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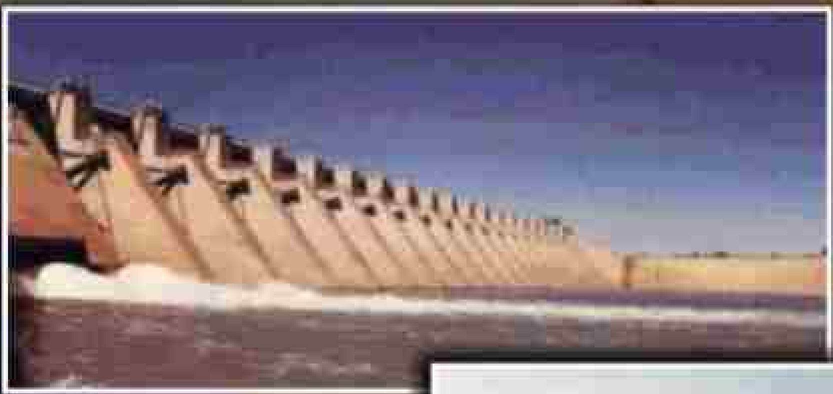
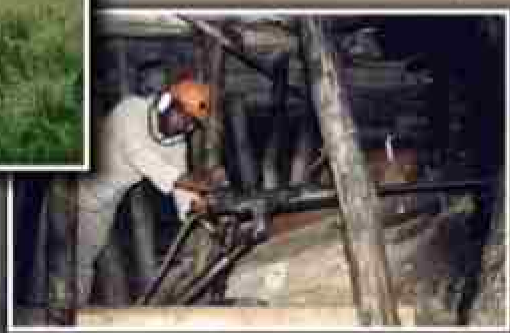
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA
Directorate: National Water Resource Planning

Vaal River System: Large Bulk Water Supply Reconciliation Strategy

FIRST STAGE RECONCILIATION STRATEGY





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DECEMBER 2006

PREPARED BY:

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VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGY

LIST OF REPORTS

Report No:	Title
P RSA C000/00/4405/01	Urban water requirements and return flows
P RSA C000/00/4405/02	Potential savings through WC/WDM in the Upper and Middle Vaal water management areas
P RSA C000/00/4405/03	Re-use options
P RSA C000/00/4405/04	Irrigation water use and return flows
P RSA C000/00/4405/05	Water resource analysis
P RSA C000/00/4405/06	Dolomite groundwater assessment
P RSA C000/00/4405/07	First stage reconciliation strategy

Above list of reports effective as at December 2006

VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGY

FIRST STAGE RECONCILIATION STRATEGY

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Vaal River System: Large Bulk Water Supply Reconciliation Strategy

First Stage Reconciliation Strategy (December 2006)

Executive Summary

Introduction

*The Large Bulk Water Supply Reconciliation Strategy Study for the Vaal River System Study has the purpose to develop a strategy for meeting the growing water requirements of the industrial and urban sectors that are served by the Integrated Vaal River System (IVRS). The need for the study was identified in the Internal Strategic Perspective (ISP) for the Vaal River System Overarching (**DWAF, 2004d**) and the key objectives were identified as follows:*

- *Update the current and future urban and agricultural water requirements.*
- *Assess the water resources and existing infrastructure.*
- *Take into account the Reserve requirements for alternative classifications.*
- *Formulate reconciliation interventions, both structural and administrative/regulatory.*
- *Conduct stakeholder consultation in the development of the strategies.*

The core of the study area consists of the Upper, Middle and Lower Vaal River Water Management areas (WMAs), however, due to the numerous inter-basin transfers that link this core area with other WMAs, reconciliation planning has to be undertaken in the context of the Integrated Vaal River System which also includes portions of the Komati, Usutu, Thukela and Senqu River (Located in Lesotho) catchments.

Study procedure and methodology

*The overarching study approach was to develop reconciliation strategies in two stages. The first stage involved developing and assessing scenarios of possible future reconciliation options. The First Stage Reconciliation Strategy was presented to the Department of Water Affairs and Forestry (DWAF) Management and Stakeholders for comments. Further investigations were identified for assessment during the development of the **Second Stage Reconciliation Strategy** which is scheduled for completion by November 2007.*

An essential part of the strategy development process was the integration of information from various processes and studies in order to arrive at a strategy that account for all major aspects that influence the bulk water supply situation in the Vaal River System. This was achieved by co-ordinating activities among the following three studies:

- ***Integrated Water Quality Management Plan Study*** *(DWAF, 2006a).*
- ***Potential Savings through Water Conservation / Water Demand Management (WC/WDM) in the Upper and Middle Vaal Water Management Areas*** *(DWAF, 2006b).*
- ***Vaal River System: Large Bulk Water Supply Reconciliation Strategy (this study)****.*

An integrated stakeholder engagement process was followed for the above three studies which involved combined Project Management and Steering Committee meetings for the Reconciliation and WC/WDM studies. Furthermore, shared representation of DWAF management and study team members on the Reconciliation and Water Quality Management studies ensured the co-ordination of interdependent activities and integration with the proposed water quality management measures was achieved.

The focus of the assessments for the First Stage Strategy included the following:

- *Develop water requirement and return flow scenarios.*
- *Determine the potential for Water Conservation and Demand Management by concentrating on the main urban areas.*
- *Estimate the irrigation water requirements and compile possible future scenarios.*
- *Identify and assess potential large scale water reuse options.*
- *Provide an initial indication of how the implementation of the Ecological Water Requirements could influence the projected water balance situation.*
- *Preliminary analysis of existing water quality management options relating to blending, dilution and water reuse.*

Water requirement scenarios

The assessment of the irrigation water requirements revealed that the estimated water use in the year 2005 for this sector is 1055 million m^3/annum, which is 288 million m^3/annum higher than what was applied in previous investigations (see **Table 4.5***). Preliminary results from the Upper Vaal Water Management Area Validation Study indicated that as much as 240 million m^3/annum of the year 2005 irrigation water use could be unlawful (calculated from* **Table 4.1** *and* **Table 4.2***). The total registered water use for irrigation in the Vaal River System is estimated to be 1 375 million m^3/annum and is an indication that the increasing trend that was experienced since 1998 could continue further if interventions to curb unlawful water use are not successful.*

Water requirement scenarios for the three large industries ***Eskom, Sasol*** *and* ***Mittal Steel*** *were provided by the respective organisation for the development of the strategy and are described in* ***Section 4.3****.*

Urban water requirement scenarios were developed for the ***Rand Water supply area*** *by applying the Water Requirement and Return Flow Model (****DWAF, 2004e****) for the planning period up to 2030. One of the driver variables in the model is population scenarios which were obtained from a parallel study that was carried out by the Directorate: Water Resource Planning Systems of the DWAF. Two future population scenarios were developed, the first scenario was made available in January 2005 and, after a review and comparison with information that was produced by Statistics South Africa (****Stats SA, 2006****), the second scenario was developed in August 2006 (see* ***Section 4.4.2*** *for details). A further population scenario, based on the National Water Resource Strategy (NWRS) Population, was applied to develop an alternative water requirement and return flow scenario.*

The Water Requirement and Return Flow Model was configured for 47 Sewage Drainage Areas (SDAs) and calibrated for the year 2001 (year for which census data was available). The calibration involved changing model parameters to match both the water use and return flows observed for each SDA for the year 2001. The 47 SDAs were divided into those draining into the Crocodile River System (Northern SDAs) and those discharging into the Vaal River System (Southern SDAs), see **Figure 4.2** *for a map showing the location of the SDAs.*

*Water requirement and return flow scenarios were compiled based on the NWRS population scenarios (****Scenario A****) and the August 2006 DWAF population scenario (****Scenario B****) for the Rand Water supply area, as summarised in* ***Table i****.*

*Water requirement scenarios for **Sedibeng Water** and **MidVaal Water Company** were obtained from the respective organisations and for all the **other urban areas*** the water requirement projections were determined using the growth rates from the National Water Resource Strategy (NWRS). Where actual water use data were available, the starting point (volume for the first year in the projection) was adjusted to match the actual value on which the future growths were applied.

***Tables ii** and **iii** summarises the water requirements for **Scenarios A** and **B** respectively, presenting the overall system gross and net water requirements for the planning years 2006 to 2030.*

Table i: Water Requirements and return flow scenarios for the Rand Water supply area

Scenario	*Component*	*Planning Year*					
		2005	2010	2015	2020	2025	2030
Scenario A (NWRS)[1]	*Water Requirements*	***1 300***	***1 352***	***1 431***	***1 496***	***1 582***	***1 681***
	Return Flows	***652***	***694***	***735***	***769***	***807***	***852***
Scenario B (August 2007) [2]	*Water Requirements*	***1 300***	***1 403***	***1 512***	***1 596***	***1 679***	***1 766***
	Return Flows	***556***	***653***	***724***	***785***	***841***	***882***

Notes:

(1) Based on the National Water Resource Strategy population scenario.

(2) Based on the DWAF August 2006 population scenario.

(3) All volumetric values are given in million m^3/annum

Table ii: Summary of water requirements and return flows (Scenario A)

Water users	*Planning years*					
	2006	***2010***	***2015***	***2020***	***2025***	***2030***
Water Requirements						
Rand Water	*1297*	*1338*	*1417*	*1481*	*1568*	*1666*
Mittal Steel	*17*	*17*	*17*	*17*	*17*	*17*
ESKOM	*330*	*381*	*407*	*416*	*417*	*416*
SASOL (Sasolburg)	*24*	*27*	*30*	*33*	*37*	*41*
SASOL (Secunda)	*92*	*104*	*108*	*112*	*117*	*123*
Midvaal Water Company	*35*	*35*	*35*	*35*	*35*	*35*
Sedibeng Water (Balkfontein only)	*41*	*41*	*41*	*41*	*42*	*43*
Other towns and industries	*161*	*163*	*167*	*167*	*167*	*168*
Vaalharts/Lower Vaal irrigation	*542*	*542*	*542*	*542*	*542*	*542*
Other irrigation	*722*	*599*	*500*	*500*	*500*	*500*
Wetland / River Losses	*325*	*326*	*327*	*329*	*330*	*331*
Return Flows						
Southern Gauteng (Rand Water)	*331*	*343*	*359*	*372*	*386*	*400*
Midvaal Water Company	*1*	*1*	*1*	*1*	*1*	*1*
Sedibeng Water	*2*	*2*	*2*	*2*	*2*	*2*
Other towns and industries	*61*	*65*	*69*	*72*	*76*	*80*
Irrigation	*60*	*48*	*38*	*38*	*38*	*38*
Mine dewatering	*114*	*105*	*121*	*123*	*121*	*121*
Increased urban runoff	*101*	*103*	*107*	*113*	*121*	*129*
OVERALL GROSS SYSTEM DEMAND:	*3587*	*3572*	*3590*	*3672*	*37711*	*3881*
OVERALL NET SYSTEM DEMAND:	*2917*	*2905*	*2893*	*2950*	*3025*	*3108*

Notes: (1) All volumetric values are given in million m^3/annum.

Table iii: Summary of water requirements and return flows (Scenario B)

Water users	Planning years					
	2006	2010	2015	2020	2025	2030
Water Requirements						
Rand Water	*1308*	*1390*	*1498*	*1582*	*1665*	*1753*
Mittal Steel	*17*	*17*	*17*	*17*	*17*	*17*
ESKOM	*330*	*381*	*407*	*416*	*417*	*416*
SASOL (Sasolburg)	*24*	*27*	*30*	*33*	*37*	*41*
SASOL (Secunda)	*92*	*104*	*108*	*112*	*117*	*123*
Midvaal Water Company	*35*	*35*	*35*	*35*	*35*	*35*
Sedibeng Water (Balkfontein only)	*41*	*41*	*41*	*41*	*42*	*43*
Other towns and industries	*161*	*163*	*167*	*167*	*167*	*168*
Vaalharts/Lower Vaal irrigation	*542*	*542*	*542*	*542*	*542*	*542*
Other irrigation	*722*	*599*	*500*	*500*	*500*	*500*
Wetland / River Losses	*325*	*326*	*327*	*329*	*330*	*331*
Return Flows						
Southern Gauteng (Rand Water)	*335*	*362*	*392*	*418*	*438*	*459*
Midvaal Water Company	*1*	*1*	*1*	*1*	*1*	*1*
Sedibeng Water	*2*	*2*	*2*	*2*	*2*	*2*
Other towns and industries	*61*	*65*	*69*	*72*	*76*	*80*
Irrigation	*60*	*48*	*38*	*38*	*38*	*38*
Mine dewatering	*114*	*105*	*121*	*123*	*121*	*121*
Increased urban runoff	*101*	*103*	*107*	*113*	*121*	*129*
OVERALL GROSS SYSTEM DEMAND:	*3597*	*3624*	*3672*	*3773*	*3868*	*3967*
OVERALL NET SYSTEM DEMAND:	*2923*	*2939*	*2942*	*3005*	*3071*	*3136*

Notes: (1) All volumetric values are given in million m^3/annum.

Potential savings through water conservation and water demand management measures

*Three saving scenarios were compiled from the assessment of the potential for water conservation and water demand managements (WC/WDM) in the urban sector. The savings were applied to the water requirements of **Scenario B** (see **Section 4.5**) and were labelled **Scenarios C**, **D** and **E** respectively. The description and saving results from the scenarios are as following:*

- **Scenario C**: 5 Year water loss programme where water wastages are reduced through measures such as leak detection and repair. The loss management measures are maintained after the five year period. This scenario also include measures to improve the efficiency of water use and the assumption was made that a 1% saving can be gained per annum from the year 2015 onwards for the entire planning period (1% of selected large urban users that were assessed in detail). .

- **Scenario D**: Reduction in wastage over 5 years. No efficiency improvement measures were included in this scenario.
- **Scenario E**: Reduction in wastage over 10 years, allowing for a slower implementation period of the proposed measures.

*A summary of the estimated savings in the water requirements of the three above-mentioned scenarios are presented in **Table iv.***

Table iv*: Savings for the indicated planning years: Scenarios C, D and E compared to Scenario B*

Scenarios	*Planning Years*				
	2010	*2015*	*2020*	*2025*	*2030*
C	*177* *(11%)*	*272* *(16%)*	*329* *(18%)*	*379* *(20%)*	*378* *(19%)*
D	*180* *(11%)*	*191* *(11%)*	*200* *(11%)*	*213* *(11%)*	*213* *(11%)*
E	110 *(7%)*	176 *(10%)*	193 *(11%)*	206 *(11%)*	208 *(10%)*

Notes: *(1)* *All volumetric values are given in million m^3/annum.*

(2) *Values in brackets give the percentage reduction in the total system urban demand from **Scenario B**. The urban demand include the following components; Rand Water, Midvaal Water Company, Sedibeng Water and "Other towns and industries" as listed in **Table iii**.*

Future intervention requirements and augmentation schemes

Given the water requirement and return flow scenarios and the potential saving scenarios through WC/WDM measures presented in the previous sections, the need for intervention (when further

WC/WDM measures and/or the development of an augmentation scheme are required) was determined by assessing the water reconciliation (water balance) situation over the planning period. This was undertaken by firstly defining the planning scenarios and, secondly, carrying out scheduling analysis to determine the date when further intervention should be required (see description of planning scenarios in a subsequent section).

The Vaal Augmentation Planning Study (VAPS), completed in 1996, concluded that either a further phase of the Lesotho Highlands Water Project (LHWP) or further water resource developments in the Thukela River System could be considered as alternatives for augmenting the water resources of the Vaal River System.

The Thukela Water Project Feasibility Study (TWPFS) determined the most feasible scheme configuration for development in the Thukela River System. The study concluded that two proposed dams, one on the Bushman's River (Mielietuin Dam) and the other on the main stem of the Thukela River (Jana Dam), with transfer infrastructure, would be the most feasible scheme configuration to provide a nominal transferable yield of 15m^3/s (473 million m^3/annum).

A further study, the "Thukela Water Project Decision Support Phase" (TWPDSP) study, was carried out to, among other things, undertake a Comprehensive Reserve Determination Study for the Thukela River System and compile an implementation programme for the TWP. The results from this study indicated that the first water could be delivered twelve years after the decision is taken to proceed with the development. The Historic Firm Yield of the TWP, incorporating the Ecological Water Requirements (EWR), for the largest dam sizes was determined to be 454 million m^3/annum.

A joint feasibility study by the South African and Lesotho governments was commissioned in 2005 with the purpose of identifying the most feasible further phases of a scheme in Lesotho. Results from the first phase of the study were made available to the Reconciliation Study Team which indicated the proposed Polihali Dam with transfer infrastructure as the preferred option. The implementation period required for the scheme was estimated to be ten years after the decision is taken to proceed with the scheme. (If the decision is taken immediately, however, a further three years preparation phase has to be added to the ten years. This is to complete the current feasibility study and to investigate funding options.) The Historical Firm Yield of the Polihali Dam option was determined to be 458 million m^3/annum.

The second phase of the LHFP Feasibility Study commenced in October 2006 and the reconciliation results presented in this report will be used initially to determine the optimal configuration during that study. Updated water requirement projection scenarios is expected from the bulk water users Eskom and SASOL, and these scenarios will be incorporated into the second phase of the Vaal River System: Reconciliation Strategy Study.

Planning scenarios and reconciliation options

Given the water requirement and return flow scenarios as well as the WC/WDM saving options, the following planning scenarios were compiled for analysis of the water balance:

- ***Scenario A**: National Water Resource Strategy (NWRS) population scenario for urban water requirements.*
- ***Scenario B**: August '06 DWAF population scenario applied for the urban water requirements.*
- ***Scenario C**: Implement the savings of all identified WC/WDM measures based on the water requirements of **Scenario B**.*
- ***Scenario D**: Implement waste management initiatives over 5 years based on the water requirements of **Scenario B**.*
- ***Scenario E**: Implement waste management initiatives over 10 years based on the water requirements of **Scenario B**.*

*NOTE: All the above scenarios assumed the unlawful irrigation water use is removed (see **Section 4.2.7** for details).*

***Figure 6.2** presents the net system demand compared to the supply capability of the system and shows:*

- *The unlawful water use in the irrigation sector results in the system being in a deficit situation from 2007 to 2009 for all the scenarios.*
- *Based on the projected balance situation for **Scenario B**, it is shown that the system will require intervention by the year 2013.*
- *If the potential savings through WC/WDM of **Scenario C** is achieved, no further intervention is required for the planning period until after the year 2030.*

- *The balance situation for **Scenarios D** and **E** shows that by eliminating wastage through WC/WDM further intervention is only required in the year 2023.*

*The reconciliation assessment (see **Section 6.6**) showed that both the Thukela Water Project (TWP) and the Lesotho Highlands Further Phases (LHFP) will be able to support the growing water requirements of **Scenario B** up to the year 2030. The respective implementation periods required for these augmentation projects will, however, result in supply deficits over the medium term (see **Figure 6.4** and **Figure 6.5**).*

*The above result illustrate that WC/WDM is the only intervention measure that can be implemented to achieve a positive water balance over the medium term. The reconciliation situation based on **Scenario D** (including WC/WDM measures) indicates that the need for augmentation is postponed to 2023 and that both the TWP and LHFP is capable of supporting the long term water requirement growth (*see **Figure 6.6** and **Figure 6.7**).

*An alternative irrigation water requirement scenario (**Scenario F**) was compiled where it was assumed the unlawful irrigation could not be reduced (see **Section 4.2.7** for details). The purpose of this option was to illustrate that large deficits in the water balance will occur. This will result in large water restrictions over the medium term and significant capital investment in the long term and is considered to be unsustainable (see **Section 6.6.5** and **Figure 6.8** for details).*

Perspective on water quality management

The situation assessment indicated that, with respect to salinity and nutrients (Phosphate and Nitrate), the river systems upstream of Vaal Dam and Grootdraai Dam are acceptable, however, the situation in the river reach from the Vaal Barrage to Bloemhof Dam is such that there are serious risks for the development of eutrophic conditions.

*Initial indications are that flow management measures, supported by intensive monitoring, could help to alleviate the risk over the short term. The impact of such releases (from Vaal Dam) on the supply capability of the system has to be assessed, which is a proposed activity for the **Second Stage Reconciliation Strategy**.*

In the long term, nutrient loads (Phosphate) in the system can be reduced by adding secondary treatment processes to the existing urban water treatment works. Initial analysis of the dilution rule (where water is released from Vaal Dam to reduce the Total Dissolved Solid's Concentration in and *downstream of Vaal Barrage) indicated that this option would only be feasible over the medium term (<8 years) and other options, such as desalination, would have to be considered for the long term management of salinity. This is due to the fact that the dilution rule will result in excess water in Bloemhof Dam from about 2012 onwards.*

It is however possible to utilise the excess water in Bloemhof Dam to support the Orange River at the time of the next augmentation from the LHFP or when the Orange system demand exceeds the current system yield by approximately 2015. This means that under these conditions it will be possible to continue with the dilution rule for a longer period, which in turn postpones the need for costly desalination.

Strategic perspective

The findings of the assessments presented above point to the following specific water resource management strategies:

- *The eradication of the unlawful water use is an essential strategy that has to be implemented in order to rectify the current deficit (negative water balance) in the Vaal River System. The legal actions and procedures that will be implemented should be designed to achieve legal precedence to protect the entitlements of lawful water users and assist in compliance monitoring and water use regulation in future.*

- *The validation studies in the three Vaal Water Management Areas must be completed to firm up on the irrigation water use in the system. A product of the validation studies should be an assessment of the lawful water use. The results from the validation studies should be used to revise the projected water balance of the system.*

- *The continuation of current and the initiation of further WC/WDM projects are essential to maintain a positive water balance in the Vaal River System. The potential savings that can be achieved through the reduction of water wastage are sufficient to delay the decision to proceed with an infrastructural option to the year 2012.*

- *The high risk of eutrophic conditions in the Vaal River reach from Vaal Barrage to Bloemhof Dam requires water resource management intervention. Over the short term the situation could be improved by releases from Vaal Dam, however, current assessments point to the need for the removal of nutrients from the urban wastewater treatment works through secondary treatment processes.*

- *Due to the importance of urban return flows and the impact WC/WDM could have on the return flows, it is required to implement continuously monitoring of the return flows to be able to determine the net water requirements of the system. This will enable regular updates of the water balance and monitoring of the situation against the scenarios presented in this document.*

- *The second phase of the Lesotho Highlands Further Phases (LHFP) Study should be completed based on the water balance results of **Scenarios B** and **D**. Once the optimal LHFP scheme has been identified it will be required to undertake a comparison with the optimal TWP options before a decision can be made on which of the two alternative schemes should be recommended for implementation.*

- *The Thukela Water Project's configuration and component sizes will have to be optimised for the deficit in the water balance as reflected by **Scenarios B** and **D**.*

- *The Directorate: Resource Directed Measures has towards the end of 2006 commissioned a Comprehensive Reserve Determination Study and the results thereof will have to be incorporated into the water balance once it becomes available.*

- *The Directorate: Option Analysis of DWAF has at the end of 2006 commissioned a study to assess options for the potential utilisation of Taung Dam in the Lower Vaal Water Management Area. The findings of the study will have to be incorporated into the water balance of the Vaal River once the results become available.*

- *It was proposed at the Steering Committee meeting of 29 March 2006 that a committee to oversee the implementation of the reconciliation strategy be formed. Broadly, the function of the committee will be to continuously monitor the water balance situation of the Vaal River System and advise the responsible institutions on whether or not the objectives of the strategies are being achieved.*

Recommendations for aspects to be considered for the Second Stage Reconciliation Strategy are provided in Chapter 11.

Stakeholder Participation

During the course of the study several Stakeholder Participation meetings were held for different purposes. A Study Steering Committee was established to guide the development of the

Reconciliation Strategy, representing the following sectors, industrial, agricultural, environmental, water service providers and local government.

The list below indicates the names and affiliations of the Steering Committee Members:

COMMITTEE MEMBER	ORGANISATION	COMMITTEE MEMBER	ORGANISATION
Eustathia Bofilatos	DWAF – D:WMIG	Derek Pretorius	Govan Mbeki Local Municipality
Carin Bosman	DWAF – D:RP&W	Sam Shabalala	Metsi-a-Lokoa Local Municipality
Cain Chunda	DWAF – D:WUE	Nic Opperman	AgriSA
Marcelle Collins	Provincial DEAT - Free State	Giddeon Dippenaar	Sedibeng Water
Hanke Du Toit	DWAF- Northern Cape	Gerhard Bakkerberg	Water Research Commission
Manie Groenewalt	DWAF - Free State Region	Mrs van Rensburg	Trans Caledon Tunnel Authority
Jacques Herselman	DWAF – Gauteng Region	William Moraka	SALGA
Pricilla Mohapi	DWAF – Free State Region	Hennie Smit	DWAF: Gauteng Regional Office
Beason Mwaka	DWAF – D:WRPS (SO)	Mrs van der Merwe	Mogale City
Kalinga Pelpola	DWAF – D:WS (Support Services)	Frans Mouton	Tshwane Metropolitan Municipality
Harrison Pienaar	DWAF – D:RDM	Nic Knoetze	Association of Water User Associations of South Africa
Elsabe Powell	Provincial DEAT - Northern Cape		
Piet Pretorius	DWAF – D:WA & U	Rodney Spies	Matjhabeng Municipality
Peter Pyke	DWAF – D:OA	Valita Roos	Johannesburg Water
Seef Rademeyer	DWAF – D:NWRP	Jon Machanik	Chamber of Business
Dragana Ristic	DWAF – D:NWRP	Nikisi Lesufi	Chamber of Mines
Hayley Rodkin	DWAF – D:WUE	Dr Nikki Wagner/Martin Ginster	Sasol
Ashwin Seetal	DWAF – D:WA	Tina Korfias	Ekurhuleni Metropolitan Municipality
Muruvan Sugandree	DWAF – D:WS (Regulation)	Jean-Pierre Mas	Johannesburg Water
Elize Swart	Dept Minerals & Energy	Roy Thompson	Rand Water
Chabedi Tsatsi	DWAF – D:WUE	Ms Hameeda Deedat	South African Water Caucus (NGOs/Civil Society)
At van Coller	National Dept. of Agriculture	Keith Naicker	Rand Water
Paul van der Merwe	DWAF – D:WRF&P	Walter De Wet	Randfontein Municipality
Walther van der Westhuizen	DWAF – Gauteng Region	Kathy Eales	City of Johannesburg
Peter van Niekerk	DWAF - CD: IWRP	Rafat Khan	Midvaal Water
Johan van Rooyen	DWAF – D:NWRP	Alwyn van der Merwe	Eskom
Jurgo van Wyk	DWAF – D:WRPS (WQP)	Thandiwe Mhlongo	Rustenburg Municipality

Vaal River System: Large Bulk Water Supply Reconciliation Strategy

First Stage Reconciliation Strategy (December 2006)

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APPENDIX A: FIGURES

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ABBREVIATIONS

Acronym	Meaning
BP	Business Plan
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
Dir: HI	Directorate: Hydrological Information
Dir: NWRP	Directorate: National Water Resource Planning
CMS	Catchment Management Strategy
Dir: OA	Directorate: Option Analysis
Dir: PSC	Directorate: Policy and Strategic Co-ordination
Dir: WRPS	Directorate: Water Resource Planning Systems
Dir: RDM	Directorate: Resource Directed Measures
Dir: WCDM	Directorate: Water Conservation and Demand Management
Dir: WDD	Directorate: Water Discharge and Disposal
Dir: WUE	Directorate: Water Use Efficiency
DWAF	Department of Water Affairs and Forestry
EWR	Ecological Water Requirements
GDP	Gross Domestic Product
GGP	Gross Geographical Product
IDP	Integrated Development Plan
IWQMPS	Integrated Water Quality Management Plan Study
ISP	Internal Strategic Perspective
LHWP	Lesotho Highlands Water Project
LHFP	Lesotho Highlands Future Phases
LORMS	Lower Orange River Management Study
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NWA	National Water Act
NWRS	National Water Resource Strategy

Acronym	Meaning
ORRS	Orange River Replanning Study
UARL	Unavoidable Real Losses
SDA	Sewage Drainage Area
TDS	Total Dissolved Solids
TWPDSP	Thukela Water Project Decision Support Phase
TWP	Thukela Water Project
VAPS	Vaal Augmentation Planning Study
VRESAP	Vaal River Eastern Sub-system Augmentation Project
WARMS	Water Allocation Registration Management System
WDM	Water Demand Management
WC	Water Conservation
WMA	Water Management Area
WSDP	Water Services Development Plan
WRPM	Water Resource Planning Model
WRSAS	Water Resource Situation Assessment Study
WUA	Water User Association
WWTW	Waste Water Treatment Works

FORMER AND NEW MUNICIPAL NAMES

Former Name	New Municipal Name	Province
Johannesburg	City of Johannesburg	Gauteng
Pretoria	City of Tshwane	Gauteng
Khayalami	Ekurhuleni Metropolitan	Gauteng
Vereeniging	Emfuleni Local Municipality	Gauteng
Bronkhorstspruit	Kungwini Local Municipality	Gauteng
Heidelberg	Lesedi Local Municipality	Gauteng
Carletonville	Merafong City Local Municipality	Gauteng
Bronkhorstspruit; Highveld DC	Metsweding District Municipality	Gauteng
Meyerton	Midvaal Local Municipality	Gauteng
Krugersdorp	Mogale City Local Municipality	Gauteng
Cullinan	Nokeng tsa Taemane Local Municipality	Gauteng
Randfontein	Randfontein Local Municipality	Gauteng
Lekoa/Vaal, Vereeniging/Kopanong,	Sedibeng District Municipality	Gauteng
Southern DC	West Rand District Municipality	Gauteng
Westonaria	Westonaria Local Municipality	Gauteng
Bethlehem	Dihlabeng Local Municipality	Free State
Trompsburg	Kopanong Local Municipality	Free State
Allanridge, Boshof, Bothaville, Bultfontein, Dealesville, Goldfields, Hertzogville, Greater Brandfort, Hennenman, Hoopstad, Moddervaal, Odendaalsrus, Sandrivier, Soutpan, Theunissen, Verkeerdevlei, Virginia, Vetvaal, Ventersburg, Welkom, Wesselbron, Winburg	Lejweleputswa District Municipality	Free State
Frankfort	Mafube Local Municipality	Free State
Qwa-Qwa	Maluti a Phofung Local Municipality	Free State

Former Name	New Municipal Name	Province
Theunissen	Masilonyana Local Municipality	Free State
Welkom	Matjhabeng Local Municipality	Free State
Sasolburg	Metsimaholo Local Municipality	Free State
Kroonstad	Moqhaka Local Municipality	Free State
Bothaville	Nala Local Municipality	Free State
Parys	Ngwathe Local Municipality	Free State
Reitz	Nketoana Local Municipality	Free State
Vrede	Phumelela Local Municipality	Free State
Senekal	Setsoto Local Municipality	Free State
Eastern Free State DC	Thabo Mofutsanyane District Municipality	Free State
Hoopstad	Tswelopele Local Municipality	Free State
Balfour	Dipaleseng	Mpumalanga
Highveld Ridge	Govan Mbeki Municipality	Mpumalanga
Standerton	Lekwa	Mpumalanga
Ermelo	Msukaligwa	Mpumalanga
Volksrust	Pixley Ka Seme	Mpumalanga
Reivilo	Greater Taung Local Municipality	North West
Ganyesa	Kagisano Local Municipality	North West
Koster	Kgetlengrivier Local Municipality	North West
Christiana	Lekwa-Teemane Local Municipality	North West
Schweizer-Reneke	Mamusa Local Municipality	North West
Wolmaransstad	Maquassi Hills Local Municipality	North West
Pomfret	Molopo Local Municipality	North West
Vryburg	Naledi Local Municipality	North West
Potchefstroom	Potchefstroom Municipality	North West
Ventersdorp, Klerksdorp, Potchefstroom, Wolmaransstad	Southern District Municipality	North West
Delareyville	Tswaing Local Municipality	North West
Ventersdorp	Ventersdorp Local Municipality	North West
Barkley West	Dikgatlong Municipality	Northern Cape
Warrenton	Magareng Municipality	Northern Cape
Hartswater	Phokwane Municipality	Northern Cape
Kimberley	Sol Plaatjie Municipality	Northern Cape
Kathu	Gamagara Municipality	Northern Cape
Kuruman	Ga-Segonyana Municipality	Northern Cape
Griekwastad	Siyancuma Municipality	Northern Cape
Danielskuil	Kgatelopele Municipality	Northern Cape
Postmasburg	Tsantsabane Municipality	Northern Cape

Vaal River System: Large Bulk Water Supply Reconciliation Strategy

First Stage Reconciliation Strategy (December 2006)

CHAPTER 1. INTRODUCTION

1.1 BACKGROUND

The Department of Water Affairs and Forestry (DWAF) has, as part of the development of the Internal Strategic Perspectives (ISPs)[1] for the three Vaal River Water Management areas (WMAs) identified and prioritised several studies that are necessary to further support Integrated Water Resource Management in the Vaal River System. Although previous water balance assessments indicated that augmentation of the Vaal River System is only required by the year 2025 (**DWAF, 2004a to d**), several factors were identified that could influence this date and require further investigations.

Firstly, it was acknowledged that the water requirement projection scenarios used in the ISP study did not explicitly include the effect of water conservation and water demand management initiatives (**DWAF, 2004d**) and as a result the Directorate Water Use Efficiency commissioned a Water Conservation and Water Demand Management study with particular focus on the Upper and Middle Vaal WMAs.

Secondly, it was recognised that the time it takes to implement a large water resource augmentation scheme could be as long as fifteen years and coupled with the fact that the future water requirement scenarios exhibit low growth rates makes the timing of any future intervention critical.

Thirdly, a comprehensive Reserve Determination has not been undertaken for the Vaal River System and will have to be incorporated into the development of reconciliation strategies.

In view of the above considerations as well as other uncertainties identified in the assumptions used in the ISP study (see **DWAF, 2004d** for details), the Directorate: National Water Resource

[1] The Internal Strategic Perspectives (ISPs), the first version was compiled in 2004.

Planning (D:NWRP) has commissioned this reconciliation study of the large bulk water supply system of the Vaal River.

The ISPs for the Vaal River WMAs further identified the need for integrated water quality management of the Vaal River and its major tributaries. Although there are several individual Catchment Management Strategies already completed, these strategies and their objectives need to be integrated and co-ordinated in a system context. To this end, the D:NWRP has commissioned a study to develop an **Integrated Water Quality Management Plan** (DWAF, 2006a) for the Vaal River System which is running concurrently with the **Reconciliation and Water Conservation and Water Demand Management** (DWAF, 2006b) studies.

During the inception phases of these studies it was identified by the respective management teams that the integration of strategies and co-ordination of study activities would be essential to development coherent water resource management measures for the Vaal River System. The management of the studies was therefore coordinated by combining the project management of the Water Conservation and Reconciliation studies and have cross representation of study managers on the Water Quality Study.

In each of the three abovementioned studies the importance of stakeholder involvement in the development of the strategies was emphasised and an integrated stakeholder engagement process was designed. This resulted in combining the stakeholder meetings for all three the studies, combining the Steering Committee Meetings of the Water Conservation and Reconciliation studies and having shared representation on the Water Quality Study.

1.2 PURPOSE OF THE STUDY

The Large Bulk Water Supply Reconciliation Strategy for the Vaal River System Study has the objective to develop strategies for meeting the growing water requirements of the industrial and urban sectors that are served by the Integrated Vaal River System. The development of these strategies requires reliable information of the water requirements and the water resources for the current situation as well as likely future scenarios for a planning horizon of twenty to thirty years.

The key objectives of the study are to:

- Update the current and future urban and agricultural water requirements.
- Assess the water resources and existing infrastructure.
- Take into account the Reserve requirements for alternative classifications.
- Formulate reconciliation interventions, both structural and administrative/regulatory.
- Conduct stakeholder consultation in the development of the strategies.

In order to achieve these objectives the study was undertaken through a series of tasks which culminated into a set of study reports that are listed on the back of the cover page of the report. The information from the task reports was combined to formulate the reconciliation strategy, the main deliverable from the study, which is presented in this report.

1.3 STUDY AREA

The core of the study area consists of the Upper, Middle and Lower Vaal River Water Management areas, however, due to the numerous inter-basin transfers that link this core area with other WMAs, reconciliation planning has to be undertaken in the context of the Integrated Vaal River System which also includes portions of the Komati, Usutu, Thukela and Senqu River (Located in Lesotho) catchments. In addition, significant water transfers occur to water users in the Olifants and Crocodile (West) River catchments of which most are totally dependant on the water resources of the Integrated Vaal River System. **Figure A-1** in **Appendix A** shows a geographical map of the Integrated Vaal River System which is the area of concern for the study.

The water resource components of the Integrated Vaal River System are highly inter-dependant due to the cascading orientation of the three Vaal River WMAs as well as the links that exist as a result of the transfer schemes (indicated by the arrows on **Figure A-1**). The water resource system provides water to one of the most populated and important areas in the country as reflected by the magnitude of the developments located in the Upper and Middle Vaal, the Olifants and the upper portion of the Crocodile West/Marico Water Management areas. These developments include many of the country's power stations, gold mines, platinum mines, petro-chemical plants, sprawling urban development as well as various other strategic industries. The water requirements in the area are therefore very important to sustain the economy of the country and the well-being of its people.

It should be noted that the study area of the Integrated Water Quality Management Plan Study (IWQMPS) covers a slightly larger area than the three Vaal River WMAs and also include the Riet and Modder River Catchments, which is part of the Upper Orange WMA. The inclusion of these catchments was necessary to cover all water quality aspects of the entire Vaal River's catchment down to it's confluence with the Orange River.

1.4 PURPOSE AND LAYOUT OF THIS REPORT

This report describes the First Stage Reconciliation Strategy for the Vaal River System and serves as a summary document that collates information of other technical reports that were compiled in the study.

The introduction, given in **Chapter 1**, is followed by descriptions of the study procedure and the reconciliation strategy development methodology in **Chapter 2** and **Chapter 3** respectively. **Chapter 4** describes the water requirement and return flow scenarios on which the water conservation and water demand management scenarios, presented in **Chapter 5**, were based. The results from the first five chapters are used to determine the requirements for future interventions to reconcile the demand with the available supply, as presented in **Chapter 6**. A brief perspective on water quality management aspects are provided in **Chapter 7**. The report concludes with four chapters covering: uncertainties concerning reconciliation, strategic perspective regarding water management, recommendation for investigations during the development of the ***Second Stage Reconciliation Strategy*** and finally, the references used in the report are presented in **Chapter 12**.

CHAPTER 2. STUDY PROCEDURE

The overarching study approach was to develop reconciliation strategies in two stages. The first stage involved developing scenarios of possible future reconciliation options which included various assessments to firm up on certain uncertainties that were identified when the study was commissioned. The intention was that the First Stage Reconciliation Strategy will be presented to DWAF Management and Stakeholders for comments and then to identify the need for possible further investigations that may be required in the period leading up to the development of the ***Second Stage Reconciliation strategy*** which is programmed for completion by November 2007.

An essential part of the strategy development process was the integration of information from various processes and studies in order to arrive at a strategy that account for all major aspects that influence the bulk water supply situation in the Vaal River System. This was achieved by co-ordinating activities among the three studies (see **Section 1.1**) as well as incorporating information from other DWAF and stakeholder investigations that were carried out in parallel assignments.

The focus of the assessments for the First Stage Strategy included the following:

- Develop water requirement and return flow scenarios by focussing the assessments on the urban water use sector of the Gauteng Province.

- Determine the potential for Water Conservation and Demand Management by concentrating on the main urban areas. This involved developing scenarios of potential savings in water use for the planning period leading up to the year 2030.

- Estimate the irrigation water requirements by evaluating preliminary information that was obtained from the water use validation process, which is undertaken by DWAF. (The final results from the validation studies were not available at the time of writing this report.)

- Identify and assess potential large scale water reuse options that could have water quality and water supply benefits.

- Provide an initial indication of how the implementation of the Ecological Water Requirements (a component of the Reserve) could influence the projected water balance situation. (In August 2006, DWAF has initiated studies to undertake Comprehensive Reserve determinations for the Integrated Vaal River System, however, results from these assessments will only become available in a year's time. Therefore the perspective presented in this report is based on readily available information that was provided by the Directorate: Resource Directive Measures and was generated from Reserve Determinations undertaken at varying levels of confidence.)

- Preliminary analysis of existing water quality management options relating to blending, dilution and water reuse.

In support of the above described technical work, an integrated stakeholder engagement process, which consolidated the communication needs of the three studies (referred to in **Section 1.1**), were followed as depicted graphically in **Figure 2.1**.

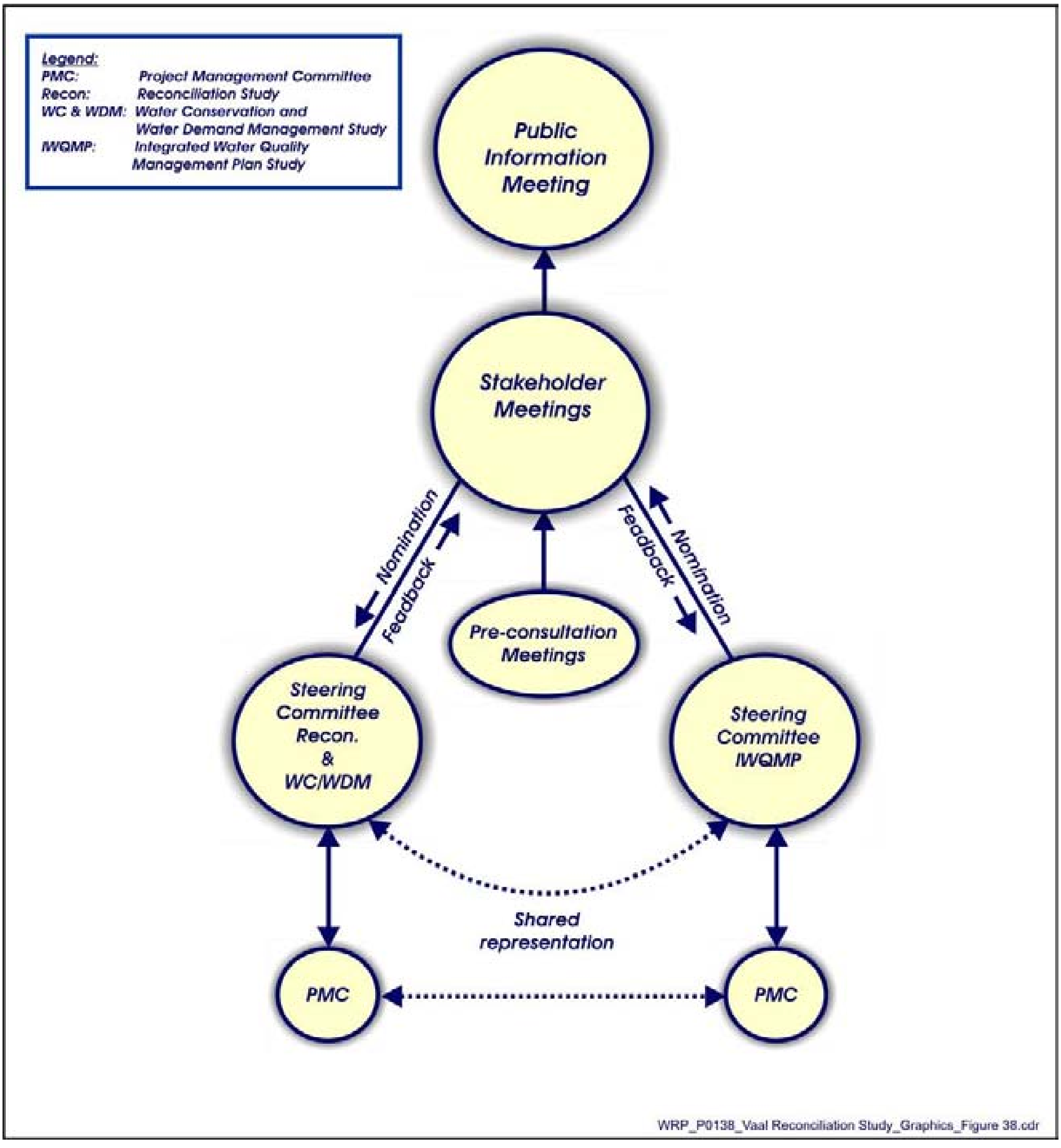


Figure 2.1: Schematic representation of the Stakeholder Engagement Process

CHAPTER 3. RECONCILIATION STRATEGY DEVELOPMENT METHODOLOGY

3.1 OVERVIEW

The development of strategies to reconcile the water requirements with the available water in the Vaal River System has to be founded on a sound understanding of the projected water balance for at least a fifteen year planning period into the future. This long term view is necessary due to the long lead time required to implement a large bulk water augmentation scheme and that the decision to proceed with such schemes has to be taken ten to fifteen years before the first water is delivered.

Understanding the water balance of the system, requires information on the water that is available from the water resource systems on the one hand, and what the water requirements are, on the other. DWAF has over the years developed sophisticated analysis techniques and decision support systems to determine the water availability and, as stated in the *Vaal River System Overarching Internal Strategic Perspective* report (**DWAF, 2004d**), the current knowledge on the water availability estimates are at a sufficient level of confidence. The approach taken in this study is to use the existing available hydrological databases and simulation models and only make changes to the configurations in accordance with the requirements of each scenario that was analysed. Therefore, neither the hydrology database nor the calibration of the salinity modules were updated in the study.

Several uncertainties were however identified concerning the current and future water requirements, with the result that the focus of the technical work revolved around determining quantitative scenarios of future water use for all sectors, quantifying the potential for water conservation and water demand management in the urban sector, estimate the irrigation water requirements, identify potential large bulk water re-use opportunities and obtain preliminary indications of the reconciliation situation in meeting the Ecological Water Requirements.

Once the quantification of the above-mentioned “demand side” components has been completed, scenarios were defined to represent possible future conditions. These scenarios were then analysed in the simulation models (Water Resource Planning Model - WRPM) to determine the date when intervention is required. The WRPM produces, among other things, a projection of the risk of curtailments for each year of the planning period, and the date when the user reliability criteria is violated (risk of curtailment are more than the criteria) defines the year in which an intervention measure should be commissioned. These interventions could be measures on either side of the water balance, such as more intensive water conservation measures or the development of an infrastructural solution in the form of new water resource augmentation schemes.

In addition to the water quantity balance the incorporation of water quality management scenarios as part of the reconciliation strategy is essential. This was achieved by integrating the options identified from the *Integrated Water Quality Management Plan Study* (IWQMPS) with the scenarios of the Reconciliation study, to account for interdependencies to be able to develop coherent strategies. Although the detail water quality assessments and results are provided in the study reports of the IWQMPS, the key outcomes of the study are briefly described in **Chapter 7**.

The sections below give brief descriptions of the methodology that was followed in the study, grouped according tot the main study tasks.

3.2 URBAN WATER REQUIREMENT SCENARIO DEVELOPMENT

Substantial increases in the water use occurred in the urban and industrial sectors in the past years, which can be contributed to the favourable socio-economic conditions in the country. The economic expansion is however unevenly distributed among the provinces, with the growth rate of the economy in the Gauteng Province being substantial higher than the country average. The opportunities created by the expanding economy in Gauteng, has resulted in a trend of in-ward migration of people to the province as reflected in the "*2006 Mid-Year Population Estimates" **(SSA,2006)**,* published in August 2006 by Stats SA. The economic prospects, coupled with rising living standards of the population, as well as other factors such as HIV AIDS are, and will continue having significant influences on the future water requirements to be supplied from the Vaal River System.

The methodology for determining the urban water requirement scenarios were based on the procedures that were developed as part of the *Crocodile River (West) Return Flow Analysis Study* (**DWAF, 2004e**). This method involves defining algorithmic models of each Sewer Drainage Area (SDA), where a SDA encompasses urban areas that are serviced by a sewer collection system that discharges to a particular Waste Water Treatment Works (WWTW). The algorithm uses population as the main driver (independent variable) and through a process of calibration of model parameters define the relationship between population and water requirements as well as return flows.

Given the inherent uncertainties that exist in long-term water requirement estimates, a process of scenario development has been followed to derive likely alternative future water requirement projections.

3.3 UPDATING OF THE IRRIGATION WATER REQUIREMENTS AND RETURN FLOWS

Water requirements of the Irrigation Sector have been the subject of various studies in the past, of which the information from the *"Loxton Venn"* Study (**DWAF,1999**) was used in all recent water resource planning investigations. The subsequent water use registration, validation and verification processes commissioned by DWAF have generated further sources of information in the form of the Water Allocation Registration Management System (WARMS) and the database generated from the validation studies. At the time the irrigation water requirement task was carried out, the validation study of the Upper Vaal Water Management Area was partly completed and it was possible to extract partial validated information (about 70% of the properties were validated) for analysis in this study. The validation studies of the other two Vaal WMAs were however only commissioned and no validated information was available at the time. The approach that was therefore followed to estimate the irrigation water use in the Middle and Lower Vaal WMAs, was to prepare comparison reports of the data sources from previous studies and the WARMS database. These comparisons were then discussed with the water resource managers of the respective regional offices to make a decision on the most appropriate data to use for the study.

3.4 POTENTIAL SAVINGS FROM WATER CONSERVATION AND WATER DEMAND MANAGEMENT

A parallel study (**DWAF, 2006b**) to determine the potential savings that can be achieved through water conservation and water demand management (WC/WDM) in the Vaal River System was commissioned by the Directorate: Water Use Efficiency, and a high level of integration with the Reconciliation Study assured that the products of the two studies were aligned.

The focus of the WC/WDM assessment was on the nine largest urban water users, which in total used 1 186 million m^3/annum of water in the year 2004, as listed in **Table 3.1** below.

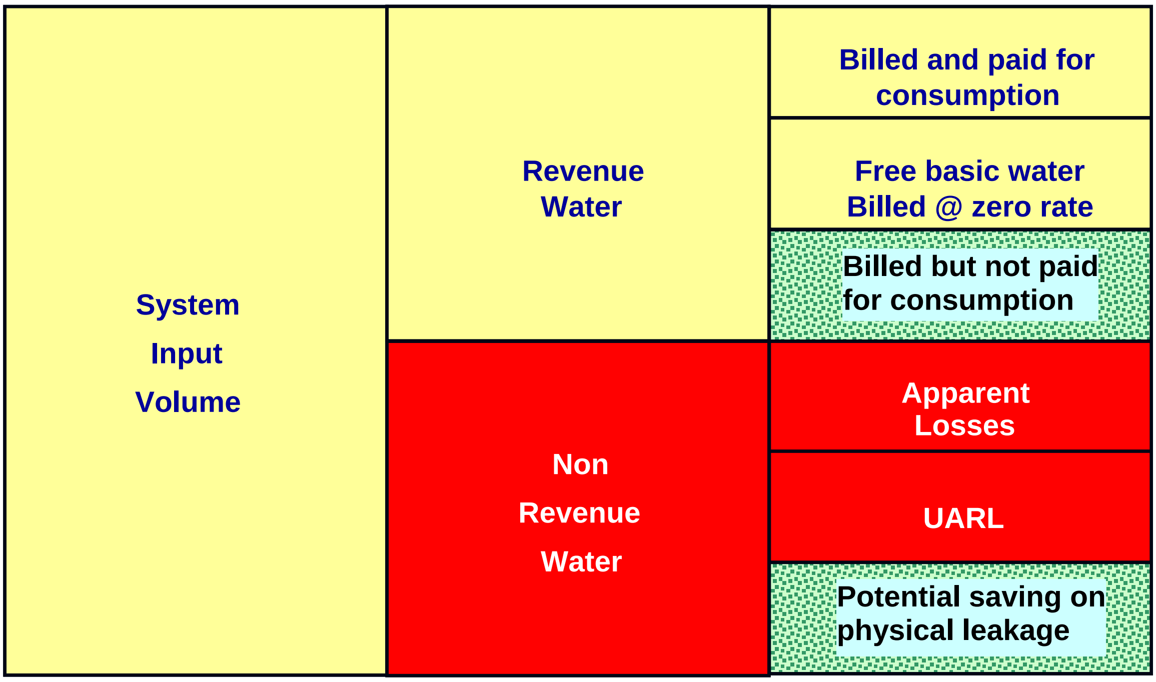
Table 3.1: Major municipal demands considered in the study listed in descending order

Municipality	Water use in the year 2004 (million m^3)
Johannesburg	**470**
Ekurhuleni	**291**
Tshwane	**255**
Emfuleni	**79**
Rustenburg	**26**
Mogale	**24**
Govan Mbeki	**18**
Matjhabeng	**16**
Randfontein	**7**
Total	**1 186**

A standard water balance was undertaken for each municipality, which was built up from assessments of water supply zones in their respective supply areas to represent the actual conditions in each zone.

An illustration of the components that make up the water balance is provided in

Figure 3.1, indicating the losses and non-revenue water. From this water balance the potential savings were determined with the focus on the “Billed but not paid for consumption” as well as the “Potential savings on physical leakage” (green hashed blocks) components.



Notes: UARL – Unavoidable Real Losses

Figure 3.1: Illustration of a standard water balance

Based on detailed assessments made on numerous supply zones in each municipal area, the potential savings coupled with a range of WC/WDM measures were determined. With the knowledge that these measures will require substantial financial and human resources to implement, a schedule (projection) of future savings were made, resulting in the development of three scenarios (see **Section 5.2.1** for a description of these scenarios).

3.5 RECONCILIATION FOR A PRELIMINARY RESERVE SCENARIO

In the **Vaal River System Overarching ISP** (DWAF, 2004d)it was recommended that a comprehensive reserve determination of the Vaal River System and the supporting source catchments has to be undertaken. Although high confidence reserve determinations have been carried out in a few catchments, the need for a Comprehensive Reserve Determination Study that covers the entire integrated system has been identified by DWAF. The Directorate: Resource Directed Measures (Dir: RDM) has, therefore, commissioned studies during the end of 2006 for undertaking Comprehensive Reserve Determination Studies.

In order to provide an interim perspective on the water balance concerning the Reserve as part of this study, an analysis was carried out where all available Ecological Water Requirement (EWR) information was sourced from Dir: RDM and incorporated into the WRPM. Two scenarios were simulated, one with, and the other without the EWRs, and in each case the date when system failure occurred were determined for a selected water requirement projection scenario that covers the planning period up to the year 2030. The results are discussed in **Section 6.5.**

3.6 DETERMINATION OF THE REQUIRED INTERVENTION DATES

Operational and planning decisions concerning the Integrated Vaal River System are informed by risk analysis techniques involving simulation of the water resource system using computer models. The analysis is undertaken by means of a suit of water resource simulation models, which contains an extensive hydrological database that covers all the catchments and river systems comprising the Integrated Vaal River System. The suit of models consists of various supporting utilities, all having the function of generating data and information required by the WRPM.

The WRPM is the main decision support system, which through scenario analysis determines, among other things, the future date when intervention is required based on the probability (risk) of curtailments for a given set of variables and assumptions. The model contains an allocation procedure (algorithm) to simulate curtailment rules, which reduce (curtail) the water requirements when the storage state of the system is depleted to such levels, that the short-term yield (supply capability) is less than the water requirements.

The date when intervention is required is determined by doing a system analysis using a large number of possible hydrological inflows (runoff). In the analysis curtailments are implemented for each of the inflow sequences when droughts occur, and an estimate of the probability of curtailments is then obtained. These simulations are carried out for a planning period of about twenty years, during which the water requirements increase over time, resulting in more frequent curtailments being required from year to year. The most important result from the simulations is the annual projected risk of curtailments, and the year in which the reliability criteria are violated, defines the date when intervention is necessary.

In this study the above described methodology were applied to the scenarios given in **Section 6.3** and the scheduling results are presented in **Section 6.4**.

CHAPTER 4. WATER REQUIREMENT AND RETURN FLOW SCENARIOS

4.1 INTRODUCTION

This chapter describes the water requirements and return flow scenarios that were developed in the study and presented according to the following headings:

- Irrigation water requirements **(Section 4.2).**
- Bulk industrial water requirements **(Section 4.3).**
- Urban water requirements and return flows **(Section 4.4).**
- Summary of the water requirement and return flow scenarios **(Section 4.5).**

4.2 IRRIGATION WATER REQUIREMENTS

4.2.1 Overview

Irrigations water requirements comprise about thirty five percent of the total system water use, of which the Vaalharts Irrigation Scheme, the largest in the country, uses 31% of this sector's water. The *Internal Strategic Perspective: Vaal River System: Overarching* **(DWAF,2004d)** indicated that, due to the strategic decision that any new water use will have to pay the full cost of water, irrigation water use is likely to remain constant. The Water Resource Managers in the regions, however, expressed their concern, in that they expected substantial irrigation developments took place since 1998, and of which most is perceived to be unlawful. This lead to the commissioning of a water use validation study in the Upper Vaal WMA, from which preliminary information was received and assessed in this study.

The following sections summarise the irrigation water use information for the three Vaal WMAs and present a description of the scenarios that were compiled for analyses.

4.2.2 Upper Vaal Water Management Area

The Upper Vaal WMA was divided in two main catchments, upstream and downstream of Vaal Dam, and thirteen sub-catchments for the purposes of presenting the results. The sub-catchments are presented in **Figure A-2** of **Appendix A**. **Table 4.1** shows the irrigation water requirements for the four data sources that were evaluated, which are listed as follow:

- VRSAU – Information obtained from the Vaal River System Analysis Update Study (**DWAF, 1996**).

- Loxton Venn – Data obtained from the Vaal River Irrigation Study (**DWAF, 1999**). This data was used for the recent planning studies prior to the Reconciliation Study, and serve as reference for the comparisons with the other sources.

- WARMS – Data extracted from the Water Allocation Registration Management System. Since WARMS is a "live" database system that is updated continuously, it should be noted that the database used for this study was dated November 2005.

- Validation Study – Preliminary results obtained from the Upper Vaal WMA Validation Study provided by Schoeman and Venote, the Professional Service Provider undertaking the work for DWAF. The data received from the validation study provide water use information for the years 1998 and 2005, as well as preliminary estimates of what is considered to be lawful water use. It should be recognised that the process of verification, during which the lawful water use is established, will be undertaken subsequent to the validation of water use. The validation task was mostly completed at the time the data was obtained from Schoeman and Venote, with respectively 74% and 60% of the properties upstream and downstream of Vaal Dam been processed.

The results in **Table 4.1** show significant more irrigation were registered than what was estimated in the VRSAU and Loxton Venn studies. The information from the Validation Study shows that the irrigation water use increased significantly by more than 100% between the year 1998 and 2005 for the area upstream of Vaal Dam. Most of the increase occurred in the Frankfort catchment, which comprises the Wilge and Liebenbergvlei rivers (see **Figure A-2** of **Appendix A** for details). The preliminary estimates of the Lawful water use compares well with the VRSAU study results, however, it is significantly less compared to the estimates of the water use in the year 2005.

Table 4.1: Irrigation water requirements in the catchment upstream of Vaal Dam

Sub-catchment Description[(2)]	VRSAU[(4)]	Loxton Venn[(3)]	WARMS	Validation Study (Preliminary Results)		
				1998	2005	Lawful (Estimate)
Grootdraai	13	25	46	18	30	12
Delangesdrift	5	0	11	4	10	3
Sterkfontein	0	0	0	0	0	0
Frankfort	48	21	192	47	114	45
Vaal Dam	28	17	200	64	115	25
Sub-total	**94**	**62**	**448**	**133**	**269**	**85**
Higher than Loxton Venn	**32**	**-**	**386**	**71**	**207**	**23**

Notes: *(1) All values are given in million m^3/annum.*

*(2) The sub-catchments are presented in **Figure A-2** of **Appendix A.***

(3) The water use from the Loxton Venn study was used in recent planning studies.

(4) Vaal River System Analysis Update Study.

Table 4.2 provides the comparisons of the irrigation water use from the different information sources for the area downstream of Vaal Dam and indicates the same trend of increased water use between the year 1998 and 2005.

Table 4.2: Irrigation water requirements in the Upper Vaal WMA, downstream of Vaal Dam

Sub-catchment Description(2)	VRSAU(4)	Loxton Venn(3)	WARMS	Validation Study (Preliminary Results)		
				1998	2005	Lawful (Estimate)
Suikerbosrand	15	8	29	8	15	4
Klip	28	12	32	19	27	8
Barrage	2	13	28	15	29	10
Klerkskraal	1	0	0	0	0	0
Boskop	0	0	4	0	4	0
Klipdrift	9	9	8	8	8	8
Mooi GWS	78	37	24	35	35	35
Kromdraai	1	1	20	4	7	3
Sub-total	**135**	**80**	**145**	**90**	**125**	**68**
Higher than Loxton Venn	**55**	**0**	**65**	**10**	**45**	**-12**

Notes: (1) *All values are given in million m^3/annum.*

(2) *The sub-catchments are presented in **Figure A-2** of **Appendix A**.*

(3) *The water use from the Loxton Venn study was used in recent planning studies.*

(4) *Vaal River System Analysis Update Study.*

4.2.3 Middle Vaal Water Management Area

Due to the absence of Validation Study information for the Middle and Lower Vaal WMA, a different approach was adopted in these areas to determine the irrigation water use. The approach involved preparing water use comparisons from the data of the VRSAU, Loxton Venn studies and the WARMS database. These comparisons were then presented to the DWAF Regional Office Water Resource Managers to obtain their consent at deriving the “Suggested” water use figures (see **Table 4.3** for details).

Table 4.3 : Irrigation water requirements in the Middle Vaal WMA

Sub-catchment Description(2)	VRSAU(4)	Loxton Venn(3)	WARMS	Suggested (2005)
Schoonspruit	34	26	31	34
Renoster	15	17	36	17
Vals	22	2	30	30
Allemanskraal	37	40	45	45
Erfenis	44	46	70	44
Sand/Vet	11	16	59	11
Kromdraa	1	1	20	7
Bloemhof	47	14	98	47
Sub-total	**210**	**161**	**369**	**226**
Higher than Loxton Venn	**49**	**0**	**208**	**65**

Notes: (1) *All values are given in million m^3/annum.*

(2) *The sub-catchments are presented in **Figure A-2** of **Appendix A.***

(3) *The water use from the Loxton Venn study was used in recent planning studies.*

(4) *Vaal River System Analysis Update Study.*

4.2.4 Lower Vaal Water Management Area

The water use in the Lower Vaal WMA is predominantly for the irrigation requirements supplied to the Vaalharts Irrigation Scheme as shown in **Table 4.4** below. The suggested water use for 2005 is slightly lower compared to the VRSAU and Loxton Venn studies and is due to unused allocations which are currently not developed in the Taung portion of the Vaalharts Irrigation Scheme.

It should be noted that DWAF has commissioned a study to investigate options for the utilisation of Taung Dam and that the findings of the study will need to be incorporated into the water balance once the results become available.

A detail evaluation of the monthly water schedule data obtained for the Vaalharts Irrigation Scheme, showed that the losses (including canal and tail water losses) is significantly more than what was estimated in previous studies. This implies that overall a higher irrigation water use of 56 million m^3/annum is suggested for this study compared to what was applied in previous investigations for the Lower Vaal WMA.

Table 4.4 : Irrigation water requirements in the Lower Vaal WMA

Sub-catchment Description[(2)]	VRSAU[(3)]	Loxton Venn	WARMS	Suggested (2005)
Upper Harts	6	1	0	5
Harts remainder	2	13	1	18
Bloemhof Dam to Vaalharts Weir	61	32	14	27
Vaalharts-Douglas	43	60	32	60
Vaalharts Scheme	350	354	365	328
Sub-total	**463**	**460**	**413**	**437**
Higher than VRSAU	0	-4	-51	-26
Vaalharts Scheme losses	**45**	**(Difference 82 million m^3/annum)**		**127**

Notes: (1) *All values are given in million m^3/annum.*

(2) *The sub-catchments are presented in **Figure A-2** of **Appendix A.***

(3) *Vaal River System Analysis Update Study and was used in recent planning studies.*

4.2.5 Vaal River System summary of irrigation water use

Table 4.5 provides a summary of the data comparison for irrigation water use and shows the current estimates are 288 million m^3/annum higher than what were applied in previous investigations. Most of the increases in the water use since 1998 is considered to be unlawful (see preliminary estimates of lawful water use in **Table 4.1**) and poses a significant challenge to DWAF as the regulating authority.

Table 4.5: Summary of irrigation water use comparisons for the three Vaal WMAs

Description	Water use applied in previous investigation	WARMS	Suggested (2005)
Total Vaal	767	1375	1055
Higher than WRPM	0	608	288
% Higher	0	79	38

Including Vaalharts Scheme's losses	**Total System Increase (Million m^3/annum)**	**370**
	Percentage Increase	**48%**

Notes: (1) All values are given in million m^3/annum.

4.2.6 Scenarios of future irrigation water use

The information presented in the previous sections focused on the historical and current irrigation water use. For planning purposes it is required to compile scenarios of future water use for the period up to 2030, which is presented in this section. Given that the current (year 2005) water use estimates are significantly higher than the preliminary estimates of what is considered lawful, a scenario was compiled where it was assumed that the current water use will be reduced over the medium term through legal interventions and water use compliance monitoring. The assumptions used in the scenario are listed below:

Irrigation Scenario 1: Curtailment of illegal irrigation water use

- **Upper Vaal WMA**
  - Assume the growing trend, which was observed over the period 1998 to 2005, continuous for two years until 2008. This implies the interventions will take two years to become effective.
  - Eradication of unlawful irrigation water use from 2008 onwards and assumes the water use will decrease over a period of 3 years.
  - The assumption is made that the interventions will reduce the irrigation to the lawful volume plus 15% and that this will be achieved in the year 2011. The additional 15% above the estimates of the lawful water use is a conservative assumption providing for possible under estimations from the current data.

- **Middle and Lower Vaal WMA**
  - Due to the absence of information from validation studies in these areas, it is assumed that the current suggested irrigation water use will remain constant over the planning period.

Irrigation Scenario 2: Recent trend continues unattended

- **Upper Vaal WMA**
  - The assumption was made that the irrigation water use will continue to increase at the trend observed between 1998 and 2005 until the registered volume from the WARMS database is reached.

- **Middle and Lower Vaal WMA**
  - Assume the future water use remains constant at the suggested water use levels.

The **Irrigation Scenario 2** will create an unsustainable situation in the Vaal River System and is not considered to be viable. However, this scenario was derived to illustrate the potential impact should the situation arises where the interventions are not successful to cut back the illegal water use.

4.2.7 Future irrigation water use scenario results

Figure 4.1 presents the future irrigation water requirements for the two scenarios described in the previous section and shows that the **Irrigation scenario 2** is about 450 million m^3/annum higher than the **Irrigation Scenario 1** over the long term. These two irrigation water requirement scenarios were used in the system planning scenarios which are described in **Section 6.3**.

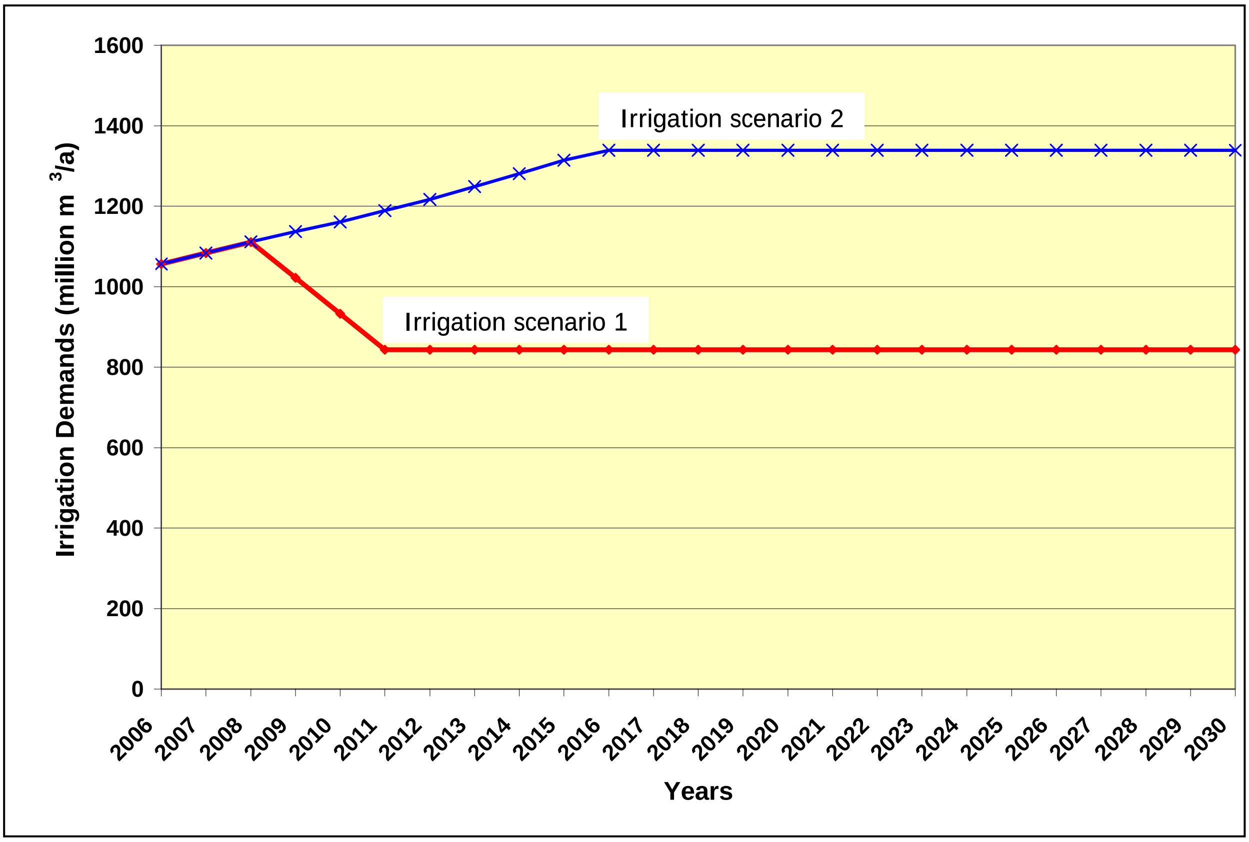


Figure 4.1: Irrigation water requirement scenarios for the Vaal River System

4.3 BULK INDUSTRIAL WATER REQUIREMENTS

4.3.1 Overview

There are three main industries receiving water in bulk from the Vaal River System, the electrical power utility Eskom, petrochemical (coal to liquid fuel) industry Sasol, and Mittal Steel. These industries were requested to provide water requirements scenarios based on their future outlook of their respective operations and water management programs. These water requirement scenarios are presented in the subsequent sections.

4.3.2 Eskom

Eskom currently operates 12 coal fired electrical power stations, which receive water from the Integrated Vaal River System. Some of these stations were decommissioned and are now reinstated to increase supply in response to the growing demand for electrical power to fuel the South African economy. There are also plans to develop three new power stations, envisaged to receive water from the Vaal River System. Two are scheduled to receive water from Vaal Dam, and current planning is that the third will be located close to the existing Kendal Power Station and receive water from the Eastern Vaal River Sub-system (a component of the Integrated Vaal River System).

Table 4.6 provide a summary of the water requirements and lists all the power stations, their primary water source, as well as the projection of water requirements for the indicated years of the planning period. These requirements were used in all the planning scenarios, see **Section 6.3** for details.

Table 4.6: Eskom power stations' water requirements (reference of projection April 2006)

Power Station	Primary Water Source	Water Requirements (million m^3/annum)					
		2006	2010	2015	2020	2025	2030
Hendrina	Komati Sub-system	31.0	32.4	33.0	32.7	32.7	32.7
Arnot		29.4	33.4	36.1	36.5	36.6	36.6
Duvha		50.8	50.4	51.6	52.2	52.2	52.2
Komati		2.6	5.6	9.9	8.3	8.4	8.4
Kriel	Usutu Sub-system	38.8	40.7	43.5	43.2	43.5	43.5
Matla		51.5	51.6	53.6	54.3	54.3	54.3
Kendal		3.2	3.3	3.4	3.4	3.4	3.4
Camden		5.5	19.2	23.2	23.2	23.2	23.2
New coal-fired 1		0.0	0.6	2.9	3.7	3.7	3.7
Majuba	Zaaihoek Sub-system	19.2	25.6	25.6	24.1	24.1	24.1
Tutuka	Grootdraai Sub-system	34.5	46.2	44.3	48.8	48.8	48.8
Grootvlei	Vaal Dam	0.8	6.1	10.4	10.1	10.1	10.1
Lethabo		45.5	46.6	49.4	50.1	50.1	50.1
New coal-fired 2		0.0	0.0	0.6	3.0	3.0	3.0
New coal-fired 3		0.0	0.0	0.0	2.6	3.0	3.0
Total		**312.9**	**361.7**	**387.5**	**396.3**	**397.2**	**397.2**

4.3.3 Sasol

Sasol has two plants receiving water from the Integrated Vaal River System. The Sasol Secunda Complex's primary source of water is Grootdraai Dam, which will be supported through the Vaal River Eastern Sub-system Augmentation Project (VRESAP) once it is operational in 2008. The Sasol Sasolburg Complex is supplied from Vaal Dam, which is supported from the Thukela-Vaal Transfer Scheme, as well as the Lesotho Highlands Water Project. The water requirements for the two complexes are presented in **Table 4.7** for the indicated years of the planning period. These requirements were used in all the planning scenarios, see **Section 6.3** for details.

Table 4.7: Sasol's water requirements for the indicated complexes

Description	Water Requirements (million m^3/annum)					
	2006	2010	2015	2020	2025	2030
Sasol Secunda Complex(1)	92.0	91.3	107.8	112.1	117.2	123.1
Sasol Sasolburg Complex(2)	26.4	28.9	32.3	35.5	38.9	42.7
Total	**118.5**	**120.2**	**140.1**	**147.6**	**156.1**	**165.8**

Notes: *(1) Reference of projection June 2006 and March 2004.*

(2) Reference of projection June 2006.

4.3.4 Mittal Steel

Mittal Steel receives its water from Vaal Dam, and in their projections (reference July 2006) they are planning to decrease their current water use from 17.4 million m^3/annum to 16.6 million m^3/annum in 2010, from where onwards it remains constant for the subsequent years of the planning period.

4.4 URBAN WATER REQUIREMENTS AND RETURN FLOWS

4.4.1 Overview

The urban sector represents the largest portion of the systems water use, and in the Gauteng Province substantial increases in the water use occurred historically as a result of the increasing urban population and expanding economic activities. In the Gauteng Growth and Development Strategy, developed by the Gauteng Provincial Government (**Gauteng Province, 2005**), it was shown that the Tertiary Sector constitutes more than 70% of the Gross Geographic Product of the province in 2001, and has continuously increased to this level since 1996. This growth in the Tertiary Sector was at the expense of Secondary and Primary Sectors, indicating that the economy of the Gauteng Province continues to expand into the service sectors where the future water requirements are predominantly driven by the population dynamics in the province.

In the Terms of Reference of the Reconciliation Study (**DWAF, 2003**), it was indicated that DWAF has commissioned a parallel demographic study (by the Directorate: Water Resource Planning Systems) to update the country wide population scenarios. The previous population scenarios used by DWAF for water resource planning purposes were developed for the National Water

Resource Strategy (NWRS) (**DWAF, 2004f**) and needed to be revised since it preceded the Census 2001 information.

The results from the parallel demographic study are discussed in the section below with the main focus on the population in the Gauteng Province.

4.4.2 Population scenarios

4.4.2.1 January 2006 population scenario results and review

During January 2006 the demographic study provided a population projection scenario database to the reconciliation study team at Municipal geographical unit. The database contained data for the year 2001 (as per Census 2001) as well as the future projection data covering the period up to the year 2025. The summarised results from the data are presented in **Table 4.8,** indicating the population for the country as a whole, as well as for Gauteng Province. The table also presents the Compounded Growth Rate for the indicated time periods.

Table 4.8: January 2006 Population Projection Scenario Update Summary (1)

Description		Planning Years					
		2001	2005	2010	2015	2020	2025
South Africa	Population	44 820	47 409	49 875	51 509	52 523	53 021
	Annual Compound Growth (%)	-	1.41%	1.02%	0.65%	0.39%	0.19%
Gauteng Province	Population	8 838	9 338	9 742	9 958	10 097	10 155
	Annual Compound Growth (%)	-	1.39%	0.85%	0.44%	0.28%	0.11%

Notes: *(1)* *Summary of data received from the Population Projection Scenario Update Study of the Directorate: Water Resource Planning Systems' produced during January 2006 (**DWAF, 2006**).*

(2) *All population values are given in thousands.*

An evaluation of the January 2006 Population Scenario Update data with two other sources of information was carried out as part of the internal review in the Reconciliation Study. The first data source was from the Census 1996 and Census 2001, and the second was the 2006 Mid-year Population Estimate published by Statistics South Africa (**Stats SA, 2006**).

Table 4.9 indicates that the growth rate for the Gauteng Province is 3.8% for the period between the years 1996 and 2001, based on the data from the pervious two censuses. This is substantially higher than the growth rate of 1.39% for the projection period immediately thereafter (see **Table** 4.8 for growth between the years 2001 and 2005), which raised a concern regarding the low initial rate of growth used in the January 2006 Population Scenario Update.

Table 4.9: Census 1996 and Census 2001 Population Data and Compound Growth

Description	Census 1996	Census 2001	Annual Compound Growth
South Africa	40 584	44 820	2.0%
Gauteng Province	7 348	8 837	3.8%

A further comparison was made with the 2006 Mid-year Population Estimate of Stats SA and **Table 4.10** presents the population data as determined using a model covering the years 2001 to 2006 for the whole of the country as well as for the Gauteng Province. The first observation that can be made is that the 2001 population estimate from the 2006 Mid-year report is less than the data from the Census 2001, probably due to adjustments required for the modelling exercise. The second observation was that the growth rates for the period, 2001 to 2006 of 2.2% is substantially higher than what was determined for the 2001 to 2005 period in the January 2006 Population Projection Scenario Update (see growth rate of 1.39% in **Table 4.8** for the period 2001 to 2005).

One of the main differences in the assumptions used for the generation of the January 2006 Population Projection Scenario Update compared to the 2006 Mid-year Population Estimate, was identified to be the migration patterns between provinces.

The result from the migration assumptions applied in the 2006 Mid-year Population Estimate is presented in **Table 4.11**, showing the percentage of the country's population residing in each province for the period 2001 to 2006. The shaded row in **Table 4.11** shows how the population in Gauteng increased over time, while the corresponding values for most of the other provinces decreased. **Table 4.10: Summary of population data from the 2006 Mid-year Population Estimate from Stats SA.**

Description		1996	2001[1]	2006
South Africa	Population	40 584	44 683	47 391
	Annual Compound Growth (%)	-	1.9%	1.2%
Gauteng Province	Population	7 348	8 254	9 211
	Annual Compound Growth (%)	-	2.4%	2.2%

Notes: (1) *The population data for 2001 was calculated based on information from the 2006 Mid-year Population Estimate report and presented in an interim task report as part of the Population Projection Scenario Update Study.*

(2) *All population values are given in thousands.*

Based on the above-mentioned findings, it was recommended that the population projection scenario from the January 2006 Population Projection Scenario Update Study be revised, using the assumption of migration as reflected in the 2006 Mid-year Population Estimate of Stats SA. This was carried out by the Study Team of the Population Projection Scenario Update Study during July 2006, and an alternative scenario was developed for Gauteng Province, referenced as the ***August 2006 Population Projection Scenario*** as presented in the following section.

4.4.2.2 August 2006 Population Projection Scenario for Gauteng – alternative scenario

The August 2006 Population Projection Scenario for Gauteng Province is presented in **Table 4.12**, showing the projected population as well as the annual compound growth for the indicated planning years.

This population scenario was used in the planning scenarios as described in **Section 6.3**.

Table 4.11: Percentage distribution of the projected provincial share of the total population (Stats SA, August 2006)

Province	Planning Years						
	2001	2002	2003	2004	2005	2006	2006(1)
Eastern Cape	15.5	15.4	15.2	15.1	15.0	14.9	14.6
Free State	6.5	6.4	6.4	6.3	6.3	6.2	6.2
Gauteng	18.5	18.7	18.9	19.0	19.2	19.4	20.1
Kwazulu-Natal	20.7	20.7	20.7	20.6	20.6	20.5	20.9
Limpopo	12.3	12.2	12.1	12.1	12.0	12.0	11.3
Mpumalanga	6.9	6.9	6.9	6.9	6.9	6.9	7.4
Northern Cape	1.9	1.9	1.9	1.9	1.9	1.9	2.3
North West	8.2	8.2	8.2	8.2	8.2	8.1	7.1
Western Cape	9.4	9.5	9.7	9.8	9.9	10.0	10.0
Total	100	100	100	100	100	100	100

Notes: (1) *New provincial boundaries were used for this column.*

(2) *All values are given as percentage of the total population for South Africa for the indicated years and provinces.*

Table 4.12: August 2006 Population Projection Scenario for Gauteng Province

Description	Planning Years					
	2001	2005	2010	2015	2020	2025
Population	8 254	9 012	9 989	10 878	11 678	12 274
Annual Compound Growth (%)	-	2.22%	2.08%	1.72%	1.43%	1.00%

Notes: (1) *All population values are given in thousands.*

4.4.2.3 National Water Resource Strategy Population Scenario

The National Water Resource Strategy (NWRS), published in September 2004, applied population projection scenarios to generate future water requirements for compiling a perspective on the reconciliation of the water requirements and availability for the years 2000 and 2025. The NWRS's water requirement "base scenario" was developed using a population projection scenario, which was a high estimate, and serve as the mainstream option for the development of the strategy. In order to provide a comparison with the NWRS in this study, this high population projection scenario was used to develop an alternative water requirement scenario for the urban water users, and **Table 4.13** presents the population projection scenario for the Gauteng Province.

Table 4.13: National Water Resource Strategy High Population Projection Scenario for Gauteng Province

Description	Planning Years					
	2001	2005	2010	2015	2020	2025
Population	8 475	9 100	9 538	10 199	10 691	11 206
Annual Compound Growth (%)	-	1.79%	1.15%	1.15%	0.95%	0.95%

Notes: (1) All population values are given in thousands.

4.4.3 Rand water Supply Area

4.4.3.1 Methodology

The water requirements and return flows for the Rand Water supply area were determined with the Water Requirement and Return Flow database model, which was developed for DWAF as part of the Crocodile (West) River Return Flow Assessment Study (**DWAF, 2004e**). The model uses Sewage Drainage Areas as modelling component where a sewer pipe network system collects the wastewater for treatment at waste water treatment works before it is discharged into a river system. There were forty seven Sewage Drainage Areas (SDAs) identified in the Rand Water (Gauteng) supply area, as illustrated graphically in **Figure 4.2,** where the thick black line shows the catchment divide between the northern and southern areas. The wastewater returned in the northern SDAs, contributes to the water resources of the Crocodile (West) River, and those SDAs draining to the south, contributes the Vaal River System. **Table 4.14** lists all the Sewage Drainage Areas in each of the indicated municipal areas.

Table 4.14: List of Sewage Drainage Areas according to municipal areas

Municipality	Sewage Drainage Areas	Number of SDAs
Ekurhuleni	Waterval, Ancor, Benoni, Carl Grungling, Daveyton, Dekema, Herbert Bickley, Jan Smuts Dam, JP Marais, McComb, Rhynfield, Rondebult, Tsakane, Vlakplaats, Heidelberg, Ratanda, Hartebeestfontein, Olifantsfontein	18
Emfuleni	Sebokeng South, Vanderbijlpark, Sharpville, Vereeniging	4
Johannesburg	Bushkoppies, Olifantsvlei, Goudkoppies, JHB Northern, Driefontein, Ennerdale, Eldorado Park, Sebokeng North	8
Mogale	Percy Stewart, Flip Human	2
Randfontein	Randfontein	1
Tshwane	Baviaanspoort, Zeekoegat, Daspoort, Rooiwal,Rietgat, Temba, Babalegi, Sandspruit, Sunderlandridge, Klipgat, Tolwane, Kutswane, Apies, Remainder – North	14
TOTAL NUMBER OF SEWAGE DRAINAGE AREAS		**47**

The methodology that was followed to compile the water requirements and return flow projection, involved the following steps:

- Populate the data for each SDA in the database model with the population scenario data for the years 2001, 2005 and five yearly intervals up to 2030.
- Incorporate land use data, other than housing land use into the database for the SDAs, where it was available.
- Assign water supply meter data of the year 2001 to the SDAs, using GIS area intersection analysis.
- Collate the discharge volume data of the year 2001 from the Waste Water Treatment Works and assign the appropriate data to each SDA.
- Establish the relationships with population and land use by calibrating the model parameters to match the recorded water requirements and return flows for the year 2001.

- A simulation was carried out with the model to generate water requirements for the year 2005 using the parameters as calibrated for the year 2001. The model results were compared against actual water use data for the year 2005 and further adjustments were made to match the 2005 water use.

- Generate the projected water requirements at five year intervals for the planning period up to 2030.

- The above steps were carried out for all 47 sewage drainage areas and the results were incorporated into a spreadsheet database to generate the data required by the Water Resource Planning Model (WRPM).

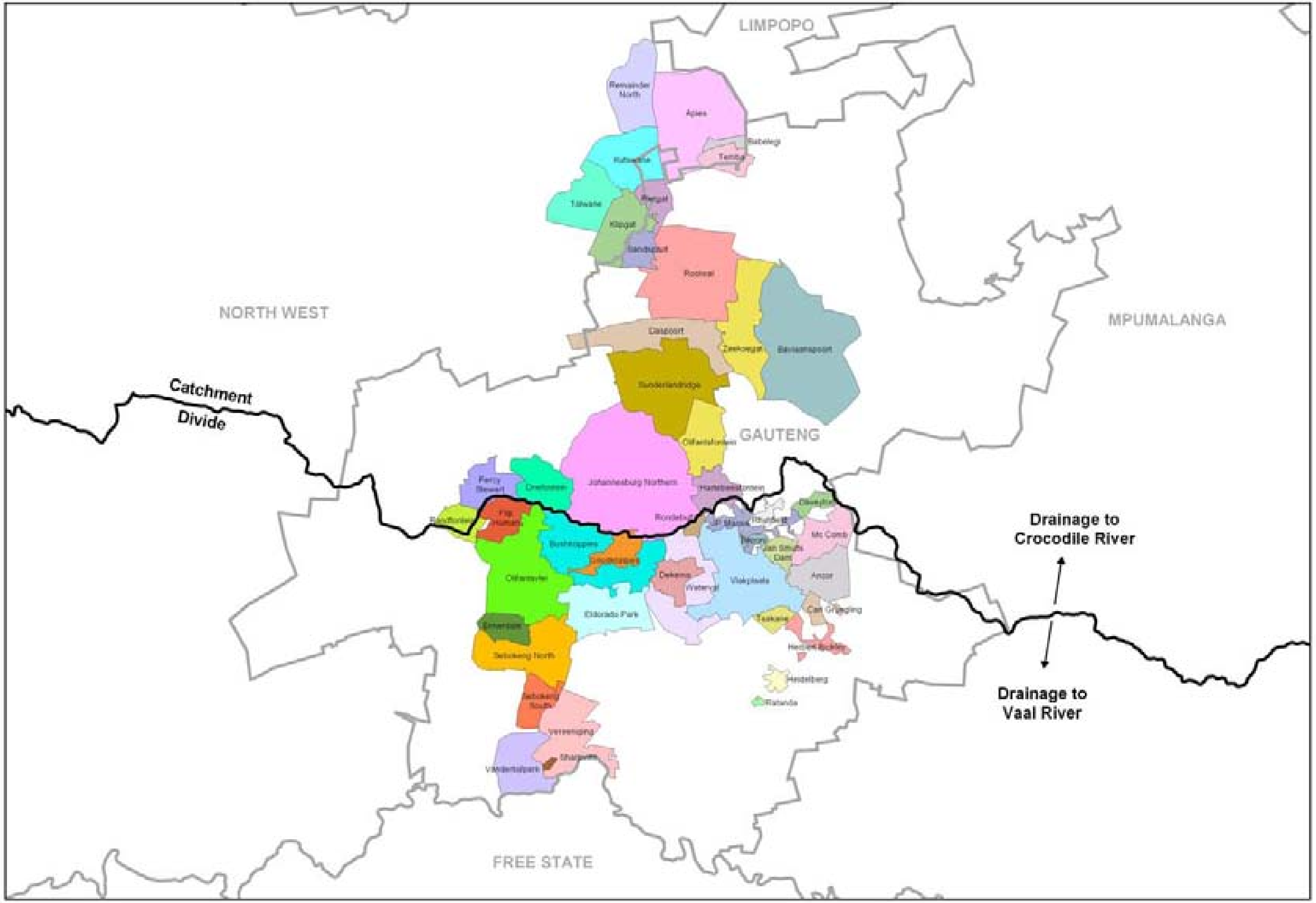


Figure 4.2: Location of the forty seven Sewage Drainage Areas

4.4.3.2 Water requirement and return flow scenario based on the August 2006 Population Projection for the Rand Water Supply Area

The August 2006 Population Projection Scenario data (described in **Section 4.4.2.2**) was imported into the water requirement generation database model, and return flow scenarios were generated for the planning period up to the year 2030, according to the steps listed in the previous section.

A summary of the water requirement projections are presented in **Figure 4.3**, showing the water requirements for each municipality and a remainder component called "Other". The "Other" component includes water requirements of individual users, including mines, industries and other small municipalities supplied from Rand Water. The assumptions for the other users were that they would increase by the same ratio as the water requirements of the municipalities.

It should be noted that for both Rustenburg and Tshwane the water requirements presented in **Figure 4.3** represent the supply from Rand Water and exclude water received from other sources.

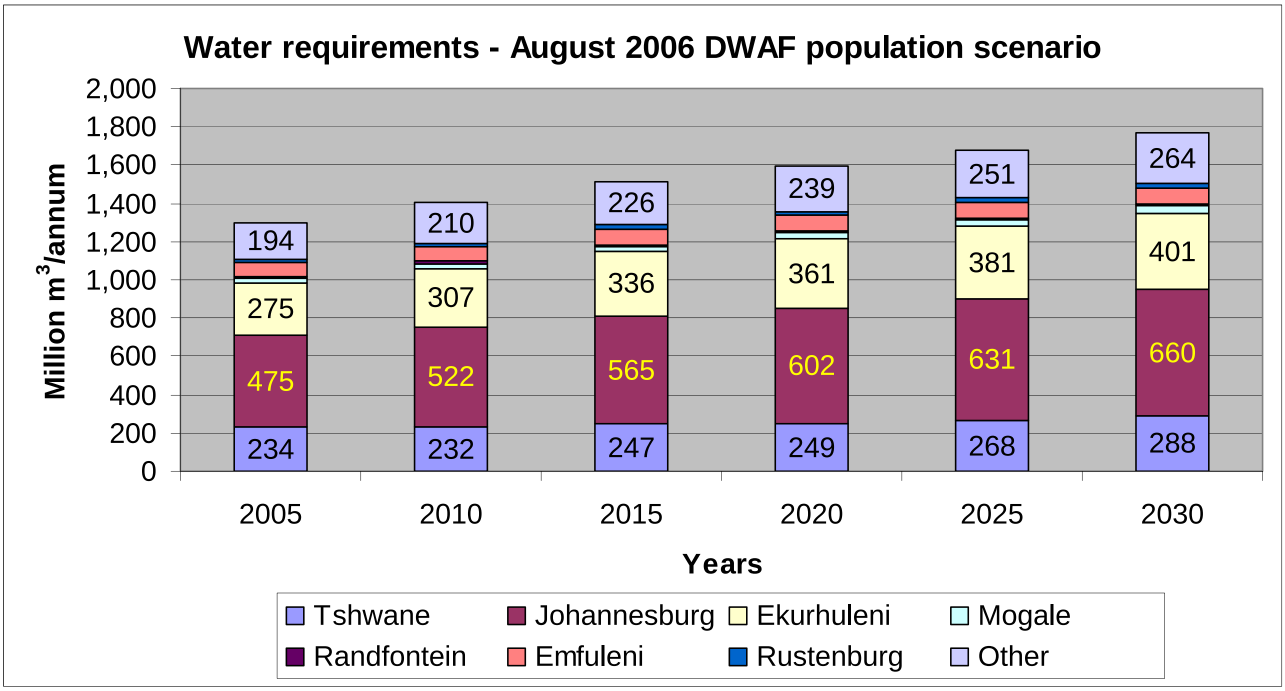


Figure 4.3: Water requirements for the Rand Water supply area (base on the August 2006 Population Projection Scenario)

The average annual growth rate of the water requirements between 2005 and 2030 is 1.23% compounded, with a slightly higher growth rate of 1.52% over the first ten years.

The total return flow projections (for the southern and northern SDAs) are presented in **Figure 4.4**, indicating an increase from about 650 million m^3/annum in 2005 to 925 million m^3/annum in the year 2030.

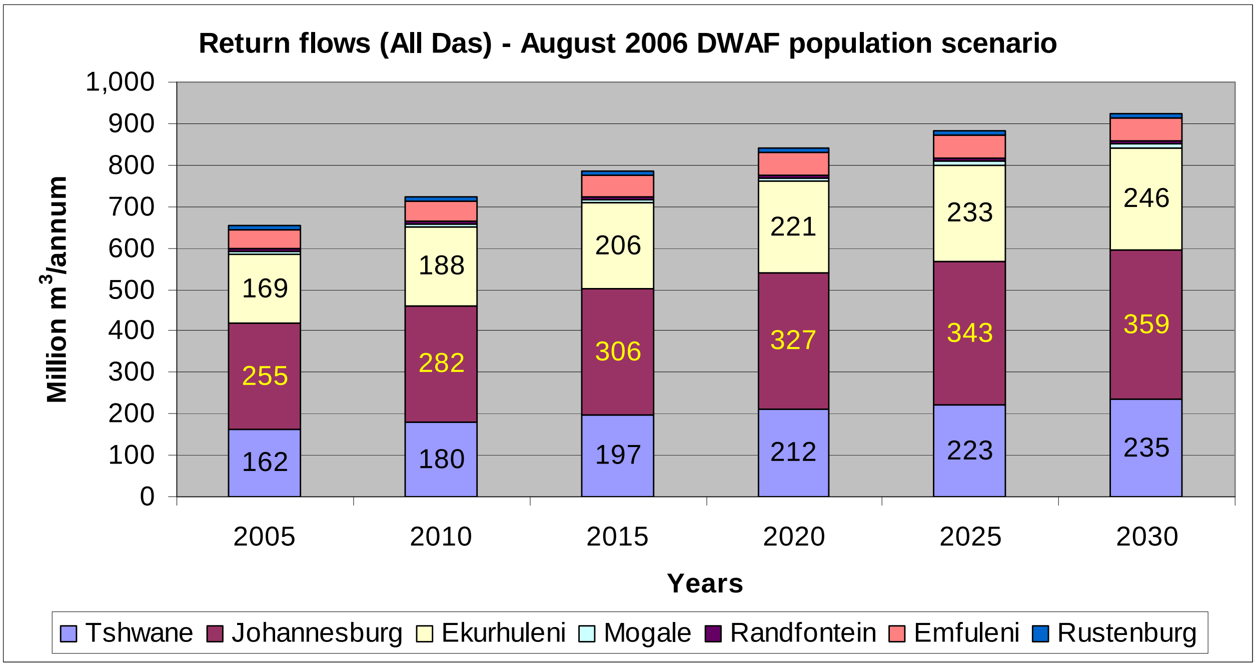


Figure 4.4: Return Flows for the Rand Water supply area (base on the August 2006 Population Projection Scenario)

The projection for the return flows contributing to the water resources of the Vaal River System (southern SDAs) is shown in **Figure 4.5** which is expected to increase from 330 million m^3/annum in the year 2005 to about 460 million m^3/annum in the year 2030.

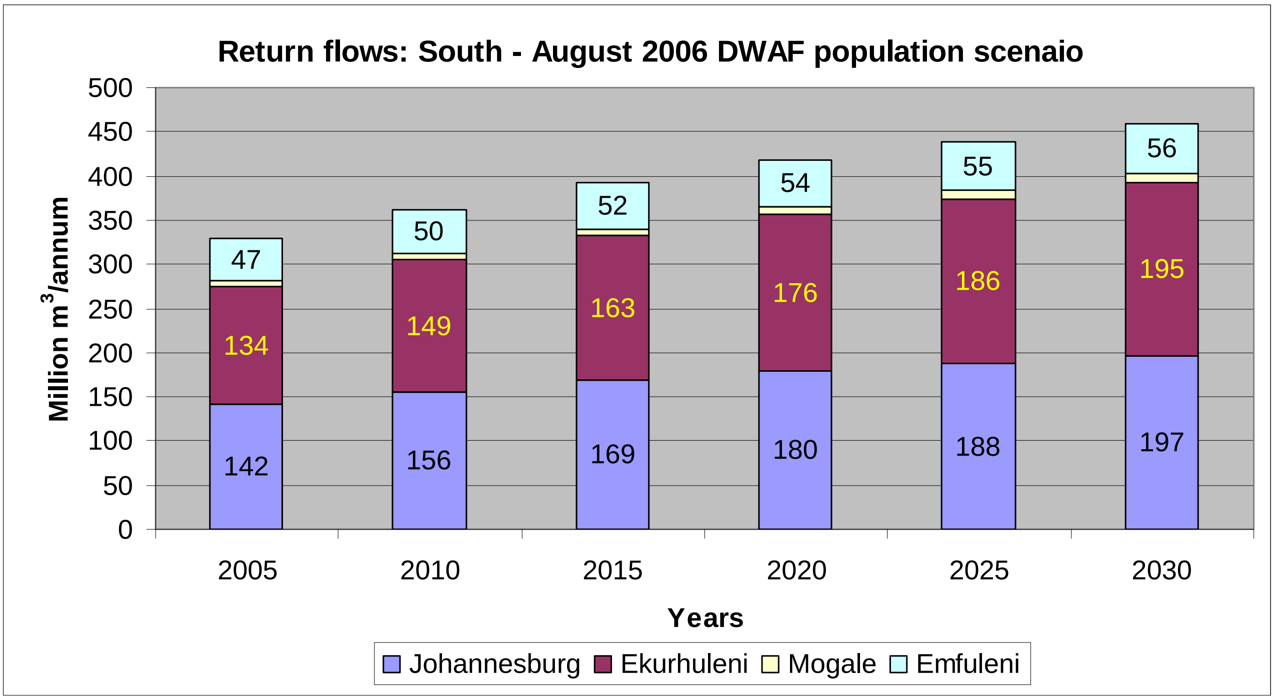


Figure 4.5: Return Flows for the Southern SDAs of the Rand Water supply area (base on the August 2006 Population Projection Scenario)

4.4.3.3 Water requirement and return flow scenario based on the NWRS population projection

Following the same methodology as explained in the previous section, an alternative water requirement and return flow scenario was developed by applying the National Water Resource Strategy (NWRP) population projection scenario (see **Section 4.4.2.3** for details). **Table 4.15** presents a summary of the results of this scenario and, for comparison purposes, **Table 4.16** provide the summarise data for the scenario presented in the previous section.

In the tables the scenarios are labelled **Scenario A** and **B** respectively and these labels are used to identify and reference the scenarios in subsequent sections in the report.

Table 4.15: Water requirement and return flow projection scenario summary based on the NWRS population projection (Scenario A)

Component Descriptions		Planning Years					
		2005	2010	2015	2020	2025	2030
Water Requirements (Supplied by Rand Water)	Northern Municipalities	542	560	600	633	683	742
	Southern Municipalities	564	590	617	639	662	687
	Other users	192	194	202	214	224	237
	Total	***1,300***	***1,352***	***1,431***	***1,496***	***1,582***	***1,681***
	Portion North	49.0%	48.7%	49.3%	49.8%	50.8%	51.9%
	Portion South	51.0%	51.3%	50.7%	50.2%	49.2%	48.1%
Return Flows (From all municipalities)	Northern Municipalities	323	351	376	396	421	451
	Southern Municipalities	328	343	359	372	386	400
	Total	***652***	***694***	***735***	***769***	***807***	***852***
	Portion North	49.6%	50.6%	51.1%	51.6%	52.2%	53.0%
	Portion South	50.4%	49.4%	48.9%	48.4%	47.8%	47.0%

Notes: (1) All volumetric values are given in million m^3/annum.

Table 4.16: Water requirement and return flow projection scenario summary based on the August 2006 Population Projection Scenario (Scenario B)

Component Descriptions		Planning Years					
		2005	2010	2015	2020	2025	2030
Water Requirements							
Supplied by Rand Water	Northern Municipalities	542	575	617	644	681	721
	Southern Municipalities	564	619	669	714	747	782
	Other users	194	210	226	239	251	264
	Total	***1,300***	***1,403***	***1,512***	***1,596***	***1,679***	***1,766***
	Portion North	47.5%	49.0%	48.1%	48.0%	47.4%	47.7%
	Portion South	52.5%	51.0%	51.9%	52.0%	52.6%	52.3%
Return Flows							
From all municipalities	Northern Municipalities	266	324	362	394	423	444
	Southern Municipalities	289	329	362	392	418	438
	Total	***556***	***653***	***724***	***785***	***841***	***882***
	Portion North	47.9%	49.6%	50.0%	50.1%	50.3%	50.3%
	Portion South	52.1%	50.4%	50.0%	49.9%	49.7%	49.7%

Notes: (4) All volumetric values are given in million m^3/annum.

4.4.4 Sedibeng Water

Sedibeng Water is the bulk service provider and receives water from the Vaal River System from two abstraction locations. The first is Balkfontein on the Vaal River and, the second, from Allemanskraal Dam at their Virginia Works. The water use in their supply area has decreased historically, mainly due to the declining mining activity in the region. Sedibeng Water provided projections in April 2006, which indicated that their water requirement will increase from 56 million m^3/annum in the year 2006 to 58 million m^3/annum in the year 2030. The portion of their total water use to be supplied from their Virginia Works (Allemanskraal Dam), is constant over the planning period at 15.2 million m^3/annum and is equal to their allocation from the resource.

4.4.5 MidVaal Water Company

Midvaal Water Co treats and supplies water to users in the Klerksdorp area and has experienced a decline in water use, mainly due to the closing of several mining operations. Projections for

Midvaal Water Co were received from them in May 2006, indicating that their water use will remain constant at 35 million m^3/annum over the planning period.

4.4.6 Other urban areas

The projections for all the other urban areas receiving water from the Vaal River System were determined, using the growth rates from the National Water Resource Strategy (NWRS). Where actual water use data was available, the starting point (volume for the first year in the projection) was adjusted to match the actual value on which the future growths were applied. In total, the water requirement in the year 2006 is projected to be 161 million m^3/annum for this group, and increases to 168 million m^3/annum in the year 2030.

4.5 SUMMARY OF WATER REQUIREMENT AND RETURN FLOW SCENARIOS

4.5.1 System summary

Combining all the water requirements and return flows of all the sectors from the information of the previous sections, and including other components such as losses and mine dewatering, provides the summary as presented in the following tables.

Table 4.17 presents the summary information for **Scenario A,** which was compiled with the NWRS population projection scenario, and **Table 4.18** for **Scenario B,** where the August 2006 population scenario was applied.

Table 4.17: Summary of water requirements and return flows (Scenario A)

Water users	Planning years					
	2006	2010	2015	2020	2025	2030
Water Requirements						
Rand Water	1297	1338	1417	1481	1568	1666
Mittal Steel	17	17	17	17	17	17
ESKOM (2)	330	381	407	416	417	416
SASOL (Sasolburg)	24	27	30	33	37	41
SASOL (Secunda)	92	104	108	112	117	123
Midvaal Water Company	35	35	35	35	35	35
Sedibeng Water (Balkfontein only)	41	41	41	41	42	43
Other towns and industries	161	163	167	167	167	168
Vaalharts/Lower Vaal irrigation	542	542	542	542	542	542
Other irrigation	722	599	500	500	500	500
Wetland / River Losses	325	326	327	329	330	331
Return Flows						
Southern Gauteng (Rand Water)	331	343	359	372	386	400
Midvaal Water Company	1	1	1	1	1	1
Sedibeng Water	2	2	2	2	2	2
Other towns and industries	61	65	69	72	76	80
Irrigation	60	48	38	38	38	38
Mine dewatering	114	105	121	123	121	121
Increased urban runoff	101	103	107	113	121	129
OVERALL GROSS SYSTEM DEMAND:	3587	3572	3590	3672	37711	3881
OVERALL NET SYSTEM DEMAND:	2917	2905	2893	2950	3025	3108

Notes: *(1) All volumetric values are given in million* m^3*/annum.*

(2) Includes 3rd party users

Table 4.18: Summary of water requirements and return flows (Scenario B)

Water users	Planning years					
	2006	2010	2015	2020	2025	2030
Water Requirements						
Rand Water	1308	1390	1498	1582	1665	1753
Mittal Steel	17	17	17	17	17	17
ESKOM (2)	330	381	407	416	417	416
SASOL (Sasolburg)	24	27	30	33	37	41
SASOL (Secunda)	92	104	108	112	117	123
Midvaal Water Company	35	35	35	35	35	35
Sedibeng Water (Balkfontein only)	41	41	41	41	42	43
Other towns and industries	161	163	167	167	167	168
Vaalharts/Lower Vaal irrigation	542	542	542	542	542	542
Other irrigation	722	599	500	500	500	500
Wetland / River Losses	325	326	327	329	330	331
Return Flows						
Southern Gauteng (Rand Water)	335	362	392	418	438	459
Midvaal Water Company	1	1	1	1	1	1
Sedibeng Water	2	2	2	2	2	2
Other towns and industries	61	65	69	72	76	80
Irrigation	60	48	38	38	38	38
Mine dewatering	114	105	121	123	121	121
Increased urban runoff	101	103	107	113	121	129
OVERALL GROSS SYSTEM DEMAND:	3597	3624	3672	3773	3868	3967
OVERALL NET SYSTEM DEMAND:	2923	2939	2942	3005	3071	3136

Notes: (1) *All volumetric values are given in million m^3/annum*

(2) *Includes 3rd party users.*

4.5.2 Summary and comparisons for the Rand Water supply area

Due to the importance of the water requirements of the Rand Water supply area, a summary of **Scenarios A** and **B** and how these projections compare to previous scenarios, are presented graphically in **Figure 4.6**.

The lines on the graph represent the following information:

- The thick line starting in the year 1970 shows the actual water use up to the year 2005. The impact of water restrictions due to drought conditions are shown during the early nineteen eighties as well as during 1995 and 1996.
- The blue (highlighted) line (**Sc A, 2006**) shows the water requirements for **Scenario A**.
- The red (highlighted) line (**Sc B, 2006**) shows the water requirements for **Scenario B**.
- **RW (2004 excl AIDS)**, is a projection scenario produced by Rand Water in 2004 and excluded the impact of HIV AIDS.
- **RW (2004 incl AIDS)**, is a projection scenario produced by Rand Water in 2004 and included the impact of HIV AIDS.
- **RW (2004 Questionnaire)**, is a projection scenario produced by Rand Water in 2004 that was compiled from information they received through a questionnaire to all the users supplied by Rand Water.
- **NWRS High-High**, was the water requirements derived as part of the National Water Resource Strategy, based on the High population projection scenario and the High economic growth scenario.
- **NWRS Ratio**, scenario was developed as part of the National Water Resource Strategy and is referred to as the “base scenario” in the NWRS document.

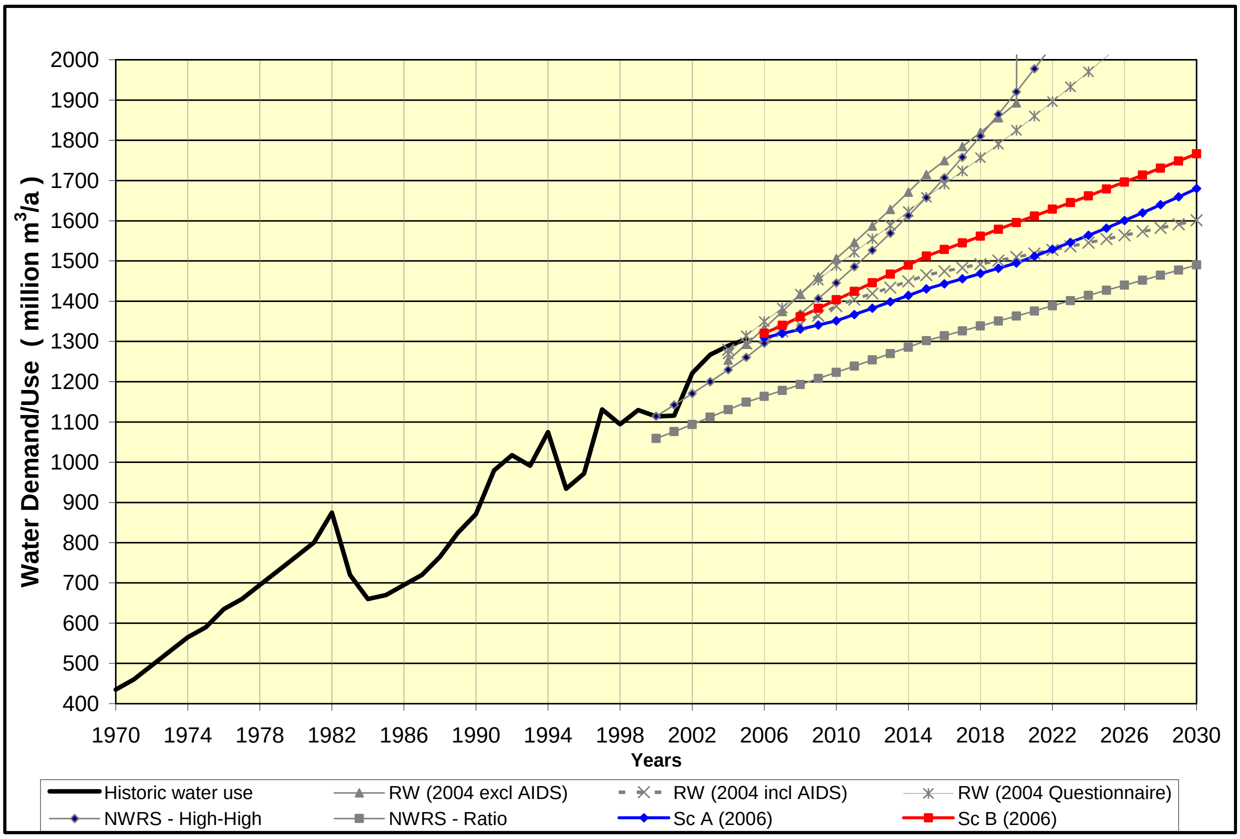


Figure 4.6: Summary of water requirement scenarios for the Rand Water Supply Area

CHAPTER 5. WATER CONSERVATION AND WATER DEMAND MANAGEMENT SCENARIOS

5.1 OVERVIEW

Three saving scenarios were compiled from the assessment of the potential for water conservation and water demand management (WC/WDM) in the urban sector. The savings were applied to the water requirement of **Scenario B** (see **Section 4.5**) and were labelled **Scenarios C**, **D** and **E** respectively. The description and saving results from the scenarios are presented in the following section.

5.2 WATER CONSERVATION AND WATER DEMAND MANAGEMENT (WC/WDM) POTENTIAL SAVING SCENARIOS

5.2.1 Scenario description

*5.2.1.1 **Scenario C**: 5 Years water loss programme and efficiency improvement measures*

This scenario assumed that the water losses can be controlled within the next 5 years (2005 to 2010) and maintained afterwards as well as the implementation of water use efficiency by targeting the billed consumption. In addition to the loss management measures it was assumed that a 1% per annum efficiency can be gained from the year 2015 onwards for the entire planning period, applied to the large urban users that were assessed in the study.

This scenario is the most optimistic with regard to the savings that can be achieved, and involves both savings from the Non-Revenue Water as well as savings from the Revenue Water, which are assumed to take place over 5 years and 10 years respectively.

The savings from the Non-revenue water concentrate on issues such as leakage detection and repair in areas where consumers have high levels of payment, and any losses after the customer meter are basically considered to be part of the customer demand – normally these losses are relatively small, since the customer will identify any household leakage and repair the leaks quickly. In the case of areas where the level of payment is very low or is based on a “lump-sum” tariff, the losses tend to be greatest inside the properties after the consumer meter. In many cases, no accounts are sent to the consumers or the accounts are so high that they are generally ignored and payment will never be received by the Municipality. In such areas, the general monthly water demand per property (assuming that there is full 24-hour supply) is usually between 35 m^3/month and 55 m^3/month. If the water use can be controlled in some manner through proper metering with billing and cost recovery (often using pre-paid meters etc.), the water demand tends to drop to approximately 10 m^3/month. In many cases, the revenue generated from the water sales is insufficient to justify the expense of metering and billing, however, the real saving to the municipality can be in the order of 40 m^3/month, which is often sufficient to justify major investment. This is currently the situation in Soweto where over 160 000 pre-paid water meters are being installed, and a very similar situation was found in Kagiso where approximately 20 000 pre-paid meters were installed. It should be noted, that the total cost of implementing such pre-payment involves not only the cost of the meter (approximately R1 200 each), but also the continual cost of maintenance, as well as a significant cost for consumer education and constant customer support. The associated costs often exceed the basic capital cost of the equipment required.

In the medium and high income areas, the main WC/WDM measures that can be used to reduce wastage (reduction in customer demand is not considered at this stage), concentrated on the reduction in losses from physical leakage before the customer meter. In these areas, most of the water supplied to consumers is both metered and paid for by the consumer, and therefore wastage inside the properties tends to be relatively small and is not the serious problem that exists in many of the low income areas. Although the physical leakage is considered to be the main problem issue in the middle and high income areas, the levels of leakage tend to be relatively small compared to the levels experienced in the low income areas and therefore the potential savings that can be achieved are also small.

In **Scenario C**, it was also assumed that some savings could be achieved through more efficient water practices inside the properties. This typically involves the use of water efficient appliances (washing machines, toilet cisterns etc) as well as low flow shower heads, and water efficient gardens, where irrigation is either not required or significantly reduced.

*5.2.1.2 **Scenario D**: Reduction in wastage over 5 years*

- Water losses can be controlled within the next 5 years (2005 to 2010) and maintained afterwards (same as for Scenario C).
- No water use efficiency is introduced.

Scenario D is basically the same as **Scenario C** with the exception that it only addresses the reduction in wastage and does not include any saving from more efficient water practices. This scenario assumes that certain actions can be implemented over a period of 5 years, after which the capital costs will decrease and only maintenance costs will remain. This is potentially problematic for the water utilities, since their capital costs and much of their operational costs are fixed, while the income is dependant on the water sales. A reduction in the overall demand can cause problems to the financial viability of a water utility.

*5.2.1.3 **Scenario E**: Reduction in wastage over 10 years*

- Water losses can be controlled within the next 10 years (2005 to 2015) and maintained afterwards.
- No water use efficiency is introduced.

Scenario E is basically the same as **Scenario D** and only addresses the reduction in wastage. This scenario, however, assumes that certain actions can only be implemented over a period of 10 years, which is considered to be more easily achievable than **Scenario D,** based on practical experience gained by the project team from many WC/WDM projects.

5.2.2 Potential savings and net system water requirements

The three tables below present the savings that can be achieved for each of the scenarios described above (savings are shown in **Row b** of each tables). It was assumed that the WC/WDM measures will also impact on the return flows as reflected in **Row c** of each table. The overall impact on the net system water requirement is determined in **Row d,** and **Row e** provides the total system net water requirement.

Table 5.1: Savings and system net water requirements for Scenario C

Component description	Row	Calculation or Reference	Planning Years					
			2006	2010	2015	2020	2025	2030
Net system demand for **Scenario B**	a	From **Table 4.18**	2923	2939	2942	3005	3071	3136
Reduction in Water Requirements **Sc. C**	b	Assessment	-	177	272	329	379	378
Reduction in Southern SDA Return Flows **Sc. C**	c	Assessment	-	69	91	110	126	135
Net reduction **Sc. C**	d	(b-c)	35	109	181	219	253	243
System net demand **Sc. C**	e	(a-d)	2888	2830	2761	2786	2818	2893

Notes: (1) All volumetric values are given in million m^3/annum.

Table 5.2: Savings and system net water requirements for Scenario D

Component description	Row	Calculation or Reference	Planning Years					
			2006	2010	2015	2020	2025	2030
Net system demand for **Scenario B**	a	From **Table 4.18**	2923	2939	2942	3005	3071	3136
Reduction in Water Requirements **Sc. D**	b	Assessment	-	180	191	200	213	213
Reduction in Southern SDA Return Flows **Sc. D**	c	Assessment	-	68	75	81	87	93
Net reduction **Sc. D**	d	(b-c)	23	112	117	120	126	120
Net system demand **Sc. D**	e	(a-d)	2900	2827	2826	2885	2945	3016

Notes: (1) All volumetric values are given in million m^3/annum.

Table 5.3: Savings and system net water requirements for Scenario E

Component description	Row	Calculation or Reference	Planning Years					
			2006	2010	2015	2020	2025	2030
Net system demand for **Scenario B**	a	From **Table 4.18**	2923	2939	2942	3005	3071	3136
Reduction in Water Requirements **Sc. E**	b	Assessment	-	110	176	193	206	208
Reduction in Southern SDA Return Flows **Sc. E**	c	Assessment	-	45	71	77	84	90
Net reduction **Sc. E**	d	(b-c)	13	65	105	115	122	118
Net system demand **Sc. E**	e	(a-d)	2910	2874	2837	2890	2949	3019

Notes: (1) All volumetric values are given in million m^3/annum.

It should be noted that the savings indicated in the above three tables are less than the total savings presented in the report "*Potential Savings through WC/WDM in the Upper and Middle Vaal Water Management Areas" (**DWAF,2006**).* This is a report that was produced from a joint study by the Directorates: Water Use Efficiency and National Water Resource Planning, (see **Chapter 1** for a description of the various studies that were carried out in parallel by DWAF). This difference is due to the assumptions made regarding the utilisation of "own sources", which are alternative sources of water to those of the Vaal River System.

These water requirements and return flows were used to compile the planning scenarios, which are presented in **Section 6.3**

5.3 WC/WDM RELATED CONCLUSIONS AND RECOMMENDATIONS

From the assessment of the scope for WC/WDM several key issues were identified, from which the following conclusions and recommendations were made:

- WC/WDM can provide a significant reduction in the water demands in the study area, if the measures are implemented properly and maintained indefinitely. The cost of implementing WC/WDM measures is often less that the maintenance costs, which are often overlooked, with the result that the WC/WDM interventions fail within a year or two of being implemented.

- WC/WDM can be effective and sustainable as has been shown by several large projects undertaken in the study area, including:
  - The Sebokeng/Evaton pressure management project.
  - The Soweto leak repair, retrofitting and pre-paid metering project.
  - The Kagiso pre-paid metering project.
- Garden irrigation, using potable water, is a huge problem issue in many low income areas where indiscriminate use of hosepipes and potable water is creating both supply and pressure problems. The use of hosepipes must be either banned completely in such areas, or the use restricted to an hour or two every 2nd day during off-peak periods. Irrigation during the hottest part of the day (from 10h00 to 18h00) should be prohibited simply on efficiency grounds.
- Government Departments must co-ordinate their efforts with regard to WC/WDM. The efforts of DWAF, where the Department is spending large budgets to educate consumers on the evils of hosepipe irrigation, is being undermined by the efforts of the Department of Agriculture, as they are providing free hosepipes to the same consumers to grow vegetables. Those wishing to grow vegetables in such areas should be provided with buckets or watering cans, which can still be used with good effect without causing the system problems mentioned previously. Alternatively, roof tanks should be provided to capture rainwater, which is ideal for such irrigation.
- DWAF should encourage WDM activities – e.g. fund projects like Sebokeng, provide subsidies for roof tanks and low flush toilets, etc. The Department should not encourage use of low quality fixtures in township retrofitting projects and should rather use the highest quality pipes, meters and fittings for poor areas, since the taps and toilets in these areas experience highest use and lower quality fittings will not last.
- Lack of maintenance will result in many systems deteriorating into intermittent supply if action is not taken quickly – particularly in township systems where lack of maintenance has occurred over past 30 years.
- Municipalities should be encouraged to combine technical and financial services into a single unit, – current trend of separate billing/treasury from water supply/technical is causing major problems, and a proper water audit is often not possible, since the split between Real and Apparent losses cannot be established with confidence.

CHAPTER 6. FUTURE INTERVENTION REQUIREMENTS

6.1 OVERVIEW

Given the water requirement and return flow scenarios provided in **Chapter 4**, and the potential saving scenarios through WC/WDM measures presented in **Chapter 5**, the need for intervention (when further WC/WDM measure and/or the development of an augmentation scheme is required) can be determined by assessing the water reconciliation (water balance) situation over the planning period. This was undertaken by firstly defining the planning scenarios and, secondly, carrying out scheduling analysis to determine the date when further intervention should be required.

The planning scenarios are described in **Section 6.3** and the results of the scheduling analysis are presented in **Section 6.4**.

6.2 INFRASTRUCTURE INTERVENTION OPTIONS

The Vaal Augmentation Planning Study (VAPS), completed in 1996, concluded that either a further phase of the Lesotho Highlands Water Project (LHWP) or further water resource developments in the Thukela River System could be considered as alternatives for augmenting the water resources of the Vaal River System.

6.2.1 Thukela Water Project

Subsequent to the VAPS, DWAF undertook the Thukela Water Project Feasibility Study (TWPFS) to determine the most feasible scheme configuration for development in the Thukela River System. The study concluded that two proposed dams, one on the Bushman's River (Mielietuin Dam) and the other on the main stem of the Thukela River (Jana Dam), with transfer infrastructure, would be the most feasible scheme configuration to provide a nominal transferable yield of 15m^3/s (473 million m^3/annum).

A further study, the "*Thukela Water Project Decision Support Phase (TWPDSP)*" (DWAF, 2005) study, was carried out to, among other things, undertake a Comprehensive Reserve Determination Study for the Thukela River System and compile an implementation programme for the TWP. The results from this study indicated that the first water could be delivered twelve years after the decision is taken to proceed with the development. The Historic Firm Yield of the TWP, incorporating the Ecological Water Requirements (EWR), for the largest dam sizes were determined to be 454 million m^3/annum.

6.2.2 Lesotho Highlands Further Phases (LHFP)

A joint feasibility study by the South African and Lesotho governments were commissioned in 2005, with the purpose of identifying the most feasible further phases of the scheme. Results from the first phase of the study were made available to the Reconciliation Study Team, which indicated the proposed Polihali Dam with transfer infrastructure was the preferred option. The implementation period required for the scheme was estimated to be ten years after the decision is taken to proceed with the scheme. (If the decision is taken today, however, a further three year preparation phase has to be added to the ten years. This is to complete the current feasibility study and to investigate funding options.) The Historical Firm Yield of the Polihali Dam options was determined to be 458 million m^3/annum.

The second phase of the LHFP Feasibility Study commenced in October 2006 and the reconciliation results presented in this report will be used to determine the optimal configuration during that study.

6.3 PLANNING SCENARIOS

Seven planning scenarios were formulated for analysis and evaluation, covering a range of possible future conditions and interventions as described in the following sections.

6.3.1 Scenario A: NWRS high population growth - based on 2001 census

- Urban water requirements and return flows: This scenario applies the NWRS high population growth rates, applied to the 2001 census population, as the base or starting population for the Rand Water Supply Area.

- **Irrigation Scenario 1**: Curtailment of illegal irrigation water use was applied, see **Section 4.2.6** for details.

- **Table 4.15** presents the water requirements and return flows of all the water users for this scenario.

6.3.2 Scenario B: August 2006 DWAF population scenario

- Urban water requirements and return flows: Implements the August 2006 population projection scenario as discussed in **Section 4.4.2.**
- **Irrigation Scenario 1**: Curtailment of illegal irrigation water use was applied, see **Section 4.2.6** for details.
- **Table 4.16** presents the water requirements and return flows of all the water users for this scenario.

6.3.3 Scenario C: WC/WDM: Implement all identified measures (based on Scenario B)

- This scenario is based on the water requirements for Scenario B as presented in **Table 4.16**.
- The savings through WC/WDM measures presented in **Table 5.1** is applied in **Scenario C**.

6.3.4 Scenario D: WC/DM: Implement waste management initiatives over 5 years (based on Scenario B)

- This scenario is based on the water requirements for Scenario B as presented in **Table 4.16**.
- The savings through WC/DM measures presented in **Table 5.2** is applied in **Scenario D**.

6.3.5 Scenario E: WC/DM: Implement waste management initiatives over 10 years (based on Scenario B)

- This scenario is based on the water requirements for Scenario B as presented in **Table 4.16**.
- The savings through WC/DM measures presented in **Table 5.3** is applied in **Scenario D**.

6.3.6 Scenario F: Unlawful irrigation water use continues (based on Scenario B)

- This scenario is based on the water requirements for Scenario B as presented in **Table 4.16**.
- **Irrigation Scenario 2** is implemented where the unlawful water use is assumed to continue to increase according the recent observed trend, see **Section 4.2.6** for details.

6.3.7 Scenario G: Water balance for Ecological Water Requirement scenario (preliminary assessment)

This scenario was based on the water requirements for **Scenario B** and applying the Ecological Water Requirement (EWR) information that was available from the Directorate: Resource Directed Measures. The EWR information were mainly determined through low confidence determination methods and the scenario results only serve as a preliminary indication of what the reconciliation situation will be if the EWRs are implemented.

It should be noted that DWAF has at the end of 2006, commissioned a Comprehensive Reserve Determination Study for the Vaal River System, and that the reconciliation options will have to be reviewed once the results become available.

6.3.8 System net water requirements (Scenarios A to E)

Combining the respective water requirements and return flow components for **Scenarios A** to **E**, produce the net system demands graph as presented in **Figure 6.1**. A similar trend is observed for all scenarios for the first five years, showing an increase over the first two years and a decrease for the remaining three. This is due to the implementation of **Irrigation Scenario 1** (see **Section 4.2.7**) in all the indicated scenarios.

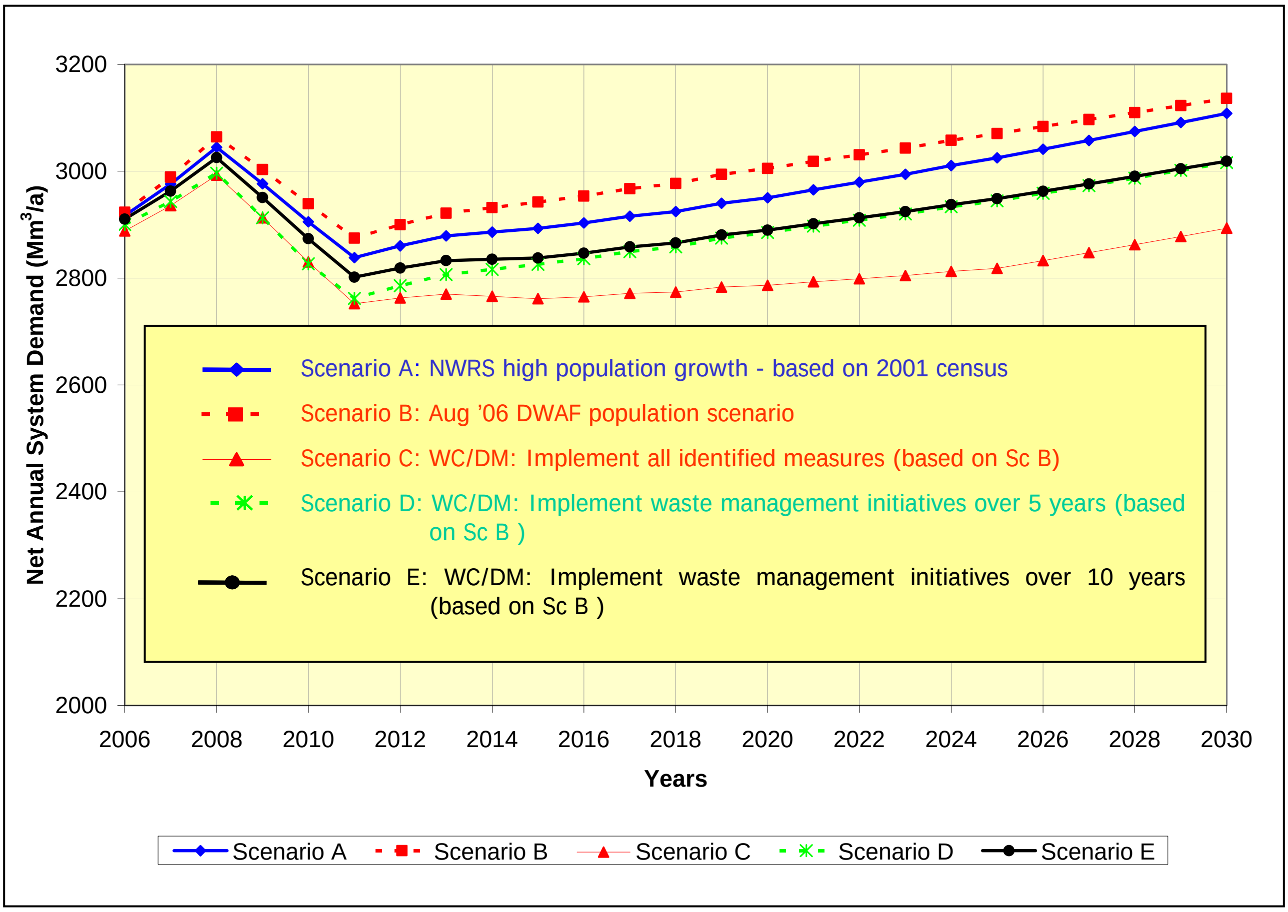


Figure 6.1: System net demand for the indicated scenarios

6.4 SCHEDULING ANALYSIS RESULTS

Projection analyses were carried out with the Water Resource Planning Model (WRPM) for the scenarios, and based on the assessment of the risk of curtailments, the supply capability of the system was determined to be 2 921 million m^3/annum. **Figure 6.2** shows the net water requirements of **Scenario A** to **E** in relation to the system supply capability, from which the following observations can be made:

- The unlawful water use in the irrigation sector results in the system being in a deficit situation from the year 2007 to 2009 for all the scenarios. This illustrates the importance of curbing the unlawful irrigation water use in order to maintain a positive water balance in the system and prevent excessive curtailments during drought periods.

- Based on the projected balance situation for **Scenario B**, it is shown that the system will require intervention by the year 2013.

- If the potential savings through WC/WDM of **Scenario C** is achieved, no further intervention is required for the planning period until after the year 2030.
- The balance situation for **Scenarios D** and **E** shows that, by eliminating wastage through WC/WDM, further interventions is only required in the year 2023.

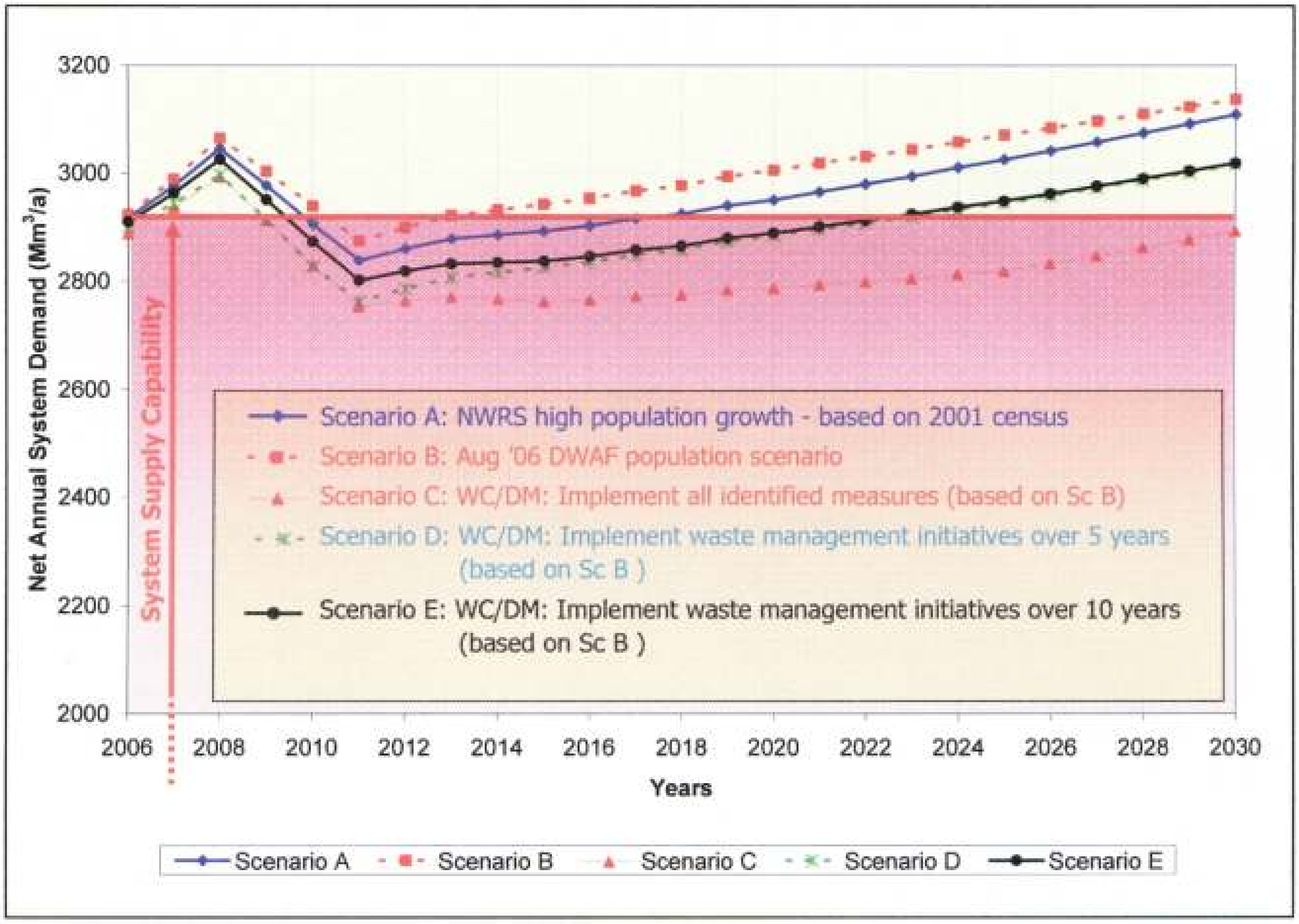


Figure 6.2: Net system demand and system supply capability

6.5 ECOLOGICAL WATER REQUIREMENT SCENARIO RESULTS (SCENARIO G)

Risk analysis showed that the supply capability of the Vaal River System would decrease by 138 million m^3/annum, and according to the balance situation provided in **Figure 6.3**, only **Scenario C** will achieve a positive water supply balance between the year 2011 and 2020.

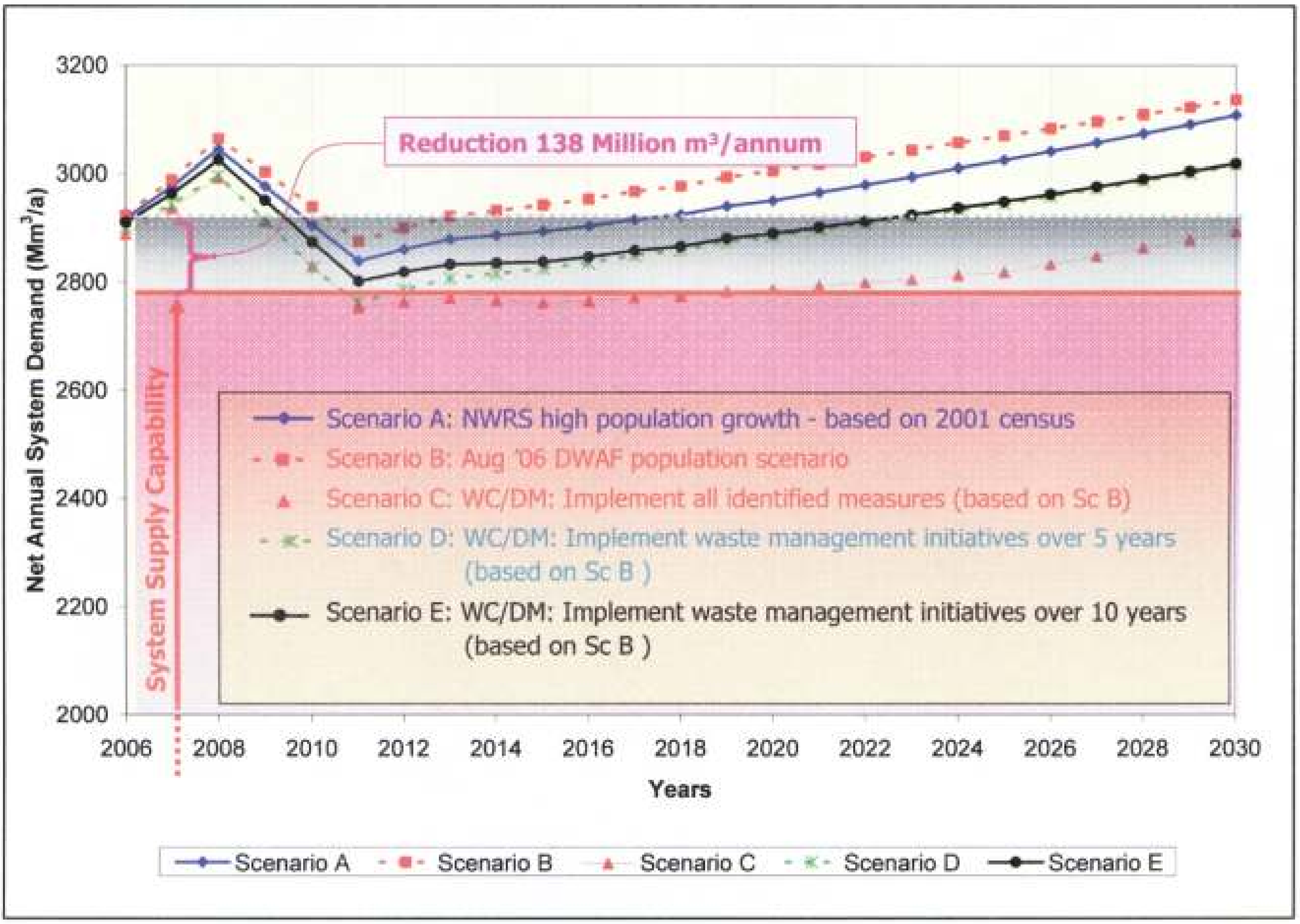


Figure 6.3: Net system demand and supply capability with EWR releases

6.6 RECONCILIATION OPTIONS

Several reconciliation options were formulated based on the scenarios described in **Section 6.3** and the augmentation options presented in **Section 6.2**, and these are presented in the subsequent sections.

6.6.1 Scenario B and implementation of the Thukela Water Project

Figure 6.4 presents the reconciliation situation based on the net water requirements of **Scenario B** and the implementation of the proposed Thukela Water Project (TWP). The bar chart portion of the figure provides the main activities and their duration for implementing the scheme. As can be seen, the time required to deliver the first water from the TWP is estimated to be 13 years. This will result in the system experiencing supply deficits for the period 2014 to 2019, which are due to the project's implementation period requirements.

Due to the slow rate of increase of the net system demand, the TWP components were implemented in two phases, firstly the Mielietuin Dam option delivering in the year 2019 and secondly the Jana Dam option delivering from 2025 onwards. What is clear from the graph is that the yield of the full TWP is much larger than the deficit for Scenario B in the year 2030. This points to the need for further optimisation of the configuration and size of the TWP scheme components.

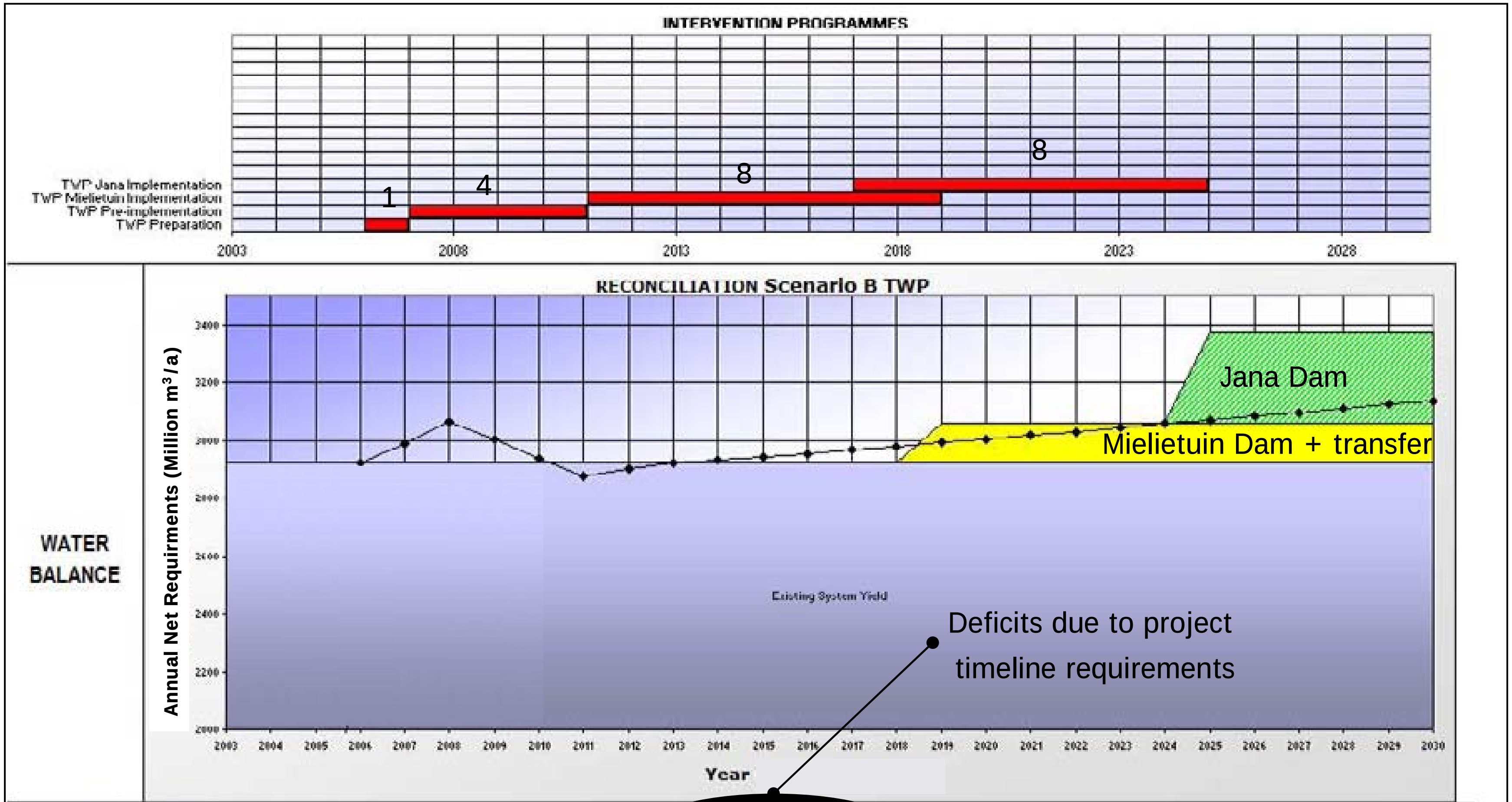
6.6.2 Scenario B and implementation of the LHFP scheme

Figure 6.5 shows the option of implementing the Lesotho Highlands Future Phases (LHFP) option, Polihali Dam and transfer conduits, with respect to **Scenario B** water requirements. Again the implementation requirements of the scheme results in deficits in supply over the period 2014 to 2019.

The total yield of the Polihali Dam option is also larger than what is required, and further optimisation of the scheme configuration is required. This will be carried out as part of the second phase of the LHFP Feasibility Study.

6.6.3 Scenario D and implementation of the TWP scheme

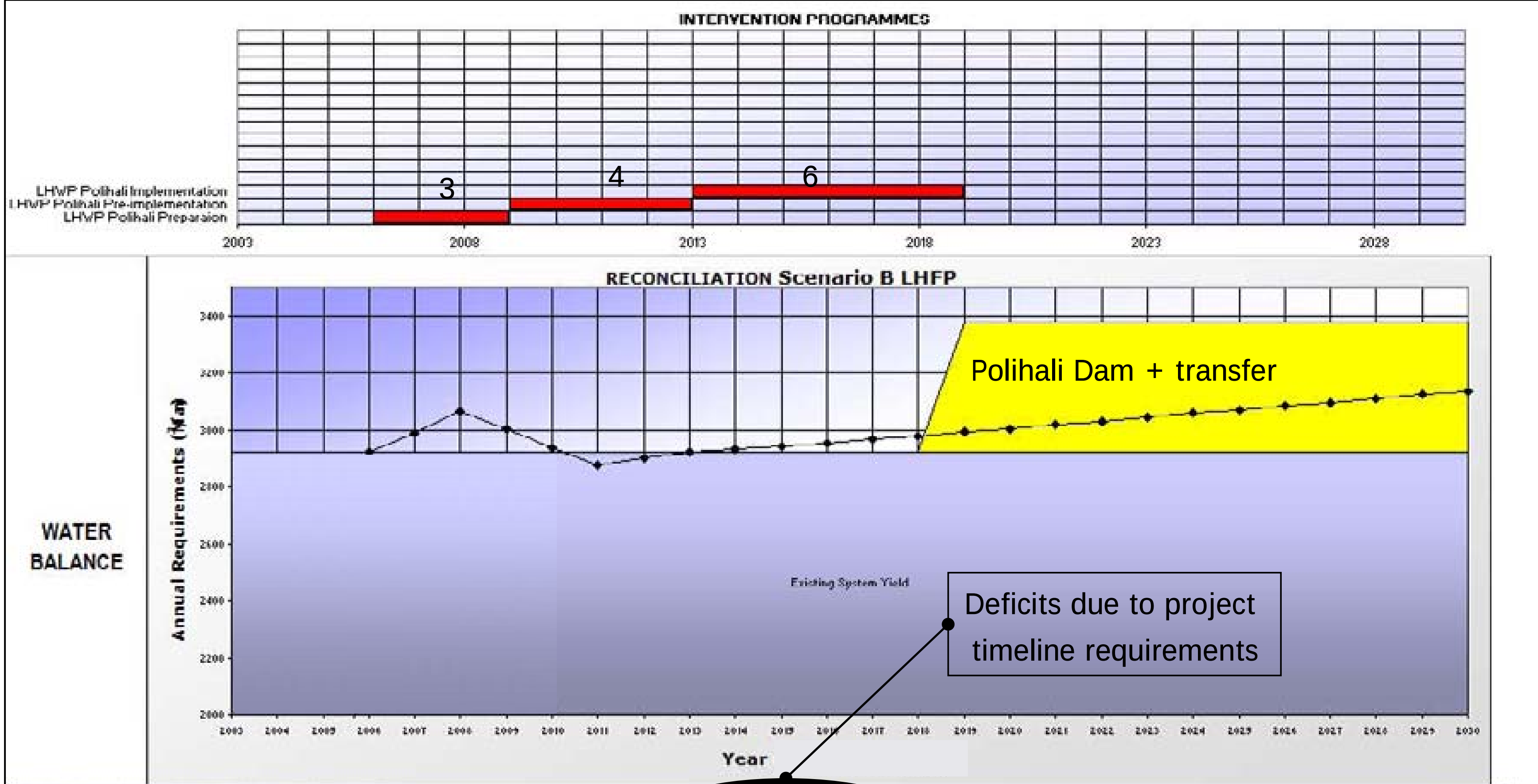
Waste management, as represented by **Scenario D**, has the advantage that the need for augmentation is postponed to the year 2023 and that the decision to proceed with the implementation of the TWP only has to be taken in the year 2012, as shown in **Figure 6.6**. Furthermore, due to the relative small deficit in the year 2030, only the Mielietuin Dam option is required to achieve a balance until the end of the planning period.



WATER BALANCE CALCULATIONS (Mm³)

Water Balance (Mm³)		-2	-68	-143	-82	-18	46	21	-0	-11	-21	-32	-46	-56	63	52	39	26	14	-1	304	291	278	265	252	239
System Yield (cumulative)		2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	3057	3057	3057	3057	3057	3057	3375	3375	3375	3375	3375	3375
Annual Interventions	Yield	0	0	0	0	0	0	0	0	0	0	0	0	0	136	136	136	136	136	136	454	454	454	454	454	454
	Saving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adjusted Requirements		2923	2989	3064	3003	2939	2875	2900	2921	2932	2942	2953	2967	2977	2994	3005	3018	3031	3043	3058	3071	3084	3097	3110	3123	3136.36
Requirements (selected scenario)		2923	2989	3064	3003	2939	2875	2900	2921	2932	2942	2953	2967	2977	2994	3005	3018	3031	3043	3058	3071	3084	3097	3110	3123	3136.36
Year		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Figure 6.4: Reconciliation option for Scenario B and implement the Thukela Water Project

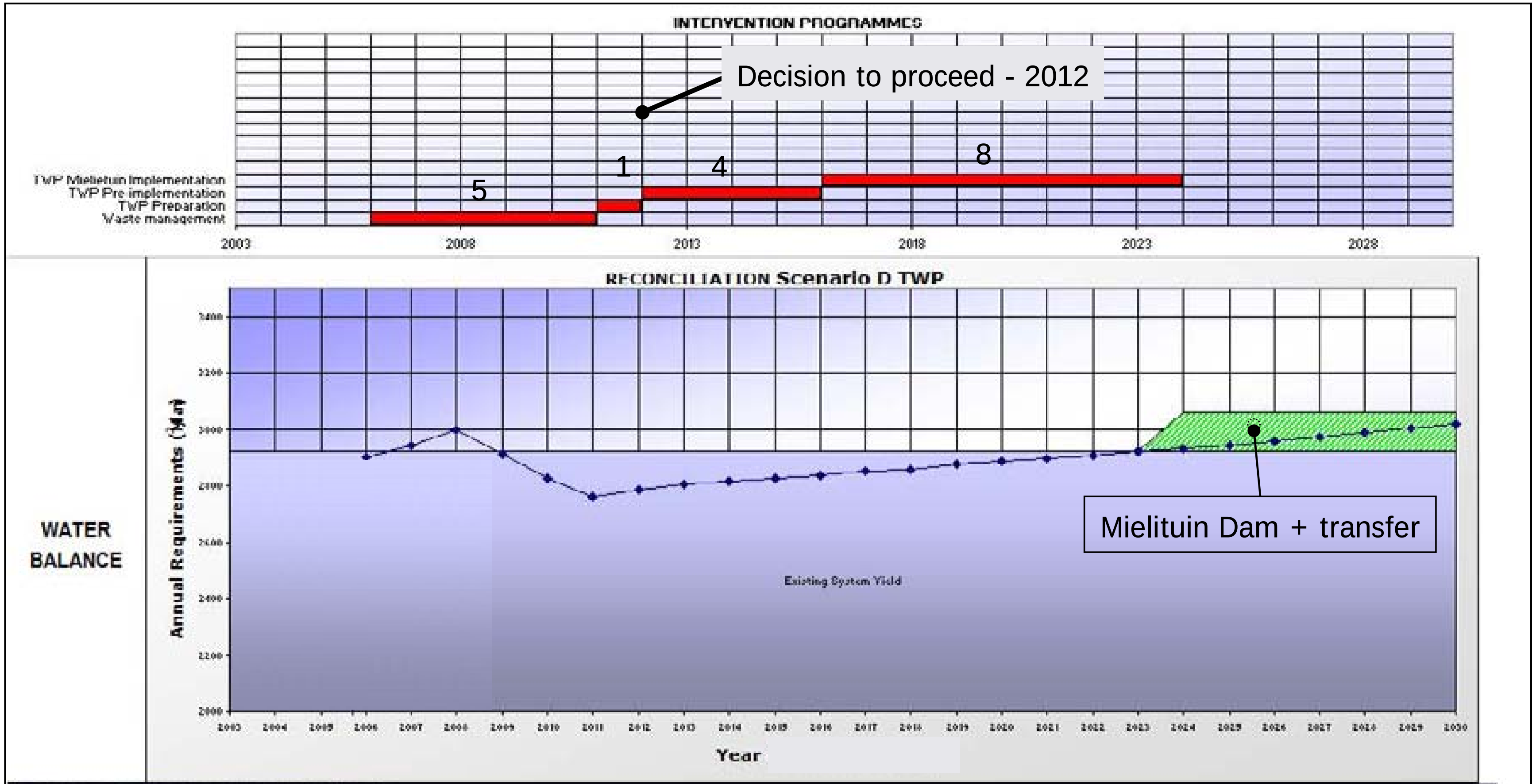


WATER BALANCE CALCULATIONS (Mm³)

Water Balance (Mm³)	-2	-68	-143	-82	-18	46	21	-0	-11	-21	-32	-46	-56	385	374	361	348	336	321	308	295	282	269	256	243
System Yield (cumulative)	2021	2021	2021	2021	2021	2021	2021	[illegible]	2021	2021	2021	2021	[illegible]	3079	3079	3079	3079	3079	3079	3079	3079	3079	3079	3079	3079
Annual Interventions – Yield	0	0	0	0	0	0	0	0	0	0	0	0	0	458	458	458	458	458	458	458	458	458	458	458	458
Annual Interventions – Saving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adjusted Requirements	2923	2989	3064	3003	2939	2875	2900	2921	2932	2942	2953	2967	2977	2994	3005	3018	3031	3043	3058	3071	3084	3097	3110	3123	3136.36
Requirements (selected scenario)	2923	2989	3064	3003	2939	2875	2900	2921	2932	2942	2953	2967	2977	2994	3005	3018	3031	3043	3058	3071	3084	3097	3110	3123	3136.36
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

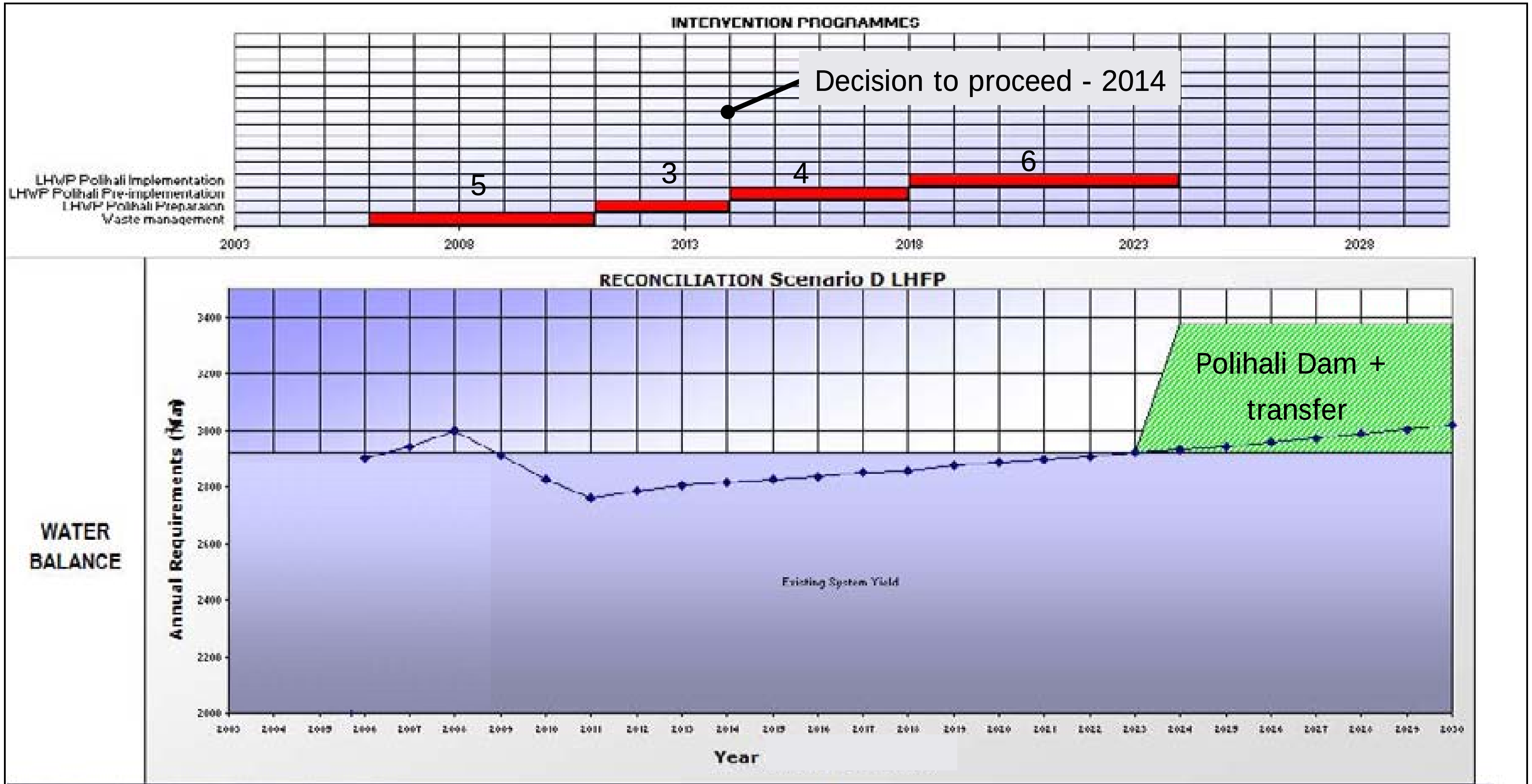
LHFP information provided by Feasability Study Team

Figure 6.5: Reconciliation option for Scenario B and implement the LHFP scheme



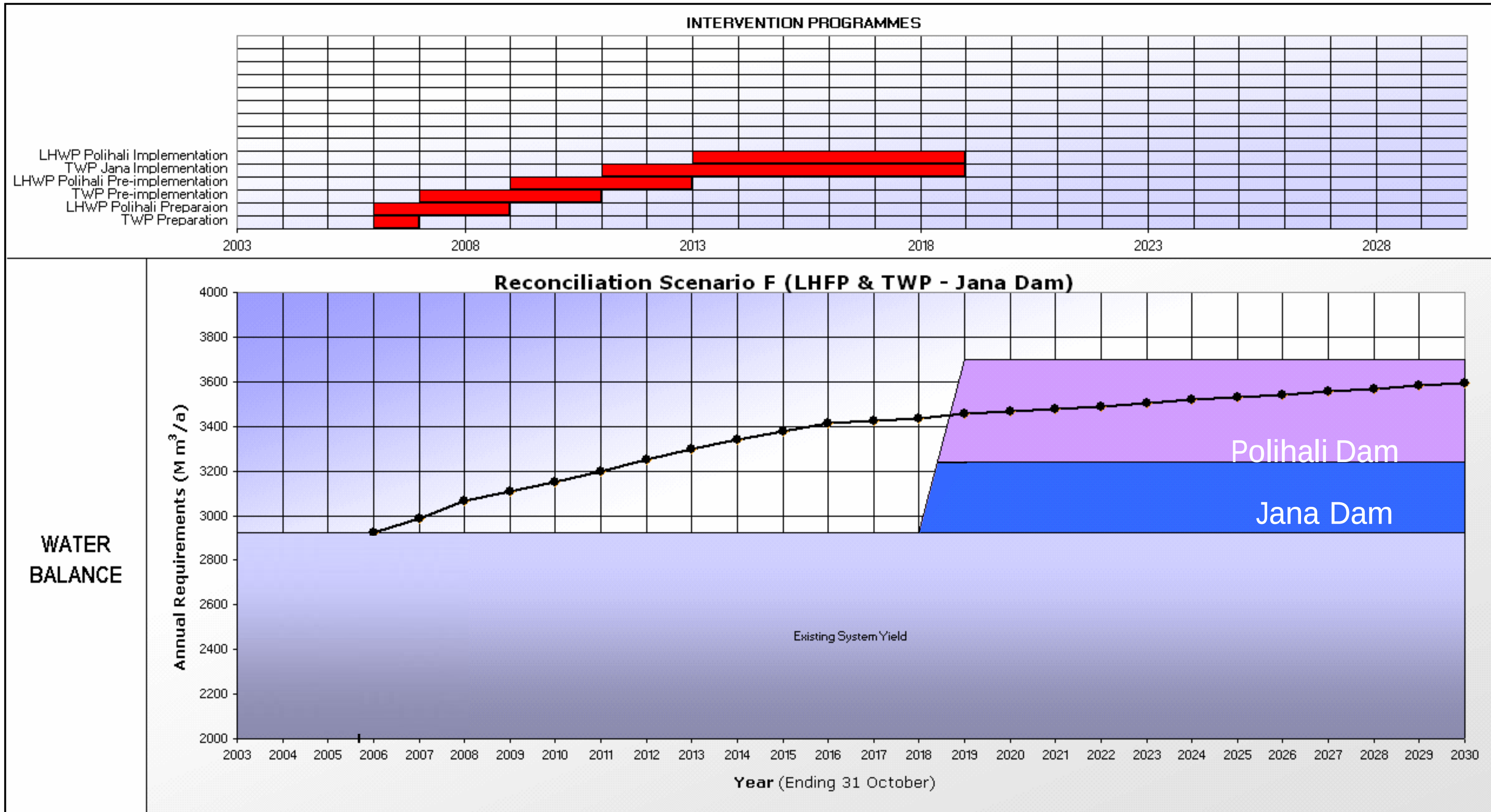
WATER BALANCE CALCULATIONS (Mm³)																										
Water Balance (Mm³)		21	-22	-75	8	94	159	135	114	105	95	85	72	63	46	36	24	12	1	124	112	98	84	70	55	41
System Yield (cumulative)		2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	3057	3057	3057	3057	3057	3057	3057
Annual Interventions	Yield	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136	136	136	136	136	136	136
	Saving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adjusted Requirements		2900	2943	2996	2913	2827	2762	2786	2807	2816	2826	2836	2849	2858	2875	2885	2897	2909	2920	2933	2945	2959	2973	2987	3002	3016.29
Requirements (selected scenario)		2900	2943	2996	2913	2827	2762	2786	2807	2816	2826	2836	2849	2858	2875	2885	2897	2909	2920	2933	2945	2959	2973	2987	3002	3016.29
Year		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Figure 6.6: Reconciliation option for Scenario D and implement the TWP scheme



WATER BALANCE CALCULATIONS (Mm³)																										
Water Balance (Mm³)		21	-22	-75	8	94	159	135	114	105	95	85	72	63	46	36	24	12	1	446	434	420	406	392	377	363
System Yield (cumulative)		2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	3379	3379	3379	3379	3379	3379	3379
Annual Interventions	Yield	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	458	458	458	458	458	458	458
	Saving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adjusted Requirements		2900	2943	2996	2913	2827	2762	2786	2807	2816	2826	2836	2849	2858	2875	2885	2897	2909	2920	2933	2945	2959	2973	2987	3002	3016.29
Requirements (selected scenario)		2900	2943	2996	2913	2827	2762	2786	2807	2816	2826	2836	2849	2858	2875	2885	2897	2909	2920	2933	2945	2959	2973	2987	3002	3016.29
Year		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Figure 6.7: Reconciliation option for Scenario D and implement the LHFP scheme



WATER BALANCE CALCULATIONS (Mm^3)

Water Balance (Mm^3)		-2	-68	-143	-189	-231	-275	-328	-378	-418	-459	-492	-506	-516	243	232	219	206	194	179	166	153	140	127	114	101
System Yield (cumulative)		2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	3697	3697	3697	3697	3697	3697	3697	3697	3697	3697	3697	3697
Annual Interventions	Yield	0	0	0	0	0	0	0	0	0	0	0	0	0	776	776	776	776	776	776	776	776	776	776	776	776
	Saving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adjusted Requirements		2923	2989	3064.4	3110	3152	3195.7	3248.7	3299.3	3339	3379.92	3413	3427	3436.8	3454	3465.1	3478.2	3491	3503	3518	3531	3544	3557	3570	3583	3596.264
Requirements (selected scenario)		2923	2989	3064.4	3110	3152	3195.7	3248.7	3299.3	3339	3379.92	3413	3427	3436.8	3454	3465.1	3478.2	3491	3503	3518	3531	3544	3557	3570	3583	3596.264
Year		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Figure 6.8: Reconciliation situation if irrigation water use continues to increase (Scenario F)

6.6.4 Scenario D and implementation of the LHFP scheme

Implementing the Lesotho Highlands Further Phase (Polihali Dam scheme) to augment the deficits of **Scenario D** (see **Figure 6.7**), indicates that the decision to proceed with the scheme only needs to be taken in the year 2012. This illustrates the benefit of implementing WC/WDM measure, by reducing water wastage in the urban supply system, and provides a flexible management scenario with substantial savings in interest costs due to the delay in capital investments.

6.6.5 Scenario F and recent trend in irrigation increases continues uncurbed

Scenario F was compiled to illustrate how the water balance will be negatively affected if the unlawful irrigation water use is not eradicated. **Figure 6.8** therefore shows the projected water balance and indicates that large deficits will occur over the planning period until the year 2019 which is the earliest date an augmentation option can be ready to deliver additional water. Furthermore both the Jana Dam option (form the TWP) and the Polihali Dam option (from the LHFP) need to be implemented to achieve the projected deficit in 2030. This scenario will result in unsustainable large restrictions over the medium term and significant capital investment that is perceived not to be sustainable.

6.6.6 Situation regarding Scenarios C and D

From **Figure 6.3** it can be seen that no augmentation is nessesary if the savings postulated for **Scenario C** is achieved for the planning period up to 2030. The date when augmentation is required for **Scenario D** is the same as for **Scenario E** with the result that the reconciliation option for **Scenario E** is the same as for **Scenarion D**.

CHAPTER 7. PRELIMINARY PERSPECTIVE ON WATER QUALITY MANAGEMENT

7.1 OVERVIEW

Water quality management is being investigated in detail as part of the parallel "***Integrated Water Quality Management Plan***" (IWQMP) study and will be reported on in a separate series of reports. At the time of writing this report, the IWQMP (DWAF, 2006a) study was still in progress, and only initial preliminary results were available for consideration in the First Stage Reconciliation Strategy. The following section, therefore, provides a brief discussion of the main issues and findings regarding water quality management.

7.2 WATER QUALITY MANAGEMENT CONSIDERATION

Sporadic elevated aluminium concentrations were observed in Vaal Dam. The source of the aluminium is thought to be the Wilge River tributary downstream of the confluence with the Liebenbergsvlei River where pH of 6.0 was recorded. Although no reports were received of aquatic organism deaths (no fish kills were observed), the elevated aluminium concentrations are a potential threat that requires management intervention. Further investigations are, however, required to improve the knowledge regarding the sources of the aluminium so that possible management measures can be evaluated.

The water quality situation in and downstream of the Vaal Barrage requires an intervention strategy for the management of salinity and nutrients. There are serious risks of eutrophic conditions in the river reach between Vaal Dam and Bloemhof Dam, which requires immediate intervention measures as well as long term strategies for reducing the nutrient load in the system.

Initial indications are that flow management measures, supported by intensive monitoring, could help to alleviate the risk over the short term. The impact of such releases (from Vaal Dam) on the supply capability of the system has to be assessed, which is a proposed activity for the ***Second Stage Reconciliation Strategy***.

Preliminary results indicated that the nutrient load (Phosphate) in the system can be reduced by adding secondary treatment processes to the existing major urban waste water treatment works, using existing and proven technologies. The costs of implementing such treatment processes are considerable, however, the environmental benefits would most likely favour this option as a long term solution. Further investigations will be carried out on these options as part of the IWQMP study.

Initial analysis of the dilution rule (where water is released from Vaal Dam to reduce the Total Dissolved Solids (TDS) Concentration in and downstream of Vaal Barrage) indicated that this option would only be feasible over the medium term (<8 years) and other options, such as desalination, would have to be considered for the long term management of salinity. This is due to the fact that the dilution rule will result in excess water in Bloemhof Dam from about 2012 onwards.

It is however possible to utilise the excess water in Bloemhof Dam to support the Orange River at the time of the next augmentation from the LHFP or when the Orange system demand exceeds the current system yield by approximately 2015. This means that under these conditions it will be possible to continue with the dilution rule for a longer period, which in turn postpones the need for costly desalination.

Initial analysis of the dilution rule (where water is released from Vaal Dam to reduce the Total Dissolved Solids (TDS) Concentration in and downstream of Vaal Barrage) indicated that this option would only be feasible over the medium term (<8 years) and other long term options, such as desalination, will have to be considered for the long term management of salinity.

Analyses were carried out with the WRPM to obtain an indication of the benefits, should desalination of mine discharges be implemented. Two scenarios were analysed with the WRPM, the first option with the discharges from the mines returned to the river (base case), and the second where the mine and industry discharges were treated to 250 mg/ℓ TDS and discharged back to river.

Table 7.1: Summarised results of desalination scenario

System monitoring point location	Option description (Total Dissolved Solids Concentration, mg/ℓ)	
	Option 1 No desalination	Option 2 Desalination to 250mg/ℓ
Vaal Barrage	750 (900)	500 (800)

Midvaal	750 (920)	600 (650)
Sedibeng	800 (1000)	600 (650)
Bloemhof Dam	500 (900)	400 (700)
Vaal Harts weir	550 (950)	420 (720)

Notes: *(1)* *Values without brackets are for the median of the distribution.*

(2) *Values in brackets are the 95 percentile of the distribution.*

The summarized results of simulation analyses for 1000 stochastic sequences that were carried with the WRPM are presented in **Table 7.1**, which indicate that the benefit of the desalination option is between 100 and 200 mg/ℓ reduction in the TDS concentration. The economic benefit and cost/benefit analysis will be undertaken as part of the IWQMP study to determine the feasibility of this measure.

CHAPTER 8. CONCLUSIONS

Given the reconciliation situation as presented in the previous chapters, the following main conclusions can be drawn:

- Unlawful irrigation water use, particularly in the catchments of Wilge and Liebenbergsvlei rivers (upstream of Vaal Dam), is a major impediment to the assurance of supply in the Vaal River System and represent an unsustainable situation that requires management intervention (results of **Scenario F**).
- Saving water through the reduction of wastage, by means of water conservation and demand management measures in the urban sector, has the benefit that the decision to proceed with an augmentation scheme can be postponed to the year 2012. (results of **Scenarios D** and **E**)
- Without WC/WDM the decision to proceed with an infrastructural intervention measure has to be taken immediately (results of **Scenario B**).
- Flow management measures have to be implemented over the short to medium terms to improve the water quality situation in, and downstream, of the Vaal Barrage. This will be studied further in the ***Second Stage Reconciliation Strategy***.
- The above described flow management measures will, over the long term, have to be replaced or augmented with alternative options, which will most likely include removal of pollutants from point sources.

CHAPTER 9. UNCERTAINTIES CONCERNING RECONCILIATION PERSPECTIVE

9.1 OUTCOME OF VALIDATION STUDIES IN THE MIDDLE AND LOWER VAAL WMAs

In **Section 4.1** it was mentioned that the validation studies in the Middle and Lower Vaal WMAs has not been carried out, and in view of the high level of unlawful water use found in the Upper Vaal WMA, it is essential that these studies be carried out as priority activities. The validation study results will have to be compared with the irrigation water requirements of **Irrigation Scenario 1**, and if found to be significantly different, revised projected water balances and reconciliation options will have to be determined.

9.2 LAWFUL IRRIGATION WATER USE IN THE UPPER VAAL WMA

In view of the fact that the validation study was only partially completed at the time the irrigation task was carried out, it would be required to review the assumption made in **Irrigation Scenario 1** once the validation study in the Upper Vaal WMA has been completed.

9.3 POPULATION GROWTH IN GAUTENG PROVINCE

Given the significance of the population projection scenario with respect to future water requirements, it is proposed that a review of the population scenarios be carried out as part of the development of the ***Second Stage Reconciliation Strategy***.

9.4 REFINEMENT OF WATER REQUIREMENT AND RETURN FLOW MODEL

Limited information was available for distributing (assigning) population into the different housing categories and quantifying other land use. It is therefore proposed that further refinements be carried out to improve the data used in the scenario generation model.

CHAPTER 10. STRATEGIC PERSPECTIVE

10.1 OVERVIEW

The findings from the water reconciliation scenario results, and the conclusion presented in the previous sections, points to specific strategies that are required for the sustainable management of the water resource of the Vaal River System.

These strategies are presented in the subsequent sections, and the intention is that projects and programmes need to be development as well, and human and financial resources made available to achieve the underlying objectives.

10.2 ERADICATE UNLAWFUL WATER USE

The eradication of the unlawful water use, mainly in the irrigation sector, is an essential strategy that has to be implemented in order to rectify the current deficit (negative water balance) in the Vaal River System. The legal actions and procedures that will be implemented, should be designed to achieve legal precedence's to protect the entitlements of lawful water users, and assist in compliance monitoring and water use regulation in future.

The responsibility for the execution of this strategy lies with DWAF, as main regulatory authority of water use entitlements.

10.3 COMPLETE THE VALIDATION STUDIES FOR THE VAAL WMAS

The completion of the validation studies in the three Vaal Water Management Areas is required to obtain a reliable estimate of the situation regarding the irrigation water use in the Vaal River System. A product of the validation studies should be an assessment of the lawful water use. The results from the validation studies should be used to revise the projected water balance of the system.

10.4 INCORPORATE TAUNG DAM UTILISATION STUDY RESULTS

The Directorate: Option Analysis of DWAF has at the end of 2006, commissioned a study to assess options for the potential utilisation of Taung Dam. The original purpose of the dam was to augment the supply to the Taung Irrigation Scheme, however, the infrastructure to convey water from the dam was not constructed, with the result that the dam is currently not being utilised.

The above-mentioned study has the purpose of investigating all possible uses of the dam, as well as determines the most feasible infrastructure to convey the water to the intended users. The responsibility for the execution of this strategy lies with the Directorates: Option Analysis and National Water Resource Planning.

10.5 IMPLEMENT WATER CONSERVATION AND DEMAND MANAGEMENT MEASURES

The continuation of current, and the initiation of further WC/WDM projects, are essential to maintain a positive water balance in the Vaal River System. The potential savings that can be achieved through the reduction of water wastage is sufficient to delay the decision to proceed with an infrastructural option to the year 2012.

The report "*Potential Savings through WC/WDM in the Upper and Middle Vaal Water Management Areas*" (DWAF, 2006b), provides detail information on the types of WC/WDM measures that should be considered in each target municipality. This serves as a point of departure for the development of projects and securing on budget funds for WC/WDM measures.

The responsibility for the implementation of WC/WDM measures reside primarily with the municipalities and their water service providers. DWAF and provincial government should provide an active supporting role in the form of appropriate legislation and regulations, as well as making dedicated financing available in areas where resources are limited or lacking at municipalities.

The WC/WDM approach to be followed in the irrigation sector is that all savings, to be achieved, will be made available for further irrigation developments with priority given to the establishment of resource poor farmers.

10.6 MANAGEMENT INTERVENTION TO REDUCE RISK OF EUTROPHIC

The high risk of eutrophic conditions in the Vaal River reach from Vaal Barrage to Bloemhof Dam requires water resource management intervention. Over the short term the situation could be improved by releases from Vaal Dam, however, current assessments point to the need for the removal of nutrients from the urban wastewater treatment works through secondary treatments processes. These management measures will be further investigated in the Integrated Water Quality Management Study (DWAF, 2006a).

10.7 MONITOR NET SYSTEM WATER DEMAND

In the past, annual monitoring was carried out only of the main water user's requirements from the Vaal River System. Due to the importance of urban return flows, and the impact WC/WDM could have on the return flows, it is required to also implement continuously monitoring of the return flows, to be able to determine the net water requirements of the system. This will enable regular updates of the water balance and monitoring of the situation against the scenarios presented in the document. System Water Balance Status Reports should be compiled annually to maintain a continuous record of the water balance, and detect deviations from the scenarios.

It is proposed that the System Water Balance Status Reports incorporate water requirement and return flow information for each of the main municipalities, i.e. Johannesburg, Tshwane, Ekhuruleni, Emfuleni, Rustenburg, Mogale, Govan Mbeki, Matjhabeng and Randfontein. Although not all of these municipalities return water to the Vaal River System, the information will be used to understand the impact of WC/WDM and to compile a similar report for the Crocodile (West) River System.

This strategy is the responsibility of the Directorate: National Water Resource Planning and will support the function of the proposed committee as described in **Section 10.11**.

10.8 COMPLETION OF LESOTHO HIGHLANDS FURTHER PHASES FEASIBILITY STUDY

The second phase of the Lesotho Highlands Further Phases Study should be completed based on the water balance results of **Scenarios B** and **D**. Once the optimal LHFP scheme has been identified, it will be required to undertake a comparison with the optimal TWP options before a decision can be made on which of the two alternative schemes should be recommended for implementation.

The Directorate: Option Analysis is the South African agency responsible for the feasibility study.

10.9 REVIEW TWP SCHEME COMPONENT SIZES AND CONFIGURATION

The objective of the TWP feasibility study was to identify the most feasible scheme to supply a nominal volume of 15 m^3/s (473 million m^3/annum) to the Vaal River System. This objective originated from the augmentation requirements that were determined in 1999, and the available capacity of the existing Thukela-Vaal scheme to convey water to the Vaal River System. The 1999 water requirement projection of the Vaal River System were higher compared to the scenarios presented in this document and required larger augmentation support.

The augmentation requirement for **Scenario B** in the year 2030 of 215 million m^3/annum, is substantially lower than the 473 million m^3/annum target that was use for the optimisation of the scheme configuration in the TWP feasibility study. Therefore, the concern is that the optimal configuration for a target of 473 million m^3/annum is not necessarily the optimal configuration for a target augmentation volume of 215 million m^3/annum.

In addition, comparing an optimised LHFP option with a sub-optimal TWP configuration would not provide a fair and realistic comparison.

It is therefore proposed that the TWP option should be re-evaluated to determine the most optimal configuration and size for a target augmentation volume of 215 million m^3/annum.

The re-evaluation work could be the function of either the Directorate: Option Analysis or the Directorate: National Water Resource Planning.

10.10 REVIEW RECONCILIATION OPTIONS BASED ON RESULTS FROM RESERVE STUDY

The Comprehensive Reserve Determination Study (commissioned by the DWAF Directorate: RDM in August 2006) will produce Ecological Water Requirement Scenarios, and the implication thereof on the reconciliation options will have to be determined and evaluated.

The review of the reconciliation options will be the function of the Directorate: National Water Resource Planning.

10.11 STRATEGY IMPLEMENTATION MONITORING

At the Steering Committee Meeting held on 29 March 2006, it was recommended that a committee be formed to oversee the implementation of the reconciliation strategies. Broadly, the function of the committee will be to continuously monitor the water balance situation of the Vaal River System, and advise the responsible institutions on whether or not the objectives of the strategies are being achieved.

The formation of the committee is the responsibility of the Directorate: National Water Resource Planning.

CHAPTER 11. RECOMMENDATIONS FOR THE SECOND STAGE RECONCILIATION STRATEGY

Based on the issues presented in this report and raised by the stakeholders, it is recommended that the following aspects be considered in the development of the ***Second Stage Reconciliation Strategy***:

- Re-evaluate system balance once the validation studies and the comprehensive reserve determination study produce information.
- Undertake further integration with the IWQMP study in terms of the following:
  - Assess the impact the proposed flow management measures (to reduce the risk of eutrophication) will have on the projected water balance of the system.
  - Design and implement the flow measures and incorporate the rules as part of the Annual Operating Analysis of the system.
  - Evaluate the implication of blending and dilution rules on the TDS concentration and the projected water balance.
- Refine the urban water requirement and return flow model with respect to:
  - Carry out a review of the population projection scenario.
  - Evaluate the information that will become available from mini census of Stats SA, planned to be undertaken in 2007.
  - Population distribution into housing categories.
  - Other urban land use information.
- Develop and implement monitoring process including the following:
  - Implementation of Water Conservation and Demand Management measures to achieve the savings presented in **Scenario D**.
  - Monitoring of the water quality in the system in support of the implementation of the flow management measures.

    - Initiate the process of collecting water use and return flow data and compile the first System Water Balance Status Report.

- Initiate the formation of the implementation and monitoring committee.

- Assess the potential impact of global warming on the reconciliation strategies.

CHAPTER 12. REFERENCES

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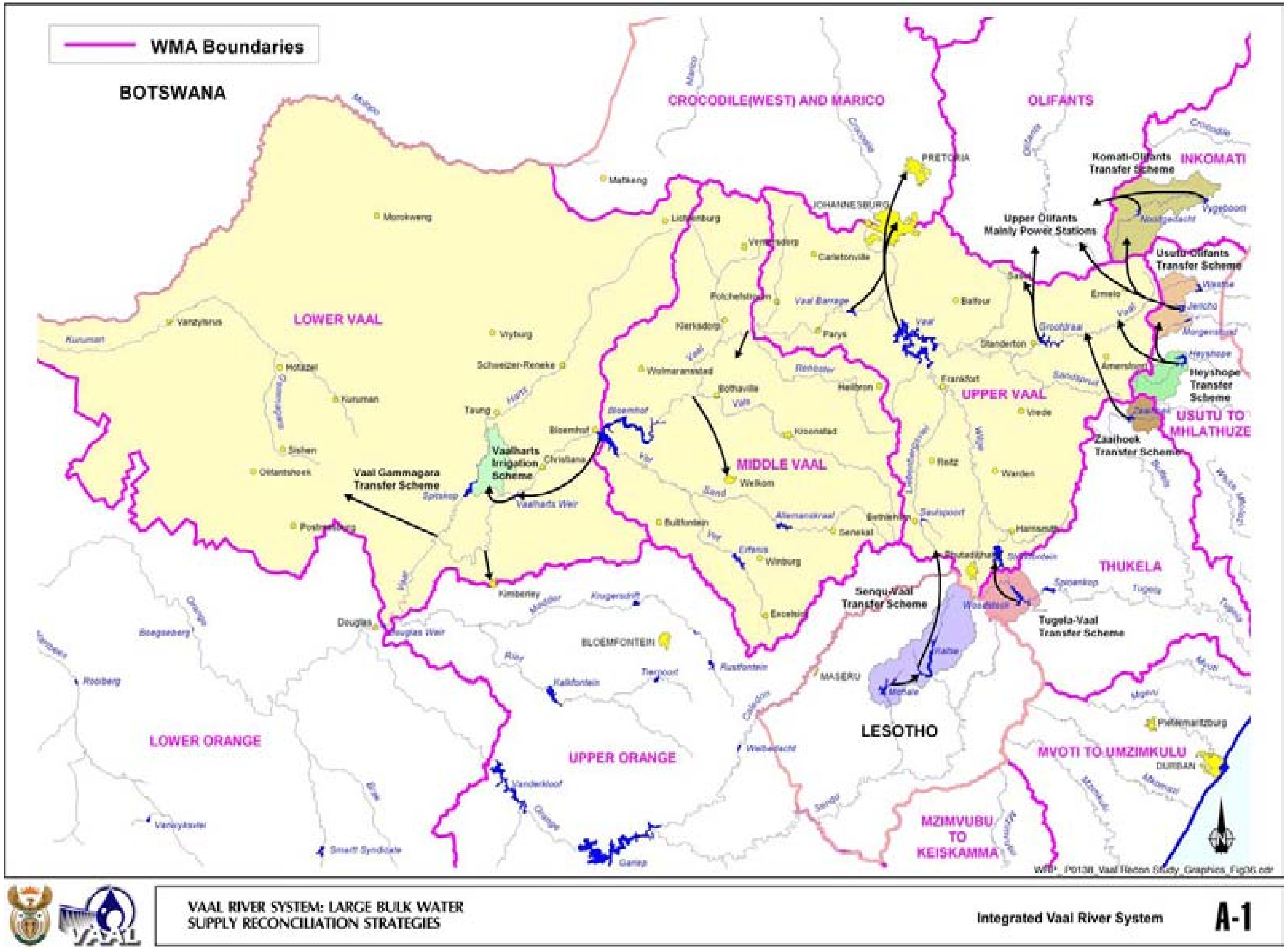
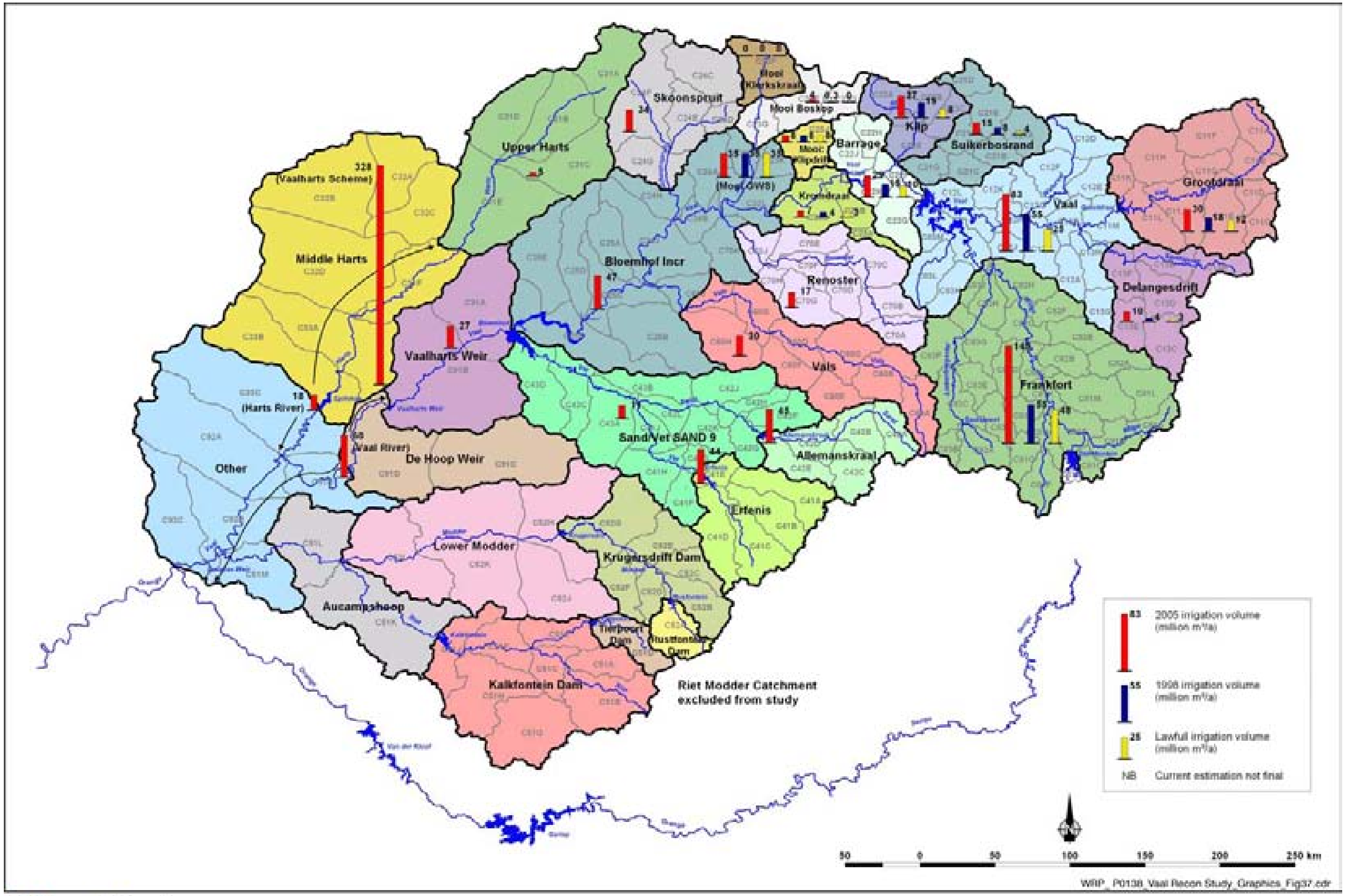
Appendix A

Figures

No:	Description
A-1	Map of the study area, Integrated Vaal River System
A-2	Irrigation development within Vaal River sub-catchments


WMA Boundaries
BOTSWANA
CROCODILE(WEST) AND MARICO
OLIFANTS
INKOMATI
Komati-Olifants Transfer Scheme
Upper Olifants Mainly Power Stations
Usutu-Olifants Transfer Scheme
Heyshope Transfer Scheme
USUTU TO MHLATHUZE
Zaaihoek Transfer Scheme
PRETORIA
JOHANNESBURG
LOWER VAAL
MIDDLE VAAL
UPPER VAAL
Vaalharts Irrigation Scheme
Vaal Gammagara Transfer Scheme
THUKELA
Senqu-Vaal Transfer Scheme
Tugela-Vaal Transfer Scheme
BLOEMFONTEIN
MASERU
LESOTHO
LOWER ORANGE
UPPER ORANGE
MVOTI TO UMZIMKULU
MZIMVUBU TO KEISKAMMA
DURBAN
VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGIES
Integrated Vaal River System
A-1



VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGIES

Irrigation development within Vaal River sub-catchments

A-2