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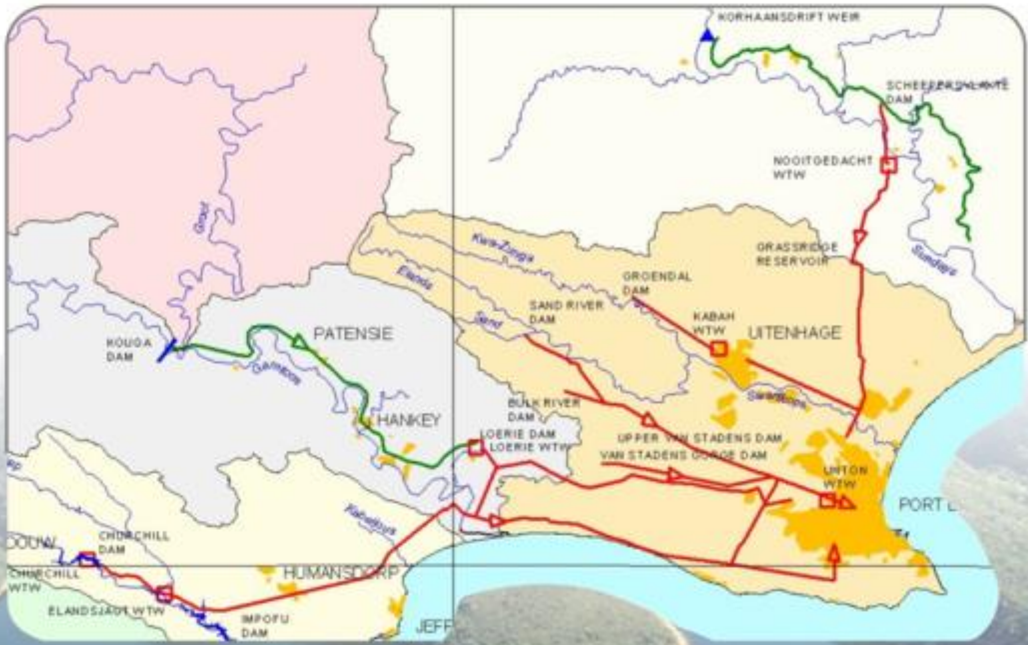
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Water Reconciliation Strategy Study for the Algoa Water Supply Area

Algoa Reconciliation Strategy



Status Report 4

September 2017

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DEPARTMENT OF WATER AND SANITATION

Directorate: National Water Resource Planning

Support of the Water Reconciliation Strategy for the Algoa Water Supply System

STATUS REPORT 4

Final

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Department of Water and Sanitation
Directorate: National Water Resource Planning

SUPPORT OF THE WATER RECONCILIATION STRATEGY FOR THE ALGOA WATER SUPPLY SYSTEM

APPROVAL

Title	:	Status Report 4
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1 Introduction

1.1 Background

The Algoa Reconciliation Strategy Development was undertaken by the Department of Water Affairs (DWA), in cooperation with the Nelson Mandela Bay Municipality (NMBM) and other stakeholders, in order to secure a sustainable future water supply for NMBM and the other towns served by the Algoa Water Supply System (AWSS), shown in **Figure 1.2** on the following page. The purpose of the Reconciliation Strategy is to determine the current water balance situation and to develop various possible future water balance scenarios for at least a 25-year planning horizon. It further aims to describe the proposed strategy, and the associated actions, responsibilities and timing of such actions that are urgently needed to reconcile available resources and requirements, to enable additional interventions to be timeously implemented so as to prevent the risk of a water shortage becoming unacceptable. The Strategy offers a system for the continuous monitoring and updating of the Algoa Reconciliation Strategy into the future.

The Strategy was initially completed in early 2010 and was subsequently updated in April 2011 due to emergency interventions planned as a result of the drought, as well as revised Coega IDZ requirements.

The Strategy has since been reviewed and updated by the Algoa Strategy Steering Committee as shown in

Figure 1.1. This Status Report (Status Report 4) provides an overview of the September 2017 update to the Strategy.

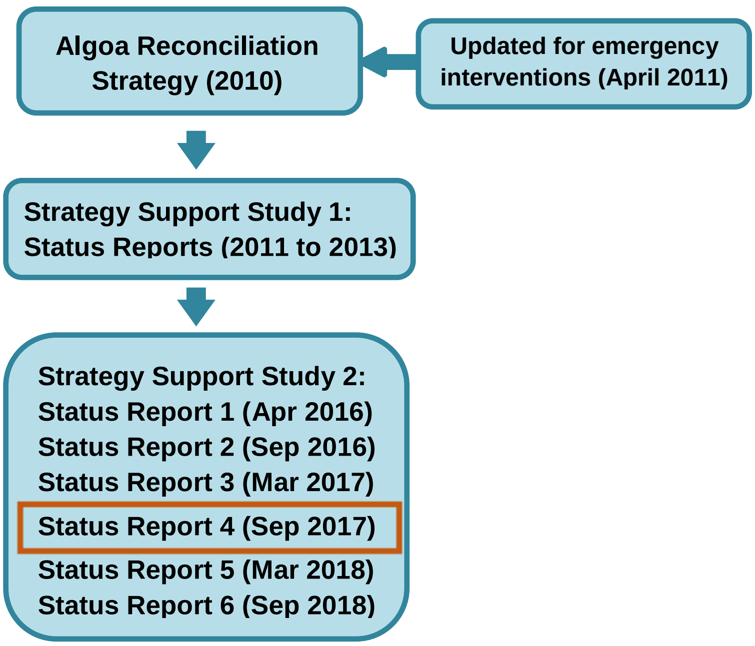


Figure 1.1: Review and updating of the Algoa Reconciliation Strategy

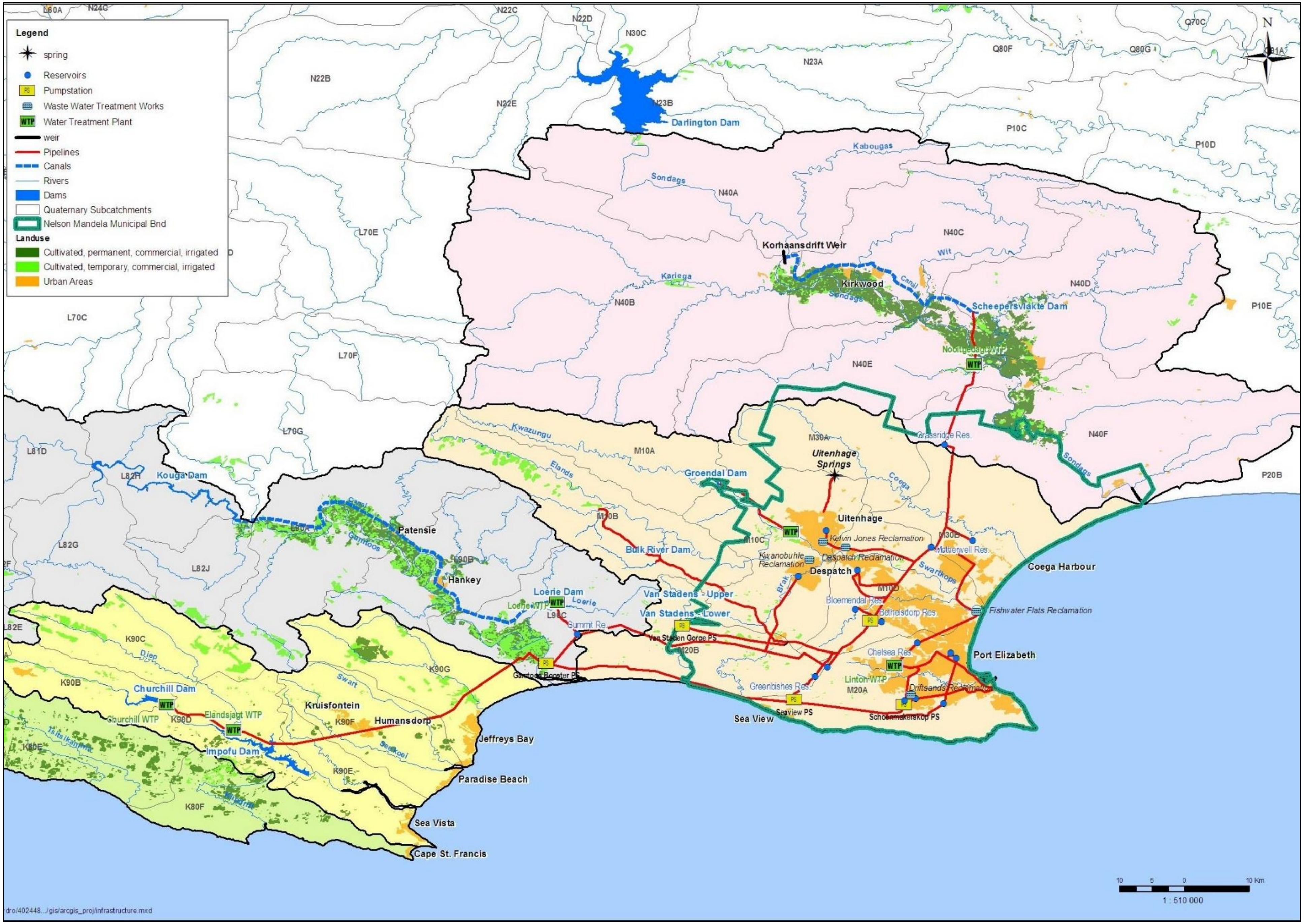


Figure 1.2: Algoa Water Supply System

1.2 The Strategy Area

The Algoa Water Supply System (WSS) 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 within the Kouga Municipality.

The Gamtoos Irrigation Board is a licensed irrigation board based in the town of Patensie close to the Baviaanskloof in the Eastern Cape, and has been in operation since 1991. The Board has a contract with the DWS to operate the Gamtoos water scheme on its behalf. Water is stored and supplied from the Kouga Dam. An area of 7 408 ha is irrigated, with an allocation of 8 000 m^3/a per scheduled hectare. In most years though, the full quota is not available for use.

The NMBM is located along Algoa Bay in the Eastern Cape Province, and comprises of the erstwhile city of Port Elizabeth and the erstwhile towns of Uitenhage and Despatch, as well as the Colchester, Blue Horizon Bay and Seaview areas. **Figure 1.3** illustrates the population growth trends and projections in NMBM, with information sourced from Statistics South Africa and the 2015 mid-year population survey. Census 2011 indicated that the Eastern Cape as a province has a lower net migration rate than other provinces, with a growth rate of 1.36%. The demographic trends indicates a city with a steady population increase.

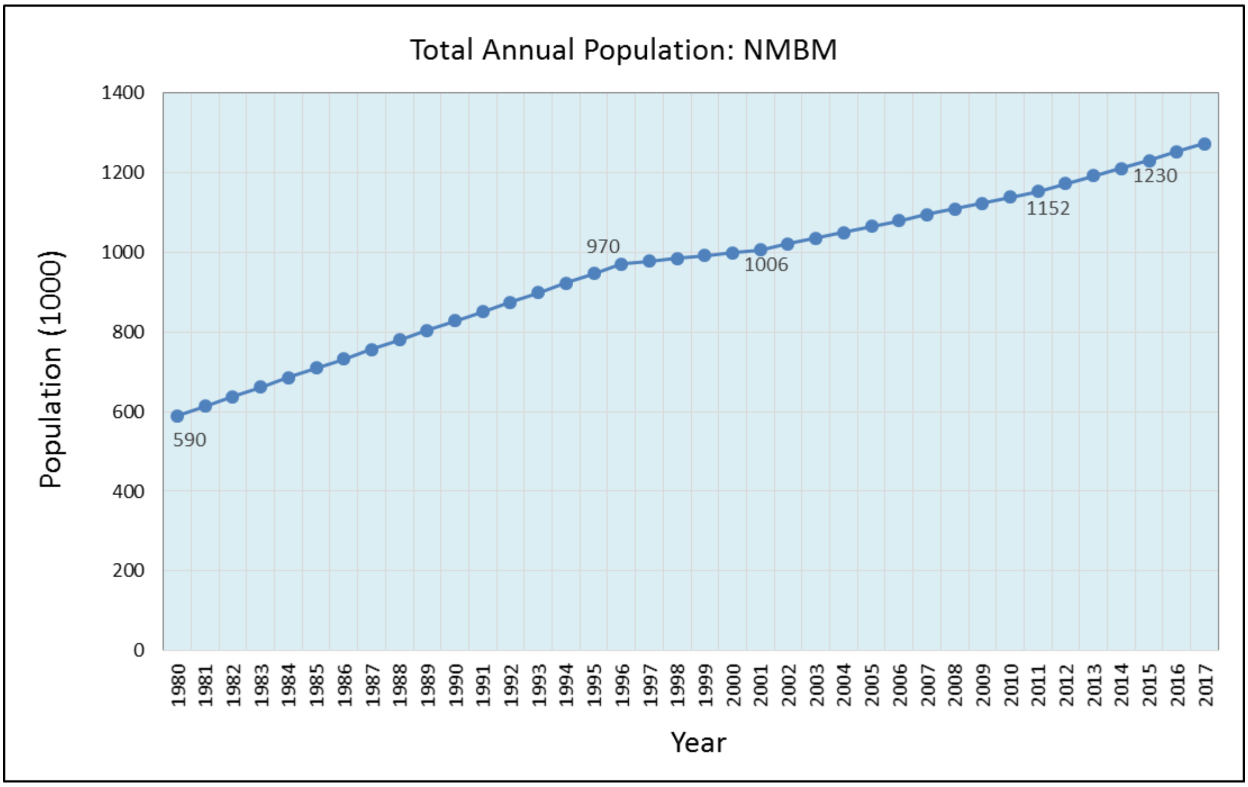


Figure 1.3: Population history of NMBM

1.3 The Algoa Water Supply System

The AWSS currently comprises three major dams in the west, several smaller dams and a spring situated near to NMBM, as well as an inter-basin transfer scheme from the Orange River via the Fish and Sundays rivers to the east.

The combined total yield of the Algoa WSS is 167.4 million m^3/a (458.6 Mℓ/d).

Western System

The Western System provides water to 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. The bulk supply of water provided to NMBM and the coastal towns from the combined Western System at an assurance of 1 in 50 years amounts to 65 million m^3/a (178 Ml/day). The Gamtoos Irrigation Board has an allocation from Kouga Dam of 60.1666 million m^3/a, following a recent slightly increased correction. There is also relatively small usage by other towns and irrigators supplied by this system as well as a small provision for ecological water requirements (EWR) below Impofu Dam. The growing water requirements of the Kouga Local Municipality (LM), who *inter-alia* receives water from the Kromme sub-system needs to be carefully monitored. Significant growth in their urban water requirements, coupled to the possibility of a nuclear power plant being established at Thyspunt, means that their requirements could start to influence decisions regarding the implementation of interventions for the Algoa WSS.

Eastern System

The Orange-Fish-Sundays Transfer Scheme supplies Orange River water from Gariep Dam to the Great Fish River valley and the Sundays River valley, to supplement local water supply for irrigation and some urban use by local towns. The Lower Sundays River Irrigation Scheme supplies water for irrigation as well as for two major water users, namely the Sundays River Valley Local and NMBM for domestic water supply in Port Elizabeth.

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, Darlington Dam and abstraction from the lower Sundays River at the Korhaansdrift Weir.

The Lower Sundays River Water User Association (LSRWUA) also obtains water from the Gariep Dam on the Orange River via the same transfer scheme, sharing some bulk storage and conveyance infrastructure with NMBM. The LSRWUA manages an area of 17 293 ha, with a total scheduled quota of 156 million m^3/a. Infrastructure is shared with NMBM from the abstraction in the lower Sundays River at Korhaansdrift Weir, up to the Scheepersvlakte Balancing Dam, with most of the water being used for irrigation. The capacity of the balancing dam is not sufficient to meet the dual purpose of supplying the upgraded Nooitgedagt WTW and irrigators in the future. The potential sites for an additional balancing dam is currently being evaluated.

Central System

The Central System consists of the older dams on the Sand, Bulk, Van Stadens and Kwa Zunga (a tributary of the Swartkops) rivers and the Uitenhage Springs, all of which are owned by the NMBM. Combined, the quantity of water that can be abstracted by NMBM from these sources is about 10 million m^3/a (27 Mℓ/day), although this supply has recently been limited.

The Groendal Dam provides 4 million m^3/a (11 Ml/day) to NMBM and 2.4 million m^3/a to irrigators.

1.4 Interventions

Potential strategy interventions were initially identified according to the following categories, to identify a longlist of interventions to screen:

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

- Desalination of seawater or
- Desalination of brackish river water; and
- Surface water schemes.

An intervention is a measure that could be timeously implemented, either by reducing water requirements or by increasing water availability, to prevent the risk of a water shortage becoming unacceptable.

More than sixty potential interventions, which could contribute to meeting the future water requirements of the AWSS, were initially identified. Preliminary screening of potential interventions were then done based on the following criteria, to identify a shortlist of interventions to consider further:

- Scheme cost based on the unit reference value (URV) which provides an indication of the combined capital and operation costs,
- The time required for implementation,
- Adequate intervention yield, and certainty that the yield can be realised,
- Spreading of risk by becoming less reliant on surface water sources, and
- Ensuring that there is an adequate number of interventions to supply water to the end of the planning period of at least 25 years.

Maximising the yield of the existing Kouga/Loerie Scheme is an operational measure that was adopted after approval of the Reconciliation Strategy in 2011. The recommended Nooitgedagt Low Level Scheme is currently being implemented in phases. Some interventions have fallen away since the reconciliation strategy was completed, an example being the trading of water entitlements, due to a change in DWS policy. The *Abstraction of lower Gamtoos River Irrigation Return Flows* was ruled out by DWS Resource Directed Measures Chief Directorate staff. The *Tsitsikamma River Diversion to Impofu Dam* was abandoned, following the DWS strategic decision that the Tsitsikamma River water should be reserved for local development in the Tsitsikamma River catchment.

The long-list of interventions that was evaluated in the 2011 Reconciliation Strategy, including the drought interventions considered, has been included in **Appendix B**.

Interventions currently being considered for the strategy is shown in **Table 1.1**.

Table 1.1: Interventions being considered

Scheme	Description
Municipal WC/WDM	Continued roll-out of a WC/WDM programme, preferably being controlled by a full-time WC/WDM manager, being the implementation of a well-formulated and funded WC/WDM strategy and programme. Besides WC/WDM in the NMBM, this is also required for especially the Kouga Local Municipality.
Rainwater harvesting	Collection of rainwater from roofs, primarily for toilet flushing, or to supplement garden watering. This normally entails promotion by a municipality or enforcement through the promulgation of a bylaw.
Removal of invasive alien plants	Programmes to remove invasive alien plants in the catchments of the Kromme, Kouga and Baviaanskloof rivers, which is already being done on a large scale.
Re-use of water treated to industrial standards – Fish Water Flats WWTW	Re-use of treated water from the Fish Water Flats Waste Water Treatment Works (WWTW), to meet requirements for industrial quality water within the Coega IDZ.
Re-use of water treated to industrial standards – Coega WWTW	Re-use of treated water from the future Coega WWTW, to meet requirements for industrial (non-potable) quality water within the Coega IDZ.

Scheme	Description
Re-use of water treated to potable standards	Potable re-use of treated water from the Fish Water Flats (and possibly Uitenhage and Despatch WWTWs) through reverse osmosis treatment, storage in Loerie Dam, or in a proposed new dam at Echodale on the Elands River, and treatment at a new water treatment works.
Lower Sundays River irrigation return flows	Abstraction of irrigation return flows in the Sundays River downstream of the Sundays River WUA, desalination, and blending at Olifantskop reservoirs with treated Orange River water supplied from the Nooitgedagt WTW.
Desalination of seawater	Supply via a bulk seawater intake system and pumping of seawater via pipeline to a proposed reverse osmosis plant site. Such a scheme can easily be phased. Potential schemes for NMBM, Coega IDZ, sea salt producers and the Thyspunt Nuclear Power Plant have been identified. A seawater desalination plant that can be sited at the old Swartkops Power Station and will discharge brine via the existing sea outfall of the Fishwater Flats WWTW is a drought mitigation backup option.
Groundwater schemes	Implementation of the South-Eastern Coega Fault groundwater scheme is underway. In addition, groundwater schemes can be implemented at Jeffreys Arch, Van Stadens River Mouth, Bushy Park and other new groundwater schemes. Some of these schemes could either supply NMBM or alternatively supply small coastal towns, freeing up water for NMBM. As fracking is a new technology, no fracking interventions have been identified.
Orange River Project/ Nooitgedagt Low-Level Scheme	This entails increased supply from the Orange River to NMBM, supplied from the Nooitgedagt WTW, via a new pipeline to the Olifantskop Reservoir. This scheme also offers significant energy savings on account of the reduced pumping heads needed. DWS issued a licence to NMBM to abstract a total of 58.3 million m^3/a of water from the Orange River, with the proviso that the licence could be reduced back to 22 million m^3/a after 20 years; however NMBM have requested that the licence be made permanent on account of the high capital investment. Implementation of the third phase of the scheme is underway. The potential for further allocation of transferred Orange River water, in line with potential efficiency savings, to be obtained along the OFS transfer route are also being considered.
Guernakop Dam on the Kouga River	Construction of a new 83 m high rollcrete dam at Guernakop approximately 15 km upstream of the upper end of Kouga Dam on the Kouga River and doubling of the capacities of the Loerie WTW and the pipelines to NMBM.
Raising Kouga Dam on the Kouga River (replacement and raising)	Construction of a mass gravity rollcrete dam immediately downstream of the existing Kouga Dam and doubling of the capacities of the Loerie WTW and the pipelines to NMBM.

1.5 Drought

The NMBM is currently experiencing one of the worst droughts in decades. With below-average rainfall being experienced, dam levels have continued to drop and average dam storage levels have receded to 32%. The NMBM originally imposed water restrictions in September 2016. More severe restrictions were imposed in May 2017 (Part C Tariffs) in order to minimise the risk of excessive drawdown of the already low water levels in the dams, as is evident from **Figure 1.4**.

Figure 1.4: Churchill Dam level in July 2017

As a result of the potential disastrous and far-reaching negative implications for NMBM, the Executive Mayor declared a Local State of Disaster on 22 May 2017.

Current estimations indicate that the NMBM has approximately 12 months of water left, reaching dead storage level in August 2018, if no inflows are experienced.

Depleting the water sources is not an option, and measures need to be implemented to ensure that the available water will last for the duration of the drought and that the NMBM consumers will always have water available.

In order to ensure that there will be sufficient water stored in the dams to supply the needs of NMBM and the various coastal towns that it supplies, the NMBM has implemented various water saving measures and strategies to reduce demand. The NMBM are also implementing several bulk water infrastructure upgrades to maximise the available yield from their respective water sources, and are fast-tracking emergency schemes that were identified as additional water sources to the municipality.

2 Progress with Implementation of the Strategy

2.1 Strategy Steering Committee

One of the recommendations of the Reconciliation Strategy Study was that a Strategy Steering Committee (SSC) be formed with a clearly defined mandate and scope of work.

The objectives of the SSC are:

- To ensure and monitor implementation of the recommendations of the Algoa Reconciliation Strategy,
- To ensure that the necessary studies by the responsible institutions identified in the Strategy, are started timeously to ensure continued reconciliation of water supply and requirements,
- To update the Strategy when necessary to ensure that it remains relevant, and
- To ensure that the Strategy, its recommendations and progress with its implementation are appropriately communicated to all stakeholders.

The SSC has met eight times since the Strategy was completed. The Committee is functioning as it was intended and the stakeholders and water users of the Algoa Water Supply System (WSS) actively take part and provide feedback in the meetings on their progress with implementing the actions for which they are responsible.

An Administrative and Technical Support Group (ATSG) was formed to support the SSC. The ATSG consists of representatives from the DWS National Office, DWS Eastern Cape Regional Office, NMBM, Eastern Cape Provincial Government, agriculture and other key stakeholder organisations. The ATSG meets between the SSC meetings to ensure that the recommendations of the strategy and committee are implemented. The list of SSC and ATSG members is contained in Appendix A.

2.2 Progress with other Studies and Activities

In the recommendations of the Algoa Reconciliation Strategy, a number of interventions were identified as possible future water augmentation schemes that could be implemented after completion of the Nooitgedagt Low-level Scheme. In order to ensure that these interventions are available for implementation when required, DWS and NMBM were assigned the responsibility of initiating feasibility and/or pre-feasibility level studies of these interventions, or to initiate other supporting activities.

This section of the progress report details the progress that the DWS and the NMBM have made in the implementation of the supply-side interventions.

2.2.1 DWS Studies

Verification and Validation of Water Use Study of a part of the Kromme and Kouga catchment areas

As the surface water resources of the Kromme and Kouga catchment areas could be under stress, the need for verification and validation (V&V) of water use for these areas was identified. The validation of water use of a significant part of the Kouga River catchment has been completed. The validation for the Langkloof area is complete but the verification is not yet complete as it forms part of the V&V project that has been awarded in 2016 for the whole of the Eastern Cape. The validation process for the Eastern Cape as a whole is 100% complete with the verification process at about 44%. Stakeholder engagements have been completed by the end of October 2016. A total of 7 532 Section 35 application letters have been generated and distributed to date. The Return to Sender letters and users that fail to respond provides a challenge and it is being addressed. 100% of Section 33 letters have been generated and signed off by Head Office and 1166 Section 35 (4) letters have been generated of which 774 have already been signed off by the DG. 83.4% of the total volume of water identified in the V&V project has already been verified with the signed Section33 and Section 35 (4) letters and those that are still in process. The failure to respond comes to 12.96% of the total volume and hence the DWS offices are trying various means to make contact with those water users. The PSP contracted has been extended with six months till March 2018. The need for Compulsory Licensing in the Seekoei-Swart and Kabeljous rivers have been identified as priority. A request has been sent to DWS National to prioritise the areas once the V&V project is concluded. The information gathered by the V&V studies will be used as input to the future Water Availability Assessment Study for the Kromme and Kouga catchments. This study is expected to be initiated after the verification and validation has been completed.

Kouga Dam raising in light of DWS dam safety evaluation

DWS' Directorate Dam Safety evaluated the need for rehabilitation and stabilisation of the Kouga Dam wall. Should significant construction be needed for potential rehabilitation, the dam wall could potentially also be raised at the same time. The outcome of the investigation is that no major dam safety rehabilitation work is necessary for the dam wall and the previously planned dam safety activities has been put on hold. In light of this, the potential for a larger Kouga Dam, which would consist of the construction of a new concrete gravity dam directly downstream of the existing one, is now less attractive from a cost perspective.

This potential development will only be addressed after the desalination of Sundays River irrigation return flows has been considered, as the raising of the dam is expected to be more expensive and to have a significant environmental impact. Potential raisings by 10.5 m, 16.5 m and 19.8 m have been considered previously. A study on the raising of the dam is also dependent on the WAAS study that is still in the pipeline.

Operating capacity of Darlington Dam

Darlington Dam was completed in 1922, and was raised in 1935 and again between 1948 and 1952. Most of the water of Darlington Dam is used for irrigation but some water is transferred to the Scheepersvlakte Balancing Dam from where water is transported to the Nooitgedagt Water Treatment Works on the right bank of the Sundays River via a gravity pipeline.

The maximum operating capacity of the Darlington Dam is currently kept at 43% (80 million m^3) of its full storage capacity (187 million m^3), due to dam safety constraints. The potential to re-instate the original full storage capacity of the dam, or at least increase it from the current limitation, will lower the risk of supply downstream of the dam. This could possibly mean an increase in the sub-system yield, and allocations downstream of the Darlington Dam could then be re-assessed. This is of interest to the NMBM and some local municipalities for potential future increased water allocations, but hitherto, due to budget cuts, no progress has been made with regards to increasing the Darlington Dam's capacity.

The gates on the Darlington Dam, which release water to Korhaansdrift Weir, are leaking significantly. The gates require refurbishment to reduce potential water losses in the Sundays River catchment.

The refurbishment of the Darlington Dam is currently being evaluated by the DWS. It is noted that the refurbishment of the Darlington Dam may result in water savings in the lower Sundays River catchment and may hold potential to increase the volume of water that can be supplied to the NMBM. Additional yield will also be created should additional allocations be made to the NMBM.

Additional balancing storage in the LSRGWS

Previously the option of increasing the balancing capacity of the Scheepersvlakte Balancing Dam was considered, but it has come to light that there is rather a need to increase the supply capacity of the Lower Sundays River Government Water Scheme (LSRGWS). Downtime for maintenance at the canal is currently not possible as there is not enough storage available for the required water.

One of the three main objectives of the ongoing Algoa Reconciliation Feasibility Study is to remove potential operating system constraints for sustainable delivery of bulk Orange River water supply to the LSRGWS and to NMBM, for water requirements up to 2040.

The objective is therefore to limit risks of shortfall in supply as well as operational risks to acceptable levels. The focus is on providing additional balancing storage, in addition to the Scheepersvlakte Balancing Dam, which includes the investigation of storage at other potential locations in the bulk transfer infrastructure.

It is essential to ensure that there are no bottlenecks regarding the transfer of additional Orange River water to NMBM with relating to the implementation of the Nooitgedagt Scheme.

The initial seven storage/conveyance options that were identified to ease the bottleneck in the water supply system to Nooitgedagt WTW, were reduced to the following two options:

- Construction of a larger dam near the present Scheepersvlakte Dam site and integration of this dam with the existing gravity pipeline to the Nooitgedagt WTW, and
- Construction of a large balancing dam on the right bank near the Nooitgedagt WTW.

There are advantages and disadvantages to both options but the preliminary environmental investigation showed no "fatal flaws" for either option. The two options are being further investigated to come to a final conclusion.

Preparations are currently underway to engage with land owners, to be followed by the geotechnical investigations and topographical surveys.

Further Orange River Water Development Options

Studies have not yet been initiated for the following options to augment Orange River water (if and when needed) in the longer term:

- Desalination of Sundays River irrigation return flows. Monitoring at the DWS monitoring station in the Lower Sundays River confirmed that sufficient water is available to justify a feasibility study. A more detailed desktop study will be done as part of this Algoa Recon Study.
- Increased allocation to NMBM. The investigation (as objective 1 of the Algoa Reconciliation Strategy Support Study) to evaluate the efficiency of the Eastern Cape Province Orange River Project will *inter-alia* quantify potential water savings and examine alternative options for reallocation of water and the related effects on system operations, taking into account the requirements of NMBM and other users depending on water from the Orange River. Preliminary recommendations are currently being refined.

2.2.2 Progress with Implementation of WC/WDM in NMBM

WC/WDM was identified in 2010 as a key action for NMBM to reduce water use and non-revenue water (NRW).

The targets of the NMBM WC/WDM Programme are:

- Algoa Reconciliation Strategy (April 2011) - recommendation of reduction of 13 500 Mℓ/year (37 Mℓ/day) within 5 years starting in the 2010/11 year. This was not achieved.
- The National Development Plan has set the following target: *"Reduce water demand in urban areas to 15 percent below business-as-usual scenario by 2030*".
- Senior Director (W & S):
    - 18 000 Mℓ per year after 3 years (49 Mℓ/day) from 2014/15 to 2016/17
    - Ultimately 15 000 Mℓ per year (41 Mℓ/day) in 2018/19
- The reduction by 15% of usage from Kouga and Kromme River Schemes by DWS by Government Gazette 29 April 2016, effective from 1 February 2016.

As the NMBM is currently experiencing one of the worst droughts in decades WC/WDM becomes even more important. With below-average rainfall, dam levels have continued to drop and average storage levels have receded to about 30% by beginning of October 2017. The NMBM have been active in implementing WC/WDM measures for over 7 years but have implemented additional measures since the introduction of water restrictions in July 2016. A large publicity and marketing campaign was launched to reduce water consumption and this continued as the drought intensified.

The WC/WDM programme continued through new contracts and existing appointments. Despite limited provision for operating and capital budgets, shortage of technical staff and delays in supply chain management processes, progress was achieved in reducing real losses. From 2015/16 to 2016/17 financial years, NRW reduced from 43.4% to 37.5% and physical water losses reduced from 37.3% to 29.4%.

The interventions to reduce NRW comprises of 13 main work streams.

Workstream 1: Bulk Supply Meters - The installation of Bulk Meters to establish actual losses and to develop a water balance

Workstream 2: GMA and DMA Meters - The installation of GMA and DMA Meters to establish where most losses occur

Workstream 3: Remote Metering - The installation of GMA and DMA Meters to establish where most losses occur

Workstream 4: Non-Revenue Water (NRW) - Summary of all the WC/WDM interventions

Workstream 5: PRV Management - Savings in water usage can be realised by applying pressure reduction

Workstream 6: ICI Consumers and Billing Database - Industrial and institutional consumers uses 42% of the total water. Special attention is given to these consumers

Workstream 7: Water Tariffs - An investigation was undertaken of the domestic water tariffs, commercial/industrial water tariffs and fixed charges of nine metropolitan municipalities for 2014/15 and 2015/16.

Workstream 8: Leak Repairs – ATTP, Schools, Ward Clusters and Leak Fixing festival

Workstream 9: Repair and Maintenance - Repairs picked up during water loss audits

Workstream 10: Domestic Meter Audit and On-property leak Investigations

Many meter readings are estimated and or are not on the billing system. An audit is being performed

Workstream 11: Valve and Fire Hydrant Audit - Many valves and Fire Hydrants have faults and need to be repaired to reduce wastage of water.

Workstream 12: Meter replacement Programme - A meter replacement programme is part of this workstream

Workstream 13: Publicity and Awareness Programme - School Awareness Programme, Drought Campaign Social facilitation and Operational Call Centre

Figure 2.1 provides a comparison of the average daily water consumption for NMBM with and without WC/WDM. While this graph is indicative of success with WC/WDM, it may be necessary to consider another ways to indicate the success or not of water efficiency programmes.

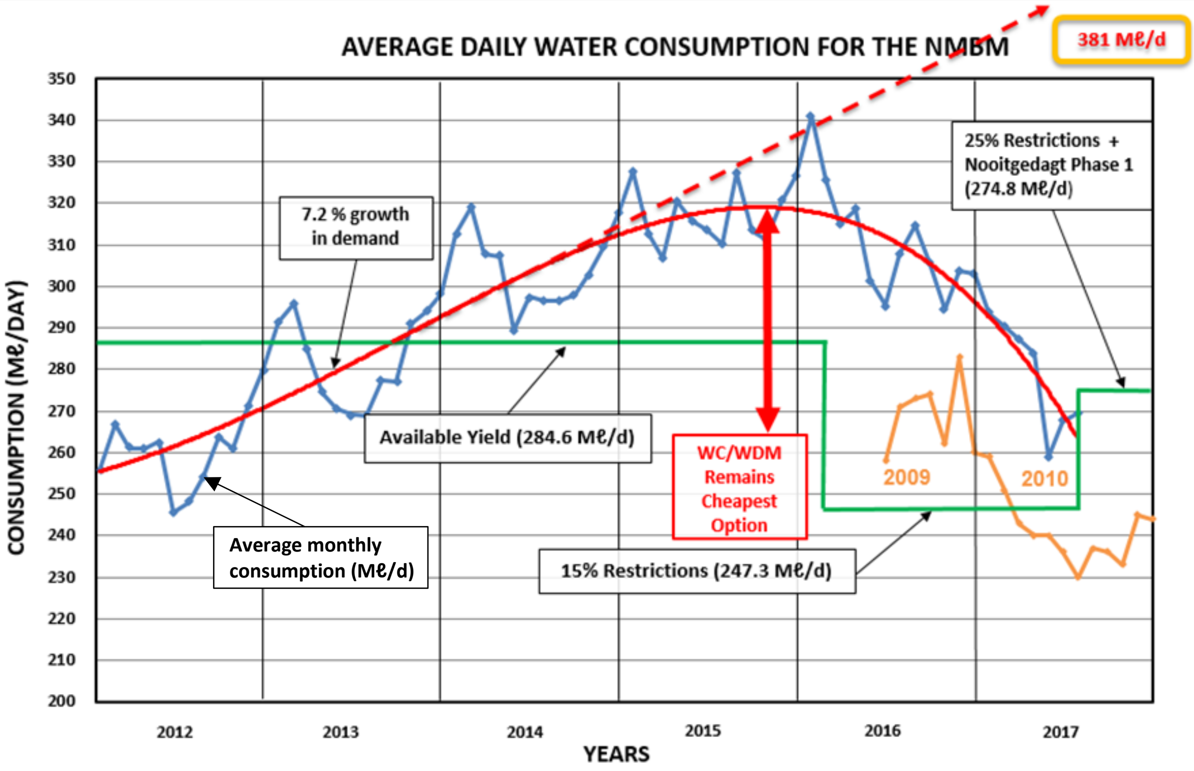


Figure 2.1: Water use for NMBM with and without WC/WDM

2.2.3 NMBM Studies and Implementation of Schemes

Removal of distribution system limitations

It is important to take into account that the distribution system of the NMBM supply area has certain limitations of which the most important capacity limitation used to be that between the Northern and Southern parts of the NMBM supply area (between Motherwell and Chelsea reservoirs). The maximum capacity of this link was 11 million m³/a (30 Ml/day). The capacity of this link was increased to 32.9 million m³/a (90 Ml/day), and has been operational since March 2013. Recently a new booster pump station was commissioned. This pump station boosts Nooitgedagt water from the Low-Level Scheme to the High-Level Scheme. The Stanford Road booster pump station has been vandalised and has recently been upgraded. This pump station boosts the Nooitgedagt water to the Chelsey reservoirs for distribution to the western zones.

ORP Nooitgedagt Low-Level Scheme

An additional allocation of water from the Orange River to NMBM has been approved by DWS for an initial period of 20 years, when DWS confirmed in 2009 that the NMBM water allocation from the Orange River had been increased to 58.4 million m³/a (160 Ml/day). The EIA for the scheme has been approved by the Provincial Department of Economic Development, Environmental Affairs and Tourism (DEDEAT), to be reviewed after 20 years. In view of the high cost of infrastructure investment, NMBM have requested DWS to consider making the additional allocation permanent.

The Metro is constructing the Nooitgedagt/Coega Low-Level Scheme (NCLLS) as an extension to the existing Nooitgedagt High-Level Scheme that will treat Orange River water, delivered through the Orange-Fish-Sundays River system, to drinking water standard for supply into the Metro's water supply system. The existing scheme capacity is 90 Mℓ/d.

NMBM is completing the outstanding works on the project in a phased approach, in line with the capacity of its capital budget. Phase 1 ensures an average supply of 90 Ml/day (32.9 m^3/a). Phase 2 ensures an average supply of 125 Ml/day (45.6 m^3/a), with a peak of 160 Ml/day. Phase 3 will ensure an average supply of 160 Ml/day (58.4 m^3/a) which is the full allocation of NMBM from the OFS Scheme, making provision for a peak supply of 210 Ml/day (76.7 m^3/a).

Phase 1 was funded by a R453 million Emergency Scheme grant from DWS and R125.7 million by NMBM from own capital budget over several financial years.

Phase 2 was funded by the Metro (R128 million, excl. VAT) commenced in March 2015, and was completed in August 2017. Phase 2 provides the new low-lift pump station to complete the low-level scheme to Port Elizabeth. Phase 2 supplies approximately 100 Ml/d through the low-level scheme which relieves pressure on the supply from the western system of the Algoa WSS.

Phase 3, to be completed in mid-2019, will be funded by the DWS, who has appointed Amatola Water as the implementing agent. Funding in the amount of R437 million has been approved by DWS for this phase, for an additional 70 Ml/day (peak) module at Nooitgedagt WTW (civil, mechanical and electrical works), 45 Ml reservoir at Olifantskop, cathodic protection and AC mitigation measures on Nooitgedagt and Churchill pipelines, and rehabilitation of the Chelsea-Motherwell pipeline). A contractor was appointed and the construction commenced in May 2017. The 45 Mℓ Olifantskop Reservoir is crucial for the operation of the NCLLS, as the 10 Mℓ reservoir has insufficient balancing capacity to allow the scheme to be operated at full capacity. The Contractor proposed a change in construction methods that will allow for a reduction in the construction time of about 25%. After review by the Engineer, the proposal was accepted and is being implemented. The 45 Mℓ reservoir should be completed by about October 2018.

Desalination

Following the drought of 2010-2011, where an emergency 30 Ml/d desalination plant at the Old Swartkops Power Station proceeded up to tender stage, several investigations have been done into possible locations for a desalination plant to augment the water supply in the NMBM. These included various sizing and implementation options. Three locations have been considered in more detail. The Swartkops Desalination Scheme remains a backup drought option.

a) Western Desalination Plant Feasibility Investigation

A feasibility investigation was undertaken in two phases, being a Site Selection and a Detailed Feasibility Investigation. Potential plant locations for a 60 Mℓ/d desalination plant for the NMBM have been investigated. The siting was concluded with the Schoenmakers inland site at the western side of the city recommended as the preferred site. The feasibility study got underway, with its components being a comprehensive water quality monitoring program, marine bathymetry and geophysical surveys, brine dispersion modelling, and preliminary design considerations for the marine intakes and outfall, the desalination plant, and the delivery pipeline. The preferred potential plant location would then also be subject to a full EIA. The Feasibility Investigation was stopped early in 2017, with the pre-feasibility investigations, site selections and marine bathymetry having been completed, and with the water quality monitoring evaluation done at desktop level.

b) Coega collaboration

The NMBM has undertaken to work in conjunction with the Coega Development Corporation to explore a common use desalination plant implementation process. This would possibly make use of the Coega Marine Corridor that is currently in the approval phase.

Even though a desalination plant located in the areas surrounding the Coega IDZ would not directly address the recurring droughts of the western sources, the overall augmentation of the NMBM's bulk sources would allow the reallocation of existing produced potable water to these stressed areas.

c) **Ab Inbev and Marina Salt Works Collaboration**

Anheuser-Busch InBev SA/NV (Ab Inbev), a Belgian-Brazilian beverage and brewing company, in conjunction with the Marina Salt works are planning to construct a desalination plant for their own industrial uses. As part of the "Adopt a Metro" initiative where Ab Inbev "adopted" the NMBM as its Metro, the two companies approached the NMBM with a possible collaboration effort in extending their planned desalination plant to supply additional water for potable use by the NMBM. A proposed 26 Mℓ/d desalination plant is considered to augment water supply in the NMBM. For reconciliation planning purposes, the potential purchasing by NMBM of 5.5 million m^3/a of potable water have been taken into account.

These options are all still in the Investigation Stage and no decisions on desalination has been made yet.

Groundwater

a. Background

DWS has indicated that groundwater is generally under-utilised and that the water scarce areas should focus on the possible extraction of ground water. Groundwater can provide an affordable and dependable water supply and can be implemented relatively rapidly once the legal requirements, especially water use licenses, have been secured. Most of the identified groundwater targets lie within a few kilometres from existing bulk supply pipelines or reservoirs which mean that construction times will generally be low, once the legal, design and tender processes have been completed.

Figure 2.2 shows the previously identified groundwater potential areas. The potential groundwater sources have been divided into those that have been investigated in detail, where drilling sites have been identified (as part of the emergency supply investigation during and after the 2010/11 drought), and those that have been investigated, but where further studies are required to locate drilling sites.

Green – areas ready to drill; yellow – areas requiring borehole siting; dark blue – bulk supply pipelines; light blue – canals (Google Earth, 2013).

Figure 2.2: Groundwater potential areas

b. Update of groundwater yields

The assumed combined yield of the identified eight groundwater interventions ranges from 23.2 to 35.6 million m^3/a, and was reported as 30.3 million m^3/a with a possible emergency yield of 59.4 million m^3/a.

c. Implementation Plan

The progress with the drilling of production boreholes at Coega Kop is as follows:

- The exploratory work has been completed and the sites for production boreholes have been identified. Procurement of a specialist driller has progressed well and drilling should commence in October 2017. Drilling should be completed by February 2019.
- The designs of the water treatment works is underway and construction should start in February 2018 and completed in August 2019.
- It is estimated that an additional 15 Mℓ/day to 20 Mℓ/day should be available on completion of this scheme.

The progress with the drilling at all the other potential groundwater sites is as follows:

- DWS plans to appoint Term Tender contractors through a Section 32 process to drill boreholes at the other potential groundwater sites.
- This process to obtain approval for the above has already commenced.
- It is envisaged that the drilling should commence in October 2017, to be completed in phases. First water is expected in December 2017, with completion in February 2018.

Re-use of water treated to industrial standards – Fish Water Flats WWTW

The upgrade of the Fish Water Flats WWTW Phase 1 has been completed. The upgrade involved a new inlet works (170 Ml/day), upgrading of dewatering facilities, upgrade of the existing biological reactors with fine bubble, diffused aeration, addition of 45 Ml/d membrane biological reactors (MBR) to increase capacity, bulk electrical upgrade and general upgrade and refurbishment of the entire plant. Programming for overall upgrade of the plant is dependent on the availability of funding.

The re-use scheme involves large-scale supply of treated water from the Fish Water Flats WWTW to industries in Port Elizabeth and the Coega IDZ. The first phase of supply is based on the understanding that NMBM will supply 30 Ml/day of Category 4 industrial process water from the Fish Water Flats WWTW, via a balancing storage reservoir at Coega Kop, to the IDZ. The second phase of the scheme will increase the water re-use scheme to 60 Ml/day and will incorporate a new storage reservoir(s) at Olifantskop. This will be constructed at a future date and is excluded at this stage. The environmental impact assessment for the scheme to supply the IDZ has been approved by the Eastern Cape DEDEAT. A 17 Ml reservoir at Coegakop is currently being constructed. The implementation of the remainder of the scheme is dependent on the water requirements from large water users establishing in the IDZ. The construction will take 18-24 months to complete and R600 million is needed to bring the bulk supply conveyance infrastructure to the Coega IDZ boundary. Sourcing these funds is still a challenge.

Re-use of water treated to industrial standards – Coega WWTW

The concept design phase of the engineering component has been completed and the draft Concept Design Report has been produced.

It is currently planned to implement the scheme in a phased approach, potentially starting with one domestic stream of 20 Mℓ/d. The degree to which the first few phases will need to accommodate light industrial effluent flows is uncertain, however several options have been evaluated. The way forward on this can only be confirmed once the client has reached a decision on the options presented in the Concept Design Report. **Table 2.1** shows the projected phasing based on a conservative approach, i.e. with a projected growth rate that is higher than actual current trends.

Table 2.1: Summarised phases of the Coega WWTW

Phase	Date	Volume per Phase (Mℓ/d)		Cumulative volume (Mℓ/d)	
		Domestic	Industrial	Domestic	Industrial
1	2019	20		20	
2	2024	20	10	40	10
3	2029	20	10	60	20
4	2034		20		40
5	2038		30		70

Progress is as follows:

- The concept design report assessed several alternatives in terms of primary, secondary and tertiary treatment. Based on a Multi-Criteria Decision Analysis workshop held with the client and the project team during June 2016, the preferred option is currently a conventional activated sludge system with treatment up to general limit standards and possible additional nutrient removal, including cloth filtration and ultra violet closed-vessel disinfection.
- The preferred brine discharge alternative is to discharge to the Coega River, up to a volume of 60 Mℓ/d to 80 Mℓ/d, mostly domestic effluent at general limit standards (and possible additional nutrient removal).
- The current brine discharge options for the treated heavy industrial effluent are still being investigated, with one option being discharge to the ocean via the CDC's combined marine outfall (currently also in concept phase of evaluation).
- Contribution to the NMBM's Re-use Scheme is incorporated in the WWTW's planning (water to be pumped to the Coega Kop treated effluent reservoir).
- The EIA is currently in the pre-application phase and will enter the scoping phase as soon as the client has confirmed the way forward in terms of the options presented in the concept design report.

Monitoring

Gauges to monitor flows and quality of WWTW flows for later possible re-use schemes are in place.

Initial data obtained from the Lower Sundays River gauging point (N4L002 – Sundays River, Poplar Grove), confirmed that the minimum volume of irrigation return flows is in the order of 43 million m^3/a (120 Ml/day). This volume excludes the flooding periods in the Sundays River system and this takes into account the possibility of leakage from Darlington Dam.

2.2.4 Other Municipalities

In 2011, the Kouga LM embarked on the implementation of a WC/WDM strategy, aimed at reducing non-revenue water and wasteful consumption, improving system and consumer metering and in this way deliver water to its consumers as cost-efficiently as possible.

Four phases have been rolled out since, these being:

PHASE 1: 2011/2012. The DWS allocated an amount of R1.5 million for the implementation of WC/WDM activities. The focus was on billing and metering. Amatola Water inspected all the billing meters that recorded zero consumption in Jeffery's Bay and Humansdorp.

PHASE 2: 2013/2014. For Phase 2 of the project R1.0 million was allocated to Kouga LM by DWS under the Accelerated Community Infrastructure Program (ACIP). During this phase mostly repairs and maintenance to bulk water infrastructure was done.

PHASE 3: 2014/2015 Funding to the amount of R2.0 million was secured through the ACIP Program, with the following main objectives:

- Investigate the condition and service air valves on the St Francis Bay bulk potable supply main from the Churchill pipeline to the town of St Francis Bay,
- Compile a water balance for the 2013/2014 financial year on the systems within the municipality, and
- Implement a retrofitting programme within Hankey and Patensie to reduce water losses.

PHASE 4: 2015/2016 Funding to the amount of R4.355 million was again secured through the ACIP Program. An audit of all existing bulk water meters was done. Installation of new bulk and zone water meters on bulk water mains were done throughout the entire Kouga LM area. Faulty bulk meters were also replaced. An audit of all domestic and ICI water meters in Kouga LM were done. Each meter was audited and all information captured. Due to budget and time constraints no repairs and/or replacement of faulty water meters was done under this project by the service provider.

Non-revenue water in the area for the past three years is depicted in **Table 2.2**.

Table 2.2: Non-revenue water in Kouga LM for the past three years

Financial year	Supplied (kl)	Billed (kl)	NRW (kl)	Non-revenue water %
2013/2014	7,358,746	4,322,270	3,036,476	41%
2014/2015	6,769,757	4,493,545	2,276,212	34%
2015/2016	9,803,845	6,018,164	3,785,681	38,6%

3 2016 Update of the Strategy

3.1 Algoa WSS yield

The Algoa WSS currently comprises of three major dams in the west, several smaller dams, a spring situated near to NMBM, and an inter-basin transfer scheme from the Orange River via the Fish and Sundays rivers to the east. The main components of the Algoa WSS are shown in **Figure 1.2**.

The need for a water availability assessment study in the Kouga and Kromme catchments to address the significant uncertainties in water availability, once the verification and validations has been completed, has been well documented

3.1.1 Priority Classes of water supply

The agreed split of the water requirements between the different assurances of supply for each category of water supply is summarised in **Table 3.1**, as originally reported in the Algoa Water Resources Bridging Study. This priority classification was derived from a process of interaction with the main role players, as part of the study. These are however not cast in concrete and can be adjusted based on the findings from the analysis as well as experience gained during the operation of the system in future.

The water user priority classification applied included five user categories, namely domestic/industrial, Gamtoos irrigation, other irrigation, environmental and losses. The water requirements associated with each category were further divided into four priority classes, each with a specific assurance of supply criteria (or acceptable risk of non-supply).

Table 3.1: Priority classes for different category water users

Category	% of total water requirement allocated to indicated priority class and acceptable risk of non-supply (assurance of supply)			
	1: 100$^{(1)}$ year (99%)	1: 50 year (98%)	1: 10 year (90%)	1: 5 year (80%)
Irrigation Gamtoos	30	20	20	30
Irrigation Other	20	20	20	40
Domestic/Industrial	50	20	20	10
Losses	100	0	0	0
Environmental	100	0	0	0

Note (1): As a recurrence interval (RI) of failure, in years.

The Algoa Operating Analysis 2017 noted that it is preferable that all irrigators (indicated in blue text in **Table 3.1**) receive the same priority water throughout the AWSS. This will be addressed in future operating analyses.

3.1.2 Yield of the Algoa Water Supply System

Bulk water planning is generally done at a 1 in 50 year assurance of supply, for urban water supply. Urban water use from the Algoa Water Supply System is in excess of 60% of total use from the system, and is expected to increase. Future evaluation and scenario planning has therefore been based on a 1 in 50 year assurance of supply.

Indications are that the yields of the Kromme and Kouga/Loerie sub-systems are too high, as these sub-systems are curtailed more often than it should be curtailed, based on the agreed assurances of supply. These discrepancies will be addressed in the Kouga-Kromme Water Availability Assessment Study, once the Validation and Verification (V&V) study has been completed. The curtailments plots for the Groendal sub-system further showed that the sub-system is totally over-allocated.

The updated 1 in 50 year long-term stochastic yields of the various sources of supply available for urban, industrial and agricultural use are shown in **Table 3.2**.

Table 3.2: Long-term stochastic yields of the Algoa Water Supply System

Sources of supply	1 in 50 year yield or existing allocation/use	
	(million m^3/a)	(Mℓ/d)
NMBM older dams	3.4	9.3
Groendal Dam	6.8	18.6
Uitenhage Springs and boreholes	2.2	6.0
Churchill/Impofu dams	30.0	82.2
Kouga/Loerie dams	75.0	205.5
Sundays River GWS transfer	50.0	137.0
Combined Total Yield	**167.4**	**458.6**

Water supply from the **old Dams** (Sand, Bulk and the Van Stadens dams), resumed in May 2017, following a period of infrastructure maintenance.

The yield of the **Kromme** River sub-system (Churchill/Impofu dams) has been reduced from 42.79 million m^3/a to 30.0 million m^3/a, to align with the finding of the Algoa Operating Analysis, given the uncertainty and the indication that the sub-system is over-allocated. The Algoa Water Resources Bridging Study indicated that the firm yield of the sub-system is about 30 million m^3/a, with the 1:50 year long-term yield reported as 42.79 million m^3/a. It was decided at the Strategy's Administrative and Technical Support Group meeting, held on 16 August 2017, and this was confirmed at the Strategy Steering Group meeting, held on 27 September 2017, that the sub-system yield of 30 million m^3/a should be used for further water balance reconciliation assessments, as this presents a conservative approach.

The yield of the **Kouga-Loerie** sub-system has been kept at 75.0 million m^3/a, despite the finding of the Algoa Water Resources Bridging Study that the yield of the sub-system has increased to 85 million m^3/a, given the uncertainty regarding land use in the catchment and the actual extent of water abstraction, and the resulting indication that the sub-system is over-allocated.

The capacity of the Sundays River GWS transfer at **Nooitgedagt WTW** has been updated to the current capacity of 50.0 million m^3/a (137 Ml/d), following the completion of Phase 2 of the scheme in July 2017.

3.2 Historical Water Requirements

Figure 3.1 shows the historical water requirements (excluding re-use of water) for the Algoa WSS for the past 17 years, with a trendline added. The depiction of water use is by 12-month periods starting in July until June the following year, to correspond with the NMBM and Gamtoos Irrigation Board financial years.

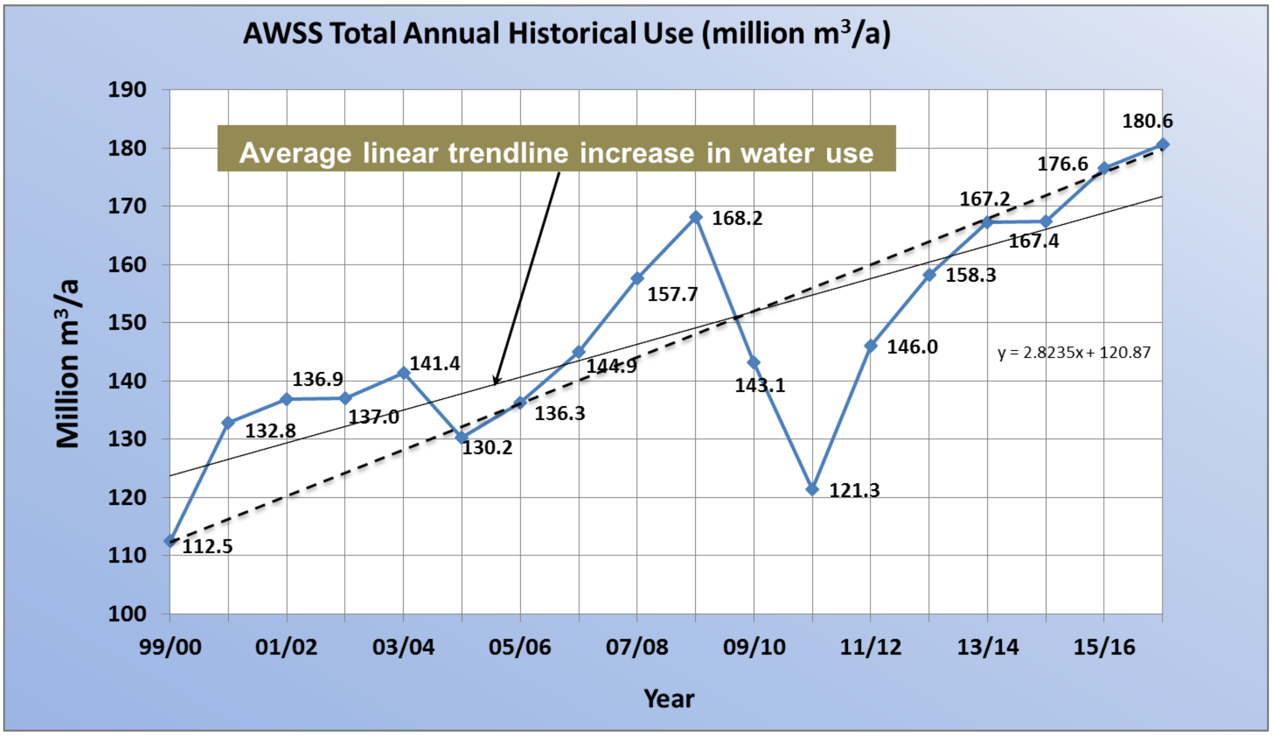


Figure 3.1: Historical Water Requirements of the Algoa WSS

The steady growth in the population of the NMBM is depicted in **Figure 3.2**, compared to the historical water requirements of the Algoa WSS.

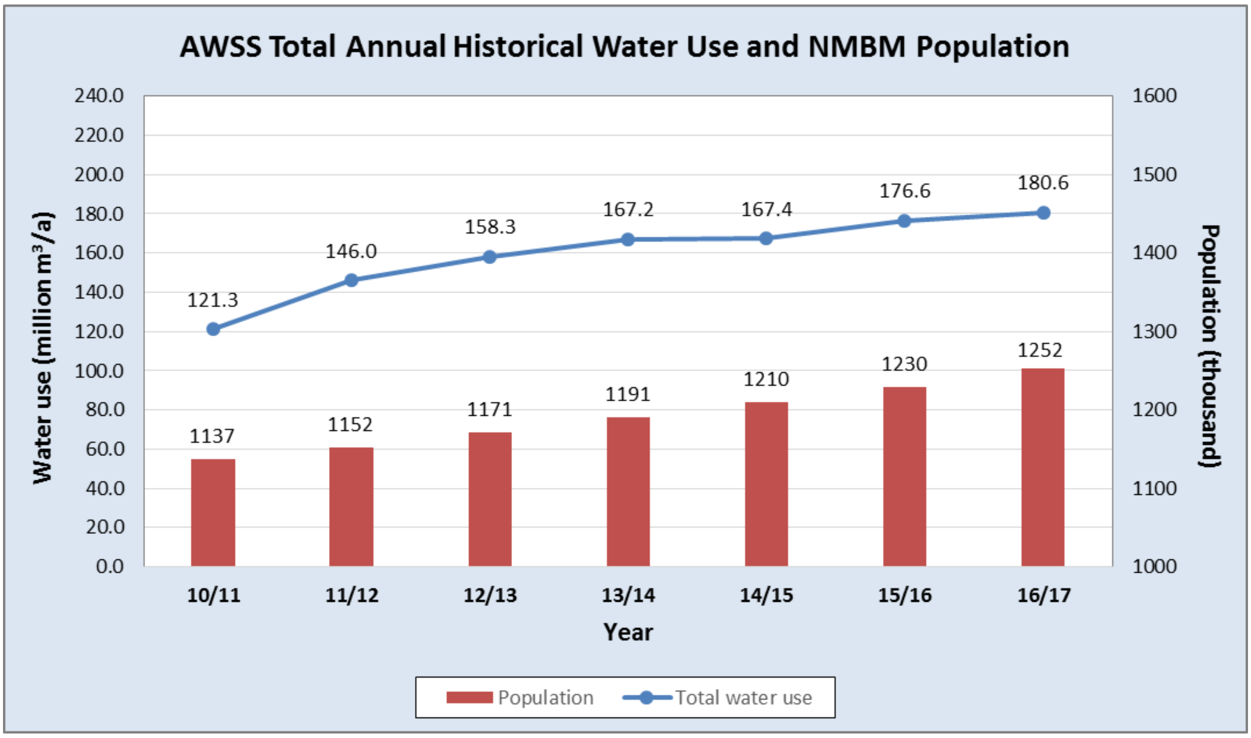


Figure 3.2: NMBM historical water use and population

The average linear increase in water use according to the trendline has been 2.8 million m³/a, while the actual increase on average has been 4.0 million m³/a, over this period. Linear trendline growth has been 2.4%/a, while actual growth has been 3.6%/a, expressed in terms of the starting values.

Figure 3.3 shows the composition of the historical water requirements (excluding the re-use of water) for the Algoa WSS. The graph shows that, while water use is inhibited during a drought (drought restriction years shown by circles) through the implementation of water restrictions, the growth trend of the water requirements has continued once the droughts were broken.

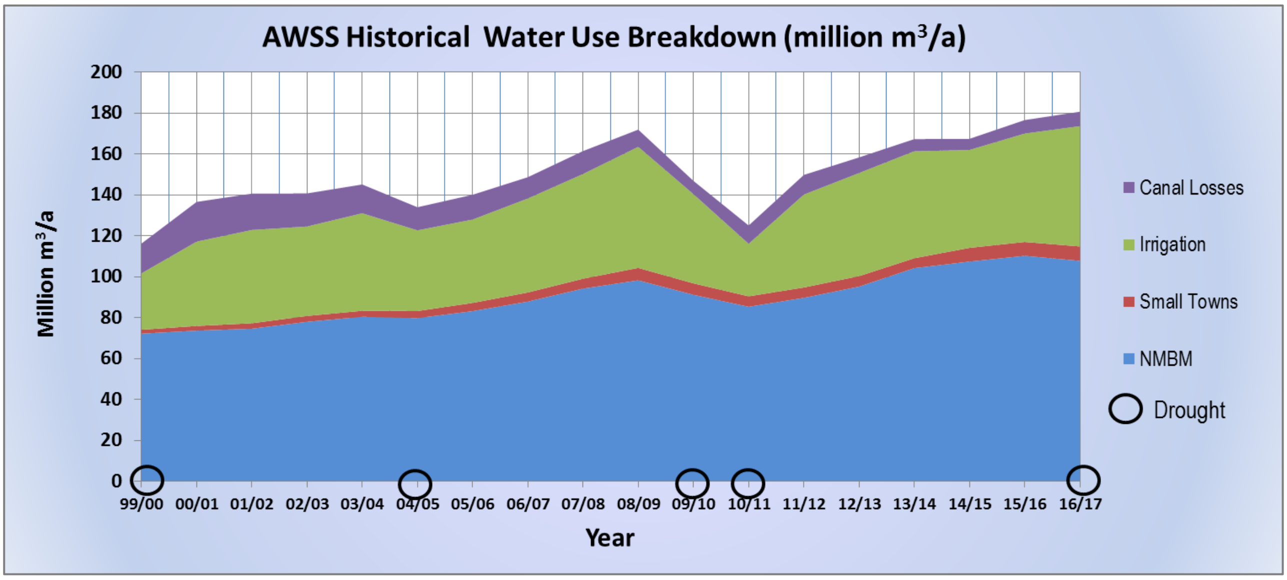


Figure 3.3: Historical Water Requirements breakdown from the Algoa WSS

Note that water use by NMBM shown in **Figure 3.1** to **Figure 3.3** includes potable water use by the Coega IDZ.

It is evident from the graph that the growth in water requirements for the past year is mainly due to increased use by the Gamtoos Irrigation Board, while the water use by NMBM has slightly declined. The rainfall over the past year in the Gamtoos Irrigation Board area has been low, as is evident from **Figure 3.4**.

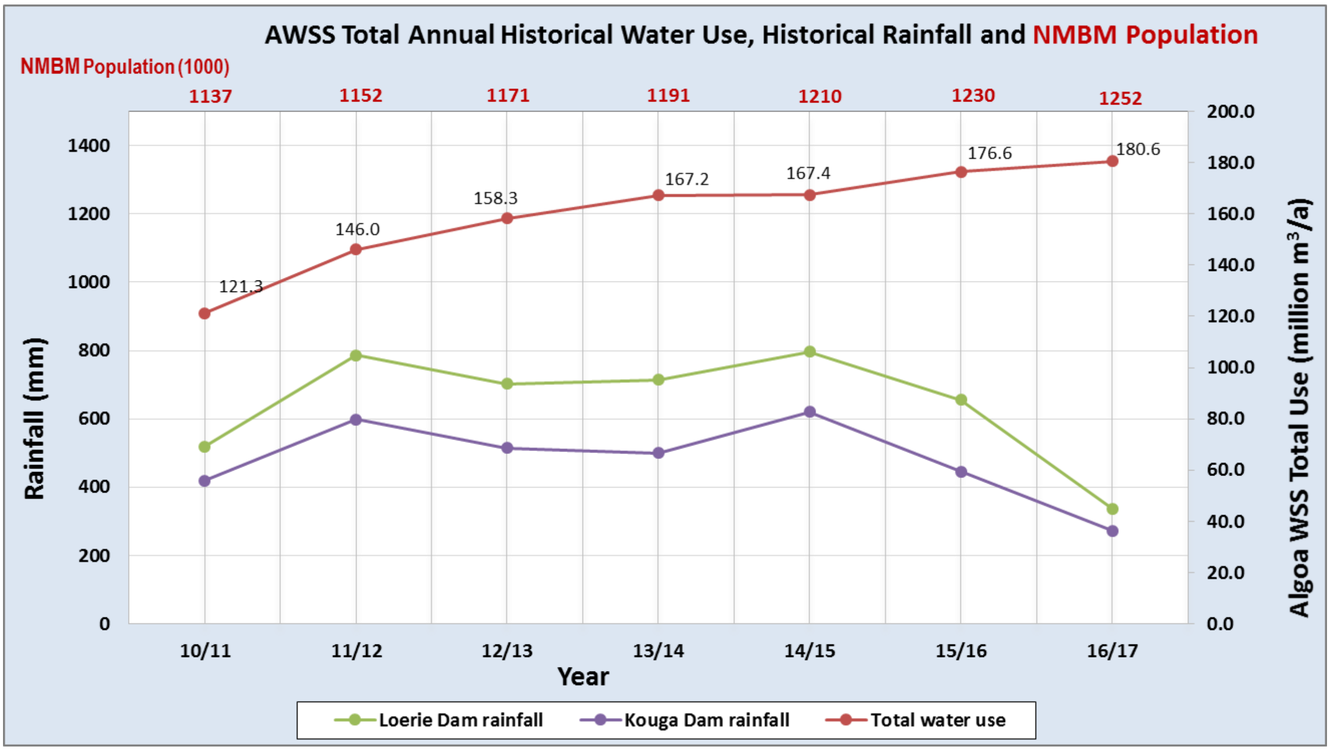


Figure 3.4: Algoa WSS Use compared to rainfall and population

3.3 Current AWSS Water Use (2016/17)

The total usage of water from the Algoa WSS in 2016/17 was 180.6 million m^3/a (Figure 3.5). This includes urban use by NMBM and various small towns, Coega IDZ, irrigation and losses from the Kouga/Loerie canal. The sectoral water use pattern for 2016/17 was as follows:

NMBM	107.0 million m^3/a (59% of the total)
Coega IDZ Potable	0.8 million m^3/a (0.4% of the total)
Small towns	7.0 million m^3/a (4% of the total)
Irrigation	58.8 million m^3/a (33% of the total)
Canal losses and UAW *(in the Gamtoos main canal to Loerie WTW)*	7.0 million m^3/a (4% of the total)
TOTAL	**180.6 million m^3/a**

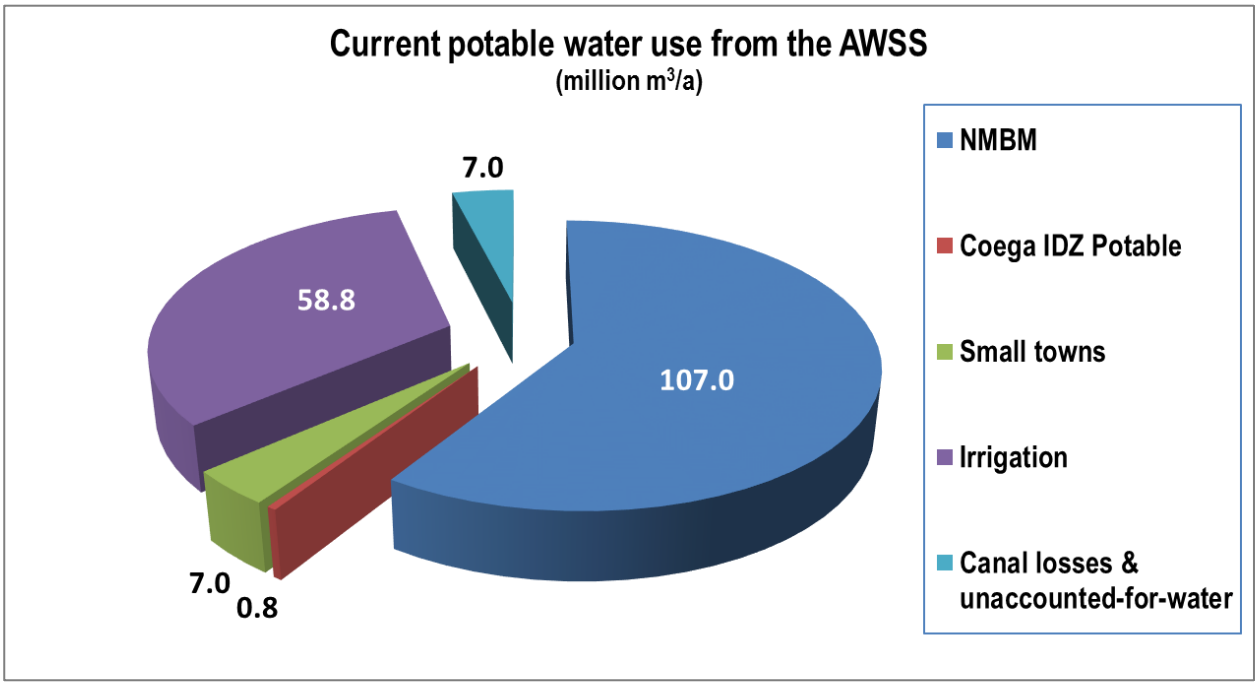


Figure 3.5: 2015/16 Algoa WSS Potable Water Use

Irrigation water use for 2016/17 were as follows:

Gamtoos Irrigation Board	54.4
Groendal irrigation	2.4
Irrigation from Impofu Dam	2.0
Total:	**58.8 million m^3/a**

The combined total allocation for irrigation in the Algoa WSS is 64.588 million m^3/a, excluding irrigation usage from the rivers upstream of the dams that form part of the Algoa WSS. This allocation is assumed to be a constant value in the evaluation of future water balance scenarios. The allocation of the Gamtoos Irrigation Board was updated from 59.36 million m^3/a to 60.188 million m^3/a during the past year.

The breakdown of allocation for irrigation within the strategy area is as follows:

Gamtoos Irrigation Board:	60.188
Groendal Irrigation Board:	2.4
Impofu Dam: Coca Cola bottling plant	2.0
Total:	**64.588 million m^3/a**

Various future water requirement scenarios were developed, with the primary considerations being population and economic growth, and reflected in the historical growth in water use. Two key future water requirement scenarios are used for the Algoa Reconciliation Strategy, namely a high-growth and a low-growth scenario. These scenarios do not take account of future WC/WDM measures or effluent reuse schemes, as these are included as interventions that could be selected to reduce the future water requirements. In the scenario development it has been assumed that irrigation usage do not change.

3.4 Coega IDZ water requirements

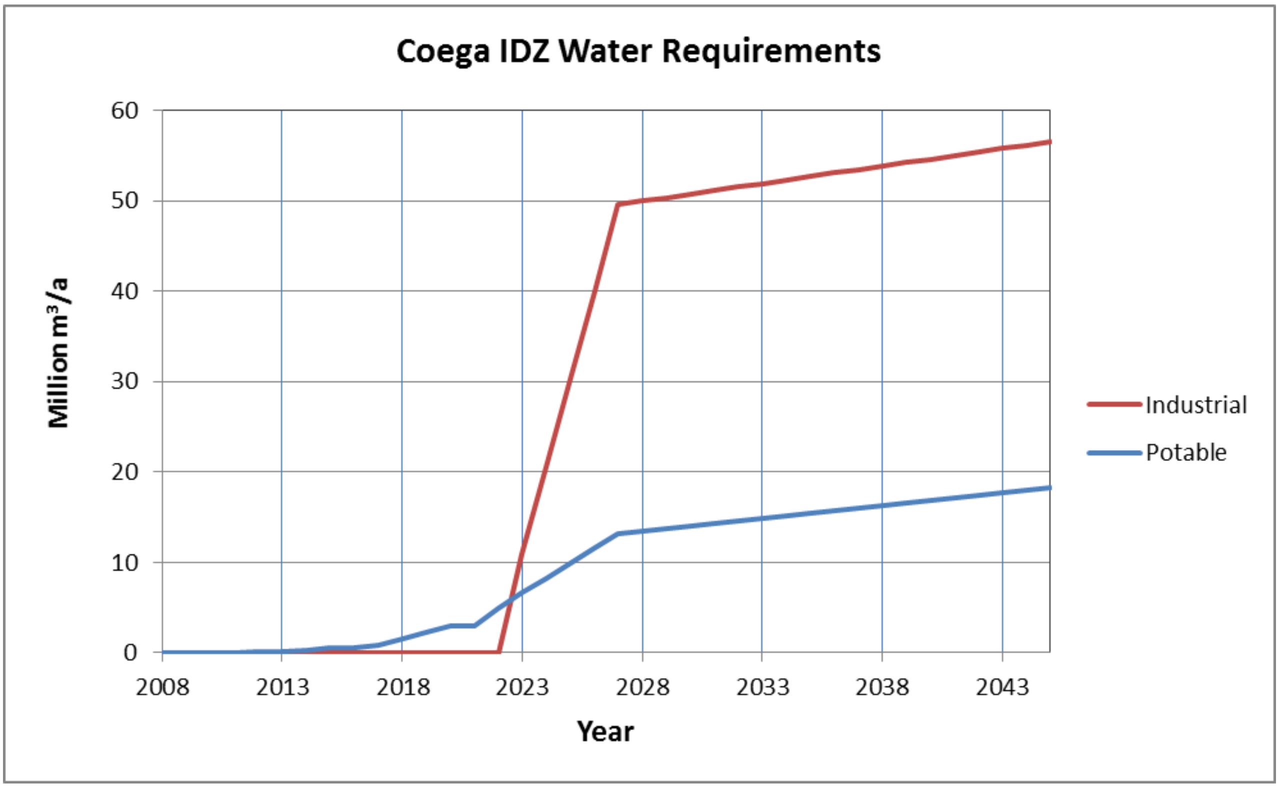
The Coega IDZ is "home to 29 operational investors" that have invested R1.2 billion, while a further R7.5 billion is at the implementation phase and further projects worth R8.1 billion are currently being negotiated. In addition, projects currently worth R116.3 billion are the subject of feasibility studies.

The estimates of the bulk water studies for the uptake of industrial water requirements have remained consistent over the past two years. However, a lack of certainty exists in respect of the new heavy industries which have previously committed and then either postponed or withdrawn their proposed developments. Future uptake of industrial water will remain uncertain until such time that the availability of industrial water supplies and power can be confirmed. The supply of industrial quality water is a requirement of the environmental authorisation for establishing large industries at the Coega IDZ. The lack of confirmed availability of industrial quality water can pose serious challenges to attracting future development to the Coega IDZ.

In terms of the future water requirements, according to projections done under this Strategy Support Study and the Water Master Plan Review document of the Metro, surplus potable water will be available from the Nooitgedagt/Coega Low-Level Scheme once completed. This potable water can be cost-effectively used as an interim industrial water supply to the Coega IDZ. The interim use of potable water in the IDZ has been accommodated through an amendment to the existing environmental authorisation for the large water user. It is however a condition of the EIA to the large water users that industrial water requirements should be met by the reuse of wastewater.

The Coega IDZ water requirement projections for potable and industrial quality water respectively, is shown in **Figure 3.6**.

Figure 3.6: Coega IDZ Projected Water Requirements from the Algoa WSS



The estimate of industrial water requirement uptake is still very uncertain as new heavy industries have previously committed and then either postponed or withdrawn their proposed developments. Future uptake of industrial water will remain uncertain until such stage that the availability of industrial quality water (and secure power supply) can be confirmed.

3.5 Kouga LM Water Requirements

3.5.1 Municipal water requirements

Kouga LM is responsible for the provision of water services to Cape St. Francis, St. Francis Bay, Hankey, Humansdorp, Kruisfontein, Jeffreys Bay, Oyster Bay, Patensie and Thornhill. *The Development of Reconciliation Strategies for all Towns in the Southern Planning Region (Version 2)* study (2013-2015), undertaken by the DWS, provides information on the current and estimated future water requirement for these towns, as discussed below.

Cape St. Francis is served through the bulk water supply system, which comprises of the Churchill pipeline and groundwater sources. NMBM currently supplies Kouga LM with potable water from the AWSS via the Churchill pipeline. This supply line was upgraded to 350 mm diameter, which increased its capacity to 95 l/s (2.996 million m^3/a).

Humansdorp and Kruisfontein obtain surface water from the Churchill bulk water supply pipeline. The Kouga LM entered into an agreement with the NMBM which permits the Kouga LM to an annual limited abstraction volume of 0.06 million m^3.

Jeffreys Bay receives all of its surface water from the NMBM via the Churchill bulk supply pipeline. An agreement between the NMBM and the Kouga LM permits the abstraction of treated water from the Churchill bulk supply pipeline. Jeffreys Bay's agreement allows for the abstraction of 0.45 million m^3/a. The current volume abstracted from the pipeline is more than the allocated volume.

Thornhill receives treated water from the Summit-Chelsea water pipeline, which runs from the Churchill WTW and is part of the AWSS. The Kouga LM is permitted to abstract treated water from the pipeline. A new agreement with the NMBM has to be negotiated to formalise the abstraction.

Oyster Bay obtains all of its bulk water from groundwater sources, and does not depend on bulk purchase of water from the NMBM.

Hankey and Patensie obtain the bulk of their water from the Gamtoos Government Water Scheme, which comprises the DWS-owned Kouga Dam, Gamtoos canals and Loerie Dam. The Gamtoos Irrigation Board operates Kouga Dam and its main canal on behalf of DWS. NMBM owns and operates Loerie Dam WTW. The Gamtoos scheme supplies water to Port Elizabeth, Hankey and Patensie for urban use, and the balance to irrigation. Water is conveyed from Kouga Dam to Loerie Dam by means of a canal from which irrigation requirements are abstracted.

The population of the Kouga Municipality has grown by 6.5% from 2011 to 2016. The current population size is 112 941. Economic activities are largely focussed on the tourism and agricultural sector.

Current water use within the municipality is 10.0 million m^3/a (27.3 Mℓ/d), with an estimated bulk water requirement of 13.0 million m^3/a (35.5 Mℓ/d). Of this, 5.85 million m^3/a was supplied from the Algoa WSS in 2016/17.

It is evident that Kouga LM abstracts volumes in excess of their agreement with NMBM from the Kromme pipeline. Their current identified sources are further limited and further sources are needed.

The Municipality plans to develop a long-term Water Provision Master Plan with reference to the upgrading and rehabilitation of bulk infrastructure.

3.5.2 Proposed Nuclear Power Plant

Eskom Holdings Limited (Eskom) proposes to construct, operate and commission conventional nuclear power stations in South Africa, as part of a plan to meet the total demand for electricity of South Africa. The approved Integrated Resource Plan 2010, which outlines government's strategy for meeting the increasing energy needs, indicates government's commitment to the construction of 9 600 MW of nuclear power by 2030. It is Eskom's intention to investigate the feasibility of pursuing the nuclear power generating capacity required by South Africa.

The first planned nuclear power station, Nuclear-1 (4 000 MW), will have an estimated total footprint of 200 to 280 ha, and is currently in the Environmental Authorisation application phase. Nuclear-1 has three alternative proposed sites, namely Duynefontein (35 km north of Cape Town), Bantamsklip (Southern Cape coast between Danger and Quoin Points) and Thyspunt (Eastern Cape coast between Oyster Bay and St. Francis Bay).

Water will be required on-site throughout the project life cycle, with a markedly increased water requirement during construction. It is estimated that the water requirement of the power plant will be 3.3 million m^3/a (9 Mℓ/day) during construction and 2.2 million m^3/a (6 Mℓ/day) during operation. The following options were considered to meet the additional water requirement:

- Boreholes
- Municipal water
- Desalination of seawater.

The water requirement of the proposed power station is significant relevant to existing municipal sources and the use of municipal and borehole water in the long-term will not be sustainable. This, coupled with the fact that seawater intake systems will be developed for component cooling, creates a suitable situation for the development of a desalination plant. The co-development of desalination and power generation plants is globally well documented. Prior to the desalination plant becoming operational, Eskom intends to use groundwater resources for a period of approximately one year, prior to the commissioning of a permanent desalination plant at the Thyspunt / Duynefontein sites. The required volume is 0.54 million m^3/a (17 ℓ/s) to 0.73 million m^3/a (23 ℓ/s). Planning for the use of boreholes is intended to ensure that it does not have an impact on existing boreholes used for domestic purposes adjacent to the site.

The specialist study report, *Fresh Water Supply Environmental Impact Report* (2015), prepared by SRK Consulting as part of the *Final Environmental Impact Assessment Report for the Eskom Nuclear Power Station and Associated Infrastructure* study (2006), concluded the following for the Thyspunt site:

- There is extensive use of groundwater in the surrounding area.
- There are coastal springs at the site.
- The surrounding towns are supplied with water from the Churchill and Impofu dams and from groundwater.
- There is scope for further development of local groundwater resources for construction supply, both on-site and in the surrounding area.
- Local and regional surface water resources are under stress and additional draw-off to supply a nuclear power plant would exacerbate this situation.
- The main option for surface water supply with least local and regional impact is import of water from the Orange River Scheme.
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change.
- Desalination of seawater is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change.

3.5.3 Future sources

A growth rate in future water requirements of 2.3% was used, to align with DWS planning estimates.

It is evident that a very significant effort is needed to improve water efficiency, which is the most obvious source of additional water. Groundwater development options exist, including the Churchill Dam and Humansdorp groundwater schemes identified as part of this strategy. While an increased allocation from the Algoa WSS (Kromme pipeline or Gamtoos GWS) is an option, this would necessitate that NMBM find replacement sources, with corresponding financial implications. This could also influence municipal distribution infrastructure, considering the location of such potential new sources to the water demand centres.

The supply of additional Orange River water to the NMBM, in lieu of more water supplied from the Kromme River sub-system to the Kouga LM and the proposed power plant is a possibility, but is not desirable from NMBM's perspective.

It seems logical that, should a power plant be established at Thyspunt, a seawater desalination plant be implemented.

3.6 LSRWUA Water Requirements

The LSRWUA is delegated to operate the LSRGWS on behalf of the DWS. The LSRGWS comprises of the Darlington Dam, the Korhaansdrift Weir, the main canal, the Scheepersvlakte Balancing Dam and a series of mostly lined distribution canals. The LSRWUA manages an area of 17 293 ha, with a total scheduled quota of 156 million m^3/a. Additional allocations will still be made to resource-poor farmers within the WUA irrigation area to a total of an additional 3 000 ha, requiring some 27 million m^3/a.

The LSRWUA uses Orange River transferred water that is abstracted at Korhaansdrift Weir, and conveyed to Scheepersvlakte Balancing Dam, from where it is distributed further to irrigators/small towns and the NMBM. The LSRWUA also supplies the towns of Addo, Kirkwood and Paterson with water for domestic use from the Caesar's Dam at Addo, which is filled from the main canal. The bulk conveyance infrastructure that is shared with NMBM forms part of the Algoa WSS.

The capacity of the existing Scheepersvlakte balancing dam is limiting to meet the purpose of supplying the increased requirements of the upgraded Nooitgedagt WTW. Increased future conveyance volumes, as a result of further phases of the Nooitgedagt WTW, will cause operating system constraints / bottlenecks for sustainable delivery of Orange River water supply to the LSRGWS and to NMBM.

The investigation of additional balancing storage in the LSRGWS aims at removing potential operating system constraints for sustainable delivery of bulk Orange River water supply to the LSRGWS and to NMBM, for water requirements up to 2040. The objective is therefore to limit risks of shortfall in supply as well as operational risks to acceptable levels. The focus is on providing additional balancing storage, in addition to the Scheepersvlakte Balancing Dam, which includes the investigation of storage at other potential locations in the bulk transfer infrastructure. Options to increase balancing storage or alternative approaches of supply have been conceptualised.

3.7 Future water requirement scenarios

Due to the great variability in water requirement growth rates, the accurate prediction of long-term future water requirement growth is of great importance to ensure adequate supply for the increase in requirements. A large number of factors influencing water requirements growth rates need to be taken into account and projections are annually updated.

Factors influencing water requirement growth include:

- Population growth
- Urban and industrial development (economic growth)
- Weather (climate)
- Efficiency of water use (WC/WDM)
- Intensification of use (new water supply to existing rural areas or improved urban service delivery)
- Regulations and policies
- Seasonal variability (holiday periods)
- Water rates

High variability makes the accurate prediction of short-term growth rates extremely difficult. Long-term future water requirements predictions are therefore predominantly based on factors such as the long-term historical growth trends, but should allow for unpredictable short-term to medium-term water requirements growth periods in excess of long-term historical growth trends.

It should be noted that the future water requirements projections presented below are not aimed at long-term accuracy, but are instead intended as a tool to provide possible future water requirements to aid the planning of future interventions and the timing of their implementation.

Seven future water requirement scenarios have been developed, these being:

1. **Coega industrial water requirements**, showing how industrial-quality water requirements can be met from re-use schemes.
2. **Low-Growth including Coega Potable**: 1% compounded growth, including Coega potable water and industrial standard water requirements.
3. **Reference – High-Growth Potable**: 3.5% linear growth, including Coega potable water requirements.
4. **High-Growth Potable without WC/WDM**: 3.5% linear growth, including Coega potable water requirements, excluding possible savings from WC/WDM.
5. **Increased supply to Kouga Local Municipality**: Similar to water requirement scenario 3, with 3.5% linear growth in WSS potable water requirements, plus additional 2.3% growth of Kouga LM and assumed water requirements from the nuclear power plant use from 2024.
6. **High-Growth including Coega**: 3.5% linear growth, including Coega potable and industrial standard water requirements.
7. **Worst Case**: 3.5% linear growth, including Coega potable water and industrial standard water requirements, with potential impact of climate change and the implementation of the ecological Reserve on existing dams.

The 2016/17 historical water use is the starting point for scenario planning.

3.8 Changes to Interventions

3.8.1 Seawater Desalination

Allowance has been made for a new desalination option, termed the Marina Sea Salt Desalination Scheme. This involves the development of a 26 Mℓ/d desalination scheme by an international company in association with the Marina Salt works that will sell potable water as a by-product to the NMBM. For reconciliation planning purposes, the potential purchasing by NMBM of 5.5 million m^3/a of potable water have been taken into account as the potential scheme yield.

A fourth potential phase of a NMBM/Coega IDZ desalination plant, yielding 11 million m^3/d has been conceptualised.

3.8.2 Further allocation of Orange River water to NMBM

The concept of further phasing (post Phase 3) of the transfer scheme that will supply Orange River water to NMBM has been further assessed. The assumed yield of the Nooitgedagt Phase 4 Scheme has been changed to 18.25 million m^3/a (50 Mℓ/d), based on preliminary findings of the Water Use Efficiency evaluation being undertaken as part of this study. This would take up the spare capacity of the NLLS, following the completion of Phase 3 of the NLLS. Conveyance to NMBM could be by either of the two bulk supply (high-level and low-level) pipelines. Should the capacity of these pipelines be exceeded (assuming that supply cannot be boosted) a further bulk supply pipeline would be required.

3.9 Adjustments to the Strategy

3.9.1 Scenario Planning Process

The scenario planning process considers a range of possible scenarios to reconcile water supply and requirements. The objective is not to select one 'favourable scenario' but rather to identify which interventions should be studied to allow consideration of a range of possible scenarios. This will allow the DWS, the NMBM and other stakeholders the maximum amount of flexibility in making informed decisions on which interventions to implement. The outcome of the process is a list of interventions that should be studied by specific dates, so as to meet implementation requirements of a range of reconciliation scenarios.

The selection of interventions, either to be studied further or to be implemented, to reconcile water availability of the AWSS with the requirements, is a complex task, with many diverse issues and criteria to consider. The need for a customised planning tool, to provide support for this task to water managers, was identified. A graphical support tool, called the Reconciliation Planning Support Tool (RPST) was therefore developed to aid the process of scenario planning of interventions. This Tool has been customised for the Algoa WSS. It allows the user to compare potential interventions, or groups of interventions, with one another, and with one or more selected future water requirements scenarios. The Tool graphically shows when decisions regarding investigations for selected interventions need to be taken to achieve a water balance.

3.9.2 Water Balance Scenarios

In order to update the scenario planning, the water balance scenarios mentioned under Section 3.7 were evaluated with the RPST, taking account of updated information. The future water requirement scenarios, of which the starting point for growth estimation is 2017, are discussed below in the following sections.

The "***Coega Industrial Water Requirements***" scenario is based on forecast industrial water requirements for the Coega IDZ growing from 0 million m^3/a in 2017 to 55.0 million m^3/a in 2042. There is significant uncertainty associated with this scenario.

The "***Low-Growth including Coega***" scenario is based on low economic and population growth rates which translate to an average water requirement compound growth rate of 1% per annum. The Coega IDZ potable and industrial water requirements projected growth rates have been used. In this scenario, the total potable/industrial system water requirements grew from 179.4 million m^3/a in 2017, to 228.1 million m^3/a in 2042.

The "Reference - ***High-Growth Potable including Coega Potable***" scenario is based on high economic and high population growth rates which translate to an average water requirement linear growth rate of 3.5% per annum. The Coega IDZ potable requirements projected growth rate has been used. In this scenario, the potable system water requirements grew from 179.4 million m^3/a in 2017, to 295.6 million m^3/a in 2042.

The "***High-Growth Potable including Coega Potable without any WC/WDM***" scenario is based on high economic and high population growth rates which translate to an average water requirement linear growth rate of 3.5% per annum. In this scenario, the potable system water requirements grew from 179.4 million m^3/a in 2017, to 295.6 million m^3/a in 2042. It has been assumed that there will be no saving in water use from the water use efficiency programme or that it is absent.

The newly conceptualised "***Increased supply to Kouga LM***" scenario is based on high economic and high population growth rates which translate to an average water requirement linear growth rate of 3.5% per annum and 3.3% for Kouga LM. The Coega IDZ potable requirements projected growth in requirements has been used in addition, considering the potential requirements of urban growth and a nuclear power plant, which local sources cannot meet. In this scenario, the potable system water requirements grew from 179.4 million m^3/a in 2017, to 304.6 million m^3/a in 2042.

The "***High-Growth including Coega***" scenario is based on high economic and high population growth rates which translate to an average water requirement linear growth rate of 3.5% per annum. In this scenario, the potable/industrial system water requirements grew from 179.4 million m^3/a in 2017, to 351.0 million m^3/a in 2042.

The "***Worst-Case***" scenario is similar to the "*High-Growth including Coega*" scenario, with the addition of the implementation of the ecological Reserve for existing system dams, from 2019 onwards, and the addition of climate change, with the reduction in yield phased in over 25 years. In this scenario, the potable/industrial system water requirements grew from 179.4 million m^3/a in 2017, to 351.0 million m^3/a in 2042.

Many possible scenarios exist between the 2017 "Reference" Scenario and the "Worst-case" Scenario, but if solutions could be found for these two scenarios, all others should be adequately covered. Should the water requirements follow the Low-Growth Water Requirement Curve and not the High-Growth Water Requirement Curve, the required implementation date of interventions would be delayed and therefore more options for implementation would become available to select from.

The Legend of colours used in **Table 3.3** to **Table 3.4** in the 'Status' column, for the various water balance scenarios, are the following:

Legend of colours in tables 3.4 to 3.11:	
	Study or implementation planning ongoing
	Under construction or groundwater drilling

3.9.3 Coega Industrial Water Requirements

This Scenario water balance is shown in **Figure 3.7**.

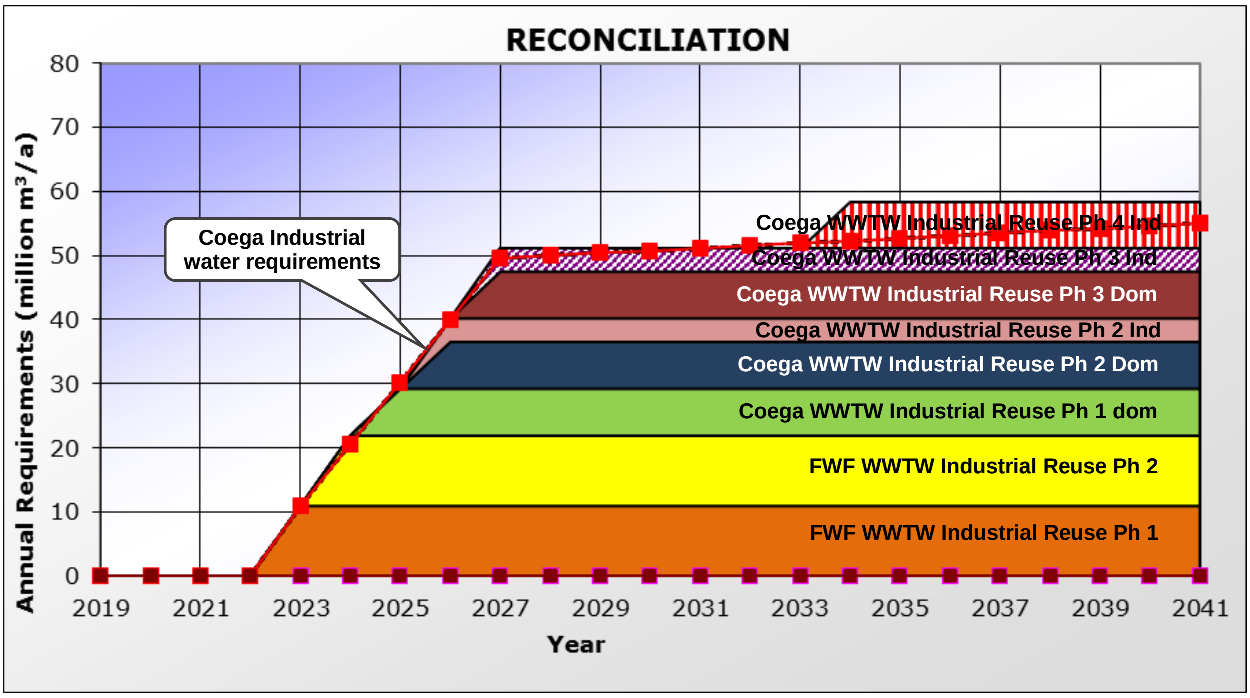


Figure 3.7: Coega Industrial Scenario

In this Scenario:

- Implementation of Phases 1 and 2 of the Fish Water Flats WWTW re-use scheme, followed by the implementation of Phases 1 to 3 domestic streams and Phases 2 to 4 industrial streams of the Coega WWTW re-use scheme, to meet growing industrial water requirements.
- Further phases of re-use schemes could be implemented.
- This illustrates that planning is on track to supply adequate volumes of industrial quality water to the Coega IDZ.

The interventions which have been used for the Scenario, as shown in **Figure 3.7**, are listed in **Table 3.3**.

Table 3.3: Interventions for the Coega Industrial Scenario

No	Intervention	Year of First Water or Saving	Yield	Status
1	FWF WWTW Industrial Reuse Scheme Phase 1	2023	11.0	Implementation planning
2	FWF WWTW Industrial Reuse Scheme Phase 2	2024	11.0	Study ongoing
3	Coega WWTW Industrial Reuse Scheme Ph1 Dom	2025	7.3	Study ongoing
4	Coega WWTW Industrial Reuse Scheme Ph 2 Ind	2026	3.65	-
5	Coega WWTW Industrial Reuse Scheme Ph 2 Dom	2026	7.3	-
6	Coega WWTW Industrial Reuse Scheme Ph 3 Dom	2027	7.3	-
7	Coega WWTW Industrial Reuse Scheme Ph 3 Ind	2027	3.65	-
8	Coega WWTW Industrial Reuse Scheme Ph 4 Ind	2034	7.3	-

For the further scenarios that include industrial water requirements, the interventions and timing of reuse schemes are silmilar to the interventions as listed in **Table 3.3**.

3.9.4 Low Growth including Coega Potable

The Scenario water balance is shown in **Figure 3.8**.

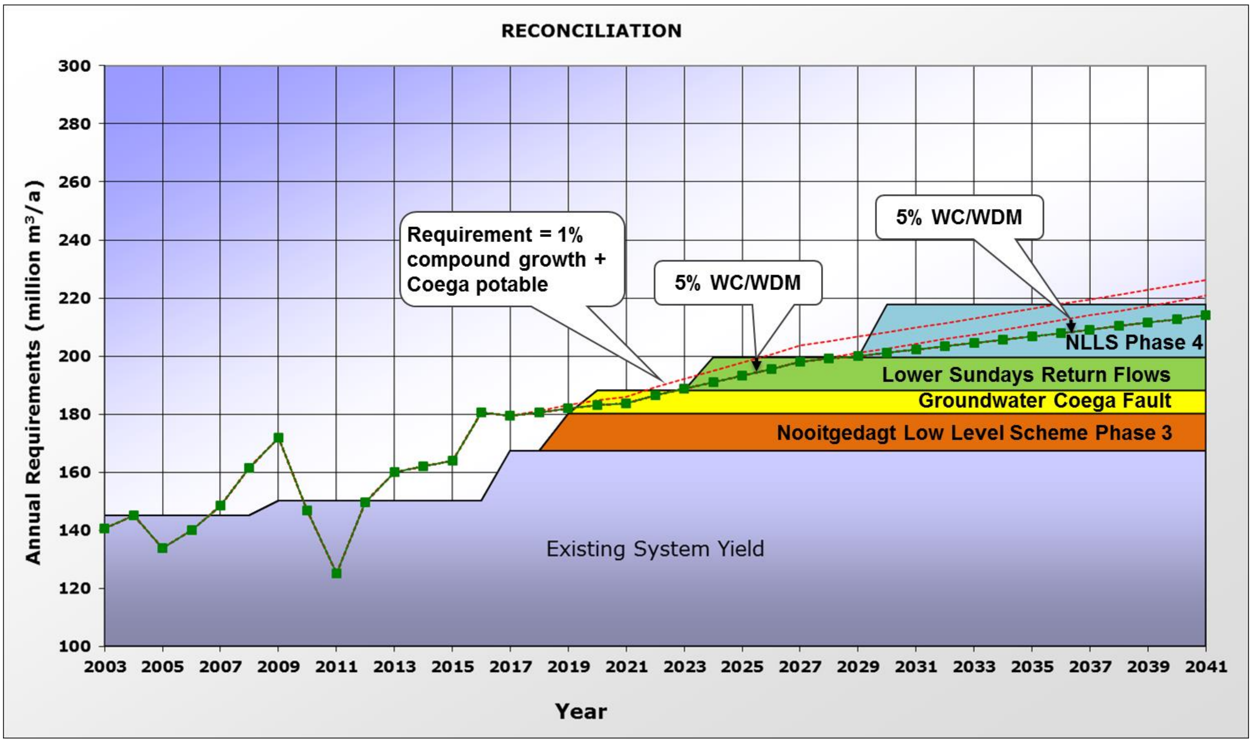


Figure 3.8: Low Growth including Coega Potable Scenario

In this Scenario:

- WC/WDM measures reduce the water requirements by 5%. This has been selected to demonstrate that for this scenario, even limited success with WC/WDM would suffice.
- The implementation of the Nooitgedagt Low Level Scheme Phase 3 is completed.
- The implementation of the Coega Fault Groundwater Scheme is completed.
- The Sundays River Return Flows scheme is implemented.
- Phase 4 of the Nooitgedagt Low Level Scheme Phase is implemented.

The interventions which have been used for the Scenario, as shown in **Figure 3.8**, are listed in **Table 3.4**.

Table 3.4: Interventions for the Low Growth including Coega Potable Scenario

No	Intervention	Year of First Water or Saving	Yield	Status
1	WCDM 2017 to 2026 (5% saving)	2018	5.6	ongoing
2	Nooitgedagt Low Level Scheme Phase 3	2019	12.8	construction
3	Groundwater - Coega Fault	2020	8.0	Implementation
4	Lower Sunday River return flows	2024	11.4	Desktop assessment
5	WC/WDM Programme from 2027 (5% saving)	2028	7.2	-
6	Nooitgedagt Low Level Scheme Phase 4	2030	18.25	Assessing yield

3.9.5 Reference – High Growth Potable Scenario

This scenario water balance is shown in **Figure 3.9**.

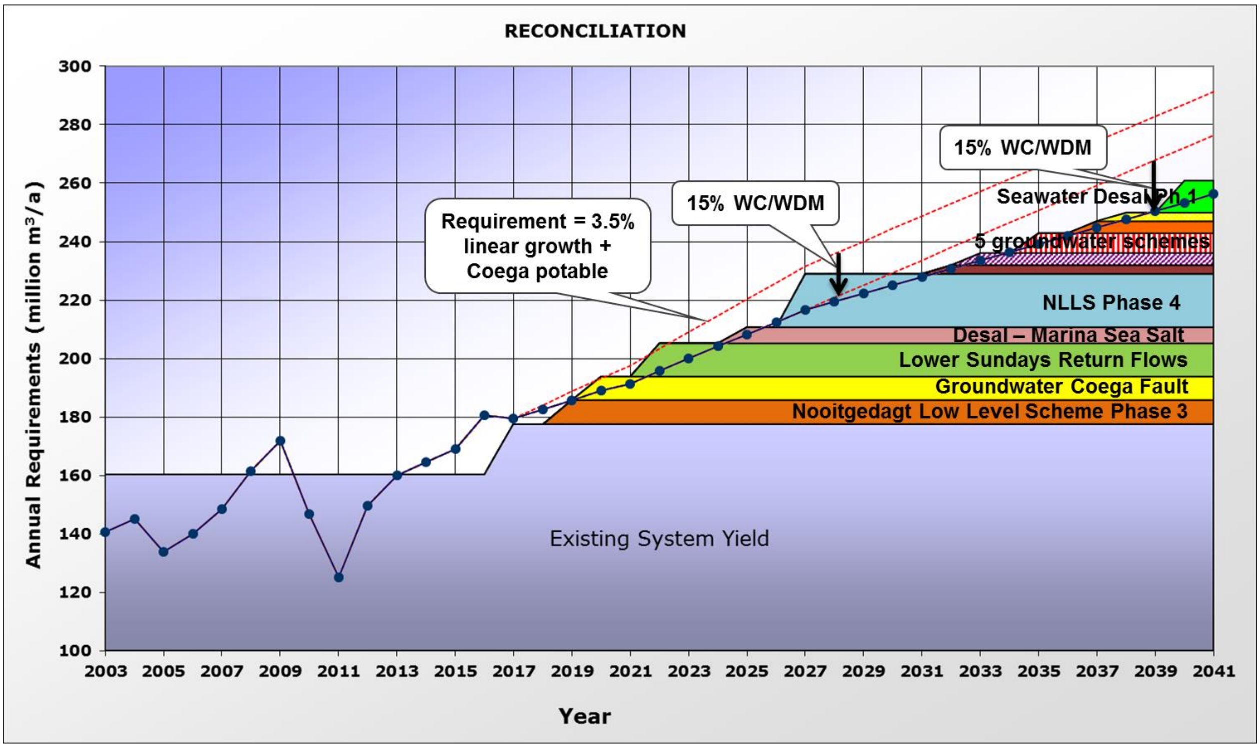


Figure 3.9: Reference - High Growth Potable Scenario

In this Scenario:

- WC/WDM measures (15% saving) reduce the water requirements.
- The implementation of the Nooitgedagt Low Level Scheme Phase 3 is completed.
- The implementation of the Coega Fault Groundwater Scheme is completed.
- The Sundays River Return Flows scheme is implemented.
- The Marina Sea Salt Desalination Scheme is implemented, and potable water is sold as a by-product to NMBM.
- Phase 4 of the Nooitgedagt Low Level Scheme Phase is implemented.
- Groundwater interventions are undertaken at Churchill, Bushy Park, Jeffreys Arch and Van Stadens.
- Seawater desalination is phased in.

The interventions which have been used for the Scenario, as shown in **Figure 3.9**, are listed in **Table 3.5**.

Table 3.5: Interventions for the Reference - High Growth Potable Scenario

No	Intervention	Year of First Water or Saving	Yield	Status
1	WCDM 2017 to 2026 (15% saving)	2018	15	ongoing
2	Nooitgedagt Low Level Scheme Phase 3	2019	8.4	construction
3	Groundwater Coega Fault	2020	8	Implementation
4	Lower Sunday River return flows	2022	11.4	Desktop assessment

No	Intervention	Year of First Water or Saving	Yield	Status
5	Marina Sea Salt Desalination	2023	5.5	Monitoring
6	Nooitgedagt Low Level Scheme Phase 4	2024	18.25	Assessing yield
7	WC/WDM Programme from 2027 (15% saving)	2028	21.6	-
8	Groundwater - Churchill Dam	2029	3	-
9	Groundwater - Bushy Park	2030	4.0	-
10	Groundwater - Jeffreys Arch	2031	7	-
11	Groundwater - Van Stadens	2034	4	-
12	Groundwater - Gamtoos Valley	2035	3	-
14	Seawater Desalination Phase 1	2036	11.0	Partial evaluation done
15	Seawater Desalination Phase 2	2040	11.0	-

3.9.6 High Growth Potable without WC/WDM

This scenario water balance is shown in **Figure 3.10**.

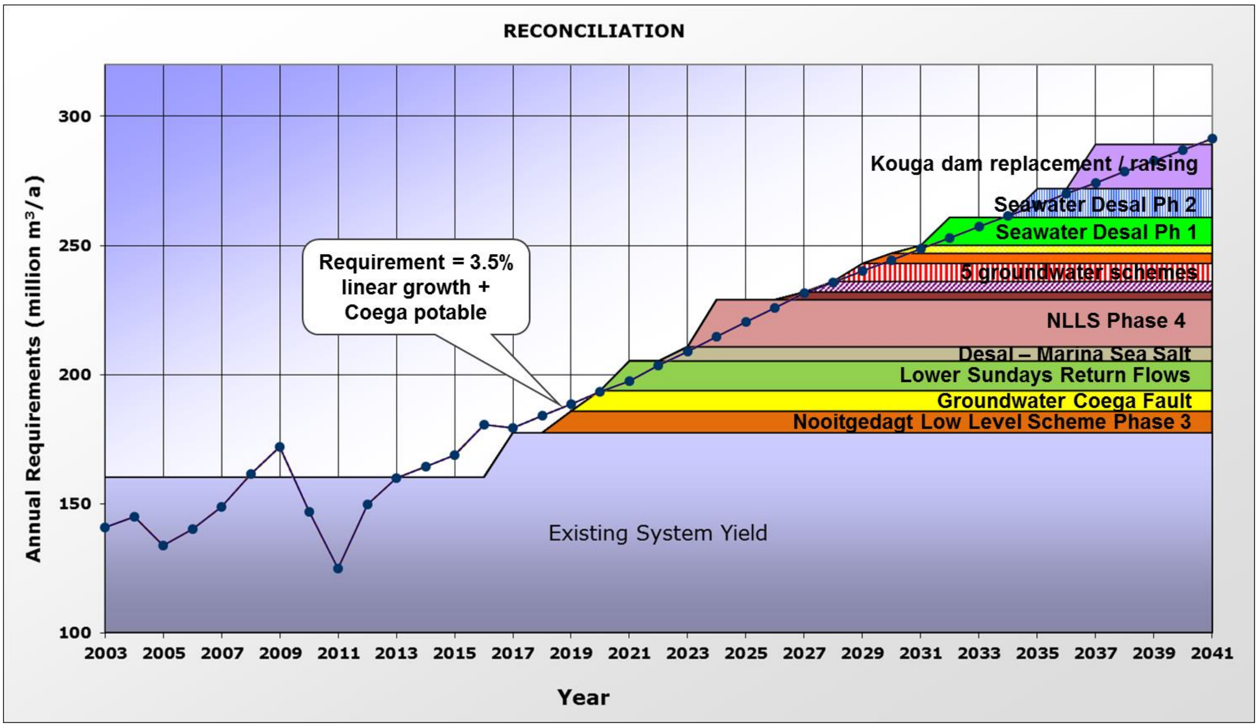


Figure 3.10: High Growth Potable without WC/WDM Scenario

In this Scenario:

- WC/WDM measures (15% saving) reduce the water requirements.
- The implementation of the Nooitgedagt Low Level Scheme Phase 3 is completed.
- The implementation of the Coega Fault Groundwater Scheme is completed.
- The Sundays River Return Flows scheme is implemented.
- The Marina Sea Salt Desalination Scheme is implemented, and potable water is sold as a by-product to NMBM.
- Phase 4 of the Nooitgedagt Low Level Scheme Phase is implemented.
- Groundwater interventions are undertaken at Churchill, Bushy Park, Jeffreys Arch and Van Stadens.
- Seawater desalination is phased in.
- Kouga Dam is raised.

The interventions which have been used for the Scenario, as shown in **Figure 3.10** are listed in **Table 3.6**.

Table 3.6: Interventions for the High Growth Potable without WC/WDM Scenario

No	Intervention	Year of First Water or Saving	Yield	Status
1	Nooitgedagt Low Level Scheme Phase 3	2019	8.4	construction
2	Groundwater - Coega Fault	2020	8	Implementation
3	Nooitgedagt Low Level Scheme Phase 4	2022	18.25	Assessing yield
4	Lower Sunday River return flows	2023	11.4	Desktop assessment

No	Intervention	Year of First Water or Saving	Yield	Status
5	Marina Sea Salt Desalination	2025	5.5	Monitoring
6	Groundwater - Churchill Dam	2025	3	-
7	Groundwater - Bushy Park	2026	4.0	-
8	Groundwater - Jeffreys Arch	2027	7	-
9	Groundwater - Van Stadens	2028	4	-
10	Groundwater - Gamtoos Valley	2029	3	-
11	Seawater Desalination Phase 1	2030	11.0	Partial evaluation done
12	Seawater Desalination Phase 2	2032	11.0	-
13	Kouga Dam replacement and raising	2035	17.3	Desktop assessment
14	Seawater Desalination Phase 3	2039	10.95	-

3.9.7 High Growth Potable plus Kouga LM

This scenario water balance is shown in **Figure 3.11**.

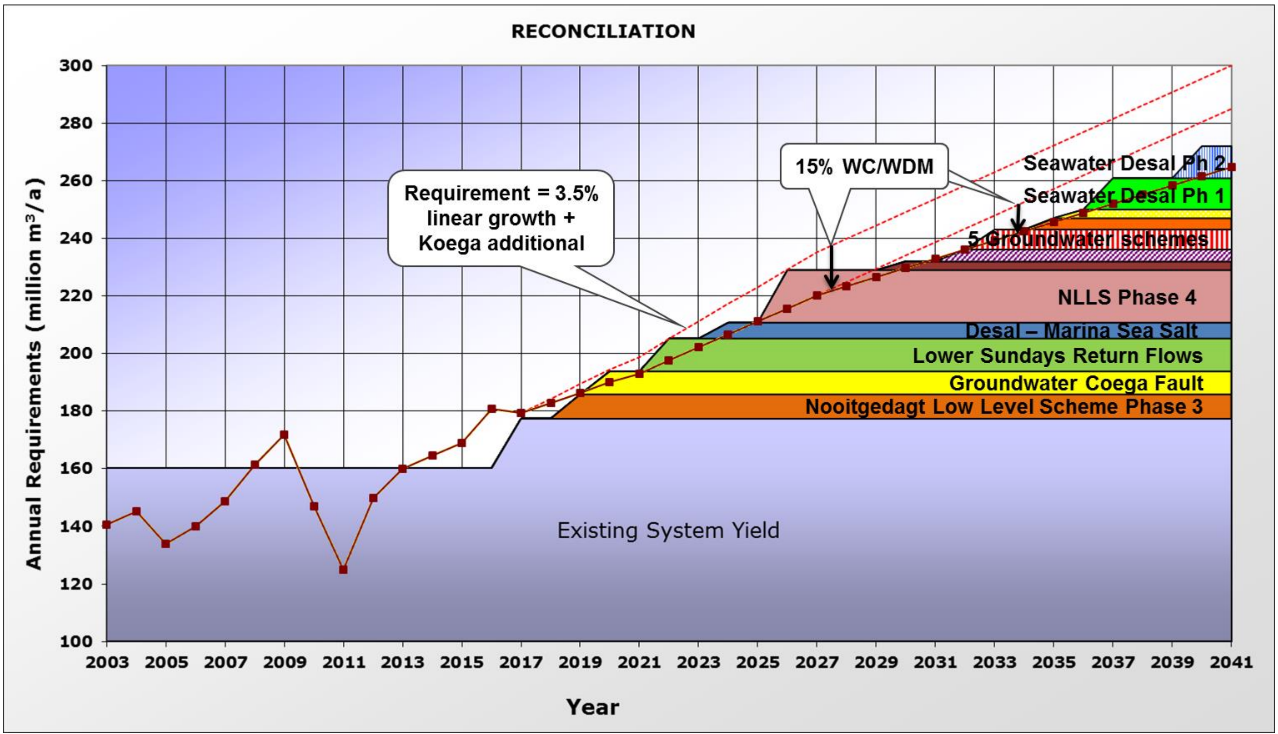


Figure 3.11: High Growth Potable plus Kouga LM

In this Scenario:

- WC/WDM measures (15% saving) reduce the water requirements.
- The implementation of the Nooitgedagt Low Level Scheme Phase 3 is completed.
- The implementation of the Coega Fault Groundwater Scheme is completed.
- The Sundays River Return Flows scheme is implemented.
- The Marina Sea Salt Desalination Scheme is implemented, and potable water is sold as a by-product to NMBM.
- The water requirements of a potential Thyspunt Nuclear Plant is met by seawater desalination,
- Phase 4 of the Nooitgedagt Low Level Scheme Phase is implemented.
- Groundwater interventions are undertaken at Churchill, Bushy Park, Jeffreys Arch and Van Stadens.
- Seawater desalination is phased in.

The interventions which have been used for the Scenario, as shown in **Figure 3.11**, are listed in **Table 3.7**.

Table 3.7: Interventions for the High Growth Potable Scenario plus Kouga LM

No	Intervention	Year of First Water or Saving	Yield	Status
1	WCDM 2017 to 2026 (15% saving)	2018	15.0	ongoing
2	Nooitgedagt Low Level Scheme Phase 3	2019	8.4	construction
3	Groundwater Coega Fault	2020	8	Implementation
4	Lower Sunday River return flows	2022	11.4	Desktop assessment

No	Intervention	Year of First Water or Saving	Yield	Status
5	Marina Sea Salt Desalination	2023	5.5	Monitoring
6	Thyspunt Desalination Scheme	2024	3	-
7	Nooitgedagt Low Level Scheme Phase 4	2025	18.25	Assessing yield
8	Groundwater - Churchill Dam	2028	3	-
9	WC/WDM Programme from 2027 (15% saving)	2028	21.6	-
10	Groundwater - Bushy Park	2030	4.0	-
11	Groundwater - Jeffreys Arch	2031	7	-
12	Groundwater - Van Stadens	2033	4	-
14	Groundwater - Gamtoos Valley	2034	3	-
15	Seawater Desalination Phase 1	2035	11.0	Partial evaluation done
16	Seawater Desalination Phase 2	2039	15.0	-

Compared to the High Growth Potable (Reference) Scenario, the implication of accommodating additional future growth in water requirements of the Kouga LM, is limited. In comparison, one additional scheme is required within the planning period, namely the Thyspunt Desalination Scheme.

3.9.8 High Growth including Coega (potable and industrial)

This scenario water balance is shown in **Figure 3.12**.

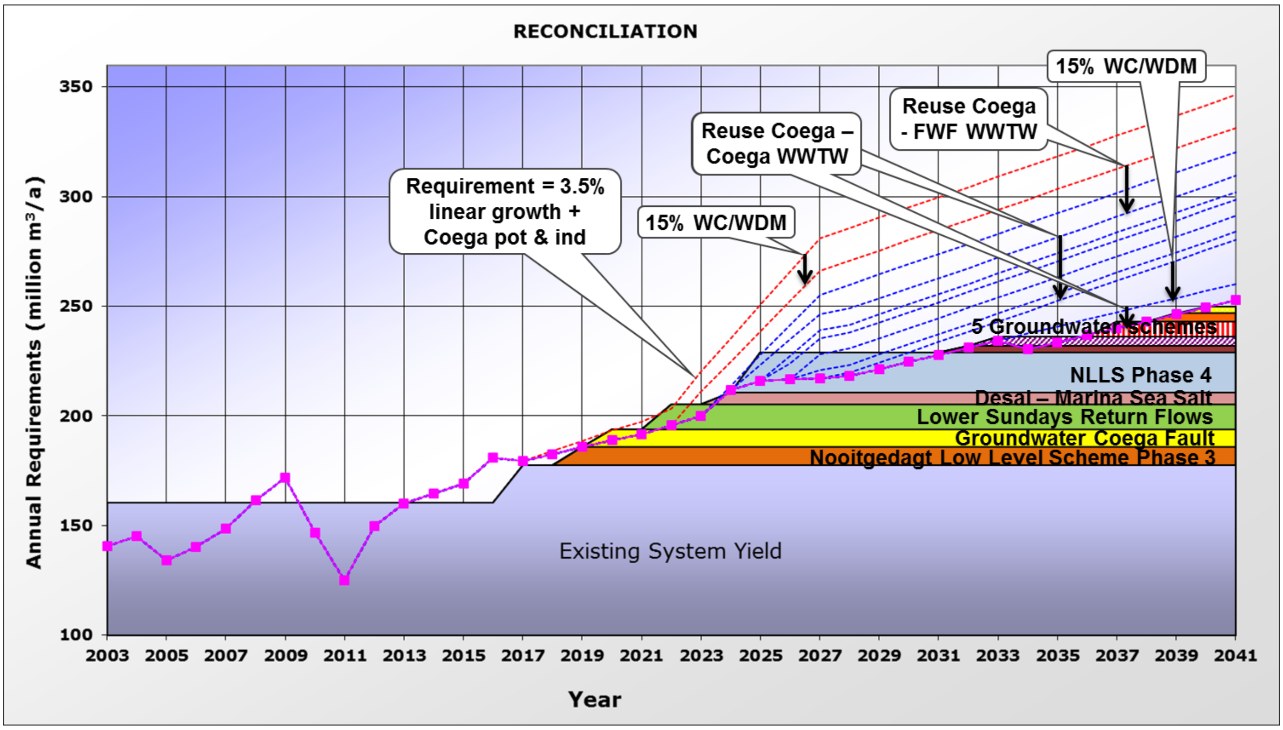


Figure 3.12: High Growth Potable including Coega Scenario

In this Scenario:

- WC/WDM measures (15% saving) reduce the water requirement.
- Phasing in of the FWF WWTW industrial re-use scheme and the Coega WWTW industrial re-use scheme.
- The implementation of the Nooitgedagt Low Level Scheme Phase 3 is completed.
- The implementation of the Coega Fault Groundwater Scheme is completed.
- The Sundays River Return Flows scheme is implemented.
- The Marina Sea Salt Desalination Scheme is implemented, and potable water is sold as a by-product to NMBM.
- Phase 4 of the Nooitgedagt Low Level Scheme Phase is implemented.
- Groundwater interventions are undertaken at Churchill, Bushy Park, Jeffreys Arch and Van Stadens.
- A Seawater Desalination Scheme is phased in.

The interventions which have been used for the Scenario, as shown in **Figure 3.12** are listed in **Table 3.8**.

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Table 3.8: Interventions for the High Growth including Coega Scenario

No	Intervention	Year of First Water or Saving	Yield	Status
1	WCDM 2017 to 2026 (15% saving)	2018	15	ongoing
2	Nooitgedagt Low Level Scheme Phase 3	2019	8.4	construction
3	Groundwater Coega Fault	2020	8	Implementation
4	Lower Sunday River return flows	2022	11.4	Desktop assessment
5	FWF WWTW Industrial Reuse Scheme Phase 1	2023	11.0	Part implementation
6	Marina Sea Salt Desalination	2023	5.5	Monitoring
7	FWF WWTW Industrial Reuse Scheme Phase 2	2024	11.0	-
8	Nooitgedagt Low Level Scheme Phase 4	2024	18.25	Assessing yield
9	Industrial effluent to Coega - ex Coega Phase1 (dom)	2025	7.3	Study imminent
10	Coega WWTW Industrial Reuse Scheme Phase 2 (dom)	2026	7.3	-
11	Coega WWTW Industrial Reuse Scheme Phase 2 (ind)	2026	3.65	-
12	Coega WWTW Industrial Reuse Scheme Phase 3 (ind)	2027	3.65	-
13	Coega WWTW Industrial Reuse Scheme Phase 3 (dom)	2027	7.3	
14	WC/WDM Programme from 2027 (15% saving)	2028	21.6	-
15	Groundwater - Churchill Dam	2029	3	-
16	Groundwater - Bushy Park	2030	4.0	-
17	Groundwater - Jeffreys Arch	2032	7	-
18	Coega WWTW Industrial Reuse Scheme Phase 4 (ind)	2034	7.3	-
19	Groundwater - Van Stadens	2036	4	-
20	Groundwater - Gamtoos Valley	2037	3	-
21	Seawater Desalination Phase 1	2038	11.0	Partial evaluation done

3.9.9 Worst Case Scenario

This scenario water balance is shown in **Figure 3.13**.

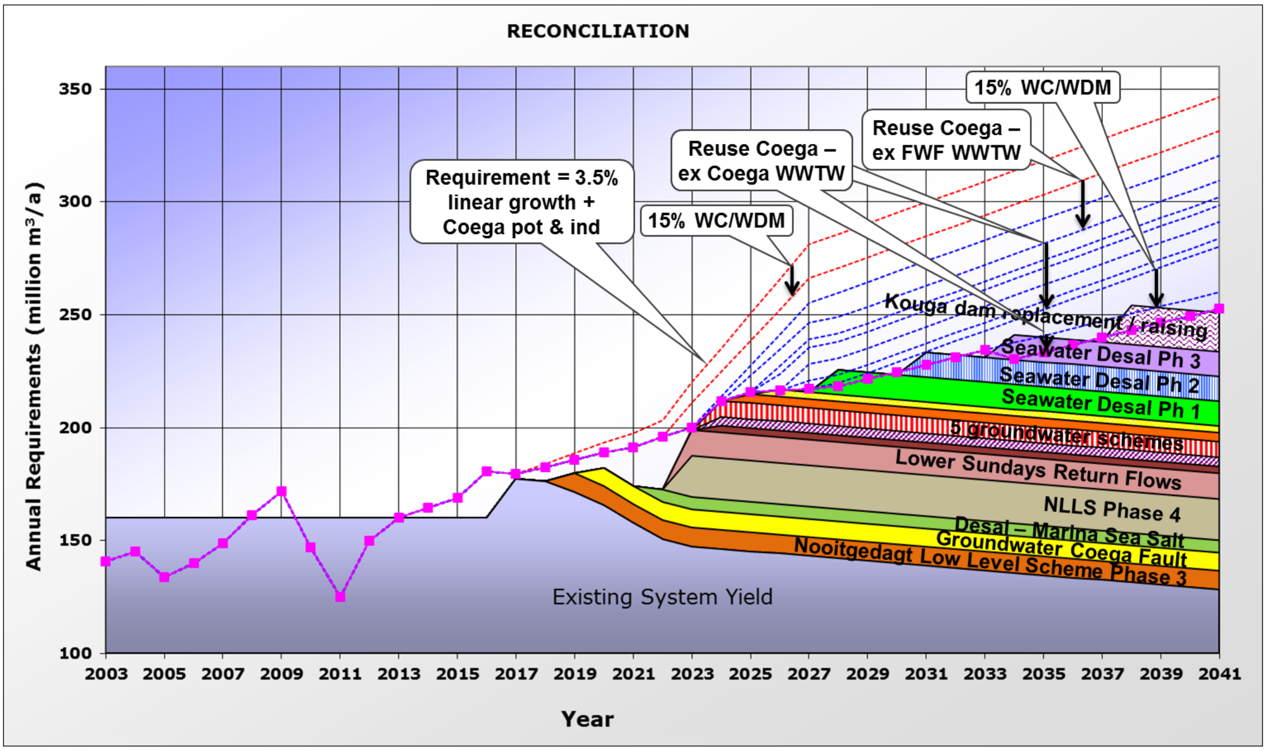

Figure 3.13: Worst Case Scenario

In the updated Scenario:

- WC/WDM measures (15% saving) reduce water requirements.
- Phasing in of the FWF WWTW industrial re-use scheme and the Coega WWTW industrial re-use scheme.
- The implementation of the Nooitgedagt Low Level Scheme Phase 3 is completed.
- The implementation of the Coega Fault Groundwater Scheme is completed.
- The Sundays River Return Flows scheme is implemented.
- The Marina Sea Salt Desalination Scheme is implemented, and potable water is sold as a by-product to NMBM.
- Phase 4 of the Nooitgedagt Low Level Scheme Phase is implemented.
- Groundwater interventions are undertaken at Churchill, Bushy Park, Jeffreys Arch and Van Stadens.
- A Seawater Desalination Scheme is phased in.
- Kouga Dam is raised.

The interventions which have been used for the Scenario, as shown in **Figure 3.13** are listed in **Table 3.9**.

Table 3.9: Interventions for the Worst Case Scenario

No	Intervention	Year of First Water or Saving	Yield	Status
1	WCDM 2017 to 2026 (15% saving)	2018	15	ongoing
2	Nooitgedagt Low Level Scheme Phase 3	2019	8.4	construction
3	Groundwater Coega Fault	2020	8	Implementation
4	Marina Sea Salt Desalination	2022	5.5	Monitoring
5	Lower Sunday River return flows	2022	11.4	Desktop assessment
6	Nooitgedagt Low Level Scheme Phase 4	2022	18.25	Assessing yield
7	FWF WWTW Industrial Reuse Scheme Phase 1	2023	11.0	Part implementation
8	Groundwater - Churchill Dam	2023	3	-
9	Groundwater - Bushy Park	2023	4.0	-
10	Groundwater - Jeffreys Arch	2023	7	-
11	Groundwater - Van Stadens	2024	4	-
12	Groundwater - Gamtoos Valley	2024	3	-
13	FWF WWTW Industrial Reuse Scheme Phase 2	2024	11.0	-
14	Industrial effluent to Coega - ex Coega Phase1 (dom)	2025	7.3	Study
15	Seawater Desalination Phase 1	2025	11.0	Partial evaluation done
16	Coega WWTW Industrial Reuse Scheme Phase 2 (dom)	2026	7.3	-
17	Coega WWTW Industrial Reuse Scheme Phase 2 (ind)	2026	3.65	-
18	Coega WWTW Industrial Reuse Scheme Phase 3 (ind)	2027	3.65	-
19	Coega WWTW Industrial Reuse Scheme Phase 3 (dom)	2027	7.3	
20	WC/WDM Programme from 2027 (15% saving)	2028	21.6	-
21	Seawater Desalination Phase 2	2029	11.0	-
22	Seawater Desalination Phase 3	2031	10.95	-
23	Coega WWTW Industrial Reuse Scheme Phase 4 (ind)	2034	7.3	-
24	Kouga Dam replacement and raising	2036	17.3	Desktop assessment
25	Seawater Desalination Phase 4	2039	11.0	-

3.10 Implications Highlighted by the updated Scenario Planning

The following implications are noted:

- The scenario planning has been done for a 25-year period.
- It is essential that the NMBM WC/WDM Strategy implementation should proceed as planned and receive the necessary high-level support and funding from NMBM, to ensure the necessary institutional capacity for implementation and adequate resourcing to be successful. Similarly, WC/WDM should be a very high priority for the Kouga LM.
- The implication of the reduction in the yield of the Algoa WSS, as a result of the reduction in the Kromme Sub-system yield is significant. There will likely be a period of a couple of years where the system water requirements cannot be fully met, because water supply schemes could likely not be implemented quickly enough. The implication is that the next schemes will have to be fast-tracked.
- In the updated 2017 "Reference" Scenario for potable supply, it is evident that:
    - The implementation of the Nooitgedagt Low-level Scheme (Phase 3) should urgently proceed as planned.
    - The implementation of the Coega Fault Groundwater Scheme should be completed as quick as possible.
- The interventions to be implemented thereafter is likely one of:
    - The Sundays River Return Flows scheme. The scheme should be further evaluated at desktop/pre-feasibility level.
    - The Marina Sea Salt Desalination Scheme. The NMBM should continue liaising with the potential developer of the scheme, for the purchasing of potable water as a by-product. It would however have to be ensured that the scheme is sustainable in the long-term.
    - Phase 4 of the Nooitgedagt Low Level Scheme. Following the completion of the evaluation of the potential saving of transferred Orange River water for re-allocation, a recommendation will be made on the potential re-allocation of transferred Orange River water to NMBM.
    - Groundwater interventions at Churchill Dam, Bushy Park, Jeffreys Arch and Van Stadens. As groundwater implementation seems to take longer than the general perception, it would be advisable to consider getting at least the first phases of the further groundwater investigations underway very soon.
- Following that, significant potable interventions are likely a seawater desalination or a new dam in the Kouga River (Kouga Dam raising or Guernakop Dam).
- Interventions to meet the growth in water requirements of the Kouga LM, including the current over-abstraction from the Kromme sub-system, coupled to the potential building of a Nuclear Plant within the municipal area, requires urgent attention.

4 Key Messages

The following key messages (conclusions) can be taken from the comparison of water supply and requirement and the scenario planning undertaken for the September 2017 Strategy Steering Committee meeting:

Message 1: Concern about assurance of supply of the Algoa WWS

Concerns about the accuracy of the assurance of supply values provided from the system modelling should be addressed, in light of the regular restrictions needed for the Algoa WSS, especially for the Kouga-Loerie sub-system, but also for the Kromme sub-system. The risk of planning according to system yields that are inaccurate could be significant.

Message 2: Successful implementation of WC/WDM is critical

It is essential that political and funding support for the NMBM WC/WDM implementation is stepped up, especially in terms of awareness creation. Measuring and reporting of the results obtained remains important. WC/WDM for the Kouga LM and smaller towns must also be implemented, measured and reported.

Message 3: The Nooitgedagt Low-level Scheme must be completed

The scheme has been phased with Phase1 and 2 having been completed. It is important for the construction of Phase 3 of the scheme to be completed as planned. Conditions around the Orange River water allocation to NMBM and measures if the additional allocation is regarded as 'temporary needs' should be further addressed. Potential operating bottlenecks for delivery of additional water needs to be evaluated and addressed.

Message 4: Consideration of further phasing of the Nooitgedagt Scheme

Further phasing of the Nooitgedagt Scheme (following the completion of Phase 3) and the unrestricted conveyance of such additional flow should be considered. Such a scheme could potentially include the use of transferred Orange River water that can be saved by the more efficient conveyance and operational releases of transferred Orange River water, and also more efficient water use by irrigation. This may potentially include the use of desalinated lower Sundays River irrigation return flows as a component.

Message 5: Groundwater is both a good back-up option and a good permanent bulk supply option

The implementation of the Coegakop Scheme should be completed. While preliminary investigations into further promising groundwater schemes were done, further phases of investigation and drilling for such schemes should be initiated.

It would be worthwhile to find alternative water sources for smaller towns such as Jeffrey's Bay, to limit the increased water use of such towns from the Algoa WSS.

Message 6: Re-use of water is an important intervention

Water reuse schemes should be implemented to provide industrial quality water to the Coega IDZ. The water requirements of the IDZ will remain uncertain until such stage that the availability of water and power to meet the needs of potential investors can be confirmed. The integration of the potential Sundays River irrigation return flows scheme as a potential source of potable or industrial quality water, or both, could be considered, along with the planned water reuse schemes.

Message 7: The feasibility of seawater desalination should be investigated further

Desalination is the ultimate future augmentation solution for the area, and may be required within less than 15 years, should water efficiency measures not be successful. The feasibility study investigation into seawater desalination for NMBM should continue, and other desalination options such as a Coega IDZ Scheme or the Marina Sea Salt Desalination Scheme should be evaluated.

Message 8: A larger dam on the Kouga River remains a long-term option

Following the decision that dam safety construction work at Kouga Dam will not proceed, this remains a long-term option. The Guernakop Dam should similarly still be considered.

Message 10: Choice of intervention will be dependent on growth in water requirements

If the actual growth in water requirements is lower than the high-growth water requirement curve, it will be possible to delay the implementation of interventions after the Nooitgedagt Low-level Scheme has been completed. If however the water requirements keep on growing at the current rate, it is important to continue with feasibility studies and implementation of the recommended range of interventions.

The specific locality of growth points within the NMBM and in the strategy area is becoming a significant factor, to be taken into consideration in the selection of interventions.

Message 11: The need to fast track studies of potential interventions

Following the implementation of the Nooitgedagt Low-Level Scheme Phase 3 and the Coega Kop groundwater scheme, it may not be possible to implement further supply-side interventions fast enough to meet growing water requirements, possibly for a couple of years. This implies that the evaluation of the studies of such possible further augmentation schemes, and possibly the implementation as well, should be fast-tracked.

Message 12: Monitoring is very important

It remains important to implement or maintain a system to monitor desalination intake seawater quality, potential indicators for climate change and to monitor the NMBM’s success in implementing their WC/WDM Strategy measures.

5 Recommendations

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

1) NMBM should submit a water use licence application to DWS for the additional water use from Loerie Dam.
2) DWS should complete the Eastern Cape Verification and Validation Study, to be followed by a Water Availability Assessment Study (WAAS), including irrigation and urban uses, to address uncertainty regarding the hydrology and assurance of supply of the Baviaans, Kouga and Kromme rivers, which feed into the different supply dams.
3) While the NMBM has made good progress with the implementation of their WC/WDM strategy during the past year, there is room for improvement.
4) NMBM should complete the implementation of the Nooitgedagt Low-level Scheme Phase 3.
5) The DWS should make recommendations on targeted water efficiency savings of transferred Orange River water to the Eastern Cape, to follow from more efficient conveyance and operational releases of transferred water, as well as more efficient water use by irrigation, and any associated re-allocation of Orange River water that can be made to the AWSS.
6) DWS should ensure that there are no bottlenecks regarding the transfer of additional Orange River water to NMBM. DWS should complete the investigation into the balancing requirements and conveyance infrastructure in the transfer between the abstraction point in the Sundays River and the Nooitgedagt treatment works as soon as possible.
7) NMBM and Kouga LM should soon continue with groundwater studies and drilling, particularly those close to and easily integrated into the existing WSS infrastructure, and refine the potential groundwater yields.
8) NMBM should continue with the implementation of re-use schemes for supplying the potable and industrial requirements of the Coega IDZ. They should ensure implementation-readiness for water re-use and implementation from the Fish Water Flats WWTW and the planned Coega WWTW, within the constraints of available development funds, and the emergence of a major water user in the Coega IDZ.
9) NMBM should continue with the feasibility study on seawater desalination, and keep abreast of development plans at the Coega IDZ and a potential associated desalination plant, and the Marina Sea Salt Desalination scheme.
10) Monitor progress with the decision of where the next nuclear power plant will be located, and its implementation planning, if it will be located at Thyspunt.
11) DWS should evaluate the re-use of Lower Sundays River Return Flows at a more detailed desktop level. This should be followed by a Feasibility-level Study by NMBM, as this could be one of the next interventions to be considered for implementation.
12) Clearing of invasive alien plants in the catchments of Algoa WSS dams by the Gamtoos Irrigation Board should and will continue.
13) DWS should initiate a study to develop a strategy for the implementation of the Reserve for existing Algoa WSS dams.

14) DWS should initiate an impact assessment study to determine the expected regional impact of climate change on the Algoa WSS water balance.

15) NMBM and small towns should continue monitoring the success of implementation of their WC/WDM interventions. DWS is responsible for monitoring water availability and will continue to monitor the quantity and quality of the Sundays River WUA return flows. NBMM should continue with monitoring of water quality at potential desalination plant intakes.

16) The high-growth water requirement scenario will still be used as basis for future scenario planning. Water requirements must be monitored and the projected water requirement curves should be updated if the current assumptions used are deemed to be no longer valid. Future water requirement curves will be projected from the latest annual water use available.

17) The Algoa Water Supply System Reconciliation Strategy should be re-assessed and updated in September 2018.

Appendix A
Representation on the Strategy Committees

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Appendix B
Interventions Considered in the 2011 Reconciliation Strategy

INTERVENTIONS CONSIDERED IN THE 2011 RECONCILIATION STRATEGY

Selection of interventions

A significant number of potential interventions, which could contribute to meeting the future water requirements of the Algoa Water Supply System, were initially identified from previous and on-going studies, with the inclusion of several newly formulated interventions. The following categories of interventions were identified:

- Water conservation and water demand management,
- Increased operational efficiency of the current water supply 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.

The selection of interventions was based on:

a. Lowest cost based on Unit Reference Value (URV) which provides an indication of the combined capital and operation costs,
b. Time required for implementation,
c. Adequate yield, and certainty that the yield can be realised,
d. Spreading of risk by becoming less reliant on surface water sources, and
e. Ensuring that there would be an adequate number of interventions available to meet the Total High-Growth Water Requirement Scenario described above.

Emergency interventions

The severe and prolonged drought in 2009-2010 led NMBM to impose severe water restrictions and to fast track the implementation of the following emergency interventions, most of which had previously been identified as priorities by the preliminary scenario planning processes:

- Improved operation of the Kouga Loerie System,
- Water Conservation and Water Demand Management
- Nooitgedagt Low-Level Scheme supplied from the Orange River,
- Swartkops desalination of seawater, and
- Groundwater abstraction close to existing infrastructure, mainly in the vicinity of Bushy Park.

Summary of interventions considered

Descriptions of the interventions that were considered for the Strategy, following preliminary screening and taking account of those considered or already implemented by NMBM as possible emergency interventions (**shown in bold**) are provided in Table B1.

Table B1: Interventions considered for the Reconciliation Strategy

Intervention	Description of intervention
Urban Water Conservation and Demand Management:	
WC/WDM upstream /downstream of user meters	Continued roll-out of the 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. **This program was expedited as one of NMBM's Emergency Interventions.**
Rainwater harvesting	Collection of rainwater from roofs, primarily for toilet flushing. The collection of rainwater for supplementing of garden water use is deemed to be an extension of this option. **Rainwater harvesting is being promoted by NMBM.**
Trading of Water Use Authorisations:	
Water trading – upper Great Fish River	Purchasing of water use entitlements from farmers using Orange River water in the upper Great Fish River, to be supplied to NMBM via the Nooitgedagt abstraction infrastructure.
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.
Land Use Changes:	
Removal of alien invasive plants	Programmes to remove invasive alien plants in the catchments of the Kromme, Kouga and Baviaanskloof rivers which is already being done on a large scale. **This is already being done on a large-scale.**
Re-Use of Water:	
Re-use of water treated to industrial standards – Coega WWTW	Re-use of treated water from the future Coega WWTW, to meet requirements for industrial (non-potable) quality water within the Coega IDZ. **This scheme was included in the business plan for the Coega IDZ.**
Re-use of water treated to industrial standards – Fish Water Flats WWTW	Re-use of treated water from the Fish Water Flats WWTW, to meet requirements for industrial quality water within the Coega IDZ. **This scheme 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 and was included in the business plan of the Coega IDZ.**
Re-use of water treated to potable standards	Potable re-use of treated water from the Fish Water Flats (and possibly Uitenhage and Despatch WWTWs) through reverse osmosis treatment, storage in a proposed new dam at Echodale on the Elands River and treated at a new water treatment works. The identified alternative scheme to utilise treated effluent via Loerie Dam would be a similar alternative, however the URV may be lower.
Desalination:	
Coega Industry Desalination Option	Purchasing of potable water by NMBM from an industry in the Coega IDZ, which utilises reverse-osmosis to produce chlorine and caustic soda and high-quality water as a by-product of the process. This option was also dependent on the construction of a bulk seawater intake system for the Coega IDZ.
Lower Sundays River irrigation return flows	Abstraction of irrigation 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.
Desalination of seawater	Supply via a bulk seawater intake system for multiple potential sea water users within the Coega IDZ area, pumping sea water via pipeline to the proposed RO plant site (to be shared with the planned Coega WWTW). **The alternative scheme to site a desalination plant on the Swartkops Estuary would be a similar alternative, with a similar URV and is one of NMBM's**

Intervention	Description of intervention
	Emergency Interventions that would also improve the diversification of the sources of supply.
Groundwater Augmentation Schemes:	
Fast-tracked groundwater schemes: - Jeffreys Arch - Van Stadens - Bushy Park - South-Eastern Coega Fault	Fast-tracking the implementation of the Jeffreys Arch, Van Stadens River Mouth, 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. **Groundwater development at Bushy Park was considered as one of NMBM's Emergency Interventions, but not implemented.**
Surface Water Augmentation Schemes:	
Maximising yield of the existing Kouga/Loerie Scheme	Lowering of the operational level to which water can be abstracted from Loerie Dam, to increase the yield, requiring no additional infrastructure or operating staff, but improved operation and increased periods of pumping at maximum capacity. **This scheme has been implemented.**
ORP/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. **DWA issued a licence to NMBM to abstract 58.3 million m^3/a of water from the Orange River with the proviso that the licence could be reduced back to 22 million m^3/a after 20 years, however NMBM have requested that the licence be made permanent on account of the high capital cost of this scheme.** **This scheme was one of NMBM's Emergency Interventions.**
Abstraction of lower Gamtoos River irrigation return flows	Abstraction of irrigation return flows by NMBM downstream of the largest irrigation component of the Gamtoos Irrigation Board (upstream of the tidal river zone) and pumping this water into the Loerie Dam for blending with water from Kouga Dam. **This scheme was considered by NMBM as a potential emergency measure but was eliminated on account of its potential impact on the ecology of the important Gamtoos Estuary.**
Guernakop Dam on the Kouga River	Construction of a new 83 m high rollcrete dam at Guernakop, approximately 15 km upstream of the upper end of Kouga Dam on the Kouga River and doubling of the capacities of the Loerie WTW and the pipelines to NMBM.
Raising Kouga Dam on the Kouga River (replacement and raising)	Construction of a mass gravity rollcrete dam immediately downstream of the existing Kouga Dam and doubling of the capacities of the Loerie WTW and the pipelines to NMBM. **DWS investigated this scheme for dam safety reasons.**
Tsitsikamma River Diversion to Impofu Dam	Diversion of flows from a diversion weir on the lower Tsitsikamma River, and pumping the water to a high point, from where the water would gravitate via pipeline into a stream which flows into Impofu Dam. The water would be treated at the Elandsjagt WTW and distributed through existing infrastructure.

Appendix C
Streamflow analysis for the catchments of the Kromme and Gamtoos rivers

Streamflow Analysis for the Catchments of the Kromme and Gamtoos Rivers

A separate technical report, titled *Streamflow analysis in the Kromme and Gamtoos catchments*, which contains detailed Appendices, has been produced in support of this Status Report.

1. Introduction

In lieu of a much needed Water Availability Assessment Study (WAAS) for the Algoa Water Supply System (WSS) Aurecon conducted a high-level streamflow analysis for the catchments of both the Kromme and the Gamtoos (i.e. the Baviaanskloof and Kouga) rivers to determine the possible impact of the last ± 10 years' of hydrology (± 2005 – 2017) on the availability of water at the major dams in these catchments, i.e. the Churchill, Impofu and Kouga dams.

Both historic firm yields (HFY) and long-term yields of all three of these dams were previously determined as part of the Algoa Water Resources Bridging Study (DWS, 2010) (refer to **Table 1** below) and has ever since been used to reconcile water availability with the growing water requirements in the Algoa WSS.

Table 1: Yield characteristics of the Kromme and Gamtoos catchments
(Source: Algoa Water Resources Bridging Study (DWS, 2010))

Catchment	Historic firm yield (HFY)	Long term yields			
		1:20 year	1:50 year	1:100 year	1:200 year
Kromme (combined Churchill and Impofu Dams)	32.9	50.0	42.5	39.0	35.0
Gamtoos (Kouga Dam only)	75.7	94.0	85.0	79.0	74.0

Although the Support of the Water Reconciliation Strategy for the Algoa Water Supply System Study (DWS, 2017) did not allow for a recalibration of the WRSM2000 rainfall-runoff model as well as a subsequent yield analyses by means of the Water Resources Yield Model (WRYM), the following analyses was done to provide information in support of the system yield and sub-system yield being used for the water balance analyses:

- Interrogate recent flow records in both rivers to see if any patterns or trends can be established, and
- Determine historic firm yields of all three major dams for the longer flow record by means of a simple Excel spreadsheet.

2. Selection of gauging stations

The positions of all available gauging stations in both the Kromme and Gamtoos catchments were established. Only one river gauge exist in these catchments that could effectively be used to conduct a representative streamflow analysis, i.e. a fairly new gauging station in the Kouga River at Stuurmanskraal (L8H005).

Other than that, the calculated inflow records at the major dams in these catchments, i.e. K9R001 (Churchill Dam) and K9R002 (Impofu Dam) in the Kromme catchment, and L8R001 (Kouga Dam) in the Gamtoos catchment, were the only means to establish patterns, trends and possible historic firm yields.

Monthly flow data for river gauging station L8H005 as well as dam balance calculations for all three reservoir stations (K9R001, K9R002 and L8R001) were obtained for this purpose from the DWS Directorate: Hydrological Services (September 2017). The available record periods for each are summarised in **Table 2**.

Table 2: Details of selected streamflow gauging stations

No.	Gauge No.	River/location	Cumulative catchment area (km²)	Previous record period (hydrological years) [(1)]		Current record period (hydrological years)	
				Available	Used	Available	Used
Kromme River catchment							
1	K9R001	Krom River @ Kromrivier Dam	364	1948 - 2004	1957 - 2004	1948 - 2017	1955 - 2015
2	K9R002	Krom River @ Impofu Dam	844	1983 - 2004	1983 - 2004	1983 - 2017	1983 - 2015
Kouga and Baviaanskloof rivers catchments							
1	L8R001	Kouga River @ Kouga Dam	3892	1961 - 2009	1970 - 2004	1961 - 2017	1970 - 2015
2	L8H005	Kouga River @ Stuurmanskraal	1627	1989 - 2009	1990 - 2004	1990 - 2017	1990 - 2017

Note:
(1) Source: Algoa Water Resources Bridging Study (DWS, 2010)

3. Patching of streamflow records

In the absence of an updated WRSM2000 rainfall-runoff model, minimal patching could be conducted on the obtained raw flow records. However, as a detailed patching exercise was conducted on the data of all four gauging stations as part of the Algoa Water Resources Bridging Study (DWS, 2010), patched values from this study were adopted for the record period up to 2004.

After 2004 the data for all four gauging stations were surprisingly complete, with only a few small negative inflow records calculated here and there. In cases where these were insignificantly small zero values, i.e. zero inflow, were adopted.

4. Streamflow analysis

Plots showing flow duration curves, monthly flows, annual flows and ranked annual flows for each of the four records were created. Findings from these are discussed below.

4.1 K9R001

A calculated inflow record for Churchill Dam covering a record period of 61 years (i.e. 1955 - 2015) was used for the analyses. The flow duration curve show that an inflow of 1.3 million m³/month can be expected at this dam for 50% of the time.

A slight decrease in flow is evident over the entire record period. This might be as a result of increased water uses upstream of the dam, a decrease in rainfall, etc.

However, the average flow over the last 10 years, i.e. 2005 to 2015 which depicts the period that was excluded from the last yield analyses, seems to be higher than the average flow recorded over the entire record period, i.e. 1955 to 2015 (as summarised in **Table 3**) although it included the 2008/2009 drought. The inflow during this drought period also seems not to be the worst experienced over the entire record period as is evident from the ranked annual flow graph, with the 1980s drought period still being worse.

Rather, a much more 'peaky' inflow, extremely high and extremely low flows, was experienced during these past 10 years, which is to be expected based on future climate change predictions which suggests that, although no significant increase or decrease in the total amount of rainfall is expected in future, there seem to be a significant reduction in the number of rain days, resulting in an increase in the average rainfall intensity with associated high (and, on the other side, low) flows.

Table 3: K9R001 - Inflow series statistics

Statistics		K9R001
Entire record period (1955 – 2015)	Average (million m³/a)	46.14
	Average (million m³/m)	3.85
	Min (million m³/a)	4.34
	Max (million m³/a)	168.86
Record period since previous yield analyses (2005 – 2015)	Average (million m³/a)	50.46
	Average (million m³/m)	4.21
	Min (million m³/a)	0.00
	Max (million m³/a)	95.10

4.2 K9R002

A calculated inflow record for Impofu Dam covering a record period of 33 years (i.e. 1983 - 2015) was used for the analyses. The flow duration curve show that an inflow of 0.52 million m³/month can be expected at this dam 50% of the time.

A notable increase in flow is evident over the entire record period as shown by the trend line included on both the monthly and annual flow graphs. This might be as a result of increased releases from the upstream Churchill Dam, a decrease in water uses between the two dams, etc. (can be further investigated if time and budget allows).

In addition, the average flow over the last 10 years, i.e. 2005 to 2015 which depicts the period that was excluded from the last yield analyses, seems to be higher than the average flow recorded over the entire record period, i.e. 1983 to 2015 (as summarised in **Table 4**) although it included the 2008/2009 drought. The inflow during this drought period also seem not to be the worst experienced over the entire record period as is evident from the ranked annual flow graph, with the 1980s drought period still being worse.

Rather, a much more 'peaky' inflow, extremely high and extremely low flows, was experienced during these past 10 years, which is to be expected based on future climate change predictions which suggests that, although no significant increase or decrease in the total amount of rainfall is expected in future, there seem to be a significant reduction in the number of rain days resulting in an increase in the average rainfall intensity with associated high (and, on the other side, low) flows.

Table 4: K9R002 - Inflow series statistics

Statistics		K9R002
Entire record period (1983 – 2015)	Average (million m³/a)	43.50
	Average (million m³/m)	3.63
	Min (million m³/a)	0.69
	Max (million m³/a)	184.84
Record period since previous yield analyses (2005 – 2015)	Average (million m³/a)	72.35
	Average (million m³/m)	6.03
	Min (million m³/a)	0.00
	Max (million m³/a)	160.04

4.3 L8R001

A calculated inflow record for Kouga Dam covering a record period of 46 years (i.e. 1970 – 2015) was used for the analyses. The flow duration curve shows that an inflow of 4.4 million m³/month can be expected at this dam 50% of the time.

A slight increase in flow is evident over the entire record period as shown by the trend line included on both the monthly and annual flow graphs. This might be as a result of a decrease in water uses above Kouga Dam, etc. (can be further investigated if time and budget allows).

In addition, the average flow over the last 10 years, i.e. 2005 to 2015 which depicts the period that was excluded from the last yield analyses, seems to be significantly higher than the average flow recorded over the entire record period, i.e. 1970 to 2015 (as summarised in **Table 5**) although it included the 2008/2009 drought. The inflow during this drought period also seem not to be the worst experienced over the entire record period as is evident from the ranked annual flow graph, with the 1980s drought period still being worse.

Rather, a much more 'peaky' inflow, extremely high and extremely low flows, was experienced during these past 10 years, which is to be expected based on future climate change predictions which suggests that, although no significant increase or decrease in the total amount of rainfall is expected in future, there seem to be a significant reduction in the number of rain days resulting in an increase in the average rainfall intensity with associated high (and, on the other side, low) flows.

Table 5: L8R001 - Inflow series statistics

Statistics		L8R001
Entire record period (1970 – 2015)	Average (million m³/a)	148.20
	Average (million m³/m)	12.35
	Min (million m³/a)	18.26
	Max (million m³/a)	729.21
Record period since previous yield analyses (2005 – 2015)	Average (million m³/a)	195.52
	Average (million m³/m)	16.29
	Min (million m³/a)	0.21
	Max (million m³/a)	235.47

4.4 L8H005

The flow record for L8H005, covering a record period of 26 years (i.e. 1990 - 2015) was used for the analyses. The flow duration curve shows that an inflow of 2.8 million m³/month can be expected at this dam for 50% of the time (Error! Reference source not found.), contributing to more than halve of the inflow at the Kouga Dam downstream.

As with the calculated inflow record at Kouga Dam, a very slight increase in flow is evident over the entire record period, as indicated by the trend line included on both the monthly and annual flow graphs. This might be as a result of a decrease in water uses above this point, etc. (can be further investigated if time and budget allows).

In addition, the average flow over the last 10 years, i.e. 2005 to 2015 which depicts the period that was excluded from the last yield analyses, seems to be higher than the average flow recorded over the entire record period, i.e. 1990 to 2015 (as summarised in **Table 6**) although it included the 2008/2009 drought. The inflow during this drought period also seem not to be the worst experienced over the entire record period as is evident from the ranked annual flow graph, with the 1980s drought period still being worse.

Rather, a much more 'peaky' inflow, extremely high and extremely low flows, was experienced during these past 10 years, which is to be expected based on future climate change predictions which suggests that, although no significant increase or decrease in the total amount of rainfall is expected in future, there seem to be a significant reduction in the number of rain days resulting in an increase in the average rainfall intensity with associated high (and, on the other side, low) flows.

Table 6: L8H005 - Inflow series statistics

Statistics		L8H005
Entire record period (1990 – 2015)	Average (million m³/a)	94.77
	Average (million m³/m)	7.95
	Min (million m³/a)	0.01
	Max (million m³/a)	143.0
Record period since previous yield analyses (2005 – 2015)	Average (million m³/a)	101.19
	Average (million m³/m)	8.78
	Min (million m³/a)	0.04
	Max (million m³/a)	143.00

5. Historic firm yield analysis

A simple yield analysis over the available historic record period, by means of an Excel spreadsheet was conducted with the patched inflow records to the major three dams, i.e. Churchill, Impofu and Kouga dams, as discussed above. The results of this yield analyses are summarised in **Table 7** with a comparison of these results and that from the previous yield analysis conducted as part of the Algoa Water Resources Bridging Study (DWS, 2010) included in **Table 8**.

Table 7: Historic firm yields based on Excel spreadsheet model

Catchment	Dam	Historic firm yield (HFY) (million m³/a)	Critical period
Kromme	Churchill Dam	17.5	Dec 1983 – Sep 1989 (full recovery in Sep 1992)
	Impofu Dam	20.2	Dec 1983 – Jul 1992 (full recovery in Dec 1993)
	Combined Churchill and Impofu Dams	37.7	-
Gamtoos	Kouga Dam	77.8	Nov 1983 – Jun 1992 (full recovery in Nov 1993)

Table 8: Comparison of yields between this analysis and the Algoa Water Resources Bridging Study (DWS, 2010)

Catchment	This analysis – Excel spreadsheet	Algoa Water Resources Bridging Study (DWS, 2010) - WRYM				
	Historic firm yield (HFY)	Historic firm yield (HFY)	Long term yields			
			1:20 year	1:50 year	1:100 year	1:200 year
Kromme (combined Churchill and Impofu Dams)	37.7	32.9	50.0	42.5	39.0	35.0
Gamtoos (Kouga Dam only)	77.8	75.7	94.0	85.0	79.0	74.0

As is evident from the above, the results for both the combined Churchill and Impofu Dams as well as the Kouga Dam are still similar to that obtained during the Algoa Water Resources Bridging Study (DWS, 2010) with the critical period remaining between ±1983 and 1992 (the 1980s drought period which was covered during the previous yield analyses). These historic firm yields seem to be supplied at an assurance of between 1:00 and 1:200 years.

6. Conclusions

The following conclusions can be reached from this streamflow analysis:

- There seems to be an upward trend in inflow at the Impofu and Kouga dams, with a slight downward trend evident at the Churchill Dam. The exact reasons for this was not confirmed during this analysis.
- At all three major dams the average flow over the last 10 years, i.e. 2005 to 2015 which depicts the period that was excluded from the last yield analyses, seems to be higher than the average flow recorded over the various entire record periods, although it included the 2008/2009 drought. The inflow during this drought period also seems not to be the worst experienced over the entire record periods, with the 1980s drought period still being worse (the 1980s drought was also much more prolonged).
- A much more 'peaky' inflow, with extremely high and extremely low flows, was experienced over the last 10 years, which is to be expected based on future climate change predictions which suggests that, although no significant increase or decrease in the total amount of rainfall is expected in future, there seems to be a significant reduction in the number of rain days, resulting in an increase in the average rainfall intensity, with associated high (and, on the other side, low) flows.
- The yield results including the last 10 years' hydrology for both the combined Churchill and Impofu dams as well as the Kouga Dam, are still similar to that obtained during the Algoa Water Resources Bridging Study (DWS, 2010) with the critical period remaining between ±1983 and 1992 (the 1980s drought period which was covered during the previous yield analyses).

7. Recommendations

The following recommendations are made based on this streamflow analysis:

- Until a detailed yield analysis can be conducted by means of a Water Availability Assessment Study for the Algoa WSS it is advisable that the yields as determined by the Algoa Water Resources Bridging Study (DWS, 2010) be used to reconcile water availability with growing water demands in the Algoa WSS.

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