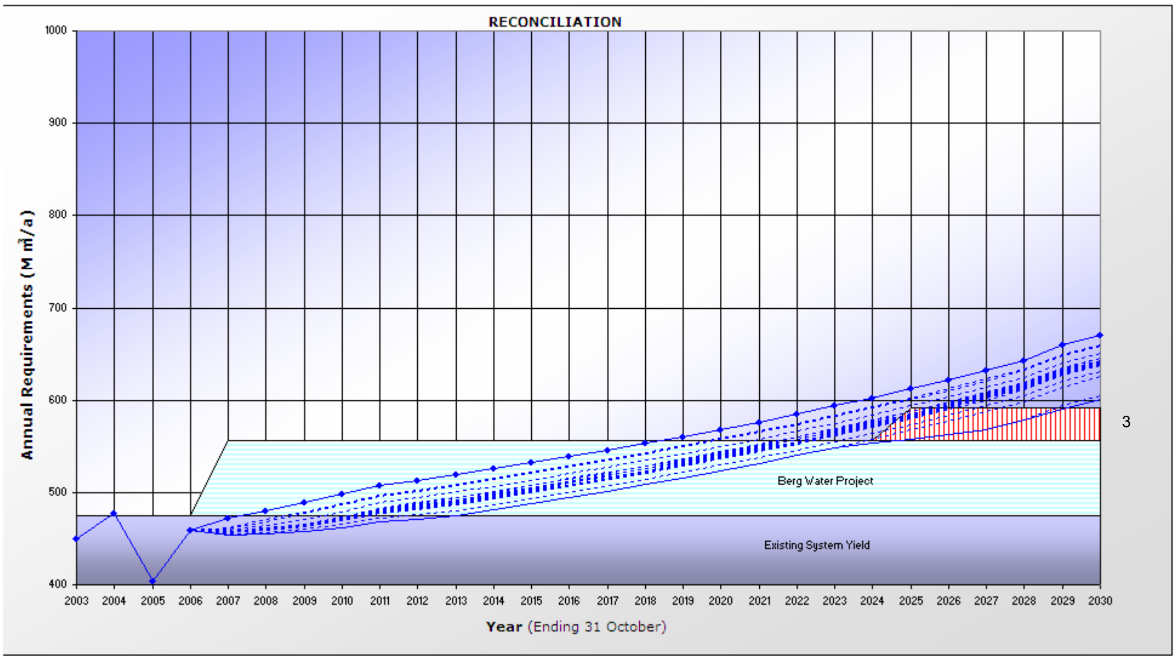


Figure 3.20 Scenario 11: LWR Curve with the CCT WC/WDM strategy and lowest URV intervention

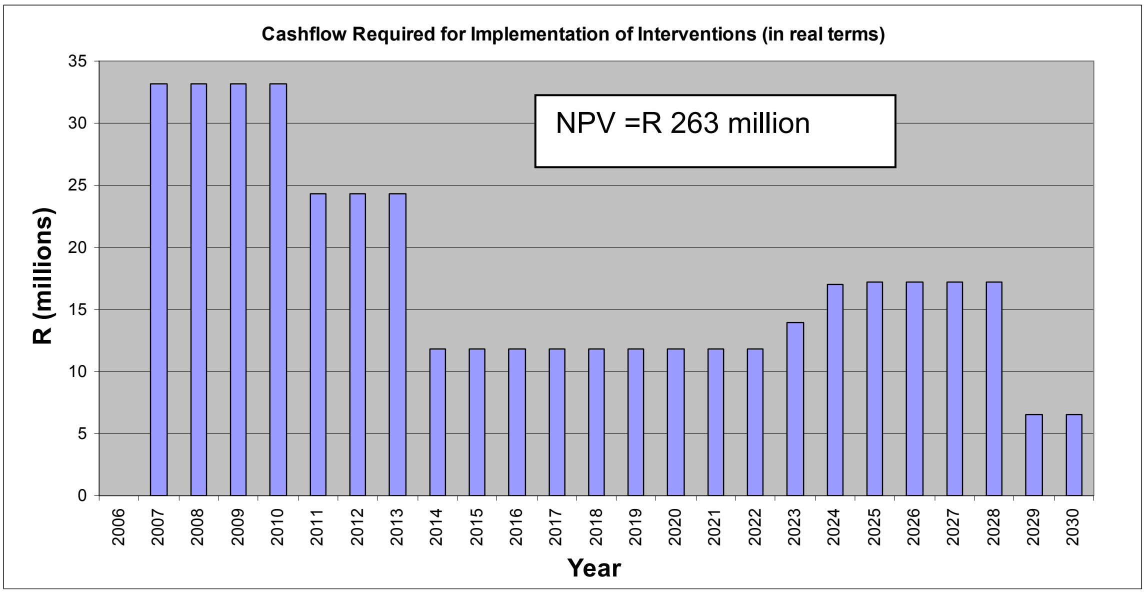


Figure 3.21 Scenario 11: Annual cash-flow requirement

The NPV for Scenario 11 is only R263 million. The low NPV (due to the LWR Curve) resulted in the demand, until 2029, being met by the implementation of two WC/WDM interventions and only one supply-side intervention.

4. CONCLUSIONS

The key findings from the analysis of scenarios evaluated are listed in Table 20. The findings lead to the following overall conclusions.

1) Successful implementation of the CCT's 8-year WC/WDM strategy and programme (assuming that the HWR Curve is followed) will delay the implementation of a new water resource until 2015.
2) It is imperative that additional longer-term WC/WDM interventions (beyond the CCT's 8-year programme) should be implemented, as the long lead time required to implement a supply-side intervention precludes the selection of a supply-side intervention prior to 2014.
3) Successful implementation of the CCT's 8-year WC/WDM strategy and programme as well as additional WC/WDM interventions, will delay additional water resource development until 2019.
4) Should the CCT not implement its 8-year WC/WDM strategy and programme, and assuming that the HWR Curve is followed, then supply will exceed demand in 2011 and the City will face an increased possibility of having to impose water restrictions on its consumers. Under these circumstances, the TMG Aquifer Scheme and/or other supply-side interventions will have to be "fast tracked" in order to reduce the implementation lead times.
5) If CCT successfully implements its WC/WDM strategy and programme and thereafter only considers supply-side interventions, the first supply-side interventions which could be implemented, due to lead time constraints, are groundwater interventions. If a surface water intervention were to be implemented, additional longer-term WC/WDM interventions would have to be implemented, after the implementation of the CCT's WC/WDM strategy and programme.
6) A number of WC/WDM interventions and supply-side interventions should be considered for further studies for the following reasons:

   - Additional longer-term WC/WDM interventions were based on the Integrated Water Resource Planning Study, which was completed in 2001. This information needs to be reviewed and new yields and costs should be developed.
   - The current supply-side intervention studies have a disparate level of estimated information regarding yields, costs and ecological impacts. It is important to compare interventions on the same level of information.
   - It is important to conduct a number of studies at pre-feasibility level and feasibility level (including EIAs) as these feasibility studies may show that one or more of the preferred interventions are no longer available for implementation.
   - It is important to study a mix of supply-side interventions (namely, surface water, groundwater, effluent re-use and desalination) as the potential impact of the changing weather patterns (climate change) is unknown and the authorities may decide to implement certain initiatives which are not dependent on rainfall.
   - The impact of implementing the ecological Reserve on the yields of the existing water resources has not been studied in detail. However, the implementation of the ecological Reserve will require that more supply-side interventions be implemented, in order to offset the deficit in yield, which would be incurred when the ecological Reserve is implemented.
   - Should the actual water demand be lower than projected, the responsible authorities may decide to implement an intervention that has a lower URV and longer implementation lead time, in preference to an intervention that has a higher URV and a shorter intervention lead time.

7) Given the uncertainty surrounding future water requirements, the impact of implementing the ecological Reserve, the impact of climate change and the success in achieving WC/WDM objectives (as modelled in the scenarios), it is proposed that more interventions be studied than are necessarily required for reconciliation. These interventions are shown in Table 4.1. The selection of studies was based on the outcome of analysing the interventions required to support Scenarios 7 to 11. The selection of interventions for further study does not support one particular "ideal scenario" but considers what interventions should be studied (at feasibility and pre-feasibility level)

so as to support a range of different scenarios. This approach will provide decision makers with the right information, at the correct level, so that they can make an informed decision on the most appropriate intervention to implement after the BWP, and beyond.

Table 4.1 Summary of Intervention Study start dates

INTERVENTION	REQUIRED STUDY START DATE FOR SCENARIOS							Earliest Date	Comments
	7	8	9	10(a)	10(b)	10(c)	11		
CCT WC/WDM strategy and programme	2007	2007	2007	2007	2007	2007	2007	2007	
WC/DM: Adjustment of water tariffs, metering and credit control	2011	2011	2009			2009	2020	2007	
WC/DM: Eliminate auto-flush urinals	2011	2011	2009			2009	2025	2007	
WC/DM: Promotion of private boreholes & wells	2015	2015	2012			2012		2007	
WC/DM: Leakage detection and repair	2007	2007	2007			2007		2007	
WC/DM: Use of Water Efficient Fittings	2018	2016	2016			2012		2007	
WC/DM: User Education	2025	2023	2022			2014		2007	
Voëlvlei Phase 1	2007	2007	2007	**2007**	**2007**	2007	2011	2007	Reduced lead time
Michell's Pass Diversion	2007	2007	2007	**2007**	**2007**	2007	2011	2007	Reduced lead time
Newlands Aquifer	2008	2008	2007					2007	
Cape Flats Aquifer	2015	2010	2009					2009	
West Coast Aquifers	2016	2013	2013					2013	
24 Rivers Dam	2014	2012	2012					2012	
"Fast tracked" TMG Scheme 1 (20 million m^3)				**2008**	**2007**			2007	Reduced lead time
"Fast tracked" TMG Scheme 2 (50 million m^3)				2013	**2009**			2009	Reduced lead time
"Fast tracked" TMG Scheme 3 (70 million m^3)									
TMG Scheme 1 (20 million m^3)	2018	2016	2015			2007		2015	
TMG Scheme 2 (50 million m^3)	2014	2012	2011			2007		2011	
TMG Scheme 3 (70 million m^3) See Notes	2010	2007	2007					2007	Continue with CCT TMG Study
Upper Wit River Diversion	2007	2007	2009					2007	
Raising Steenbras Lower Dam		2012	2011	**2009**	**2007**	**2008**		2007	Reduced lead time
Lourens River Diversion		2019	2018	2011	2007	2010		2007	
Upper Molenaars Diversion					2007	2008		2007	
Re-use irrigation/industrial	2013	2010	2009	2010	**2007**	2007		2007	Reduced lead time
Dual Reticulation									
Commercial Irrigation Exchange									
Treated Effluent to Potable Standards					2007	2010		2007	
Removal of Invasive Alien Plants									Ongoing
Desalination					2011			2011	

Date Indicates a "fast tracked" or reduced implementation time

Date Indicates studies required in 2007

Notes:
1) Voëlvlei Phase 1 and Michells Pass utilise the same infrastructure
2) If intervention with reduced lead time gave a study start date after 2007, it was made 2007
3) If study start date was 2006.5 or 2006 it was made 2007, otherwise study start dates were rounded down
4) Where TMG Scheme (not fast tracked) gives 2007 study start date, this implies that the CCT Feasibility Study and Pilot Project should continue in 2007

8) For additional longer-term WC/WDM interventions, notwithstanding the study start dates given in Table, it is recommended that, owing to the uncertainty with the existing base data, that all WC/WDM interventions are studied at feasibility level. It is important to commence with the WC/WDM intervention studies in 2007, as the implementation and success of WC/WDM has a significant impact on the study start dates and implementation dates of the supply-side interventions.

9) The CCT should proceed with the TMG Aquifer feasibility study and pilot project, as the TMG Aquifer has been identified as a potentially significant water source for future development. There is the option to study the TMG Aquifer Scheme in parallel to the CCT’s feasibility study and pilot project. The CCT has expressed concern regarding this approach, as the purpose of the pilot project is an incremental learning approach aimed at gaining a better understanding of the aquifer and the associated potential environmental impact, prior to investing in production wellfields. By "fast tracking" the TMG Aquifer Scheme one could reduce the implementation time by approximately 4 to 5 years. Due to the sensitivity of "fast tracking" the TMG Aquifer Scheme, it is proposed that additional WC/WDM interventions rather be "fast-tracked."

10) The CCT should proceed with the implementation of a pilot desalination plant in order to learn lessons for ultimate large-scale desalination, understand the pre- and post-treatment processes, and obtain a better understanding of the actual operating and capital costs associated with desalination, as well as the environmental impact.

11) Due to the significance of the impact of climate change on the reconciliation of water supply and requirement, it is proposed that the DWAF initiate a pre-feasibility study to determine the impacts more accurately.

12) A number of potential interventions have been identified as possible future interventions, but the confidence in the data available for these interventions, in terms of yield and cost, is lower than that for other interventions. It is therefore proposed that these interventions be studied at reconnaissance level, so that a more accurate comparative evaluation can be made in the future.

13) Both the Voëlvlei Phase 1 Scheme and the Michell's Pass Diversion Scheme make use of the full capacity of the CCT's Voëlvlei pipeline. This pipeline is a pre-stressed concrete pipeline and is known to be susceptible to bursts. The pipeline is currently operated below its conveyance capacity for the following reasons:

    (a) the water quality within Voëlvlei Dam has deteriorated and the current water treatment process cannot cope with the poor water quality
    (b) concern regarding stressing the Voëlvlei pipeline unnecessarily.

It is imperative that the capacity of this pipeline be assessed by the CCT as soon as possible, as the condition of this pipeline may impact on the viability of implementing either the Voëlvlei Phase 1 Scheme or the Michell's Pass Diversion Scheme. The cost implications of other supply-side interventions should also be assessed, such as utilising an additional pipeline from Voëlvlei to the CCT.

Table 4.2 Key findings from scenario evaluations

Scenario	Description	Key Findings
Scenario 1	No WC/WDM. All supply-side interventions can be implemented.	• Supply-side intervention required by 2011 (after the BWP). • Due to long lead times earliest supply-side intervention could only be implemented by 2014. • To achieve this date the TMG Aquifer scheme would have to be "fast tracked."” • Shortfall in supply between 2011 and 2013.
Scenario 2	CCT WC/WDM strategy and programme implemented. All supply-side-side interventions can be implemented.	• Supply-side intervention required by 2015 (after the BWP). • Implementation of CCT's WDM strategy and programme allows supply-side interventions to be implemented without "fast tracking" or reducing implementation lead times.
Scenario 3	CCT WC/WDM strategy and programme implemented as well as additional WC/WDM interventions. All supply-side interventions can be implemented.	• Implementation of CCT's WC/WDM Strategy and Programme, as well as additional WC/WDM initiatives allows the next supply-side intervention to be delayed until 2019 with no restriction on implementation lead time. • Comprehensive WC/WDM (100% successful implementation) can effect a saving of approx 100 million m^3 of water per annum by 2019. • 50% successful implementation of all WC/WDM interventions will delay next intervention till approx 2014. • LWR Curve and 100% successful WC/WDM will delay the need for supply-side intervention till 2029. • No restriction on implementation lead times.
Scenario 4	CCT WC/WDM strategy and programme implemented. Only groundwater interventions can be implemented.	• Supply-side intervention required by 2015 (after the BWP). • Cape Flats Aquifer, Newlands Aquifer and West Coast Aquifers will be implemented by 2015, without reducing lead time. • Thereafter the TMG Aquifer scheme could be implemented without having to be "fast tracked." • Should one of the Cape Flats Aquifer, Newlands Aquifer or the West Coast Aquifers not be implemented, or should the aquifers have a yield less than anticipated, it would be a requirement to "fast track" the implementation of the TMG Aquifer.
Scenario 5(a)	CCT WC/WDM strategy and programme implemented. Only effluent re-use interventions can be implemented.	• Treated effluent re-use schemes (not to potable standards) could be implemented to meet the increasing water demand until 2018. • Thereafter, there would be a potential shortfall in supply-side for one year, prior to a treated effluent re-use intervention to potable standards being commissioned.

Scenario	Description	Key Findings
Scenario 5(b)	CCT WC/WDM strategy and programme implemented. Only fast tracked effluent re-use interventions implemented.	• In order to achieve a water balance, a treated effluent re-use scheme to potable standards would be required by 2018, to achieve this, the intervention would need to be fast-tracked (reduced lead-times). • Effluent re-use needs a comprehensive study to conceptualise schemes, determine full potential and study the health risk and social acceptability.
Scenario 6	CCT WC/WDM strategy and programme implemented. Only desalination implemented.	• Shortfall in supply-side from 2013 to 2016, prior to a desalination plant being commissioned. • Implementation lead time would have to be reduced to implement a desalination plant by 2016. • Effluent re-use to potable standards is more cost effective, but has potential social impacts. • Based on the implementation timeframes of the Perth desalination plant, it may be possible to "fast track" implementation of a desalination plant by 2013. • Net present value of this option is R11 491 million.
Scenario 7	CCT WC/WDM strategy and programme implemented. Thereafter selection of interventions based on URV (both WC/WDM and supply-side interventions).	• A mix of supply-side and WC/WDM interventions are available for selection in order to offset the anticipated shortfall in supply in 2015. • No restriction on implementation lead times. • Net present value of this option is R1 092 million.
Scenario 8	CCT WC/WDM strategy and programme implemented. Thereafter selection based on URV (Scenario 7) with the ecological reserve being phased-in for existing water resources.	• The yield of the existing water resources decreased by approx. 46 million m^3. • A mix of supply-side and WC/WDM interventions are available for selection in order to offset the anticipated shortfall in supply in 2015 and beyond. • No restriction on implementation lead times. • Net present value of this option is R1 263 million. The cost of implementing additional interventions in order to offset the anticipated decrease in system yield is approximately R171 million in today's terms.
Scenario 9	CCT WC/WDM strategy and programme implemented. Thereafter selection based on URV (Scenario 7) with the potential for climate change being factored in.	• The yield from the existing water resources and future water sources was assumed to be reduced by approx. 107 million m^3 in 2030. • A mix of WC/WDM interventions and supply-side interventions are available for selection in order to offset the anticipated shortfall in supply in 2013 and beyond. • No restriction on implementation lead times. • Net present value of this option is R1 576 million. The cost of implementing additional interventions in order to offset the anticipated reduction in system yield is approximately R474 million.

Scenario	Description	Key Findings
Scenario 10(a)	CCT WC/WDM strategy and programme implemented (50% of total potential for WC/WDM). Thereafter selection based on a conservative selection of interventions.	• It would be required to "fast track" the TMG Aquifer Scheme and also to reduce the implementation lead time for other supply-side interventions, in order to be able to reconcile supply and requirement until 2030. • It would be important to ensure that the implementation of WC/WDM is successful in order to avoid "fast tracking" the implementation of supply-side interventions. • The net present value of this option is R1 841 million. This is in comparison to a NPV of R 749 million for Scenario 7 which was based on least cost selection and not a selection based on considerations of practicality and sustainability.
Scenario 10(b)	CCT WC/WDM budget strategy and programme implemented. Thereafter selection based on a conservative selection of interventions including potential impacts of ecological Reserve and climate change	• It would be required to “fast track” the TMG Aquifer Scheme and also to reduce the implementation lead time for other supply-side interventions, in order to be able to reconcile supply and requirement until 2030. • The net present value of this option is R4 473 million. This is in comparison to a NPV of R1 841 for Scenario 10 (a). The cost of implementing additional interventions in order to offset the anticipated reduction in system yield as a result of implementing the ecological Reserve and the potential impact of climate change is approximately R2 632 million.
Scenario 10(c)	All WC/WDM interventions implemented (as per Scenario 7). Thereafter, selection based on a conservative selection of interventions, including potential impacts of ecological Reserve and climate change	• Implementation of supply-side interventions is delayed by 3 years. • By implementing additional WC/WDM interventions in this Scenario, the NPV Value over the period 2007 to 2029 was reduced to R2 714. This represents a reduction in NPV of R1 759 million compared with Scenario 10(b). • The implementation of desalination was postponed by 3 years when compared to Scenario 10 (b).
Scenario 11	The LWR Curve formed the basis of this analysis. CCT WC/WDM strategy and programme implemented. Thereafter selection based on URV (Scenario 7)	• If the LWR Curve is assumed, then the implementation date of the next intervention after the implementation of the CCT's WC/WDM strategy would be 2024. • Because of the uncertainty regarding requirement projections, following water restrictions, the conservative approach is to utilise the HWR Curve for planning of future studies. • The NPV Value of this option is R263 million.

5. RECOMMENDATIONS

The following recommendations are made based on the conclusions and findings of the scenarios that were evaluated.

In order to ensure the reconciliation of water supply and requirement within the WCWSS, it is recommended that:

1) A Strategy Steering Committee should be formed in order to make recommendations, on an annual basis, on long term planning activities required to ensure reconciliation of requirement and available supply in the WCWSS area.
2) The CCT's 8-year WC/WDM strategy and programme should be implemented in order to ensure that no shortage of supply exists prior to the implementation of the next intervention.
3) The CCT should initiate a feasibility study to determine the potential of additional longer term WC/WDM interventions to be implemented beyond the existing eight year strategy. Table 5.1 contains a summary of the intervention study start dates and identifies the responsible organisations for initiating the studies.

Table 5.1 Summary WC/WDM intervention study start dates

Intervention	Date Study Required	Study Level Required	Responsibility
CCT 8-year WC/WDM Strategy and Programme	2007	To be implemented	CCT
LONGER TERM WC/WDM INTERVENTIONS			
WC/DM: Adjustment of water tariffs, metering and credit control	2007	Feasibility (yields to be updated)	CCT
WC/DM: Eliminate auto-flush urinals	2007	Feasibility (yields to be updated)	CCT
WC/DM: Leakage detection and repair	2007	Feasibility (yields to be updated)	CCT
WC/DM: Promotion of private boreholes and wells	2007	Feasibility (yields to be updated)	CCT
WC/DM: Use of water efficient fittings	2007	Feasibility (yields to be updated)	CCT
WC/DM: User education	2007	Feasibility (yields to be updated)	CCT

4) Studies at an appropriate level of detail should be carried out for all the supply-side interventions listed in Table 5.2, in order to ensure the reconciliation of water supply and requirement.
5) The CCT should proceed with the TMG Aquifer feasibility study and pilot project, as the TMG Aquifer has been identified as a potentially significant water source for future development.
6) The CCT should proceed with the implementation of a pilot sea water desalination plant in order to learn lessons for the implementation of large-scale desalination. It is important to understand the pre- and post-treatment processes, obtain a better understanding of the actual operating and capital costs associated with desalination, as well as any potential environmental impacts. The CCT should also monitor sea water quality along the Western Cape Coastline in order to develop a database of the varying sea water qualities.
7) The CCT and all other WSAs in the WCWSS should develop integrated effluent re-use policies for their areas of jurisdiction and also initiate feasibility studies to determine the full future potential for effluent re-use in their respective areas. There should be close collaboration and integration between all the WSAs in this regard where appropriate. This would include the conceptual design of various effluent re-use interventions, and a comprehensive EIA.
8) The DWAF should initiate an integrated WCWSS effluent re-use study, which would include interventions such as the exchange of Berg River irrigation water.
9) The Strategy Steering Committee should monitor the progress of the CCT's TMG Aquifer Feasibility Study and Pilot Project and after considering the outcomes, takes a decision regarding further feasibility studies on the TMG Aquifer Scheme.

Table 5.2 Summary of supply intervention study start dates

Intervention	Date Study to Start	Study Level Required	Responsibility
EXISTING FEASIBILITY STUDIES			
TMG Aquifer Feasibility Study	Ongoing	Feasibility	CCT
Pilot Desalination Plant	Ongoing	Feasibility	CCT
TMG Regional Monitoring	Ongoing	Monitoring	DWAF
Invasive Alien Plant Clearance	Ongoing	Ongoing	DWAF
PLANNED FUTURE STUDIES			
Voëlvlei Phase 1 (Note 1)	2007	Update feasibility	DWAF
Michell's Pass Diversion	2007	Pre-feasibility/Feasibility (Note 2)	DWAF
Newlands Aquifer	2007	Pre-feasibility	CCT
Cape Flats Aquifer	2007	Feasibility	CCT
West Coast Aquifer Recharge (Langebaan)	2007	Pre feasibility	DWAF
Upper Wit River Diversion	2007	Pre-feasibility	DWAF
Raising Steenbras Lower Dam (including pre-feasibility of Upper Campanula Dam)	2007	Pre-feasibility	DWAF/CCT
Lourens River Diversion Scheme	2007	Update Pre-feasibility (as linked to Raising Steenbras Lower)	CCT/DWAF
Upper Molenaars Diversion	2007	Pre-feasibility	DWAF
Effluent Re-use (policy, effluent treated to potable standards, effluent treated for irrigation/industry)	2007	Pre-feasibility	CCT and all WSAs
WCWSS Effluent Treatment Re-use Study	2007	Pre-feasibility	DWAF

Notes :
1. This would include a pre-feasibility study of the Voëlvlei Phase 2 Scheme.
2. Michell's Pass Diversion may have to be carried out at Feasibility in order to make a comparison with Voëlvlei Phase 1.

10) All interventions where very little data exists (specifically in terms of yield and cost) should be studied at reconnaissance level, so that a comparative evaluation can be made in the future. These interventions are listed in Table 5.3.
11) A study should be undertaken by the DWAF to investigate and assess the implications and costs of implementing the Ecological Reserve on existing water resources schemes.
12) The capacity of the Voëlvlei pipeline should urgently be assessed by the CCT, as the condition of this pipeline may impact on the viability of implementing either the Voëlvlei Phase 1 Scheme or the Michell's Pass Diversion Scheme. The cost implications on other supply-side interventions, utilising an additional pipeline from Voëlvlei to the CCT should be assessed.
13) Owing to the potential impact of climate change on the reconciliation of water supply and requirement, the DWAF should initiate an impact assessment study in this regard.
14) The Scenario Planning process should be updated on a regular basis to cater for:
    - Revised future water requirement projections.
    - Updated information on the implementation of the ecological Reserve and the potential for climate change.
    - Updated information from recently completed studies (reconnaissance level, pre-feasibility level and feasibility level) for WC/WDM and supply-side interventions.
    - Any other change to the input data.
    - Revision to the CCT's 8-year WC/WDM strategy.

Table 5.3 Summary of intervention where insufficient information is available

Intervention	Timing	Responsibility
Groundwater		
Conjunctive use	To be determined by Strategy Steering Committee	DWAF
Artificial Recharge (ASR)	To be determined by Strategy Steering Committee	DWAF
Artificial Recharge: Breede River Alluvium	To be determined by Strategy Steering Committee	DWAF
Maximise existing infrastructure		
Steenbras Pumped Storage Scheme Intake	2007	CCT
Possible additional off- channel raw water storage at Misverstand Dam	To be determined by Strategy Steering Committee	DWAF
Maximise WCWSS yield		
Operation of Kleinplaas Dam	2007	CCT
Improve Operation of Atlantis Aquifer (See Note 1)	2007	CCT
Other		
Implications of implementing Ecological Reserve on existing water resources	To be determined by Strategy Steering Committee	DWAF
Water Trading	As soon as possible	All WSAs
Non-Flow Related Interventions	To be determined by Strategy Steering Committee	DWAF
Integrated Catchment Management	To be determined by Strategy Steering Committee	DWAF
Integrated WSWSS Re-use Study (incl. Berg River Water exchange)	2007	DWAF
Note 1: Improved management and operation of the Atlantis Aquifer will reduce the reliance placed on Voëlvlei Dam		

15) The Strategy Steering Committee must ensure that the following monitoring is undertaken in order to be able to ensure the reconciliation of water supply and requirement over the longer term:

- The success of the WC/WDM interventions implemented. This is of particular importance as the volume and implementation date of anticipated water-saving interventions have a significant impact on future supply intervention study start and scheme implementation dates.
- Actual water use (agricultural and urban)
- Population growth and economic growth rate figures in order to be able to develop a better understanding of future water requirements
- Hydrological and geo-hydrological monitoring
- Water quality monitoring

APPENDIX A
Interventions screened out at the Selection of Interventions Workshop

The following 19 options were screened out at the Screening of Interventions Workshop and were not considered for further investigation during the WCRSS.

INTERVENTIONS	REASON FOR SCREENING OUT
A2 Irrigation Practices In the Berg and Breede WMAs most on-farm irrigation technologies are modern and sophisticated, leaving little room for improvement.	• This option is useful for farmers to be more efficient in their irrigation practices and for on-farm expansions and future development of agriculture but would not provide additional water to the WCWSS because farmers are allowed to use the additional water saved, through more efficient use, for the expansion of their activities.
A4 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%.	• Likely to be prohibitively expensive for farmers. • Water will be utilised on farms and not be available to the WCWSS
A5 Crop Selection Crop type is the major influence on the quantity of water required for irrigation. Planting low-value "thirsty" crops in a water-stressed area should be avoided. The potential water savings from alternative crop types needs to be weighed up against the potential income from that crop type.	• Different root stocks and not crop selection plays a role in water demand. • The opportunity to change root stocks is dependent on where the agriculture is located (wet or dry region), and by economic trends and demands. • There were localised opportunities for changing crops but any water made available through this intervention will be utilised on farms and would not be available to the WCWSS.
A6 Deficit Irrigation A technique used to induce controlled water stress by periodically irrigating at less than the full irrigation demand of the crop. Successful implementation is reliant on careful monitoring of soil moisture content, pruning and fertilising.	• Farmers are currently irrigating on the lean side of optimum water requirements for many crops, reducing the opportunity to implement this intervention. • Would result in increased operating and management costs to farmers • Water reductions would result in large decreases in productivity • Water saved through this reduction method was unlikely to be returned to the river but would be utilised for crop expansion.
E10 Rainwater Tanks This is an augmentation option entailing collection of rainwater from roofs, primarily for toilet flushing and garden watering	• Not feasible for garden watering in the Western Cape summer due to the amount of storage required. • Recent reduction in cost of rainwater tanks makes this option more affordable but still has a low yield and high URV and would only be appropriate for certain income groups • It is not an appropriate option to provide increased yield for the WCWSS • Implementation is largely driven by the property owner and should be encouraged for use by private home owners.
G2b Upper Campanula Dam and supplement Includes a weir just upstream at the Palmiet Estuary. Transfer from the weir via a tunnel into Upper Campanula Dam and then into a raised Lower Steenbras Dam, via Kogelberg/Rockview dams**.**	• In middle of the Kogelberg Biosphere Reserve with visual impacts and economic impacts • Activities would include removal of tunnel spoil, access and blasting activities. • Weir and dam will impact on indigenous fish species.

INTERVENTIONS	REASON FOR SCREENING OUT
G9 Watervals River Dam The dam would be located in the catchment adjacent to Voëlvlei Dam. A 14 m high rockfill dam (12 Mm^3 capacity) would feed water via a tunnel into the Voëlvlei Dam.	• Once the Reserve is implemented it is likely that the yield will reduce significantly. • 160 ha of land would be inundated, including pristine mountain fynbos and high altitude seeps. • The tunnel transfer would cross areas of pristine mountain fynbos and renosterbos.
G15 Raising Theewaterskloof Dam Benefit would be additional system storage and only viable in conjunction with an intervention to supply water to Theewaterskloof Dam (G15 Brandvlei to Theewaterskloof Transfer).	• Significant social and economic impact on riparian property owners and inundation of high value fruit crops and low-lying deciduous growing fruit farms. • There is little yield benefit from runoff from its own catchment and high evaporation is an issue.
G17 Upper Wit River Dam Site is 5 km upstream of Bain's Kloof Village and entails a 32 m high rockfill dam with a 650 m crest length. Only winter water would be stored and conveyed to Paarl via a 17,5 km steel pipeline.	• There is likely to be significant social and environmental objections and economic concern regarding this intervention • Inundation of 72 ha of pristine fynbos and displacement of mammals and reptiles. • Dam would act as barrier to indigenous fish, eels and may result in introduction of black bass • Inundation of existing hiking trails and significant impact on sense of place.
G19 Olifants River Diversion A 5 m high weir on the upper Olifants River (Keerom site). Tunnel (34 m^3/s capacity) into the Berg WMA and new canal linking to existing Twenty-four Rivers canal, and thence to Voëlvlei Dam. Transfer of 120 Mm^3/a of winter water. A second pipeline to Cape Town required plus raising of Voëlvlei Dam and new WWTW.	• The area is already water stressed and this intervention is likely to meet significant social and ecological objections • Inundation of Olifants River gorge and weir impact on migration of endemic fish. • Canal construction impact on existing farmers.
G20 Dam on the Kuils River	• No suitable dam site. • Much of the flow is treated effluent return flow and could be further treated for re-use and would not require a dam on the Kuils River.
G21 Dredging of existing dams	• Silt loading in the Western Cape rivers is not significant. • Dredging may be an option in decades to come but not viable within the next 50 years. • Deepening of dam basins would be expensive - nature of the excavation and required modifications to dam outlet structures. • What to do with dredged material.
G22 Raised Nuweberg Dam – Palmiet River The dam forms part of the Eikenhof system.	• Eikenhof Dam was raised in 1999 and was considered the most cost effective option for that system. • Raising Nuweberg Dam would offer little benefit due to the small dam basin • Significant relocation of the existing road would be required.
I1 Water transfers from the Congo River Importation by sea-faring tankers (fleet of 9 super tankers each with 280 000 m^3 capacity), towing inflatable bladders, or an undersea pipeline (12m dia plastic conduit from the Congo River mouth to Cape Town).	• Additional off-shore loading point required as Table Bay Harbour too small. • Payments to the Democratic Republic of Congo (DRC) could further increase the URV. • Sea conditions along the West Coast of Africa are likely to be problematic for towing, and for loading and unloading.

INTERVENTIONS	REASON FOR SCREENING OUT
	• Undersea pipeline is untested technology and would be subjected to marine hazards. • Use of international waters and associated political uncertainty.
I2 Water transfers from the Orange River A pipeline route to Cape Town would need to be about 600 km long and following either the N7 or along the coast.	• Water from the Orange River is close to being fully allocated already. • High URV. • Pipeline route may have to be through a restricted coastal area.
I3 Towing of icebergs Involves capturing and towing icebergs from Antarctic. Processing plant to extract the water would lie in deep water as the continental shelf would prohibit closer towing. Conveyance to mainland either via smaller vessels or undersea pipeline.	• Implementation challenges include preventing melting en route and harvesting the water in a manageable way, • Uncertain environmental impacts. • This is unproven technology.
I6 Rainfall, mist and dew harvesting	• Low yield • High URV
I7 Utilisation of urban storm water	• High URV • Potential health risks
I8 Cloud seeding	• Not considered as a viable option in the Western Cape due to unsuitable cloud types.

APPENDIX B:
Starter document for Selection of Intervention Workshop

(Please see separate volume)

APPENDIX C:
Summary of Interventions Considered in the Scenario Process

OPTION	DESCRIPTION
A: Agricultural Water Conservation and Demand Management (1)	
A1 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 Mm^3/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.
D: Re-use of Treated Effluent (7)	
D1 Treated for Local Irrigation/ 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	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 45 km pipeline and 0,5 Mm^3 balancing dam near Stellenboschberg Tunnel Outlet would be required.
D3a Treated for Potable Use Option 1	Entails the use of wastewater treated to potable standards for year-round use with a yield of 60.1 Mm^3/a. Further treatment than conventionally would be undertaken with a 1:4 blending ratio (4 parts treated fresh water to one part treated wastewater). Cape Flats, Michell's Plain, Zandvliet and Macassar WWTW are proposed with treatment/blending at Faure WWTW.
D3a Treated for Potable Use Option 2	As above but with a yield of 41.2 Mm^3/a.
D3a Treated for Potable Use Option 3	As above but with a yield of 21.9 Mm^3/a.
D4 Dual Reticulation Networks	Entails conveyance of treated effluent via a separate network to domestic users for gardening and toilet-flushing purposes. This option must be considered conjunctively with other WC/WDM initiatives which target the same users (private boreholes, grey water, rain tanks, etc.).
D5 Re-use Berg River Exchange	Entails conveyance of treated effluent back to the Berg River for possible exchange with ecological Reserve or agricultural demand.
E: Urban Water Conservation and Demand Management (9)	
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 Mm^3/a.
E3 Domestic Leakage Repair (Low Income Households)	Repair of domestic plumbing leaks (toilets, taps, etc.). The target area is lower-income households who are unable to afford regular maintenance and repair.

OPTION	DESCRIPTION
E4 Pressure Management	During periods of low requirement (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 replacing automatic-flush urinals (AFUs) with user-activated or waterless urinals. Opportunity within public office buildings, railway stations, schools, private hotels, bars and restaurants. Malfunctioning AFUs 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 increased 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 8 m deep) or boreholes (deeper than 8 m). Wellpoints have lower yields but are cheaper to install.
F: Groundwater Development Options (12)	
F1 TMG Aquifer Scheme 1 (1 year into CCT pilot monitoring)	Pilot phase development of 13 production boreholes and several monitoring boreholes with a yield of 20 Mm^3/a.
F1a TMG Aquifer Scheme 1 (after CCT exploratory phase)	Pilot phase development of 13 production boreholes and several monitoring boreholes with a yield of 20 Mm^3/a. This intervention would be fast tracked to allow implementation after the CCT exploratory phase.
F2 TMG Aquifer Scheme 2 (1 year into CCT pilot monitoring)	Pilot phase development of 13 production boreholes and several monitoring boreholes with a yield of 50 Mm^3/a.
F2a TMG Aquifer Scheme 2 (after CCT exploratory phase)	Pilot phase development of 13 production boreholes and several monitoring boreholes with a yield of 50 Mm^3/a. This intervention would be fast tracked to allow implementation after the CCT exploratory phase.
F3 TMG Aquifer Scheme 3 (1 year into CCT pilot monitoring)	Pilot phase development of 13 production boreholes and several monitoring boreholes with a yield of 70 Mm^3/a.
F3a TMG Aquifer Scheme 3 (after CCT exploratory phase)	Pilot phase development of 13 production boreholes and several monitoring boreholes with a yield of 70 Mm^3/a. This intervention would be fast tracked to allow implementation after the CCT exploratory phase.

OPTION	DESCRIPTION
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 Michell's Plain, sufficiently far away from existing WWTWs 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 Mm^3/a.
F7 Conjunctive Use	The scheme involves injecting surplus winter surface water into aquifers 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.
F8 Aquifer Storage Recovery	This entails injecting surplus winter water into an aquifer for abstraction when needed.
F9 Breede River Alluvium	This option offers the opportunity to utilise the storage capacity of the alluvium during the winter months, to pump water into Brandvlei Dam over a more extended period. This would be used to replace yield that would be lost if other interventions were implemented on the upper Breede.
G: Surface Water Development Options (17)	
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.
G2 Upper Campanula Dam	Alternative 1 – Construction of a 50 Mm^3 dam on the lower Palmiet River, and a pipeline and canal to the existing Kogelberg Dam. Water transferred to a raised Lower Steenbras Dam via the existing Palmiet Pumped Storage Scheme.
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 m^3 capacity) weir on the Eerste River, with pumping into a new off-channel balancing dam and on to the Faure WWTW. A bypass pipeline would be required from Stellenbosch due to water quality concerns.
G5 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 WWTW. Treatment would be for direct delivery to CCT or alternatively, pre-treatment for storing water in Voëlvlei Dam. The scheme would optimise spare capacity in the existing WWTW and in the pipeline to CCT (total 20 million m^3/a). Balance to supply other users reliant on Voëlvlei Dam.
G6a 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 Mm^3 capacity) weir on the Berg River and a rising main to the Voëlvlei Dam, with a diversion capacity of 20 m^3/s.

OPTION	DESCRIPTION
G6b Voëlvlei Augmentation : Phases 2 and 3 (include pipeline)	As above but includes a 1,5 m diameter steel pipeline to CCT.
G7 New dam at Misverstand	This option involves the construction of a 27 m high dam (280 Mm^3 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.
G10 Upper Molenaars Diversion	Involves the construction of a pumping sump in the Molenaars River. Winter flows would be pumped at 5 m^3/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.
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.
G13a 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. With a diversion capacity of 4 m^3/s.
G13b Michell's Pass Diversion	As above but with a diversion capacity of 8 m^3/s.
G13c Michell's Pass Diversion	As above but with a diversion capacity of 8 m^3/s and a pipeline to CCT.
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.
G16 Lower Wit River Dam	This scheme entails the construction of a 28 m high (24 Mm^3 capacity) rockfill dam at the bottom of Bain's Kloof on the Lower Wit River. Winter water (1,2 m^3/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 (4)	
H1a Desalination Scheme 1 Generic	One option is to place this plant at the Koeberg Nuclear Power Station and to provide seawater to a reverse osmosis desalination plant. In this case, no inlet or outlet structures would be required. There are cost-saving benefits in using this heated seawater, as well as operating benefits associated with using water of a relatively constant temperature. The plant will generate an additional yield to the system of 22 Mm^3/a.

OPTION	DESCRIPTION
H1b Desalination Scheme 2 Generic	As above. Three separate interventions of similar yield facilitate the consideration of an incremental increase in the yield from the plant.
H1c Desalination Scheme 3 Generic	As above. Three separate interventions of similar yield facilitate the consideration of an incremental increase in the yield from the plant.
H2 CCT: Desalination pilot scheme	This is a small pilot scheme that will generate a yield of only 0.183 Mm^3/a.
Other Interventions (6)	
C Removal of Invasive Alien Plants	In the Berg WMA, an area of approx. 137 000 ha is infested with dense invasive alien plants. 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 Mm^3/a. Clearing efforts are currently focused on a 30 m strip on either side of the river channel and light infestations in high mountain areas (reduction in seed spread).
B 1 Water trading	This involves a variety of trading options, including, inter alia: • During the periods investigated, less than 60 % of the allocated water from the system was used by the Zonderend and Upper Berg River Irrigation Boards. This equated to some 57 Mm^3/a not being utilised by irrigators • Approximately 4,5 Mm^3/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. • Approximately 3 Mm^3/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.
I4 Non-flow related interventions	This entails focusing on the improvement of mainly riparian habitat to improve the ecological state pf rivers and reduce the flow needed to meet the ecological water requirement, thus easing up flow for other uses.
I5 Maximise existing infrastructure	This intervention will allow more efficient use of existing infrastructures and will include inter alia: • Eliminate the potential need for freshening releases into the Berg River; • Full use of storage in the Upper Steenbras Dam; • Maximum use of Eerste River water from Kleinplaas Dam; • Maximum use of the Palmiet Pump Storage Scheme during droughts; and • Possible additional off-channel raw water storage at Misverstand Dam.
I6 Maximise WCWSS yield	The intervention entails maximising the existing and future WCWSS yield through careful and correct operation of the system.
I7 Integrated Catchment Management	Similar to I4 but focuses on integrated management of the entire catchment area (beyond the riparian edge).

APPENDIX D:
Overview of the Reconciliation Planning Support Tool

WCWSS RECONCILIATION PLANNING SUPPORT TOOL (RPST)

***Note:* The Reconciliation Planning Support Tool, whilst functional, is still in the developmental phase and should not be utilised unless the user understands the interrelationships between the sheets and how the calculations in the model work**

1. INTRODUCTION

The selection of interventions, either to study further or to implement, to reconcile water availability with the requirement for the Western Cape Water Supply System (WCWSS) is a complex task, with many diverse criteria to consider. The need for a graphical tool, to provide support for this task was identified, and is being incrementally developed. This Appendix describes the features of the tool, and how it will be used to assist in the selection process.

The tool is run in Excel, with Visual Basic macro-programmes. This tool will be interactive, and the user will be able to adjust all input data. The output will be a graph, incorporating time-related implementation programmes of interventions, illustrating the influence on the water requirement scenarios (WC/WDM interventions) or system yield increases (other supply interventions).

2. PURPOSE OF THE TOOL

The purpose of this tool is to provide graphical support to assist managers in planning how best to meet users' water requirements from the Western Cape Water Supply System (WCWSS). It will facilitate the selection of a suite of potential interventions for a particular water requirement scenario (specific selected forecasting graph or graphs) and/or for a particular scenario, which is being investigated.

The tool allows the user to compare the potential interventions with one another, and with one or more selected future water requirements scenarios. The output graphically shows when decisions to investigations selected interventions need to be taken to achieve water balance, in order to influence the requirements or to make the yield (annual volume of water available) from a new source available by a certain date (year).

Furthermore, the tool displays financial parameters, namely unit reference value (URV), operating costs, capital cost and the unit cost of water per intervention selected and will give the net present value (NPV) and expected cash flow for a selected suite of interventions.

3. TOOL WORKSHEETS

The following worksheets are contained in the model:

- Introduction, explanations and instructions (not complete);
- Water requirement scenarios & current system yield (Input Sheet);
- Intervention programmes, yields and financial parameters – all interventions (Input Sheet);
- Selection sheet (Input Sheet);
- Water balance graph and programmes (Output Sheet);
- Selection of Studies (Input and Output Sheet);
- Cost of Intervention and Net Present Value (Output Sheet);
- CCT budget and expenditure parameters (Input Sheet);
- Financial Indicators (Output Sheet);
- Reporting sheets (Output Sheet) and;
- Various calculation worksheets.

3.1 INPUT DATA SHEETS

3.1.1 Water Requirement Data Sheet

The first set of input data is the historical water use for the WCWSS, plus a series of projected water requirement scenarios (which can be populated with up to five scenarios) for each year (covering 25 years), populated in the Water Requirements Data Sheet. The data is extended to 2054 by a selected growth factor, as this additional data is required for the financial calculations. An example of the type of input is given in Table 1 below.

Table 1: Water Requirement Tables

ACTUAL GROWTH IN WATER DEMAND (Million cubic metres)									
		Year	2003	2004	2005	2006	2007	2008	2009
Historical Water Use			459	476	399	457			

CURRENT SYSTEM YIELD (Million cubic metres)									
		Year	2003	2004	2005	2006	2007	2008	2009
Existing System Yield			475	475	475	475	475	475	475

WATER REQUIREMENT SCENARIOS (Million cubic metres)									
		Year	2003	2004	2005	2006	2007	2008	2009
Future water require-ments	Low Scenario		450	477	403	459	472	480	489
	High Scenario		450	477	462	504	511	528	541
	Req 3		450	477	464	507	516	535	550
	Req 4		450	491	496	508	517	526	536
	Req 5		450	491	496	508	517	526	536

CCT DEMAND CURVES									
		Year	2003	2004	2005	2006	2007	2008	2009
CCT Historic Unconstrained Curve				545	524	570	587	604	621
CCT Low Water Demand Curve				488	462	503	514	525	537

Historical and all future water requirement scenarios can be modified.

3.1.2 City of Cape Town WC/WDM 8-year Programme Sheet

The 8-year WC/WDM programme and budget which was part of the CCT's draft WC/WDM strategy is included as a separate input sheet. In this sheet, the users can vary the annual savings and budget in accordance with corporate budget approvals. An example of this sheet is provided in Table 2. This table is currently in the process of being revised by the CCT and is included for illustrative purposes only.

Table 2: WC/WDM 8-year programme (not yet approved)

Objective number		Programme	06/07	Mm3/a	07/08	Mm3/a	08/09	Mm3/a	09/10	Mm3/a	10/11	Mm3/a	11/12	Mm3/a	12/13	Mm3/a
Objective A1	A1.1	Pressure reduction	3,000	2.4	2,900	2.3	2,900	2.3	50	0.0	50	0.0	50	0.0	50	0.0
	A1.2	Establishment of leak detection task teams	1,400	0.4	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3
Objective A2	A2.1	Comprehensive water supply management projects in previously disadvantaged areas	8,000	1.3	8,020	1.3	8,000	1.3	8,000	1.3	1,000	0.2	1,000	0.2	1,000	0.2
Objective A3	A3.2	Preventative maintenance	700	-	1,150	-	1,150	-	1,150	-	1,150	-	1,150	-	1,150	-
Objective A4	A4.2	Meter management /replacement programme	4,200	0.1	4,050	0.1	4,000	0.1	4,000	0.1	4,050	0.1	4,000	0.1	4,000	0.1
Objective B1	B1.1	Consumer awareness campaign	2,010	0.2	2,410	0.2	2,610	0.2	2,710	0.2	2,710	0.2	2,710	0.2	2,710	0.2
	B1.2	Consumer education campaign	2,040	0.3	2,040	0.3	1,790	0.2	1,790	0.2	1,590	0.2	1,590	0.2	1,590	0.2
	B1.3	School education	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2
	B1.4	Special events	845	-	895	-	945	-	995	-	1,045	-	1,095	-	1,145	-
Objective B2	B2.2	enforcement of by-laws	705	-	705	-	860	-	715	-	715	-	715	-	715	-
Objective B5	B5.1	Implement a plumbing retro –fit programme	500	0.1	2,300	0.5	5,000	1.1	5,000	1.1	5,050	1.1	5,000	1.1	5,000	1.1
	B5.4	Implement an on-going support programme for large consumers	520	0.5	1,070	1.0	1,070	1.0	870	0.8	870	0.8	870	0.8	870	0.8
Objective E1	E1.3	Recycling of water from wastage plants to parks & industry	40,772	10.0	2,575	-	2,575	-	2,575	-	2,575	-	2,575	-	2,575	-
Objective E2	E2.1	Support working for water programme	950	-	950	-	950	-	950	-	950	-	950	-	950	-
Objective C1	C1.1	Establish Distircti management areas	1,500	-	1,500	-	-	-	-	-	-	-	-	-	-	-
Objective C2	C2.1	Management Information System	10,000	0.6	10,000	0.6	1,000	0.1	1,000	0.1	1,000	0.1	1,000	0.1	1,000	0.1
	C2.2	Upgrading the telemetry system, remote communications (cell)	-	-	200	0.0	6,400	0.3	6,530	0.3	6,730	0.3	2,030	0.1	2,030	0.1
Total			79,442	16.0	44,065	6.8	42,550	7.1	39,635	4.7	32,785	3.5	28,035	3.3	28,085	3.3
Total, cumulative savings, Ml/day				28		35		42		47		50		54		57

3.1.3 Intervention Data Sheet

The second set of data is the estimated implementation programmes of approximately 60 water resource and additional WC/WDM interventions. The programme illustrates the duration (in years, or parts of years to the nearest 0.25 years) of separate implementation phases (i.e. pre-feasibility study, EIA approval process) for each intervention. Information on respective yields and financial parameters (URV, capital cost and operating cost) is also included as input data. An example of the Intervention Data Sheet is shown in Table 3. The WC/WDM interventions that are in the CCT's draft WC/WDM strategy and 8-year implementation programme are included. Provision is made to allow additional generic WC/WDM interventions that would be implemented beyond the CCT's 8-year budgeted programme.

Because the number of potential interventions can vary with time, the tool is designed to facilitate flexibility. The tool allows one to add new interventions and to delete existing interventions as information is updated. The number and names of phases (e.g. reconnaissance, pre-feasibility), durations of phases or lag-times and yields of interventions are also editable, as is the colour coding.

There is a facility to allow for overlapping phases; for example the DWAF licensing process and the D: EA&DP approval process can be concurrent, and therefore only the longer of the two periods is taken into account.

The Intervention Data Sheet also enables the user to input the amount of time required until the full utilisation of the yield/saving of the specific intervention is achieved.

Various criteria are included in the model in order to enable the interventions to be compared against each other. These criteria include, *inter alia*, the following:

- URV,
- Environmental Impact,
- Socio-economic impact,
- Health risk,
- Creates additional storage,
- Facilitates diversification, and
- Reduces System Risk Profile.

A basic Multi-Criteria Decision Making Tool is included in the intervention data sheet in order to assist the user in the selection process. The user has the flexibility to alter the weighting of the selected criteria and also has the ability to alter the criteria themselves. Five different variables can be compared on this basis. The grading (from highest URV to lowest URV) of the URV variable can be determined on a straight line, or in accordance with a predetermined curve.

The remainder of the criteria can be utilised for a more qualitative assessment i.e. does the intervention provide a diversification of resources, does the intervention reduce the overall risk of non supply, etc.

A set of filters is included for all the criteria so that interventions can be analysed in the following ways:

- ranked in ascending or descending order,
- filtered in accordance the inputted data,
- ordered in accordance with type of intervention e.g. WC/WDM or surface water, and
- ordered by earliest possible implementation date.

A function is also available to reduce the required lead time associated with each intervention, and the user can select a “max” or “min” lead time. The “min” lead time option assumes that the study will go straight into the feasibility phase (bypassing the pre-feasibility phase) and will also reduce the lead times associated with budgeting and approvals.

The user must select the options which the user wishes to carry over to the Selection Sheet.

Table 3: Intervention data sheet (The selection and information included in the table are for illustrative purposes only)

INTERVENTION PROGRAMMES		Pre-feasibility (years)			Feasibility (years)				Construction/Implementation (years)								Zero Yield at Start (years)			
		max time			max time		concurrent	concurrent	max time		concurrent	concurrent					Full Yield at End (years)			
Select / de-select	Scheme	Lag time (budget delay)	TOR / Appoint Consultant	Pre-feasibility	Lag time (budget delay)/ Pilot study	TOR / Appoint Consultant	Feasibility Study/ EIA	DWAF Reserve determination	Lag time (budget delay)	TOR / Appoint Consultant	DWAF licensing process (Reserve)	DEA&DP approval process	Design / tender prepar. & award	Construct /Implement/ Council Bylaw	Warm up /First filling		Minimum time to develop yield		Maximum time to develop yield	
															Start	End	Start	End	Start	End
.	.																			
Selected	**Wemmershoek BWP Pipeline**				1	0.5	1	0	1	0.5	0.5	0.5	1.25	1.5	0	1	**4.25**	**5.25**	**6.25**	**7.25**
Selected	**Michell's Pass Diversion (8m3/s)**		0.5	1.5	1	0.5	2	2	1	1	2	1.5	2	2	0	1	**8.5**	**9.5**	**12.5**	**13.5**
Selected	**Michell's Pass Diversion (4m3/s)**		0.5	1.5	1	0.5	2	2	1	1	2	1.5	2	2	0	1	**8.5**	**9.5**	**12.5**	**13.5**
Selected	**Lourens River Diversion**				1	0.5	2	2	1	0.5	1	1	2	1.5	0	1	**6.5**	**7.5**	**8.5**	**9.5**
Selected	**Voëlvlei Phase 1**				1	0.5	1.5	1.5	1	1	2	2	2	2.5	0	1	**8.5**	**9.5**	**10.5**	**11.5**
Selected	**Upper Wit River Diversion**				1	0.5	2	2	1	0.5	2	2	2	1.5	0	1	**7.5**	**8.5**	**9.5**	**10.5**
Selected	**24 Rivers Dam**				1	0.5	1.5	1.5	1	0.5	1	1	1.5	1.5	0	1	**5.5**	**6.5**	**7.5**	**8.5**
Selected	**Raise Lower Steenbras**		0.5	1.5	1	0.5	2	2	2	1	1.5	1.5	2.5	3	0	1	**9.5**	**10.5**	**14.5**	**15.5**
Selected	**Voëlvlei Phases 2 & 3**	1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	2.5	0	1	**9.5**	**10.5**	**15.5**	**16.5**
Selected	**Lower Wit River Dam**	1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	3	0	1	**10**	**11**	**16**	**17**
Selected	**Eerste River Diversion**				1	0.5	2	2	1	0.5	1	1	2	1.5	0	1	**6.5**	**7.5**	**8.5**	**9.5**
Selected	**Upper Molenaars (To Berg River Dam)**		0.5	1.5	1	0.5	2	2	1	1	2	2	2	2.5	0	1	**9**	**10**	**13**	**14**
Selected	**Brandvlei to TWK transfer**	1	0.5	0.5	1	0.5	2	1	1	0.5	2	2	2	2	0	2	**7**	**9**	**11**	**13**
Selected	**Michell's Pass Diversion (8m3/s) (incl CCTp/l)**		0.5	1.5	1	0.5	2	2	1	1	2	1.5	2	2	0	1	**8.5**	**9.5**	**12.5**	**13.5**
Selected	**Voëlvlei Phases 2 & 3 (incl. CCT Pipeline)**	1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	2.5	0	1	**9.5**	**10.5**	**15.5**	**16.5**
Selected	**Upper Campanula Dam (Option 1)**	1	0.5	1.5	1	0.5	2	2	2	1	1.5	1.5	2	3	0	1	**9**	**10**	**15**	**16**
Selected	**Dam at Misverstand**	1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	2.5	0	1	**9.5**	**10.5**	**15.5**	**16.5**

Table 3 Continued): *Intervention data sheet (The selection and information included in the table are for illustrative purposes only)*

INTERVENTION PROGRAMMES																				
Select / de-select	Scheme	Study Status Completed	Implementation lead time	Capital Cost (R million)	Operating Cost	Annual Operating Cost	WDM Implementation Date	Time to Implement (min/max)	Yield (million m^3/a)/Saving	URV (Economic evaluation)	Socio Economic Impact	Ecological Impact	Health Risk	Creates Additional Storage	Facilitates diversification of hydrologic risk	Mutually Exclusive	WCWSS can utilise yield (Scheme specific)	Enhances WCWSS operation	Reduces infrastructure risk Profile	Implementation can be phased
										100%	0%	0%	0%	0%	0%					
.	.									.	.	.	.	.	.	.	.	.	.	.
Selected	Wemmershoek BWP Pipeline	R	7.25					Max	5		L	L	L	Y	N				Y	N
Selected	Michell's Pass Diversion (8m3/s)	R	13.5	56		0.14		Max	52	0.11	M	M	L	N	N				Y	N
Selected	Michell's Pass Diversion (4m3/s)	R	13.5	51		0.13		Max	35.7	0.14	M	M	L	N	N				Y	N
Selected	Lourens River Diversion	PF	9.5	45.6		2.3		Max	19	0.32	L	L	L	N	N				Y	N
Selected	Voëlvlei Phase 1	PF	11.5	87		9.7		Max	35	0.5	L	M	L	N	N				N	N
Selected	Upper Wit River Diversion	PF	10.5	40		2		Max	10	0.54	L	M	L	N	N				Y	N
Selected	24 Rivers Dam	PF	8.5	9.9		0.02		Max	1.8	0.63	L	M	L	Y	N				Y	N
Selected	Raise Lower Steenbras	R	15.5	258				Max	25	0.89	L	M	L	Y	N				Y	N
Selected	Voëlvlei Phases 2 & 3	R	16.5	1096		18.7		Max	110	0.98	M	H	L	Y	N				Y	N
Selected	Lower Wit River Dam	PF	17	333.6		3		Max	29.5	1.17	M	H	L	Y	N				Y	N
Selected	Eerste River Diversion	PF	9.5	101.5		1.9		Max	8.3	1.28	M	L	L	N	N				Y	N
Selected	Upper Molenaars (To Berg River Dam)	R	14	345.21		2.3		Max	27	1.28	M	L	L	N	N				Y	N
Selected	Brandvlei to TWK transfer	PF	13	426.8		15.2		Max	41	1.4	M	M	L	Y	N				N	N
Selected	Michell's Pass Diversion (8m3/s) (incl CCTp/l)	R	13.5	900		6		Max	52	1.48	M	M	L	N	N				Y	N
Selected	Voëlvlei Phases 2 & 3 (incl. CCT Pipeline)	R	16.5	2100		30		Max	110	1.5	M	H	L	Y	N				Y	N
Selected	Upper Campanula Dam (Option 1)	R	16	311		5		Max	13.5	1.98	M	H	L	Y	N				Y	N
Selected	Dam at Misverstand	R	16.5	801.6		17.6		Max	40	2.3	L	M	L	Y	N				Y	N

3.1.4 Selection Sheet

This sheet provides the facility to select which future water requirement scenarios appear on the graph. The user must "select" the Water Requirement Curve, upon which the user will base the analysis. The term “selected for financial calculations” will appear next to the water requirement selection, which is being used in the analysis. A user may select more than one Water Requirement Curve and both curves will be displayed on the graph. Figure 1 contains an example of a selection sheet.

The tool has the facility to select interventions and to add them to the water balance graph in a particular order. The year of "First Water" (when the scheme comes on line or water is first saved in a dam, etc.) needs to be selected per option. A small version of the Water Balance graph is displayed in this sheet to assist with a reasonable estimate of the "First Water" dates that are populated. A date when the projected demand exceeds the available supply is also shown in order to assist the user when inputting the "Year of First Water or Saving". All interventions, with a red flag before the intervention should not be selected until the red flag disappears, as the lead time required for these interventions exceeds the time available to implement the intervention.

The Selection Sheet will also retain the functionality of the intervention data sheet with regards to the multi criteria decision making tool and the filters. This assists in screening and assessing interventions prior to selection. The user also has the ability to vary the weighting of the criteria, should it be required.

The total NPV of the selected interventions will also be indicated on the Selection Sheet. It is important to note that the NPV indicator only becomes a relevant comparative indicator if the scenarios, which are being compared, are developed to a common end date (e.g. until 2029 or 2030).

Once a selection is made for a given water requirement scenario, the selected interventions can be transferred to the Study Sheet. The Selection Sheet enables the transfer of three water requirement scenarios through to the Study Sheet for further evaluation and comparison.

This sheet also allows the user to select a confidence level for the yield/saving of the WC/WDM interventions (e.g. a 50% confidence level will reduce the yield/saving of all the WC/WDM interventions by 50%).

Macro buttons also exist to clear all the interventions selected ("clear all") or to select all the interventions listed in the selection sheet ("select all"). The user can also clear all the interventions transferred from the intervention data sheet, using the macro button "clear shortlist".

Once any selections or changes are made to the Selection Sheet, the user must select the macro button "Draw Graph" to update the graphic and financial calculations.

Please note the following:

It is recommended that the user update the spreadsheet using the "Draw Graph" macro upon the selection of each individual intervention, as this will update the date upon which the next intervention is required.
If reconciliation between supply and requirement is not achieved, the date indicator will indicate the date when a deficit still occurs. In this instance, the red flags indicating non-availability due to lead time will not function correctly.

WATER REQUIREMENT SELECTION			
Low Scenario	select	clear	
High Scenario	select	clear	selected for financial calculations
Req 3	select	clear	
Req 4	select	clear	
Req 5	select	clear	

FUNCTIONS

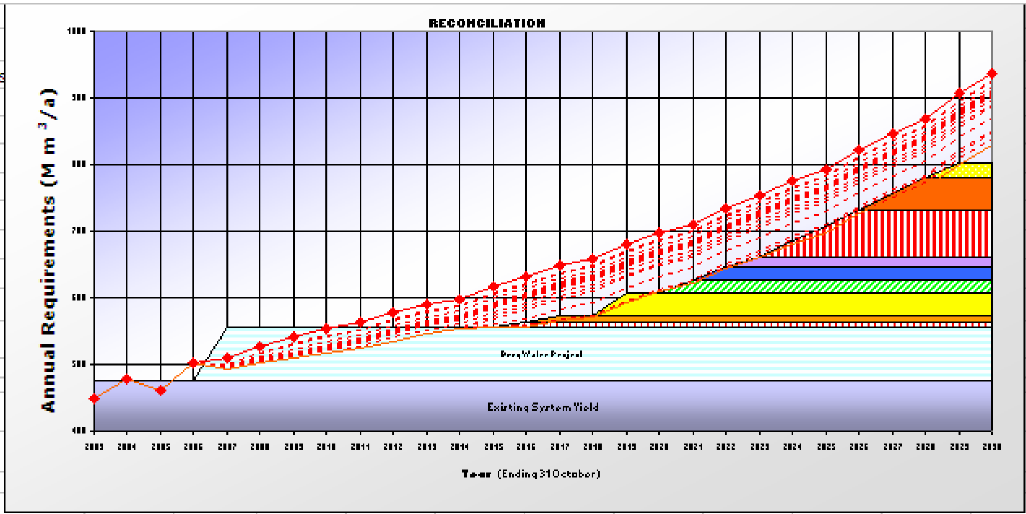
Draw Graph

Notes | Save

NET PRESENT VALUE
R 1,092
OF SELECTION (in millions)
2020

SAVE TO STUDY SHEET

Option 1 | Option 2 | Option 3 | Clear Studies



KEY

Selected for input to graph

Start year is earlier than current year

100% WDM Confidence Index

INTERVENTION SELECTION

Clear Shortlist

Select All | Clear All

Order	Intervention		Year of First Water or Saving	Yield	Total Lead Time	Study Start Date	Time to full yield / saving	Study Status Completed	Capital Cost (R million)	Operating Cost	Annual Operating Cost	SPARE	SPARE	Yield (million m³/a)/Saving
1	Pressure reduction	select clear	2007	7.07228	1	2006	3	R	9	0	0	2006	0	7.07228
1	Establishment of leak detection task teams	select clear	2007	1.99997	1	2006	7	R	0	7.4	0	2006	0	1.99997
1	Comprehensive water supply management projects in	select y clear ntaged ar	2007	5.50616	1	2006	4	R	0	35.02	0	2006	0	5.50616
1	Meter management /replacement programme	select clear	2007	0.832	1	2006	7	R	28.3	0	0	2006	0	0.832
1	Consumer awareness campaign	select clear	2007	1.43615	1	2006	7	R	0	17.87	0	2006	0	1.43615
1	Consumer education campaign	select clear	2007	1.54947	1	2006	7	R	0	12.43	0	2006	0	1.54947
1	School education	select clear	2007	1.44617	1	2006	7	R	0	16.1	0	2006	0	1.44617
1	Implement a plumbing retro –fit programme	select clear	2007	6.31265	1	2006	7	R	0	27.85	0	2006	0	6.31265
1	Implement an on-going support programme for large	select s clear	2007	5.99088	1	2006	7	R	0	6.14	0	2006	0	5.99088
1	Recycling of water from wastage plants to parks & ind	select clear	2007	10	1	2006	1	R	56.222	0	0	2006	0	10
1	Management Information System	select clear	2007	1.61924	1	2006	2	R	25	0	0	2006	0	1.61924
1	Upgrading the telemetry system, remote communicati	select clear	2007	0.99098	1	2006	5	R	23.92	0	0	2008	0	0.99098
1	WC/DM: Adjustment of water tariffs, metering and cre	select l clear	2015	20	4	2011	4	PF	0	0	1	0	Max	20
	Wemmershoek BWP Pipeline	select clear	2017	5	7.25	2009.75	1	R	0	0	0	0	Max	5
	Michell's Pass Diversion (8m3/s)	select clear	2017	52	13.5	2003.5	1	R	56	0	0.14	0	Max	52
	Michell's Pass Diversion (4m3/s)	select clear	2020	35.7	13.5	2006.5	1	R	51	0	0.13	0	Max	35.7

Figure 1: Selection Sheet

3.1.5 Reserve Sheet

Once a selection is made for a given water requirement scenario, the selected interventions are transferred to the Study Sheet. The Selection Sheet enables the transfer of three water requirement scenarios through to the Study Sheet for further evaluation and comparison.

This sheet can also be modified to take into account the possible impact of climate change on the yield of existing water resources.

3.1.6 CCT Budget Sheet (this sheet is in the process of development)

The implementation and impact of both supply-side and WC/WDM interventions cannot be assessed in isolation to the financial and infrastructural requirements, which are contained in the CCT's Water Services Development Plan (WSDP). The output from the RPST will be informed by and will in turn inform the CCT’s WSDP. The CCT’s WSDP will also inform its Integrated Development Plan (IDP).

Based on the overall capital and operating budgets of the CCT (excluding water resource and WC/WDM interventions) when superimposed on the capital and operating budget requirements of the selected interventions, may cause the user to reassess the options chosen or the phasing of the options chosen. The user could accommodate tariff increases either by arranging finance in a structured manner (i.e. the user may decided to pay more now and less later of *vice versa*) or the user may decide to implement the available interventions in a certain order.

This sheet enables one to input the following budget parameters (pertaining to potable water supply):

- The water services operating budget
- The anticipated real growth in operating budget
- The 10 year asset replacement and refurbishment capital programme for water services
- The 10 year capital programme for water services (new infrastructure)
- Additional significant capital schemes, which may be implemented and which are beyond the 10 year capital requirement.

3.1.7 Notes Sheet

On the Water Requirement Data Sheet, the Intervention Data Sheet and the Selection Sheet, a “notes” button is available to take the user to a Notes Sheet. Here the user is able to type in any notes or comments concerning the water requirement selection or choice of interventions. A macro button takes the user back to the relevant worksheet.

3.2 OUTPUT DATA SHEETS

3.2.1 Water Balance Sheet

The output on the Water Balance Sheet is a graph showing the selected future water requirement scenarios, in million cubic meters per annum, plotted against time in years, as shown in Figure 2. Normally, one scenario would be selected.

The intervention programmes block, at the top of the worksheet illustrates the following:

- selected interventions,
- yield/saving for each intervention,
- total programme length of each selected intervention, and
- the financial parameters of each intervention.

These interventions are displayed in two colours, blue and yellow. The blue bar indicates the planning component of the intervention and the yellow bar the implementation component of the intervention.

When a specific WC/WDM intervention is selected, a revised water requirements scenario curve is created to illustrate the estimated reduction in water requirement achieved through the intervention. The remainder of the original curve still remains visible. This revised curve is derived by subtracting the intervention yield from the original requirements curve values and growing the requirements from that point at the same % as the original selected curve.

For supply-side interventions, the yield of the selected intervention is added to the cumulative yield of the previously selected intervention. This only applies from the date upon which the intervention is required.

The following additional facilities are available to the user:

- A facility to display the water balance in real time, for each year of the planning period under consideration (as interventions are added or deleted), at the same timescale as the graph. Only the water balance values are visible on the screen. One can then scroll down to see the detail of the calculation.
- The ability to display additional water requirement curves on the Reconciliation Water Balance Graph. In this instance the CCT's historic unconstrained water requirement curve as well as the CCT's Low Water Demand Curve can be displayed.

Figure 2 contains a graphic illustration from the water balance sheet.

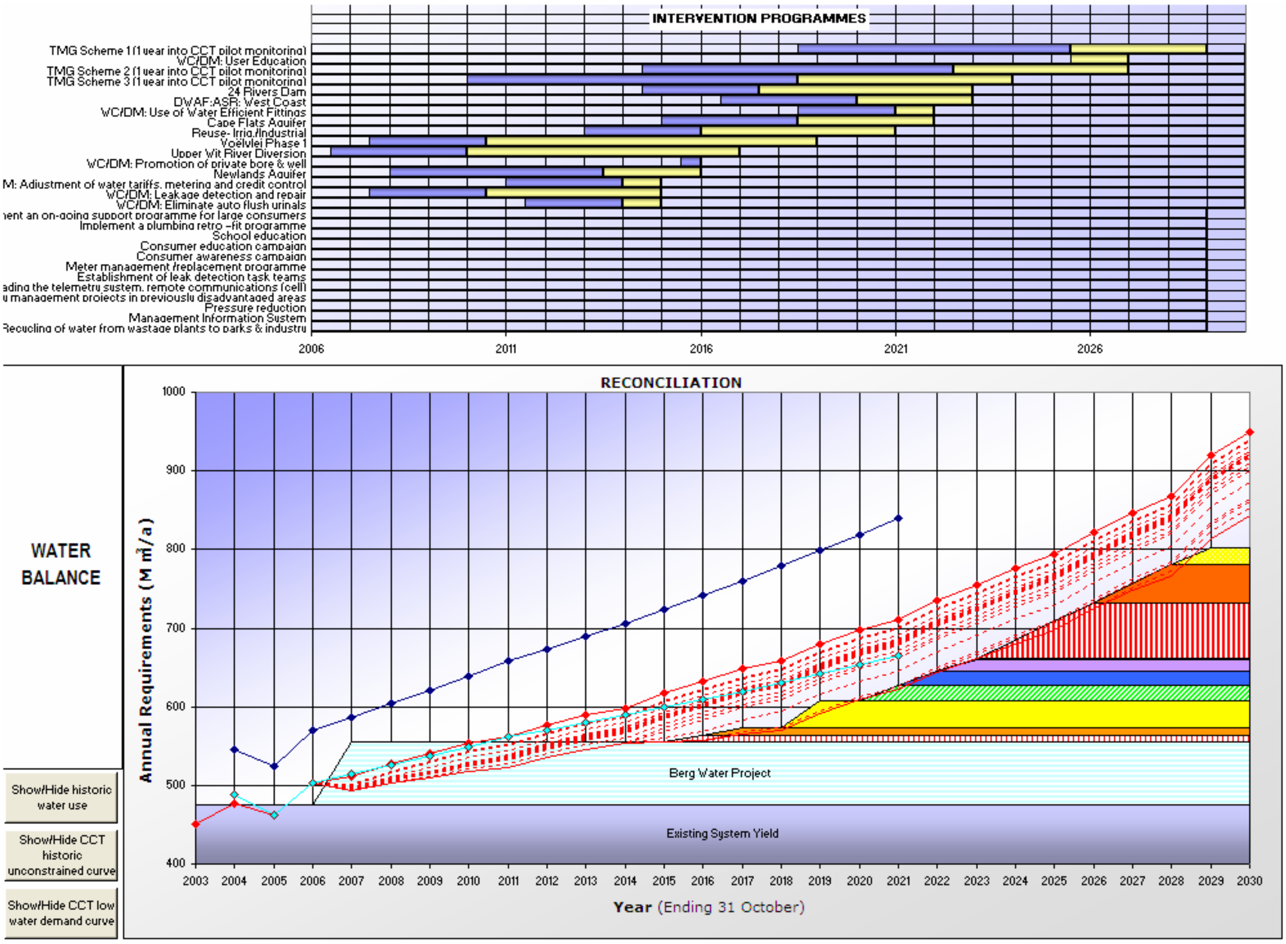


Figure 2: Graphic illustration of a water balance

3.2.2 Report 1 Sheet

Report Sheet 1 produces a tabular report of all the selected interventions. The user can then utilise the filter function to order the interventions in the report. In order to produce this report, the user must go to the Selection Sheet and insert a "1" next to each intervention selected for the reconciliation. On the Report Sheet, the user must then use the filter function and select all the interventions which have a "1" adjacent to the intervention.

3.2.3 Report 2 Sheet

Report Sheet 2 displays the water balance graph, the present value cash flow graph and the NPV of the selected reconciliation scenario.

3.2.4 Study Selection Sheet

The Study Selection Sheet can receive and store 3 different planning scenarios. The 3 different planning scenarios could arise from one or more of the following analyses:

- alternative choices in interventions,
- alternative choices regarding water requirement curves,
- percentage success of WC/WDM, and/or
- impacts of climate change and/or implementation of the ecological Reserve

The study dates and associated first-water dates for the 3 planning scenarios (water requirement scenarios) are graphically depicted on this sheet. This graphical depiction informs the user when the studies should commence for each water requirement scenario. The user can also manually select the study start date for each intervention. Figure 3 illustrates the output from a Study Selection Sheet.

TS Recommended Target Study Date

S1 Study Date for 100% WDM
S2 Study Date for 50% WDM
S3 Study Date for 0% WDM

W1 First water Date for 100% WDM
W2 First water Date for 50% WDM
W3 First water Date for 0% WDM

	SUPPLY WDM	Authority	Status Complete	Target Study Date	INTERVENTION NAME	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	WDM	CCT	R		Pressure reduction	S1	W1																		
1	WDM	CCT	R		Establishment of leak detection task teams	S1	W1																		
1	WDM	CCT	R		Comprehensive water supply management projects in previously disadv	S1	W1																		
1	WDM	CCT	R		Meter management /replacement programme	S1	W1																		
1	WDM	CCT	R		Consumer awareness campaign	S1	W1																		
1	WDM	CCT	R		Consumer education campaign	S1	W1																		
1	WDM	CCT	R		School education	S1	W1																		
1	WDM	CCT	R		Implement a plumbing retro –fit programme	S1	W1																		
1	WDM	CCT	R		Implement an on-going support programme for large consumers	S1	W1																		
1	WDM	CCT	R		Recycling of water from wastage plants to parks & industry	S1	W1																		
1	WDM	CCT	R		Management Information System	S1	W1																		
1	WDM	CCT	R		Upgrading the telemetry system, remote communications (cell)	S1	W1																		
1	WDM	CCT	PF		WC/DM: Adjustment of water tariffs, metering and credit control			S2			S1	W2			W1										
1	S	DWAF	R	2006	Michell's Pass Diversion (4m3/s)	S1																			
1	WDM	CCT	PF		WC/DM: Eliminate auto flush urinals				S2		S1		W2		W1										
1	WDM	CCT	PF		WC/DM: Leakage detection and repair		S1								W1										
1	S	CCT	PF		Lourens								S1										W1		
1	WDM	CCT	PF		WC/DM: Promotion of private bore & well							S2	W2		S1	W1									
1	S	DWCT	PF		Voëlvlei Phase 1		S1												W1						
1	S	DWAF	PF		Upper Wit River Diversion					S1											W1				
1	WDM	CCT	R		Reuse- Irrig./Industrial			S1								W1									
1	WDM	CCT	PF		WC/DM: Use of Water Efficient Fittings				S2				W2				S1				W1				
1	WDM	CCT	PF		WC/DM: User Education						S2		W2							S1		W1			
1	S	DWCT	R		Raise Lower Steenbras	S1																W1			
1	WDM	CCT	PF		Reuse - dual reticulation											S1								W1	
1	S	CCT	PF		Eerste										S1										W1
1	S	DWAF	R		Upper Molenaars (To Berg River Dam)							S1													
1	S	DWAF	R		Michell's Pass Diversion (8m3/s) (incl CCTp/l								S1												
1	S	DWAF	R		Voëlvlei Phases 2 & 3 (incl. CCT Pipeline)							S1													

Figure 3: An illustrative example of the output from a study selection sheet

3.2.5 Financial Indicator Sheet

This sheet graphically depicts the annual cash flow, in today's terms, for the range of selected interventions. The impact of the reconciliation of water supply and demand on the average retail tariff for the City of Cape Town is also shown. This bar graph separately depicts the following components of the average retail tariff:

- base growth in tariff,
- growth in average retail tariff due to the organic growth of the CCT,
- impact on average retail tariff of the CCT's proposed capital programme over the next 20 years, and
- impact on average retail tariff of the selection of reconciliation interventions

This sheet will enable the user to understand the impact of the chosen selection of interventions on the average cost of water until 2030. The output from this sheet will assist the user to understand the financial relationship between the implementation of WC/WDM, the growth in water requirements and the financial implications of implementing additional water supply-side interventions.

3.2.6 Unit Cost of Intervention Sheet

The Unit Cost of Intervention Sheet displays what the unit cost would be, in R/kl, to implement each selected intervention. This is a useful comparative indicator and the user is able to immediately identify whether or not a selected intervention is an expensive intervention to implement. The implementation date of the intervention, relative to the water requirement curve, is also taken into account in the unit cost calculation. If an intervention is implemented prematurely (i.e. the user will not be able to recover the cost of the water through water sales) it will impact on the unit cost of the intervention. In these calculations it is assumed that supply-side interventions are constructed over the 2 years prior to first water being required.

A filter function has been included so that the unit cost of each intervention can be viewed separately.

3.3 CALCULATION SHEETS

3.3.1 Calculation Sheet

The Calculation Sheet contains a summary of the selected interventions and is used as the basis for further financial calculations as well as to support some of the graphs.

3.3.2 Chart Data Sheet

This sheet calculates a revised water requirement curve, taking into account the selected WC/WDM interventions.

3.3.3 Fin Calcs 1 Sheet

This sheet supports the financial calculations contained in the Fin Calcs 2 Sheet.

3.3.4 Fin Calcs 2 Sheet

This sheet calculates the following parameters:

- Total NPV of the selected interventions
- The annual cash flow at present day costs
- The URV or tariff of each specific intervention

3.3.5 CCT Tariff Sheet

This sheet calculates the average water tariff for the CCT taking into account the CCT future capital and operating budgets and the costs associated with the implementation of the selected interventions.

3.4 FUTURE SHEETS CURRENTLY NOT INCLUDED IN THE TOOL

3.4.1 Intro and Manual

A Future Sheet could be developed to assist the user (a help file).

3.4.2 File Management sheets

Future Sheets could be developed to save and recall various scenarios, which were run. This will enable the user to have one Master Copy of the spreadsheet. Currently, each individual scenario is a master copy on its own.

City of Cape Town Draft WC/WDM Strategy: Summary cost of main projects indicating potential savings in Mm^3/a

Objective number		Programme	06/07	Mm^3/a	07/08	Mm^3/a	08/09	Mm^3/a	09/10	Mm^3/a	10/11	Mm^3/a	11/12	Mm^3/a	12/13	Mm^3/a
Objective A1	A1.1	Pressure reduction	3,000	2.4	2,900	2.3	2,900	2.3	50	0.0	50	0.0	50	0.0	50	0.0
	A1.2	Establishment of leak detection task teams	1,400	0.4	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3
Objective A2	A2.1	Comprehensive water supply management projects in previously disadvantaged areas	8,000	1.3	8,020	1.3	8,000	1.3	8,000	1.3	1,000	0.2	1,000	0.2	1,000	0.2
Objective A3	A3.2	Preventative maintenance	700	-	1,150	-	1,150	-	1,150	-	1,150	-	1,150	-	1,150	-
Objective A4	A4.2	Meter management /replacement programme	4,200	0.1	4,050	0.1	4,000	0.1	4,000	0.1	4,050	0.1	4,000	0.1	4,000	0.1
Objective B1	B1.1	Consumer awareness campaign	2,010	0.2	2,410	0.2	2,610	0.2	2,710	0.2	2,710	0.2	2,710	0.2	2,710	0.2
	B1.2	Consumer education campaign	2,040	0.3	2,040	0.3	1,790	0.2	1,790	0.2	1,590	0.2	1,590	0.2	1,590	0.2
	B1.3	School education	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2
	B1.4	Special events	845	-	895	-	945	-	995	-	1,045	-	1,095	-	1,145	-
Objective B2	B2.2	enforcement of by-laws	705	-	705	-	860	-	715	-	715	-	715	-	715	-
Objective B5	B5.1	Implement a plumbing retro –fit programme	500	0.1	2,300	0.5	5,000	1.1	5,000	1.1	5,050	1.1	5,000	1.1	5,000	1.1
	B5.4	Implement an on-going support programme for large consumers	520	0.5	1,070	1.0	1,070	1.0	870	0.8	870	0.8	870	0.8	870	0.8
Objective E1	E1.3	Recycling of water from wastage plants to parks and industry	40,772	10.0	2,575	-	2,575	-	2,575	-	2,575	-	2,575	-	2,575	-
Objective E2	E2.1	Support working for water programme	950	-	950	-	950	-	950	-	950	-	950	-	950	-
Objective C1	C1.1	Establish District management areas	1,500	-	1,500	-	-	-	-	-	-	-	-	-	-	-
Objective C2	C2.1	Management Information System	10,000	0.6	10,000	0.6	1,000	0.1	1,000	0.1	1,000	0.1	1,000	0.1	1,000	0.1
	C2.2	Upgrading the telemetry system, remote communications (cell)	-	-	200	0.0	6,400	0.3	6,530	0.3	6,730	0.3	2,030	0.1	2,030	0.1
Total			79,442	16.0	44,065	6.8	42,550	7.1	39,635	4.7	32,785	3.5	28,035	3.3	28,085	3.3
Total, cumulative savings, Mm^3/a				16		23		30		35		38		41		45

Objective E1.3 only indicates treated effluent which is going to replace potable supply

APPENDIX E
Summary of Intervention Data

Column Number	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	Reconnaissance (years)			Pre-feasibility (years)			Feasibility (years)				Construction/Implementation (years)								Zero Yield at Start (years)												
	max time			max time			max time		concurrent	concurrent	max time		concurrent	concurrent					Full Yield at End (years)												
Scheme	Lag time (budget delay)	TOR / Appoint Consultant	Recon-naissance	Lag time (budget delay)	TOR / Appoint Consultant	Pre-feasibility	Lag time (budget delay)/ Pilot study	TOR / Appoint Consultant	Feasibility Study/ EIA	DWAF Reserve determination	Lag time (budget delay)	TOR / Appoint Consultant	DWAF licensing process (Reserve)	DEA&DP approval process	Design / tender prepar. & award	Construct /Implement/ Council Bylaw	Warm up /First filling		Minimum time to develop yield		Maximum time to develop yield		Study Status Completed	Implementation lead time	Capital Cost (R million)	Operating Cost	Annual Operating Cost	WDM Implementation Date	Time to Implement (min/max)	Yield (million m^3/a)/Saving	URV (Economic evaluation)
																	Start	End	Start	End	Start	End									100%
.																															.
Pressure reduction																	0	3					R	1	9	-		2006		7.1	
Establishment of leak detection task teams																	0	7					R	1	-	7		2006		2.0	
Comprehensive water supply management projects in previously disadvantaged areas																	0	4					R	1	-	35		2006		5.5	
Preventative maintenance																	0	0					R	1	-	8		0		0.0	
Meter management /replacement programme																	0	7					R	1	28	-		2006		0.8	
Consumer awareness campaign																	0	7					R	1	-	18		2006		1.4	
Consumer education campaign																	0	7					R	1	-	12		2006		1.5	
School education																	0	7					R	1	-	16		2006		1.4	
Special events																	0	0					R	1	-	7		0		0.0	
enforcement of by-laws																	0	0					R	1	-	5		0		0.0	
Implement a plumbing retro –fit programme																	0	7					R	1	-	28		2006		6.3	
Implement an on-going support programme for large consumers																	0	7					R	1	-	6		2006		6.0	
Recycling of water from wastage plants to parks & industry																	0	1					R	1	56	-		2006		10.0	
Support working for water programme																	0	0					R	1	-	7		0		0.0	
Establish Distircti management areas																	0	0					R	1	-	3		0		0.0	
Management Information System																	0	2					R	1	25	-		2006		1.6	
Upgrading the telemetry system, remote communications (cell)																	0	5					R	1	24	-		2008		1.0	
WC/DM: Leakage detection and repair							1	0.5	1.5	0	1	0.5			1	2	0	2	3.5	5.5	5.5	7.5	PF	7.5	63.1		0		Max	15.6	0.31
WC/DM: Domestic leakage repair							1	0.5	1.5	0	1	0.5			1	0	0	3	0.5	3.5	2.5	5.5	PF	5.5					Max	-2.2	5.5
WC/DM: Pressure management							1	0.5	1	0	1	0.5			1	2	0	2	3	5	5	7	PF	7	77.1		1.2		Max	16.7	0.4
WC/DM: Use of Water Efficient Fittings							1	0.5	1	0						1	0	3	-0.5	2.5	0.5	3.5	PF	3.5	62				Max	7.9	0.6
WC/DM: Eliminate auto flush urinals							1	0.5	1	0						1	0	1	1.5	2.5	2.5	3.5	PF	3.5	14.2				Max	4.2	0.26
WC/DM: Adjustment of water tariffs, metering and credit control							1	0.5	1.5	0						1	0	4	-1	3	0	4	PF	4	0		1		Max	20	0
WC/DM: User Education												0.5			1	0	0	3	-1.5	1.5	-1.5	1.5	PF	1.5			7		Max	10	0.7
WC/DM: Promotion of grey water use							1	0.5	1	0						0	0	3	-1.5	1.5	-0.5	2.5	PF	2.5					Max	1	4.88
WC/DM: Promotion of private bore & well								0.5	1									3				0.5	PF	0.5					Max	3.6	0.46
Reuse- Irrig./Industrial							1	0.5	1.5	0	1	0.5			1.5	2	0	1	5	6	7	8	R	8	206		2.8		Max	20	0.55
Reuse - Commercial Irrigation				1	0.5	1.5	1	0.5	1.5	0	1	0.5	0	0.5	1.5	2	0	3	3.5	6.5	8.5	11.5	R	11.5	134		2.4		Max	5	2.77
Reuse - Berg River Exchange				1	0.5	1.5	1	0.5	2	2	1	1	2	2	2	2.5	0	5	5	10	10	15	R	15					Max	50	
Reuse - potable UWP Study Option 1				1	0.5	1.5	1	0.5	2	1	1	0.5	1	1	2	2	0	1	7	8	12	13	PF	13	676		39.7		Max	60.1	1.6
Reuse - potable UWP Study Option 2				1	0.5	1.5	1	0.5	2	1	1	0.5	1	1	2	2	0	4	4	8	9	13	PF	13	589.7		29.9		Max	41.2	1.94
Reuse - potable UWP Study Option 3				1	0.5	1.5	1	0.5	2	1	1	0.5	1	1	2	2	0	4	4	8	9	13	PF	13	170		14.1		Max	21.9	1.29
Reuse - dual reticulation							1	0.5	1.5	0	1	0.5			1.5	2	0	3	3	6	5	8	PF	8	375.4		4.9		Max	28	1.25
TMG Scheme 2 (after CCT exploratory phase)							1	0.5	2.5	2.5			1.5	1.5	0.5	2.5	0	2	5.5	7.5	6.5	8.5	PF	8.5	246		6.3		Max	50	0.3 to 0.8
TMG Scheme 1 (after CCT exploratory phase)							1	0.5	1.5	1.5			1	1	0.5	2	0	1	4.5	5.5	5.5	6.5		6.5	114		2.2		Max	20	0.3 to 0.8
TMG Scheme 1 (1 year into CCT pilot monitoring)							5	0.5	1.5	1.5			1	1	0.5	2	0	1	4.5	5.5	9.5	10.5	PF	10.5	114		2.2		Max	20	0.3 to 0.8
TMG Scheme 2 (1 year into CCT pilot monitoring)							5	0.5	2.5	2.5			1.5	1.5	0.5	2.5	0	2	5.5	7.5	10.5	12.5	PF	12.5	246		6.3		Max	50	0.3 to 0.8
TMG Scheme 3 (after CCT exploratory phase)							1	0.5	3	3			2	2	0.5	3	0	4	5	9	6	10	PF	10	342		8.5		Max	70	0.3 to 0.8
TMG Scheme 3 (1 year into CCT pilot monitoring)							5	0.5	3	3			2	2	0.5	3	0	3	6	9	11	14	PF	14	342		8.5		Max	70	0.3 to 0.8
Cape Flats Aquifer							1	0.5	2	2			1	1	0.5	2	0	1	5	6	6	7	PF	7	52.9		6.2		Max	18	0.58
Newlands Aquifer				1	0.5	1	1	0.5	1.5	1.5			1	1	0.5	1						8	R	8	5.51		0.551		Max	7	0.53
DWAF: West Coast Aquifers						1	1	0.5	1	1			1	1	0.5	1.5	0	1	3.5	4.5	5.5	6.5		6.5	80		3		Max	13.8	0.6
Conjunctive use (future possible usage)							1	0.5	1.5	1.5	1	0.5	0.5	0.5	1.5	1	0	2	3.5	5.5	5.5	7.5		7.5					Max		
Aquifer Storage Recover (ASR)							1	0.5	1.5	1.5	1	0.5	1.5	1.5	1.5	2	0	3	4.5	7.5	6.5	9.5		9.5					Max		
ASR: Breede River Alluvium							1	0.5	1.5	1.5	1	0.5	1	1	1.5	1.5	0	1	5.5	6.5	7.5	8.5		8.5					Max		
Raise Lower Steenbras					0.5	1.5	1	0.5	2	2	2	1	1.5	1.5	2.5	3	0	1	9.5	10.5	14.5	15.5	R	15.5	258				Max	25	0.89
Upper Campanula Dam (Option 1)				1	0.5	1.5	1	0.5	2	2	2	1	1.5	1.5	2	3	0	1	9	10	15	16	R	16	311		5		Max	13.5	1.98
Lourens							1	0.5	2	2	1	0.5	1	1	2	1.5	0	1	6.5	7.5	8.5	9.5	PF	9.5	45.6		2.3		Max	19	0.32
Eerste							1	0.5	2	2	1	0.5	1	1	2	1.5	0	1	6.5	7.5	8.5	9.5	PF	9.5	101.5		1.9		Max	8.3	1.28
Voëlvlei Phase 1							1	0.5	1.5	1.5	1	1	2	2	2	2.5	0	1	8.5	9.5	10.5	11.5	PF	11.5	87		9.7		Max	35	0.5
Voëlvlei Phases 2 & 3				1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	2.5	0	1	9.5	10.5	15.5	16.5	R	16.5	1096		18.7		Max	110	0.98
Voëlvlei Phases 2 & 3 (incl. CCT Pipeline)				1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	2.5	0	1	9.5	10.5	15.5	16.5	R	16.5	2100		30		Max	110	1.5
Dam at Misverstand				1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	2.5	0	1	9.5	10.5	15.5	16.5	R	16.5	801.6		17.6		Max	40	2.3
24 Rivers Dam							1	0.5	1.5	1.5	1	0.5	1	1	1.5	1.5	0	1	5.5	6.5	7.5	8.5	PF	8.5	9.9		0.02		Max	1.8	0.63
Upper Molenaars (To Berg River Dam)					0.5	1.5	1	0.5	2	2	1	1	2	2	2	2.5	0	1	9	10	13	14	R	14	345.21		2.3		Max	27	1.28
Wemmershoek BWP Pipeline							1	0.5	1	0	1	0.5	0.5	0.5	1.25	1.5	0	1	4.25	5.25	6.25	7.25	R	7.25					Max	5	
Michell's Pass Diversion (4m3/s)					0.5	1.5	1	0.5	2	2	1	1	2	1.5	2	2	0	1	8.5	9.5	12.5	13.5	R	13.5	51		0.13		Max	35.7	0.14
Michell's Pass Diversion (8m3/s)					0.5	1.5	1	0.5	2	2	1	1	2	1.5	2	2	0	1	8.5	9.5	12.5	13.5	R	13.5	56		0.14		Max	52	0.11
Michell's Pass Diversion (8m3/s) (incl CCTp/l					0.5	1.5	1	0.5	2	2	1	1	2	1.5	2	2	0	1	8.5	9.5	12.5	13.5	R	13.5	900		6		Max	52	1.48
Brandvlei to TWK transfer				1	0.5	0.5	1	0.5	2	1	1	0.5	2	2	2	2	0	2	7	9	11	13	PF	13	426.8		15.2		Max	41	1.4
Lower Wit River Dam				1	0.5	1.5	1	0.5	2	2	2	1	2	2	2.5	3	0	1	10	11	16	17	PF	17	333.6		3		Max	29.5	1.17
Upper Wit River Diversion							1	0.5	2	2	1	0.5	2	2	2	1.5	0	1	7.5	8.5	9.5	10.5	PF	10.5	40		2		Max	10	0.54
Maximise existing infrastructure							1	0.5	1.5	0	1	0.5	0.5	0	1.5	1	0	1	4.5	5.5	6.5	7.5	PF	7.5					Max	5	
Maximise WCWSS yield									0		1	0	0	0	0	1	0	1	0	1	1	2	PF	2					Max	2	
CCT:Desalination pilot scheme							0				1	0.5	0	0.5	1	1	0	1	2	3	3	4	PF	4	7		0.67		Max	0.183	
Desalination 1 Generic				1	0.5	1	1	0.5	2	0	1	0.5	1	2	2	2.5	0	1	8.5	9.5	13	14	PF	14			132		Max	22	
Desalination 2 Generic				1	0.5	1	1	0.5	2	0	1	0.5	1	2	2	2.5	0	1	8.5	9.5	13	14	PF	14			132		Max	22	
Desalination 3 Generic				1	0.5	1	1	0.5	2	0	1	0.5	1	2	2	2.5	0	1	8.5	9.5	13	14	PF	14			132		Max	22	
Desalination IWRP Study Koeberg proposal							1	0.5	2	0	1	1	1	2	2	2.5	0	1	9	10	11	12	PF	12	850		132		Max	22	9.8
River Release Management							1	0.5	1.5	0	1	0.5	0	0	1.5	1	0	1	4	5	6	7	R	7	40	30	2		Max	15	1
Water Trading							1	0.5	1.5	0	1	0.5	0.5	0	1.5	1	0	3	2.5	5.5	4.5	7.5	R	7.5					Max		
Removal of Invasive Alien Plants															0.5		0	2	-1.5	0.5	-1.5	0.5	R	0.5					Max		
Non-Flow Related Interventions																			0	0	0	0	R	0					Max		
Integrated Catchment Management																			0	0	0	0	R	0					Max		

Notes:

Interventions where a range of URV's could be applicable

Interventions where URV's need to be re-calculated and confirmed. Rough Estimates made for RPST

The URV's and capital costs of the treated effluent to potable standards and desalination interventions include water treatment costs

APPENDIX F

WC/WDM Interventions Listed in the Draft CCT WC\WDM Strategy

The CCT's WC/WDM Strategy and Programme as accepted by the CCT in May 2007. Please refer to the approved Strategy for the final implementation program and budget.

City of Cape Town Draft WC/WDM Strategy: Summary cost of main projects indicating potential savings in Mm3/a

Objective number		Programme	06/07 R	Mm3/a	07/08 R	Mm3/a	08/09 R	Mm3/a	09/10 R	Mm3/a	10/11 R	Mm3/a	11/12 R	Mm3/a	12/13 R	Mm3/a	Total R		Mm3/a
Objective A1	A1.1	Pressure reduction	3,000	2.4	2,900	2.3	2,900	2.3	50	0.0	50	0.0	50	0.0	50	0.0	9,000	C	7.1
	A1.2	Establishment of leak detection task teams	1,400	0.4	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	1,000	0.3	7,400	O	2.0
Objective A2	A2.1	Comprehensive water supply management projects in previously disadvantaged areas	8,000	1.3	8,020	1.3	8,000	1.3	8,000	1.3	1,000	0.2	1,000	0.2	1,000	0.2	35,020	O	5.5
Objective A3	A3.2	Preventative maintenance	700	-	1,150	-	1,150	-	1,150	-	1,150	-	1,150	-	1,150	-	7,600	O	-
Objective A4	A4.2	Meter management /replacement programme	4,200	0.1	4,050	0.1	4,000	0.1	4,000	0.1	4,050	0.1	4,000	0.1	4,000	0.1	28,300	C	0.8
Objective B1	B1.1	Consumer awareness campaign	2,010	0.2	2,410	0.2	2,610	0.2	2,710	0.2	2,710	0.2	2,710	0.2	2,710	0.2	17,870	O	1.4
	B1.2	Consumer education campaign	2,040	0.3	2,040	0.3	1,790	0.2	1,790	0.2	1,590	0.2	1,590	0.2	1,590	0.2	12,430	O	1.5
	B1.3	School education	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	2,300	0.2	16,100	O	1.4
	B1.4	Special events	845	-	895	-	945	-	995	-	1,045	-	1,095	-	1,145	-	6,965	O	-
Objective B2	B2.2	enforcement of by-laws	705	-	705	-	860	-	715	-	715	-	715	-	715	-	5,130	O	-
Objective B5	B5.1	Implement a plumbing retro –fit programme	500	0.1	2,300	0.5	5,000	1.1	5,000	1.1	5,050	1.1	5,000	1.1	5,000	1.1	27,850	O	6.3
	B5.4	Implement an on-going support programme for large consumers	520	0.5	1,070	1.0	1,070	1.0	870	0.8	870	0.8	870	0.8	870	0.8	6,140	O	6.0
Objective E1	E1.3	Recycling of water from wastage plants to parks & industry	40,772	10.0	2,575	-	2,575	-	2,575	-	2,575	-	2,575	-	2,575	-	56,222	C	10.0
Objective E2	E2.1	Support working for water programme	950	-	950	-	950	-	950	-	950	-	950	-	950	-	6,650	O	-
Objective C1	C1.1	Establish District management areas	1,500	-	1,500	-	-	-	-	-	-	-	-	-	-	-	3,000	O	-
Objective C2	C2.1	Management Information System	10,000	0.6	10,000	0.6	1,000	0.1	1,000	0.1	1,000	0.1	1,000	0.1	1,000	0.1	25,000	C	1.6
	C2.2	Upgrading the telemetry system, remote communications (cell)	-	-	200	0.0	6,400	0.3	6,530	0.3	6,730	0.3	2,030	0.1	2,030	0.1	23,920	C	1.0
Total			79,442	16.0	44,065	6.8	42,550	7.1	39,635	4.7	32,785	3.5	28,035	3.3	28,085	3.3	336,382		44.8
Total, cumulative savings, Mm3/a				16		23		30		35		38		41		45			

Objective E1.3 only indicates treated effluent which is going to replace potable supply