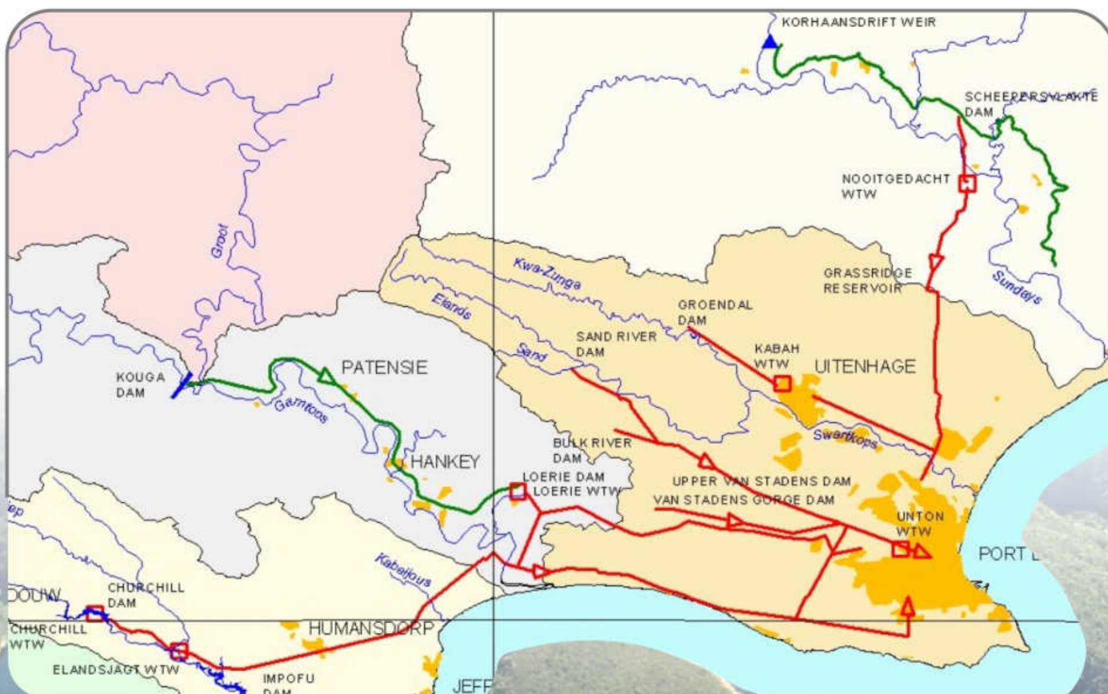
water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Water Reconciliation Strategy Study for the Algoa Water Supply Area

Preliminary Reconciliation Strategy



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CONSULTING SERVICES

May 2009

Department of Water Affairs and Forestry
Directorate: National Water Resource Planning

NS Project No. 402448

Water Reconciliation Strategy Study for the Algoa Water Supply Area

PRELIMINARY RECONCILIATION STRATEGY REPORT

Final

May 2009

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Department of Water Affairs and Forestry
Directorate National Water Resource Planning

Water Reconciliation Strategy Study for the Algoa Water Supply Area

APPROVAL

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EXECUTIVE SUMMARY

Introduction

The Algoa Reconciliation Strategy Study is being undertaken by the Department of Water Affairs and Forestry (the DWAF), in cooperation with the Nelson Mandela Bay Municipality (NMBM) in order to secure a sustainable future water supply to NMBM and surrounding towns served by the Algoa Water Supply System (AWSS). The study area extends from the Kouga River system in the west to the Sundays River system in the east. The AWSS provides water to the Gamtoos Irrigation Board, the NMBM and several smaller towns in the Kouga Municipality and the Sundays River Municipality.

Purpose of this document

The purpose of this document is to firstly describe the current water balance situation of the AWSS, and develop potential future water balance scenarios. It further aims to describe the proposed actions, and the associated responsibilities and timing of such actions that are urgently needed to prevent the risk of a water shortage becoming unacceptable. The Preliminary Reconciliation Strategy will focus more on the medium-term (i.e. up to 2020) interventions to meet the immediate and potential medium-term requirements. The final Reconciliation Strategy will evaluate the long-term needs to address the water requirements up to 2035.

The Algoa Water Supply System

The AWSS provides water to the Gamtoos Irrigation Board, the NMBM and several smaller towns in the Kouga Municipality and the Sundays River Municipality, as shown in the map on the following page. Although the Lower Sundays River Water User Association and the towns in the Sundays River Municipality do not form part of the AWSS, they also receive Orange River water. The total water available to NMBM from these sources is currently 93 million m^3/a (255 Ml/day) and for irrigation 50.4 million m^3/a (138 Ml/day) when agricultural use from rivers above dams that form part of the AWSS are excluded. The three components of the AWSS and main water users are described below.

Western System

The western system provides water to the NMBM from the Churchill and Impofu Dams on the Kromme River, Kouga Dam on the Kouga River and Loerie Balancing Dam on the Loerie Spruit, a tributary of the Gamtoos River. Bulk water provided to NMBM from the combined western system amounts to about 57 million m^3/a (156 Ml/day). The Gamtoos Irrigation Board requires 46 million m^3/a (126 Ml/day) on average.

Eastern System

The eastern system receives water transferred from the Gariep Dam on the Orange River via the Orange-Fish Tunnel, the Fish River and the Fish-Sundays Canal. The current quantity of bulk water provided to NMBM from this system is 25.6 million m^3/a (71 Ml/day). The Lower Sundays River Water User Association also receives water from the Gariep Dam via the same transfer scheme. Their average use is about 99 million m^3/a (271 Ml/day), with an allocation of 155 million m^3/a (424 Ml/day).

Secondary System

The secondary system consists of older dams on the Sand, Bulk, Van Stadens and Swartkops Rivers and the Uitenhage groundwater aquifer, all of which are owned by the NMBM. Combined, the quantity of water abstracted by NMBM from these sources is around 10 million m^3/a (27 Ml/day). Irrigation from Groendal Dam is 2.4 million m^3/a (6.5 Ml/day).

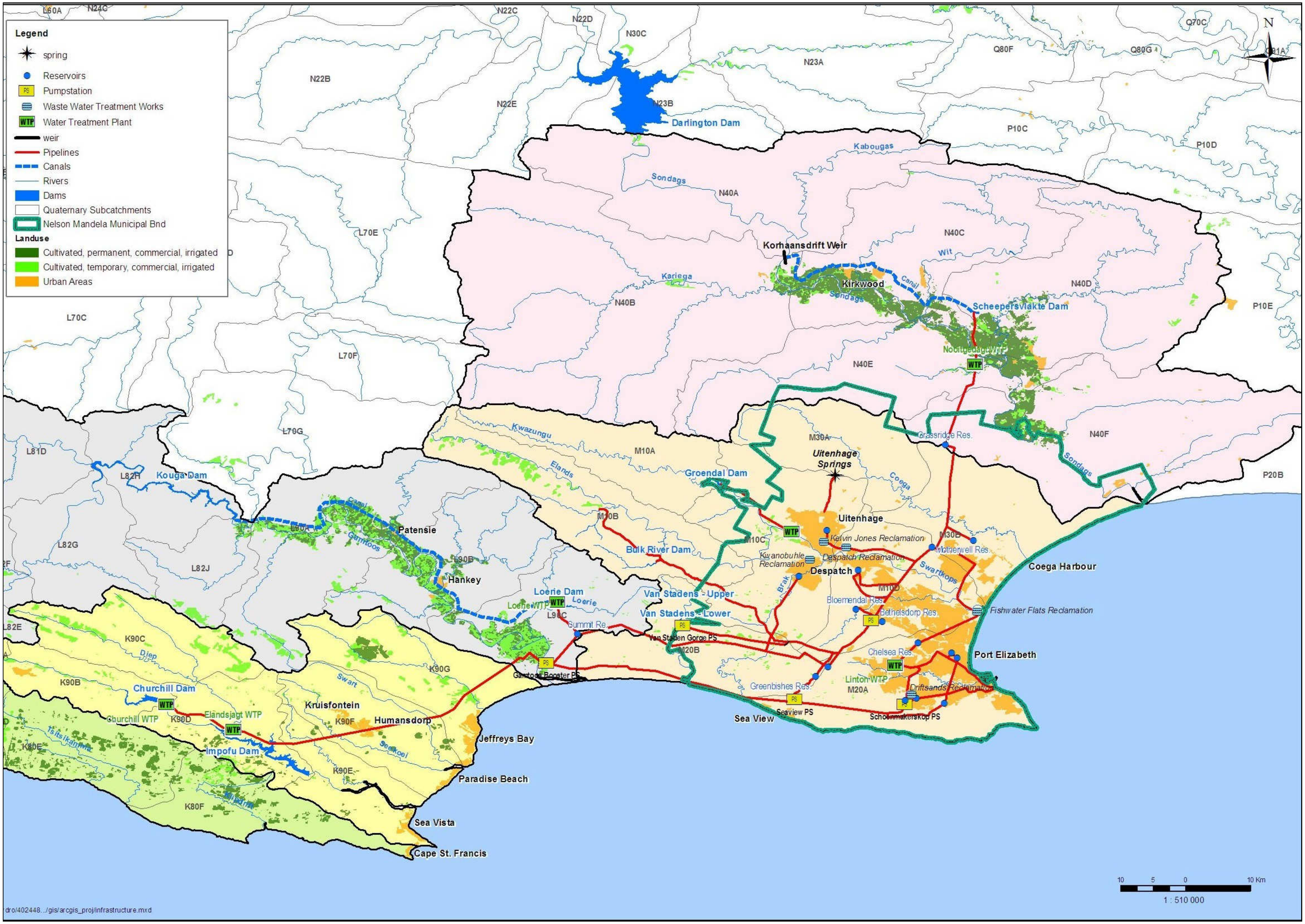

Figure E1 The Algoa Water Supply System

Total water use from the AWSS

Of the 159.1 million m^3 of water used from the AWSS in 2007/08, total urban/industrial use was 98.3 million m^3, total irrigation use was 50.4 million m^3, ecological water requirements were 2.0 million m^3, and canal losses/unaccounted-for-water from the infrastructure serving the Gamtoos Irrigation Board/NMBM amounted to 8.4 million m^3. Use by the various water use sectors is as shown in the following diagram.

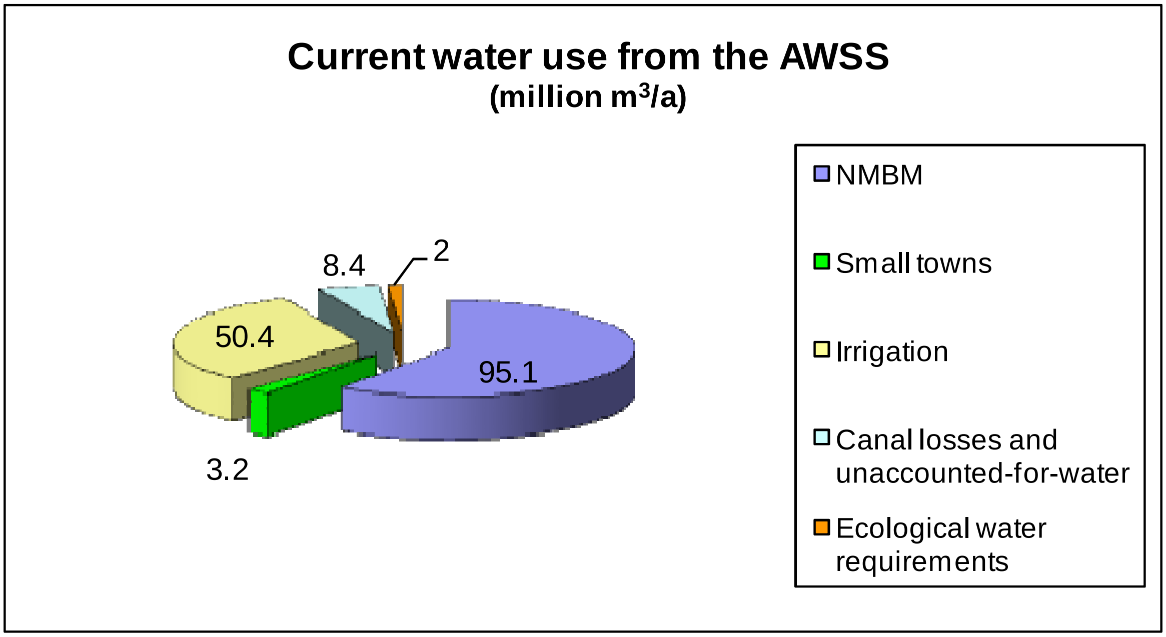

Figure E2 Current water use from the AWSS

Future water requirements

Water requirements in the Coega Industrial Development Zone (IDZ) will have a significant impact on the future water requirements of the region. Unfortunately, there is still a high degree of uncertainty related to water requirement forecasts for the Coega IDZ. If the Coega IDZ is established within the anticipated time-frames, then water supply to this area could be required by about 2012/13. The future water requirements of all sectors, other than urban/industrial water use, have been assumed to remain constant, as it is unlikely that further allocations will be made for irrigated agriculture from the AWSS.

The following scenarios for growth in urban/industrial use from the system were formulated:

- Scenario 1: *Low Growth Water Requirement*, 0.5% annual growth in water requirements. This scenario is based on low population growth (0.5%/a) and low economic growth.
- Scenario 2: *High Growth Water Requirement*, 2.5% annual growth in water requirements.
- Scenario 3: *Very High Growth Water Requirement*: 3.5% annual growth in water requirements.
- Scenario 4: *Alternative Very High Growth Water Requirement*, 3.5% annual growth in water requirements for 5 years, and 2.5% growth thereafter.
- Scenario 5: *High Coega Growth Requirement*, 2.5% growth/a of urban water requirements; Coega IDZ potable water requirements starting in 2008, growing to full use of 18.6 million m^3/a (51 Ml/day) over 20 years, and Coega IDZ industrial use starting

with a requirement of 20 million m^3/a (55 Ml/day), phased in over three years from 2012, and growing by 10%/a thereafter up to 2018, and at 2.5%/a thereafter.

Scenarios 3, 4, and 5 were developed to take into account the possible higher growth in water requirements arising from development in the Coega IDZ. The base year for water requirement scenarios is 2007/2008.

Water availability

The 1 in 50 year and 1 in 20 year long-term stochastic yields of the various sources of supply, available for urban, industrial and agricultural use are shown in the table below.

Table E1 Long-term stochastic yields of the Algoa Water Supply System

Sources of supply	1 in 50 year yield or existing allocation/use (Mm^3/a)	1 in 20 year yield or existing allocation/use (Mm^3/a)
NMBM older dams	3.3	4.0
Groendal Dam	6.5	6.5
Uitenhage Springs	2.4	2.4
Churchill/Impofu Dams	44.4	51.0
Kouga/Loerie Dams	75.5	86.0
Sundays River GWS	25.6	25.6
Re-use	1.7	1.7
Combined Total Yield	**159.4**	**177.2**

Bulk water planning is generally done at a 1 in 50 year assurance of supply, for urban water supply. For the AWSS, the urban water use is more than 60% of total use, and is expected to increase. Further evaluation and planning was done at a 1 in 50 year assurance of supply. Should some or all AWSS water users be supplied at a 1 in 20 year assurance of supply, an increased yield would be available for use, but at a much higher risk.

Comparison of requirement and availability

The Reconciliation Planning Support Tool (RPST) is a graphic, interactive support tool that assists water managers in planning how best to meet users' water requirements from the AWSS. It allows user to compare potential interventions, or groups of interventions, with one another, and with one or more selected future water requirements scenarios. The RPST was customised for the AWSS, and populated with the water requirement scenarios, 1:50 year yield of the AWSS, and information on the range of interventions evaluated, to be able to establish the estimated shortfall in water supply.

The water balance is as shown in the graph on the following page.

It is concluded that the system is just in balance now and that any increase in use will put the system in risk. The higher the growth in water requirements, the higher the risk would be, especially if the large users in the Coega IDZ manage to get established within the next five years. It is clear that measures to solve this problem must be implemented immediately.

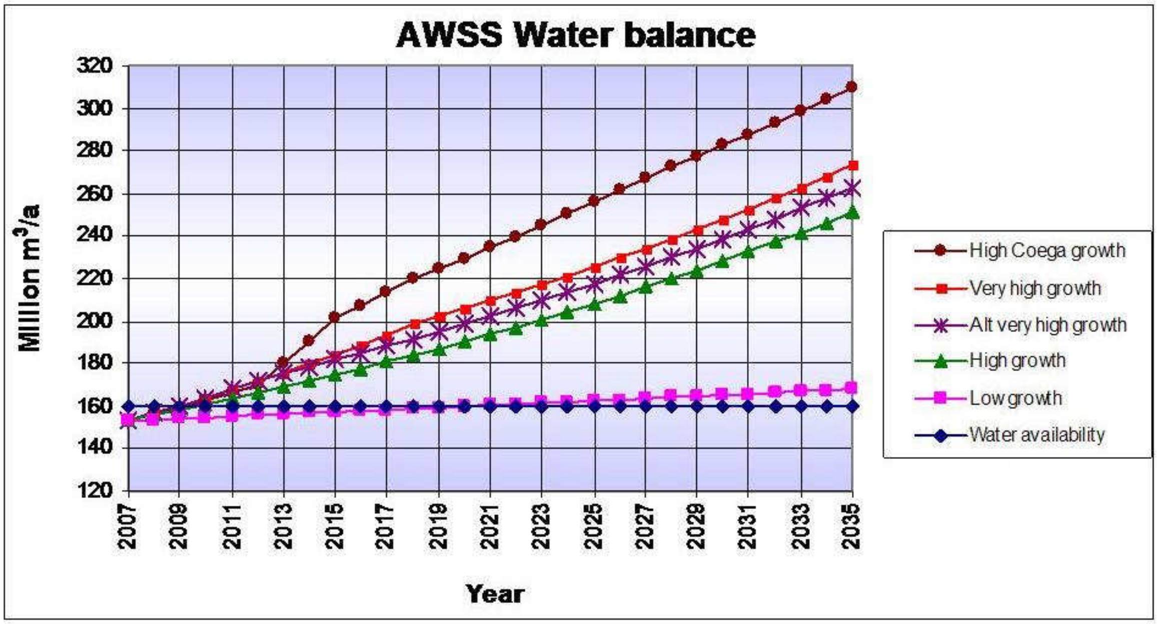

Figure E3 AWSS water balance

Selection of interventions

A significant number of potential interventions, which could contribute to meeting the future water requirements of the AWSS, were initially identified from previous and ongoing studies, with the inclusion of several newly formulated interventions. The following categories of interventions were identified:

- Water conservation and water demand management (WC/WDM);
- Increased operational efficiency of the current system;
- Trading of water use authorisations;
- Re-use of water;
- Groundwater schemes;
- Inter-basin transfer schemes;
- Desalination of seawater;
- Desalination of brackish river water; and
- Surface water schemes.

Detailed intervention implementation programmes were developed and interventions that could potentially be implemented in the medium-term were then identified.

Selection of interventions to consider for the Preliminary Strategy were based on:

a. Interventions that could, according to programme, be implemented before 2020;
b. Adequate intervention yield, and certainty that the yield can be realised; and
c. Reduction of risk, i.e. become less reliant on surface water sources.

Evaluation of interventions

These selected "medium-term" interventions were then evaluated and compared with one another. **Interventions that were not considered for the Preliminary Strategy can therefore not be implemented over the medium-term**, but could be considered for the Final Strategy. Further evaluation of the remaining potentially viable interventions will be done in the remainder of the study.

Preliminary scenario planning

The primary focus of the scenario planning evaluation was to find and evaluate the range of interventions available to be considered for potential implementation, to meet the expected shortfalls in the medium-term, up to 2020. This will enable early study and actioning of recommendations. Planning was done to meet the projected water requirements of the scenario with the highest water requirements, namely the *High Coega Growth Requirement Scenario*. The recommended interventions that are available for action, as soon as possible (as in most cases implementation will take a number of years) that could meet the immediate shortfalls, are shown in the following figure, and are described below:

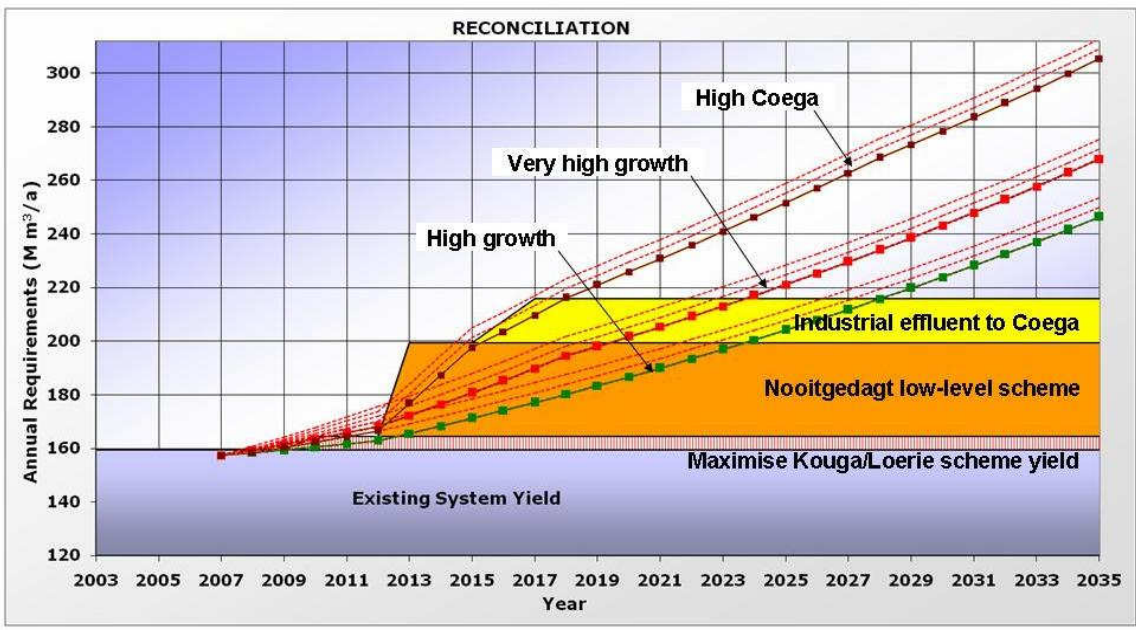

Figure E4 Recommended AWSS Water balance scenario

- **Implementation of the approved WC/WDM programme** over a 5-year period, to achieve the current identified potential savings of 7.3 million m^3/a (20 Ml/day) by NMBM. WC/WDM is an essential intervention. Its implementation should be afforded the highest priority and the required resources should be supplied. WC/WDM should be used as a proactive measure to lower water requirements;

- **Maximising of the existing Kouga/Loerie Scheme yield** through improved operational measures is a cost-effective and quick measure to implement, and should be pursued by both the DWAF and NMBM;

- **Implementation of the Nooitgedagt Low Level Scheme**, using additional Orange River water. This is the only significant intervention that can be implemented with an adequate level of certainty, and within a short enough period to avoid the risk of a significant shortfall. This would however depend on a licence allocation from the DWAF; and

- **Supply of treated effluent from the Fishwater Flats Wastewater Treatment Plant to the Coega IDZ**, which is a prerequisite for industrial water use by the Coega IDZ. Development of this scheme would however be influenced by the uncertainty that still prevails, about the likely level of industrial development in the Coega IDZ, and the timing thereof.

The selection of the Preliminary Strategy interventions described above is mainly based on the need to reduce the risk of shortfalls in the bulk water supply to the AWSS in the medium-term, the periods of time required for intervention implementation, and the certainty that intervention yields can be realised.

Recommendations

The periods required for the implementation of new water supplies, the potential available yields, and the extent of the additional infrastructure that would be required make it impractical to implement only a single solution. The Preliminary Reconciliation Strategy Action Plan therefore recommends that the following intervention be implemented as soon as possible:

- **Maximise the yield of the existing Kouga/Loerie scheme;**

Maximising the yield of the existing Kouga/Loerie scheme could be achieved by changing the operation of the relevant bulk infrastructure.

The Preliminary Reconciliation Strategy Action Plan further recommends that further studies of the following suite of interventions, dealing with both demand-side water management measures and supply-side water resource developments, are undertaken as a priority in order that these could be implemented as soon as possible:

- **Implementation of WC/WDM measures;**
- **Implement the Nooitgedagt Low Level Scheme, using additional Orange River water; and**
- **Re-use of water from the Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ.**

The Preliminary Reconciliation Strategy Action Plan also recommended that further studies of the following interventions should also be initiated as soon as possible:

- **Groundwater well-field development – responsibility NMBM;**
- **Seawater desalination: the Straits Chemicals supply option; and**
- **Use of desalinated lower Sundays River return flows – responsibility NMBM.**

There is a further urgent requirement to establish monitoring of flows in the lower Sundays River and possibly the lower Gamtoos River as well.

Interventions that have been evaluated for the Preliminary Reconciliation Strategy, but for which no recommendations are made will be addressed in the Final Reconciliation Strategy. The specific recommendations for the AWSS are described in subsequent sections. Other related aspects requiring attention are also presented.

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ABBREVIATIONS

AADD	Average annual daily demand
AADWF	Annual average daily water flow
AWSS	Algoa Water Supply System
CDC	Coega Development Corporation
DEAET	Eastern Cape Department of Economic Affairs, Environment and Tourism
DWAF	Department of Water Affairs and Forestry
EWR	Ecological Water Requirement
FWF	Fish Water Flats
IDZ	Industrial Development Zone
ISP	Internal Strategic Perspective
LSRWUA	Lower Sundays River Water User Association
NaCl	Sodium Chloride
NMBM	Nelson Mandela Bay Municipality
ORP	Orange River Project
RO	Reverse Osmosis
RPST	Reconciliation Planning Support Tool
WARMS	Water Use Authorisation and Registration Management System
WC/WDM	Water Conservation and Water Demand Management
WTW	Water treatment works
WWTW	Wastewater Treatment Works

Preliminary Reconciliation Strategy

1. BACKGROUND

1.1 Purpose

The purpose of this document is to firstly describe the current water balance situation of the Algoa Water Supply System (AWSS), and potential future water balance scenarios. It further aims to describe the proposed actions and the associated responsibilities and timing of such actions that are urgently needed to prevent the risk of a water shortage becoming unacceptable. The Preliminary Reconciliation Strategy will focus more on the medium-term (i.e. up to 2020) interventions to meet the immediate and potential medium-term requirements. The final Reconciliation Strategy will evaluate the long-term needs to address the water requirements up to 2035.

1.2 Overview of the study area

The Nelson Mandela Bay Municipality (NMBM) is regarded as the economic hub of the Eastern Cape Province, contributing more than 40% of the Gross Geographic Product of the whole Province. For the next ten years, economic growth has the potential to rise above 5% per annum (although this may be tempered by the current economic climate), given the establishment of the Coega Industrial Development Zone (IDZ) and the international deep harbour at Ngqura. The proximity of extensive commercial agriculture contributes to growth in the NMBM, providing permanent and seasonal jobs, and value-added activities for communities, both within and on the fringe of the NMBM. The opportunities within the NMBM have led to a rapidly increasing population through in-migration and growth in peri-urban settlements, which has exacerbated the backlog in services.

1.3 The Algoa Reconciliation Strategy

1.3.1 The need for a strategy

As a proactive activity to ensure water availability for continued growth and development in the country the Directorate: National Water Resource Planning of the Department of Water Affairs and Forestry (the DWAF) embarked on a number of reconciliation strategy studies of large metropolitan areas. The *Water Reconciliation Strategy Study for the Algoa Water Supply System* covers the area supplied by the AWSS.

1.3.2 Strategy objectives

The purpose of the Strategy is to achieve reconciliation of the available water supply with the water requirements up to 2035 of water services authorities, mainly the NMBM, and industrial and agricultural water users in the area served by the AWSS. The Strategy aims for adequate levels of assurance of supply within the constraints of affordability and at appropriate levels of service to users, whilst ensuring protection of current and possible future resources, and efficiency of operation and management of the AWSS, in an integrated and sustainable manner.

As the current water supply available can just meet the current requirements, urgent augmentation of the available water supplies is required. The purpose of the Preliminary Reconciliation Strategy is to identify and prioritise suitable reconciliation measures to ensure a water balance up to about 2020. The Preliminary Strategy will form part of the full (longer-term) Strategy.

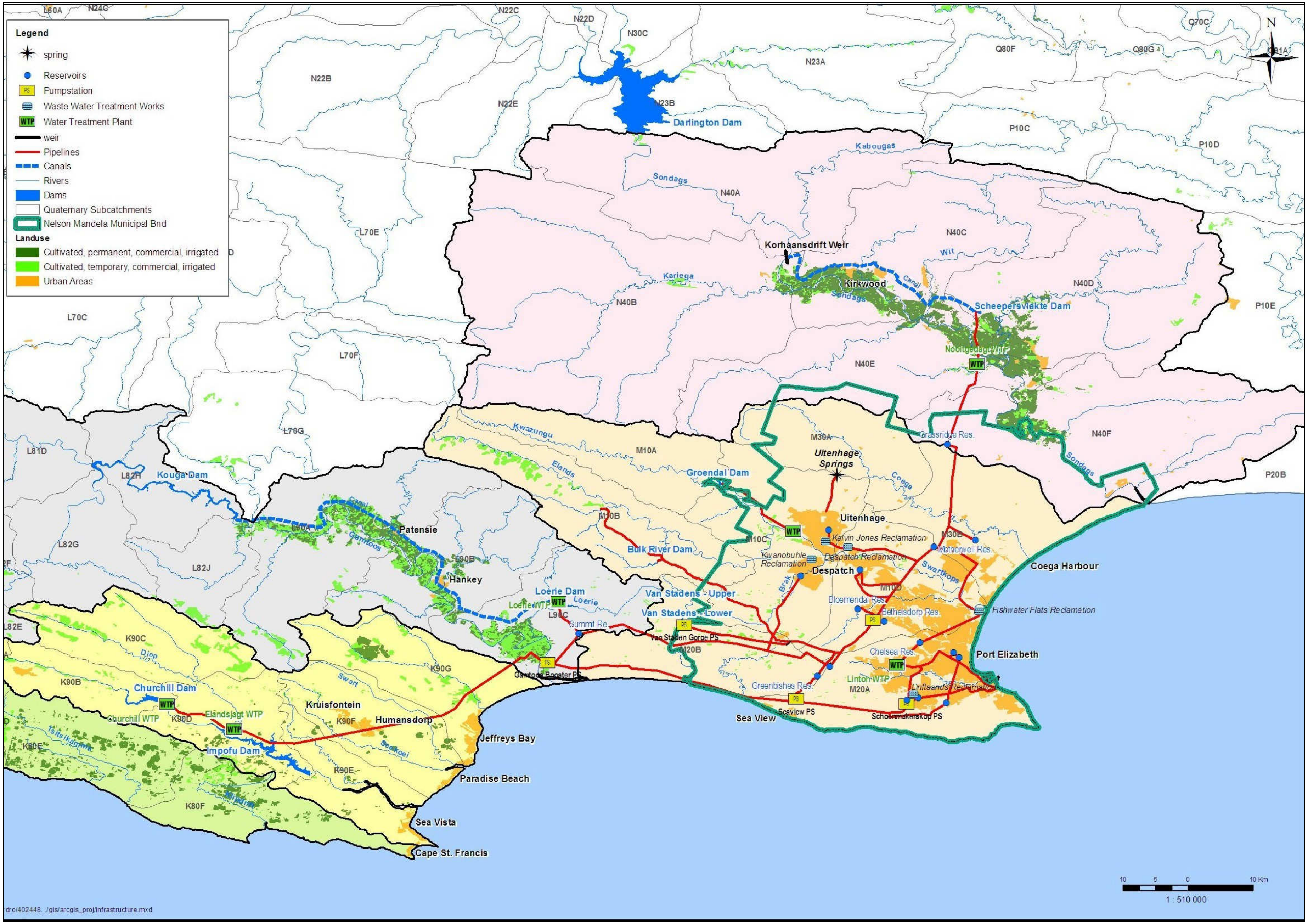

Figure 1.1 The Algoa Water Supply System

Following development of the Preliminary Reconciliation Strategy, development of the full Reconciliation Strategy will aim to refine identified aspects of the Preliminary Strategy, and identify and prioritise suitable further reconciliation measures to ensure a water balance up to about 2035.

The Strategy Action Plan consolidates the planning process to ensure implementation of actions.

The objectives of the Preliminary Reconciliation Strategy are to:

- Commence with public participation and awareness creation of the imminent water shortages and the study;
- Establish an initial database of key stakeholders and role-players within the AWSS;
- Devise a set of interventions and water-balance scenarios for further review and consideration by stakeholders and experts;
- Devise criteria for selection and short-listing of interventions for applicability to the ten-year timeframe; and
- Prepare recommendations for implementation of interventions and propose actions regarding further investigations, to meet the anticipated significant medium-term growth in the water requirements of the AWSS.

1.4 The Algoa Water Supply System

The AWSS provides water to the Gamtoos Irrigation Board, the NMBM and several smaller towns in the Kouga Municipality and the Sundays River Municipality, as shown in **Figure 1.1** on the previous page. Although the Lower Sundays River Water User Association and the towns in the Sundays River Municipality do not form part of the AWSS, they also receive Orange River water. The total water available to NMBM from these sources is currently 93 million m^3/a (255 Ml/day) and for irrigation 50.4 million m^3/a (138 Ml/day), excluding agricultural use from the rivers upstream of the dams that form part of the AWSS. The three components of the AWSS and main water users are described below.

Western System

The Western System provides water to the NMBM from the Churchill and Impofu Dams on the Kromme River, from the Kouga Dam on the Kouga River and from the Loerie Balancing Dam on the Loerie Spruit, a tributary of the Gamtoos River. Bulk water provided to NMBM from the combined Western System amounts to about 57 million m^3/a (156 Ml/day). The Gamtoos Irrigation Board requires 46 million m^3/a (126 Ml/day) on average from Kouga Dam. There is further relatively small usage by towns and irrigator and for ecological water requirements (EWR).

Eastern System

The Eastern System receives water transferred from the Gariep Dam on the Orange River via the Orange-Fish Tunnel, the Fish River, the Fish-Sundays Canal, Skoenmakers River, and Darlington Dam. The current quantity of bulk water provided to NMBM from this system is 25.6 million m^3/a (71 Ml/day). The Lower Sundays River Water User Association (LSRWUA) also obtains water from the Gariep Dam via the same transfer scheme. Their total average use is about 99 million m^3/a (271 Ml/day) and their total allocation, including the reserved water to be allocated at some future date for the proposed expansion of the irrigation area to serve historically disadvantaged farmers, is 155 million m^3/a (424 Ml/day).

Secondary System

The Secondary System consists of the older dams on the Sand, Bulk, Van Stadens and Swartkops Rivers and the Uitenhage groundwater aquifer, all of which are owned by the NMBM. Combined, the quantity of water abstracted by NMBM from these sources is around 10 million m^3/a (27 Ml/day) and Groendal Dam also supplies 2.4 million m^3/a (6.5 Ml/day) to irrigators.

2. WATER REQUIREMENTS

2.1 Water use

The total current (2007/08) usage of water from the AWSS is 159.1 million m^3/a. Comprising urban use by NMBM and towns, agricultural water use, losses from the Kouga/Loerie canal, and ecological water requirements as discussed below.

2.1.1 Urban water use

The AWSS provides water for domestic use and for more than 373 industrial users in the NMBM and several other smaller towns within the Kouga Municipality.

The opportunities within the NMBM have led to a rapidly increasing population through in-migration and growth in peri-urban settlements. This has exacerbated the backlog in services, which were inherited when the NMBM was created through the amalgamation in 2000 of four separate municipalities. At present the housing backlog is around 88 000 units, most of which fall within the low-income categories. In addition to the housing backlog, it is estimated that the need for new residential erven could be as high as 28 000. Of the current 300 000 households within the NMBM, around 27 000 do not have in-house water supplies and 32 000 do not have sanitation services. A further 25 000 are on the bucket system, which the NMBM is committed to eradicate and replace with reticulated sewage systems. Approximately 45 000 new low-cost houses were built from 1994 to 2008. All new houses built since 1994 are fully serviced, contributing to the high growth in water requirements.

The water use and water allocations of NMBM, as registered in DWAF's Water Use Authorisation and Registration Management System (WARMS) database, are the following:

Table 2.1 NMBM registered water use and water allocations

Dam or river	**Water use start date or registration date**	**Registered volume (Mm^3/a)**	**Water allocation (Mm^3/a)**
Kouga/Loerie dams	1968/01/01	23.000	23.000
Lower Sundays River	1993/01/01 2005/06/01 2007/01/01	13.500 17.000 22.000	13.500
Kromme River, Impofu Dam	1985/01/01	18.000	18.000
Kromme River (Churchill Dam)	1946/01/01	20.075	20.075
Bulk River (Bulk River Dam)	1906/01/01	0.910	0.910
Sand River and Palmiet River (Sand River Dam)	1973/01/01 2005/06/01	1.825 2.555	1.825
Van Stadens River (Upper Dam)	1975/05/01	0.365	0.365
Van Stadens River (Lower Dam)	1975/05/01	0.730	0.730
Total allocation			**78.410**

The registered uses by NMBM have not yet been verified and water use licences have therefore not yet been issued.

The water requirements of the NMBM have increased steadily over the past few years, due to the in-migration, increased service levels and industrial activity. In 2007/2008 urban water use of NMBM was 93.4 million m^3/a (255.9 Ml/day), with additional re-use of water by industries located within the NMBM of.1.7 million m^3/a. The 2007/2008 urban water use of Humansdorp, Jeffrey's Bay, Paradise Beach, and St Francis Bay was 2.6 million m^3/a (7.1 Ml/day). Urban use from the Kouga/Loerie sub-System by the small inland towns of Hankey, Patensie, and Loerie is estimated to be 0.6 million m^3/a (1.6 Ml/day). Total urban and industrial use from the system is therefore estimated to be 98.3 million m^3/a (269.3 Ml/day).

Historical urban and industrial water use from the AWSS is shown in **Figure 2.1**.

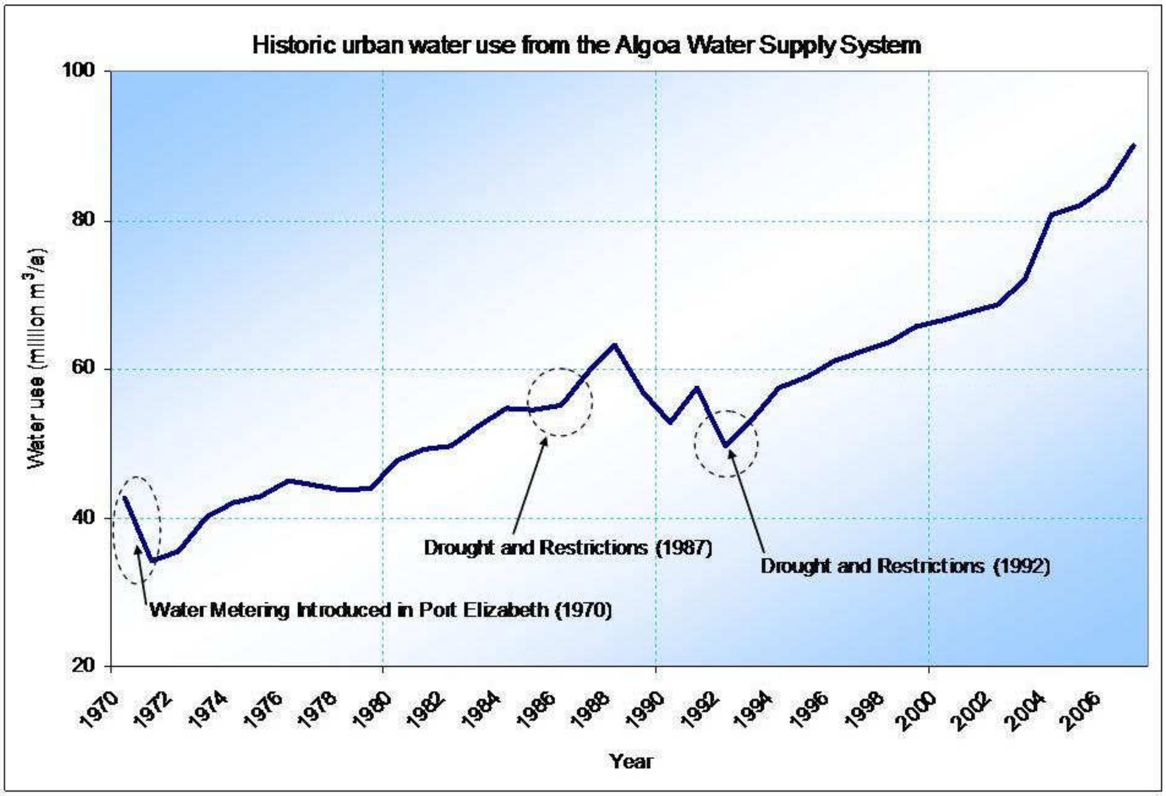

Figure 2.1 Historical urban and industrial water use from the AWSS

2.1.2 Agricultural water use

The full allocation to the Gamtoos Irrigation Board is 59.36 million m^3/a (7 420 ha at 8 000 m^3/ha), but in most years inadequate yield is available from the Kouga Dam to enable the irrigators to make full use of this allocation. Until recently, the modelled annual use of the Gamtoos Irrigation Board was 42 million m^3/a. This use has increased in the last two years to 46 million m^3/a (126 Ml/day), mainly as a result of expansion of irrigated areas (mainly citrus). Another possible reason for some of the apparent increase in water use is the replacement of old water meters with new ones. As a result, some hitherto unaccounted-for-water/losses have been identified as water use. Noting the increased actual use in recent years, it was decided amongst the delegates at the Operations Workshop for this study, held in October 2008 that, for future yield or planning analyses of the AWSS, an average use of 46 million m^3/a (126 Ml/day) by the Gamtoos Irrigation Board, from the Kouga Dam, should be modelled.

Historical water use by the Gamtoos Irrigation Board is shown in **Figure 2.2.**

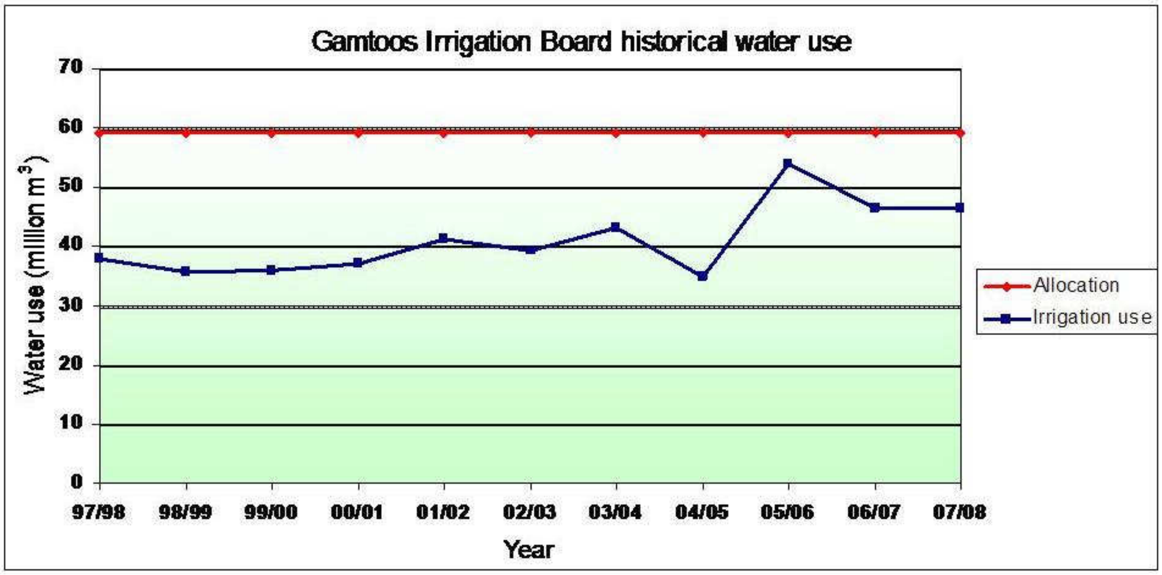

Figure 2.2 Historical water use by the Gamtoos Irrigation Board

The allocated irrigation quota from the Groendal Dam is 2.4 million m^3/a (6.5 Ml/day). This use was not previously included as use from the AWSS, but for completeness, is now taken into account. Usage from the Impofu Dam for irrigation and a bottling plant is about 2 million m^3/a (5.5 Ml/day).

Therefore the combined total usage by agriculture from the current AWSS is estimated to be 50.4 million m^3/a (138 Ml/day). This excludes irrigation usage from the rivers upstream of the dams that form part of the AWSS. Upstream usage is taken into account in the determination of the yields that are available from the dams for downstream usage from the AWSS.

The LSRWUA irrigates with Orange River water transferred from Gariep Dam on the Orange River via the Orange-Fish Tunnel, the Fish River, the Fish-Sundays Canal, Skoenmakers River, and Darlington Dam. The total allocation from the Gariep Dam is 155 million m^3/a (424 Ml/day) and the current average usage is in the order of 99 million m^3/a (271 Ml/day). These figures have not been included in the AWSS model, as the water is transferred from a system that is separate from the AWSS.

2.1.3 Canal losses

Estimated losses/unaccounted for water from the conveyance canal from Kouga Dam to Loerie Balancing Dam have decreased from previous estimates, mainly due to improved metering, to 8.4 million m^3/a (23 Ml/day) in 2007/08.

2.1.4 Total current use from the AWSS

The estimated current water usage from the AWSS is as follows:

Table 2.2 Current use from the AWSS (million m^3/a)

Use or allocation	Million m^3/a
NMBM – urban and industrial use	93.4
Re-use of water by industries located within the NMBM	1.7
Humansdorp, Jeffrey's Bay, Paradise Beach and St Francis Bay – urban use	2.6
Hankey, Patensie and Loerie – urban use	0.6
Gamtoos Irrigation Board*****	46.0
Groendal irrigators	2.4
Agricultural use from Impofu Dam	2.0
Ecological water requirement (EWR) from Impofu Dam	2.0
Gamtoos Irrigation Board canal losses / unaccounted-for-water	8.4
Total use	**159.1**

* Note that the annual requirement of the Gamtoos Irrigation Board has increased from 42 million m^3/a to 46 million m^3/a as a result of hitherto unaccounted-for-water/losses, which have been identified as water use, after improved metering.

Of the 159.1 million m^3 of water used from the AWSS in 2007/08, total urban/industrial use was 98.3 million m^3, total irrigation use was 50.4 million m^3, ecological water requirements were 2.0 million m^3, and unaccounted-for water/canal losses from the Gamtoos Irrigation Scheme amounted to 8.4 million m^3. Usage by the various water use sectors in 2007/08 is as shown in **Figure 2.3**.

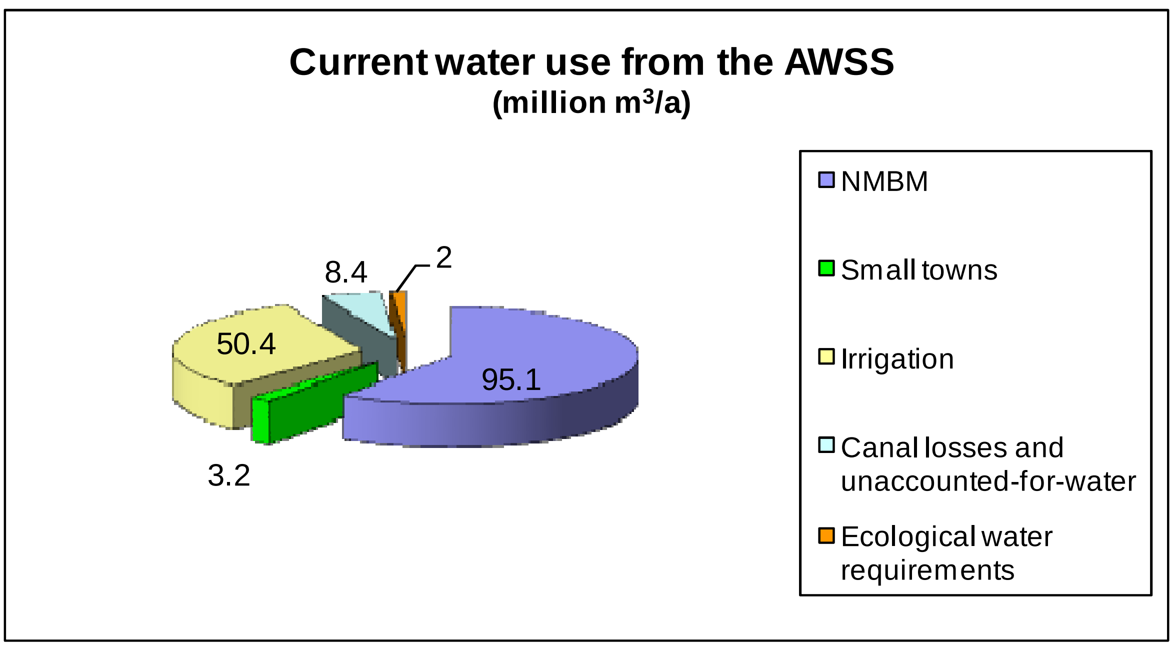

Figure 2.3 Current water use from the AWSS

2.2 Future water requirements scenarios

2.2.1 Understanding past growth in urban and industrial water use

Although population and economic activity records are too coarse to do a detailed econometric analysis of the contributing factors to the water use over the period, the following observations are made, based on the available data and on the various investigations of the work undertaken in the study area in the recent past.

Urban and industrial water use in the region has grown, on average, at 3.9%/a over the period 1971 to 2007. The key drivers of this growth have been population growth and economic development. This growth has not been consistent over this period, and has fluctuated quite significantly. The water growth has included periods of negative growth as a result of water restrictions in times of drought, and periods of more rapid growth in the periods following these restrictions.

Water use, when expressed on a per capita basis, has ranged between 150 and 200 litres per person per day. There are uncertainties, however, associated with the urban population numbers. Census data shows a significant decline in population growth in more recent years, from 3.2%/a in the 1970s to less than 1%/a after the 1996 Census.

From a management perspective, urban and industrial water requirements are also sensitive to the metering, billing, credit control and cash collection practices.

2.2.2 Key factors affecting future urban and industrial water use

The following factors are likely to impact significantly on future water use:

- **Population growth**, which in turn will be affected by fertility levels, life expectancy, and migration patterns. There appears to be a fairly strong consensus that fertility levels are declining and that life expectancy will decline significantly as a result of HIV/AIDS. This results in base population growth forecasts being low, at 0.5%/a. The key uncertainty has to do with migration patterns. Immigration from rural areas to the NMBM area is expected to be strong. However, there also appears to be out-migration from this area to urban areas in the Western Cape and Gauteng. These patterns are driven largely by economic forces.

- **Economic growth**. The region enjoyed strong economic growth in the 1970s and more recently after 2000. This was partly the result of the strong country–wide economic growth experienced in the previous seven years. However, a major contributor to growth in this region is government services and related investment associated with the Coega IDZ and its associated infrastructure requirements. The success, or otherwise, of the Coega IDZ will have a significant influence on the future economic growth of this area.

- **Price**. Although urban water price elasticities are not anticipated to be very high (typically less than -0.3 and more often substantially less than this), if future supply options are significantly more expensive than the current supplies, then water requirements will be affected.

- **Water management**. The effectiveness of water management in terms of water meter coverage, the extent and accuracy of meter reading and billing, and the effectiveness of credit control policies will also affect water requirements.

2.2.3 Coega IDZ use

Future water requirements in the Coega IDZ will have a significant impact on the total water requirements of the system. Unfortunately, there still appears to be a high degree of uncertainty relating to the establishment of industries and the resultant water requirement forecasts for the Coega IDZ.

The following information was sourced from the Coega IDZ Water and Return Effluent Study Report, 2007. As better data becomes available, this information will be updated. The 2007 future water requirement estimates indicated that:

- A total of 18.6 million m^3/a (50.9 Ml/d AADD) of potable water is required for the fully developed IDZ, including Markman, by 2040; and
- The total requirement for water treated to industrial standards is 20.6 million m^3/a (56.5 Ml/d AADD), including Markman.

Recent information provided by the Coega IDZ for the Metallurgical Cluster (the largest expected user group) located within the Coega IDZ shows that significant industries (e.g. Kalagadi, Exxaro and PetroSA) have signed up or have indicated potential requirements for potable and industrial water usage. If development takes off as anticipated by the Coega IDZ, current indications are that, by 2015, industrial and potable water requirements of up to 19 million m^3/a (52 Ml/day) could potentially be needed for the Metallurgical Cluster.

It should be noted that both the volume of these additional requirements, as well as their timing, is very uncertain (refer to the qualification to water requirement scenarios given below).

2.2.4 Future water requirement scenarios

Key assumption

The future water requirements from the AWSS of all sectors, other than urban/industrial water use, have been assumed to remain constant, as it is unlikely that further allocations will be made.

Important qualification

It is important to note that the scenarios presented below were developed at a very early stage of the global economic crisis. A global recession and a slow recovery from this recession are likely to have significant implications for water requirement growth projections for the AWSS. **In particular, there is a significant risk that the projected requirements for Coega IDZ may not materialise, or may materialise much more slowly than presented in these scenarios**.

The resultant implications for a strategy to meet water requirements are the following:

- We have entered into a more fluid situation with much greater uncertainty;
- Water use must be continuously and carefully monitored;
- Future scenarios/projections need to be revised frequently, based on updated information;
- Planning to increase water availability needs to be as flexible as possible; and
- Interventions that are more flexible in terms of timing should be favoured, all other considerations being equal.

Further work on water requirement scenarios will be undertaken during the remainder of the study, refining these scenarios and taking into account the risks of the global recession on local economic activity and on projected water requirements in the Coega IDZ. The likely impact of this refinement could be to reduce the growth rate for projecting future water requirements and to increase or reduce the total water requirement. The refinement to the water requirement scenarios will also take the potential for water demand management into account.

Urban/industrial water use scenarios

The following scenarios for growth in urban/industrial use from the system were agreed at the Water Requirements Workshop for this study, held in October 2008:

Scenario 1: *Low Growth Water Requirement*, 0.5% annual growth in water requirements. This scenario is based on low population growth and low economic growth.

Scenario 2: *High Growth Water Requirement*, 2.5% annual growth in water requirements.

Scenario 3: *Very High Growth Water Requirement*: 3.5% annual growth in water requirements.

Scenario 4: *Alternative Very High Growth Water Requirement*, 3.5% annual growth in water requirements for 5 years, and 2.5% growth thereafter.

Scenario 5: *High Coega Growth Requirement*, 2.5% growth/a of urban water requirements; Coega IDZ potable water requirements starting in 2008, growing to full use of 18.6 million m^3/a (51 Ml/day) over 20 years, and Coega IDZ industrial use starting with a requirement of 20 million m^3/a (55 Ml/day), phased in over 3 years from 2012, and growing by 10%/a thereafter up to 2018, and at 2.5%/a thereafter.

Scenarios 3, 4, and 5 were developed to take into account the possible higher growth in water requirements arising from development in the Coega IDZ. The base year for water requirement scenarios is 2007/2008. These water requirement scenarios are shown in **Figure 2.4**.

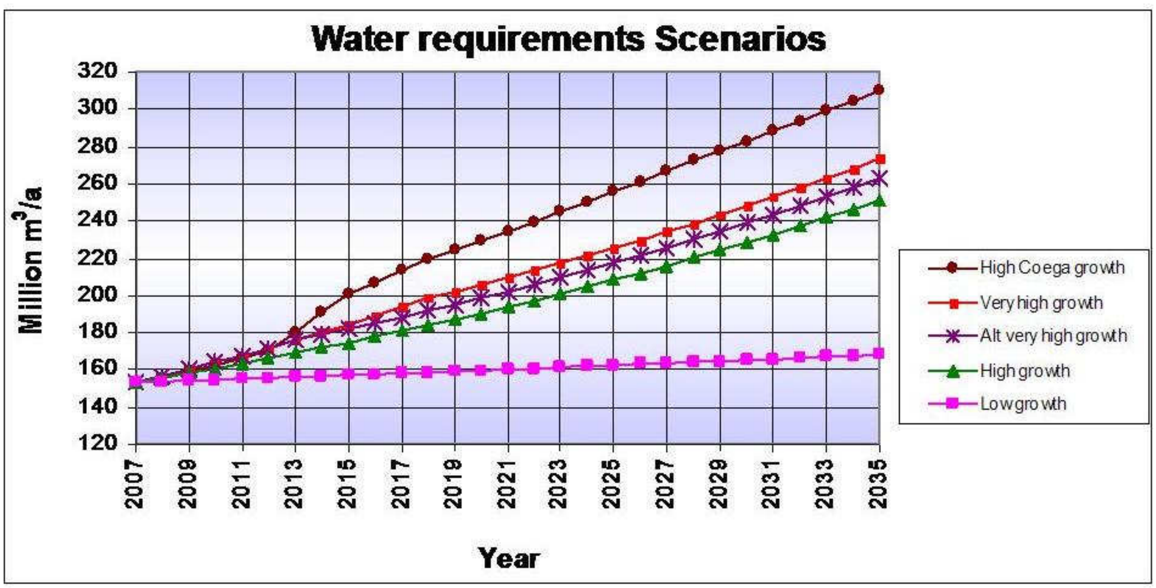

Figure 2.4 Water requirement scenarios for the AWSS

Figure 2.5 illustrates how each water use sector would contribute to the growth in water requirements of the AWSS, for the *High Coega Growth Requirement Scenario*.

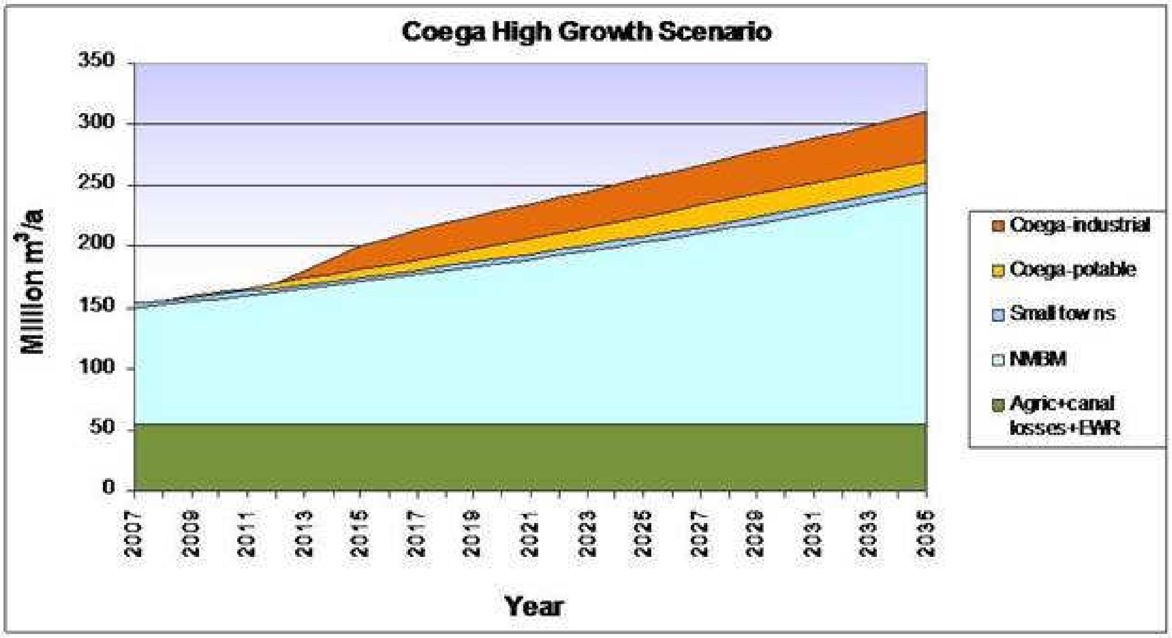

Figure 2.5 Scenario 5: Sectoral contribution to growth in water requirements

3. WATER AVAILABILITY AND SYSTEM OPERATION

3.1 Yield of the Algoa Water Supply System

The 1 in 50 year and 1 in 20 year long-term stochastic yields of the various sources of supply, available for urban, industrial and agricultural use are shown in **Table 3.1**. These yields are mainly based on the Algoa Water Resources Stochastic Analysis Study (DWAF, 1996), but also on the Algoa Pre-feasibility Study (DWAF, 2002) and the latest available yield estimates for the Uitenhage Springs. The Algoa Operational Analysis Study has confirmed the yields of the Kouga/Loerie and Churchill/Impofu sub-systems. No information on updated yield determinations have to date become available from the Algoa Water Resources Bridging Study (DWAF, 2007).

Table 3.1 Long-term stochastic yields of the Algoa Water Supply System

Sources of supply	1 in 50 year yield or existing allocation/use (Mm^3/a)	1 in 20 year yield or existing allocation/use (Mm^3/a)
NMBM older dams	3.3	4.0
Groendal Dam	6.5	6.5
Uitenhage Springs	2.4	2.4
Churchill/Impofu Dams	44.4	51.0
Kouga/Loerie Dams	75.5	86.0
Sundays River GWS	25.6	25.6
Re-use	1.7	1.7
Combined Total Yield	**159.4**	**177.2**

Bulk water planning is generally based on a 1 in 50 year assurance of supply, for urban water supply. For the AWSS, urban water use comprises more than 60% of the total use, and is expected to increase. Therefore evaluation and future planning will be based on a 1 in 50 year assurance of supply. Should irrigation water use in the AWSS be supplied at a 1 in 20 year assurance of supply, an increased yield would be available for use, but at a higher risk.

The allocated quota for irrigation of 2.4 million m^3/a (6.46 Ml/d), from the Groendal Dam, which according to a Water Court ruling takes priority over the urban water allocation from Groendal Dam, has been included in the yield of Groendal Dam.

3.1.1 Ecological water requirements

No new EWRs have been taken into account for the rivers of the AWSS in the Preliminary Strategy, but this will be revisited in the compilation of the final Strategy.

The existing ecological water requirement (EWR) for the lower Kromme River of 2 million m^3/a (5.5 Ml/day) has been taken into account, although no ecological releases are at present being made from the Impofu Dam. The Preliminary Kromme Estuary EWR of 5 million m^3/a (13.7 Ml/day), as determined in the 2005 Kromme/Seekoei Comprehensive Reserve Determination Study, has not been taken into account in the determination of the system yield.

3.2 Operation of the AWSS

The AWSS system also comprises extensive bulk conveyance infrastructure components which are owned and operated by the DWAF, the Gamtoos Irrigation Board, and the NMBM. Irrigation requirements from the AWSS peak in the summer months from October to January, which is also the rainy season. Domestic requirements of NMBM also peak over the summer season, with the added effect of around 300 000 visitors to the many holiday resorts close by, most of whom arrive during this peak period.

The municipal supply is optimised for cost of operation, however, the available storage capacity for all dams is not utilised due to capacity limitations of pipelines and treatment works. There is also some capacity (which is currently not fully utilised) to re-use more water from the six largest wastewater treatment works (WWTW).

As indicated in **Appendix B**, an additional 1:50 year system yield of 26 million m^3/a (71.2 Ml/day) relative to the current system yields, and a 1:20 year system yield of 17 million m^3/a (46.5 Ml/day) could be accommodated by the existing pipeline infrastructure if this is upgraded by boosting, so as to meet the peak week demand factor of 1.3. The capacities of all existing water treatment works, pumps, and pipelines were considered for the assessment.

Unaccounted-for water losses are around 20%, reaching up to 40% in some municipal areas, which represent significant potential for water savings from the existing water supply system. The operation and management of the AWSS can also be modified to improve operation and reduce water wastage (including improved operation of Loerie Dam as discussed in Section 6.2).

The inter-basin transfer from the Gariep Dam on the Orange River contributes about 560 million m^3 per year to the Fish and Sundays Rivers, mainly for irrigation and to dilute the salinity levels in these rivers when there is surplus water in the Orange River system. Current water supply for irrigation from the Orange River to the LSRWUA is about 99 million m^3 per year.

4. COMPARISON OF REQUIREMENT AND AVAILABILITY

For the determination of the current water balance of the AWSS, it is recommended that urban water requirements, EWR, and losses/unaccounted-for-water from the Gamtoos Canal be assessed at a 1:50 year assurance of supply, whilst water for irrigated agriculture is assessed at a 1:20 year assurance of supply. The exception would be the 2.4 million m^3/a supplied to the irrigators below Groendal Dam, which receives preference above the urban water supply from Groendal Dam, in terms of a Court Order, and is therefore assessed at a 1:50 year assurance of supply.

The assurance of supply at which irrigators receive water from Kouga Dam needs to be considered further, on account of uncertainties concerning the extensive irrigation usage in the Langkloof upstream of the Kouga Dam. It is generally accepted that the Kouga/Loerie sub-system is over-allocated, that the confidence in the water balance of this sub-system is low, and that the water balance of this sub-system must be revisited. The determination of the maximum yield available for irrigation, for use by the Gamtoos Irrigation Board from the Kouga/Loerie Sub-system, has been determined from the 1:50 year yield of the sub-system minus the 1:50 year urban water use allocation from the sub-system (NMBM and some small towns) and the main canal UAW/distribution losses; i.e.:

$$75.5 - (23.0+0.6+8.4) = 43.5 \text{ million } m^3/a.$$

Using the relationship between the 1:50 year and 1 :20 year yields for the Kouga/Loerie Sub-system determined for the Algoa Stochastic Analysis, this translates to a maximum 1:20 year requirement of 49.5 million m^3/a at an assurance of 1:20 year for irrigation. The 2007/08 water use of 46.0 million m^3/a at an assurance of 1:20 years is therefore still less than the theoretical maximum potential irrigation water supply from this sub-system, although there is doubt whether such additional water is actually available for increased use.

Use by the various water use sectors of the AWSS, according to assurance of supply, is as shown in **Table 4.1**.

Table 4. 1 Current requirement from the AWSS according to assurance of supply (million m^3/a)

Water use	Requirement		
	At 1:50 year	At 1:20 year	Equivalent 1:50 year
Urban and industrial use	98.3		98.3
Gamtoos Irrigation Board[1]		46.0[1]	40.4[2]
Groendal irrigators	2.4		2.4
Agricultural use from Impofu Dam		2.0	1.7[3]
Ecological water requirement (EWR) from Impofu Dam	2.0		2.0
Gamtoos Irrigation Board canal losses / unaccounted-for-water	8.4		8.4
Total use			**153.2**

1. Note that the annual requirement of the Gamtoos Irrigation Board has increased from 42 million m^3/a to 46 million m^3/a as a result of hitherto unaccounted-for-water/losses, which have been identified as water use, after improved metering.
2. The equivalent 1:50 year agricultural water use for the Gamtoos Irrigation Board was calculated using the relationship between the 1:50 year and 1:20 year stochastic yields for the Kouga/Loerie Sub-system.
3. The equivalent 1:50 year agricultural water use from Impofu Dam was calculated using the relationship between the 1:50 year and 1:20 year yields for the Churchill/Impofu Dams.

If the 2007/08 equivalent 1:50 year water use of 153.2 million m^3/a is compared with the 1:50 year system yield of 159.4 million m^3/a, the 2007/08 surplus was 6.2 million m^3/a (17.0 Ml/day).

The Reconciliation Planning Support Tool (RPST), described in Section 5.2, was customised for the AWSS. The RPST was populated with the water requirement scenarios described in Section 2.2.4, 1:50 year yield of the AWSS, and information on the range of interventions evaluated, to be able to establish the estimated shortfall. The Water Availability from the existing AWSS is compared with the Water Requirement Scenarios (**Figure 2.4**) in **Figure 4.1**.

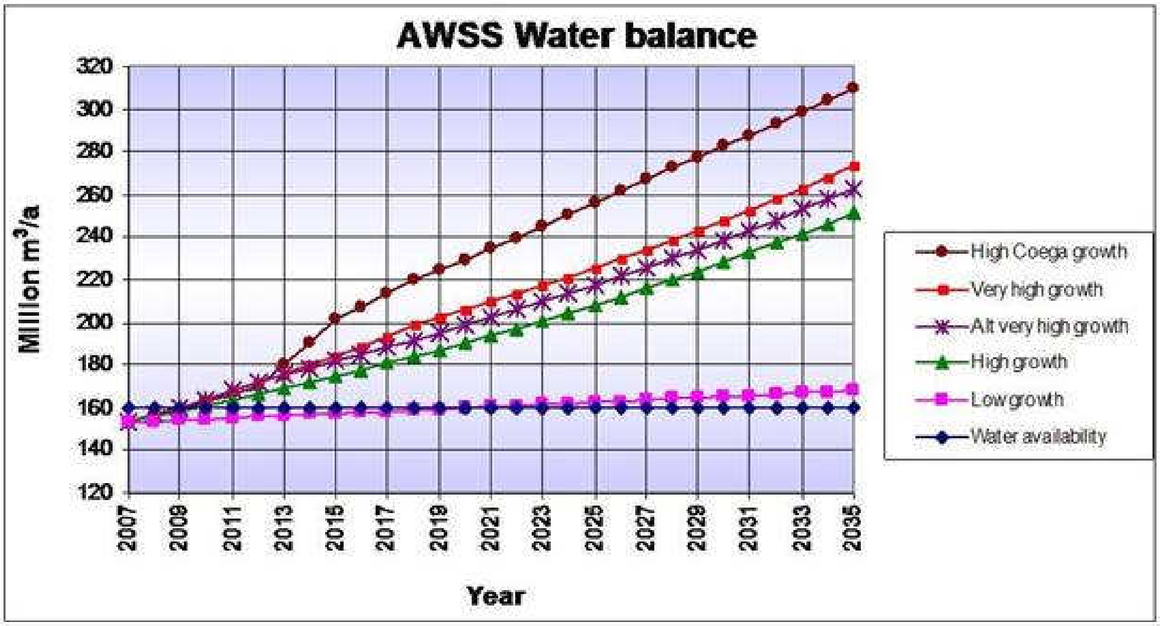

Figure 4.1 AWSS water balance

The potential influence of additional EWRs from the existing AWWS dams and of climate change were not considered in the determination of the water balances for the Preliminary Reconciliation Strategy, but will be evaluated for the Final Reconciliation Strategy. This would further lower the quantity of water available for use from the existing AWSS. The preliminary estimates of the ecological Reserves have to be accounted for in considering the potential future infrastructure developments.

It is concluded that the system was just in balance in 2008/2009 and that any increase in use would put the system at risk. The higher the growth in water requirements, the higher the risk would be, especially if the large users in the Coega IDZ are established within the next five years. It is clear that measures to solve this problem must be proceeded with immediately on account of the lead times necessary for implementation.

5. INTERVENTIONS AND PLANNING

5.1 Selection of interventions

A number of potential interventions, which could contribute to meeting the future water requirements of the AWSS, were initially identified from previous and ongoing studies, including several newly formulated interventions, as shown in **Appendix A**.

The following categories of interventions were identified:

- Water conservation and water demand management (WC/WDM);
- Increased operational efficiency of the current system;
- Trading of water use authorisations;
- Re-use of water;
- Groundwater schemes;
- Inter-basin transfer schemes;
- Desalination of seawater;
- Desalination of brackish river water; and
- Surface water schemes.

Interventions that could potentially be implemented in the medium-term were then identified.

The selection of interventions to consider for the Preliminary Strategy was based on:

a. **Interventions that could, according to programme, be implemented before 2020;**
b. **Adequate intervention yield, and certainty that the yield could be realised; and**
c. **Spreading of risk by becoming less reliant on surface water sources.**

The selected "medium-term" interventions were then evaluated and compared with one another. **Interventions that were not considered for the Preliminary Strategy could be considered for the Final Strategy**. Further evaluation of the remaining potentially viable interventions will be done during the remainder of the study.

The interventions that were considered for the Preliminary Strategy are the following:

Table 5.1 Interventions considered for the Preliminary Strategy

Intervention	Description of intervention
WC/WDM upstream/downstream of user meters	Continued roll-out of an active WC/WDM programme within NMBM, controlled by a full-time manager, and implementation of the existing WC/WDM programme and new WC/WDM activities.
Fast-tracked groundwater schemes: - Jeffreys Arch - Van Stadens - Bushy Park - South-eastern Coega fault	Fast-tracked implementation of the Jeffreys Arch, Van Stadens River Mouth Arch, Bushy Park and the South-eastern Coega fault new groundwater schemes. Some of these schemes could either supply NMBM or alternatively supply small coastal towns, freeing up water for NMBM.
Nooitgedagt Low Level Scheme	Increased supply from the Orange River to NMBM, supplied from Nooitgedagt Water Treatment Works (WTW) via a new pipeline to the Olifantskop Reservoir. This scheme would also offer significant energy savings on account of the reduced pumping heads needed.
Maximising yield of Kouga/Loerie Scheme	Lowering of the operational level to which water can be abstracted from Loerie Dam (from 40% of FSC to 12% of FSC), to increase the yield, requiring no additional infrastructure or operating staff, but improved operation and increased periods of pumping at maximum capacity.
Straits Chemicals Supply Option	Purchasing of potable water by NMBM of reverse-osmosis desalinated seawater, as a by-product of the process at the Straits Chemicals chlor-alkaline plant. This option is heavily dependent on the construction of a bulk seawater intake system for the Coega IDZ.
Lower Sundays River return flows	Abstraction of return flows in the Sundays River downstream of the Sundays River Water User Association, desalination, and blending at Olifantskop reservoirs with treated Orange River water supplied from the Nooitgedagt WTW.
Re-use to industrial standards	Re-use of water from the Fishwater Flats WWTW, to meet requirements for industrial quality water within the Coega IDZ. This has been set by the Eastern Cape Department of Economic Affairs, Environment and Tourism (DEAET) as a condition of water supply to the Coega IDZ.
Water trading - Baviaanskloof River	Purchasing of water use entitlements from farmers in the Baviaanskloof River valley, to be supplied to NMBM via the existing Kouga/Loerie system.

Below is an abbreviated list of the interventions that will be included for the Final Study but which are not included in the Preliminary Study on account of the long periods of implementation :

- Supplies from the coastal rivers and raising of Impofu Dam;
- Guernakop Dam or raising of Kouga Dam on the Kouga River; and
- Ecodale Dam on the Elands River (a tributary of the Swartkops River) together with increased water re-use.

5.2 Evaluation of interventions

Information was drawn from various existing reports, as well as from expert knowledge, to compile the summary evaluations of interventions, to be able to compare interventions with one another at a common baseline. It was found that some of the interventions had been evaluated very superficially, or not at all. Evaluation was done at desktop level for such interventions, to provide a reasonable level of information.

Whilst the baseline information differs in extent and reliability, it nevertheless represents the latest available sources of information for each option.

The Reconciliation Planning Support Tool (RPST)

- The RPST is a graphic, interactive support tool that assists water managers in planning how best to meet users' water requirements from the AWSS. It is run in MS Excel, with Visual Basic macro-programmes.
- Information relating to the various water requirement scenarios, the current system yield, intervention programmes, planning studies (including Environmental Impact Assessments (EIAs), design, construction, etc), yields, and financial parameters has been populated in the RPST and can easily be updated or added to.
- The RPST facilitates the comparison of potential interventions, or groups of interventions, with one another, and with one or more selected future water requirements scenarios. It has the ability to handle the complexity of the comparison and the selection of a large number of diverse interventions.
- The RPST graphically shows when decisions regarding investigations for selected interventions need to be taken to achieve a water balance. It also shows the time-related implementation programmes for the selected interventions, the effects of WC/WDM in reducing requirements and the increases in system yield provided by water schemes. The required study start dates, for the various interventions of a selected suite that comprise a scenario, are shown.
- The RPST therefore aids scenario planning, by facilitating the selection of a suite of potential interventions, to meet a particular water requirement curve and/or for a particular identified scenario, to ensure water balance of the AWSS.
- It contains financial parameters, namely unit reference values, operating costs and capital costs, and displays the unit cost of water per intervention selected. It calculates the net present value and expected cash flow for a selected suite of interventions. Further financial evaluations could be undertaken, should the relevant supporting financial information be available.
- Output from the RPST graphically shows when decisions to study selected interventions need to be taken to achieve a water balance, in order to implement demand management measures, or to make the yield from a new source available, by a certain date (year).

The RPST was customised for the AWSS, and was populated with the water requirement scenarios, the 1:50 year yield of the existing AWSS, and information on the range of interventions evaluated, to be able to establish the estimated shortfalls in water supply for the various future scenarios.

Where possible, **capital costs** were based on costs available from previous studies. These costs were escalated to be representative of the base year costs (June 2009). In some cases, costs had to be estimated from basics, as some interventions had not been costed previously. An evaluation period of 25 years was selected for the determination of unit reference values (URVs) of all water augmentation schemes. Discount rates of 0%, 3%, and 6% were used in the calculation of URVs, to cater for funding by both NMBM and the DWAF. Multiplication factors were applied to allow for additional costs. Annual **operating costs** were also determined.

Detailed **implementation programmes** were developed for the evaluated interventions. The programmes take account of the duration (in years, or parts of years) of separate implementation phases (e.g. pre-feasibility study and EIA approval process) for each intervention, i.e. the time required to implement each intervention. The time to implement an intervention is determined by the various processes and procedures that must be undertaken. Based on the existing level of information for each intervention, different studies or processes are required such as reconnaissance, pre-feasibility and feasibility studies, and construction or implementation. The processes for the various interventions depend 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.

Yields of interventions were mainly drawn from existing reports, or determined from available hydrological information.

5.3 Preliminary scenario planning

A preliminary scenario planning evaluation was undertaken to identify the most favourable interventions or groups of interventions that could be implemented to meet the potential supply shortfalls for selected water requirement scenarios, to prevent the imminent risk of shortages in water supply. This was initially done for the medium-term, i.e. for at least up to 2020, for this *Preliminary* Reconciliation Strategy, to ensure early recommendations on actions and studies to be undertaken. The longer-term scenario planning evaluation, i.e. for at least up to 2035, to inform the Reconciliation Strategy, will be done once all potential interventions have been adequately evaluated. A Preliminary Options Workshop was held in November 2008, to specifically address the potential interventions and actions to achieve a water balance in the medium-term.

These water balance scenarios are presented in the following sections. Three of the five water requirement scenarios are shown in the following water balance graphs, however, planning is focused on meeting the projected water requirements of the scenario with the highest water requirements, namely the *High Coega Growth Requirement Scenario*.

5.3.1 Scenario 1

Figure 5.1 shows Scenario 1, as output from the RPST, for which it was assumed that the following interventions would be implemented as soon as possible, so as to meet the shortfall in the medium-term.

- Continuous implementation of WC/WDM over a 5-year period, to achieve the currently identified potential savings of 8% by NMBM, i.e. 7.3 million m^3/a (20 Ml/d);
- Maximise the Kouga/Loerie Scheme yield through improved operational measures;
- Implement the Nooitgedagt Low Level Scheme; and
- Implement re-use of water from the Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ with industrial quality water.

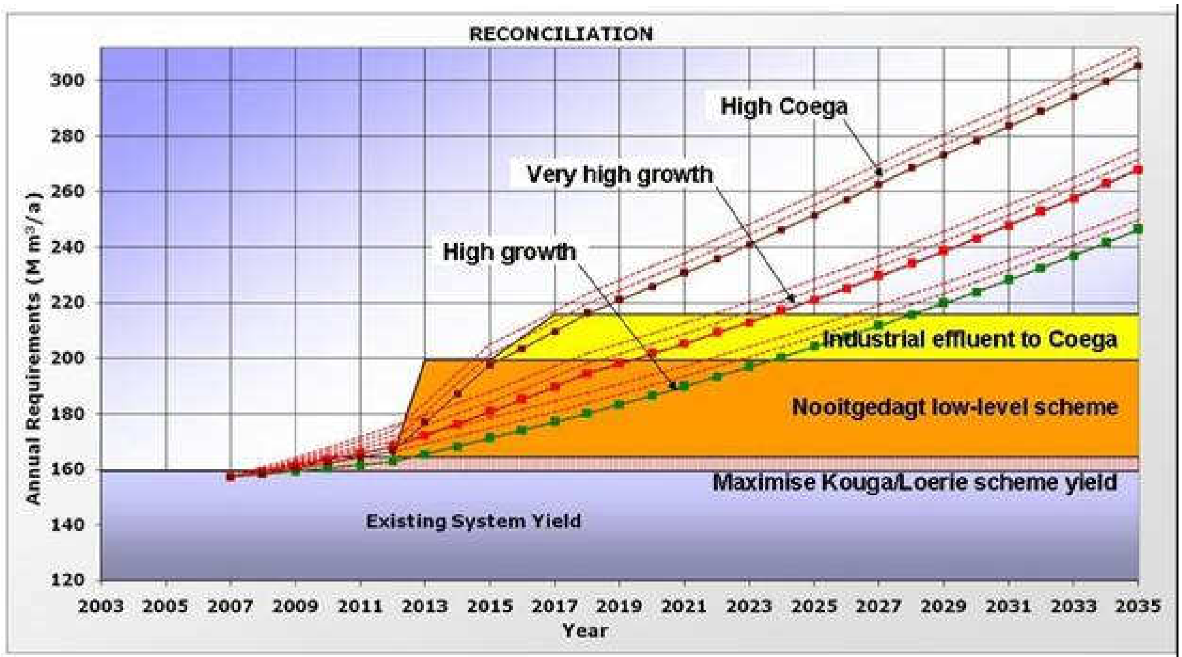

Figure 5.1 AWSS Water balance Scenario 1

5.3.2 Scenario 2

Figure 5.2 shows Scenario 2, as output from the RPST, whereby the following interventions were assumed to be implemented as soon as possible, to meet the shortfall in the medium-term.

- Continuous implementation of WC/WDM, to achieve the current identified potential savings of 8% by NMBM over a 5-year period, and savings of an additional 8% over the following 5-year period, i.e. 7.3 million m^3/a (10 Ml/d);
- Maximise the Kouga/Loerie Scheme yield through improved operational measures;
- Implement the Nooitgedagt Low Level Scheme; and
- Implement re-use of water from Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ with industrial quality water. Note that the "first water" delivery date of this intervention is set by the requirement for industrial water by the Coega IDZ.

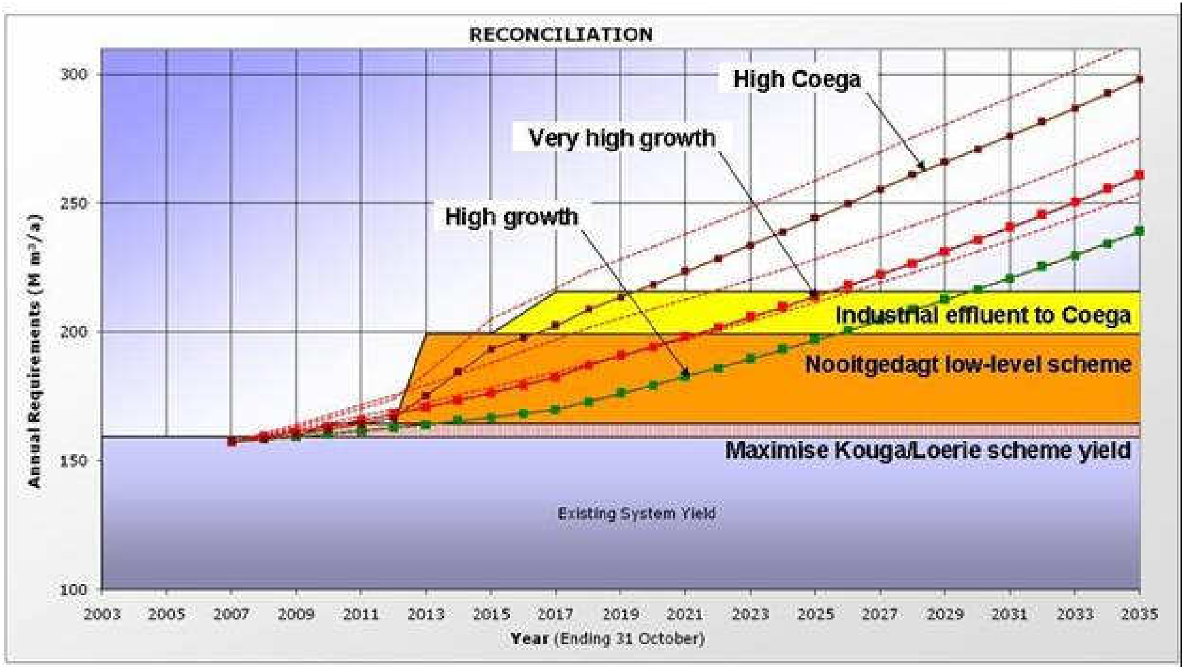

Figure 5.2 AWSS Water balance Scenario 2

5.3.3 Scenario 3

Figure 5.3 shows Scenario 3, as output from the RPST, for which the following interventions would be implemented as soon as possible, to meet the shortfall in the medium-term.

- Implement WC/WDM measures, over a 5-year period from 2008, to achieve the currently identified potential savings of 7.3 million m^3/a (20 Ml/day) by NMBM;
- Maximise the Kouga/Loerie Scheme yield through improved operational measures;
- Implement four fast-tracked groundwater schemes; and
- Implement re-use of water from Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ with industrial quality water.

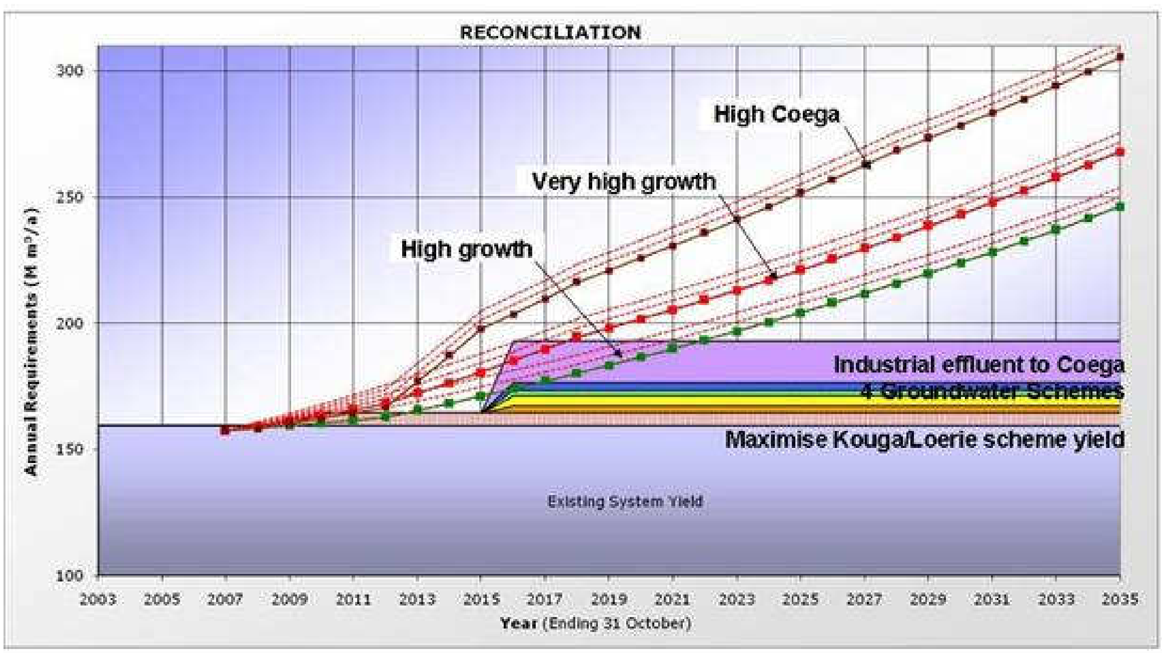

Figure 5.3 AWSS Water balance Scenario 3

5.3.4 Scenario 4

Figure 5.4 shows Scenario 4, as output from the RPST, whereby the following interventions were assumed to be implemented as soon as possible, to meet the shortfall in the medium-term.

- Implement WC/WDM measures, over a 5-year period from 2008, to achieve the current identified potential savings of 7.3 million m^3/a (20 Ml/day) by NMBM;
- Maximise the Kouga/Loerie Scheme yield through improved operational measures;
- Take up the Straits Chemicals desalination option; and
- Implement re-use of water from the Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ with industrial quality water.

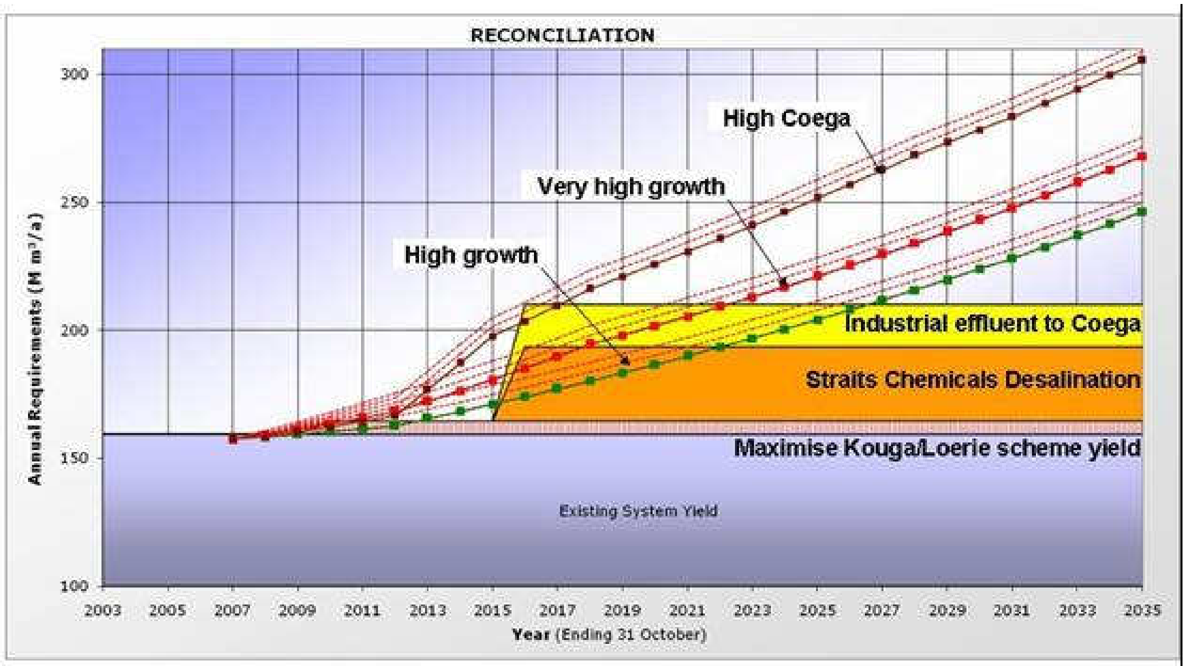

Figure 5.4 AWSS Water balance Scenario 4

5.3.5 Scenario 5: Meeting requirements up to 2035

Figure 5.5 shows Scenario 5, as output from the RPST, whereby the following interventions would be implemented, as **an example** of meeting water requirements of the AWSS up to 2035.

- Implement increased WC/WDM measures, over a 10-year period from 2008, to achieve potential savings of 14.6 million m^3/a (40 Ml/day);
- Maximise the Kouga/Loerie Scheme yield through improved operational measures;
- Implement the Nooitgedagt Low Level Scheme;
- Implement re-use of water from the Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ with industrial quality water;
- Implement re-use of water from the Coega WWTW to supply the Coega IDZ;
- Take up the Straits Chemicals desalination option;
- Implement four groundwater schemes;
- Implement the Lower Sunday River Return Flows Desalination Scheme; and
- Implement the Guernakop Dam Scheme.

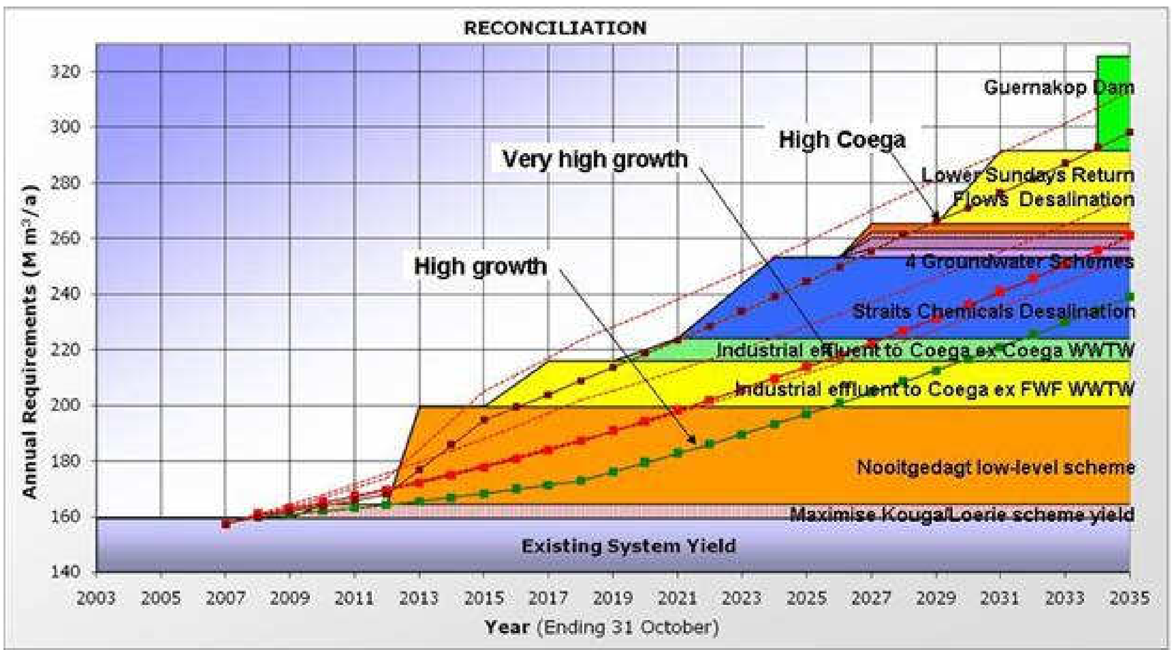

Figure 5.5 AWSS Water balance Scenario 5

5.3.6 Scenario 6: Meeting requirements up to 2035 with no WC/WDM

Figure 5.6 and **Figure 5.7** both show Scenario 6, as output from the RPST. This scenario and the implementation dates of interventions that are shown in **Figure 5.6** is the same as that of Scenario 5 (refer to **Figure 5.5**), except that the WC/WDM Intervention has not been taken into account, so as to show the influence of the specified WC/WDM measures. Because of the absence of WC/WDM this would lead to unacceptable periods of risk, as indicated in **Figure 5.6** for the periods when requirements would exceed the supply.

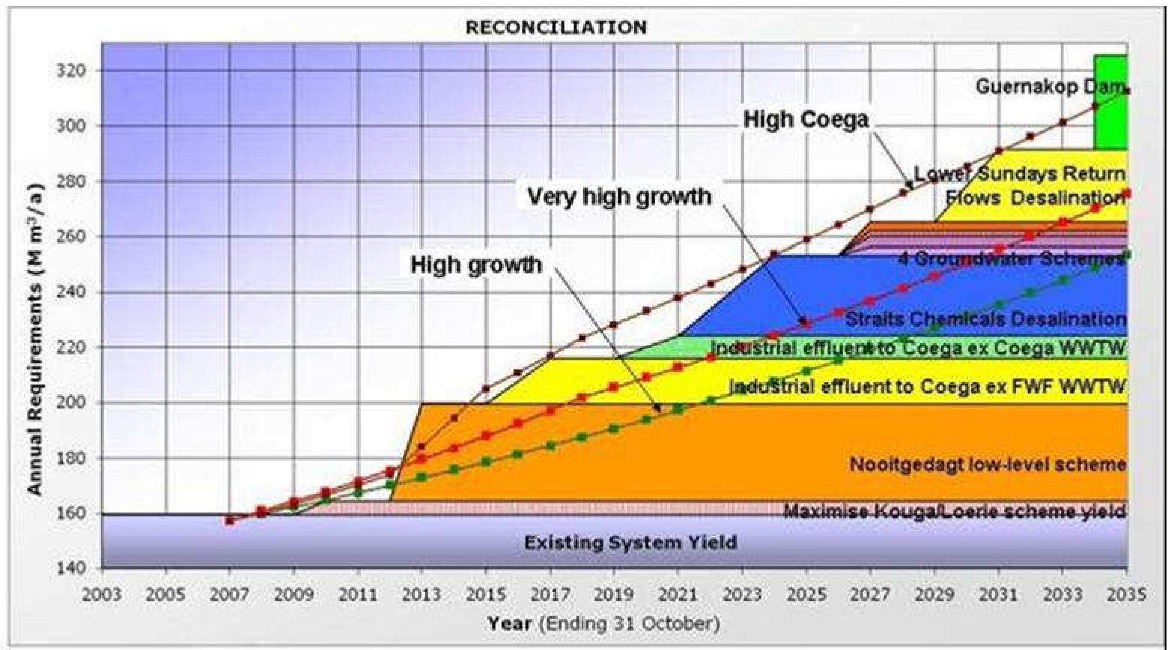

Figure 5.6 AWSS Water balance Scenario 6

If none of the WC/WDM measures were implemented, then some of the interventions would have to be implemented earlier than shown in **Figure 5.6**, as illustrated in **Figure 5.7**, which illustrates the water balance situation and implications in the long-term, should WC/WDM measures not be successful.

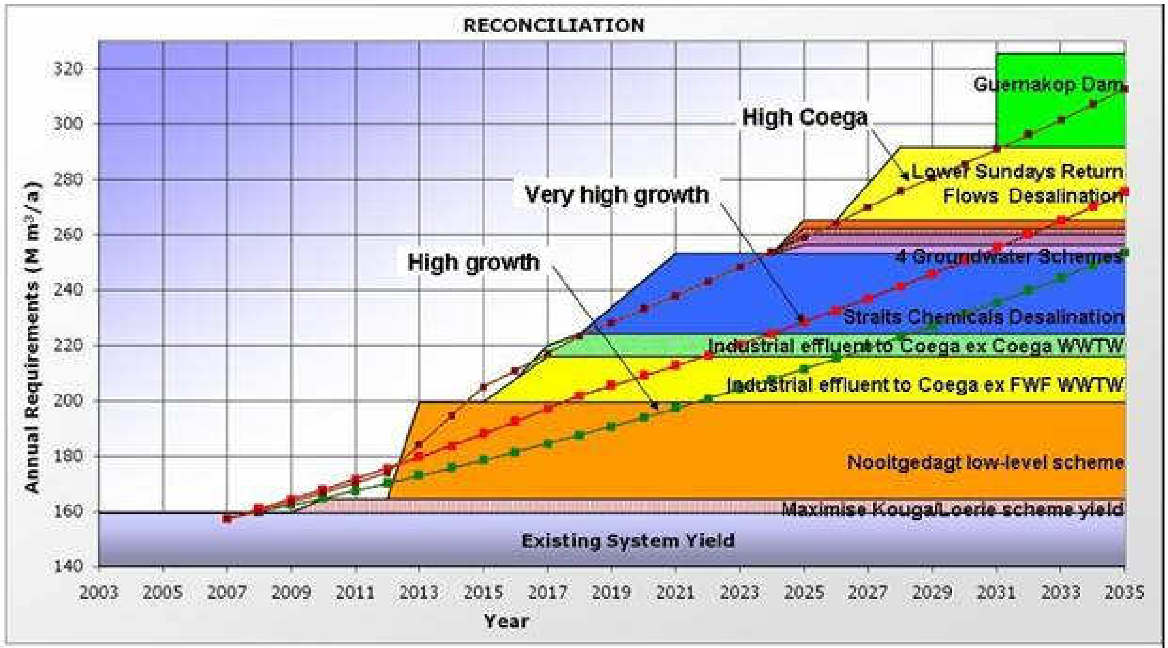

Figure 5.7 AWSS Water balance Scenario 7

To ensure a water balance in this situation would require the implementation of the *Straits Chemicals Desalination option* before the *Industrial Effluent to Coega ex Coega WWTW* intervention, and earlier implementation of the interventions thereafter. This would change the net present value of the selected range of interventions from R 2 925 million (Scenario 5) to R 3 394 million (Scenario 6), an increase of 16% in net present value cost.

5.4 Discussion of scenario implications

The selection of Preliminary Reconciliation Strategy interventions has been mainly based on the need to spread the risk of shortfall of the bulk water supply to the AWSS in the medium-term, on the durations of the intervention implementation programmes, and on the certainty that intervention yield can be realised. The Preliminary Strategy has also identified the studies of interventions, and other actions, that should be initiated as a priority, with the associated responsibilities and timing.

Evaluation of the seven Scenarios and their resultant water balances, leads to the following conclusions:

- WC/WDM is an essential intervention and its implementation should be afforded the highest priority. It should be used as a proactive measure to lower water requirements, instead of waiting for a crisis to develop. The currently identified savings that can be achieved by NMBM should be revisited to target much higher AWSS WC/WDM savings, which should include the full range of AWSS water users.

- Implementation of increased and effective WC/WDM (see **Figure 5.2**) would delay the implementation of other interventions.

- Testing of the influence of ineffective WC/WDM implementation indicates that this would necessitate advancing the implementation date of capital intensive interventions, with corresponding cost implications. Ineffective WC/WDM would further change the preferred order for the implementation of interventions.

- Maximising the yield of the existing Kouga/Loerie Scheme yield through improved operational measures is a cost-effective and rapidly implementable measure and should be actively pursued.

- Only three significant interventions can be considered for implementation in the medium-term, namely the Nooitgedagt Low Level Scheme, fast-tracked groundwater schemes, and the Straits Chemicals Desalination option. Of these, the only intervention that can be implemented with an adequate level of certainty, and within a short enough period to avoid the risk of a significant shortfall, is the Nooitgedagt Low Level Scheme. Implementation of the Nooitgedagt Low Level Scheme would depend on a licence being allocated by the DWAF.

- The DEAET has set the re-use of water from the Fishwater Flats WWTW as a prerequisite for water supply to the Coega IDZ. The timing of the development of this scheme would however be influenced by the uncertainty that still prevails regarding the likely level of industrial development in the Coega IDZ, and the timing thereof.

- There is an adequate range of interventions to meet the growing water requirements of the AWSS until 2035 and beyond.

- Re-use of water from the Coega WWTW for supply to the Coega IDZ should be phased in as soon as an adequate quantity of effluent is available. The volume of waste water available for re-use will increase over time as more industries are established within the Coega IDZ. The re-use of water will be evaluated in more detail for the final strategy.

6. RECOMMENDED PRELIMINARY INTERVENTIONS

The periods required for the implementation of new water supplies, the potential available yields, and the extent of the additional infrastructure that would be required make it impractical to implement only a single solution. The Preliminary Reconciliation Strategy Action Plan therefore recommends that the following interventions be implemented as soon as possible:

- **Maximise the yield of the existing Kouga/Loerie scheme;**

Maximising the yield of the existing Kouga/Loerie scheme could be achieved by changing the operation of the relevant bulk infrastructure.

The Preliminary Reconciliation Strategy Action Plan further recommends that further studies of the following suite of interventions, dealing with both demand-side water management measures and supply-side water resource developments, are undertaken as a priority in order that these could be implemented as soon as possible:

- **Implementation of WC/WDM measures;**
- **Implement the Nooitgedagt Low Level Scheme, using additional Orange River water; and**
- **Re-use of water from the Fishwater Flats Wastewater Treatment Plant to supply the Coega IDZ.**

The Preliminary Reconciliation Strategy Action Plan also recommends that further studies of the following interventions should also be initiated as soon as possible:

- **Groundwater well-field development – responsibility NMBM;**
- **Seawater desalination: the Straits Chemicals supply option; and**
- **Use of desalinated lower Sundays River return flows – responsibility NMBM.**

There is a further urgent requirement to establish monitoring of flows in the lower Sundays River and possibly the lower Gamtoos River as well.

Further interventions that have been or may not have been evaluated for the Preliminary Reconciliation Strategy, and for which no recommendations are made, will be addressed in the Final Reconciliation Strategy. The specific recommendations for the AWSS are described in subsequent sections. Other related aspects requiring attention are also presented.

6.1 Urban Water Conservation and Demand Management

6.1.1 Background

Urban WC/WDM is the most significant measure to mitigate the expected risk of water shortage in the AWSS over at least the next five years. It is also one of the most cost-effective options, and its effective implementation must therefore be given high priority by the NMBM and other municipalities that are supplied with water from the AWSS.

Water wastage is generally attributed to distribution losses (leakages) and wastage by users, e.g. leaks within properties and indiscriminate wastage (e.g. taps left open). Inefficient water usage is attributed to the fact that water is often used for the service that is derived from it, rather than for the water itself. The potential for savings in water use through WC/WDM measures is high in the NMBM area and significant savings in water loss reduction are possible.

As gardening and toilet flushing represent approximately 35% and 30% respectively of the total domestic water requirements, these are key focus areas for targeting inefficiencies. Certain industries and large bulk users would also be sectors to target.

The current situation

There is unfortunately a lack of up-to-date and in-depth evaluation of WC/WDM data for the NMBM. Detailed reticulation system analyses of zone and sub-zone water balances are not yet available.

The Algoa Water Supply Pre-Feasibility Study (DWAF, 2001) concluded that up to 8 million m^3/a (22 Ml/day) could be cost-effectively saved.

The Algoa Water Resources Bridging Study (DWAF, 2007) reported (draft report) that the NMBM has performed as follows on the various activities related to this intervention:

- Water Balance - Monthly detailed analysis of “water purchased” and “water sold” and an annual water balance;
- Sectorisation of reticulation system: out of a total of 162 zones, zone meters have been installed in 140 zones; and
- A leakage reporting and repair system is in place but can be improved on.

The report further indicated that in 2007 the following shortcomings still existed within the NMBM water management:

- No formal WC/WDM section is in place;
- A WC/WDM Manager should be appointed; and
- No active leakage control system is in place; a passive leakage repair system (reaction to visible leaks reported only) is in operation.

This study estimated that about 7.3 million m^3/a (20 Ml/day) could be achieved as a saving from this intervention, materialising over 3 to 5 years. This target for reducing water requirements may however be somewhat low, and it is recommended that the current identified savings that can be achieved by NMBM be revisited to target much higher AWSS WC/WDM savings, which should include the full range of AWSS water users.

Existing WC/WDM initiatives

The NMBM has implemented the following programmes and actions to date:

- A domestic meter replacement programme;
- An industrial meter replacement programme;
- A leak repair programme for households registered under the ATTP programme;
- A three-stepped water tariff is in use throughout the Metro;
- An investigation was undertaken into water use and sanitation at 35 schools in the NMBM supply area;
- User education through informative monthly billing; and
- Significant elimination of automatic flush urinals.

NMBM had recently appointed consultants to investigate their WC/WDM requirements, and the institutional aspects of implementing their WC/WDM Plan. Water use data of individual users would further be evaluated over the next three years. No information is as yet available from this study.

The Preliminary Strategy has mainly focussed on WC/WDM in NMBM. The situation in other municipalities and their WC/WDM initiatives will be evaluated in the remainder of the study.

6.1.2 Description of intervention

WC/WDM downstream of water meters entails the continued rollout of the previously mentioned programmes and the addition of the following activities to the WC/WDM programme:

a) A public awareness/ user education programme;
b) A schools (educators and learners) awareness programme;
c) Retrofitting of inappropriate plumbing and sanitation fittings;
d) Pressure management;
e) Use of water-efficient fittings; and
f) Elimination of automatic flush urinals.

WC/WDM upstream of water meters entails the rollout of an active WC/WDM Section within the NMBM Silo for Water and Sanitation, controlled by a full-time WC/WDM Manager. The WC/WDM Section should perform the following activities:

- Monthly readings of all zone meters;
- The conducting of monthly water balances to identify zones and sub-zones with leakage problems; and
- The identification and repair of leaks within the system (not only visible leakage) as part of an active leakage control system.

Effective WC/WDM implementation has the potential to significantly reduce water use and alleviate the pressure on the available supply for the short to medium term. This means that the need for further capital intensive water augmentation interventions can be deferred, and it represents a savings in bulk capital costs, for water supply schemes and purification and distribution infrastructure.

6.1.3 Recommendations

- The existing approved WC/WDM Programme of NMBM should be implemented. In addition, NMBM's assessment of their WC/WDM requirements and institutional aspects should be completed, as well as the evaluation of water use data of individual users, over the next three years.

- The currently identified savings that can be achieved by NMBM must be revisited to target much higher AWSS WC/WDM savings, which should include the full range of AWSS water users. Unaccounted-for-water should be limited to less than 15% of total use.

- The DWAF should write a letter to the Mayor and the Municipal Manager of NMBM, informing them of the required WC/WDM plan/actions, and the team required to implement this task.

- The significant water wastage and inadequate water and sanitation facilities in schools must be urgently addressed, as the Eastern Cape Provincial Government is not attending to this problem. Although it is not their responsibility, it is recommended that the NMBM prepare a "Plan of Action" to address the significant water wastage in schools. This should include the team members to be employed and the budget required, and should be submitted to the DWAF Eastern Cape Regional Office and to the DWAF's Director: Water Use Efficiency, to together plan the best way to solve the problem.

- It is essential that the DWAF support the NMBM with the implementation of their WC/WDM Plan.

6.2 Increased system operational efficiency: Loerie Dam

6.2.1 Background

The existing Kouga/Loerie scheme comprises the Kouga Dam, the Gamtoos Canal, and the Loerie Dam from which NMBM abstracts water for treatment at the 36.5 million m^3/a (100 Ml per day) Loerie WTW. Loerie Dam has a capacity of 3.4 million m^3 and the MAR is estimated to be about 25 million m^3/a.

There is currently limited opportunity for controlling the flows from the Gamtoos Canal into Loerie Dam, as there is only one balancing dam in the upper reaches of the canal near Patensie, whereas the original White Paper made provision for three balancing dams. The minimum inflow to Loerie Dam from the Gamtoos Canal is 18 million m^3/a (49.3 Ml/day).

6.2.2 Description of intervention

The lowering of water levels in the Loerie Dam associated with increased pumping would result in an increase in the yield of the dam, thereby providing more water to users dependent on this water source. In terms of the current inflows to Loerie Dam, the yield of Loerie Dam could be increased by about 5 million m^3/a (13.7 Ml/day), without the addition of another balancing dam. The proposed operation would not require additional infrastructure or operating staff.

6.2.3 Recommendations

The option to maximise the yield of the existing Kouga/Loerie scheme must be implemented, with the following conditions (to be implemented in the indicated order):

- NMBM needs to assess the quality of the water in Loerie Dam, when the dam is drawn down to 12% of its full supply capacity, as the targeted normal operating level, to create capacity for storage of runoff which should be delivered to NMBM by pumping at maximum capacity. This will confirm whether the dam can be drawn down to this level. It is recommended that the dam be drawn down gradually to the targeted normal operating level and thereafter operated at that level as described above.

- The construction of a further balancing dam upstream of Loerie Dam should be evaluated as a further alternative intervention, during the remainder of the study. This would include assessment of the new level to which Loerie Dam needs to be drawn down, with an additional balancing dam in place. The raising of Loerie Dam is not regarded as a competitive option due to its small incremental yield unless it is determined that it is not feasible to operate the dam and pump station as recommended under the first bullet above.

- Once the maximised abstraction volume from Loerie Dam can be confirmed, the NMBM must apply for a formal licence from DWAF, for the additional water to be abstracted.

6.3 Re-use of water treated to industrial standards

Background

Significant volumes of wastewater are currently processed by NMBM and other municipalities, and are discharged either directly, or indirectly, via the coastal rivers or directly to the ocean.

According to the 2008 Draft Sewerage Master Plan shown in **Table 6.1**, there are seven wastewater treatment facilities in the NMBM, with an installed annual average daily water flow (AADWF) capacity of 53.9 million m^3/a (196.9 Ml/day). According to the Master Plan, the proposed new Coega WWTW and upgrading of existing WWTWs are expected to be completed by 2015, with a total installed AADWF capacity of 79.7 million m^3/a (290.9 Ml/day).

NMBM has already successfully implemented water re-use for industrial purposes, albeit limited and supplying water of relatively low quality. Reconnaissance investigations show that by applying additional nutrient removal and tertiary and reverse osmosis treatment processes (in addition to current wastewater treatment) further water re-use by industry would seem feasible and economically comparable to other alternatives. An advantage of water re-use is that it could be implemented over a shorter time period, compared to large surface water augmentation options, and it reduces the demand on natural resources by industrial users. This source would produce a constant, reliable output, irrespective of drought cycles.

Table 6.1 NMBM Water Reclamation Works

WRW	Treatment Mm^3/a (Mℓ/day AADWF)			Reclaimed effluent Mm^3/a (Mℓ/day)	
	Existing capacity (2007)	Future capacity (2015)	Current flow	Capacity	Current use
Fishwater Flats	36.2 (132)	46.6 (170)	34.2 (125)	4.1 (15)	0.8 (±3)
Cape Receife	3.0 (11)	4.4 (16)	2.3 (8.5)	0.5 (1.9)	0.2 (0.7)
Driftsand	3.3 (12)	4.9 (18)	4.0 (14.6)	-	-
Coega	-	8.2 (30) (2015) 16.4 (60) (2040)	0	-	-
Despatch	2.4 (8.9)	2.4 (8.9)	1.1 (3.9)	0.2 (0.9)	0.1 (0.3)
Kelvin Jones, Uitenhage	6.6 (24)	9.9 (36)	5.2 (18.9)	0.5 (2)	0.3 (1.2)
Kwa Nobuhle	2.5 (9)	3.3 (12)	2.7 (10)	1.1 (4)	0.3 (<1)
Total	**53.9 (196.9)**	**79.7 (290.9)**	**49.6 (180.9)**	**6.5 (23.8)**	**1.7 (6.2)**

The utilisation of secondary effluent, subject to tertiary treatments and reverse osmosis, as a source of potable water supply was also considered as an intervention, but was not considered any further, since the latest available information indicates that the Coega IDZ will require in excess of 36.5 million m^3/a (100 Ml/day) of water supply of industrial quality. The net yield Fish Water Flats (FWF) WWTW effluent treated to potable standards would be similar to that of water treated to industrial standards. It therefore makes sense to treat sufficient effluent for industrial water requirements (with less health risks) than to treat effluent to potable standards and to use potable water only to supplement industrial requirements in the Coega IDZ. Consideration should also be given to future wastewater sources (from increased future requirements) for potential reuse in future.

There is a possibility that about half of Motherwell's wastewater will be diverted to a new WWTW, thus reducing the domestic inflow into the FWF WWTW. Approximately 20 000 new housing units are however planned for the catchment area of the FWF WWTW, which will effectively not alter the quality or quantity of sewerage and effluent available for tertiary treatment.

Description of intervention

This intervention would aim to meet the increased demand for industrial quality water within the Coega IDZ. It entails the utilisation of secondary treated effluent of a consistent quantity and quality from the FWF WWTW for the initial supply of treated effluent to a proposed low pressure, low rejection reclamation system capable of delivering a product of consistent quality and quantity to users, either for industrial or commercial usage. A post-treatment site near Redhouse has been provisionally identified. The site is also well positioned to supplement treated effluent yields in future, by the addition of final treated effluent from the Uitenhage and Despatch WWTWs.

This option entails pumping secondary treated effluent, subjected to flocculation and rough screening, from a dedicated balancing tank to be located at the discharge point into the seawater outfall at the FWF WWTW, via a pipeline to the proposed Redhouse post-treatment site. At the treatment site, the effluent will, due to high variability of FWF WWTW effluent and to optimise utilisation rates, be passed through a 24-hour artificial reed bed system. Thereafter the water will make a full (100%) pass through a treatment microfiltration and reverse osmosis train, as a required minimum, before being considered suitable for distribution into the Coega IDZ industrial water infrastructure system. The available land at FWF WWTW can accommodate the additional infrastructure.

This intervention would have an estimated yield of 16.4 million m^3/a (45 Ml/day), and a URV of R5.17/m^3, for a social discount rate of 6%.

Recommendations

Undertake a Pre-feasibility Study and set-up a pilot plant for the reverse-osmosis treatment of effluent to industrial standards.

6.4 Additional Orange River water (Nooitgedagt low level scheme)

Background

This intervention is aimed at the NMBM receiving an increased water supply from the Orange River. It entails the development of a low-level scheme from the Nooitgedagt WTW on the right bank of the lower Sundays River to a proposed reservoir site on Olifantskop farm. The proposed scheme is essential for the future water supply to the Coega IDZ, currently under development, and will offer huge energy savings in terms of the reduced pumping heads required, relative to the current high-level scheme.

Description of intervention

Existing allocations and use of Orange River water are as follows:

(a) NMBM was allocated an exchange volume of 13.5 million m^3/a (37 Ml/day) from the Orange River Project (ORP) for an equivalent reduction in allocation from Kouga Dam in 1993.

(b) NMBM has a registered water use dated June 2005 of 17.0 million m^3/a (46.6 Ml/day) from the ORP system, which has for this evaluation been regarded as the existing legal use.

(c) NMBM's water use from the ORP system over the 2007/08 period was 25.2 million m^3/a (69 Ml/day).

Planning done to date indicates that the Coega IDZ, with an additional estimated requirement of 21.9 million m^3/a (60 Ml/d) potable use and 65.7 million m^3/a (180 Ml/day) industrial water use, will require up to 25.6 million m^3/a (70 Ml/day) by 2016 (this requirement can change, depending on which water requirement scenario is used for future planning). **The Nooitgedagt Low Level Scheme is the only intervention that can timeously meet initial growth of the Coega IDZ**.

Water from the Orange River, which is an inland source with many and large competing water users, is almost fully allocated. The DWAF Internal Strategic Perspective (ISP) indicated that some 41.3 million m^3/a (113.2 Ml/d) is still available (reserved) for NMBM from the ORP system. NMBM has recently submitted a licence application to the DWAF for an additional allocation from the Orange River water. There is the further possibility that "surplus" flows in the Orange River could be temporarily allocated for use by NMBM, although such surpluses are diminishing.

A scenario was assumed whereby the present registered water use of 17.0 million m^3/a (46.6 Ml/day) would be increased by the 41.3 million m^3/a unallocated water to a total allocation of 58.3 million m^3/a (159.7 Ml/day) from the ORP. Based on the existing High Level Scheme capacity of 25.6 million m^3/a (70 Ml/d, with a peak of 91 Ml/d), the incremental yield of the Low Level Scheme is estimated to be 32.7 million m^3/a (89.7 Ml/d, with a peak of 115 Ml/d). The low level scheme could be extended in future, should NMBM obtain and purchase irrigation water rights in the Fish or Sundays River catchments.

At present, the Nooitgedagt WTW and the final water pump station have a supply capacity (High Level Scheme) to Grassridge reservoir of 32.9 million m^3/a (90 Ml/day). Recent additions of a second pulsator clarifier and a fourth pump to the high lift pump station increased the previous output capacity of 25.6 million m^3/a (70 Ml/day) to the present capacity.

The ORP/Nooitgedagt Low Level Scheme will consist of the following elements:

- An extension of the treatment capacity of Nooitgedagt WTW from 32.9 million m^3/a (90 Ml/day) (peak) to 76.7 million m^3/a (210 Ml/day) (peak);
- A Low Lift Pump Station at Nooitgedagt;
- A rising pipeline (22.7 km x 1200 mm dia) from Nooitgedagt to Olifantskop reservoir;
- A first phase reservoir (40 Ml) at Olifantskop;
- A gravity pipeline from Olifantskop to Motherwell (15.7 km x 1200/1000 mm dia).

The project is already in its preliminary design phase with alternative pipeline routes and reservoir sites having been identified and initial soil testing and profiles completed. An EIA is currently being undertaken for this project. This will shorten the implementation period of the project, compared to other interventions.

The low level scheme will pump about 40-50% of the present high-level requirement along the low level route. This will bring about an immediate energy saving (estimated at approximately R 110,000/month), which will diminish over the medium-term with growth in requirements from both the High and Low Level Schemes. The power supply to the Eskom yard and the 22 kV power supply line from Eskom to the Nooitgedagt transformer yard does not require any upgrading.

The Scheepersvlakte Balancing Dam has a small storage capacity (815 Ml). This would require that during the three months annual dry periods of the Lower Sundays River WUA, the NMBM bulk water supply system must be rezoned, to draw less water from this source.

The URV (based on a 6% social discount rate) for the Nooitgedagt Low Level Scheme, is R3.40/m^3. For the calculation of the URV, a DWAF transfer tariff of R1.50/m^3 was assumed (present tariff = R1.002/m^3 for 2009/10) for ORP water supplied to the Lower Sundays River Scheme for urban use.

Recommendations

- The NMBM should continue with their plan to develop the Nooitgedagt Low Level Scheme, as there is no alternative, due to the very short time that is available for a significant intervention to be implemented, and the high risk and delay periods of alternative interventions, such as the

Straits Chemicals desalination supply. NMBM had in December 2007 applied for a total Orange River water allocation of 85.045 million m^3/a (233 Ml/d).

- The NMBM must provide the DWAF with firm recommendations on the following:
  - The sizing of the required infrastructure and whether this is adequate; and
  - The allocation required from the Orange River, so that DWAF can ascertain whether they can issue a licence for this abstraction volume.

- Further options to be investigated as part of the Algoa Water Reconciliation Strategy are:
  - The option of running the ORP/Nooitgedagt Low Level Scheme in parallel with the Straits Chemicals supply option and the water re-use option (to industrial standards). The seawater intake at the Coega IDZ required for the Straits Chemical supply option would be excluded from this investigation and is understood to be the subject of a study currently being undertaken by the Coega Development Corporation.
  - Should the Nooitgedagt Low Level Scheme be treated as a temporary scheme (i.e. the water use licence is only allocated for ± 20 years), then this scheme may potentially be used in the future as a peaking scheme to supply water during peak water requirement periods. This would allow a degree of flexibility, especially if the desalination options for Straits Chemicals and/or the lower Sundays River return flows after 2020 are implemented.

6.5 Groundwater development

Background

The Uitenhage Aquifer, a confined artesian basin, which comprises a number of discreet aquifers, currently supplies Uitenhage from springs. The St Francis Bay and Jeffreys Bay wellfields supply coastal towns.

The Uitenhage Aquifer (comprising the area of the previous Subterranean Government Water Control Area), and in particular the area around the Coega Fault, is currently being studied by SRK Consulting. This study should *inter alia* indicate whether groundwater in the Uitenhage Aquifer is under or over-utilised. This study has recently been put on hold due to a lack of funds.

Groundwater offers diversification of sources, increased system storage and the possibility of conjunctive use (meeting seasonal peaks) and optimisation of sub-surface storage (i.e. large-scale abstraction in summer and artificial recharge in winter).

Description of interventions

In the greater Port Elizabeth area, eighteen target areas were originally identified for groundwater exploration. These areas were based on the findings of Goedhard, *et al* (2004). These areas were selected and grouped as interventions, as follows:

- Jeffreys Arch area, including the Zuurbron, Rooihoek and Uitsig areas. The target aquifer is the folded Table Mountain Group (TMG) in the greater Jeffreys Bay area.

- Van Stadens River Mouth area. The main groundwater target is the Elandsberg Fault, fed by TMG formations in the Maitland Mines area east of the Van Stadens River, and a similar geological setting west of the river.

- Bushy Park area. The target aquifer is the folded TMG at Bushy Park, with possible additional groundwater targets along the Chelsea and Moregrove faults south of central Port Elizabeth.

- The Uitenhage Aquifer and the Coega Fault. The current DWAF study of the Uitenhage Aquifer should establish whether the aquifers in this area can yield more water without affecting springflow from the Uitenhage springs. This sizeable area includes the following prime drilling target areas:
  - North-western section of the Coega Fault (west of Uitenhage towards the Grootwinterhoek Mountains).
  - South-eastern section of the Coega Fault (east of Uitenhage towards the coast).
  - The Amanzi-Coega Ridge Aquifer.
  - The Kruisrivier-Uitenhage Group west of Uitenhage.

- Gamtoos Basin. The target aquifer is the buried gravel terraces at the mouth of the Gamtoos River and the Gamtoos Fault.

- Near Alexandria. The target aquifer is the sediments of the Zuney Valley and Kaba Trough.

All proposed wellfield areas are rough indications of prime drilling target areas. In all cases these identified wellfields would have to be visited in the field. They would need to be reviewed after a process of gathering more borehole data, including studying site-specific reports, undertaking of a hydrocensus, geological mapping, and in places, geophysics.

Water from developed wellfields will typically be pumped to a single treatment and storage site. The water will be pH corrected (lime dosing) and chlorinated. A balancing storage reservoir and chlorine contact tank will be provided. Water will gravitate under outlet valve control or be pumped into the supply pipelines of the AWSS or directly into balancing storage reservoirs.

The combined yield from the four identified groundwater interventions is approximately 12 million m^3/a (32.9 Ml/day). URVs vary between R3.30/m^3 and R3.90/m^3. All areas could potentially have higher groundwater potential, however, until there is a better understanding, conservative yield estimates are shown.

Implementation programmes are quite long at about 12 years, but these schemes could potentially be fast-tracked to about 7 years, if authorisations could be streamlined.

Recommendations

- Complete the Uitenhage Aquifer Modelling Study.

- Submit a proposal to the DWAF indicating the following:
  - A scope of work (which groundwater option or combination of options to be taken forward, and how this would be achieved);
  - A programme for the work; and
  - A breakdown of the budget required (e.g. budget required for well-fields, boreholes etc).

  The DWAF would assess who would be responsible for implementation, i.e. NMBM or the DWAF. The proposal should be developed taking into account any interim findings of the current Uitenhage Aquifer Study.

6.6 Desalination

Advances in desalination technology over the last decade have significantly reduced the cost of desalination. Desalination presents an opportunity to diversify sources, and is independent of drought cycles. Although desalination is likely to be more expensive than most other interventions, its merits lie in the promotion of resource diversification. For the AWSS, a number of desalination interventions were identified. These included:

- The Straits Chemicals supply option;
- Desalination of return flows in the lower Sundays and Gamtoos Rivers;
- Desalination of water from the Swartkops estuary;
- Desalination of seawater in Algoa Bay; and
- Redirecting freshening releases in the Fish River for the Glen Mellville Dam offtake and desalinating water for Grahamstown and other users from the Fish River.

For the AWSS Preliminary Reconciliation Strategy, only the Straits Chemicals supply and Lower Sundays River return flow options were considered feasible, based on their shorter implementation programmes, lower level of complexity, and likely lower costs in comparison with the other options.

6.6.1 The Straits Chemicals supply option

Background

This intervention is aimed at the NMBM purchasing water desalinated by a reverse osmosis (RO) process for potable use from the Straits Chemicals plant, a potential industrial manufacturer of chlorine from sea salt (NaCl) within the Coega IDZ. Potable water is a by-product of the manufacturing process. In order to start chlorine production, Straits Chemicals proposes initially to import salt through the Ngqura Harbour, until a sea water intake and supply is available from the Coega Development Corporation (CDC). If this scheme is successful and full development is realised, the dependence on Orange River Project water could in future be downscaled as inland requirements grow.

Description of intervention

The scheme will consist of a bulk seawater intake system to be provided by the CDC for various potential seawater users within the Coega IDZ area. Straits Chemicals will pump seawater from the onshore bulk supply to the manufacturing site, from which they will extract Sodium Chloride (NaCl) from brine obtained from a double pass RO system, which will provide high quality water as a by-product.

Freshwater from the RO process will be stabilised and chlorinated for potable use and will then be delivered into balancing storage on site. A pump station (operated by NMBM or Straits Chemicals) will deliver the potable water via a 13.4 km long rising main to the proposed Olifantskop Reservoir, which will be located to the north of the Coega IDZ area. The potable water from the RO process could potentially be blended with water supplied from the Nooitgedagt WTW (both at Olifantskop and Grassridge reservoirs) to improve the final water quality supplied to end users.

The return of final effluent to the sea will require a discharge pipeline provided by either the CDC or Straits Chemicals. The quality of “brine” will however be of a much-improved quality compared to that of standard RO/seawater systems, because of the removal of salt.

Straits Chemicals has received authorisation from the DEAET for the construction and operation of a chlorine and associated caustic soda manufacturing facility (authorisation dated 29 August 2008). A separate EIA will need to be undertaken for the seawater intake which would be the responsibility of the CDC.

The current energy shortage in South Africa could inhibit this initiative due to the high energy requirements. Another risk is that Straits Chemicals is an industrial manufacturer (not a water supply business) driven by market demands with associated risk for continuity of supply to the NMBM.

Initial correspondence with the manufacturer during October 2007, indicated that the initial quantity of potable water available would be about 18.3 million m^3/a (50 Ml/day), which in the long-term could increase to as much as 62.1 million m^3/a (170 Ml/day). For the purposes of this study, it was assumed that a treated water supply of 29.2 million m^3/a (80 Ml/d) will be provided (a comparative selected yield), until more clarity on the long-term plans of chlorine manufacturing within the Coega IDZ become available.

The unit cost of water supplied at the Straits Chemicals site was assumed to be R5.00/m^3 (initial offer made by the manufacturer to NMBM, based on the basic unit selling rate to water users) with annual escalation, which then forms part of the annual operating costs. This gave a URV (based on a 6% social discount rate) of R6.51/m^3.

Recommendations

No action can be taken immediately, as this option is dependent on the construction of the sea intake for a potential power station and various industries. NMBM should liaise with the CDC and with Straits Chemicals to determine the time frame of planning and constructing of the seawater intake and the desalination plant respectively.

6.6.2 Lower Sundays River return flows

Background

Return flow from irrigation activities of the Sundays River Water User Association enters the lower Sundays River and flows to sea. A recent Rapid Reserve determination of the estuary of the Sundays River reported that up 45 million m^3/a (123 Ml/day) "return flow" could be available for abstraction and use in the lower Sundays River, without impacting negatively on the ecological state of the estuary. The return flow volume has been determined at a low confidence, and monitoring is urgently required to establish what the actual flows are in the lower Sundays River.

The scheme is aimed at the NMBM abstracting return flows downstream of the Sundays River Water User Association (upstream of the tidal zone) and desalination of this water before blending at Olifantskop reservoirs with water supplied from Nooitgedagt WTW.

Description of intervention

The intervention will consist of a raw water abstraction pump station on the lower Sundays River in the vicinity of Barkly Bridge. Raw water will be pumped approximately 4.3 km to an off-channel balancing dam, where the water will undergo micro filtration/ultra filtration and reverse osmosis. A pump station will pump the desalinated water to Olifantskop reservoir site over a distance of approximately 9 km, where it will be blended with Orange River water (a moderately hard water) supplied from Nooitgedagt WTW.

The brine and ultra-filtration backwash streams (estimated at 20% of initial feed water volume) will be discharged via a gravity pipeline system from a balancing storage at the treatment site over a distance of approximately 20 km to the mouth of the Sundays River. The discharge will be carried out on 6-hour cycles on the outgoing tides, to minimise the overall environmental impacts on the estuary.

Based on 80% utilisation (variable flows and a small abstraction weir), a 13% waste stream for backwashing of filters, and a further 15% as a brine stream for RO, a possible source yield of 26.4 million m^3/a (72 Ml/day) was assumed. This would result in a URV (based on a 6% social discount rate) of R4.01/m^3.

Recommendations

- Putting in place a programme of data collection and monitoring of the discharge and quality of the return flows should be undertaken immediately.

- The Algoa Reconciliation Strategy Study Team should submit a proposal to the DWAF, indicating what work would be required to implement this option and within what time frame.

- Further desalination options to be investigated as part of the Algoa Water Reconciliation Strategy are:
  - The possibility of conjunctive use of desalinated Sundays River water and the regulation of good quality Orange River water. A combined scheme may lead to increased yields in the long-term.
  - Straits Chemicals may be interested in using the brine.

7. INSTITUTIONAL ARRANGEMENTS

Co-operation of the institutions responsible for the entire water supply chain is essential to achieve the intended objectives. The creation of an environment where partnerships can be formed to tackle specific recommended actions should be encouraged.

It is recommended that an Algoa Strategy Steering Committee be established towards the end of the Reconciliation Strategy Study. In the mean time, the current Study Steering Committee would need to confirm the preliminary recommendations, and would facilitate communications between the various stakeholders. The Strategy Steering Committee has as its main functions and objectives:

- Provide overall guidance to the Study Team;
- Represent respective stakeholder groups;
- Ensure implementation of the recommendations of the Reconciliation Strategy;
- Ensure that the Strategy and its recommendations are appropriately communicated;
- Ensure that the necessary studies are started timeously to ensure reconciliation of water availability and requirements.

The successful development and implementation of the identified actions requires the main stakeholders in the study area to be actively involved in the Study Steering Committee. Effective partnerships have been established with the main stakeholders. These organisations were consulted with regard to information sourcing and have been involved in the transparent process of developing the Preliminary Strategy.

High-level management and political support will in the mean time be required to ensure that the recommendations are implemented.

8. PUBLIC PROCESS

The primary intention of the public process is to create awareness of the project at a broad-based level throughout the AWSS and potentially affected areas. Specific aims of the public process are as follows:

- Establish a database of stakeholders with potential interest in the Strategy, and regularly update the database;
- Establish a mechanism for receiving comments, responding to it and to enable any interested and affected party to contract the project team;
- Create awareness in the printed media, radio and television for the scheduled public meetings;
- Distribute newsletters and other documentation to key stakeholders; and
- Identify potential problems, disputes, or other negative elements emerging from the public process and escalate these timeously, with recommendations on how to address these.

The public participation process was started upon initiation of the study will continue throughout the study. The study team compiled a public database for the study from existing databases and input from DWAF and NMBM staff and key stakeholders. Distribution of the newsletters and the response sheets has also resulted in inputs and amendments to the database.

The first public meeting was held on 26 August 2008 in Port Elizabeth, to present the objectives and scope of work of the study to stakeholders, and to invite comments. Advertisements were placed in newspapers to ensure raised public awareness about the public meeting. The study's Newsletter 1 was issued to stakeholders by post and e-mail before the public meeting (Public Participation Report is included in Appendix E).

Following approval of the Preliminary Strategy by the Study Steering Committee, the study's Newsletter 2 was issued to stakeholders by post and e-mail. A second public meeting was held on 18 March 2009 in Port Elizabeth to present the Preliminary Strategy, and to provide an opportunity for the public to comment, and to provide feedback. Advertisements were placed in the Herald newspaper and announcements were made on the Algoa FM and Umhlobo Wenene radio stations to ensure raised public awareness about the public meeting. The meeting was attended by 33 people.

The study team conducted several separate briefing sessions, with *inter-alia* the Portfolio Councillor for Water Infrastructure and the Executive Director for Infrastructure and Engineering, in preparation for the public meetings.

The public participation at the public meetings was regarded as a success in that all participants were generally satisfied with the level of information given by the study team. The public participants demonstrated a high level of understanding, which is reflected in the topical nature of the questions posed. This is generally regarded as a good indication of the degree of comprehension by participants in any public participation process. A further indication of successful communication and awareness creation was the open and transparent responses provided to all questions posed to the panel. This created a sense of trust between the participants in the study team, as there was no attempt made to mislead or misdirect questions. The public participation and awareness is progressing well to date.

9. PRELIMINARY STRATEGY ACTION PLAN

9.1 Urban Water Conservation and Demand Management

a. **Action**: The existing WC/WDM Programme of NMBM should be implemented. In addition, NMBM's assessment of their WC/WDM requirements and institutional aspects should be completed, as well as the evaluation of water use data of individual users.
Responsibility: NMBM
Timing: WC/WDM Programme: Ongoing
Evaluation of water use data: Over the next three years

b. **Action**: WC/WDM interventions that will limit UAW of the AWSS to less than 15% of total water use should be evaluated.
Responsibility: Algoa Reconciliation Strategy Study Team/NMBM
Timing: Upon approval of the Preliminary Strategy

c. **Action**: The DWAF should write a letter to the Mayor and the Municipal Manager of NMBM, informing them of the required WC/WDM plan/actions, and the team to be allocated to this task.
Responsibility: DWAF
Timing: Upon approval of the Preliminary Strategy

d. **Action**: NMBM should prepare a "Plan of Action" to address the significant water wastage in schools, even though it is a responsibility of the Provincial Government (who is not attending to the problem). This should include the team members to be employed and the budget required, and should be submitted to the DWAF Eastern Cape Regional Office and to the DWAF's Director: Water Use Efficiency, to together agree on the best way to solve the problem.
Responsibility: NMBM
Timing: Upon approval of the Preliminary Strategy

e. **Action**: The DWAF's Water Use Efficiency Directorate should be appointed to address the schools (wastage and inadequate water and sanitation facilities) problem, as the Eastern Cape Provincial Government was not attending to this problem. NMBM should submit a motivation in this regard to the DWAF.
Responsibility: NMBM and DWAF
Timing: Upon approval of the Preliminary Strategy

f. **Action**: It is essential that the DWAF support the NMBM with the implementation of their WC/WDM Plan.
Responsibility: DWAF
Timing: Immediate

9.2 Increased system operational efficiency: Loerie Dam

a. **Action**: NMBM needs to assess the quality of the water in Loerie Dam, when the dam is at 12% of its full supply capacity, the lowest it can be drawn down. This will confirm whether the dam can be drawn down to this level. It is recommended that initially the dam is drawn down gradually.
Responsibility: NMBM
Timing: Upon approval of the Preliminary Strategy

b. **Action**: The construction of a further balancing dam upstream of Loerie Dam should be evaluated as an additional intervention, during the remainder of the study. This would include assessment of the new level to which Loerie Dam needs to be drawn down, with an additional balancing dam in place.
Responsibility: Algoa Reconciliation Strategy Study Team
Timing: During the remainder of the Algoa Reconciliation Strategy Study

c. **Action**: Once the maximised abstraction volume from Loerie Dam can be confirmed, the NMBM must apply for a formal licence from the DWAF, for the additional water to be abstracted.
Responsibility: NMBM
Timing: Once the maximum abstraction volume from Loerie Dam has been confirmed

9.3 Re-use of water treated to industrial standards

a. **Action**: Undertake a Pre-feasibility Study and set up a pilot plant for the RO treatment of effluent to industrial standards.
Responsibility: NMBM
Timing: Upon approval of the Preliminary Strategy

9.4 Additional Orange River water

a. **Action**: The NMBM should continue with their plan to develop the Nooitgedagt Low Level Scheme, as there is no alternative, due to the very short time that is available for a significant intervention to be implemented, and the high risk of the alternatives.
Responsibility: NMBM
Timing: Ongoing

b. **Action**: The NMBM must provide the DWAF with firm recommendations on the following:
- The sizing of the required infrastructure and whether this is adequate;
- The allocation required from the Orange River, so that the DWAF can ascertain whether they can issue a licence for this abstraction volume; and
- Who would be responsible to purchase the water rights for any additional allocation above the 54.8 million m^3/a (13.5 million m^3/a + 41.3 million m^3/a)?

Responsibility: NMBM
Timing: Upon approval of the Preliminary Strategy

c. **Action**: Further options to be investigated as part of the Algoa Water Reconciliation Strategy Study:
- The option of running the ORP/Nooitgedagt Low Level Scheme in parallel with the Straits Chemicals supply option and water re-use option (to industrial standards), excluding investigation of the seawater intake;
- If the Nooitgedagt Low Level Scheme is to be treated as a temporary scheme, then consider the scheme as a potential peaking scheme in the long-term. This would allow a degree of flexibility, especially if planning on implementing the desalination options for Straits Chemicals and/or the lower Sundays River return flows.

Responsibility: Algoa Reconciliation Strategy Study Team/ NMBM
Timing: During the remainder of the Algoa Reconciliation Strategy Study

9.5 Groundwater development

a. **Action**: Complete the Uitenhage Aquifer Modelling Study.
Responsibility: SRK/DWAF Eastern Cape RO
Timing: Ongoing

b. **Action**: Submit a proposal to the DWAF indicating the following:
- A scope of work (which groundwater option or combination of options to be taken forward, and how this would be achieved);
- A programme for the work; and
- A breakdown of the budget required (e.g. budget required for well-fields, boreholes etc).
- Taking into account any interim findings of the current SRK Study.

Responsibility: Algoa Reconciliation Strategy Study Team
(The DWAF would assess who would be responsible for implementation, i.e. NMBM or the DWAF)
Timing: Upon approval of the Preliminary Strategy

9.6 Desalination : The Straits Chemicals Supply option

a. **Action**: No action can be taken immediately, as this option is dependent on the construction of the seawater intake for a potential power station and various industries at the Coega IDZ. NMBM should liaise with the CDC and with Straits Chemicals to determine the time frame of planning and constructing the seawater intake and the desalination plant respectively.
Responsibility: NMBM
Timing: Immediately

b. **Action**: NMBM should liaise with the CDC and with Straits Chemicals to recommend the implementation of a seawater quality monitoring programme.
Responsibility: NMBM
Timing: Upon approval of the Preliminary Strategy

c. **Action**: NMBM has appointed a consultant to investigate the contractual arrangements of a potential future contract between Straits Chemicals and NMBM.
Responsibility: NMBM

Timing: Ongoing

9.7 Desalination: Lower Sundays River return flows

a. **Action**: Implement a programme of data collection and monitoring of the discharge and quality of the return flows.
Responsibility: The DWAF
Timing: Upon approval of the Preliminary Strategy

b. **Action**: Submit a proposal to the DWAF, indicating what work would be required to implement this option and within what time frame?
Responsibility: Algoa Reconciliation Strategy Study Team
Timing: Upon approval of the Preliminary Strategy

c. **Action**: Further desalination options to be investigated:
- The possibility of conjunctive use of desalinated Sundays River water and the regulation of good quality Orange River water. A combined scheme may lead to increased yields in the long-term.
- Straits Chemicals may be interested in using the brine.

Responsibility: Algoa Reconciliation Strategy Study Team
Timing: During the remainder of the Algoa Reconciliation Strategy Study

9.8 Public process

a. **Action**: Issue Newsletter 2 to stakeholders by post and e-mail.
Responsibility: The Study Team, DWAF and NMBM.
Timing: March 2009

b. **Action**: Present the Preliminary Reconciliation Strategy at a public meeting in Port Elizabeth
Responsibility: The Study Team, DWAF and NMBM.
Timing: 18 March 2009

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APPENDIX A

INCLUSIVE LIST OF POTENTIAL INTERVENTIONS

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1. IDENTIFICATION AND SELECTION OF INTERVENTIONS

1.1 IDENTIFICATION OF INTERVENTIONS

A significant number of potential interventions were initially identified for the AWSS, from existing reports, studies, and expert knowledge. This complete list of potential interventions identified during the course of this project is described briefly in Chapters 2 to 9. Documents, from which information has been sourced, are referred to in each chapter.

1.2 SELECTION OF INTERVENTIONS EVALUATED FOR THE PRELIMINARY STRATEGY

From the comprehensive list compiled, the range of potential interventions that that could be considered for implementation in the medium-term, up to 2020, were selected according to specified criteria, and evaluated according to a standard template, in order to be able to table early study recommendations.

Information to evaluate the selected interventions was drawn from various existing reports, as well as from expert knowledge, to compile the summary evaluations of interventions, to be able to compare interventions with one another at a similar level. It was found that some of the interventions had been studied only very superficially, or not at all. Additional evaluation was done at desktop level for such interventions, to provide a reasonable level of information. Whilst the base information differs in extent and reliability, it nevertheless represents the latest available sources of information for each option. Base information of the evaluated interventions was populated in the Reconciliation Planning Support Tool, which allows the user to compare potential interventions with one another, and with one or more selected future water requirement scenarios.

The complete list of all interventions, indicating which interventions were evaluated for the Preliminary Strategy, and which interventions will be evaluated in the remainder of the study, is presented in **Table 10.1**.

1.3 INTERVENTIONS TO BE EVALUATED FOR THE STRATEGY

Expert screening of the potential interventions was done, and an initial list of interventions to study further has been proposed, as presented in **Table 10.1**. Options that had been screened out in previous studies have generally not been identified for evaluation. Many new interventions have been identified, which had not been studied previously.

2. AGRICULTURAL WATER DEMAND MANAGEMENT

- Undertake compulsory licensing to address illegal irrigation and allocate water savings to the NMBM. Areas in which compulsory licensing should be done include:
  - The Kouga/Gamtoos River systems.
  - All irrigation schemes using Orange River water in the Fish and Sundays River systems.
  - Irrigation schemes which abstract water from other rivers of the AWSS.

- Undertake compulsory licensing in the Seekoei, Kabeljous and Swart Rivers to address illegal agricultural water use, notably illegal dams which reduce the yield of local rivers. Allocate water savings to Humansdorp, Jeffrey's Bay, and St Francis Bay to replace water that these towns currently receive from the NMBM Churchill/Impofu pipeline.

DWAF. 2001. Algoa Water Supply Pre-feasibility Study. Report No. PM000/00/2401, prepared by BKS ACRES (PTY) LTD

3. URBAN WATER DEMAND MANAGEMENT

- WC/WDM downstream of water meters (waste minimisation) that entails the continued roll-out of the ongoing NMBM programmes, and the addition of the following activities to the WC/WDM programme:
  - A public awareness/ user education programme;
  - A schools (educators and learners) awareness programme;
  - Retrofitting of inappropriate plumbing and sanitation fittings;
  - Pressure management;
  - Use of water-efficient fittings; and
  - Elimination of automatic flush urinals.

- WC/WDM upstream of water meters (municipal supply and distribution system) that entails the rollout of an active WC/WDM Section within the NMBM Silo for Water and Sanitation, controlled by a full-time WC/WDM Manager. The WC/WDM Section should perform the following activities:
  - Monthly readings of all zone meters;
  - The conducting of monthly water balances to identify zones and sub-zones with leakage problems; and
  - The locating and repair of those leaks within the system as part of an active leakage control system.

- Rainwater harvesting - Use of rainwater tanks to collect runoff from roofs, which could be used to supply water for gardening purposes or in-house/building usage. A desktop study on the cost of the rainwater tanks and the volume of rainwater which potentially could be captured from an average roof area previously concluded that this intervention could not be regarded as an economic source of water supply. This intervention will however be further investigated to ascertain if it has become more affordable and to explore its potential for implementation in new developments.

DWAF. 2001. Algoa Water Supply Pre-feasibility Study. Volume: Development of as Water Demand Management Programme. Report No. PM000/00/2401, prepared by BKS ACRES (Pty) Ltd.

Algoa Water Resources Bridging Study (2007/2008) by WRP (Pty) Ltd (Draft Volume – "Draft Water Conservation and Water Demand \Management Strategy", Oct 2007).

4. WATER TRADING

Water trading opportunities for unused water allocations should be approached per area, as purchase prices are likely to vary. Areas to be considered for water trading include:

- Baviaanskloof River;

DWAF. 2001. Algoa Water Supply Pre-feasibility Study. Report No. PM000/00/2401, prepared by BKS ACRES (Pty) Ltd

- Langkloof (upper Kouga River);
- Gamtoos River;
- Groendal irrigators;
- All irrigation schemes using Orange River water located in the Fish and Sundays River catchments, taking into account the incremental losses between the source and Port Elizabeth and water quality, inclusive *inter-alia* of the:
  - Lower-Sundays Government Water Scheme;

- Lower Fish (e.g. Tyhefu scheme. Find alternate and better quality water for use by Tyhefu farmers from the eastern rivers, such as the Keiskamma River, as well as the Buffalo River system: Kat River Dam, Sandile Dam, Cata Dam, Mnyemeni Dam);
- Upper Fish (Kleinvisrivier) farmers outside the GFRWUA scheme; and

DWAF. 2008. Algoa System Annual Operation Analysis. Prepared by Water for Africa.

- Desalination of Fish River water pumped to Glen Mellville Dam for water supply to Makana and Ndlambe Municipalities, together with the development of an alternative water source for Tyhefu Irrigation Scheme farmers, would save the freshening releases of about 70 million m^3/a of Orange River water, currently needed to improve river water quality for abstraction. Water from the Kat River could be a potential alternative source.

- Reduction of on-farm losses through improved operational methods, better scheduling, or improved maintenance, which consist of (a) reducing conveyance losses, which occur in conveying the water from the point at which it is abstracted from a canal, river, or farm dam to field edge and (b) reducing application losses due to inefficient technologies by:
  - Improved metering both in irrigation schemes and riparian users;
  - Changing crop type;
  - Improving irrigation practices and technologies; and
  - Introducing deficit-irrigation.

  This only qualifies as a potential intervention should an agreement(s) can be put in place that water saved would be made available for trading with NMBM.

5. LAND-USE CHANGES

- Eradication and control of invasive alien plants, notably in the catchments of AWSS dams, *inter-alia* extending Working for Water in the Kouga River catchment. Yields of system dams would increase as a result of increased baseflow, coupled to measures to be put in place to ensure that increased flow is not intercepted.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

- Non-flow related interventions, which entails focussing on the improvement of mainly riparian habitat, to improve the ecological state of rivers and reduce the flow needed to meet the ecological flow requirements, thus easing up flow for other users. This is only applicable in specific cases, where high flow is specified in the Reserve to maintain a river management class.

Brown, C. Pemberton, C. Birkhead, A. Bok, A., Boucher, A. Dollar, E. Harding, W. Kamish, W. King, J. Paxton, B. Ratcliffe, S. 2006. In support of water-resources planning - highlighting key management issues using DRIFT: a case study. Water SA Vol. 32 No. 2. Pg 181-191.

- Rehabilitation of land following the clearing of invasive alien plants: The Kouga Riparian Rehabilitation Project is an initiative undertaken in the Kouga River catchment. This project will be used as a platform to develop best practices for the rehabilitation of riparian zones following the clearing of invasive alien plants.

The Water Wheel. 2008. Kouga Catchment Enters Rehabilitation.

6. USE OF TREATED EFFLUENT

- Expansion of the Fishwater Flats WWTW treatment of effluent to non-potable standards for non-domestic use. Non-domestic use would mainly be for industrial use in the Coega IDZ, but could include local irrigation of parks, sports fields, golf courses and public gardens, industrial use and commercial agriculture. This will be developed in three phases. Phase 1 will be the Fishwater Flats WWTW, Phase 2 the connection of further NMBM treatment plants and Phase 3 the Coega WWTW.

Coega IDZ Bulk Water. 2007. Water and Return Effluent Study Report. Prepared by SSI and AfriCoast Engineers.

- Effluent treated to non-potable standards at other NMBM treatment works (including the future Coega WWTW) for non-domestic use. Non-domestic use would include local irrigation of parks, sports fields, golf courses and public gardens, industrial use and commercial agriculture. This could include either replacement of existing potable water use with non-potable water use, to free up potable water for urban use, or water for new industrial use.

- Effluent treated to non-potable standards for non-potable domestic use. Non-potable domestic use would entail an expensive dual distribution system with the attendant risk of misuse and accidental connection. To reduce this risk, effluent might be used only for toilet flushing, thereby eliminating garden taps and other access points.

- Effluent treated to potable standards: Direct use of effluent by means of varying treatment processes. This option imposes a potential health risk to users, potentially arising on account of incorrect operation or poor maintenance, and might also necessitate duplication of clear water storage. It further seems likely that all treated effluent would be required for industrial use, at least in the medium-term.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

DWAF. 2001. Algoa Water Supply Pre-feasibility Study. Report No. PM000/00/2401, prepared by BKS ACRES (PTY) LTD.

- Exchange of treated effluent (possibly after desalination) with irrigators in the Swartkops or Sundays Rivers catchments.

- Pumping of treated effluent for storage in dams, and subsequent reuse.

7. GROUNDWATER RESOURCE DEVELOPMENT SCHEMES

- *New groundwater development*: There are a number of sizeable aquifers in the greater Algoa Bay area. Some are already used, such as at Uitenhage (natural discharge from springs) and from boreholes, like at Jeffrey's Bay, Humansdorp and many other areas. The extent to which they are under-utilised is not known at this stage, but it appears as if most are not being used to their capacities. Currently known options are listed below:
  - The Jeffreys Arch including the Zuurbron, Rooihoek and Uitsig areas. Target aquifer: Folded Table Mountain Group (TMG) in the greater Jeffreys Bay area.
  - Van Stadens River Mouth Area. The main groundwater target is the Elandsberg Fault fed by TMG formations in the Maitland Mines area east of the Van Stadens River, and a similar geological setting west of the River.

   - Bushy Park. Target aquifer: Folded TMG at Bushy Park with possible additional groundwater targets along the Chelsea and Moregrove faults south of central Port Elizabeth.
   - The Uitenhage Aquifer and the Coega Fault. The current DWAF study of the Uitenhage Aquifer should establish whether the aquifers in this area can yield more water without affecting springflow from the Uitenhage springs. This sizeable area includes the following prime drilling target areas:
     - NW section of the Coega Fault (West of Uitenhage towards the Grootwinterhoek Mountains);
     - SE section of the Coega Fault (East of Uitenhage towards the coast);
     - The Amanzi-Coega Ridge Aquifer;
     - Kruisrivier-Uitenhage Group west of Uitenhage.
   - Gamtoos Basin. Target aquifer: Buried gravel terraces at the mouth of the Gamtoos River and the Gamtoos Fault.
   - Near Alexandria. Target aquifer: Sediments of Zuney Valley and Kaba Trough.

- *Artificial recharge* (conjunctive use) of alluvial aquifers using surface water or treated wastewater, either to support production borehole yields, or to create a freshwater buffer against marine incursion. This involves aquifer storage with local surplus winter runoff, treated water or imported water. This option would only be considered after large-scale groundwater use of newly developed hard-rock well fields (i.e. it is a medium- to long-term option). Its viability would depend primarily on the availability of surplus surface water runoff and aquifer characteristics.

- *Offshore wellfields*: The Offshore Water Company (OWC) has been established with the intention of harvesting freshwater from under the seabed, where it has been found in the Table Mountain Sandstone Group that extends out into the continental shelf off the coast of Southern Africa. In the past, offshore exploration boreholes in search of oil and gas, which had strikes of freshwater, were sealed up and regarded as valueless to the oil industry. The OWC has obtained the seismic data for the entire coastline of the sub-continent and has appointed Fugro, a Dutch based company, to analyse the data and develop a hydrogeological model to describe and quantify the water source. OWC has the stated intention of supplying raw water to large metropolitan centres along the coast.

8. DESALINATION

- Straits Chemicals manufacturing facility in Coega IDZ. An environmental impact assessment (EIA) was conducted in 2007/2008 for the construction and operation of a chlorine and caustic soda manufacturing facility. The EIA was undertaken for the complete facility, which includes a seawater intake pipeline, land based pipeline, desalination plant, electrolysis plant, facilities for the storage and transportation of products, and a brine outfall pipeline and diffusers to return brine to Algoa Bay. A by-product of this facility is the production of high-quality water, which NMBM can purchase. Due to concerns regarding the seawater intake pipeline, the EIA was amended to omit the marine inlet, desalination, and marine discharge components. The project authorised by Eastern Cape Department of Economic Development and Environmental Affairs, only entails importing course grade solar salt from overseas suppliers and an electrolysis plant (Record of Decision dated 29/08/2008).

SRK. 2007. Final Environmental Impact Assessment and Draft Environmental Management Plan for the Proposed Chlor-Alkali-Plant within the Coega Industrial Development Zone. Report No. 357398/7.

- Desalination of the Lower Sundays River return flows. Return flows and seepage from irrigation land downstream of Korhaansdrift is a possible source of water, which could be considered to supplement the ORP water treated at Nooitgedagt WTW. The quantities available must be verified.

- Desalination of the Swartkops River return flows. Returns flows, mainly discharges from wastewater treatment works, are a possible source of water, which could be considered for industrial or potable use. The quantities available must be verified. Storage of this water in a potential new dam on the Elands River at Echodale can be considered.

Afri-Coast /SSI JV 2009: Coega IDZ Water and Return Effluent Master Plan Update for the Coega Development Corporation. Report No P1956/01

- Desalination of natural flows and return flows in the lower Gamtoos River, pumped to Loerie Dam. The quantities available must be verified, but would depend on the ecological Reserve.

- Redirect freshening releases in the Fish River for the Glen Mellville Dam offtake and desalinate water for Grahamstown and other users from the Fish River. This could be coupled to some form of compensation to the users from Glen Mellville Dam to cover the increased cost.

- Desalination of seawater, likely using the proposed seawater intake planned for the Coega IDZ, as an alternative to the Straits Chemicals option.

9. SURFACE WATER RESOURCE DEVELOPMENT SCHEMES

9.1 IMPROVED OPERATION OF THE AWSS

- Through conjunctive operation, a shortfall at any reservoir could be met by drawing more heavily on another reservoir. Conjunctive operation is possible between the Kouga and Loerie Dams, by dropping the level of Loerie Dam to as low as possible, from which an increase in yield could be obtained by utilising the existing reserve capacity in the main Gamtoos Canal.

Ninham Shand and Partners (1972). "Preliminary Report on the Future Augmentation of the Water Supply for the Port Elizabeth Metropolitan Area", Report No. C.T. 193, City of Port Elizabeth, May 1972.

- The construction of an additional balancing dam upstream of Loerie Dam could be evaluated as an alternative intervention. This would include assessment of the new level to which Loerie Dam needs to be drawn down, with an additional balancing dam in place. The simultaneous raising of Loerie Dam can be considered.

- An interbasin transfer from the Kouga River to the Kromme River for storage in Churchill and Impofu Dams, when there is a high likelihood that Kouga Dam will overflow.

9.2 SCHEMES ON THE KOUGA/GAMTOOS RIVER AND ITS TRIBUTARIES

- Construct a dam at Guernakop on the Kouga River.

DWAF. 2001. Algoa Water Supply Pre-feasibility Study. Report No. PM000/00/2401, prepared by BKS ACRES (PTY) LTD.

- Raising of Kouga Dam: option to rebuild the dam wall immediately adjacent to the existing wall, e.g. as a concrete gravity dam.

- Use of natural flows and return flows in the lower Gamtoos River, pumped to Loerie Treatment Plant and blended with water from Kouga Dam.

- Brandkop and Tafelkop Dam Sites (downstream from the confluence of Kouga River and Baviaanskloof River), to be operated in conjunction with Kouga Dam.

- Brandekraal, Stuurmanskraal and Brandkop Dam Sites, to release water down the Kouga River to Kouga Dam.

- Diversion weir at Brandekraal, Stuurmanskraal and Brandkop Dam Sites to divert water into the Kromme River, possibly through a tunnel, which will then run down into Churchill Dam.

- De Eensaamheid Dam Site on the Baviaanskloof River to meet shortfalls at Kouga Dam.

- Cambria Dam constructed on the Groot River, possibly to be combined with a diversion canal to bypass the dam which would transfer the low flows back into the river. Another option would be to store the water in Cambria Dam and establish a RO desalination plant at the dam. The apparent discontinuance of irrigation below Beervlei Dam may have improved the salinity in the Groot River.

- Dam Sites on the Saagkuile, Klein and Loerie Rivers, together with pipelines to transport water from the dam sites to the main Gamtoos Canal. Alternatively, water could be diverted only from the Klein River via canal, although the yield would be very small. A reservoir at the Upper Loerie dam site on the left bank of the tributary could provide reserve storage for Loerie Dam.

- Raising of Loerie Dam: Operate Loerie Dam at lower levels and install iron removal at the WTW.

9.3 SCHEMES ON THE KROMME AND COASTAL RIVERS

- Tsitsikamma and Klipdrift Dam Sites, from which water could be pumped into a canal leading to Elandsjagt Treatment works or Impofu Dam. From there the water could feed into the Churchill pipeline. Addressing illegal water use through compulsory licensing may make these schemes more viable.

- Construction of a dam on the Groot River, from which water would be pumped up to a tunnel or pipeline, which would then gravitate water into the Kromme River and thence into Churchill Dam.

Ninham Shand and Partners (1972). "Preliminary Report on the Future Augmentation of the Water Supply for the Port Elizabeth Metropolitan Area", Report No. C.T. 193, City of Port Elizabeth, May 1972.

- Construction of a gravity canal to convey water from the rivers along the Tsitsikamma coast into the Kromme River, upstream of Kareedouw. The supply from the gravity canal could be augmented by pumping water from further downstream on the Groot River into the canal.

- The water from the coastal river gravity canal or the water from the dam/weir on the Groot River could be transferred into the Kouga River via an additional tunnel between Kromme and Kouga River. This would however provide no additional storage, unless a dam is built at Guernakop or Kouga Dam is raised.

- The Groot to Kouga transfer scheme would involves construction of a diversion dam on the Groot River, a pumpstation and a pipeline crossing the Tsitsikamma and Suuranys Mountains to the Kouga River.

- An inter-basin transfer from the Tsitsikamma River to the Kromme River to supplement yield from the Churchill and Impofu Dams on the Kromme River. The scheme involves the construction of a dam/diversion weir on the Tsitsikamma River.

- Schemes where it is assumed that the Tsitsikamma to Kromme River transfer has already been implemented as a first phase upgrade, or could be linked to other schemes bringing water into the Kromme River, or that can be considered as a scheme on its own:
  - Fusegates at Impofu Dam which would probably only be feasible if additional water is transferred from another source.
  - An inter-basin transfer from the Tsitsikamma and Groot River into the Kromme River, where water from both the Tsitsikamma and Groot Rivers is transferred directly into the Kromme River. The Tsitsikamma water will be transferred via a pipeline into the Impofu Dam. The Groot River water will be transferred into the Kromme River upstream of Churchill Dam via a diversion dam on the Groot River and a pipeline.
  - Groot to Tsitsikamma to Kromme transfer, which involves the transfer of water from the Groot River into the upper reaches of the Tsitsikamma River from where it flows into the proposed dam on the Tsitsikamma River and is diverted to Impofu Dam (tunnel options were ruled out in 1996).
  - Coastal rivers to Tsitsikamma to Kromme Transfer Scheme, which involves diverting the coastal rivers into the Tsitsikamma River under gravity, storage in a new dam on the Tsitsikamma River, and pumping water from dam into the Impofu Dam.
- Schemes for diverting the coastal rivers via a tunnel at Kareedouw. These tunnel options were screened out as options in the 1996 Algoa Water Resources Stochastic Analysis due to excessive costs.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

9.4 SCHEMES ON THE TSITSIKAMMA RIVER

Two alternative schemes:

- Construct a dam on the Tsitsikamma River and operate it as an independent dam. Water would be treated at the Elandsjagt Treatment Works and supplied to NMBM through the existing infrastructure from the Impofu Dam.
- Construct a smaller dam (diversion weir) and transfer the water into the Impofu Dam where the water would be stored, water would be treated at the Elandsjagt Treatment Works and supplied to PE through the existing infrastructure from the Impofu Dam.

DWAF. 1994. Algoa Water Resources System Analysis – Preliminary Evaluation of Tsitsikamma River as a Source of Water Supply", Report No. 10, prepared by Ninham Shand Consulting Engineers.

9.5 SCHEMES ON THE SUNDAYS RIVER – ADDITIONAL ORANGE RIVER ALLOCATION

- Upgrade the Nooitgedacht treatment works nominal capacity from 100 000 m^3 per day to 140 000 m^3 per day and construct a new low-level pipeline and storage reservoir at Coegakop, to convey additional yield of 41.3 million m^3/a to the Motherwell and new Coega Industrial Development Zone area.

Afri-Coast Engineers 2006: NMBM Water Master Plan Report. Report No NMBM B855

- Potential for temporary allocations from the Gariep Dam when there is surplus water in the Orange River System.

- NMBM to pay for a new Orange River Scheme to create additional yield. This would depend on the value placed nationally on the use of Orange River water, and the scheme tariff imposed.

- Use of the full storage capacity of Darlington Dam on the lower Sundays River, i.e. replacing the existing gates and restoring the original FSL, to store Orange River water and increase the yield of the Orange-Fish-Sundays transfer scheme.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

9.6 SCHEMES ON THE ELANDS RIVER

- Construction of a dam on the main stem of the Elands River at Echodale to supplement water supply to Uitenhage. A pipeline would be required from Echodale to the Uitenhage Treatment Works. There is a further option of using this potential dam in conjunction with desalinated Swartkops River return flows, by storage in the dam.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

Schemes where it is assumed that the Tsitsikamma to Kromme River transfer has already been implemented as a first phase upgrade. Schemes where it is assumed that the Groot River to Tsitsikamma River transfer was implemented as a second phase upgrade:

- Kruis/Elands Canal to Groot to Tsitsikamma to Kromme Transfer, which involves the construction of a canal linking the Kruis and Elands Rivers to the upper reaches of the Groot River.

- Elands to Groot to Tsitsikamma to Kromme Transfer, which involves the diversion of water from Elands River to the upper reaches of the Groot River. The diversion works would consist of a dam in the Elands River, a pumpstation and pipeline to the upper reaches of the Groot River.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

9.7 SCHEMES ON THE VAN STADENS RIVER

- Construction of a larger dam on the Van Stadens River from where the water would be pumped into the existing NMBM raw water infrastructure presently fed from the Van Stadens Dams.

DWAF. 1996. Algoa Water Resources Stochastic Analysis – Possible future Augmentation Schemes", Report No. 3, prepared by Ninham Shand Consulting Engineers.

9.8 REGIONAL TRANSFER SCHEMES

- Importation of water via a regional transfer scheme from the Mzimvubu River via the Kraai River and the Orange-Fish-Sundays system.

Vaal Augmentation Planning Study. Mzimvubu Transfer Options. Engineering design and costing Pre-reconnaissance stage. CONSULT 4 July 1995 DWAF Report No. P C000/00/13794

10. SELECTION OF INTERVENTIONS FOR EVALUATION

Table 10.1: Complete list of all interventions, indicating selection for evaluation

No.	Intervention	Evaluate in: Prelim. Strategy	Evaluate in: Final Strategy	Motivation / notes
1.	**SELECTION FOR EVALUATION**			
	The range of identified interventions, and their selection for evaluation is depicted in **Table 10.1**. Some options have been evaluated for the Preliminary Strategy, and some options have been identified for evaluation during the remainder of the study, for the Strategy. Some options have been screened out through expert analysis, and will not be evaluated in this study. Short motivations are provided.			
2.	**AGRICULTURAL WC/WDM**			
	Undertake compulsory licensing in the Kouga/Gamtoos system, Orange-Fish-Sundays transfer system and possibly for irrigation schemes that abstract water from other rivers of the AWSS, and allocate water savings to NMBM.	No	**Yes**[1]	The potential yields that may be realised through compulsory licensing are unknown. The compulsory licensing process would need to be under-taken for each catchment.
	Undertake compulsory licensing in the Seekoei, Kabeljous and Swart rivers and allocate water savings to coastal towns.	No	**Yes**	The potential yields that may be realised through compulsory licensing are unknown. The compulsory licensing process would need to be under-taken for each catchment.
3.	**URBAN WC/WDM**			
	WC/WDM downstream of water meters.	Yes	Yes	Evaluated as one intervention for the Preliminary Strategy. This intervention can potentially be split into several interventions once updated information becomes available.
	WC/WDM upstream of water meters.	Yes	Yes	Evaluated as one intervention for the Preliminary Strategy. This intervention can potentially be split into several interventions once updated information becomes available.
	Rainwater harvesting - use of rainwater tanks to collect runoff from roofs, which could be used to supply water for gardening purposes or in-house/building usage.	No	**Yes**	Earlier studies have showed that this option could not be regarded as an economic source of water supply. This intervention will however be further investigated to review its financial viability and its potential for implementation at *inter-alia* new developments.
4.	**TRADING OF WATER USE AUTHORISATIONS**			
	Areas to consider for potential water trading: – Baviaanskloof River – Langkloof (upper Kouga River), Kromme River, Gamtoos River, Groendal irrigators.	 Yes No	 Yes No	Water trading should be approached per area, as purchase prices are likely to vary. Real costs depend on market conditions. There is significant uncertainty regarding quantities that can be traded. There are risks in ensuring that water reaches dams or other abstraction points.

[1] The bold "**Yes**" in this column indicates the interventions for which evaluations will be undertaken during the remainder of the study.

No.	Intervention	Evaluate in:		Motivation / notes
		Prelim. Strategy	Final Strategy	
	Areas to consider for potential water trading: – Fish and Sundays rivers irrigation with Orange River water.	No	**Yes**	Water trading should be approached per area, as purchase prices are likely to vary. Real costs depend on market conditions. There is significant uncertainty regarding quantities that can be traded.
	Desalination of Fish River water, to be pumped to Glen Mellville Dam for water supply to Makana and Ndlambe Municipalities, together with the development of an alternative water source for Tyhefu farmers (e.g. Kat River). This will free up Orange River water for use by NMBM.	No	No	Refer to Section 7, *Desalination.* This would likely be a complicated and politically sensitive option but, if successful, could free up large quantities for use by NMBM. The use of this water can be allocated to the NMBM on an interim basis until the water is required by the Tyhefu farmers. The major saving would be the freshening releases currently made.
	Reduction of on-farm losses through improved operational methods, better scheduling, or improved maintenance.	No	No	This only qualifies as a potential intervention should an agreement(s) be put in place that water saved would be made available for trading with NMBM.
5.	**LAND-USE CHANGES**			
	Eradication and control of invasive alien vegetation in the catchments of AWSS dams or abstraction sites.	No	**Yes**	Individual projects should be identified, preferably in co-operation with Working for Water and the CAPE Riparian Rehabilitation Project.
	Non-flow related interventions.	No	No	Non-flow related interventions, entailing the improvement of riparian habitat to reduce the flow needed to meet the ecological flow requirement, thus easing up flow for other users.
6.	**RE-USE OF WATER**			
	Re-use of water treated to industrial standards for commercial and industrial use at the Coega IDZ from the WWTW located within NMBM. Phase 1 will be the Fishwater Flats WWTW, Phase 2 is the connection of further NMBM treatment plants, Phase 3 is the Coega WWTW. Further phasing of these interventions could be considered.	Yes	Yes	Non-domestic use would mainly be used for industrial use in the Coega IDZ, but could include local irrigation of parks, sports fields, public gardens, and commercial agriculture. To be developed in three phases. Three separate interventions will be developed, with further phasing of these interventions if needed.
	Re-use of water treated to non-potable standards for non-potable domestic use – dual distribution networks.	No	No	Non-potable domestic use would entail expensive dual distribution systems with the risk of misuse and accidental connection. To reduce the risk, re-used water might be used only for toilet flushing, thereby eliminating garden taps and other access points. The risk of implementing this option is regarded as too high.
	Re-use of water treated to potable standards for direct use.	No	No	This option poses a potential health risk to users, arising from incorrect operation or poor maintenance. It seems as if all runoff to WWTW will be needed for re-use by the Coega IDZ, and that this option may not materialise. However, if the Coega IDZ does not materialise as expected, it could become an option again.

No.	Intervention	Evaluate in:		Motivation / notes
		Prelim. Strategy	Final Strategy	
	Exchange of re-used water with irrigators in the Swartkops or Sundays river catchments.	No	No	The latest indication from Coega IDZ is that a demand of industrial water of 58.4 Mm^3/a (160 Ml/day) will be required. In order to achieve this, all effluent from FWF, Uitenhage, Despatch WWTWs and the future Coega WWTW will have to be treated. This is therefore not currently an intervention that can be considered. If Coega development however does not materialise as expected, it could become an option again.
	Pumping of re-used water for storage in dams and subsequent re-use.	No	No	The latest indication from the Coega IDZ is that the industrial water requirement would be 58.4 Mm^3/a (160 Ml/day). In order to achieve this, all effluent from Uitenhage, Despatch and FWF WTW will have to be treated, in addition to flows obtained from Coega WWTW. If Coega development however does not materialise as expected, it could become an option again.
7.	**GROUNDWATER RESOURCE DEVELOPMENT SCHEMES**			
	Increasing the yield of the Uitenhage Aquifer and the Coega Fault.	Yes	Yes	The current DWAF study by SRK Consulting should establish whether the Uitenhage Aquifer could yield more water without affecting springflow from the Uitenhage springs.
	The Jeffreys Arch including the Zuurbron, Rooihoek and Uitsig areas. The target aquifer is folded Table Mountain Group (TMG) in the greater Jeffreys Bay area.	Yes	Yes	A TOR has been compiled, for NMBM to initiate a study of this intervention.
	Van Stadens River Mouth Area. Fault fed by TMG formations in the Maitland Mines area east of the Van Stadens River, and a similar geological setting west of the River.	Yes	Yes	A TOR has been compiled, for NMBM to initiate a study of this intervention.
	Bushy Park. Folded TMG at Bushy Park with possible additional groundwater targets.	Yes	Yes	A TOR has been compiled, for NMBM to initiate a study of this intervention.
	Gamtoos Basin. The target aquifer is buried gravel terraces at the mouth of the Gamtoos River and the Gamtoos Fault.	No	No	It is recommended that the hard-rock aquifers first be evaluated. A TOR has been compiled, for NMBM to initiate a study of this intervention.
	Sediments of Zuney Valley and Kaba Trough near Alexandria.	No	No	Both the Zuney Valley and Kaba Trough are far from existing NMBM bulk supply infrastructure, and are more favourable for water supply to Alexandria than Port Elizabeth. Both areas look promising from a groundwater prospective, however they have not been previously explored to an extent where their yields can be reliably estimated. Much of the Kaba Trough sits inside a restricted area (SANParks), and large-scale groundwater use may not be permitted.
	Offshore wellfields.	No	No	This involves technology not previously used in South Africa, and is likely to be very expensive.
	Artificial recharge of alluvial aquifers using surface water or re-used water.	No	No	Identified hard-rock aquifers should first be developed (i.e. they have been prioritised to be developed before any potential alluvial aquifers).

No.	Intervention	Evaluate in:		Motivation / notes
		Prelim. Strategy	Final Strategy	
8.	**DESALINATION**			
	Straits Chemicals' manufacturing facility in the Coega IDZ. High-quality water is a by-product of this facility, which NMBM can purchase.	Yes	Yes	This option is dependent on the proposed construction of the seawater intake, and a power plant.
	Desalination of the lower Sundays River return flows.	Yes	Yes	Use of mainly agricultural return flows, taking into consideration the required flows for the Sundays Estuary. Synergy with the Straits Chemicals desalination option should be considered.
	Desalination of the Swartkops River return flows.	No	No	Use of mainly industrial return flows, taking into consideration the required flows for the Swartkops Estuary. This option falls away if all flows from WWTWs draining to the Swartkops River are re-used.
	Desalination of natural flows and return flows in the lower Gamtoos River, integrated into the AWSS at Loerie Dam.	No	No	Use of mainly agricultural return flows, taking into consideration the required flows for the Gamtoos Estuary.
	Desalination of seawater, using the proposed seawater intake planned for the Coega IDZ, as an alternative to the Straits Chemicals desalination option.	No	**Yes**	This option is dependent on the proposed construction of the seawater intake, and a power plant.
	Desalination of Fish River water, to be pumped to Glen Mellville Dam for water supply to Makana and Ndlambe Municipalities, together with the development of an alternative water source for Tyhefu farmers, freeing up Orange River water for use by NMBM.	-	-	Incorporated under Section 3, *Trading of water use authorisations*.
9	**SURFACE WATER RESOURCE DEVELOPMENT SCHEMES**			
9.1	**Improved operation of the AWSS**			
	Conjunctive operation between the Kouga and the Loerie Dams, from which an increase in yield could be obtained by utilising the existing reserve capacity in the main Gamtoos Canal.	Yes	Yes	Conjunctive operation is possible between the Kouga and Loerie Dams, by dropping the Loerie Dam level to as low as possible.
	Additional balancing dam to be constructed on the Gamtoos canal upstream of the Loerie Dam. An additional balancing dam would control the inflows from the Gamtoos Canal into the Loerie Dam so as to maximise the yield available from the Loerie Dam.	No	No	There is currently limited opportunity for controlling the flow from the Gamtoos Canal into Loerie Dam. It is, however, not expected that the addition of a balancing dam will significantly increase the yield.
	An inter-basin transfer from the Kouga River to the Kromme River for storage in Churchill and Impofu Dams, when there is a high likelihood that Kouga Dam will overflow.	No	No	This option will increase the overall yield of the AWSS, through improved system operation. The cost may however be exorbitant.

9.2	**Schemes on the Kouga/Gamtoos River and its tributaries**			
	Dam constructed at Guernakop on the Kouga River.	Yes	Yes	An EIA was conducted in 2001 to identify a suitable site for the proposed dam. The EIA found that the identified sites would not have a major impact on the environment. The study concluded that an incremental historical firm yield of 15 Mm^3/a could be achieved with the construction of a dam at Guernakop.
	Raising of Kouga Dam by constructing a mass gravity rollcrete dam immediately downstream of the existing dam wall.	Yes	Yes	Due to safety risks, the Kouga Dam cannot be raised. It is proposed to construct a mass gravity rollcrete dam immediately downstream of the existing dam, with a full supply level of RL 170 m and a capacity of 313 Mm^3.
	Use of natural flows and return flows in the lower Gamtoos River, pumped to Loerie Treatment Plant and blended with water from Kouga Dam.	No	**Yes**	Use of mainly agricultural return flows, taking into consideration the required flows for the Gamtoos Estuary.
	Brandkop and Tafelkop Dam Sites (downstream from the confluence of Kouga River and Baviaanskloof River), to be operated in conjunction with Kouga Dam.	No	No	Screened out in earlier studies.
	Brandekraal, Stuurmanskraal and Brandkop Dam Sites, to release water down the Kouga River to Kouga Dam.	No	No	Screened out in earlier studies.
	Diversion weir at Brandekraal, Stuurmanskraal and Brandkop Dam Sites to divert water into the Kromme River, possibly through a tunnel, which will then run down into Churchill Dam.	No	No	Screened out in earlier studies.
	De Eensaamheid Dam Site on the Baviaanskloof River to meet shortfalls at Kouga Dam.	No	No	Screened out in earlier studies.
	Cambria Dam constructed on the Groot River, possibly to be combined with a diversion canal to bypass the dam which would transfer the low flows back into the river. Another option would be to store the water in Cambria Dam and establish a RO desalination plant at the dam. The apparent discontinuance of irrigation below Beervlei Dam may have improved the salinity in the Groot River.	No	No	Screened out in earlier studies.
	Dam Sites on the Saagkuile, Klein and Loerie Rivers, together with pipelines to transport water from the dam sites to the main Gamtoos Canal. A reservoir at the Upper Loerie Dam site on the left bank of the tributary could provide reserve storage for Loerie Dam.	No	No	Screened out in earlier studies.
	Raising of Loerie Dam, conjunctive with improved operation, by operating Loerie Dam at lower levels and installing iron removal at the WTW.	No	No	Screened out in earlier studies.
9.3	**Schemes on the Kromme and coastal rivers**			
	Combined coastal rivers transfer scheme to the Kromme River, involving transfer from coastal rivers/Tsitsikamma River to the Kromme River, incorporating the most likely of the various options previously investigated.	No	No	A new look at this possibility, taking updated information into account. Aspects of the range of options considered would be integrated in this option. Revisiting of this scheme could only be considered once other currently more feasible options have been investigated.

	Tsitsikamma and Klipdrift Dam Sites, from which water could be pumped into a canal leading to Elandsjagt Treatment Works or Impofu Dam,	No	No	Screened out due to lower flows in the Tsitsikamma River than previously expected. To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	Construction of a dam on the Groot River for transfer to the Kromme River.	No	No	To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	Construction of a gravity canal to convey water from the rivers along the Tsitsikamma coast into the Kromme River, upstream of Kareedouw.	No	No	To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	The water from the coastal river gravity canal or the water from the dam/weir on the Groot River could be transferred into the Kouga River via an additional tunnel between Kromme and Kouga River.	No	No	This would however provide no additional storage, unless a dam is built at Guernakop or Kouga Dam is raised. To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	Groot to Kouga transfer scheme, with a diversion dam on the Groot River.	No	No	To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	An inter-basin transfer from the Tsitsikamma River to the Kromme River, involving construction of a dam/weir on the Tsitsikamma River.	No	No	To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	Schemes where it is assumed that the Tsitsikamma to Kromme River transfer has already been implemented: • Fusegates at Impofu Dam. • An inter-basin transfer from the Tsitsikamma and Groot River into the Kromme River. • Groot to Tsitsikamma to Kromme transfer. • Coastal rivers to Tsitsikamma to Kromme Transfer Scheme.	 No No No No	 No No No No	Fusegates at Impofu Dam would only be an option if additional water is transferred from another source, and could potentially be incorporated in the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	Schemes for diverting the coastal rivers via a tunnel at Kareedouw.	No	No	These tunnel options were screened out as options in the 1996 Algoa Water Resources Stochastic Analysis due to excessive costs.
9.4	**Mutually-exclusive schemes on the Tsitsikamma River**			
	Construct a dam on the Tsitsikamma River and operate it as an independent dam. Water would be treated at the Elandsjagt Treatment Works.	No	No	Screened out due to lower flows in the Tsitsikamma River than previously expected. To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
	Construct a smaller dam (diversion weir) on the Tsitsikamma River and transfer the water into the Impofu Dam.	No	Yes	Although river flows are lower than originally estimated, and allowance for the Reserve must be made, the scheme may compare favourably with many of the options currently under investigation.
9.5	**Schemes on the Sundays River: additional Orange River allocation**			
	Upgrade the Nooitgedacht treatment works nominal capacity from 100 000 m^3 per day to 140 000 m^3 per day and construct a new low-level pipeline and storage reservoir at Coegakop, to convey additional yield of 41.3 Mm^3/a to the Motherwell and new Coega IDZ area.	Yes	Yes	Depends on an additional Orange River water allocation from the DWAF.
	Potential for temporary allocations from the Gariep Dam when there is surplus water or unused allocations from the Orange River System.	No	No	This would entail the determination of the status of "surplus flows" in the Orange River and is likely an option that would in any event fall away in the long-term.

	NMBM to pay for an Orange River Scheme to create additional yield.	No	No	This option can only really be addressed if the opportunity arises, and the cost implications for NMBM become known. The DWAF is not keen to allocate further Orange River water to NMBM (apart from the reserved quantity, which may also be temporary).
	Use of the full storage capacity of Darlington Dam on the lower Sundays River.	No	No	The fixing of the Darlington Dam gates would restore the dam to its original size, but the cost will likely be prohibitive. Evaporation and flood storage would increase.
9.6	**Schemes on the Elands River**			
	Construction of a dam on the Elands River at Echodale to supplement water supply to Uitenhage.	No	No	Link with Section 7, Desalination, as desalinated water from the Swartkops River could be stored in this potential dam. This could be blended with Groendal Dam water to improve water quality.
	Schemes where it is assumed that the Tsitsikamma to Kromme River transfer has already been implemented: • Kruis/Elands Canal to Groot to Tsitsikamma to Kromme Transfer. • Elands to Groot to Tsitsikamma to Kromme Transfer.	No	No	To be addressed by the *Combined coastal rivers transfer scheme to the Kromme River* intervention.
9.7	**Schemes on the Van Stadens River**			
	Construction of a larger dam on the Van Stadens River.	No	No	This scheme was deemed impractical owing to its low yield and relatively high unit cost.
9.8	**Regional transfer schemes**			
	Importation of water via a regional transfer scheme from the Mzimvubu River via the Kraai River and the Orange-Fish-Sundays system.	No	No	The study undertaken could not confirm the overall best cost due to the lack of detail and recommended further investigation. Costs are, however, very high.

APPENDIX B

CURRENT AND POTENTIAL FUTURE CAPACITIES OF WATER TREATMENT WORKS AND PIPELINES OF THE AWSS

CURRENT AND POTENTIAL FUTURE CAPACITIES OF WATER TREATMENT WORKS AND PIPELINES OF THE AWSS

1. PIPELINE AND TREATMENT WORKS CAPACITIES

The existing peak week capacities and possible future peak week capacities have been evaluated for the various components of the AWSS, as portrayed in **Table B1**, for a peak week factor of 1.3. Capacity limitations and potential improvements to infrastructure to increase future capacity are discussed in the Table.

Table B1 Pipeline and treatment works capacities

Conveyance Infrastructure Components	Existing peak week capacity		Possible future peak week capacity		Limitations and possible improvements to infrastructure to increase future capacities and other comments
	Ml/d	Mm^3/a	Ml/d	Mm^3/a	
OLD DAMS					
Sand and Bulk Pipelines					Booster pumps would provide limited capacity increase.
Van Staadens Pipelines					Booster pumps would provide limited capacity increase.
Total Old Dam Pipelines	***16***	***6***	***16***	***6***	***Booster pumps would provide limited capacity increase.***
Linton WTW	20	7	20	7	Max Month Average Annual Daily Demand (AADD) over period 1999-2007 was 11.5 Ml/d in Jan 2002, and max AADD was 8.85 Ml/d for 2003.
GROENDAL/UITENHAGE					
Groendal Pipeline	18	7	18	7	Booster pumps commissioned in 1985. Peak capacity shown is for dam at 70% full and with pipeline boosted but not cleaned for some 5 years.
Uitenhage Springs	6	2	6	2	Capacity of springs limits peak supply. Yield increased to steady 6Ml/d after DWAF capped boreholes in 1992/93.
Groendal Pipeline, WTW and Uitenhage Springs	***24***	***9***	***24***	***9***	***Booster pumps would provide limited increase in capacity.***
CHURCHILL/IMPOFU					
Churchill WTW	105	38	105	38	No augmentation is considered viable and existing supply limited to 100 Ml/d for satisfactory quality water. A 12m-lift booster has been built at Elandsjagt WTW to lift Churchill water into the Elandsjagt final water reservoir during peak flow conditions, i.e. as first capacity upgrade to pipeline system. Prior to this intervention, the outlet from Elandsjagt WTW was operated by throttled valve to balance the hydraulics.
Churchill to Elandsjagt Pipeline and Pumps	143	52	143	52	No augmentation is considered viable. The low lift pump station to be completed but problems have been experienced and it is not operational at present.
Elandsjagt WTW	105	38	160	58	The WTW was designed to be upgraded and was recently upgraded with additions to the sedimentation tanks, etc to provide quality water at 105 Ml/day. A check should be undertaken to determine whether the site can accommodate further extensions.
Elandsjagt to Coastal Towns and to Gamtoos (Coastal Towns) (Gamtoos)	154 (16) (138)	56 (6) (50)	210 (36) (174)	77 (13) (64)	At present a maximum flow of 138 Ml/d can be delivered to Gamtoos, until the bottlenecks presently being addressed have been removed and the additional Gamtoos Pump Station (to Summit Reservoir) is commissioned in 2010 (26 Ml/d). In addition, some 16 Ml/d can be delivered to the coastal towns. The age of pipelines may be the determining factor on whether the pipelines could be boosted beyond 180 Ml/day. A total delivery of 210 Ml/d should, however, be possible with the new Gamtoos pumps installed (the present Maintenance project) and with the draw-offs to Jeffreys Bay and other coastal towns drawing (in 2016) a peak week demand of some 36 Ml/d. The potential for boosting the pipeline from Elandsjagt to Gamtoos may limit the potential increase in supply capacity.

Conveyance Infrastructure Components	Existing peak week capacity		Possible future peak week capacity		Limitations and possible improvements to infrastructure to increase future capacities and other comments
	Ml/d	Mm^3/a	Ml/d	Mm^3/a	
Coastal towns	***16***	***6***	***36***	***13***	***The existing pipeline can supply to the coastal towns their current peak week demand of about 16 Ml/day and in future should be able to provide a peak week demand of about 36 Ml/day.***
Gamtoos to Greenbushes/Chelsea Pipeline and Pumps	***138***	***50***	***145***	***53***	***This pipeline is already boosted, however this additional peak week capacity will only be available once the Gamtoos Pumps have been replaced (upgraded).***
Gamtoos to Summit Pumps and Pipeline	***0***	***0***	***26***	***9***	***These pumps are currently being designed for completion in 2010.***
LOERIE					
Loerie WTW	***100***	***37***	***100***	***37***	***No increase in the existing capacity of the Loerie WTW is indicated, as this would not be effective unless the supply from Kouga Dam to NMBM is augmented. The Loerie WTW was however planned for doubling, i.e. based on the 1963 plans for future raising of Kouga Dam wall. The provision of additional clarifiers may necessitate relocating the sludge dams but an additional filter gallery could be added quite easily.***
Loerie to Summit Pumps and Pipeline	***100***	***37***	***100***	***37***	***A surge analysis will be required to check the pipeline integrity if flows are increased to more than the existing capacity of 100 Ml/day. Increasing the pumping capacity may however not be economical, due to the large increase in head and the expected electricity tariffs. An additional pipeline might be preferable and might only be required if the supply from Kouga Dam is augmented.***
Summit to Chelsea	140	51	140	51	The maximum discharge was 136 Ml/d, however the KwaNobuhle off-take a short distance from Chelsea Reservoir has enabled the peak flow to be increased to about 140 Ml/d. The inlet to Chelsea Reservoir must still be improved to enable the maximum flow to the reservoir for high water levels, without overflowing the inlet building.
Total Pipeline Capacity Gamtoos to Greenbushes+ Summit to City	278	101	278	101	This capacity is only applicable for a peak week factor of 1.3 or higher.
NOOITGEDACHT ALLOCATION					
Scheepersvlakte to Nooitgedacht Pipeline	280	102	280	102	This pipeline was sized to deliver an average flow of 200 Ml/d and a peak flow of 280 Ml/day. Scheepersvlakte Dam has a balancing capacity of 800 Ml which may be drawn down during dry periods and reduce the pipeline capacity.
Nooitgedacht WTW	***73***	***27***	***105***	***38***	***The WTW is currently being upgraded to match the capacity of the pumps. Additional filters will be required to increase the capacity to 105 Ml/day.***
Nooitgedacht to Grassridge Pipeline	93	34	105	38	Either the pumping capacity should be upgraded or the 4th standby pump must be used to deliver 105 Ml/day.
Grassridge to Motherwell Pipeline	135	49	135	49	Upgrading is not required.
Existing Total Capacity and Possible Future Capacity		***135***		***165***	

Notes:
1. Limiting future conveyance infrastructure capacities are shown in ***bold italics***.
2. It has been assumed that transfers can take place within the Metropolitan area and that the possible improvements to the existing infrastructure required to meet the possible future increase in peak week capacities will be provided as indicated in the table.

2. ASSESSMENT OF ADDITIONAL 1 IN 20 YEAR AND 1 IN 50 YEAR YIELDS THAT COULD BE SUPPLIED BY EXISTING PIPELINES

The estimated 1 in 50 year and 1 in 20 year yields of the various sources of supply available to NMBM (after provision for the original ecological allocations but not the recently determined increased ecological reserve releases) are compared in **Tables B2** and **B3** with the present day and future conveyance capacities respectively shown in **Table B1**. These Tables show the following:

- Table B2 shows that the existing conveyance infrastructure supplying NMBM would only be able to supply a peak week demand equivalent to 135 million m^3/a (370 Ml/d) which corresponds to a peak week demand factors of 1.3 and 1.2 for the present day 1 in 50 year and 1 in 20 year yields respectively.
- Table B3 shows that if the existing pipeline infrastructure is upgraded by boosting then the overall peak week capacity of the pipeline system could be boosted to 165 million m^3/a (452 Ml/d) corresponding to peak week demand factors of 1.6 and 1.5 for the present day 1 in 50 year and 1 in 20 year yields respectively. Therefore for a peak week demand factor of 1.3, the boosted infrastructure would be capable of supporting an augmented yield of 127 million m^3/a (165/1.3) which corresponds to augmentation of the present day 1 in 50 year by 26 million m^3/a (127-101) and of the 1 in 20 year yield by 17 million m^3/a (127-110).

Table B2 Assessment of additional 1 in 20 year and 1 in 50 year yields that could be supplied by existing pipelines for a peak week factor of 1.3

Sources of Supply	Possible Future Conveyance Infrastructure Peak Week Capacity (Mm^3/a)	1 in 50 Year Yield or Existing Allocation		1 in 20 Year Yield or Existing Allocation	
		Yield or Allocation (Mm^3/a)	Peak Factor	Yield or Allocation (Mm^3/a)	Peak Factor
Old Dams	6	3	2.0	4	1.5
Groendal/Uitenhage springs	9	6	1.5	6	1.5
Churchill/Impofu	56 (6+50)	44	1.3	51	1.1
Kouga/Loerie	37	22	1.6	23	1.6
Nooitgedacht	27	26	1.0	26	1.0
Combined Total Yield	**135**	**101**	**1.3**	**110**	**1.2**

Notes: 1. Peak Factor based on (Present Conveyance Infrastructure Capacity) / (1 in 20 year or 1 in 50 year yields)
2. Yields based on the 1996 Stochastic Analysis

Table B3 Assessment of additional 1 in 20 year and 1 in 50 year yields that could be supplied by boosting existing pipelines for a peak week factor of 1.3

Sources of Supply	Possible Future Conveyance Infrastructure Peak Week Capacity (Mm^3/a)	1 in 50 Year Yield or Existing Allocation		1 in 20 Year Yield or Existing Allocation	
		Yield or Allocation (Mm3/a)	Peak Factor	Yield or Allocation (Mm^3/a)	Peak Factor
Old Dams	6	3	2.7	4	2.0
Groendal/Uitenhage springs	9	6	1.5	6	1.5
Churchill/Impofu	75 (13+53+9)	44	1.7	51	1.5
Kouga/Loerie	37	22	1.6	23	1.6
Nooitgedacht	38	26	1.5	26	1.5
Combined Total Yield	**165**	**101**	**1.6**	**110**	**1.5**

Notes: 1. Peak Factor based on (Future Conveyance Infrastructure Capacity) / (1in 20 year or 1 in 50 year yields)
2. Yields based on the 1996 Stochastic Analysis

Water Reconciliation Strategy Study for the Algoa Water Supply Area

Study Reports

Report Name	DWA Report Number	NS Report number
Impact of Changed Crops on Water Quality in the Great Fish River	WMA 15/M00/00/1409/01	5004
Preliminary Reconciliation Strategy	WMA 15/M00/001409/02	5005
Inception	WMA 15/M00/00/1409/03	5006
Reconciliation Strategy (future)	WMA 15/M00/00/1409/04	5007