Feasibility Study for Foxwood Dam (WP10580)

Water Requirements

Final

DWS Report Number: **P WMA 15/Q92/00/2113/8**

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SIGNATURE PAGE

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STUDY REPORTS

The Water Requirements report assesses the requirements for water supply in the potential water supply area that could be supported by the development of the proposed Foxwood Dam.

Feasibility Study for Foxwood Dam: Inception Report	**P WMA 15/Q92/00/2113/1**
Feasibility Study for Foxwood Dam: Preliminary Study Report	**P WMA 15/Q92/00/2113/2**
Feasibility Study for Foxwood Dam: Environmental Screening	P WMA 15/Q92/00/2113/3
Feasibility Study for Foxwood Dam: Geotechnical Reconnaissance	P WMA 15/Q92/00/2113/4
Feasibility Study for Foxwood Dam: Alternative Water Supply Options	P WMA 15/Q92/00/2113/5
Feasibility Study for Foxwood Dam: Feasibility Study Main Report	**P WMA 15/Q92/00/2113/6**
Feasibility Study for Foxwood Dam: Koonap River Hydrology	P WMA 15/Q92/00/2113/7
Feasibility Study for Foxwood Dam: Water Requirements	P WMA 15/Q92/00/2113/8
Feasibility Study for Foxwood Dam: Agro-Economic Study Report	P WMA 15/Q92/00/2113/9
Feasibility Study for Foxwood Dam: Water Quality	P WMA 15/Q92/00/2113/10
Feasibility Study for Foxwood Dam: Geotechnical Investigation	P WMA 15/Q92/00/2113/11
Feasibility Study for Foxwood Dam: Dam Feasibility Design	P WMA 15/Q92/00/2113/12
Feasibility Study for Foxwood Dam: Project Feasibility Costing	P WMA 15/Q92/00/2113/13
Feasibility Study for Foxwood Dam: Economic Impact Assessment	P WMA 15/Q92/00/2113/14
Feasibility Study for Foxwood Dam: Record of Implementation Decisions	P WMA 15/Q92/00/2113/15
Feasibility Study for Foxwood Dam: Book of Maps	P WMA 15/Q92/00/2113/16
Feasibility Study for Foxwood Dam: Public Participation (Queries & Responses Report)	P WMA 15/Q92/00/2113/17

REPORT REFERENCE

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, 2015. Feasibility Study for Foxwood Dam: Water Requirements Report, P WMA 15/Q92/00/2113/8

Note on Departmental name change

In 2014, the Department of Water Affairs (DWA) changed its name to the Department of Water and Sanitation (DWS). This occurred during the course of this study and as a result some reporting which was commenced and/or approved prior to the name change may still refer to DWA. References herein to DWA and DWS should be considered one and the same.

EXECUTIVE SUMMARY

The Department of Water and Sanitation (DWS) has appointed Arup (Pty) Ltd to carry out an investigation into the feasibility of developing a multi-purpose dam on the Koonap River outside of Adelaide in the Eastern Cape. The proposed Foxwood Dam site is located immediately upstream of Adelaide in the Koonap River catchment area with a catchment area of 3 334 km², and is situated in the Eastern Cape Province and lies within the Fish to Tsitsikamma Water Management Area (WMA). The project is being considered for implementation as a strategic initiative to mobilize the water resources in the area as a stimulus for socio-economic development in this rural, economically depressed region. This initiative would support the objectives of the National Development Plan (NDP) and is consistent with the National Water Resource Strategy 2 (NWRS2).

Prior to the decision to invest very large capital sums in the construction of a major dam, it is necessary to determine the current and projected need for water that would be supplied by the proposed dam. To this end, in this Water Requirements report the requirements for water are assessed in the immediate vicinity of the proposed dam site, outside Adelaide, as well as the requirements for water in the wider potential supply area in and around the Koonap River Valley.

A 30-year projection has been used for the estimation of future domestic water requirements for Adelaide. For reference, it is noted that a 1 MAR dam at the proposed Foxwood Dam site would have a yield of 11,3 million m^3/a at a 1:100 year assurance.

Domestic water requirements

The current water requirements and water resources for Adelaide, Bedford and Fort Beaufort are summarised in Table 1 below.

Table 1: Current water balance for Adelaide, Bedford and Fort Beaufort

Area	Current population	Current water requirement (million m^3/a)	Current water resources (million m^3/a)
Adelaide	10 714	0,850	1,115
Bedford[1]	13 250	0,526	0,561[2]
Fort Beaufort[1]	31 700	1,200	1,680

[1] Data extracted from Reconciliation Strategies (DWA 2010b & DWA 2010c)

[2] Where full use is made of water transferred from the Fish River, the potential water resource in Bedford increases to 0.876 million m^3/a

In all three towns, projected growth rates are negative. However, even with positive growth rates projected, existing water resources are generally sufficient to meet future water requirements. Although it is clear that domestic water requirements are small relative to the potential yield of a major dam at the Foxwood site, it is noted that development of a dam would provide the opportunity to improve the assurance of supply to all three urban areas within close proximity of the Koonap River.

Industrial and commercial water requirements

There is no known historical record or future proposal for commercial or industrial use of water within the Koonap River Valley.

Irrigation water requirements

The WARMS database contains records for 4,03 million m^3/a of irrigation water abstractions from the Koonap River downstream of the Foxwood Dam site. Consultation with stakeholders through the convening of an Agricultural Technical Working Group has established that there is potential to develop further irrigation along the Koonap River downstream of Foxwood so long as there is a cost effective and reliable supply of water. Initial investigation suggests that the availability of irrigable land along the river exceeds the potential yields of an appropriately sized dam at the Foxwood site. However, following consultation with the Department of Rural Development and Land Reform and the Department of Agriculture, Forestry and Fisheries, there are currently no formal or commercial irrigation development proposals within the Koonap River Valley.

Although there is currently little demand that would require the construction of a major dam on the Koonap River, the Department of Water and Sanitation is investigating the feasibility of developing a multi-purpose dam at the Foxwood site for implementation as a strategic initiative to mobilize the water resources in the Koonap River as a stimulus for socio-economic development in this rural, economically depressed region.

Development of the Foxwood Dam would, in the first instance, provide additional, high assurance water supplies for domestic use in Adelaide. The effective development of a major storage dam at the Foxwood site would also regulate the variable runoff in the Koonap River to the extent that, after full provision is made for maintaining the Reserve and for foreseeable domestic water requirements, a significant quantity of water would be made available at an appropriate level of assurance for irrigation development. It is this resource that would be mobilized, together with land and human resources in the region, to provide a stimulus for socio-economic development. This vision is assessed in the context of agricultural development, land reform and rural development policies within the framework of the National Development Plan (NDP).

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LIST OF ACRONYMS

ACRONYM	
ADM	Amathole District Municipality
Nxuba LM	Nxuba Local Municipality
WSA	Water Service Authority
AW	Amatola Water
WSP	Water Service Provider
DAFF	Department of Agriculture, Fisheries and Forestry
PSP	Professional Service Provider
SA	South Africa
WSDP	Water Services Development Plan
UWP	UWP Consulting (Pty) Ltd
WTW	Water Treatment Works

LIST OF UNITS

MEASURE	UNIT
Volume (storage)	m^3, million m^3
Yield, use, requirements	million m^3/a, Ml/d, l/s
Percentage	%

1. INTRODUCTION

The Department of Water and Sanitation is carrying out an investigation into the feasibility of developing a multi-purpose dam on the Koonap River outside of Adelaide in the Eastern Cape. The proposed site is known as the Foxwood Dam site. Investigations into the potential development of the water resource within the Koonap River Valley date back to the 1960's. The project is once again being considered due to the potential for the development of the water resource in this area to provide stimulus for development in the region in line with the objectives of the National Development Plan and the National Water Resource Strategy 2. Development of a dam at the Foxwood Dam site could provide additional assurance of water supply to improve resilience of domestic water supply within the region. In addition, development of a dam at the Foxwood site could provide additional assurance of supply of water for irrigation development in the region which may provide stimulus for socio-economic development when combined with agriculture and land reform policies.

The Foxwood Dam site is located immediately upstream of Adelaide (coordinates 32˚40'30"S, 26˚16'0"E) in the Koonap River catchment shown in Figure 1 below. The Koonap River catchment has a catchment area of 3 334 km², is situated in the Eastern Cape Province and lies within the Fish to Tsitsikamma Water Management Area (WMA).

The location of Foxwood Dam within the context of Adelaide is shown in Figure 2. Adelaide is located within Nxuba Local Municipality (Nxuba) within the Amathole District Municipality (ADM). ADM is the Water Service Authority (WSA) responsible for water services in Nxuba and Amatola Water (AW) is the Water Service Provider (WSP).

1.1 Objectives of the Water Requirements report

Prior to the decision to invest very large capital sums in the construction of a major dam, it is necessary to determine the current and projected requirement for water that would be supplied by the dam. To this end, the requirement for water in the immediate vicinity of the proposed dam site, outside Adelaide, is assessed in this Water Requirements report as well as the requirement for water in the wider potential supply area in and around the Koonap River Valley.

A 30-years projection has been used for the estimation of future domestic water requirements for Adelaide.

1.2 Structure of the report

The Water Requirements report is structured into the following main sections

- **Existing water requirements and water supply infrastructure in Adelaide** – an assessment of the existing water requirements in and around the Koonap River Valley and overview of the existing water supply infrastructure that supplies these areas.
- **Projected future water requirements in Adelaide** – an assessment of likely population growth and associated change in water requirements.
- **Projected future water requirements and existing water resources in Bedford and Fort Beaufort**
- **Non-domestic water requirements** – an assessment of non-domestic water requirements in Adelaide and along the Koonap River, namely for Industrial and commercial water use and irrigation water use.

It is noted that the Ecological Water Requirements pertaining to the Reserve are addressed in the Water Resources report of the Feasibility Study (DWS, 2015).

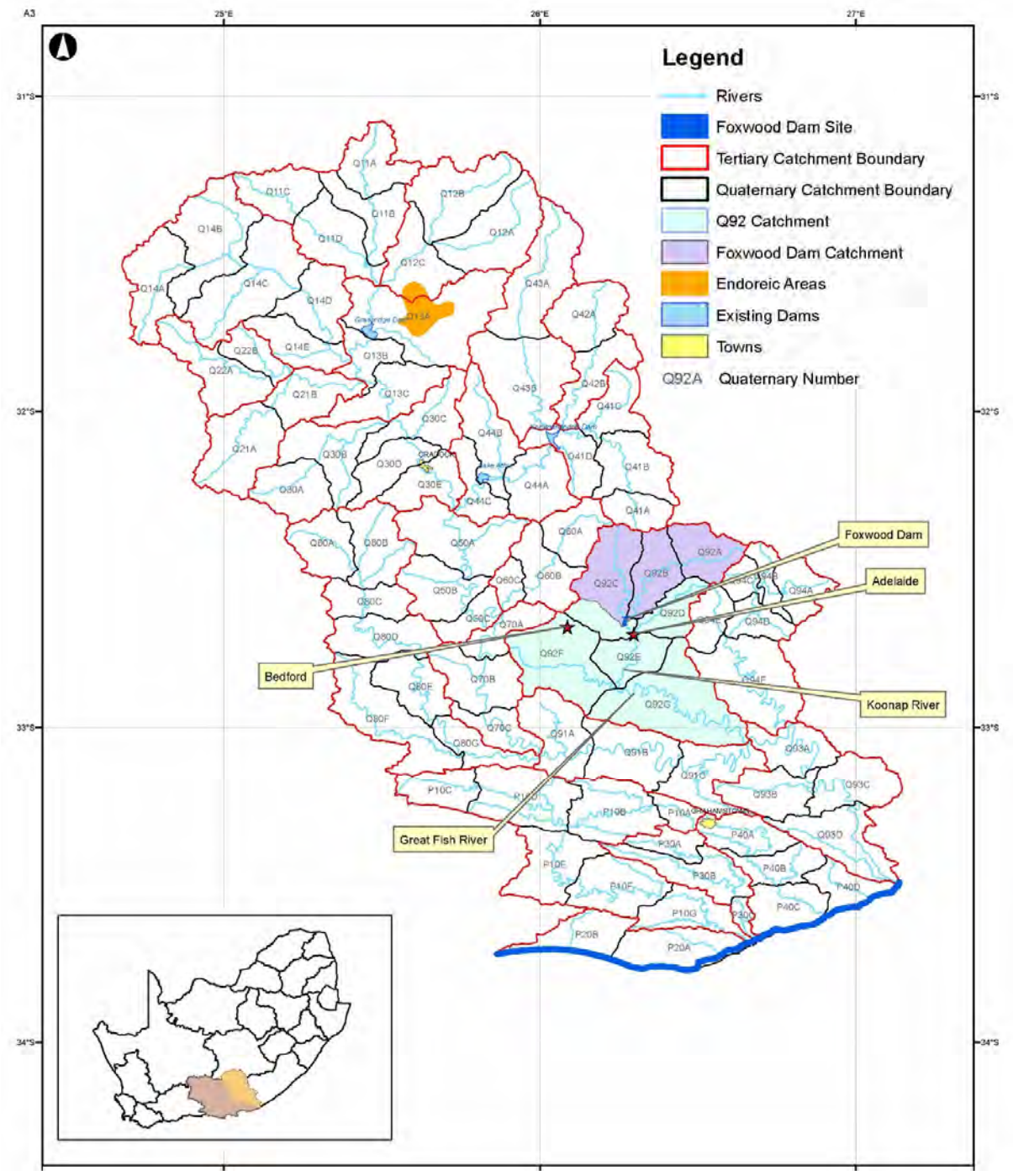

Figure 1: Fish River Catchment with Koonap Sub-catchment

2. DOMESTIC WATER REQUIREMENTS

2.1 Domestic water requirements in and around the Koonap River Valley

The Koonap River catchment is rural in nature with farming the main activity. There is some irrigation, which is mostly run of river abstractions, and some cattle farming. The urban centres of Adelaide and Bedford are located in the catchment. Adelaide's primary source of water is a run-of-river abstraction to an existing off-channel storage dam, supported by groundwater and a transfer scheme from the Fish River (via Bedford). Bedford is supplied via the Andrew Turpin dam with support from Fish River transfers. Fort Beaufort, although located outside of the Koonap River catchment, is a large urban centre which could be considered for supply from a dam at Adelaide should water requirements require this as Adelaide. Refer to Figure 2.

The assessment of water requirements and water resources in Bedford and Fort Beaufort have taken into account information from the All Towns Reconciliation Strategies in the first instance along with information from other recently carried out water resource studies. (The Reconciliation Strategies for Adelaide, Bedford and the Kat River Valley are provided in Appendix C for reference) The same approach has been taken for Adelaide along with a new assessment of population trends and associated domestic water requirements.

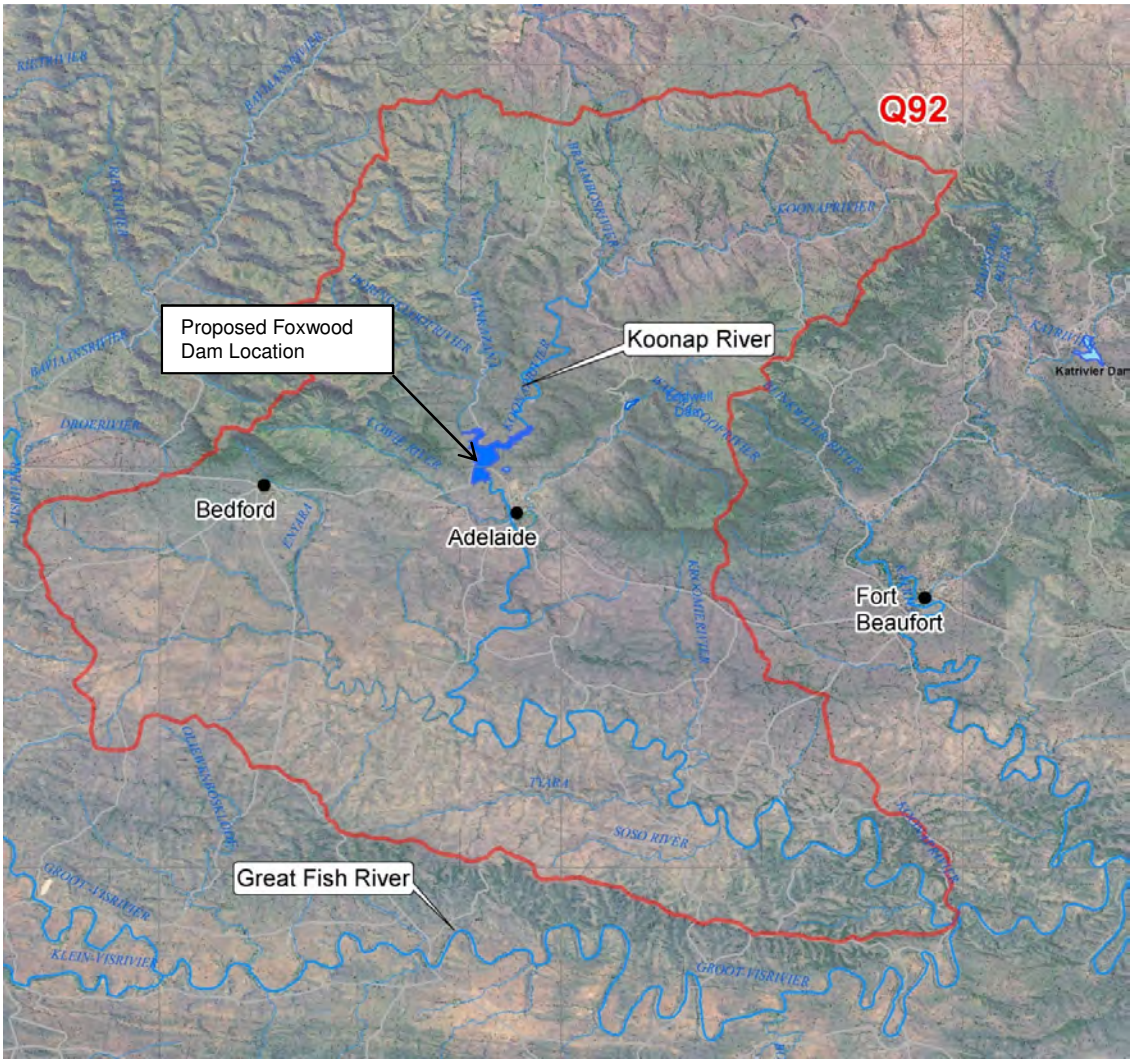

Figure 2: Koonap River Valley showing Adelaide, Bedford and Fort Beaufort

2.2 Domestic water requirements and water resources in Adelaide

Water Resources

Adelaide's primary water source is from the Koonap River via the abstraction weir that supplies an existing dam located to the north of Adelaide. The existing Adelaide Dam has an estimated historic firm yield of 0,7 million m^3/a based on approximately 90 years of records. The supply from the dam is backed up by a municipal borehole which is estimated to have a yield of 0,1 million m^3/a and an extension to the Fish River transfer pipeline to Bedford. The gravity pipeline from Bedford to Adelaide has a maximum capacity of 0,315 million m^3/a.

The total assumed current available water resource for Adelaide is therefore estimated to be **1,115 million m^3/a.**

A detailed review of the existing water supply infrastructure for Adelaide has been carried out as part of this feasibility study and is recorded in the *Feasibility Study for Foxwood Dam Alternative Supplies Report* (DWA, 2015). In this report it is noted that with an increase in capacity of the existing Adelaide dam from 0,7 million m^3 to 1,1 million m^3, the yield of the system could be increased by approximately 0,2 million m^3/a. The report also estimates that there is realistic groundwater potential in the Adelaide area of 1,2 million m^3/a.

Projected population change

For the purpose of calculating water requirements in the Adelaide area, a review of the urban population in the vicinity of Adelaide was carried out. This was based on the zoning of Adelaide and its surrounding urban developments by the Municipal Demarcation Board and Stats SA. The Municipal Demarcation Board have divided Adelaide and its surrounding areas into six different areas. The six areas are as depicted in Figure 3 below: Adelaide, Adelaide Urban, Lingelethu, New Lingelethu, Old Lingelethu and Bezuidenhoutville.

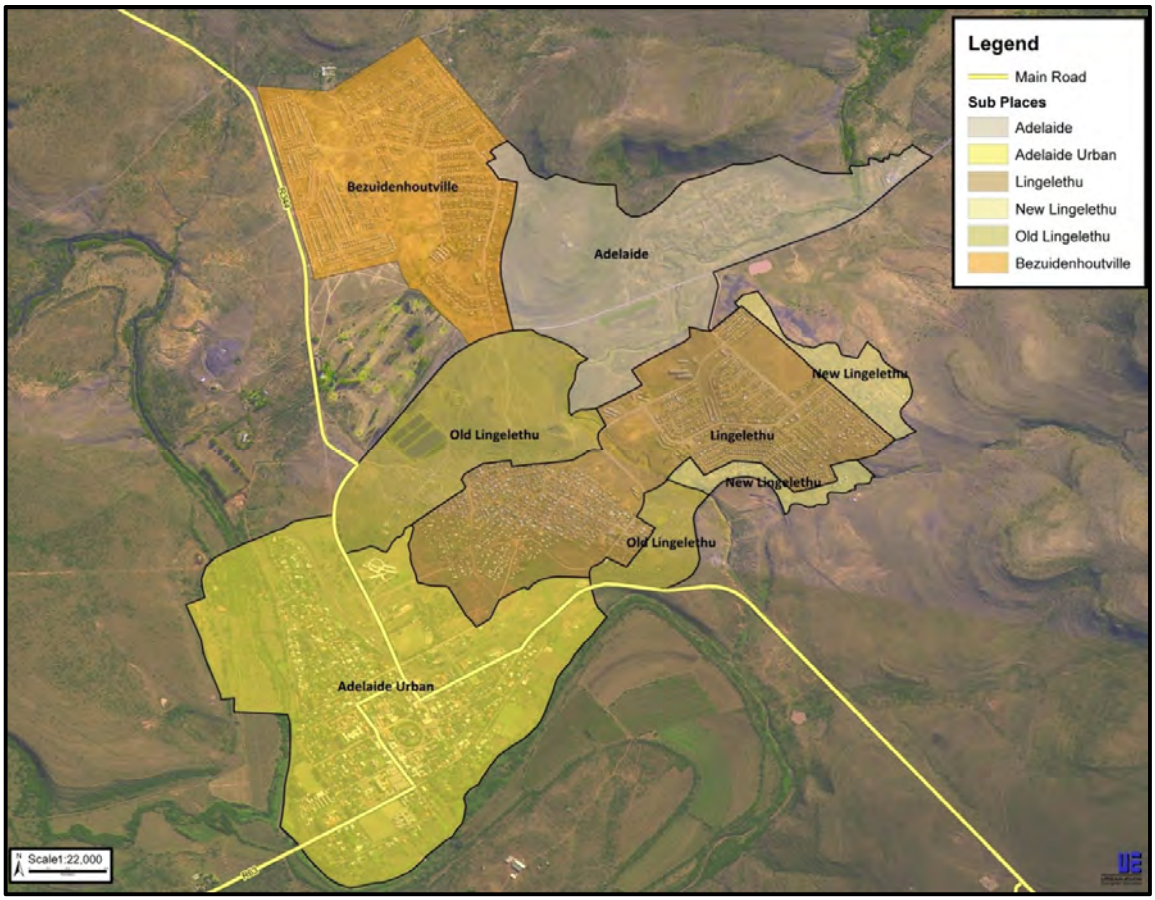

Figure 3: Adelaide sub-areas demarcation

Existing and projected populations for the six sub-places were derived from a comparison of 2001 and 2011 census data. At the time of reporting the historical growth rate of sub-places from the 2011 Census results at a sub-place level have not yet been released, therefore for the purpose of estimating population growth in Adelaide, the average deduced growth rate in Nxuba has been applied to the Adelaide sub-places. Based on Population Census, the following stats for Nxuba are recorded:

Population 2011 = 24 262
Population 2001 = 24 824

This equates to a growth rate of -0,2% between 2001 and 2011 for Nxuba LM. A meeting was held with ADM and Amatola Water (AW, water service provider to ADM) to review these findings and it was agreed that a realistic population growth rate for Adelaide for modelling purposes should be 0%.

For the purpose of context and comparison, water requirements for population growth rates of -0,5%, 1% and 2% were also estimated. A projection period of 30 years from 2018 to 2048 was used.

Table 2: Adelaide population projections

StatsSA Growth Scenario	Projected Adelaide Population							
	2013	2018	2023	2028	2033	2038	2043	2048
-0,2% (actual)	10 714	10 607	10 502	10 397	10 293	10 191	10 089	9 989
0,5%	10 714	10 985	11 262	11 546	11 838	12 137	12 443	12 757
1,0%	10 714	11 261	11 835	12 439	13 073	13 740	14 441	15 177
2,0%	10 714	11 829	13 060	14 420	15 920	17 577	19 407	21 427

Projected water requirements

To estimate future water requirements for Adelaide, requirements have been allocated to the sub-areas shown in Figure 3 above. The typical water requirement for each sub-area is provided in Table 3 below.

Table 3: Typical water requirements per capita based on different development level

Area	Water Requirements Calculation Assumptions				
	Assumed development levels	Redbook Values (l/p/d)	Summer Peak Factor	15% Losses through Infrastructure	Total Requirements (l/p/d)
Adelaide (Urban)	High	250	1,2	1,15	345
Bezuidenhoutville	Moderate to high	130	1,2	1,15	179
Lingelethu	Moderate to high	130	1,2	1,15	179
New Lingelethu	Moderate to high	130	1,2	1,15	179
Old Lingelethu	Moderate to high	130	1,2	1,15	179
Adelaide	Moderate to high	130	1,2	1,15	179

Adelaide urban is assumed to have the potential for a ‘high’ development level. All other sub-areas are assumed to have the potential for a ‘moderate’ to a ‘high’ development level. These requirements account for an appropriately developed service delivery level including water-borne sanitation. The projected water requirements are provided in Table 4.

ADM noted that current losses in the water supply system are estimated at around 25%, however this is not considered acceptable by DWS and a figure of 15% has been agreed for modelling purposes. This also reflects the obligation for ADM to demonstrate a commitment to Water Conservation and Demand Management before investment would be made in a project such as Foxwood Dam to augment domestic water supplies. A full breakdown of the projected population calculations is provided in Appendix A and B.

For reference, a copy of the Reconciliation Strategy for Adelaide (DWA, 2010a) is provided in Appendix C

Table 4: Projected water requirements for Adelaide based on various growth scenarios.

StatsSA Growth Scenario	Projected Annual Water Requirements (million m^3/a)							
	2013	2018	2023	2028	2033	2038	2043	2048
-0,2% (actual)	0,78	0,77	0,76	0,76	0,75	0,74	0,73	0,73
0,5%	0,78	0,80	0,82	0,84	0,86	0,88	0,91	0,93
1,0%	0,78	0,82	0,86	0,91	0,95	1,00	1,05	1,11
2,0%	0,78	0,86	0,95	1,05	1,16	1,28	1,41	1,56

Due to irregular and inconsistent metering at the Adelaide water treatment works, it has not been possible to determine reliable current water requirements for comparison with the projected requirements based on population and typical consumption. However, in February 2014, ADM published a report (ADM, 2014) including summaries of water flow data at the water treatment works and water storage reservoirs. Although the data is irregular and inconsistent, it is apparent that current end user requirements is approximately 1 600 m^3/day which equates to approximately 0,584 million m^3/a.

It is noted that in some areas of Lingelethu and Bezuidenhoutville water borne sanitation has not been installed/connected and that there is a housing backlog of approximately 1000 houses. This may explain the lower measured requirements compared to the projected requirements based on population projections and typical consumption.

For the purpose of design of water supply infrastructure associated with the proposed Foxwood Dam, a 0% growth projection has been assumed with a resulting water requirement of 0,78 million m^3/a for Adelaide. However, for context and comparison, water requirements resulting from 0,5%, 1% and 2% annual growth rates have also been estimated and compared to existing water resource development in Adelaide.

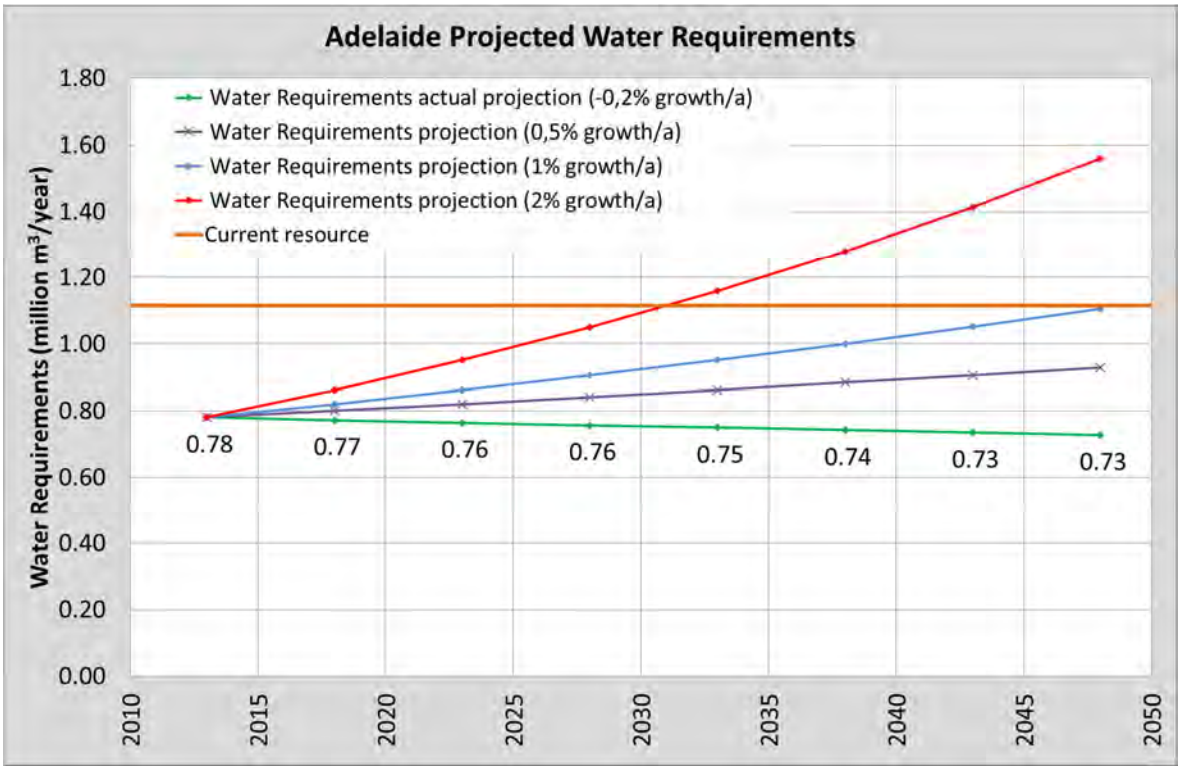

Figure 4: Graph showing projected Adelaide water requirements growth scenarios and existing water resource capacity

It is noted that even with significant growth in population, existing water resource infrastructure is capable of meeting possible water requirements for a significant time period into the future. **The status and yield of the existing water supply infrastructure is discussed in detail in the *Feasibility Study for Foxwood Dam Alternative Supplies Report* (DWA, 2015).**

2.3 Domestic water requirements and water resources in Bedford

Bedford lies approximately 20 km to the west of Adelaide. According to the Reconciliation Strategy for Bedford (DWA, 2010b), Bedford's population was 13 250 in 2007 with a growth rate of -0,29% (derived from the WSDP, based on StatsSA population estimates between 2004 and 2015. The resulting annual bulk water requirement is estimated as **0,526 million m^3/a** with an estimated requirement per capita of 108 l/p/day.

The primary water source for Bedford is the Andrew Turpin Dam which has a catchment of about 4,8 km^2 and 1:50 year assured yield of 0,27 million m^3/a. Bedford also receives water from the Fish River via a transfer pipeline scheme. The registered legal transfer is for 0,25 million m^3/a although the pipeline has recently been upgraded to have a capacity of 0,48 million m^3/a. Allowing for full supply to Adelaide form the Fish River scheme – limited to 0,315 million m^3/a by the size of the gravity pipe from Bedford to Adelaide leaves 0,165 million m^3 available to Bedford. Boreholes have also been established in the town for emergency back-up supply with a yield of 0,126 million m^3/a. Combining the full capacity of the three existing supply options, Bedford's total water resource is estimated at **0,561 million m^3/a**. This is a conservative figure as it assumes that full use is made of the potential to supply water to Adelaide from the Fish River Pumping Scheme. In the event that Adelaide no longer has any reliance on the transfer from the Fish, full water resource in Bedford would be **0,876 million m^3/a**

The above water requirements and water resource figures are summarised in Figure 5 below. In line with the Reconciliation Strategy, water requirements based on 1% and 2% growth have been illustrated in addition to the currently projected growth rate of -0,29%.

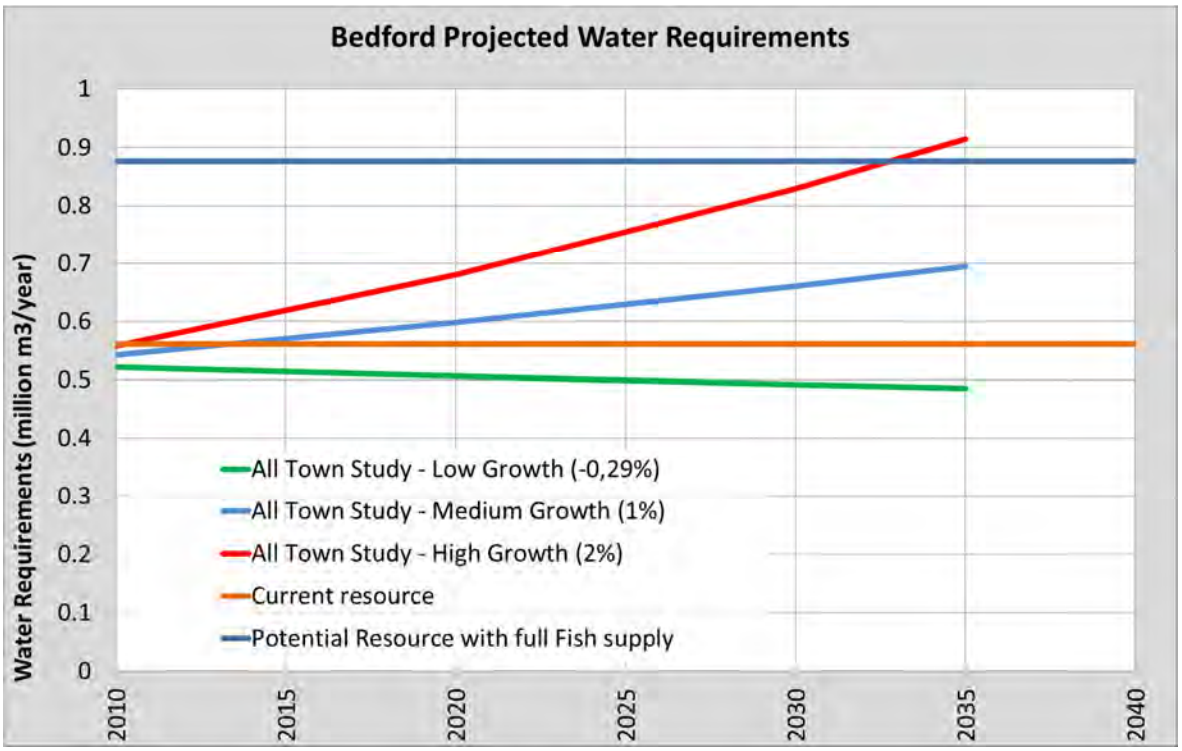

Figure 5: Graph showing probable Bedford water requirements growth scenarios and existing water resource capacity

In summary, the existing water supply infrastructure has adequate capacity to supply likely future water requirements in Bedford. In line with the objectives of the National Water Resource Strategy, maximum use should be made of existing water supply infrastructure before additional capital expenditure is spent on new infrastructure; the development of a dam at Foxwood is not necessary to meet the likely future water requirements of Bedford.

The assessment of the current water resource for Bedford is conservative as it assumes that the full capacity of the gravity pipeline from Bedford to Adelaide is used to transfer water from the Fish River to Adelaide.

In the event that a dam is constructed at Foxwood, there would be no need to transfer water from Bedford to Adelaide, allowing full utilization of the water from the Fish River in Bedford. In addition, it should be noted that, subject to water allocation review and meeting other need from the yield from the dam, it may be preferable to transfer water from the proposed Foxwood Dam to Bedford in place of the water transfer from the Fish to Bedford. This is primarily due to the probable better quality of the Foxwood Dam water compared to the high silt load of the Fish River water.

2.4 Domestic water requirements and water resources in Fort Beaufort

Fort Beaufort is located approximately 35 km to the east of Adelaide, within Nkonkobe Local Municipality. According to the WSDP, Fort Beaufort has a population of 31 700. Fort Beaufort sits within the Kat River catchment. According to the Reconciliation Strategy for the Kat River Valley (DWA,2010c) the water requirements within the Kat River valley (primarily the towns of Seymour and Fort Beaufort as well as smaller villages) is estimated as **1,2 million m^3/a**. The primary source

of water within the Kat River valley is the Kat River Dam located near Seymour. The allocated yield for domestic use from the dam is **1,68 million m³/a**. However, in a study commissioned by ADM (ADM, 2011) the actual abstractions for domestic use are estimated to be **3,04 million m³/a**. Allowing for the full irrigation water allocation and the estimated actual domestic water abstraction from the dam, there remains approximately **1,20 million m³/a** of unallocated water in the dam. These figures are illustrated in Figure 6 below. The available resource is assumed to be the full yield of the dam less the allocated irrigation abstraction. Therefore the assumed available source for domestic use is estimated as 1,20 million m³/a in addition to the 3,04 million m³/a estimated current actual domestic extraction giving a total of 4,24 million m³/a. Full details of the Kat River Dam are given in the Nkonkobe Water and Sanitation Master Plan (ADM, 2011)

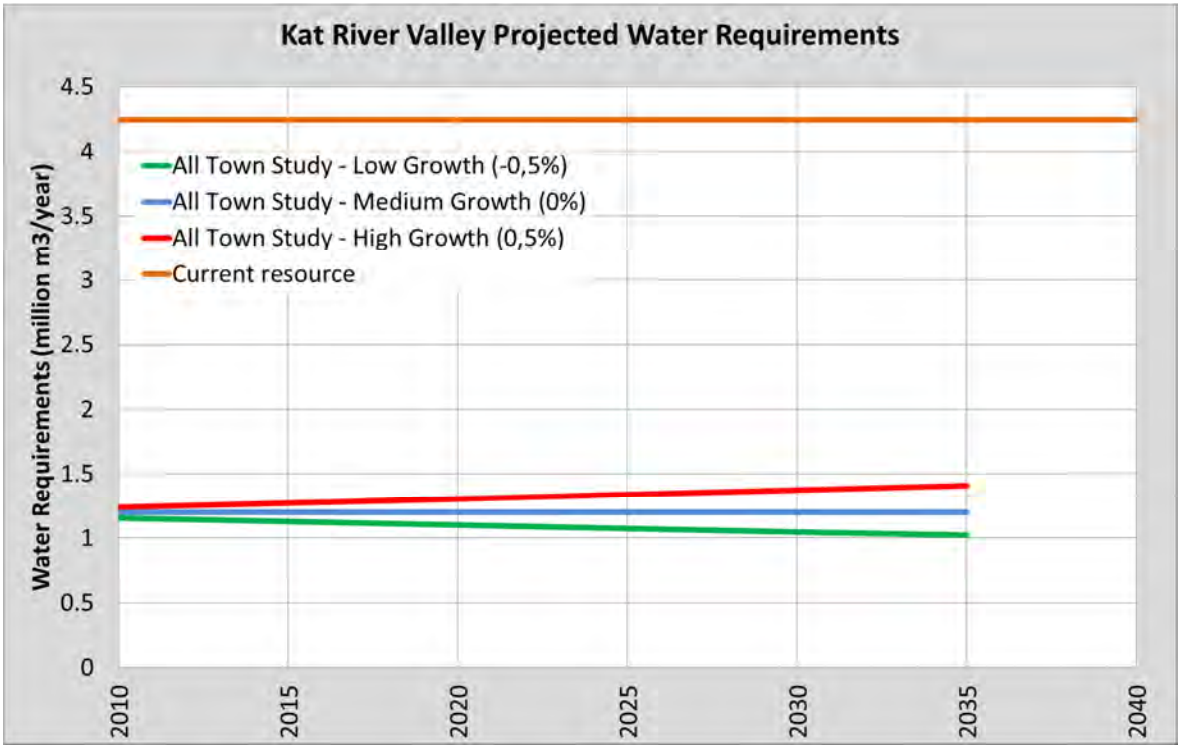

Figure 6: Graph showing probable Fort Beaufort water requirements growth scenarios and existing water resource capacity

Similarly to Bedford, it is noted that the existing water resources are greater than current and likely future water requirements. It is unlikely that there will be a requirement in the future to supplement water resources in the Kat River Valley.

2.5 Summary of domestic water requirements

As discussed in the section above, in general the probable future water requirements within the towns of Adelaide, Bedford and Fort Beaufort can be met by the existing water resource developments and water supply infrastructure in the different locations. However, in the event that a major dam is developed at the Foxwood site, such a development would provide the opportunity for more strategic overall water allocation review within the Koonap River Valley that will result in improved resilience of supply, especially during drought periods.

Nevertheless, it is noted that the domestic requirements of Adelaide, Bedford and Fort Beaufort are relatively small (estimated total annual requirements of 2,6 million m³/a) when compared to the likely yields of an appropriately sized dam on the Koonap River at the Foxwood site (a 1 MAR

dam would yield approximately 11,3 million m^3/a at 1:100 year assurance). Furthermore in the event that future growth in these areas results in water requirement that exceeds the existing developed water resource infrastructure. The shortages (i.e. imbalance) will be very small compared to the likely yields of an appropriately sized dam on the Koonap River at the Foxwood site.

3. INDUSTRIAL AND COMMERCIAL WATER REQUIREMENTS

A review has been carried out of industrial and commercial water requirements in the Koonap River Valley based on the last two records of surface water resources in South Africa (WRC, 1990 and WRC 2008), however none were found. There has been no record of water abstraction for industrial use for the last 25 years and it is considered unlikely that there will be notable future commercial or industrial requirements developed.

Within the most recent Integrated Development Plan issued by Nxuba LM (Nxuba LM, 2013), no reference is made to significant industrial or commercial development.

4. IRRIGATION WATER REQUIREMENTS

The Koonap catchment is rural in nature with farming the main activity. There is some irrigation, which is mostly run-off-river abstractions and some cattle farming.

According to the WARMS database (mfeneT@dwa.gov.za; 9 December 2012) a total field area of 21,48 km^2 (2 148 ha) is registered as irrigation in the Koonap River catchment. The irrigation of crops occurs from a number of water sources. Of the total area registered, 93% is registered to surface water sources and 7% to groundwater sources. Most abstractions are from run-of-river sources (88%) with remaining abstractions from farm dams (5%). According to the WARMS database, there is 4,03 million m^3/a of registered allocated abstractions from the Koonap River downstream of the proposed Foxwood Dam site.

Historical information about irrigation was extracted from the WR90 and WR2005 studies (WRC, 1994; WRC, 2008). The declining trend in irrigation area within the Koonap River catchments is not unexpected. It has been noted, anecdotally, by farmers that irrigation development in the Koonap River Valley has been limited by the poor reliability of water supply.

Following consultation with stakeholders an Agricultural Technical Working Group was convened to identify the potential for agriculture development downstream of the proposed Foxwood Dam in the event of the construction of the dam. Out of this consultation, it was clear that there is both willingness and opportunity to develop irrigation downstream of the potential site so long as economically viable agricultural models can be established to pay for the cost of the water. There is sufficient irrigable land that could be developed and make use of the available yield from an appropriately sized major dam at the Foxwood site.

However, following consultation with officials from the Department of Rural Development and Land Reform and the Department of Agriculture, Forestry and Fisheries, it was confirmed that there are currently no proposed irrigation development proposals within the Koonap River Valley. Nevertheless, the project is being considered for implementation as a strategic initiative to mobilize the water resources in the Koonap River as a stimulus for socio-economic development in this rural, economically depressed region. The assessment of the opportunity for irrigation development along the Koonap River downstream of the potential Foxwood Dam site is being carried out in detail within the Irrigation Development study that forms part of the feasibility study. This report will be published once completed and approved by DWS.

5. CONCLUSION

Domestic water requirements

As part of the feasibility study into the potential development of a major dam at Adelaide it is necessary to assess the current and future water requirements in the area. This report records the domestic, commercial & industrial and irrigation water requirements at Adelaide and along the Koonap River. Given the large expenditure required to develop a major dam, a high level review was also carried out of the water requirements and resources of Bedford and Fort Beaufort, two significant towns located within and immediately adjacent to the Koonap River Valley.

Data regarding the existing water resources and water requirements for Bedford, Fort Beaufort and Adelaide were extracted from the All Towns Reconciliation Strategies and assessed in comparison to the potential yield of a dam at the Foxwood site. A detailed review of probable population and water requirements growth in Adelaide was also carried out. It was generally found that the existing water resources in all three towns are adequate for meeting current and probable future domestic water requirements.

In addition, it was noted that the order of magnitude of the domestic requirements of Adelaide, Bedford and Fort Beaufort (0,85 million m^3/a, 0,53 million m^3/a, 1,2 million m^3/a, respectively) is small compared to the probable yield of an economically optimized dam design at the Foxwood site (a 1 MAR dam would yield approximately 11,3 million m^3/a at 1:100 year assurance) Nevertheless, it is noted that in the event that a major dam is developed at the Foxwood site, there would be the opportunity to improve the assurance of supply of domestic water to all three areas.

Industrial and commercial water requirements

There is no known historical record or future proposal for commercial or industrial use of water within the Koonap River Valley.

Irrigation water requirements

The WARMS database contains records for 4,03 million m^3/a of irrigation abstractions from the Koonap River downstream of the Foxwood Dam site. Consultation with stakeholders through the convening of an Agricultural Technical Working Group has established that there is willing to develop further irrigation along the Koonap River downstream of Foxwood so long as there is a cost effective and reliable supply of water. Initial investigation suggests that the availability of irrigable land along the river exceeds the potential yields of an appropriately sized dam at the Foxwood site.

Water requirements for Foxwood Dam

It is apparent that the only significant requirements for water that could justify the construction of a dam of a size suitable for the Foxwood site would be for irrigation development. However, following consultation with officials from the Department of Rural Development and Land Reform and the Department of Agriculture, Forestry and Fisheries, there are currently no proposed irrigation development proposals within the Koonap River Valley. Therefore the determination of a realistic irrigation water requirement is subject to the establishment of economically viable agricultural models. To this end, a detailed study into the potential for irrigation development is being carried out as a separate part of this feasibility study.

Although there is currently little demand that would require the construction of a major dam on the Koonap River, the Department of Water and Sanitation is investigating the feasibility of developing a multi-purpose dam at the Foxwood site for implementation as a strategic initiative to

mobilize the water resources in the Koonap River as a stimulus for socio-economic development in this rural, economically depressed region.

Development of the Foxwood Dam would, in the first instance, provide additional, high assurance water supplies for domestic use in Adelaide. The effective development of a major storage dam at the Foxwood site would also regulate the variable runoff in the Koonap River to the extent that, after full provision is made for maintaining the Reserve and for foreseeable domestic water requirements, a significant quantity of water would be made available at an appropriate level of assurance for irrigation development. It is this resource that would be mobilized, together with land and human resources in the region, to provide a stimulus for socio-economic development. This vision is assessed in the context of agricultural development, land reform and rural development policies within the framework of the National Development Plan (NDP).

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APPENDIX A: ADELAIDE POPULATION PROJECTIONS

Area	Population StatsSA actual projection (-0,2 %/a growth)							
	2013	**2018**	**2023**	**2028**	**2033**	**2038**	**2043**	**2048**
Adelaide (Urban)	1 303	1 290	1 277	1 264	1 252	1 239	1 227	1 215
Bezuidenhoutville	2 052	2 032	2 011	1 991	1 971	1 952	1 932	1 913
Lingelethu	5 941	5 882	5 823	5 765	5 708	5 651	5 595	5 539
New Lingelethu	673	666	660	653	647	640	634	627
Old Lingelethu	634	628	621	615	609	603	597	591
Adelaide	111	110	109	108	107	106	105	103
Total Population	**10 714**	**10 607**	**10 502**	**10 397**	**10 293**	**10 191**	**10 089**	**9 989**

Area	Population StatsSA (1%/a growth)							
	2013	**2018**	**2023**	**2028**	**2033**	**2038**	**2043**	**2048**
Adelaide (Urban)	1 303	1 369	1 439	1 513	1 590	1 671	1 756	1 846
Bezuidenhoutville	2 052	2 157	2 267	2 382	2 504	2 632	2 766	2 907
Lingelethu	5 941	6 244	6 563	6 897	7 249	7 619	8 008	8 416
New Lingelethu	673	707	743	781	821	863	907	953
Old Lingelethu	634	666	700	736	774	813	855	898
Adelaide	111	117	123	129	135	142	150	157
Total Population	**10 714**	**11 261**	**11 835**	**12 439**	**13 073**	**13 740**	**14 441**	**15 177**

Area	Population (2%/a Growth)							
	2013	**2018**	**2023**	**2028**	**2033**	**2038**	**2043**	**2048**
Adelaide (Urban)	1 303	1 439	1 588	1 754	1 936	2 138	2 360	2 606
Bezuidenhoutville	2 052	2 266	2 501	2 762	3 049	3 367	3 717	4 104
Lingelethu	5 941	6 559	7 242	7 996	8 828	9 747	10 761	11 881
New Lingelethu	673	743	820	906	1,000	1 104	1 219	1 346
Old Lingelethu	634	700	773	853	942	1 040	1 148	1 268
Adelaide	111	123	135	149	165	182	201	222
Total Population	10 714	11 829	13 060	14 420	15 920	17 577	19 407	21 427

APPENDIX B: BEDFORD AND FORT BEAUFORT WATER REQUIREMENTS PROJECTIONS

All Towns Reconciliation Strategy – Bedford Water Requirements (million m^3/a)	2010	2020	2030	2035
All Town Study - Low Growth (-0,29%/a)	0,521	0,506	0,492	0,485
All Town Study - Medium Growth (1%/a)	0,542	0,598	0,661	0,694
All Town Study - High Growth (2%/a)	0,558	0,68	0,829	0,915

All Towns Reconciliation Strategy - Kat River Valley Water Requirements (million m^3/a)	2010	2020	2030	2035
All Town Study - Low Growth (-0,5%/a)	1,157	1,1	1,046	1,02
All Town Study - Medium Growth (0%/a)	1,198	1,198	1,198	1,198
All Town Study - High Growth (0,5%/a)	1,241	1,304	1,371	1,405

Data extracted from Reconciliation Strategies (DWA 2010b & DWA 2010c)

APPENDIX C: RECONCILIATION STRATEGIES FOR ADELAIDE, BEDFORD AND FORT BEAUFORT

Reconciliation Strategy for Adelaide

Nxuba LM	
Amathole DM	**[WSA]**
Eastern Cape Province	
Fish to Tsitsikamma WMA	
Q92C/D/E Quaternary	
None	**[WUA]**
Medium intensity level Strategy	

Context

The small town of Adelaide lies 37 km west of Fort Beaufort, on the R63 between Bedford and Fort Beaufort, and nestles in the foothills of the Winterberg Mountain range, in the heart of the Eastern Cape Midlands.

Adelaide serves as an administrative and decision-making centre in the region. It is predominantly a farming town, complemented with beef, mutton, wool and citrus farming district, and is situated in an eco-tourist centre, surrounded by the countryside, a spectacularly rich bird life, fine examples of rock art, a rich diversity of flora and fauna, and access to a number of game reserves and game farms. The surrounding areas for Adelaide have significant agricultural use, mainly for cattle, sheep, and mohair goat farming. The predominant crop in the area is lucerne.

This strategy includes the water supply area that is currently supplied by the Adelaide Water Treatment Works, which includes the urban area of Adelaide and the townships of Bezuidenhoutville and Lingelethu. The population data available in the Amathole DM WSDP reflects a population for Adelaide of 10 500 for 2007. However, a current report for the expansion of the WWTW (KweziV3, 2007) is based on a population of 23 047 (on 3881 erven).

Adelaide falls under the Nxuba Local Municipality, but the Amathole District Municipality is the Water Services Authority (WSA) responsible for the provision of water services to Adelaide.

[Please refer to Figure 1, Locality map in the Appendix]

Executive Summary

Opportunities/ Problems / Challenges

Adelaide obtains its water from a scheme in which water is diverted from the Koonap River into an off-channel storage dam with a capacity of 0.7 million m³. The storage dam has a yield of approximately 1.09 million m^3/a. This is the main source currently supplying Adelaide, and the town regularly experiences minor shortfalls during the dry summer months because of the limited storage and uncontrolled pumping by agricultural users from the river. A pipeline was build from Bedford to Adelaide to augment the supply. The full capacity of the pipeline is about 10 l/s, equalling 0.315 million m^3/a.

The water requirements are stated in the WSDP as 800 kl/d at the end-user level and 1 992 kl/d or 0.727 million m^3/a at the source. The report by Kwezi V3 (2007) assumes end-user water requirements of 2 171 kl/d. However, this does not match the metered bulk consumption, as stated in the WSDP. Hence, it is assumed that the gross requirement is currently in the order of 2 000 kl/d.

Approximately 27 km^2 of land in the vicinity of Adelaide is irrigated directly from the rivers or from farm dams. The abstraction from the river during low flow periods put additional strain on the supply to Adelaide.

Based on the figures, given in the WSDP, the water losses for the town are very high (unaccounted-for water in the order of 60%), and there are no current plans or targets for reducing unaccounted for water

and water inefficiencies. Asset management, a water conservation strategy and Operation and Management plans are needed to minimise leakage losses.

The sewerage treatment works consists of six oxidation ponds and an aerated lagoon with a total volume of 2795 m³, which covers an area of 3.44 ha. The total capacity of the sewerage treatment works is 380 kl/day. The WWTW poses potential health problems as it is situated at approximately 100m from the township of Lingelethu. Although not policy, an 800m buffer is recommended between residential development and oxidation ponds for treatment of sewerage. The WWTW is currently overloaded and needs to be upgraded to cater for current inflow and any future development in the area.

The town has suffered serious water shortages during the last years and especially during the recent drought situation. However, based on the assumptions and calculations, stated above, the yield of the supply sources is sufficient for the current water requirements.

Recommendations

Depending upon the data set used for evaluation, the current yield seems to be sufficient to support growth in the town for all the proposed scenarios, but this existing source is not reliable during the dry months or drought periods. If the end-user water requirements are higher (see above) and the yield of the off-channel-storage dam is only 0.4 million m^3/a, water shortages are expected now and these will increase by 2035 to 0.26 million m^3/a under the medium growth scenario and 0.566 million m^3/a under the high growth scenario.

Alternative sources need to be considered to augment the current water supply. These should be considered in line with the intervention of reducing water losses significantly in the town, hence focussing on local sources. The following interventions are proposed as potential sources to augment the current water supply:

- Reduce water losses in bulk supply infrastructure
- Groundwater development
- Re-use of water for domestic supply

There is a possibility for high yielding boreholes which should be investigated and developed. This will bridge both seasonal shortage problems and drought periods.

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Signatures			
Place, Date	.....	Place, Date	.....
Signature	_____	Signature	_____
Name	.....	Name	.....
Designation	Municipal Manager	Designation	Area Manager
Institution	Municipality, WSA	Institution	DWA Regional Office
Prepared by: Umvoto Africa (Pty) Ltd. P.O. Box 61 – Muizenberg – 7950 Tel. 021 788 8031 UMVOTO		Place, Date Signature Name Designation Institution	..... _____ .....

1. Current Situation

a. Status Quo of Water Services

Date of information: 2007

Normal Population	10500
Current growth rate	-0.29%

Average Annual Daily Demand

	kl/d	l/c/d
End user	800	76
Bulk meter-WTW	1000	190

Peak Demand	
Peak Month ADD	4980 kl/d
Gross Annual Demand (Source)	
GAADD	1992 kl/d
Annual Bulk Water demand (GAAD)	0.727 Mm^3/a

Population / Consumer Profile

- The information about the population is derived from the following sources:
  - The population data available in the Amathola DM WSDP reflects a population for Adelaide of 10 500 for 2007, which is based on a projection of the 2001 Census information.
  - Population information available in the DWA Water Services Report tool reflects a total population of 10 641 for the urban town of Adelaide and the townships Bezuidenhoutville and Lingelethu.
  - A current report for the expansion of the WWTW (KweziV3, 2007) is based on a population of 23 047 (on 3 881 erven). A current count of erven on Google Earth indicated 3 453 (S Nash, pers. comm., 2009).
  - For the purposes of this study, the WSDP data have been used and projected till 2035. The population data includes the town and surrounding townships of Bezuidenhout and Lingelethu.
- The estimated population growth rate is -0.29% as derived from the WSDP, and is based on StatsSA population estimates between 2004 and 2005 as calculated from community's level.
- The estimated water requirements listed in the table alongside include provisions for domestic and commercial use, system water losses and unaccounted-for water (UAW).
- The housing backlog for Amathole DM is 28.3%, with a housing backlog of 1 105 units for Adelaide.

Economic drivers

- Adelaide is predominantly a farming town, complemented with beef, mutton, wool and citrus farming district.
- Adelaide is situated in an eco-tourist centre, surrounded by the countryside, a spectacularly rich bird life, fine examples of rock art, a rich diversity of flora and fauna, and access to a number of game reserves and game farms.

Assumptions

- The peak month factor is assumed to be 2.5 times the water demand. The peak month ADD was calculated by means of multiplying the current water requirements for Adelaide with the peak factor.

Service level information for Adelaide received from DWA Water Services Report tool (based on 2007 Community Survey) is as follows:

- Piped water inside dwelling – 53.3%
- Yard tap – 38.2%
- Communal standpipe, within 200m – 8.5%
- Below RDP level – 0%

Service level	Urban	53.3%
	RDP	38.2%
	informal	0.0%

The total unaccounted for water (UAW) between source and end user is calculated as 0.435 million m^3/a, which relates to 60 % total losses.

- Internal losses in the reticulation are assumed to be in the order of 20%.
- Bulk transmission losses are in the order of 50%.

Non Revenue Water	0.435 Mm^3/a
UAW (%)	60%
Internal losses	20%
Bulk transmission loss	50%

b. Water Resources

Date of information: 2007

Currently Allocated/Utilised Yield

- The Koonap River, with a catchment area of 3334 km^2 rises in the Winterberg Mountains where the mean annual precipitation is about 600 mm and flows into the lower reaches of the Great Fish River in a drier area (Q92G) where the mean annual precipitation is 466 mm.
- The town of Adelaide obtains its water from a scheme in which water is diverted from the Koonap River into an off-channel storage dam with a capacity of 0.7 million m³. The yield of the storage dam is given in the WSDP as 0.4 million m^3/a on page 67 and 1.09 million m^3/a on page 83. This is the main source currently supplying Adelaide, which is a major problem during the dry months (low flow periods).
- Approximately 27 km^2 of land in the vicinity of Adelaide is irrigated directly from the rivers or from farm dams. The abstraction from the river during low flow periods put additional strain on the supply to Adelaide.
- A pipeline was build from Bedford to Adelaide to augment the supply. The full capacity of the pipeline is about 10 l/s, equalling 0.315 million m^3/a.

Run-of-river	N/appl.
Reservoirs/dams	1.090 Mm^3/a
GW / boreholes	N/appl.
GW / springs	N/appl.
Bulk purchase	0.315 Mm^3/a
Effluent Reclamation	N/appl.
Leiwater	N/appl.
Raw Water Quality	
AAWS	**1.090 Mm^3/a**

c. Bulk and Reticulation Infrastructure

Raw water abstraction works and mains

- Adelaide bulk water supply comes from an off-channel storage dam in the Koonap River. Shortfalls are common as the water source is unreliable during the dry summer periods.
- The three areas (Adelaide Town and the townships Bezuidenhoutville and Lingelethu) make use of water stored in the three reservoirs located on each area. The capacity of the reservoirs is unknown.

Water Treatment Works

- There is no information available on the current WTW capacity. The WTW received a Blue Drop Score of 68% with a water quality compliance of 99%.

Abstraction capacity	1000 kl/d
Dam capacity	0.4 Mm^3
WTW capacity	1000 kl/d
Current utilization (2008)	N/av.
Drinking water quality	Good
Reservoir capacity	N/av.
State of infrastructure	N/av.

The reticulation network.

- Adelaide and Bezuidenhoutville are completely metered. Only 50% of the township of Lingelethu is served by a reticulation system.
- The reticulation network of the overall system is poor, and there are significant areas that need to be upgraded due to poor, old infrastructure.

State of infrastructure	Average to Poor

WWTW

- The sewerage treatment works consists of six oxidation ponds and an aerated lagoon with a total volume of 2795 m³, which covers an area of 3.44 ha. The total capacity of the sewerage treatment works is 380 kl/day. The WWTW poses potential health problems as it is situated at approximately 100m from the township of Lingelethu. Although not policy, an 800m buffer is recommended between residential development and oxidation ponds for treatment of sewerage.
- A total of four sewerage pump stations service the area, three in Adelaide and one in Bezuidenhoutville.
- The WWTW is currently overloaded and needs to be upgraded to cater for current inflow and any future development in the area.

WWTW capacity	380 Kl/d
Peak dry weather flow	N/av.
Effluent water quality	N/av.
Compliance, quality	N/av.
Discharged to	Koonap River
State of infrastructure	N/av.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
WTW not complying.	Upgrade WTW to ensure Blue Drop Status.	Amathole DM	2012
Insufficient information on the water reticulation network. UAW is high, assumed mainly to be a result of water losses.	Water Master Plan to be initiated for the study area.	Amathole DM	2010
WWTW at Adelaide poses environmental problems due to close proximity of residential area.	Sewer Master Plan to be initiated for the study area.	Amathole DM	2015

d. Legal Agreements

Type of authorization

- The abstraction from the Koonap River for Adelaide is registered in the WARMS database with a volume of 0.240 million m^3/a. This is significantly less than the yield of the off-channel storage dam of 1.09 million m^3/a.
- There is no information about the authorization of the WWTW and storage reservoirs.

Surface Water	**N/av.**
Registered abstraction	N/av.
Groundwater	
Registered abstraction	N/appl.
Storage	
Registered storage	N/av.
Leiwater system	N/appl.
Legality of water use	N/appl.
Effluent discharge	
WWTW (Operation)	N/av.
WWTW (Reclamation)	N/av.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Possible abstraction not registered.	Amend registration certificates and apply for a license for the full yield.	Amathole DM	2010

e. Institutional Arrangements

- A billing system is used and is promulgated by the municipality. According to the WSDP, 81% of the population is indigent, thus reasonable tariffs to all consumers of water must be established.
- There is currently no “official” water conservation and demand management strategy in place.
- Water losses are very high for the town, and there are no current plans or targets for reducing unaccounted for water and water inefficiencies. Asset management, a water conservation strategy and Operation and Management plans are needed to minimise leakage losses.
- No further information is currently available on Institutional arrangements.

Skills / Capacity	Yes
Pricing / tariff structure	Yes
WDM Strategy	No
Monitoring system	N/av.
Drought Management	No
Operation and Management plan	N/av.
Catchment Management Plan	N/av.
Social / political issues	N/av.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
No WDM strategy in place.	Develop and implement a formal WDM Strategy.	Amathole DM	2010
Investigate tariff structure.	Revisit pricing structure to ensure that the drivers of the marginal costs are being properly taxed.	Amathole DM	2012
No drought management plan in place.	Develop a drought management plan.	Amathole DM	2010
No Operation and Maintenance plan in place.	Develop and implement an Operation and Maintenance plan.	Amathole DM	2010

2. Future Requirements

a. Water Requirement Scenarios

- The estimated population growth rate for the Nxuba LM is -0.29% as derived from the WSDP. This is based on StatsSA population estimates between 2004 and 2005 as calculated from community's levels. This low rate is mainly driven by migration to bigger towns.
- Three different population growth scenarios are calculated:
  - Low scenario with – 0.29 % annual population growth,
  - Medium scenario with 1% annual population growth, and
  - High scenario with 2% annual population growth.

Population			
Year	**Low**	**Medium**	**High**
2007	10500	10500	10500
2010	10409	10818	11143
2020	10111	11950	13583
2030	9822	13200	16557
2035	9680	13874	18281

Developments:

- Adelaide was part of the Bucket Eradication Programme in 2008, which resulted in most people having access to water borne sanitation.
- There is a significant housing backlog in the town of approximately 1 105 units. However, there is no information available on plans to eradicate the backlog. The high-growth scenario accounts for future low income possible housing developments

Development plans	No
Service level change	No

- Three different water requirement scenarios were developed, based on population growth rates:
  - Low scenario with a – 0.29 % annual population growth,
  - Medium scenario with a 1% annual population growth, and
  - High scenario with a 2% annual population growth was assumed.
- In all scenarios it is assumed that there is no change in the split of service levels.
- Decrease in UAW is not taken into account in this calculation, but considered under Interventions (Section 2c).

GAAD (Mm^3/a)			
Year	Low	Medium	High
2007	0.727	0.727	0.727
2010	0.721	0.749	0.772
2020	0.700	0.827	0.941
2030	0.680	0.914	1.147
2035	0.670	0.961	1.266

[See Figure 3 in Appendix]

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Current population and water requirements uncertain.	Verify population figures and establish current water consumption through census and installation of bulk meters.	Amathole DM / Nxuba LM	2010
Growth rate for town uncertain.	Monitor water consumption and update growth scenarios regularly.	Amathole DM	Ongoing

b. Water Balance

- Based on the assumptions and calculations, stated above, the yield of the supply sources is sufficient for the current water requirements. However, it is known that shortages occur, as the water source is unreliable. The town has suffered serious water shortages during the last years and especially during the recent drought situation.
- Water shortages are only expected for the high-growth scenario, namely 0.057 million m^3/a by 2030 and 0.176 million m^3/a by 2035, as indicated in the first table alongside.
- However, if the end-user water requirements are much higher (see Section 1a) and the yield of the off-channel-storage dam is only 0.4 million m^3/a, as described in Section 1b, water shortages are expected now and these will increase by 2035 to 0.26 million m^3/a under the medium growth scenario and 0.566 million m^3/a under the high growth scenario.

Surplus (+)/ Shortfalls (-) Case 1 (Mm^3/a)

Year	Low	Medium	High
2007	0.363	0.363	0.363
2010	0.369	0.341	0.318
2020	0.390	0.262	0.149
2030	0.410	0.176	-0.057
2035	0.420	0.129	-0.176

Surplus (+)/ Shortfalls (-) Case 2 (Mm^3/a)

Year	Low	Medium	High
2007	-0.027	-0.027	-0.027
2010	-0.021	-0.049	-0.072
2020	0.000	-0.127	-0.241
2030	0.020	-0.214	-0.447
2035	0.030	-0.261	-0.566

[See Figure 4 in Appendix]

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Yield of the water source seasonal fluctuations.	Additional storage is needed to store water to be utilised in drought periods.	Amathole DM	2012

c. Interventions to reduce Water Demand

Measures to reduce Water Demand

- Currently, the UAW is in the order of 60% (see Section 1a) and assumed to be mainly losses in bulk infrastructure between the source and towns reservoirs.
- Water losses should be managed, specifically in the supply network to improve loss control. Attention should also be given to reticulation leaks, illegal connections, unmetered connections and internal pump leaks for reducing unaccounted for water and water inefficiencies.

WC/WDM	✓
Asset management	✓
Operation and management optimization	✓
Possible reduction	**35-40 %**

- WC/WDM principles should be implemented, specifically on water losses management to reduce actual losses. A survey of the actual bulk system inclusive of pipelines, pump stations and WTW is proposed, in order to identify problems areas and repair where possible.
- Focus should be placed on asset management and operation and maintenance optimization, with the aim that this will reduce the current water consumption by 2.5%.

d. Water Resource Availability – Potential

Re-use of water

- The table alongside presents the potential yield for re-use of water of the town.
- The provision of re-use of water as irrigation water to nearby farm holdings and for recreational properties is a feasible option. The WWTW needs to be upgraded before this option could be implemented.

Potential re-use of water available (Mm^3/a)

Year	Low	Medium	High
2007	0.509	0.509	0.509
2010	0.505	0.524	0.540
2020	0.373	0.441	0.501
2030	0.286	0.385	0.483
2035	0.282	0.405	0.533

Groundwater resources

The town of Adelaide is underlain by the Adelaide Subgroup within the Beaufort Group of the Karoo Supergroup. The Adelaide Subgroup consists of grey and brownish-red mudstone (80%); interspersed with fine-grained sandstone layers (20%). These form shallow inter-granular and weathered fractured rock aquifers. Dolerite intrusions are common in the area and the contact to a large inclined sill is at present 2-3 km northwest, north and northeast of the town. The contact zone of the intrusion is often highly fractured in the host rock (i.e. the Adelaide) making this zone the preferred groundwater target.

No groundwater use is reported in the WSDP or DWA Reference Frameworks. The WARMS database of registered usage has one entry registered to the Water Services Provider for a borehole supply. The registration is for 1 440 m^3/a. The location of the registration is within the town away from the dolerite sills to the north, suggesting that the borehole has not been sited in the position with the highest potential.

	Adelaide	**Dolerite**
Recharge	Q92C 18.2 Q92D 7.66 Q92E 6.41	Q92C 2.45 Q92D 0.99 Q92E 0.29
Use	Q92C 1.32 Q92D 0.40 Q92E 0.80	Q92C 0.21 Q92D 0.05 Q92E 0.00
Reserve	Q92C 3.00 Q92D 1.49 Q92E 0.00	
Quality	Fair	Good
Distance		

The potential of high yielding boreholes is supported by eight boreholes clustered around a meander in the Koonap River in the south of the town; one of which has a yield of above 15l/s, and two have yields of 10-15l/s. The remainder have yields of 0.5 - 4l/s. The high yields are possibly associated with the proximity to the Koonap River, alternatively a buried inclined sill (which outcrops to the south) has been successfully targeted. High yields are also given in the reference framework document which has one record of >10l/s.

The water quality of shallow inter-granular and weathered fractured rock aquifers is often poor with high salinity. The reference framework document gives an 'expected' borehole water quality as class 0 – ideal. The development potential for Adelaide is listed as definite.

Adelaide sits on the junction between three quaternary catchments, the boundaries of which do not correspond with the boundary of the aquifers. Groundwater recharge is given for these catchments however it is not possible to determine the groundwater potential of the Adelaide Subgroup aquifer which is available to Adelaide town. Is it recommended that drilling exploration commence in the Adelaide Subgroup close to the contact to the dolerite sills north of the town, and the possibility of targeting the buried sill beneath the town be assessed.

Surface water resources

- The mean annual precipitation (MAP) for the region is between 400 and 600 mm.
- Earlier studies have identified that the Koonap River is a suitable source for further augmentation, but additional storage is needed. This has included the option of the Foxwood Dam identified in the Water Situation Assessment studies carried out during 2002.
- There is also the possibility to relay water from the Fish River which presents one of the more realistic surface water options for Adelaide. This should be investigated in further detail, by looking at the Bedford supply as an option or another existing scheme of the Fish River.
- The possibility to relay water from the Orange River via Bedford has been indentified as a potential option in the Water Situation Assessment studies carried out during 2002. However, this is considered not feasible due to the competing demands on the Orange River and the associated costs.

Catchment(s)	**Q92C/D/E**
Catchment MAP	464–594 mm/a
Catchment MAR	16 – 46 mm/a
Rivers	
Koonap River	
Run-of-river MAR	N/av.
Reserve IFR	N/av.
Water quality	N/av.
Fish River	
Run-of-river MAR	N/av.
Reserve IFR	N/av.
Water quality	N/av.
Dams	
Dam yield (98% AoS)	N/av.
Currently allocated:	N/av.

Other potential sources

- Rainwater harvesting is a suitable option as part of a WCDM strategy to reduce water requirements at the end-user level.

Desalination	**N/appl.**
Rainwater harvesting	✓

Summary of potential sources

The following potential sources are available to augment the current water supply, if required:

- Groundwater development.
- Re-use of water for irrigation.
- Increase abstraction from Koonap River.

Water re-use	✓
Groundwater	✓
Surface water, local	✓
Water trading	**N/appl.**
Desalination	**N/appl.**
Rainwater harvesting	✓
Transfer schemes	✓
Total yield	**N/av.**

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Reduce bulk water losses.	Investigation to reduce losses, possibly a survey of the actual bulk system inclusive of pipelines, pump stations and WTW is proposed in order to identify problem areas and repair where possible.	Amathole DM	2010
River flow (MAR and yield) unknown of the Koonap River.	Compile / develop a Hydrology Assessment and Feasibility Study for further abstraction from this surface source. Investigate the possibility of the Foxwood Dam.	DWA	2012
Groundwater yield uncertain.	Hydrogeological reconnaissance and feasibility study, combined with exploration drilling, to determine the groundwater potential.	Amathole DM	2012

3. Reconciliation

Reconciliation Strategy

Depending upon the data set used for evaluation, the current yield seems to be sufficient to support growth in the town for all the proposed scenarios, but this existing source is not reliable during the dry months or drought periods.

Alternative sources need to be considered to augment the current water supply. These should be considered in line with the intervention of reducing water losses significantly in the town, hence focussing on local sources.

The following interventions are proposed as potential sources to augment the current water supply:

1. Reduce water losses in bulk supply infrastructure;
2. Groundwater development; and
3. Increase abstraction from Koonap River, in conjunction with increased storage facilities.

Water Demand Management	2010
Demand reduction	40%
Groundwater development	2010
Yield	0.25 Mm^3/a
Increase abstraction from Koonap River	2020
Yield	0.3 Mm^3/a

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule

References

Primary:

[1] Water Services Development Plan, Amatole District Municipality, May 2007, Amatole Water.

[2] Overview of Water Resources Availability and Utilisation, Fish to Tsitsikamma Water Management Area, (WMA No. 15), DWAF, September 2003.

[3] Integrated Development Plan (2007 – 2012), Nxuba Local Municipality.

[4] Water Resource Situation Assessment, Fish to Tsitsikamma Water Management Area, (WMA No. 15), DWAF, August 2002.

[5] Kwezi V3 (2007): ADM – Adelaide: Technical Report for the Expansion of the WWTW.

General:

[1] Internal Strategic Perspective for Fish to Tsitsikamma Water Management Area, (WMA No. 15), DWAF, February 2004.

[2] Urban Dynamics, 2003, Nxuba Municipality IDP (Intergrated Development Plan Review).

[3] JJ Roux, 1998, Mt Pleasant farm (Adelaide) groundwater resource evaluation project.

Appendix

Acronyms

AADD	Average Annual Daily Demand
AAWD	Average Annual Water Demand
AAWS	Average Annual Water Supply
ADD	Average Daily Demand
AoS	Assurance of Supply
CMA	Catchment Management Authority
DM	District Municipality
DWA	Department of Water Affairs
GAAD	Gross Average Annual Demand
GAADD	Gross Average Annual Daily Demand
IFR	Instream Flow Requirements
ISP	Internal Strategic Perspective
LM	Local Municipality
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
N/appl	Not applicable
N/av	Not available
NWRP	National Water Resource Planning
O & M	Operations and Management
RDP	Reconstruction and Development Programme
RO	Regional Office
UAW	Unaccounted-for Water
URV	Unit Reference Value
WC	Western Cape
WC/WDM	Water Conservation and Water Demand Management
WDM	Water Demand Management
WMA	Water Management Area
WMP	Water Master Plan
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Services Provider
WTW	Water Treatment Works
WUA	Water Users Association
WWM	Wastewater Management
WWTW	Wastewater Treatment Works

Units

hr	Hour
kl/d	Kilolitres per day
km^2	Square kilometres
l/c/d	Litres per capita per day
l/s	Litres per second
Ml/a	Megalitres per annum [= 1 000 kl/a = 2.74 kl/d]
mm/a	Millimetres per annum
Mm^3/a	Million cubic metres per annum [= 1 000 Ml/a]

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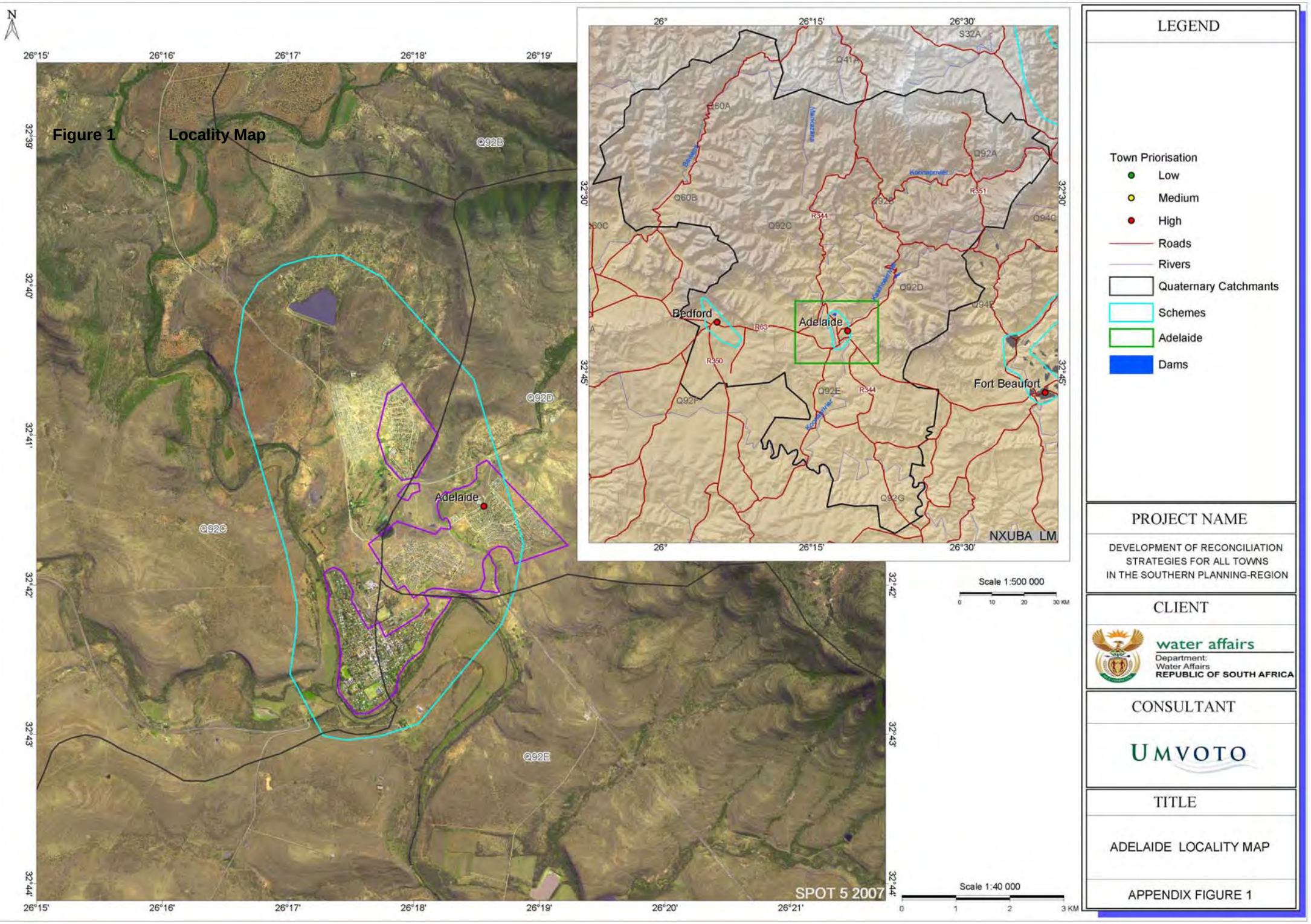
Figure 1 Locality Map
N
26°15'
26°16'
26°17'
26°18'
26°19'
26°20'
26°21'
32°39'
32°40'
32°41'
32°42'
32°43'
32°44'
Q92B
Q92D
Q92C
Q92E
Adelaide
SPOT 5 2007
Scale 1:40 000
0 1 2 3 KM
26°
26°15'
26°30'
32°30'
32°45'
S32A
Q41A
E60A
Q92A
Q60B
R551
R344
Q92C
Q92B
Q94C
Q92D
Q94E
Bedford
R63
Adelaide
R350
Q92E
Q92F
Fort Beaufort
Q92G
NXUBA LM
Scale 1:500 000
0 10 20 30 KM
LEGEND
Town Priorisation
Low
Medium
High
Roads
Rivers
Quaternary Catchmants
Schemes
Adelaide
Dams
PROJECT NAME
DEVELOPMENT OF RECONCILIATION STRATEGIES FOR ALL TOWNS IN THE SOUTHERN PLANNING-REGION
CLIENT
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
CONSULTANT
UMVOTO
TITLE
ADELAIDE LOCALITY MAP
APPENDIX FIGURE 1

Figure 2 Layout of Bulkwater Infrastructure (not available)

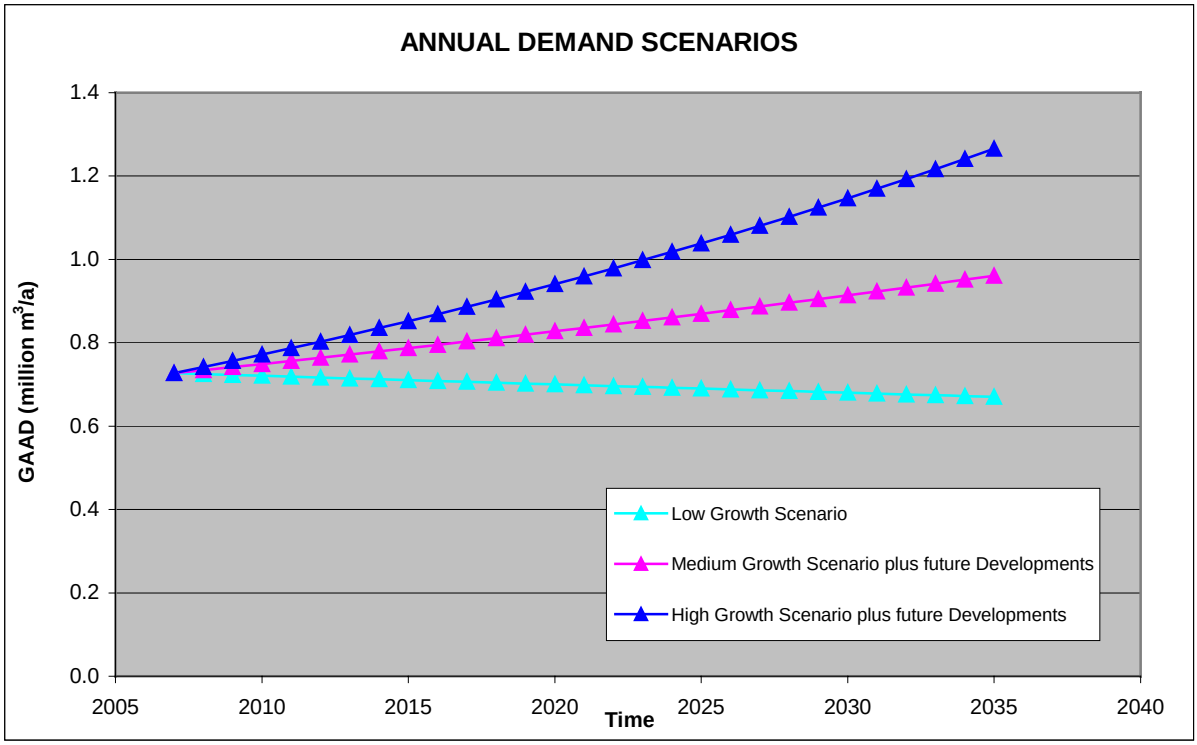

Figure 3 Population and Water Requirement Growth Scenarios

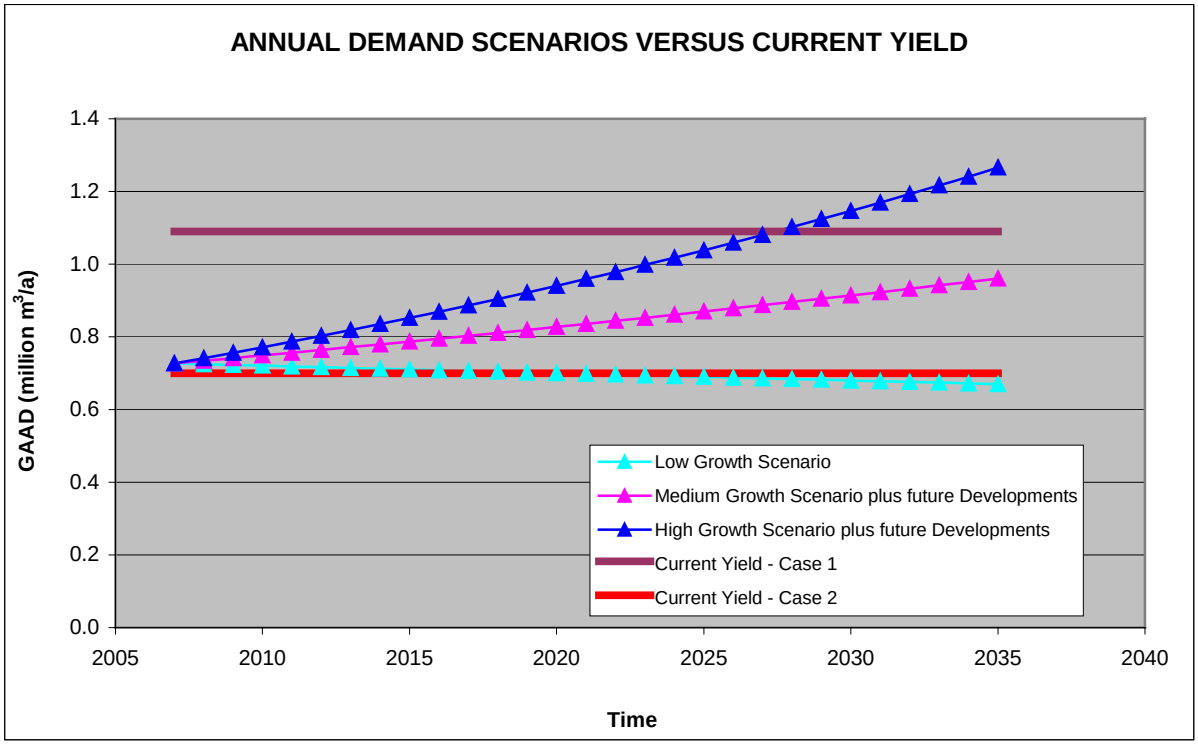

Figure 4 Water Balance; Water Requirement Scenarios and current Yield

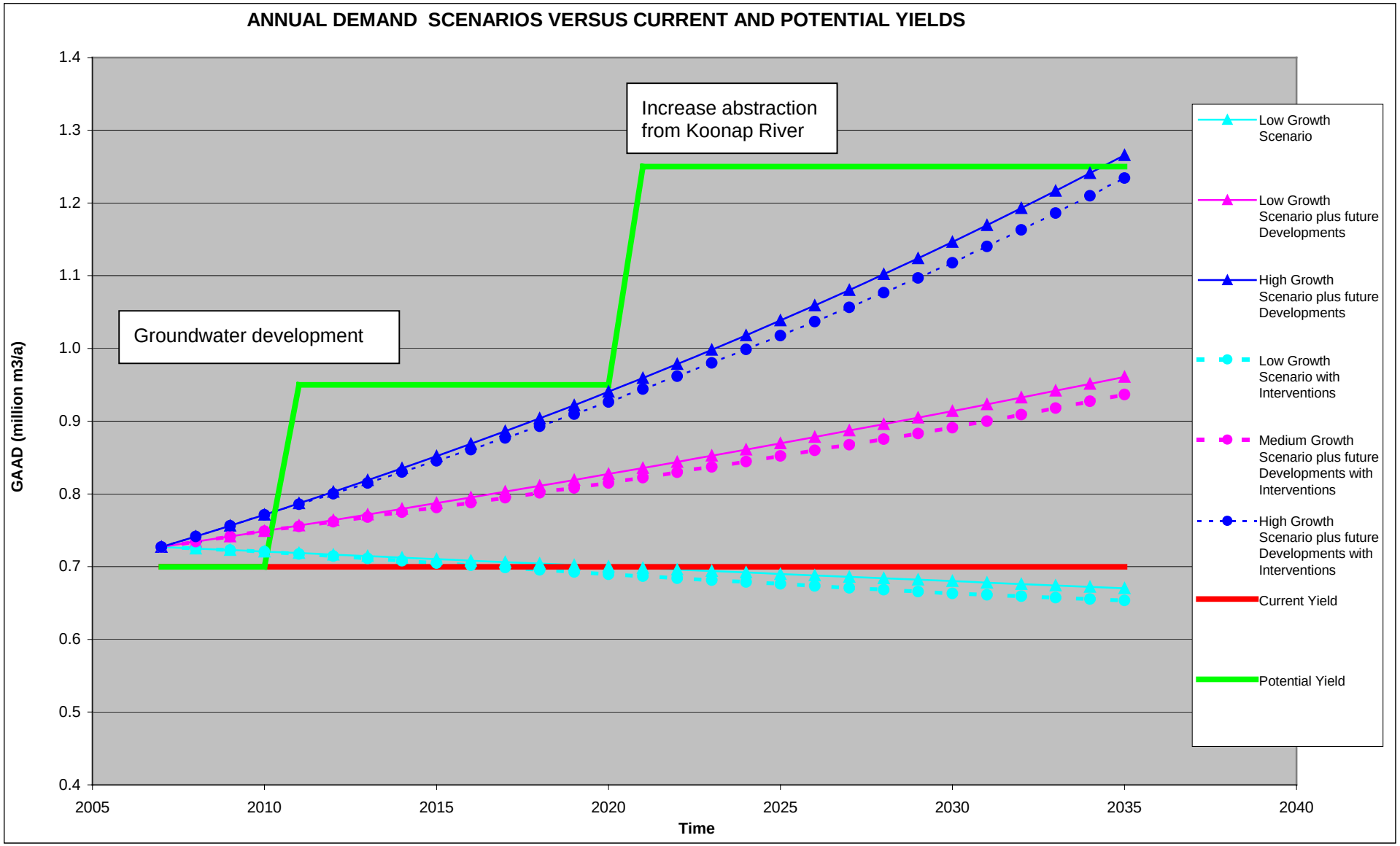

Figure 5 Intervention options; Measures to reduce demand and potential sources (Case 2 – yield of off-channel dam only 0.4 million m^3/a)

Reconciliation Strategy for Bedford

Nxuba LM	
Amathole DM	**[WSA]**
Eastern Cape Province	
WMA	
Q92F Quaternary	
None	**[WUA]**
Medium intensity level Strategy	

Context

The small town of Bedford lies 20 km to the west of Adelaide nestled in the foothills of the Winterberg Mountain range in the heart of the Eastern Cape Midlands.

The Amathole DM WSDP reflects a population for Bedford of 13 250 for 2007, based on a projection of the 2001 Census information. However, a recent report by Kwezi V3 (2007) assumes a population of 19 085 (on 3 208 erven).

Bedford is predominantly a farming town, in a beef, mutton, wool and citrus farming district. It is also situated in an eco-tourist centre, surrounded by countryside and has a spectacularly rich bird life, fine examples of rock art, a rich diversity of flora and fauna, and access to a number of game reserves and game farms.

It falls under the Nxuba Local Municipality, but the Amathole District Municipality is the Water Services Authority (WSA) responsible for the provision of water services to Bedford.

[Please refer to Figure 1, Locality map in the Appendix]

Executive Summary

Opportunities/ Problems / Challenges

The municipality reported severe water shortages prior to and during the recent drought. However, available data from the WSDP and other sources do not indicate a water shortfall that is due to water resource problems. The water requirements for Bedford under normal climatic conditions are estimated at 0.526 million m^3/a.

The primary water source for Bedford is from the Andrew Turpin Dam, which has a 1:50 year yield of 0.27 million m^3/a. The live capacity of the dam is 0.237 million m^3. Three streams currently feed the dam, namely Seeppot, Saw Mill and Donkerhoek, which have a combined catchment area of 4.8 km^2.

In addition, Bedford receives water from the Fish River (Q70A) via a 200 mm diameter pumping main for which the pumping capacity was recently upgraded. In terms of the authority for the abstraction of water, the Municipality may extract a maximum of 0.25 million m^3/a of water from the Fish River for domestic purposes within the old Bedford Municipal area but the scheme can pump, due to the upgrading, 0.48 million m^3/a of water to Bedford and Adelaide. This scheme was originally build to augment the water supply from the Andrew Turpin Dam during an emergency or periods of drought.

The capacity of the pipeline from Bedford to Adelaide is 10 liters per second which can transfer 0.315 million m^3 per year. It is not known what the permissible volume in accordance to the licence is.

The town can also be supplied from boreholes with a yield of 0.126 million m^3/a, held in reserve as an emergency supply during droughts. Springs in the Bedford area are associated with dolerite sill intrusions.

The WTW has been recently upgraded, and now has a design capacity of 1 644 kl/d. It consists of one rapid gravity sand filter. A second sand filter can potentially increase the current capacity of the works, which can easily cater for future water requirements over the 25-year planning horizon for any of the proposed scenarios. The WTW received a Blue Drop Score of only 40%, mainly due to a failure to comply fully with water quality requirements and process controlling.

The design capacity of the WWTW is 510 kl/d. A percentage of the treated water is irrigated onto a golf course and the rest is discharged into the Koonap River. The treated effluent does not comply with the set standards.

Water shortfalls are not expected, with the exception of a minor shortfall of 0.039 million m^3/a by 2035 for the high-growth scenario. Currently, there are shortfalls in peak summer daily requirements. This is expected to be a major problem beyond 2020 only for the medium and high-growth scenarios.

The current yield is sufficient to support growth in the town for all the proposed scenarios, and there are additional and alternative sources to cater for current and future requirements, such as:

- Groundwater development.
- Re-use of water, if the WWTW is upgraded to maintain good water quality standards.
- Inclusion of Bedford into a possible Koonap River Valley Scheme (should the Foxwood Dam be constructed).

The following interventions are recommended for implementation, in order of priority and sequence:

- Water Conservation and Water Demand Management Strategy development and implementation,
- Revitalise the existing boreholes for regular supply to Bedford, and
- Further groundwater development.

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   b. Water Resources
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3. **Reconciliation**
   a. Reconciliation Strategy

References

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Signatures		
Place, Date	East London 5/11/2010	EAST LONDON 2/11/2010
Signature		
Name	A. Smalley	T THOMPSON
Designation	Act Chief Director	Chief Engineer South
Institution	DWA EC RO	DWA D:NWRP
Place, Date		Prepared by: Umvoto Africa (Pty) Ltd. P.O. Box 61, Muizenberg 7950 Tel. 021 788 8031
Signature		
Name		
Designation	Municipal Manager	UMVOTO
Institution	Municipality, WSA	

1. Current Situation

a. Status Quo of Water Services

Date of information: 2007

Population / Consumer Profile

- This strategy includes the water supply area that is currently supplied by the Bedford Water Treatment Works. This includes the urban area of Bedford and the surrounding townships of New Brighton, Phola Park, Sizakhele, Ndlovi and Nyara.
- The population data for Bedford differ, depending upon the source of the data:
  - The Amathole DM WSDP reflects a population for the Bedford supply area of 13 250 for 2007, based on a projection of the 2001 Census information.
  - Population information available in the DWA Water Services Report Tool reflects a total population of 12 985 for Bedford, including the townships.
  - A recent report for the expansion of the WWTW (KweziV3, 2007) is based on a population of 19 085 (on 3 208 erven).
- For the purposes of this study, the WSDP data have been used and projected until 2035.

Population (2007)	13250	
Current growth rate	-0.29%/a	
Average Annual Daily Demand		
	kl/d	l/c/d
End-user	1120	85
Bulk meter-WTW	1400	106
Peak Demand		
Peak Month ADD	3600 kl/d	
Gross Annual Demand (Source)		
GAADD	1440 kl/d	
Annual Bulk Water demand (GAAD)	0.526 mcm/a	

- Estimated population growth rate for the Nxuba LM, derived from the WSDP, is -0.29%/a, which is based on StatsSA population estimates between 2004 and 2005.
- The estimated water requirements include provisions for domestic and commercial use, system water losses and unaccounted-for water (UAW)
- The housing backlog for Amathole DM is 28.3%, and Bedford has a backlog of 2 041 units.

Economic drivers

- Bedford is predominantly a farming town, in a beef, mutton, wool and citrus farming district.
- Bedford is situated in an eco-tourist centre, surrounded by countryside. It has a spectacularly rich bird life, fine examples of rock art, a rich diversity of flora and fauna, and access to a number of game reserves and game farms.

Assumptions

- The peak month factor is assumed to be 2.5 times the average water requirement. The peak month ADD was calculated by multiplying the current water allocation to Bedford with the peak factor.
- Current growth rate is based on the average growth rate between 2004 and 2005 and is -0.29%/a.

Service level information for water services has been extracted from the DWA Water Services Report Tool (based on the 2007 Community Survey), which reflects the water service level breakdown for Bedford as follows:

- Piped water inside dwelling – 58%
- Yard tap – 41.7%
- Communal standpipe, within 200 m – 0.3%
- Below RDP level – 0 %

Service level	Urban	58%
	RDP	42%
	informal	0.0%

The total unaccounted-for water (UAW) between the source and end-user is calculated as 0.117 million m^3/a, which relates to 22% total losses.

- Internal losses are assumed to be in the order of 20%;
- Bulk transmission losses are calculated at 2.8%.

Non-Revenue Water	0.117 mcm/a
UAW (%)	22.2 %
Internal losses	19.4%
Bulk transmission loss	2.8 %

b. Water Resources

Date of information: 2007

Currently Allocated/Utilised Yield

- The primary water source for Bedford is the Andrew Turpin Dam, which has a 1:50 year yield of 0.27 million m³/a. The live capacity of the dam is 0.237 million m³. Three streams feed the dam, (namely Seeppot, Saw Mill and Donkerhoek), and which have a combined catchment area of 4.8 km².
- Bedford can also receive water from the Fish River (Q70A) via a 200 mm diameter pumping main. In terms of the authorisation for the abstraction of water, the Municipality may extract a maximum of 0.25 million m³/a of water from the Fish River for domestic purposes in the old Bedford Municipal area. This scheme is used to augment water supply from the Andrew Turpin Dam during an emergency or periods of drought.
- The town can also be supplied from boreholes with a yield of 0.126 million m^3/a, held in reserve as an emergency supply during droughts.

Run-of-river	
Reservoirs/dams	0.270 mcm/a
GW / boreholes	0.126 mcm/a
GW / springs	N/appl.
Bulk purchase	0.480 mcm/a
Effluent Reclamation	N/appl.
Leiwater	N/appl.
Raw Water Quality	Good
AAWS	**0.876 mcm/a**

- The old pipeline scheme from the Fish River has recently been upgraded with increased pumping capacity to supply water to Bedford and Adelaide. It is designed to convey 0.48 million m^3/a of water to Bedford and the pipeline to Adelaide can transfer about 0.315 million m^3/a.

c. Bulk and Reticulation Infrastructure

Raw water abstraction works and mains

- There is no confirmed information available on the bulk system between the Andrew Turpin Dam and Bedford.
- The infrastructure scheme from the Fish River comprises a pumping scheme, which can deliver about 30 l/s (2 592 kl/day).

Water Treatment Works

- The WTW has recently been upgraded, and now has a design capacity of 1 644 kl/d.
- The current WTW consists of one rapid gravity sand filter. A second sand filter can potentially increase the current works capacity, which will easily cater for future water requirements over the 25-year scenario for any of the proposed scenarios listed in Section 2 below.
- The WTW received a Blue Drop Score of only 40%, mainly due to a failure to comply fully with water quality requirements and process controlling.

Abstraction capacity (Andrew Turpin Dam)	2000 kl/d
Abstraction capacity (Fish River)	2592 kl/d
Dam capacity	0.237 mcm
WTW capacity	1 644 kl/d
Current utilisation (peak)	N/av.
Drinking water quality	Poor
Reservoir capacity	N/av.
State of infrastructure	N/av.

The reticulation network.

- No information is available on the reticulation network.

State of infrastructure	N/av.

WWTW

The WWTW comprises of numerous treatment ponds as follows:

- One oxidation pond
- One primary pond
- Three secondary ponds
- Two tertiary ponds
- One irrigation pond

- The design capacity of the WWTW is 510 kl/d, and currently serves Bedford and the surrounding townships.

WWTW capacity	510 kl/d
Peak dry weather flow	N/av.
Effluent water quality	N/av.
Compliance, quality	No
Discharged to	Irrigation & Koonap River
State of infrastructure	Poor

- A percentage of the treated water is irrigated onto a golf course and the rest is discharged into the Koonap River. The treated effluent does not comply with standards.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Insufficient information on the water reticulation network.	Water Master Plan to be initiated for the study area.	Amathole DM	2011
Drinking water quality does not routinely comply with standards.	Upgrade operation of WTW.	Amathole DM	2011
Treated sewage effluent does not comply with the standards.	Investigate the capacity of the WWTW and the effluent inflow.	Amathole DM	2011

d. Legal Agreements

Type of authorisation

- The abstraction from the Andrew Turpin Dam is registered in the WARMS database as 0.175 million m^3/a. However, this is listed under the resource type "Spring/Eye".
- The WARMS database lists one entry for a transfer from the Great Fish River to the Koonap River of 0.234 million m^3/a. However, this is registered for an individual for irrigation purposes in the Q91C catchment. There is no other abstraction registered that can be linked to Bedford.
- There is no information regarding the authorisation of the WTW and WWTW.

Surface Water	**Autorised**
Registered abstraction	0.175 mcm/a
Groundwater	**Not authorised**
Registered abstraction	N/appl.
Storage	
Registered storage	N/av.
Leiwater system	N/appl.
Legality of water use	Partly
Effluent discharge	
WWTW (Operation)	N/av.
WWTW (Reclamation)	N/av.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Registration and licensing of water use unclear.	Clarify licensing and apply for licences, if required; update registration.	Amathole DM/DWA RO	2012
Authorisation of WTW and WWTW unclear.	Clarify authorisation of WTW and WWTW and apply for licences, if required.	Amathole DM/DWA RO	2012

e. Institutional Arrangements

- A billing system is used and is promulgated by the municipality. According to the WSDP, 81% of the population is indigent and receives free basic water of up to 6 kl per month. A block tariff system is in place for all residential and commercial users.
- There is currently no Water Conservation and Water Demand Management Strategy in place.
- Asset management, a Water Conservation and Water Demand Strategy and an operation and maintenance plan are needed to maintain the infrastructure.
- No further information is currently available on Institutional arrangements.

Skills / Capacity	Yes
Pricing / tariff structure	Yes
WC/WDM Strategy	N/av.
Monitoring system	No
Drought Management	No
Operation and maintenance plan	N/av.
Catchment Management Plan	N/av.
Social / political issues	N/av.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
No WC/WDM strategy in place.	Develop and implement a formal WC/WDM Strategy.	Amathole DM	2011
Investigate tariff structure.	Revisit pricing structure to ensure that the drivers of the marginal costs are being properly taxed.	Amathole DM	2011
No drought management plan in place.	Develop a drought management plan.	Amathole DM	2011
No operation and maintenance plan in place.	Develop and implement an operation and maintenance plan.	Amathole DM	2011

2. Future Requirements

a. Water Requirement Scenarios

- The estimated population growth rate is -0.29%/a as derived from the WSDP, based on StatsSA population estimates between 2004 and 2005 calculated at a community level. This low rate is mainly driven by migration to bigger towns.
- Three different population growth scenarios are developed:
  - Low-growth scenario with a – 0.29 % annual population growth,
  - Medium-growth scenario with a 1% annual population growth, and
  - High-growth scenario with a 2% annual population growth.

Population			
Year	Low	Medium	High
2007	13250	13250	13250
2010	13135	13651	14061
2020	12759	15080	17140
2030	12394	16657	20894
2035	12215	17507	23069

Developments:

- Nyara currently has a bucket system that will most likely be upgraded to water borne-sewage, implying improved service levels in terms of sanitation.
- There is a significant housing backlog of over 2 000 units in the town. However, there is no information available on future low-income housing developments and more information is required on this to quantify the impact on water requirements.
- This is indirectly accounted for in the high-growth scenario.

Development plans	No
Service level change	No

- Three different water requirement scenarios are developed, based on population growth rates:
  - Low-growth scenario with a -0.29 % annual population growth,
  - Medium-growth scenario with a 1% annual population growth, and
  - High-growth scenario with a 2% annual population growth.
- In all scenarios it is assumed that there is no change in the split of service levels as it is unlikely that the new low-growth houses will also be supplied with water-borne sewage.
- A decrease in UAW has not been taken into account in this calculation, but considered under Interventions (Section 2c).

GAAD (mcm/a)			
Year	Low	Medium	High
2007	0.526	0.526	0.526
2010	0.521	0.542	0.558
2020	0.506	0.598	0.680
2030	0.492	0.661	0.829
2035	0.485	0.694	0.915

[See Figure 3 in the Appendix]

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Growth in water requirements uncertain.	Meter and monitor water abstraction from water sources and consumption at WTW and end-user level, to update growth scenarios.	Amathole DM	2011, ongoing

b. Water Balance

Current municipality reports indicate a severe shortfall in water for the supply to Bedford. However, the available data do not indicate any current water shortage.

- No shortfall in supply is expected for the next 25 years under the low and medium-growth scenarios.
- A minor water shortfall of 0.039 million m^3/a only is expected by 2035 for the high-growth scenario.
- Currently, there are shortfalls in the peak summer daily requirements. This is expected to be a major problem beyond 2020 only for the medium and high-growth scenarios.

Surplus (+) / Shortfalls (-) (mcm/a)			
Year	Low	Medium	High
2007	0.350	0.350	0.350
2010	0.355	0.334	0.318
2020	0.370	0.278	0.196
2030	0.384	0.215	0.047
2035	0.391	0.182	-0.039

[See Figure 4 in the Appendix]

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Discrepancy of information regarding current water shortage.	Meter and monitor water abstraction from water sources, consumption at WTW and end-user level, to update water balance.	Amathole DM	2011, ongoing

c. Interventions to reduce Water Requirement

Measures to reduce Water Requirement

- Currently, unaccounted-for water is calculated to be 22% (see Section 1a), and should be confirmed.
- Focus should be placed on asset management and operation and maintenance optimisation, with the aim of reducing the current water consumption by 2.5%.
- WC/WDM measures should be implemented, specifically on water loss management and user education to reduce actual water requirements.

WC/WDM	✓
Asset management	✓
Operation and maintenance optimisation	✓
Possible reduction	5-10 %

d. Water Resource Availability – Potential

Re-use of water

- The table alongside presents the potential for re-use of water yield in the town.
- Treated water from the WWTW is currently used for irrigation purposes at the local golf course, but this is of concern as treated effluent does not comply with treatment requirements of DWA. The provision of water for re-use as irrigation water for nearby farm holdings and recreational facilities is not a feasible option until the water quality is guaranteed.

Potential water available for re-use (mcm/a)			
Year	Low	Medium	High
2007	0.368	0.368	0.368
2010	0.361	0.375	0.387
2020	0.332	0.393	0.446
2030	0.319	0.429	0.538
2035	0.315	0.451	0.594

Groundwater resources

The town of Bedford is underlain by the Adelaide Subgroup within the Beaufort Group of the Karoo Supergroup. The Adelaide Subgroup consists of grey and brownish-red mudstone (80%); interspersed with fine-grained sandstone layers (20%). These form shallow inter-granular and weathered, fractured-rock aquifers. Dolerite intrusions are common in the area and the contact to a large sill is present immediately north of town (<1 km), forming a prominent escarpment. The contact zone of the intrusion is often highly fractured in the host rock (i.e. the Adelaide Subgroup), making this zone the preferred groundwater target.

	Adelaide	Dolerite
Recharge	14.01	0.26
Use	6.53	0.12
Reserve	0.00 (all aquifers)	
Quality	Fair	Good
Distance		

Substantial groundwater yields from the contact zone are evidenced by the Nyara River which feeds the Andrew Turpin Dam. The river rises at the base of the dolerite sill escarpment and is likely to be almost 100% groundwater fed. The dam registration in the WARMS database confirms this, by listing the resource type for the dam as a spring/eye.

There are 25-30 boreholes registered for the town likely to be used for private garden watering and yields range from 0.2 to 2 l/s (NGDB). These do not intersect the dolerite contact zone. The average borehole yield for the area is mapped as 3-10l /s (DWAF Reference Framework), and the higher end of this range is likely in the dolerite contact zone. A borehole yielding 5.3l /s is recorded towards the south-east of the town, registered to the municipality. This data may reflect the combined yield of the backup boreholes. They are not sited in an optimal position close to the escarpment.

The water quality of shallow inter-granular and weathered fractured rock aquifers is often poor with high salinity. The reference framework document gives an 'expected' borehole water quality as Class 2: marginal water quality. The development potential for Bedford is listed as definite.

The groundwater recharge for the Adelaide Sub-group within the Q92F catchment is given as 14.01 million m^3/a. The potential is high, dictated by the large catchment and the extensive area covered by the Adelaide Sub-group. As there are no other settlements in the catchment, theoretically, all this potential is available to Bedford. The town sits at the north of the catchment and the aquifer yield accessible from this area, especially if the sheet dyke contact point is targeted, needs to be analysed in greater detail. An upgrade to the existing wellfield is recommended to meet the requirement. If this is not possible, drilling exploration in the Adelaide Subgroup north of the town at the foot of the escarpment should be undertaken.

Surface water resources

- The mean annual precipitation (MAP) for the Q92F catchment is approximately 415 mm.
- The existing yield from all schemes available for Bedford is more than adequate to cater for future scenarios. Potential schemes for further augmentation may include:
  - The Koonap River as a suitable source for further augmentation as indicated by earlier studies but additional storage is needed. This includes the option of the Foxwood Dam but this would be a very costly scheme.
  - Increase the current abstraction and treatment from the Fish River, which is located 20 km west of Bedford.

Catchment(s)	
Catchment MAP	415 mm
Catchment MAR	4.56 mcm/a
River	
Fish River	
Run-of-river MAR	N/av.
Reserve EWR	N/av.
Water quality	N/av.
Dams	
Dam yield (98% AoS)	N/appl.
Currently allocated:	N/appl.

Other potential sources

- Rainwater harvesting is a possible option as part of a user-focused Water Conservation and Water Demand Management Strategy, considering that the MAP is above 400 mm/a.

Desalination	N/appl.
Rainwater Harvesting	✓

Summary of potential sources

The current yield is sufficient to support growth in the town for all the proposed scenarios, and there are additional and alternative sources to cater for current and future requirements:

- Groundwater development.
- Re-use of water, if WWTW is upgraded to guarantee water quality standards.
- Inclusion of Bedford into the Koonap River Valley Scheme, if the Foxwood Dam is constructed.

Water re-use	✓
Groundwater	✓
Surface water, local	✓
Water Trading	N/appl.
Desalination	N/appl.
Rainwater Harvesting	✓
Transfer schemes	✓
Total Yield	N/av.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
Groundwater potential.	Hydrogeological feasibility study with exploration drilling and testing to develop future wellfield.	Amathole DM	2011

3. Reconciliation

Reconciliation Strategy

The following interventions are recommended for implementation, in order of priority and implementation sequence:

1. Water Conservation and Water Demand Management Strategy,
2. Revitalise the existing boreholes for regular supply to Bedford,
3. Further groundwater development.

Water Conservation and Water Demand Management	2011
Requirement reduction	10%
Revitalise existing boreholes	2011
Increase in assurance of supply	
Groundwater development	2015
Yield	0.3 mcm/a

The recommended reconciliation with the sequence and yield of interventions vs. water requirement scenarios is shown graphically in Figure 5.

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule

References

Primary:

[1] Water Services Development Plan, Amatole District Municipality, Amatola Water, May 200.

[2] Overview of Water Resources Availability and Utilisation, Fish to Tsitsikamma Water Management Area, (WMA No. 15), DWAF, September 2003

[3] Integrated Development Plan (2007 – 2012), Nxuba Local Municipality

[4] Water Resource Situation Assessment, Fish to Tsitsikamma Water Management Area, (WMA No. 15), DWAF, August 2002

[5] ADM – Bedford: Technical Report for the Expansion of the WWTW, Kwezi V3, 2007

General:

[1] Internal Strategic Perspective for Fish to Tsitsikamma Water Management Area, (WMA No. 15), DWAF, February 2004

[2] Nxuba Municipality IDP (Integrated Development Plan Review) Urban Dynamics, 2003

[3] Additional Groundwater Development in the Bedford Region, Eastern Cape DWAF, 1987

Appendix

Acronyms

AADD	Average Annual Daily Demand
AAWD	Average Annual Water Demand
AAWS	Average Annual Water Supply
ADD	Average Daily Demand
AoS	Assurance of Supply
CMA	Catchment Management Authority
DM	District Municipality
DWA	Department of Water Affairs
GAAD	Gross Average Annual Demand
GAADD	Gross Average Annual Daily Demand
IFR	Instream Flow Requirements
ISP	Internal Strategic Perspective
LM	Local Municipality
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
N/appl	Not applicable
N/av	Not available
NWRP	National Water Resource Planning
O & M	Operations and Management
RDP	Reconstruction and Development Programme
RO	Regional Office
UAW	Unaccounted-for Water
URV	Unit Reference Value
WC	Western Cape
WC/WDM	Water Conservation and Water Demand Management
WDM	Water Demand Management
WMA	Water Management Area
WMP	Water Master Plan
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Services Provider
WTW	Water Treatment Works
WUA	Water Users Association
WWM	Wastewater Management
WWTW	Wastewater Treatment Works

Units

hr	Hour
kl/d	Kilolitres per day
km^2	Square Kilometres
l/c/d	Litres per capita per day
l/s	Litres per second
Ml/a	Megalitres per annum [= 1 000 kl/a = 2.74 kl/d]
mm/a	Millimetres per annum
mcm/a	Million cubic metres per annum [= 1 000 Ml/a]

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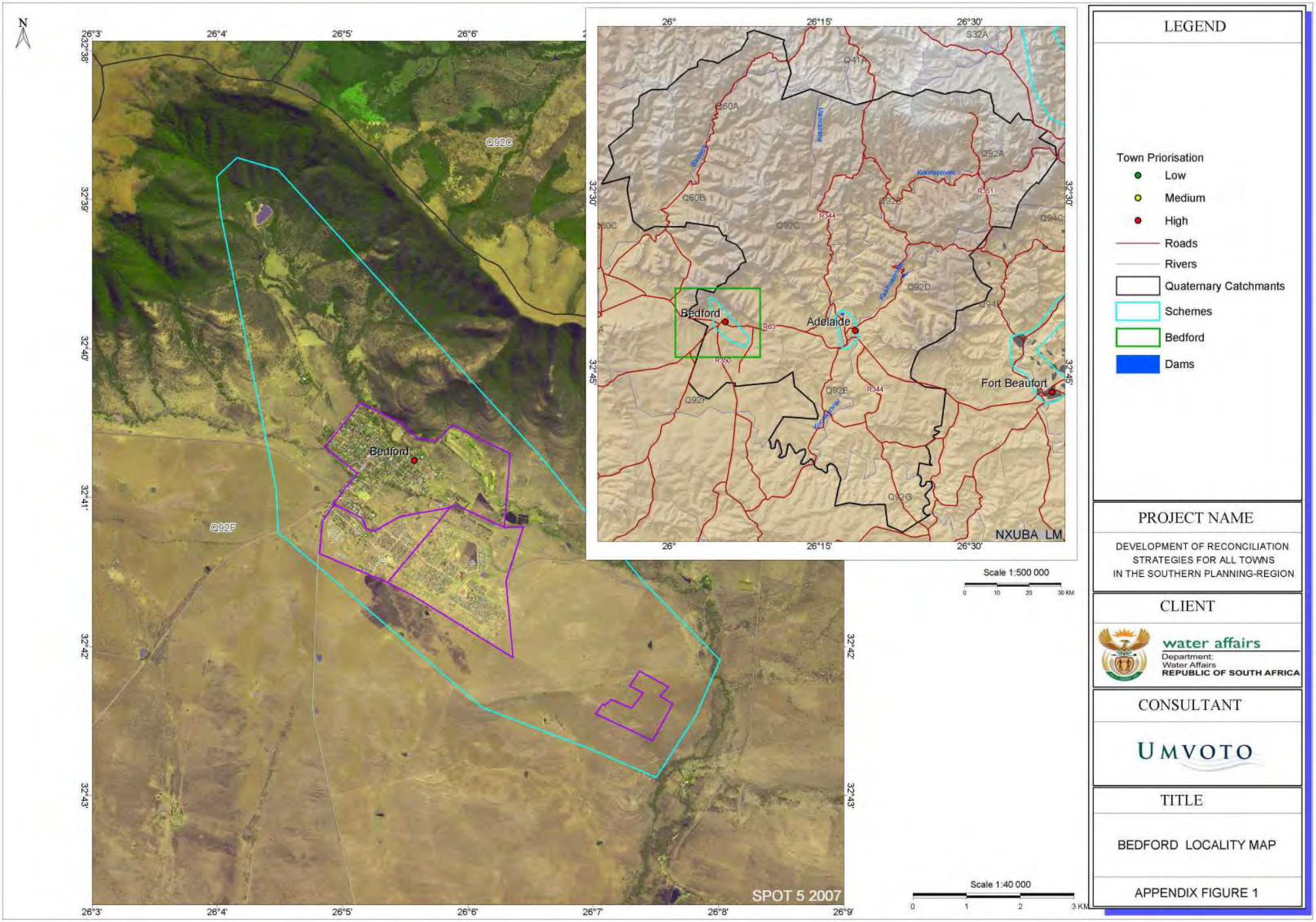
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Q41A
Q60A
Q60B
Q60C
Q92A
Q92B
Q92C
Q92D
Q92E
Q92G
Q92I
Q94C
Q94E
R344
R351
R63
R350
Adelaide
Fort Beaufort
NXUBA LM
Scale 1:500 000
0 10 20 30 KM
Scale 1:40 000
0 1 2 3 KM
LEGEND
Town Priorisation
Low
Medium
High
Roads
Rivers
Quaternary Catchmants
Schemes
Bedford
Dams
PROJECT NAME
DEVELOPMENT OF RECONCILIATION STRATEGIES FOR ALL TOWNS IN THE SOUTHERN PLANNING-REGION
CLIENT
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
CONSULTANT
UMVOTO
TITLE
BEDFORD LOCALITY MAP
APPENDIX FIGURE 1

Figure 2 Layout of Bulkwater Infrastructure (not available)

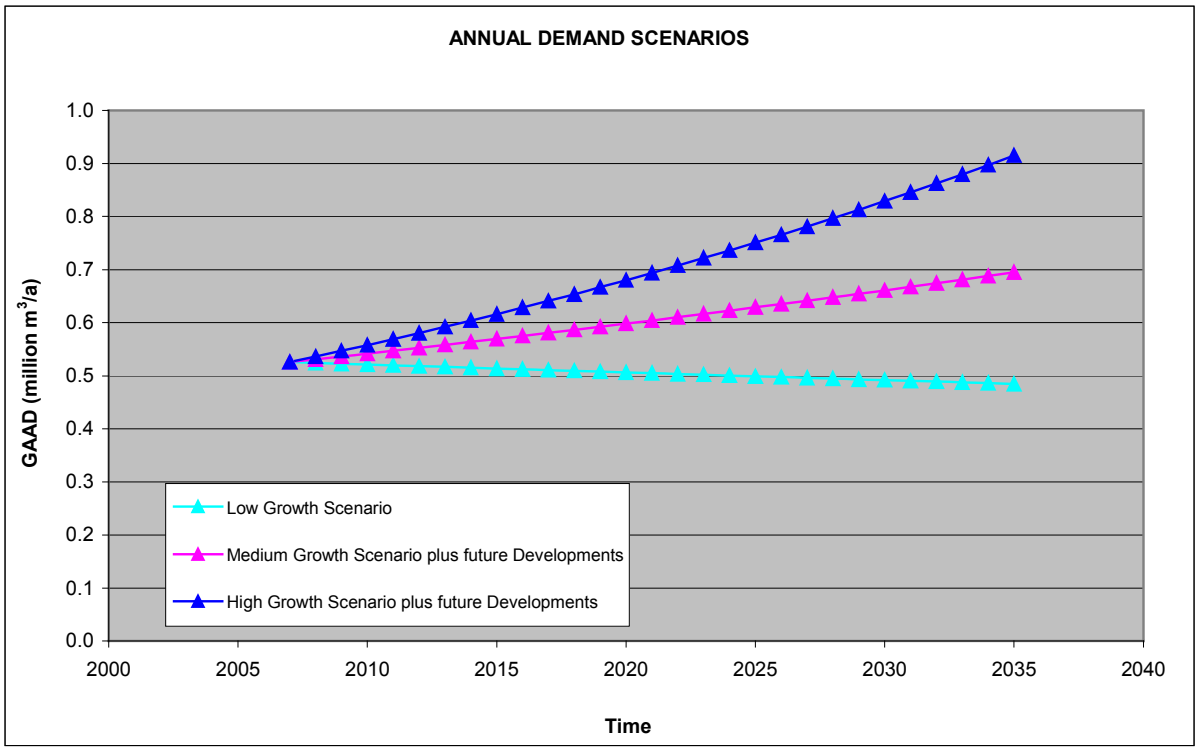

Figure 3 Population and Water Requirement Growth Scenarios

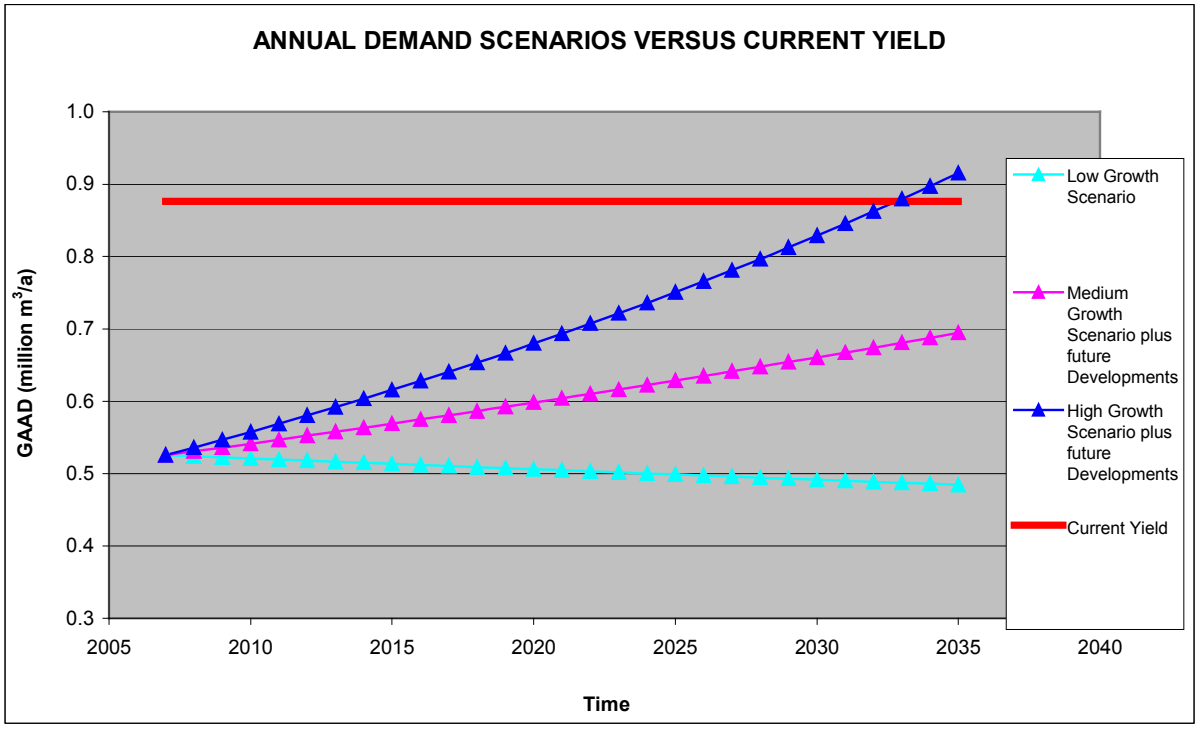

Figure 4 Water Balance; Water Requirement Scenarios and current Yield

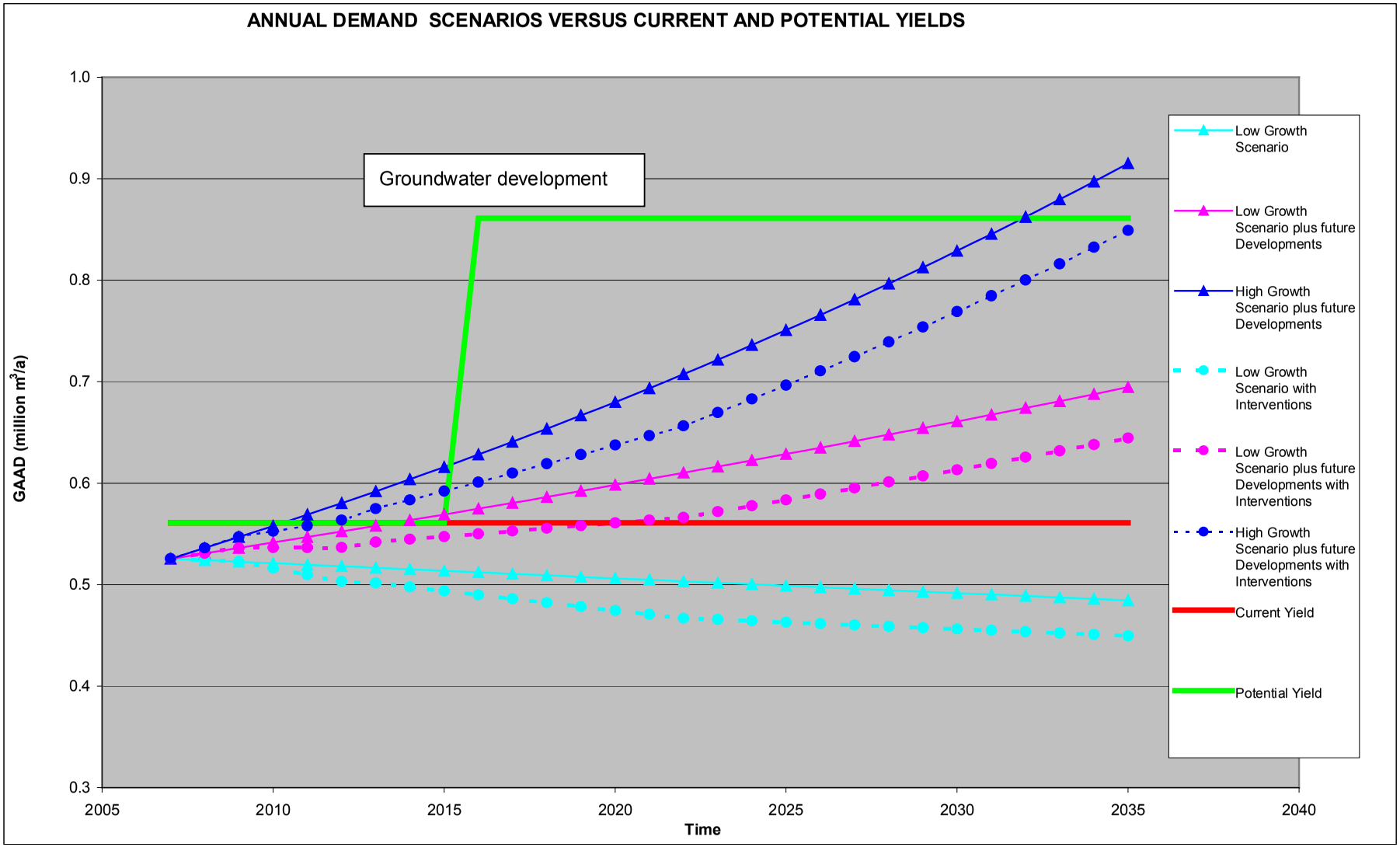

Figure 5 Intervention options; Measures to reduce demand and potential sources (assuming pipeline to Adelaide is fully utilised)

Reconciliation Strategy for Kat River Valley

Nkonkobe LM
Amathole DM [WSA]
Eastern Cape Province
Fish to Tsitsikamma WMA
Q94A, Q94B, Q94C, Q94D, Q94F Quaternaries
Kat River WUA
Medium intensity level Strategy

Context

This strategy covers the Kat River catchment and its tributaries, and includes the area that is currently supplied by the Kat River Dam and the Kat River run of river scheme.

The towns of the strategy area are Fort Beaufort, Seymour and Balfour.

Seymour is located next to the Kat River Dam, approximately 30 km north of Fort Beaufort.

Fort Beaufort is situated along the Kat River, approximately 20 km west of Alice.

Balfour is located about 8 km west of Seymour.

Seymour has experienced acute negative growth in recent years. There are currently only four businesses in the town, a far cry from the once thriving town. Seymour is one of the poorest areas in the municipality with large backlogs in infrastructure.

The economy of Fort Beaufort is based on large-scale citrus farming. Despite this, there are high levels of unemployment in the town. There are agricultural activities in the lower Kat River catchment, downstream of Fort Beaufort, which is dominated by subsistence farming.

Municipal and other Government Departments are situated in Fort Beaufort and the town is equipped with numerous amenities (supermarkets, petrol stations, a hospital, police station, schools, fire department, etc.). This draws day visitors from the surrounding villages.

Balfour is a small town without any significant economic activity.

The Kat River is utilised for irrigation along the upper and lower Kat River Valley. The allocation is administered by the Kat River WUA. There are distinct differences in agricultural water consumption between the commercial farms in the upper Kat River Valley between Seymour and Fort Beaufort, and the farming communities and subsistence farming dominant in the lower Kat River Valley.

The area falls under the Nkonkobe Local Municipality, which in turn falls under the Amathole District Municipality, which is the Water Services Authority (WSA) responsible for the provision of water services to the area under its jurisdiction.

[Locality map in the Appendix, Figure 1]

Current Situation

Water requirements

The 2007/08 WSDP for the Amathole DM reflects a population of 31 700 for Fort Beaufort and 6 000 for Seymour. Balfour and the villages in the middle and lower Kat River catchment are not included in the WSDP.

The DWA Water Services Tool (2007) indicates a population of 50 400 for the entire area covered in this strategy, the majority of which is supplied by the Kat River Dam and the Kat River run of river scheme

Adopting the actual consumption rates given in the WSDP for Seymour (0.6 Ml/d) and for Fort Beaufort (1.1 Ml/d) and applying a minimum of 60 l/c/d for the remaining population, the total water requirements are estimated as 1.2 million m^3/a. This includes total losses of 25%, as stated in the Fish to Tsitsikamma WMA Water Resource Situation Assessment Report (DWAF, 2002).

The town of Seymour is poorly serviced, lacking most basic infrastructure services (roads, water, sanitation, electricity, etc.). The town is largely underdeveloped, and that which does exist is not maintained or managed. There is no service-level information for Fort Beaufort, but it is assumed that most households have access to water supply within the yard or dwelling, as the town is served by a waterborne sewerage system with effluent treatment at a WWTW.

Service level information for Seymour, based on the 2007 DWA Water Services Tool, is as follows:

- Piped water inside dwelling – 24.7%
- Yard tap – 17.6%
- Standpipe – 57.7%

Water supplied to Seymour is treated at the Seymour WTW which has a design capacity of 0.74 Ml/d or 0.27 million m³/a. Amathole District Municipality owns and operates the Seymour WTW, which achieved 99% compliance with drinking water quality and health standards.

The WSDP indicates that the WTW capacity is unable to supply the fully developed scenario of Seymour, and this certainly holds true for future growth in water requirements that will result from the eradication of water backlogs and the bucket system.

The WTW in Fort Beaufort has a capacity of 4.5 Ml/d or 1.36 million m³/a.

Water source and supply

The main source of water for the area is the Kat River Dam, which is located in the upper Kat River catchment. Water for Seymour is abstracted directly from the dam whereas water for Fort Beaufort is released into the river channel and abstracted at a weir near the town, where it is treated and distributed to the consumers in town.

The yield of the dam and its allocation to domestic and irrigation users is stated variably in different sources.

Table 1 Yield of Kat River Dam and its allocation (million m^3/a)

	Domestic			Irrigation	Total
Source of data	**FBeaufort**	**Seymour**	**Others**		
Kat River O&M Manual (2001)	2.46			17.76	20.22
Fish to Tsitsikamma WMA WRSA (2002)	1.68			11	12.68
Amathole DM WSDP (2007)	0.40 *	0.22 *			12.7
Amathole DM IDP (2005)	1.36				

* Actual consumption

The total resource availability for domestic use is assumed as 1.68 million m³/a. This volume, taken from the Water Resources Situation Assessment, also almost matches with the registered abstraction rates mentioned in the WARMS database.

Balfour is supplied by groundwater. However, as there is no abstraction or yield information available this is not considered in the total water resources availability.

According to the Fish to Tsitsikamma WRSA, 0.85 million m³/a of effluent is re-used. As this number refers to data from 1995 it is not clear if water re-use is still in place. The number is not considered for the total availability because it is assumed that this water is discharged back into the river and thus used by agriculture or for irrigation of sportfields and parks.

Future Requirements

Water balance

The current population (2007) in the towns and villages in the Kat River Valley is estimated at approximately 50 400. Throughout the Nkonkobe Municipality there has been a significant decline in the population size and the area is not expected to experience any significant economic growth in the near future. As it is an area of both rural and urban settlements the average population is estimated to stay more or less constant. The following growth rates were assumed:

- Low-growth scenario with population decline of 0.5%/a (i.e. – 0.5%/a growth),
- Medium-growth scenario with stagnant population (i.e. growth of 0.0%), and
- High-growth scenario with population growth of 0.5%/a.

Applying the high-growth scenario, the domestic water requirements at the source would increase to 1.4 million m^3/a.

In all scenarios it is assumed that there is no change in the split of service levels and that the present per capita consumption stays constant. Decrease in UAW is not taken into account as this will be considered under Interventions.

Currently, there are no shortfalls in the water supply to the Kat River supply area. Assuming that the domestic allocation from the dam is fully available for domestic supply, this would be sufficient until 2035, even under the high-growth scenario.

GAAD [mcm/a]			
Year	Low	Medium	High
2003	1.198	1.198	1.198
2010	1.157	1.198	1.241
2020	1.100	1.198	1.304
2030	1.046	1.198	1.371
2035	1.020	1.198	1.405

Water resources

Water shortages experienced in Fort Beaufort and Seymour are due to deteriorating infrastructure and inadequate WTW capacities, and not as a result of water resource availability.

The yield from the Kat River Dam and the Kat River run of river scheme is adequate to cater for future water requirements. However, the following sources have been identified to augment the current water supply, if this might be required:

- WC/WDM to reduce water losses in bulk and reticulation networks.
- Groundwater development to augment supply to selected remote rural villages.
- Rainwater harvesting in rural villages.

Groundwater resources

The area surrounding and south of Fort Beaufort is underlain by the Adelaide Subgroup within the Beaufort Group of the Karoo Supergroup. The Adelaide Subgroup consists of grey and brownish-red mudstone (80%); interspersed with fine-grained Sandstone layers (20%). These form shallow intergranular and weathered, fractured-rock aquifers. Alluvial deposits associated with the Kat River overlie the Adelaide Subgroup in and around the town of Fort Beaufort, but these are not laterally extensive and likely to be fairly thin.

Dolerite intrusions are common in the area. The contact zone of the intrusion is often highly fractured in the host rock (i.e. the Adelaide Subgroup) making this zone the most favourable for groundwater development.

In the area of Seymour the lack of groundwater use is surprising given the geological setting. (The closest boreholes listed in the NGDB are 5 km to the west of Seymour. There are no borehole registrations in WARMS.) The Amatole Reference Framework Water Resource Perspective gives an average borehole yield for Seymour of 0.4 l/s. It is not clear what data (which boreholes) these averages are based on and the average is too low for the geological setting. Boreholes with yields of at least 2 l/s are likely from the Adelaide Subgroup, and higher yields can be expected from boreholes in the Katberg Formation.

At a distance of 10 km north and north-east of Seymour, the topography rises to a plateau formed by the Katberg Formation (Tarkastad Subgroup, Beaufort Group, Karoo Supergroup). The Katberg Formation is comprised of fine to medium-grained, horizontally laminated sandstone with subordinate fine-grained, brownish-red and grey mudstones. On average, sandstone comprises about 90% of the Formation, which is 500 to 1 000 m thick. Because of the higher sandstone content in the Katberg Formation, this is the most favourable unit for groundwater development in the wider region. The steep slopes of the plateau are capped by a thin dolerite sill, which has allowed the ridge to form in the Katberg Formation. The Kat River has its source at the base of this ridge, and is likely to be fed by groundwater emanating at the base of the Katberg Formation, and from the dolerite contacts within the Katberg Formation.

In the area around Seymour the highest groundwater potential is from the Katberg Formation in the S32E catchment to the north (15.57 million m^3/a recharge). Whether the Adelaide Subgroup in the vicinity of dykes closer to the town, or the Katberg Formation further afield is targeted depends on a cost-benefit analysis of likely yields versus infrastructure costs of the greater length of pipeline. The potential target areas are all topographically higher than the town facilitating gravity feed. A possibility is to drill close to the Kat River Dam (Adelaide Subgroup) to augment the water supply system directly. The advantage of this is that it does not require new reticulation and the existing infrastructure could be used to transmit water to the towns. A disadvantage is that the groundwater is then also subject to evaporation and pollution.

Should pressure on the Kat River Dam increase due to increased requirements from neighbouring villages, there is sufficient groundwater potential in Fort Beaufort, Seymour, Balfour and the surrounding rural areas to augment supply.

Surface water resources

The Kat River Dam currently supplies domestic water to Fort Beaufort and Seymour, as well as irrigation water to farms in the area. In order to determine the possibility of increasing the domestic allocation from the Kat River Dam, if this were required, both the current allocation and the future requirements for irrigation, should be further investigated and discussed with the Kat River WUA.

Water Conservation and Water Demand Management

It is recommended that a Water Conservation and Water Demand Management Strategy be developed and implemented over the next 5 – 10 years. This should focus on loss control and water use efficient technology for both domestic and agricultural users. Even if requirements can be met, WC/WDM is an important strategy in reducing unnecessary losses and associated costs.

Reconciliation

The following interventions are recommended for implementation, in order of priority and implementation sequence:

1. Development and implementation of a Water Conservation and Water Demand Management (WC/WDM) Strategy.
2. Groundwater development in remote areas to reduce transmission costs.

Water Demand Management	2010
Demand reduction	15%
Localised groundwater development	2010
Yield	0.7 mcm/a

REQUIRED ACTIONS

Issue	Action	Responsibility	Schedule
WTW inadequate.	Upgrade WTW.	Amathole DM	2010
Losses unknown	Develop Water Demand Management Strategy.	Amathole DM	2010

References

[1] Water Services Development Plan, Amatole District Municipality, May 2007, Amatola Water

[2] Integrated Development Plan (2007 – 2012), Nkonkobe Local Municipality

[3] Water Resource Situation Assessment, Fish to Tsitsikamma Water Management Area, DWAF, August 2002

[4] Internal Strategic Perspective for Fish to Tsitsikamma Water Management Area (Fish to Sundays ISP Area), DWAF, February 2005

[5] DWAF, 1998, An explanation of the 1:500 000 general hydrogeological map Queenstown 3126

[6] Final Report on GW Exploration in the Fort Beaufort – Alice Area, SRK Consulting, SRK Consulting, 1990

[7] Katberg Golf Estate – Desk Study & Geophysical Investigation, SRK Consulting, SRK Consulting, 2005

[8] Hydrogeological Investigation: Seymour, SRK Consulting, 2002

Appendix – Figures

Figure 1 Locality Map 7

Figure 2 Water Balance; Intervention options; Measures to reduce demand and potential sources ... 8

Signatures

Place, Date	East London 5/11/2010	EAST LONDON 2/11/2010
Signature		
Name	A. Sokley	I THOMPSON
Designation	Act Chief Director	Chief Engineer South
Institution	DWA EC RO	DWA D:NWRP
Place, Date		Prepared by:
Signature		Umvoto Africa (Pty) Ltd.
Name		P.O. Box 61, Muizenberg 7950
Designation	Municipal Manager	Tel. 021 788 8031
Institution	Municipality, WSA	UMVOTO

Appendix Acronyms

AADD	Average Annual Daily Demand
AAWD	Average Annual Water Demand
AAWS	Average Annual Water Supply
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WSDP	Water Services Development Plan
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WUA	Water Users Association
WWM	Wastewater Management
WWTW	Wastewater Treatment Works

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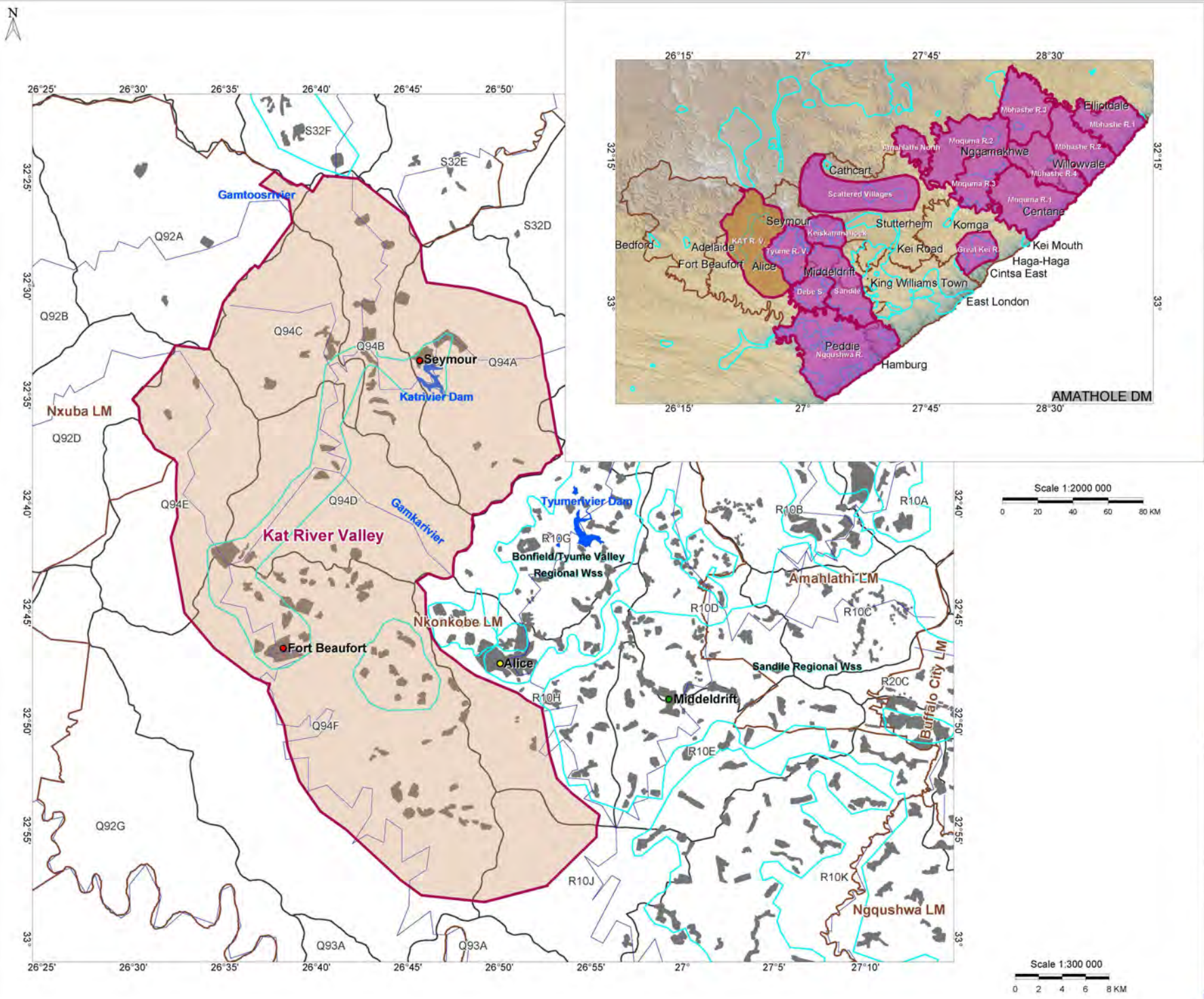
mm/a	millimetres per annum
mcm/a	million cubic metres per annum [= 1 000 Ml/a]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Q92B
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Q92G
Q94C
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Q94A
Q94E
Q94D
Q94F
Q93A
Seymour
Katrivier Dam
Nxuba LM
Kat River Valley
Gamkarivier
Fort Beaufort
Nkonkobe LM
Alice
Tyumerivier Dam
Bonfield/Tyume Valley
Regional Wss
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R10H
R10J
R10K
R10B
R10A
R10D
R10C
R10E
R20C
Amahlathi LM
Sandile Regional Wss
Middeldrift
Buffalo City LM
Ngqushwa LM
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27°45'
28°30'
32°15'
33°
Mbhashe R.3
Elliotdale
Mbhashe R.1
Mbhashe R.2
Mbhashe R.4
Moquma R.2
Moquma R.3
Moquma R.1
Amahlathi North
Nggamakhwe
Willowvale
Centane
Cathcart
Scattered Villages
Seymour
Stutterheim
Komga
Kei Mouth
Haga-Haga
Cintsa East
Kei Road
Great Kei R.
Bedford
Adelaide
KAT R. V.
Tyume R. V.
Fort Beaufort
Alice
Middeldrift
Debe S.
Sandile
King Williams Town
East London
Peddie
Ngqushwa R.
Hamburg
AMATHOLE DM
Scale 1:2000 000
0 20 40 60 80 KM
LEGEND
Town Priorisation
None
Low
Medium
High
Quaternary Catchmants
Schemes
LM Boundary
Rivers
Dams
Villages
Village Clusters
Kat River Valley Village Cluster
PROJECT NAME
DEVELOPMENT OF RECONCILIATION STRATEGIES FOR ALL TOWNS IN THE SOUTHERN PLANNING-REGION
CLIENT
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
CONSULTANT
UMVOTO
TITLE
KAT RIVER VALLEY VILLAGE CLUSTER
LOCALITY MAP
APPENDIX FIGURE 1

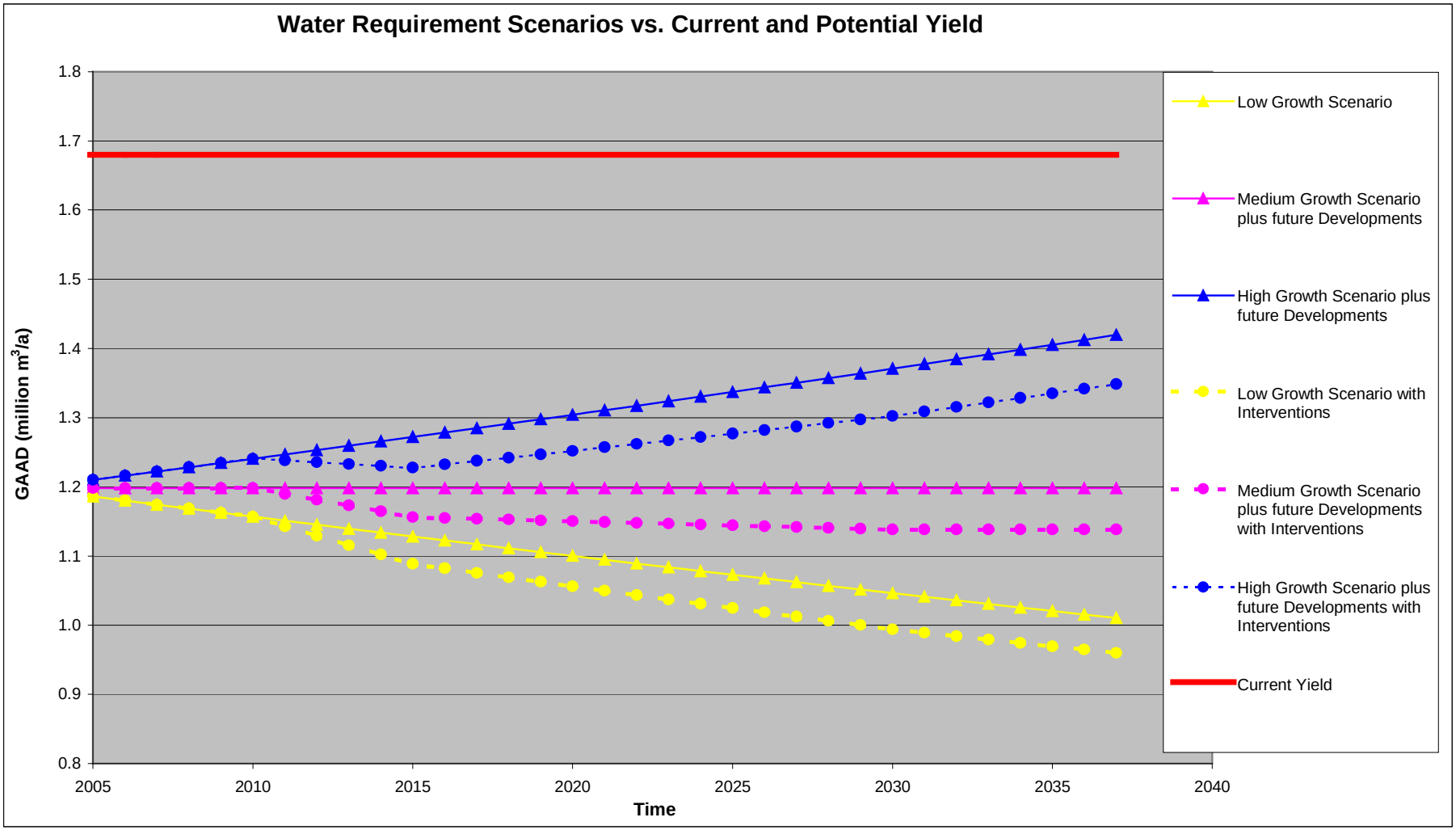

Figure 2 Water Balance; Intervention options; Measures to reduce demand and potential sources