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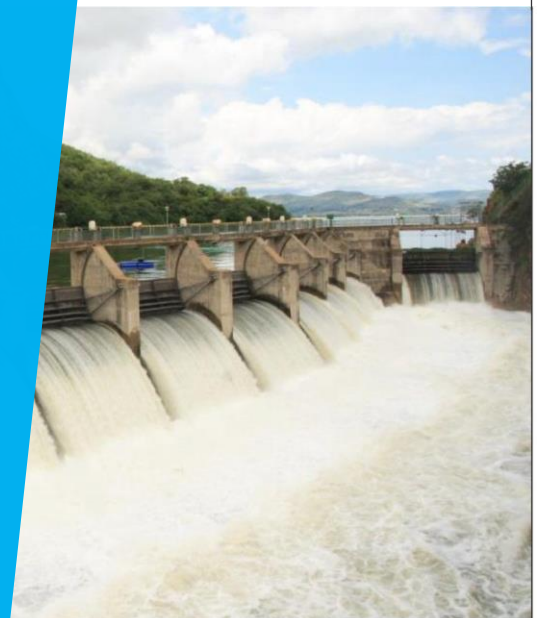
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**RECONCILIATION STRATEGY
OF THE CROCODILE (WEST)
WATER SUPPLY SYSTEM:
CONTINUATION PHASE 2**

**CROCODILE (WEST)
RIVER
RECONCILIATION
STRATEGY 2015**

FINAL

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CONTINUATION OF THE RECONCILIATION STRATEGY OF THE CROCODILE (WEST) WATER SUPPLY SYSTEM: PHASE 2

CROCODILE (WEST) RIVER RECONCILIATION STRATEGY 2015

The Crocodile (West) Reconciliation Strategy 2015 in a nutshell

The abridged 2015 Reconciliation Strategy for the Crocodile West Water Supply System entails the following:

- i. The Rand Water service area in the Crocodile West River catchment will in future continue to be supplied from the Vaal River system and additional re-use will be considered only when surplus in the Crocodile River catchment becomes available.*
- ii. The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the metropolitan areas as a future source of water.*
- iii. In the Waterberg area (north of Crocodile (West) River catchment) the optimal utilisation of local resources will continue and surplus water will be transferred to the Lephalale area to support water supply to the users there.*
- iv. Intervention to supply short-duration shortfall will be evaluated by investigating water demand management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile (West) River catchment.*
- v. Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface / groundwater utilisation should be explored.*

The rollout of the Strategy will rely on the following recommended activities:

- i. The mining sector should provide annual updates of actual and projected water requirements.*
- ii. Continuous coordination of planning between bulk water service providers.*
- iii. Annual monitoring of water requirements and return flows as well as review of the water balance to consider revising long-term requirements projections.*
- iv. Undertake Annual Operating Analyses and engage water users through the System Operating Forum (as part of a separate study undertaken by the Department of Water and Sanitation).*
- v. Complete validation and verification of existing lawful use and review the water balance.*

RECONCILIATION STRATEGY OF THE CROCODILE (WEST) WATER SUPPLY SYSTEM: CONTINUATION PHASE 2

CROCODILE (WEST) RIVER RECONCILIATION STRATEGY 2015

EXECUTIVE SUMMARY

Background

The catchment area of the Crocodile (West) River is one of the most developed in the country. It is characterized by the sprawling urban and industrial areas of northern Johannesburg and Pretoria, extensive irrigation downstream of Hartbeespoort Dam and large mining developments north of the Magaliesberg. As a result, the Crocodile River is one of the rivers in the country that has been most influenced by human activities, and where more specific management strategies are of paramount importance.

The water resources that naturally occur in the catchment have already been fully developed and most of the tributaries as well as the main stem of the Crocodile (West) River are highly regulated. Much of the water supplied to the metropolitan areas and some mining developments is transferred from the Vaal River system via Rand Water. This in turn results in large quantities of effluent from the urban and industrial users, most of which is after treatment, discharged to the river system, for re-use downstream. In many of the streams and impoundments, water quality is severely compromised by the proportionately large return flows. The effluent return flows constitute a large portion of the water availability in the catchment and are an important resource.

Water balance

The water balance in the Crocodile (West) River system was assessed by undertaking sophisticated risk analyses, including salinity modelling. Projected water balances were compiled for the planning period until the year 2050. It was found that the system has surplus water originating from growing treated wastewater generated in the urban areas of Northern Gauteng.

This water balance makes provision for the growing water needs of the mining sector (mainly around Rustenburg and north of the Magaliesberg and the Pilanesberg), the sprawling urban developments of Tshwane's northern areas, Madibeng Local Municipality as well as the areas served by the expansion plans of Magalies Water, primarily outside of the Rand Water supply area. The water requirements of the agricultural sector were also taken into consideration. Special attention was given to ensure that the assurance of water supply to irrigators, such as the Crocodile (West) Irrigation Board and the Makoppa area, was maintained.

The water balance scenarios made provision that the source of water for the Rand Water supply area remains to be the Vaal River system, supported through all their transfer schemes, effectively representing an increasing inter-basin transfer taking place through the bulk supply pipelines of Rand Water.

The utilisation of the projected surplus water in the Crocodile (West) River catchment will be for transfer to the Lephale area as well as for re-use schemes within the catchment. Planned future utilisation of the increasing treated return flows through the proposed Tshwane Potable Water Augmentation Program will in future reduce the transfer from the Vaal River system and will also have an impact on the implementation date of further phases of the Lesotho Highlands Water Project.

Due to the priority accorded by Government to the Strategically Important Projects (SIPs), which include the Lephale mineral belt in the Mokolo River catchment north of the Crocodile (West) River, it was prudent to formulate the Strategy so that priority can be given to the future water needs of the Lephale area in support of the national development imperatives.

The resulting water balance for the Crocodile (West) River system, including the future transfer of water to the Lephale area, indicated that small projected shortages could occur over the medium-term planning period. These shortages, however, are relatively small in volume and only temporary as the return flows in the Crocodile (West) River continue to grow. These projected shortfalls will require further interventions that could be in the form of infrastructure developments (further transfers from the Vaal River system) or water demand management measures within the Crocodile (West) River catchment.

Reconciliation Strategy

The objective of the Reconciliation Strategy is “to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner”. The Strategy is targeted at water related issues and addresses options, interventions and actions towards achieving the above objective. It is aware of the possible development scenarios and of the impacts and risks/uncertainties associated with the various options.

The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should be both flexible and robust under changing future conditions.

The Strategy comprises:

- (1) Certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy; and*
- (2) Specific strategies, other than the above, for addressing of other key issues.*

General items and ongoing activities

Certain elements of the Strategy are common to all scenarios and are of general application towards improved water resource management. These include:

- *The validation and verification of existing lawful water use, and confirmation of actual abstraction and use. This process has already been embarked upon and should be completed in the near future. The impact of the outcome of the study should be assessed, taken into account and updated in the data used to determine the water balances.*
- *Regular review as well as constant monitoring and enforcement of water use licenses. Without proper enforcement much of the water resource management strategies will be futile. These activities appear to have been neglected in recent years.*
- *The allocation and management of water resources to meet user water quality objectives.*
- *Management of the water resources in the Crocodile (West) River catchment in order to minimise both the excess outflows into the Limpopo River as well as the overall water transfers from the Vaal River system.*

Specific Reconciliation Strategies

The revised 2015 Crocodile (West) River System Reconciliation Strategy entails the following:

- *The Rand Water service area in the Crocodile (West) River catchment will in future continue to be supplied from the Vaal River system and additional re-use within the catchment will be considered only when surplus becomes available.*
- *The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the Metropolitan areas as a future source of water.*
- *In the Waterberg area, north of the Crocodile (West) River catchment, the future optimal utilisation of local resources will continue and surplus water in the Crocodile (West) River catchment will be transferred to the Lephalale area to augment the growing water supply to the users in the Mokolo River catchment.*
- *Interventions to supply a possible future temporary projected shortfall will be evaluated by investigating water demand management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile (West) River catchment. Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface / groundwater utilisation should be explored.*
- *The mining sector should provide annual updates of historic water use and future water requirement projections.*

- *Continuous coordination of planning between bulk water service providers.*
- *Annual monitoring of actual water requirements and return flows and with a coinciding review of the water balance, to consider revising possible long-term projections.*
- *Continue with the Crocodile (West) Annual Operating Analyses and engage water users through the System Operating Forum associated with that project.*

**CONTINUATION OF THE RECONCILIATION STRATEGY OF THE
CROCODILE (WEST) WATER SUPPLY SYSTEM: PHASE 2
CROCODILE (WEST) RIVER RECONCILIATION STRATEGY 2015**

TABLE OF CONTENTS

	Page
1. INTRODUCTION	1
1.1 BACKGROUND AND PURPOSE OF THE STRATEGY	1
1.1.1 Crocodile West Reconciliation Strategy: Version 1	2
1.1.2 Crocodile West Reconciliation Strategy 2012	2
1.1.3 Crocodile West Reconciliation Strategy 2015	3
1.2 STRATEGY STEERING COMMITTEE	4
1.3 OBJECTIVES OF THE RECONCILIATION STRATEGY	4
1.4 KEY FACTORS INFLUENCING THE STRATEGY	5
1.5 PURPOSE OF THIS REPORT	5
2. WATER REQUIREMENTS IN THE CROCODILE (WEST) RIVER CATCHMENT.....	6
2.1 URBAN WATER REQUIREMENTS	7
2.1.1 Urban water requirements supplied by Rand Water	7
2.1.2 Urban water requirements supplied from own sources	7
2.1.3 Total urban water requirements	8
2.2 IRRIGATION WATER REQUIREMENTS	8
2.3 MINING WATER REQUIREMENTS	8
2.4 OTHER WATER REQUIREMENTS.....	10
2.5 TOTAL WATER REQUIREMENTS	10
2.6 INTER-BASIN TRANSFERS	11
2.6.1 Transfers to the north to Modimolle and Mookgopong.....	11
2.6.2 Water transfers to the Lephalale area (MCWAP Phase 2).....	11
2.7 ENVIRONMENTAL WATER REQUIREMENTS (RESERVE).....	12
3. WATER AVAILABILITY	14
3.1 LOCAL WATER RESOURCES.....	14
3.1.1 Surface water.....	14
3.1.2 Groundwater	14
3.2 INTER-BASIN TRANSFERS IN	14
3.3 EFFLUENT RETURN FLOWS	15
3.4 TOTAL AVAILABILITY	16

4.	WATER CONSERVATION AND DEMAND MANAGEMENT (WC/WDM)	17
4.1	INTRODUCTION	17
4.2	OVERVIEW	21
4.3	STATUS QUO ASSESSMENT	22
4.3.1	Background.....	22
4.3.2	WC/WDM status quo.....	22
4.3.3	Common factors inhibiting WC/WDM	29
4.4	WC/WDM STRATEGIES	30
4.4.1	Institutional strategy	30
4.4.2	Social strategy	31
4.4.3	Financial strategy	31
4.4.4	Technical strategy	32
4.4.5	Potential savings from WC/WDM	33
4.4.6	Critical risk factors.....	34
4.5	SUMMARY AND CONCLUSIONS	35
4.6	IRRIGATION WC/WDM.....	37
4.6.1	Background.....	37
4.6.2	Water loss targets as in the Water Management Plan for the Hartbeespoort Irrigation Board	37
5.	WATER QUALITY	38
6.	DEVELOPMENT SCENARIOS	40
6.1	BASE SCENARIO	40
6.2	ALTERNATIVE SCENARIOS.....	40
6.2.1	Higher growth in the Metropolitan areas.....	40
6.2.2	Higher growth in the Magalies Water Supply area.....	40
7.	WATER BALANCES	41
7.1	SCENARIO 1: BASE SCENARIO	41
7.2	SCENARIO 2: BASE SCENARIO AND HIGHER ALTERNATIVE GROWTH IN THE METROPOLITAN AREAS	42
8.	WATER TARIFF	44
8.1	BRIEF OVERVIEW OF THE CROCODILE RIVER WATER RESOURCES.....	44
8.2	CURRENT APPLICATION OF THE PRICING STRATEGY	45
8.3	VALUE OF RETURN FLOWS.....	46
8.3.1	Option 1: A systems based raw water use charge for a combined Crocodile (West) and Vaal River system	46
8.3.2	Option 2: No payment for current return flows, but payment for later direct transfers	47

8.3.3	Option 3: Incorporating the Vaal River return flows into a Crocodile (West) systems tariff	47
8.4	COMPENSATING CROCODILE (WEST) USERS FOR POORER QUALITY OF WATER	48
8.5	MCWAP1 AND MCWAP2	48
8.6	IMPACT ON THE VAAL RIVER TARIFF OF A VAAL RIVER – CROCODILE (WEST) SYSTEMS TARIFF	49
8.7	RAW WATER USE CHARGES FOR IRRIGATION	49
8.8	CONCLUSIONS AND RECOMMENDATIONS FOR A PROPOSED TARIFF STRATEGY FOR THE CROCODILE (WEST) RIVER SYSTEM.....	49
9.	KEY FACTORS INFLUENCING THE WATER BALANCE.....	51
10.	CURRENT WATER RESOURCES MANAGEMENT PROJECTS	52
10.1	CROCODILE WEST ANNUAL OPERATING ANALYSES	52
10.2	VALIDATION AND VERIFICATION OF WATER USE	53
10.3	WATER RESOURCES CLASSIFICATION IN THE MOKOLO-MATLABAS, CROCODILE WEST AND MARICO CATCHMENTS	54
11.	STATUS OF INFRASTRUCTURE PLANNING	57
11.1	MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT.....	57
11.2	TSHWANE WATER RESOURCES MASTER PLAN.....	57
11.2.1	Existing and future water resources	58
11.2.2	Existing and future wastewater treatment works	59
11.3	MAGALIES WATER – BULK WATER EXPANSION PLANS AND REGIONAL STUDY/PLANNING	62
12.	PROPOSED RIVER MANAGEMENT PLAN FOR THE LOWER CROCODILE (WEST) RIVER	65
12.1	WHAT WILL A RIVER MANAGEMENT PLAN ENTAIL?.....	65
12.2	OUTLINE OF RIVER MANAGEMENT PLAN.....	65
12.3	SYSTEM COMPONENTS	67
13.	RECONCILIATION AND MANAGEMENT STRATEGY	69
13.1	GENERAL ITEMS AND ONGOING ACTIVITIES	69
13.2	SPECIFIC RECONCILIATION STRATEGIES	70
14.	RECOMMENDATIONS	71
15.	REFERENCES	72

APPENDICES

APPENDIX A	LOCALITY MAP: CROCODILE (WEST) RIVER CATCHMENT AND PROPOSED TRANSFER TO THE LEPHALALE AREA
APPENDIX B	EXECUTIVE SUMMARY OF THE RECONCILIATION STRATEGY VERSION 1 (2008)
APPENDIX C	EXECUTIVE SUMMARY OF THE CROCODILE (WEST) RIVER RECONCILIATION STRATEGY 2012

LIST OF TABLES

Page

Table 2.1	Latest water supply and return flow information for the Metropolitan Municipalities	7
Table 2.2	Urban water requirements in the Crocodile (West) River catchment supplied by Rand Water.....	7
Table 2.3	Urban water requirements in the Crocodile (West) River catchment supplied from own sources	8
Table 2.4	Total urban water requirements for the Crocodile (West) River catchment.....	8
Table 2.5	Irrigation water requirements in the Crocodile (West) River catchment.....	8
Table 2.6	Mining water requirements per sector for the Crocodile (West) River catchment.....	10
Table 2.7	Other water requirements in the Crocodile (West) River catchment.....	10
Table 2.8	Total water requirements in the Crocodile (West) River catchment.....	11
Table 2.9	Water transfers from the Crocodile (West) River catchment to Bela Bela, Modimolle and Mookgopong.....	11
Table 3.1	Projected water availability from local sources in the Crocodile (West) River catchment.....	14
Table 3.2	Projected water future transfers into the Crocodile (West) River catchment from Rand Water via the Vaal River system.....	15
Table 3.3	Projected water future transfer volumes into the Crocodile (West) River catchment from the Vaal by Rand Water for domestic water supply.....	16
Table 4.1	Demographics summary	20
Table 4.2	WC/WDM potential assessment per municipality	21
Table 4.3	Water loss and efficiency targets	34
Table 8.1	Water balance of the total Crocodile (West) River catchment (2014)	44
Table 8.2	Current application of the pricing strategy for domestic and mining users.....	45
Table 8.3	Water users who are not being charged domestic and mining raw water charges.....	46
Table 8.4	Domestic and mining system based charge in the Crocodile (West) River catchment.....	47
Table 10.1	Progress of the validation and verification of water use as reported at Strategy Steering Committee meeting no. 9 on 26 August 2015.....	53
Table 10.2	Gazetted EWR information in the Crocodile (West) River catchment.....	55
Table 11.1	Existing and future water resources of the City of Tshwane.....	60
Table 11.2	Wastewater treatment works of the City of Tshwane	61

LIST OF FIGURES

Figure 1.1	Locality Map: Crocodile (West) River catchment and proposed transfer to the Lephalale area.....	1
Figure 1.2	Process for revising and updating the Reconciliation Strategy	3
Figure 2.1	Projected mining water requirements	10
Figure 2.2	Water transfers for requirement scenarios in the Lephalale area.....	12
Figure 3.1	Sewage drainage areas that contribute to effluent return flows.....	15
Table 3.2	Effluent return flows.....	16
Figure 4.1	Map showing municipalities in the Crocodile (West) River catchment.....	19
Figure 4.2	Thabazimbi LM water balance trend.....	23
Figure 4.3	Bela-Bela LM water balance trend.....	24
Figure 4.4	Moretele LM water balance trend	25
Figure 4.5	Madibeng LM water balance trend	26
Figure 4.6	Rustenburg LM water balance trend.....	27
Figure 4.7	Kgetlengrivier LM water balance trend	28
Figure 4.8	Moses Kotane LM water balance trend	28
Figure 7.1	Water balance for the Crocodile (West) River catchment for Scenario 1	41
Figure 7.2	Water balance for the Crocodile (West) River catchment for Scenario 2	42
Figure 10.1	Location of the EWR sites in the Crocodile (West) River catchment.....	56
Figure 11.1	Location of City of Tshwane Metropolitan Municipality	58
Figure 11.2	Simplified schematic of the City of Tshwane water resource system	61
Figure 11.3	Water requirements of municipalities supplied by Magalies Water	63
Figure 11.4	Total water requirements of municipalities supplied by Magalies Water	64

LIST OF ACRONYMS AND ABBREVIATIONS

DM	District Municipality
DWA	Department: Water Affairs
DWS	Department: Water and Sanitation
EIS	Ecological importance sensitivity
EWR	Ecological water requirements
IDP	Integrated Development Plan
LM	Local Municipality
MCWAP	Mokolo and Crocodile River (West) Water Augmentation Project
MM	Metro Municipality
NEPAD	New Partnership for Africa's Development
NRW	Non-revenue water
NWSKS	National Water Services Knowledge System
PES	Present ecological state
RDP	Reconstruction and Development Programme
RQO	Resource Quality Objective
RRU	Rapid Response Unit
RWQO	Resource water quality objective
SDA	Sewage drainage area
SIP	Strategically Important Project
SOF	System Operating Forum
SSC	Strategy Steering Committee
TCTA	Trans-Caledon Tunnel Authority
WC/WDM	Water conservation and water demand management
WISP	Water Infrastructure Status and Intervention Plan
WMA	Water Management Area
WQT	Water Quality Model
WRC	Water Research Commission
WRPM	Water Resources Planning Model
WSA	Water Services Authority
WSP	Water Services Provider
WSDP	Water Services Development Plans

1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE OF THE STRATEGY

The study area covers the Crocodile (West) River catchment, which forms the major part of the Crocodile (West) and Marico Water Management Area (WMA)⁽¹⁾, but excludes the Marico River catchment. It extends northwards from the Witwatersrand catchment divide in central Johannesburg (where the Crocodile River originates), to the confluence of the Crocodile (West) and Marico rivers. The catchment area includes part of the Gauteng, North West and Limpopo Provinces.

From the confluence of the Crocodile (West) and Marico rivers, the river is known as the Limpopo River, which forms the northern border of South Africa with Botswana and then with Zimbabwe, before flowing into Mozambique where it discharges into the Indian Ocean. The Limpopo River basin thus is an international basin, shared by South Africa, Botswana, Zimbabwe and Mozambique. The total catchment area is about 29 000 km². A locality map is included as **Figure 1.1**.

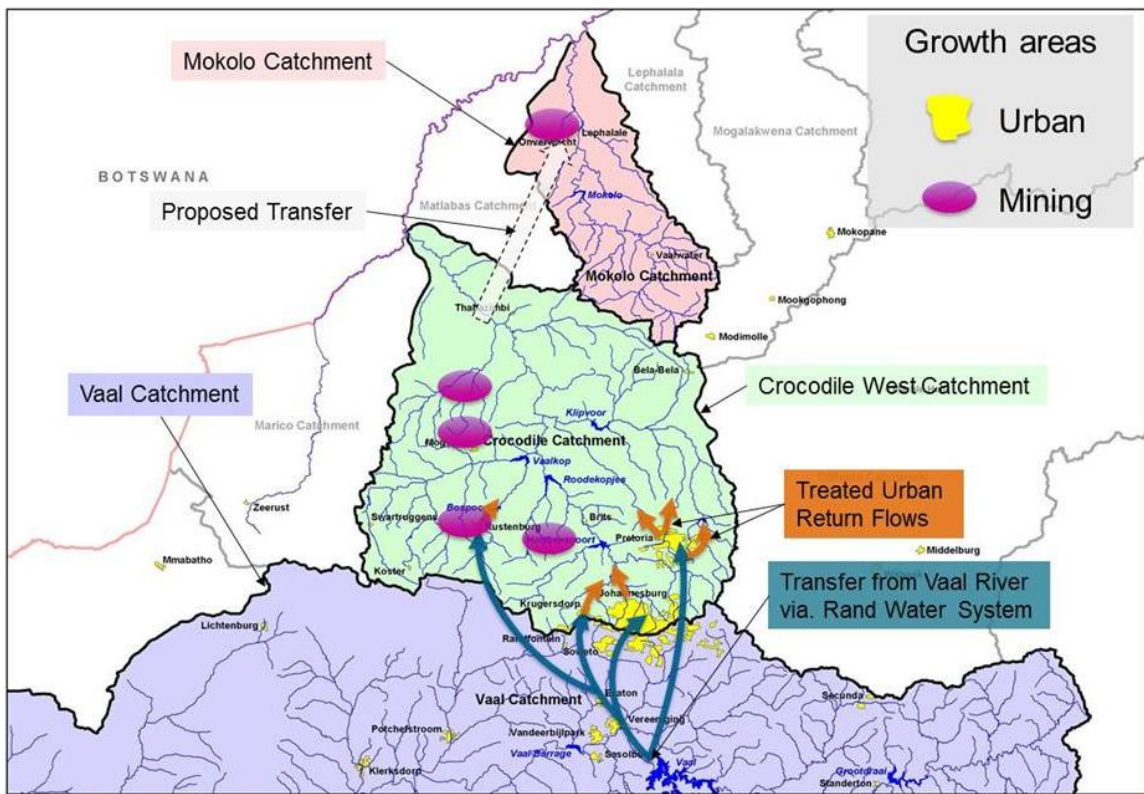


Figure 1.1 Crocodile (West) River catchment and proposed transfer to the Lephallale area

⁽¹⁾ Water Management Area 3: Crocodile (West) and Marico as established in NWRS 1, 2004.

The catchment area of the Crocodile (West) River is one of the most developed in the country, and strategically an important catchment. Further to this the overarching planning of Government through the Strategically Important Projects (SIPs) links the Crocodile (West) River catchment with the Mokolo River catchment through the planned future transfer of water to support the developments in the Lephalale area, investigated as part of the *Mokolo and Crocodile River (West) Water Augmentation Project* (MCWAP). More detail about this project this project is included in Chapter 13 of this report.

The Reconciliation Strategy for the Crocodile (West) Water Supply system was first developed in 2008, revised in 2012, and continues to be reviewed and updated by the Department: Water and Sanitation (DWS) in cooperation with institutions and stakeholders in the water sector.

The first Reconciliation Strategy for the Crocodile (West) Water Supply System was developed and published in 2008 by the then Department: Water Affairs to ensure sufficient water can be made available to supply the current and future water requirements of the urban, industrial, mining and irrigations users in the system. The Strategy primarily focused on the quantitative reconciliation of the water requirements with the available resources and also considered water quality where it impacts on the water balance.

1.1.1 Crocodile (West) Reconciliation Strategy: Version 1

The 2008 Crocodile (West) Reconciliation Strategy summarised the background information from the *Crocodile (West) Modelling Study* and other supporting documentation, leading to the formulation of a Strategy for reconciling the requirements for water in the Crocodile (West) River catchment with the availability thereof. Version 1 (2008) of the Crocodile (West) River Reconciliation Strategy is summarised in **Appendix A**.

Water balances were determined for the period 2005 to 2030 at 5-year intervals to facilitate the development of a robust strategy that would be stable over time. These were done for eleven representative sub-areas.

1.1.2 Crocodile (West) Reconciliation Strategy 2012

The revised 2012 Reconciliation Strategy for the Crocodile (West) River system entailed the following:

- The Rand Water service area in the Crocodile (West) River catchment will in future continue to be supplied from the Vaal River system and additional re-use within the catchment will be considered only when surplus becomes available.
- The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the metropolitan areas as a future source of water.

- In the Waterberg area (north of the Crocodile(West) River catchment) the optimal utilisation of local resources will continue and surplus water in the Crocodile (West)River system will be transferred to the Lephalale area.
- Interventions to supply projected future temporary shortfalls were evaluated by investigating demand management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile (West)River system. Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface / groundwater utilisation should be explored.
- The mining sector should provide annual updates of historic water use and future water requirement projections.
- Continuous coordination of planning between bulk water service providers.
- Annual monitoring of actual water requirements and return flows and review of the water balance.
- Undertake Annual Operating Analyses and engage water users through the Crocodile (West) River System Operating Forum (SOF).
- Complete validation and verification study of existing lawful use and review the water balance.

1.1.3 Crocodile (West) Reconciliation Strategy 2015

This 2015 Crocodile (West)River Reconciliation Strategy updated and refined the 2012 Strategy based on updated new information and continued stakeholder involvement. The process for revising and updating the Crocodile (West) Reconciliation Strategy is summarised in **Figure 1.2**.

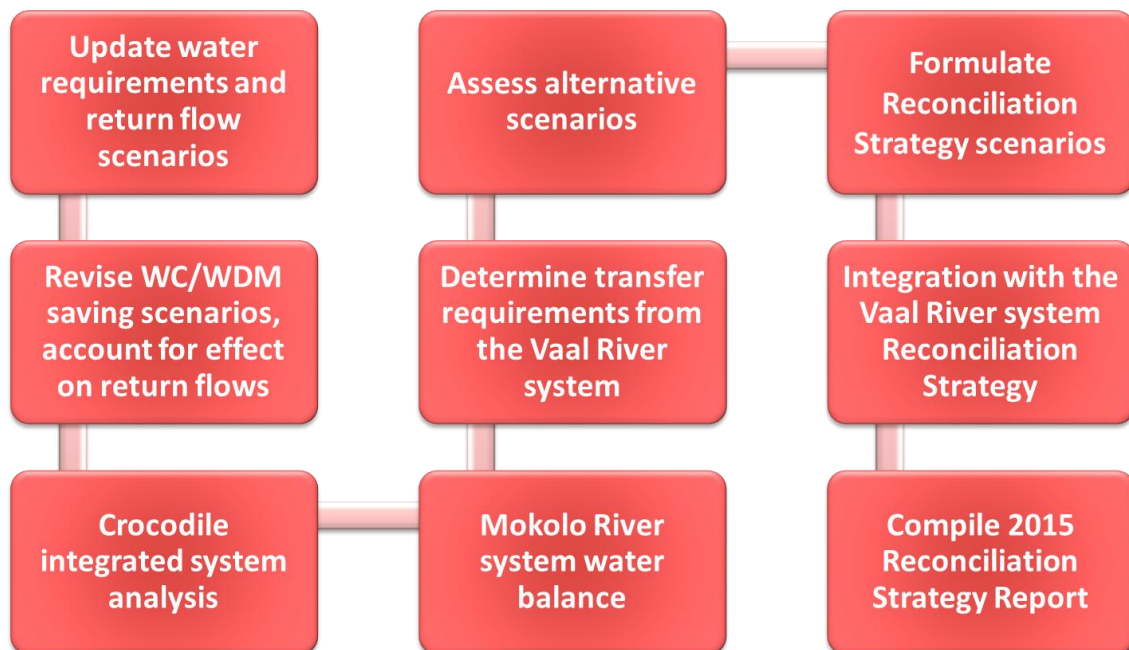


Figure 1.2 Process for revising and updating the Reconciliation Strategy

1.2 STRATEGY STEERING COMMITTEE

The Department (DWS) recognised that the successful implementation of the Crocodile West River System Reconciliation Strategy requires continuous monitoring, review and revision to ensure its relevance in a changing environment where both short-term economic swings and evolving long-term development planning has to be accommodated. The Strategy also aims at promoting co-operation among water institutions through a Strategy Steering Committee (SSC) which drives the Strategy, with the Department taking the lead.

Stakeholder involvement was achieved through this SSC, which met twice a year, and reviewed the Strategy based on the updated information, including revised water balances. Through the Strategy water resources development planning and management are also conducted in a coordinated manner.

The SSC consists of more than 150 individuals representing National and Provincial Government departments, municipalities, water service providers, industry, agriculture as well as Non-Governmental Organisations.

The objective of the Water Resource Reconciliation and Management Strategy is “*to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner*” (DWA, 2010).

The Reconciliation Strategy is targeted at water-related issues and recommends options, interventions and actions towards achieving the above. It is cognisant of possible future socio-economic developments and aims to integrate water related planning initiatives of all institutions by formulating coherent scenarios of elements affecting the projected water balance for the planning period up to the year 2040.

The Strategy is intended to be both flexible and robust under changing conditions. The Strategy takes future anticipated water use in the catchment, linkages with other key systems such as the Integrated Vaal Water Supply system, the Limpopo Water Management Area as well as the relevant Strategic Integrated Projects (SIPs) into account.

1.3 OBJECTIVES OF THE RECONCILIATION STRATEGY

- To maintain a positive water balance in future and reconcile growing water requirements and availability.
- Identify, plan and monitor necessary interventions needed.
- Integrated planning between the different WSAs/ WSPs.
- In the unique case of the Crocodile (West) River system, to identify the optimal use of the growing water availability due to increasing return flows. This resource is a limited asset to be best used from a regional perspective, i.e. supply within the catchment and transfers to Lephalale and other neighbouring catchments.

1.4 KEY FACTORS INFLUENCING THE STRATEGY

- Level of developmental growth and associated growth in water requirements in the metropolitan areas (Rand Water supply areas):
 - Directly impacts return flows and the availability of water in the Crocodile (West) River catchment; and
 - Ability of the Vaal River system to meet growing requirements over the next decade.
- The roll-out of power generation developments in the Lephalale area (in the Mokolo River catchment) and *Mokolo and Crocodile River (West) Water Augmentation Project Phase 2 (MCWAP2)*.
- Timing of the different phases of Tshwane's Water Augmentation Program dependant on growth in return flows in the catchment, as well as the power generation and mining developments in the Lephalale area.
- Success of water conservation and water demand management measures.
- Water quality of available water resources – this continues to come under strain and is likely to be a growing issue due to continued return flows of treated effluent, urban growth, acid mine drainage (AMD) challenges, mining and other diffuse sources of pollutants such as agriculture. Addressing water quality challenges will be a key aspect in maintaining long-term sustainable supply.
- Classification of water resources and ecological monitoring.

1.5 PURPOSE OF THIS REPORT

The purpose of this report is to update and summarise the gathered and received information, to analyse and model the water requirements and availability, to determine shortages / surpluses and to present the revised *Crocodile (West) Reconciliation Strategy 2015*.

2. WATER REQUIREMENTS IN THE CROCODILE (WEST) RIVER CATCHMENT

New updated information on water requirements and return flows that was received and presented at the SSC8 meeting in March 2015 was the 2014 recorded water supply and return flow volumes for monitoring purposes, together with preliminary water requirement information emanating from Magalies Water's Regional Bulk Water Planning initiative.

The preliminary information on water requirements in the Magalies Water supply area, as quantified in their current infrastructure planning, generally align with the reconciliation strategy scenarios over the short-term. Some deviations were noted in the long-term water requirement growth in some supply regions. Further engagement between the role players is anticipated in future to better understand long term growth potential, particularly in the more water scarce north-western parts of the catchment. Magalies Water are currently finalising investigations into the potential of supplying these long-term requirements, some of which are located in areas where local water resources are already fully utilised, and other available water sources are located far away. Affordability and financing resources to implement the supply infrastructure is also likely to reduce the Magalies Water projections over the long term.

The completed Tshwane's Water Resources Master Plan, discussed in **Section 11.2** of this report, has identified a series of expansions in abstractions from dams in the Crocodile (West) River catchment (amongst others). These increased abstractions have been sized to make use of the growing return flows in the catchment, and will reduce the reliance on water supplied from the Vaal River system through Rand Water. The proposed increase in abstractions constitutes indirect re-use of water at the three key locations; namely Rietvlei, Roodeplaat and Leeukraal dams, where growing return flows accumulate. The planned increases will be phased in modular expansions of the associated water treatment works capacity, so as not to negatively impact on existing water supply plans, such as Phase 2 of the *Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP2)*.

As part of the revision of water requirements and return flows in the system, appropriate levels of water use efficiency should be considered and the impacts of water conservation and water demand management (WC/WDM) factored into the water requirements and water balance.

The water supply and return flow figures for the Metropolitan Municipalities in the Crocodile (West) River catchment are summarised in **Table 2.1**.

The recorded water supply and return flow information in the metro areas showed that, while the overall water requirements in the metro areas are similar to the volumes that were projected for the 2014 year, the return flows have been about 6% higher than projected. This suggests that over the short-term period considered, the proportion of return flows being generated from water supply to urban water users has increased.

Table 2.2 Latest water supply and return flow information for the Metropolitan Municipalities

Metropolitan Municipality	2014 volume (million m ³ /a)			
	Water requirements		Return flows	
	Projected	Actual	Projected	Actual
Tshwane	300	270	166	167
Ekurhuleni	63	65	43	51
Johannesburg	202	225	145	158
Total	564	560	355	377

These short-term trends need to be monitored in future to determine if that is indeed a trend or just a factor of the conditions prevailing in that specific year. Increased return flows as a percentage of the supply volume will positively benefit the Crocodile (West) River catchment from a water availability perspective. The additional return flows will on the other hand have to be managed to ensure water that quality is not negatively impacted.

The urban, irrigation, mining and other users' water requirements were updated per water user sector until 2050 for the preferred planning scenario (high population growth) and are reported on below.

2.1 URBAN WATER REQUIREMENTS

2.1.1 Urban water requirements supplied by Rand Water

The urban water requirements in the Crocodile (West) River catchment supplied by Rand Water are summarised in **Table 2.3**.

Table 2.3 Urban water requirements in the Crocodile (West) River catchment supplied by Rand Water

User group	2015	2020	2025	2030	2035	2040	2045	2050
Urban (Rand Water)	562.7	633.4	706.6	788.7	860.1	932.5	1 006.1	1 076.7

2.1.2 Urban water requirements supplied from own sources

Domestic water requirements include medium efficiency (15% savings) water conservation and water demand management (WC/WDM).

The urban water requirements in the Crocodile (West) River catchment supplied from own sources are summarised in **Table 2.4**.

Table 2.4 Urban water requirements in the Crocodile (West) River catchment supplied from own sources

User group	2015	2020	2025	2030	2035	2040	2045	2050
Urban (own sources)	161.2	183.9	199.5	211.5	222.4	233.4	244.0	254.8

2.1.3 Total urban water requirements

The urban water requirements in the Crocodile (West) River catchment supplied by Rand Water are summarised in **Table 2.5**.

Table 2.5 Total urban water requirements for the Crocodile (West) River catchment

User group	2015	2020	2025	2030	2035	2040	2045	2050
Urban (Rand Water)	562.7	633.4	706.6	788.7	860.1	932.5	1 006.1	1 076.7
Urban (Own sources)	161.2	183.9	199.5	211.5	222.4	233.4	244.0	254.8
Urban total	723.9	817.3	906.1	1 000.2	1 082.5	1 165.9	1 250.1	1 331.5

2.2 IRRIGATION WATER REQUIREMENTS

No growth in irrigation water requirements is considered. The irrigation water requirements in the Crocodile (West) River catchment are summarised in **Table 2.6**.

Table 2.6 Irrigation water requirements in the Crocodile (West) River catchment

User group	2015	2020	2025	2030	2035	2040	2045	2050
Irrigation Boards and Schemes	268.0	268.0	268.0	268.0	268.0	268.0	268.0	268.0
Diffuse irrigation (private farmers)	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
Irrigation total	393.0	393.0	393.0	393.0	393.0	393.0	393.0	393.0

2.3 MINING WATER REQUIREMENTS

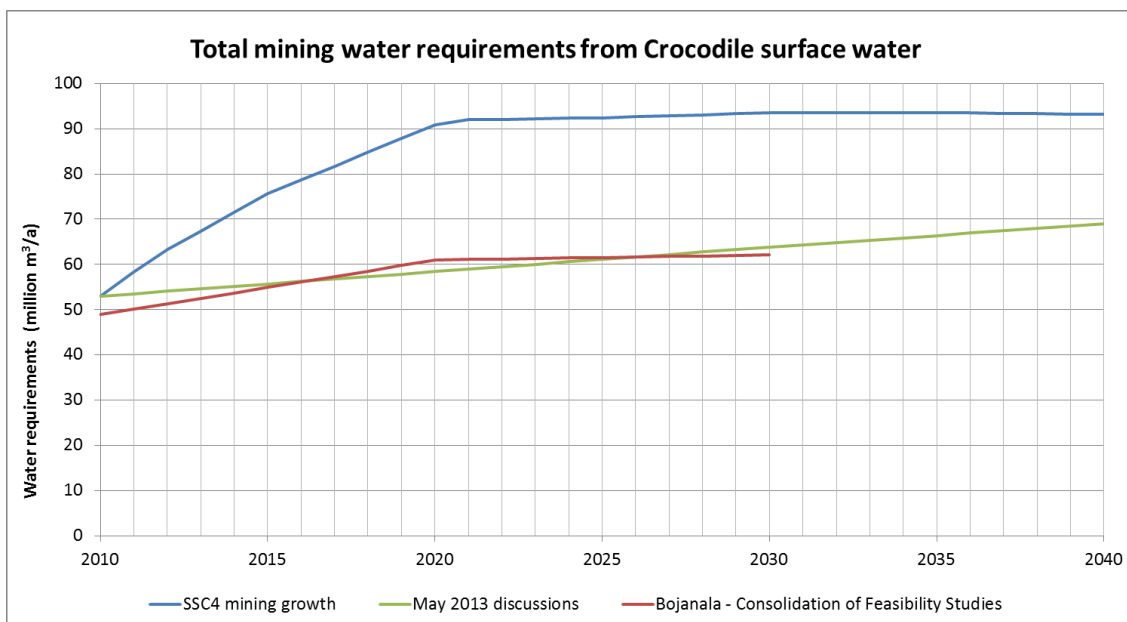
Anticipated water requirements for the mining sector presented in November 2013 remained unchanged, reflecting current challenges in the platinum mining industry, but with allowance for nominal growth. The mining water requirements in the Crocodile (West) River catchment are summarised in

Table 2.7.

Table 2.7 Mining water requirements per sector for the Crocodile (West) River catchment

User group	2015	2020	2025	2030	2035	2040	2045	2050
Mining	54.1	57.3	61.2	62.2	64.8	67.4	70.1	72.9

The projected mining water requirements are presented in **Figure 2.1**.

**Figure 2.1 Projected mining water requirements**

2.4 OTHER WATER REQUIREMENTS

Ecological water requirements in the catchment have recently been finalised with the completion and gazetting of the ecological water requirement classes of the Crocodile (West) and Mokolo catchments. Comments received during the gazetting are now being considered by the DWS. The process to determine the Resources Quality Objectives will be the next step. Tenders for the execution of this study were advertised during September 2015. The power and industry water requirements in the Crocodile (West) River catchment supplied by Rand Water are summarised in **Table 2.8**.

Table 2.8 Other water requirements in the Crocodile (West) River catchment

User group	2015	2020	2025	2030	2035	2040	2045	2050
Power generation and industry (supplied individually)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

2.5 TOTAL WATER REQUIREMENTS

The total water requirements in the Crocodile (West) River catchment supplied by Rand Water are summarised in **Table 2.9**.

Table 2.9 Total water requirements in the Crocodile (West) River catchment

User group	2015	2020	2025	2030	2035	2040	2045	2050
Urban (Rand Water)	562.7	633.4	706.6	788.7	860.1	932.5	1 006.1	1 076.7
Urban (own sources)	161.2	183.9	199.5	211.5	222.4	233.4	244.0	254.8
Total Domestic	723.9	817.3	906.1	1 000.2	1 082.5	1 165.9	1 250.1	1 331.5
Irrigation Boards and Schemes	268.0	268.0	268.0	268.0	268.0	268.0	268.0	268.0
Diffuse irrigation (private farmers)	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
Total Irrigation	393.0	393.0	393.0	393.0	393.0	393.0	393.0	393.0
Mining	54.1	57.3	61.2	62.2	64.8	67.4	70.1	72.9
Power generation and industry	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
TOTAL	1 211.0	1 307.6	1 307.6	1 400.3	1 495.4	2 580.3	1 666.3	1 753.2

2.6 INTER-BASIN TRANSFERS

2.6.1 Transfers to the north to Modimolle and Mookgopong

The existing pipeline to Bela-Bela may be extended to supply water to meet the growing domestic water requirements in Modimolle and Mookgopong. The possible source of water is either Roodeplaat Dam on the Pienaars River or Klipvoor Dam on the Moretele River. The volumes required are 7.6 million m³/a by 2040 and have been included as a future transfer in the water balance assessment of the Crocodile (West) River catchment. The strategy will be to continue working with Magalies Water to refine these volumes over time.

The water requirements of Modimolle and Mookgopong are summarised in **Table 2.10**.

Table 2.10 Water transfers from the Crocodile (West) River catchment to Bela Bela, Modimolle and Mookgopong

User group	2015	2020	2025	2030	2035	2040	2045	2050
Bela Bela	2.9	3.3	3.6	4.0	4.3	4.5	4.8	5.0
Modimolle	2.4	3.4	4.5	5.5	5.6	5.7	5.7	5.7
Mookgopong	1.2	1.7	2.1	2.5	2.9	3.3	3.5	3.8

2.6.2 Water transfers to the Lephalale area (MCWAP Phase 2)

The first of 17 Strategic Integrated Projects (SIP), aims to unlock the enormous mineral belt in the Steelpoort, Mpumalanga, and the Waterberg areas west of Lephalale. In

addition, SIP 1 also makes provision for the transportation of coal by rail from the Waterberg area to the power stations located in the Highveld of Mpumalanga. The increased water requirements for these developments will exceed the available water resources in Lephalale (Mokolo River system) and further augmentation, by transferring water from the Crocodile (West) River system, will be necessary.

The proposed transfer of water from the Crocodile (West) River to Lephalale is thus of high strategic importance and would constitute Phase 2 of the *Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP2)*. Detail planning and optimisation of MCWAP2 must still be completed.

The projected water transfers to the Lephalale area is presented in **Figure 2.2** Water transfers for requirement scenarios in the Lephalale area

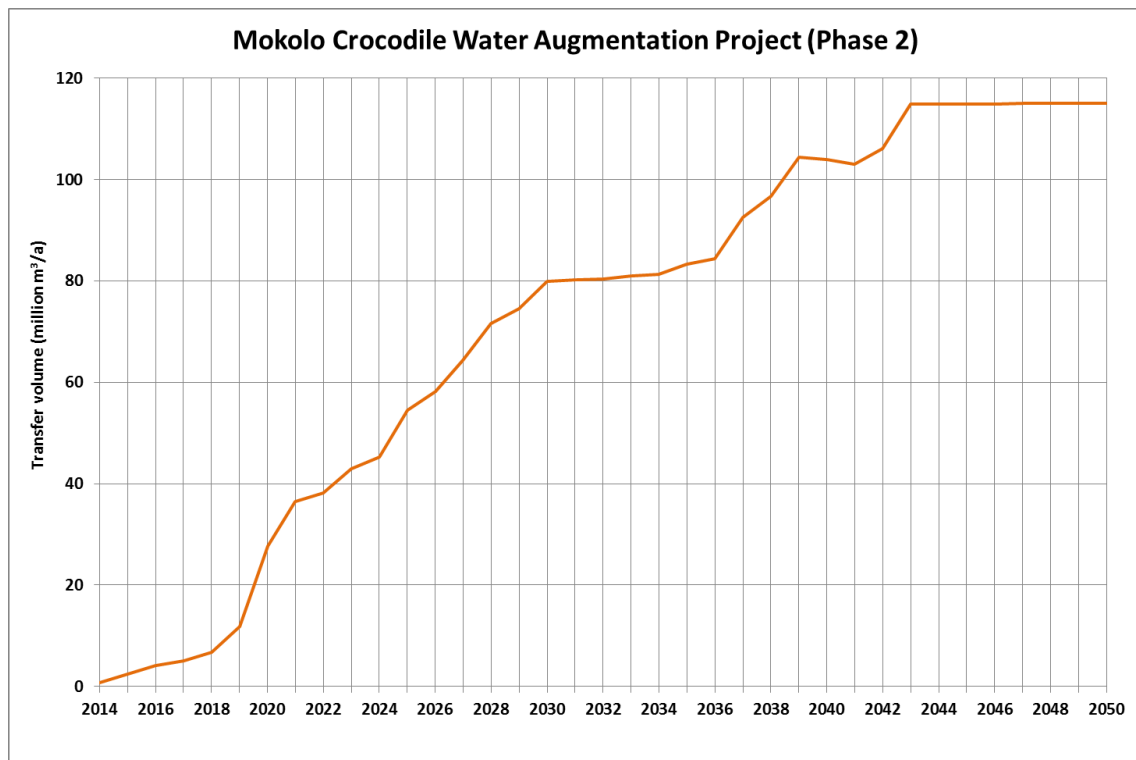


Figure 2.2 Water transfers for requirement scenarios in the Lephalale area

2.7 ENVIRONMENTAL WATER REQUIREMENTS (RESERVE)

Due to the highly altered flow regime in the Crocodile (West) River catchment where the volumes of return flows are well in excess of the natural runoff for the main stem of the river and most of the main tributaries, provision for the Reserve has little impact on the yield from reservoirs and the availability of water.

A negative impact of the high proportion of return flows and the regulation of flow by control structures is that the natural variability of stream flow is smoothed out, also with resultant unnaturally high winter flows.

A comprehensive Reserve determination has been conducted for the catchment. Further to this, the continuation of the Strategy will integrate with the current classification study for the purpose of coherent scenario formulation and planning.

It is recommended that further attention be given to the inclusion of the EWR, particularly at site EWR8 on the Lower Crocodile (West) River. Please refer to **Section 10.3** of this report.

3. WATER AVAILABILITY

The water availability has been determined from different sources and sectors which are discussed and summarised below.

3.1 LOCAL WATER RESOURCES

Local water resources include surface water and groundwater naturally occurring in the catchment. Effluent return flows constitute a significant portion of the available surface water resource.

3.1.1 Surface water

Water availability from surface water is reported in the WRYM Analyses Report of the *Crocodile (West) Modelling Study*. However, the availability of surface water resources was better accounted for in the Water Resources Planning Model (WRPM) where the assurance supply criteria of the users are taken directly into account. The water availability from local sources is summarised in **Table 3.1** Projected water availability from local sources in the Crocodile (West) River catchment

Table 3.1 Projected water availability from local sources in the Crocodile (West) River catchment

Source	2015	2020	2025	2030	2035	2040	2045	2050
From local resources (million m ³ /a)	376.9	372.2	372.8	364.8	356.9	342.9	330.1	314.8

3.1.2 Groundwater

A separate report on groundwater assessment was compiled as part of the *Crocodile (West) Modelling Study* (DWAF, 2007). Water availability from groundwater was determined on a quaternary basis. These figures were accepted as best available and have not been updated since.

No further groundwater sources were included as additional water availability in the Crocodile River catchment. Groundwater supply is considered in-directly in the water balance by reducing the volume of water required to be supplied by surface water resources.

3.2 INTER-BASIN TRANSFERS IN

Transfers of water into the catchment from the Vaal by Rand Water, supplies a majority of the domestic water requirements in the larger Metros in the southern part of the catchment. The current and projected transfers into the Crocodile (West) River catchment from the Vaal River system by Rand Water for domestic supply are shown in **Table 3.2** Projected water future transfers into the Crocodile (West) River catchment from Rand Water via the Vaal River system.

Table 3.2 Projected water future transfers into the Crocodile (West) River catchment from Rand Water via the Vaal River system

Source	2015	2020	2025	2030	2035	2040	2045	2050
Rand water (million m ³ /a)	562.7	633.4	706.6	788.7	860.1	932.5	1006.1	1076.7

3.3 EFFLUENT RETURN FLOWS

Return flows are an important resource and the study team used sewage drainage area (SDAs) as the unit of analysis to develop scenarios. As can be seen in **Figure 3.1**

Sewage drainage areas that contribute to effluent return flows there are SDAs where the water is discharged to the North (contributes to the Crocodile River catchment) and others that discharge to the South (contributing to the Vaal River system). It is very important to monitor the split of the SDAs which lies across the hydrological divide (between the Vaal River system and the Crocodile River catchment).

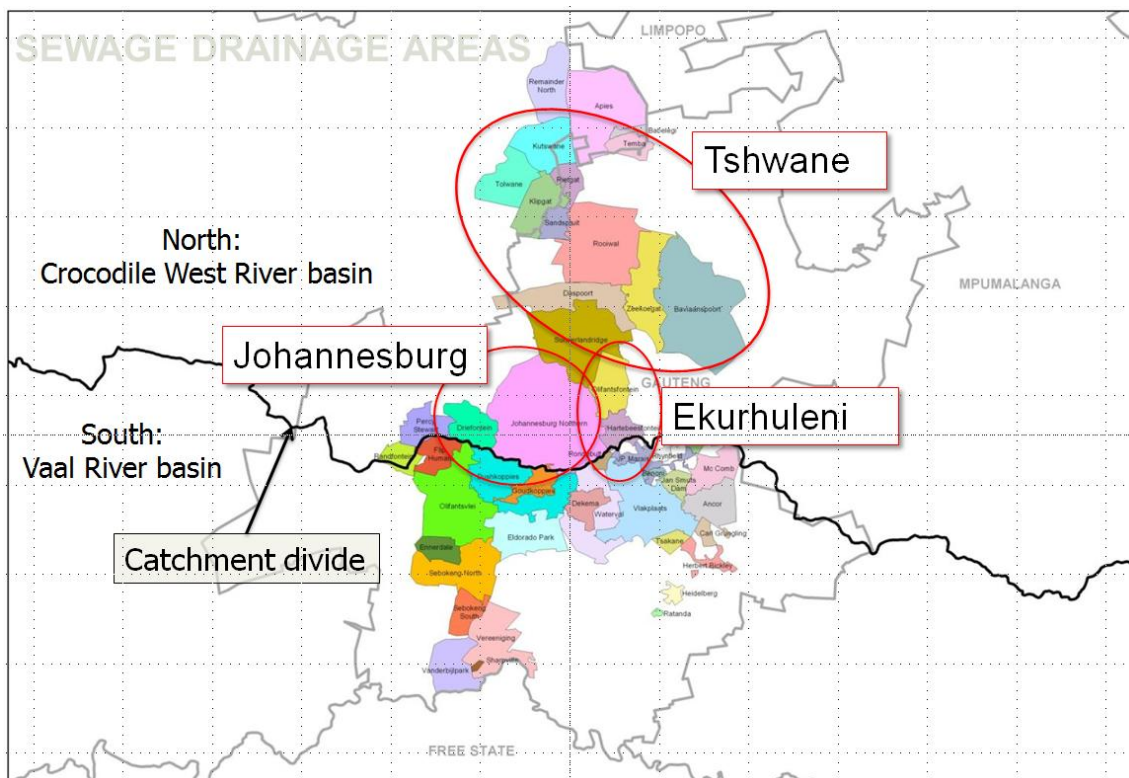


Figure 3.1 Sewage drainage areas that contribute to effluent return flows

Monitoring the split in the supply and the return flows between north (Crocodile (West) River catchment) and south (Vaal River system) is very important. Effluent return flows from wastewater treatment plants into the river systems constitute a significant portion of the available surface water resources in the Crocodile River catchment. The urban water requirements in the Crocodile (West) River catchment supplied by Rand Water are summarised in **Table 3.2**.

Table 3.2 Effluent return flows

Source	2015	2020	2025	2030	2035	2040	2045	2050
Urban return flows (million m ³ /a)	387.9	428.5	466.2	508.2	543.8	580.1	617.1	656.7

3.4 TOTAL AVAILABILITY

The total water availability in the Crocodile River catchment is shown in **Table 3.3**

Projected water future transfer volumes into the Crocodile (West) River catchment from the Vaal by Rand Water for domestic water supply.

Table 3.3 Projected water future transfer volumes into the Crocodile (West) River catchment from the Vaal by Rand Water for domestic water supply

Source	2015	2020	2025	2030	2035	2040	2045	2050
Urban return flows	387.9	428.5	466.2	508.2	543.8	580.1	617.1	656.7
*Estimated yield from local resources	376.9	372.2	372.8	364.8	356.9	342.9	330.1	314.8
Rand water supply (excluding mines in Rustenburg area)	562.7	633.4	706.6	788.7	860.1	932.5	1006.1	1076.7
Total availability in Crocodile (West)	1327.5	1434.1	1545.7	1661.7	1760.9	1855.6	1953.3	2048.1
Water available for re-use and MCWAP2- over and above Crocodile (West) requirements	116.5	126.4	145.4	166.3	180.6	189.2	200.0	210.8

4. WATER CONSERVATION AND DEMAND MANAGEMENT (WC/WDM)

4.1 INTRODUCTION

Water use can be classified in to two main components:

- (i) water that is used consumptively; and
- (ii) non-consumptive water use, which is the component giving rise to return flows.

Most return flows originate from urban areas where, for the Crocodile (West) River catchment, more than 50% of the urban water requirements are discharged as effluent and returned to the rivers for possible re-use.

Savings on consumptive use would reduce the requirements for water, without impacting on the volume of return flows. It would, however, change the proportion of water requirements that ends up as return flows. Such savings would include the reduction of leakage (throughout the whole water distribution system), more efficient garden irrigation, etc.

Savings with respect to non-consumptive uses of water would influence both the requirements for water and the resultant return flows. Examples of non-consumptive use include most in-house uses of water, office buildings as well as certain components of industrial processes.

Water conservation and demand management is defined in the National Water Resources Strategy report of the Department as the following:

Water conservation is the minimisation of loss or waste, the care and protection of water resources and the efficient and effective use of water.

Water demand management is the adaptation and implementation of a strategy or a programme by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability.

Water conservation and water demand management (WC/WDM) in the Crocodile (West) River catchment can reduce the water transfers from the Vaal River system and, depending on the measures implemented, may also reduce the volume of return flows available for re-use.

Municipalities are encouraged to attend the Crocodile (West) River system Strategy Steering Committee meetings and share information on water conservation and water demand management (WC/WDM) initiatives and also to learn how others are dealing with similar problems at local authority (WSA) level. The attendance of these SSC meetings by representatives of the municipalities was, however, very poor, since the SSC was established in 2010.

Sufficient funding for WC/WDM remains to be a limiting factor in achieving the potential savings in water use. Problems facing some of the smaller towns include the absence of bulk water meters to measure how much water is actually abstracted and supplied.

Magalies Water has been appointed by the DWS to assist with WC/WDM support to all Water Services Authorities in the study area. There are serious gaps in terms of municipalities reporting on WC/WDM initiatives and this project should improve the data available on WC/WDM. All available reports have been collected from the municipalities that are serving as the baseline for this project. Meetings were held with the municipalities to find out more about the WC/WDM challenges they are facing. One of the main aims of this project is to prepare a WC/WDM plan for the North West Province.

The Crocodile (West) part of the WMA is a diverse combination of three metropolitan municipalities, scattered small towns, urban and rural settlements, surrounded by agricultural farmlands. The municipalities included in the study area are shown in **Figure 4.1** Map .



Figure 4.1 Map showing municipalities in the Crocodile (West) River catchment

The information for the study has been collected from different sources such as:

- All Town Reconciliation Strategies (2011);
- Vaal Reconciliation Strategy;
- Water Infrastructure Status & Intervention Plan (WISIP);
- Water Services Development Plans (WSDP);
- IDP;
- Blue Drop Reports;
- DWS data sources (National Water Services Knowledge System (NWSKS), RPMS, Water Services Information Reference Framework and FBW);
- The State of Non-Revenue Water in South Africa (2012) and;
- Existing municipal information and WC/WDM strategies.

Demographics

The April 2015 DWS National Water Services Knowledge System (NWSKS) population and household figures were accepted and summarised in **Table 4.1**.

Table 4.1 Demographics summary

Province	DM code	DM name	Code	LM name	Population Apr 2015	Households Apr 2015
Gauteng			EKU	Ekurhuleni	3 437 216	1 216 487
Gauteng			JHB	City of Johannesburg	4 795 833	1 718 924
Gauteng			TSH	City of Tshwane	3 159 297	1 091 982
Gauteng	DC48	West Rand	GT481	Mogale City	391 913	140 600
Gauteng	DC48	West Rand	GT482	Randfontein	161 437	51 865
Limpopo	DC36	Waterberg	LIM361	Thabazimbi	89 121	27 060
Limpopo	DC36	Waterberg	LIM366	Bela-Bela	69 533	19 497
North West	DC37	Bojanala	NW371	Moretele	197 276	59 523
North West	DC37	Bojanala	NW372	Madibeng	503 749	183 701
North West	DC37	Bojanala	NW373	Rustenburg	579 932	227 496
North West	DC37	Bojanala	NW374	Kgetlengrivier	53 871	16 772
North West	DC37	Bojanala	NW375	Moses Kotane	255 947	85 937
Total					13 695 125	4 839 844

Notes

- *Source: Department: Water and Sanitation - National Water Services Knowledge System (NWSKS)*
- *The total population for all municipalities are shown although some are only partially included in the study area.*

Municipalities with a high potential to successfully implement WC/WDM is based on the availability of skills and capacity, funding, previous WC/WDM activities and operations of the existing system. Municipalities with a medium to low potential have limited skills and capacity, budgets and the systems are generally operated on intermittent supply.

4.2 OVERVIEW

The study area covers nine local municipalities (LM), three district municipalities (DM) and three Metros. The municipalities covered under the Vaal Reconciliation strategy were not further investigated and only partially included in this study. The remaining municipalities generally have very poor information with no existing strategies.

A preliminary analysis to assess the potential for loss reduction through the implementation of WC/WDM indicates that there is scope to reduce the total demand through improved non-revenue water and water losses but it is expected that any savings will be redistributed to areas currently without water. The municipalities within the study area and scope for WC/WDM are summarised in **Table 4.2**.

Table 4.2 WC/WDM potential assessment per municipality

Municipality	Category	% piped water inside dwelling or yard*	Confidence level – data	WC/WDM potential success	Comments
City of Johannesburg (north)	A	96.7	High	High	Vaal Recon study
City of Tshwane (north)	A	94.4	High	High	Vaal Recon study
Ekurhuleni MM (north)	A	94.6	High	High	Vaal Recon study
Madibeng LM	B1	78.2	Low	Low	Poor data, no Strategy
Mogale City LM	B1	93.2	High	Medium	Vaal Recon study
Rustenburg LM	B1	88.9	High	Medium	Vaal Recon study
Randfontein LM	B2	95.5	High	Medium	Vaal Recon study
Bela-Bela LM	B3	89.4	Medium	Medium	Strategy – RRU
Kgetlengrivier LM	B3	89.6	Low	Low	Poor data, no Strategy
Thabazimbi LM	B3	84.0	Medium	Medium	Poor data, no Strategy
Moretele LM	B4	81.6	Medium	Low	Some data, no Strategy
Moses Kotane LM	B4	80.8	Low	Low	Poor data, no Strategy

Notes: * The municipal category is as per the Municipal Infrastructure Investment Framework (MIIF), which are metros (A), major cities (B1), minor cities (B2), rural dense (B3) and rural scattered (B4).

4.3 STATUS QUO ASSESSMENT

4.3.1 Background

In order to identify the key challenges faced by the municipalities, the study team analysed previous studies, interviewed key municipalities and used knowledge from previous studies to assess the status quo of the municipalities within the study area. Based on the different data sources, the current water loss for in the study area is estimated to be approximately 40% of the total water supplied. Except for the metros, very few municipalities within the study area carry out proactive WC/WDM activities. The most common challenges facing the LMs include poor institutional arrangements, lack of human resources, limited knowledge and skills, and non-prioritisation of funding to embark on WC/WDM programmes.

In order to address the current challenges and usage of water within the study area, many WC/WDM interventions can be considered but each municipality within the study area has its own unique problems, to some extent, although the main underlying issues are often similar. Before deciding on how to address these problems, it is first necessary to understand it.

An overview of all possible WC/WDM interventions is required so that municipalities can implement the correct measures to reduce water losses and non-revenue water (NRW), leading to a reduction in system input volumes (SIV), improved water use efficiency and achieve water savings. A full WC/WDM strategy would normally include a wide range of interventions tailored to the specific problems identified in each area. The interventions would be prioritised in such a manner that the maximum savings can be achieved for the minimum expense and the implementation would be scheduled accordingly.

4.3.2 WC/WDM status quo

a) Thabazimbi LM

Thabazimbi has a population of 89 121(NWSKS, Apr 2015). The urban hub is the town of Thabazimbi. Based on Census 2011, 21 056 (84%) households have RDP (Reconstruction and Development Programme) or better level of access to water, 2 474 (9.9%) households have below RDP access to water infrastructure and 1 550 (6.2%) have no access. Thabazimbi LM is a Category B3 municipality with a relatively small population and significant proportion of urban population but with no large town as core. Most infrastructure is formal which enables effective metering, billing and cost recovery systems. No credible information could be obtained from this municipality and what was obtained in the past is clearly incorrect as shown in **Figure 4.2**.

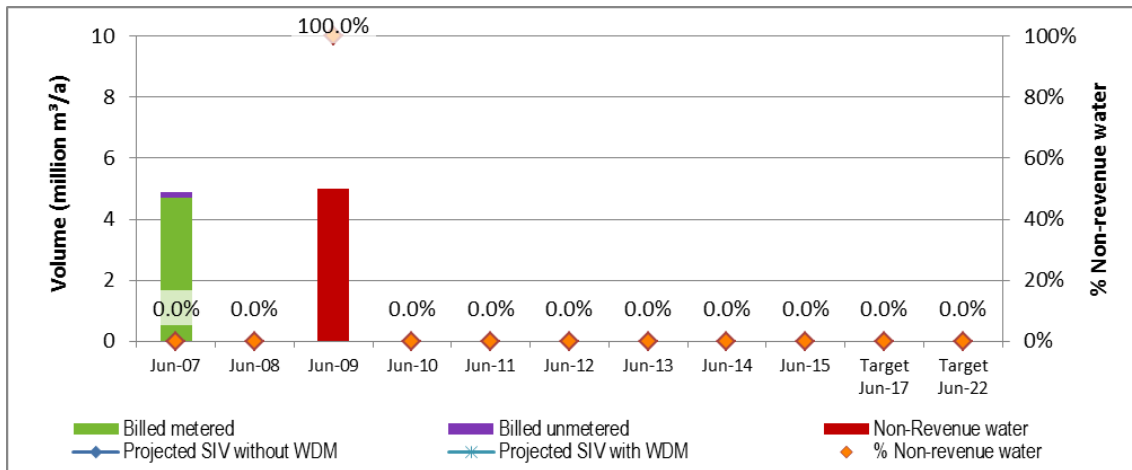


Figure 4.2 Thabazimbi LM water balance trend

The municipality does not have water balance data and no effective WC/WDM measures can be implemented without this information. The municipality has no WC/WDM strategy and business plan and no WC/WDM is implemented. The national average for Category B3 municipalities of 37% (WRC, 2012) water loss was accepted for Thabazimbi.

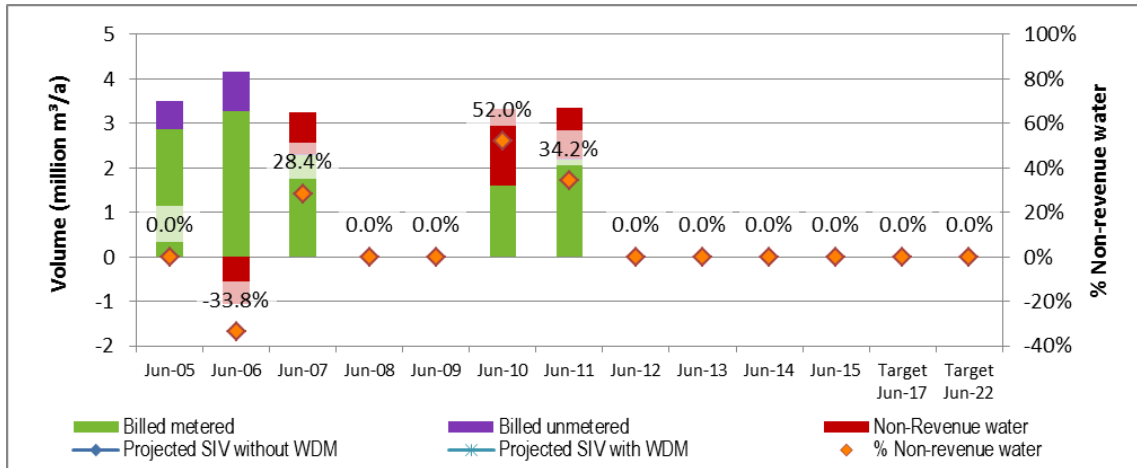
A first order WC/WDM strategy and business plan was developed for Thabazimbi as part of this study and included in **Appendix A**.

b) Bela Bela LM

Bela-Bela LM has a population of 69 533(NWSKS, Apr 2015). The urban hub is the town of Bela-Bela. Based on Census 2011, 16 144 (89.4%) households have RDP or better level of access to water, 1 336 (7.4%) households have below RDP access to water infrastructure and 585 (3.2%) have no access. Bela Bela LM is a Category B3 municipality with a relatively small population and significant proportion of urban population but with no large town as core. Most infrastructure is formal which enables effective metering, billing and cost recovery systems.

The data quality for Bela Bela is generally poor except for the 2010/11 data set which seems credible and was accepted as correct. Historical water balance information for Bela Bela is shown in Note: *Negative non-revenue water figures were captured by the Municipality, but they could not give any explanation for it.*

Figure 4.3.A WC/WDM strategy and business plan was developed under the DWS Rapid Response Unit (RRU), but is not implemented.

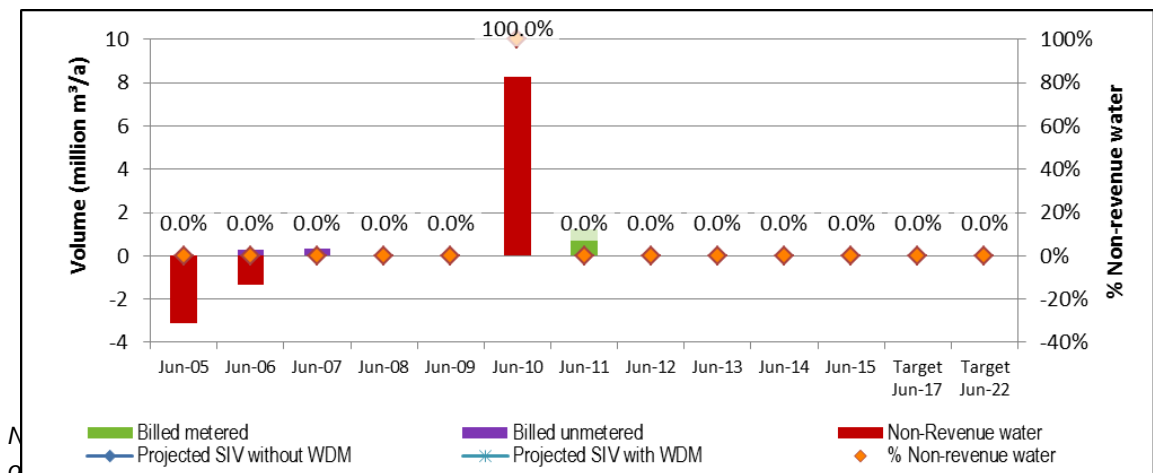


Note: Negative non-revenue water figures were captured by the Municipality, but they could not give any explanation for it.

Figure 4.3 Bela-Bela LM water balance trend

c) Moretele LM

Moretele has a population of 197 276(NWSKS, Apr 2015). The urban hub is the town of Makapanstad. Based on Census 2011, 42 472 (81.6%) households have RDP or better level of access to water, 3 621 (7.0%) households have below RDP access to water infrastructure and 5 971 (11.5%) have no access. Moretele LM is a Category B4 municipality which is mainly rural with, at most, one or two small towns in the area. Most infrastructure is informal which makes effective metering, billing and cost recovery systems difficult if not impossible. No credible information could be obtained from this municipality and what was obtained in the past is clearly incorrect as shown in



Note: Negative non-revenue water figures were captured by the Municipality, but they could not give any explanation for it.

Figure 4.4.

Note: Negative non-revenue water figures were captured by the Municipality, but they could not give any explanation for it.

Figure 4.4 Moretele LM water balance trend

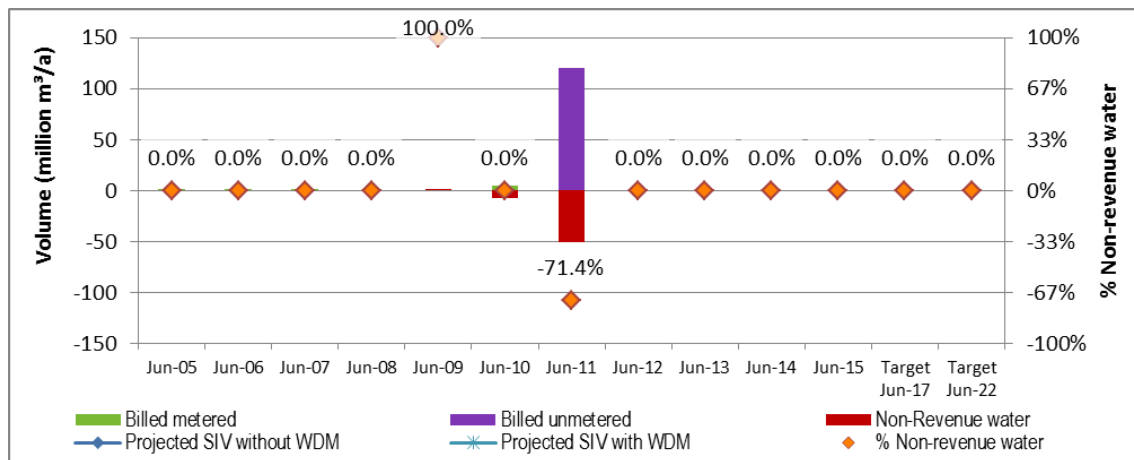
The municipality does not have water balance data and no effective WC/WDM measures can be implemented without this information. The municipality has no active WC/WDM programme. The national average for Category B4 municipalities of 73% (WRC, 2012) water loss was accepted for Moretele.

d) Madibeng

Madibeng municipality has a population of 503 749(NWSKS, Apr 2015). The urban hub is the town of Brits. Based on Census 2011, 125 739 (78.2%) households have RDP or better level of access to water, 11 039 (6.9%) households have below RDP access to water infrastructure and 23 942 (14.9%) have no access. Madibeng LM is a Category B1 municipality. Category B1 municipalities are municipalities of economic significance with the largest budgets. Most infrastructure is formal which enables effective metering, billing and cost recovery systems.

No credible information could be obtained from this municipality and what was obtained in the past is clearly incorrect as shown in **Note:** *Negative non-revenue water figures were captured by the Municipality, but they could not give any explanation for it.*

Figure 4.5. The municipality does not have water balance data and no effective WC/WDM measures can be implemented without this information. The national average for Category B1 municipalities of 41.3% (WRC, 2012) water loss was accepted for Madibeng.



Note: Negative non-revenue water figures were captured by the Municipality, but they could not give any explanation for it.

Figure 4.5 MadibengLM water balance trend

The All Town Study attached a low confidence to available information, since there were no records of actual supply volumes. The DWSRRU estimated NRW at 75%. The *All Town Study* found that there was sufficient water for current and future needs, but that water quality was problematic.

A first order WC/WDM strategy and business plan was developed for Madibeng as part of this study and included in **Appendix A**.

e) Rustenburg LM

The municipality has a population of 579 932 (NWSKS, Apr 2015), and receives water from both Magalies Water (from Vaalkop Dam) and Rand Water. The urban hub is the town of Rustenburg. Based on Census 2011, 177 043 (88.9%) households have RDP or better level of access to water, 9 466 (4.8%) households have below RDP access to water infrastructure and 12 528 (6.3%) have no access. Rustenburg LM is a Category B1 municipality, which are municipalities of economic significance with the largest budgets. Most infrastructure is formal which enables effective metering, billing and cost recovery systems.

Credible information could be obtained from this municipality as shown in **Figure 4.6**, but the municipality has no WC/WDM targets. The municipality is implementing WC/WDM.

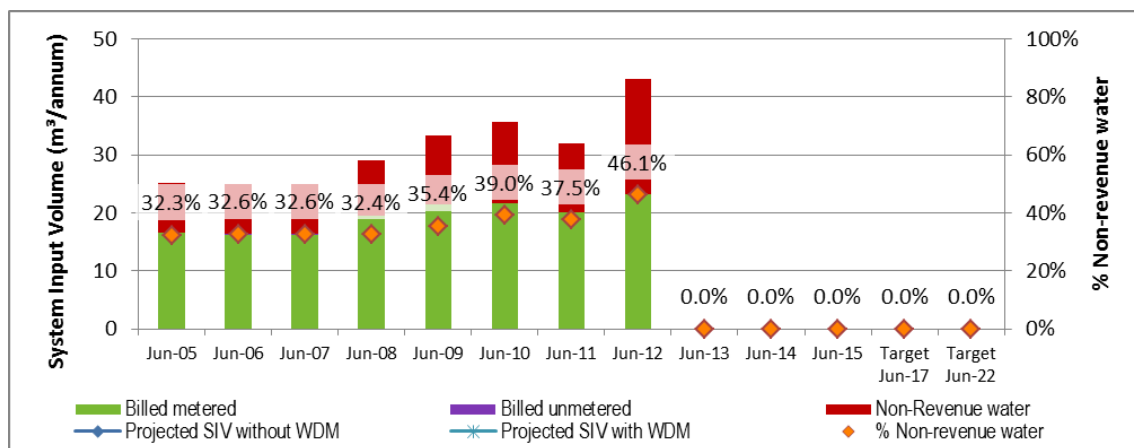


Figure 4.6 Rustenburg LM water balance trend

The *All Town Study*, which excluded mining usage, estimated water losses to be 28%, substantially lower than the NRW assessment. It found that the Vaalkop Cluster area was already in a water deficit and that WC/WDM was urgently required. The study found that a metering programme was required to separate domestic, industrial and mining uses. An active leakage detection and repair system was also recommended and illegal connections should be removed. It also recommended the exploration of groundwater supplementation. The consumption of 271 l/c/d is high, and leakage and NRW are not under control.

f) Kgetlengrivier LM

Kgetlengrivier LM serves a population of 53 871 (NWSKS, Apr 2015). The key demand centres are Koster and Swartruggens. Based on Census 2011, 13 147 (89.6%) households have RDP or better level of access to water, 613 (4.2%) households have below RDP access to water infrastructure and 914 (6.2%) have no access. Kgetlengrivier LM is a Category B3 municipality with a relatively small population and significant proportion of urban population but with no large town as core. Most infrastructure is formal which enables effective metering, billing and cost recovery.

No credible information could be obtained from this municipality and what was obtained in the past is clearly incorrect as shown in **Figure 4.7**. The national average of 37% (WRC, 2012) water loss was accepted for Kgetlengrivier.

A first order WC/WDM strategy and business plan was developed for Kgetlengrivier as part of this study and is included in **Appendix A**.

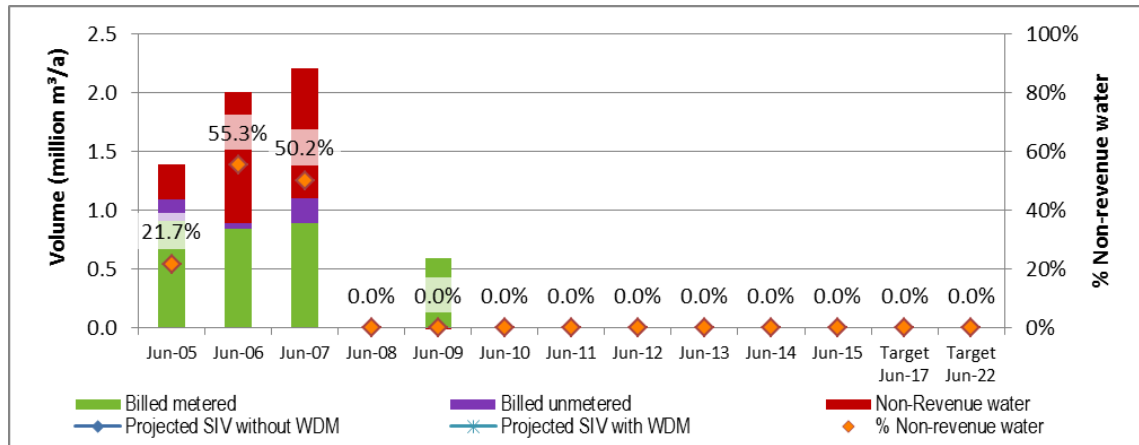


Figure 4.7 Kgetlengrivier LM water balance trend

g) Moses Kotane

Moses Kotane LM has a population of 255 947 (NWSKS, Apr 2015). The urban hub is the town of Mogwase. Based on Census 2011, 60 758 (80.8%) households have RDP or better level of access to water, 9 046 (12.0%) households have below RDP access to water infrastructure and 5 392 (7.2%) have no access. Moses Kotane LM is a Category B4 municipality which is mainly rural with, at most, one or two small towns in the area. Most infrastructure is informal which makes effective metering, billing and cost recovery systems difficult if not impossible.

No credible information could be obtained from this municipality and what was obtained in the past is clearly incorrect as shown in **Figure 4.8**.

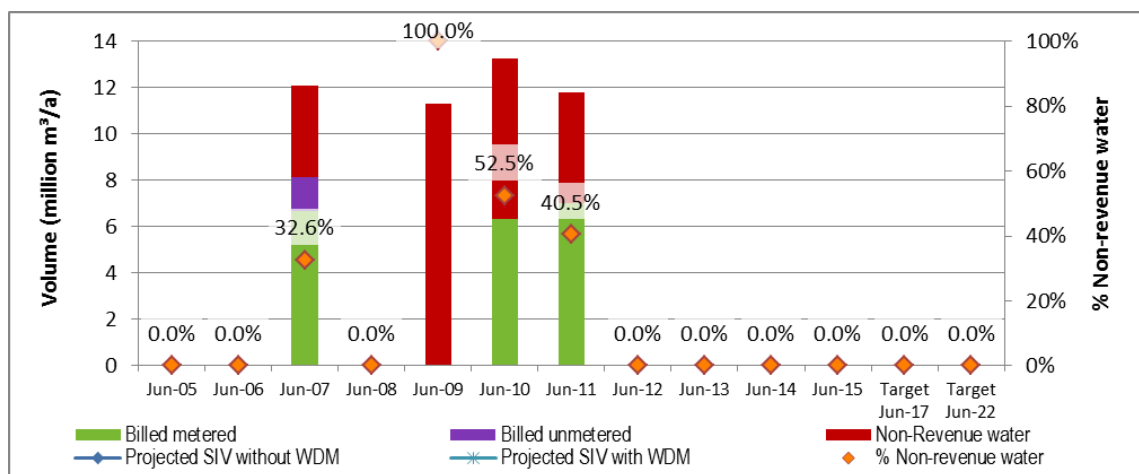


Figure 4.8 Moses Kotane LM water balance trend

The municipality does not have water balance data and no effective WC/WDM measures can be implemented without this information. The municipality has no active WC/WDM programme. The national average for Category B4 municipalities of 73% (WRC, 2012) water loss was accepted for Moses Kotane.

4.3.3 Common factors inhibiting WC/WDM

The most common factors inhibiting the implementation of WC/WDM include the following:

Access to potable water: Most formal areas within the study area have access to 24-hour potable water supply, however, some have been struggling to achieve this goal as some parts of the formal and informal areas are on scheduled intermittent supply. This has a negative impact on service delivery and the lifespan of the water supply infrastructure, which will lead to high water losses within the reticulation system.

Bulk metering: Bulk meters are often broken or the information obtained from operational meters is seldom recorded and/or purposefully utilised, with the exception of a few municipalities.

Consumer Metering: Most municipalities appear to exhibit average, to below average, performance on consumer metering. There is a general lack of definitive policies and legislation to enforce consumer metering. Several municipalities within the study area have poor or no consumer metering and charge a flat rate. It is understood that a significant number of municipalities, particularly the rural municipalities and those that do not have a core formal town, find it challenging to effect metering, billing and cost recovery. The status of consumer meters varies in most municipalities and it is summarised as follows:

- Consumer meters generally ranged between 1 to 20 years old (most of them being older than 10 years). The accuracy of the meters is thus compromised, which has a negative impact on the quantification of consumer consumption;
- All municipalities surveyed have no structured meter replacement programmes in place;
- Limited field investigations showed that many of the meters are covered with soil, which is an indication that they are not read regularly.

Water audit / water balance: Most municipalities lack an adequate water balance to fully understand the extent of water losses and NRW. There is thus significant potential for improved monitoring and control of water use in most of the municipalities in the study area. Having a firm grasp of the extent of water losses in the municipalities will assist in ensuring that financial resources are prioritised and directed towards water loss interventions that will yield the required results. The purpose is to improve efficiency, management, and cost recovery within the municipalities. The quality of the water balance/audit is reliant on the consumer database and monitoring results, which are functions that cut across both the finance and technical services departments.

Human resources and skills: There are significant vacancies and skills shortages in the water and sanitation departments within the municipalities and this has a negative impact on the ability of the municipalities to provide good quality water service and to manage the systems appropriately. Municipalities need to address the skills shortage and fill all critical vacancies to improve institutional capacity and skills to embark on WC/WDM programmes.

Community Awareness Programmes: Promotion of improved water use practices and general awareness regarding the importance of water conservation is not undertaken within most municipalities in the study area. Continuous engagement with consumers and provision of information regarding WC/WDM can assist municipalities, particularly with WC/WDM measures such as passive leak detection, through consumers reporting leakages. Furthermore, such initiatives could result in a general improvement of water use efficiency, which would in turn improve the functioning of the water supply systems and eradication of scheduled intermittent supply. Such programmes, however, need to be continuous and consistent, and fully supported by the political leaders in the communities.

Retrofitting of wasteful devices: Most municipalities are characterised by a high prevalence of internal plumbing leakage and poor quality installations, which leads to further leakage. Municipalities need to engage in removal of wasteful devices in public places, such as tip tray urinals in public toilets and proper monitoring to ensure good quality workmanship when it comes to the installation of household water connections.

Infrastructure maintenance: It appears that most municipalities do not have a comprehensive asset register in place. Ideally, the asset register should comply with MFMA requirements and provide a working mechanism for tracking the maintenance and refurbishment requirements of existing assets. It is recommended that municipalities adopt and implement modern GIS water and sanitation master planning and a fault reporting and repair system that will link with the consumer billing system and service level data. The asset register should ideally contain information such as the lifespan of the network, location of the assets and estimated replacement value, to aid proper planning and maintenance.

4.4 WC/WDM STRATEGIES

4.4.1 Institutional strategy

From an institutional standpoint, the key intervention in the WSAs within the study area will be to address the considerable vacancies or shortages in human resources and skills. Dedicated individuals or sections ideally should be established in order to drive WC/WDM. Specialised training in WC/WDM is pertinent to support the municipal personnel in undertaking the required water loss reduction activities particularly at the management level where guidance and leadership is required to drive demand management. It is also crucial that the lines of communication are opened between the different municipal departments in order to aid more efficient access to information which will allow for more effective and coordinated planning.

In this regard, a NRW steering committee comprising of the relevant councillors, finance representatives, communication and the technical department can be established to facilitate improved reporting and management of NRW. Procurement processes during and after the transition period must also be streamlined in order to enable swifter access to support structures required for operations and maintenance tasks, which are necessary to mitigate water losses in the systems. Political support cannot be separated from any of the above-mentioned strategic matters as it is essential for the acceptance, adoption and implementation of all the key NRW reduction initiatives.

4.4.2 Social strategy

One of the key findings of the assessments undertaken was the pervasive poor relationship existing between the WSAs and the consumers. The assessment also revealed that very little was being done to engage the consumers on water issues and to gain their cooperation whilst the WSAs tackle the pertinent water challenges within the study area. Consumer behaviour and adaptation, to increasing water scarcity, are crucial in not only water loss reduction initiatives, but also the mitigation of further water scarcity in the study area. Extensive and continuous consumer water education programmes are required which will focus on the community and other key water users including agricultural users and institutions such as schools which are potent avenues for the reduction of water losses. The installation of water efficient devices, as well as rain water harvesting; are also avenues which can further be explored for promotion and implementation in different sectors which can aid water loss reduction at the consumer level, particularly in areas where metering and billing cannot immediately be effected, and where cost recovery is very low due to high indigent populations. Structures should also be put in place to support consumers in reporting leakage and other service related complaints which should be captured electronically in order to allow proper tracking and analysis of water loss contributors and significant problem areas. The political leadership should ideally lead these interventions and provide substantial support in order to improve the sustainability of the community based interventions.

4.4.3 Financial strategy

It is widely accepted that one of the key reforms required in the municipal sector, which is pertinent to the viability and the sustainability of the municipalities, is financial reform. The reform should include the overhaul of metering and billing systems to improve the state of internal revenue collection as well as tariff setting process and outcomes that not only promote water loss and demand reduction, in line with the presidential targets, but also take into account the cost of water services. One of the findings of the financial review conducted was the lack of a proper methodology when it comes to the tariff setting process. In the absence of the application of guidelines to the process, the tariffs in no way promote demand management or reflect the cost of water services. Whilst this ideal is not easy to achieve in light of the indigent levels in the municipalities

under investigation, where practicable, metering and billing must be affected particularly in the non-domestic sector.

As a first step, meter audits should be undertaken in this consumer sector in order to identify unmetered connections and non-functional meters which could in the short term significantly improve cost recovery. Furthermore, it is imperative that the tariff setting process include inputs from the technical departments which could assist in making the tariffs increasingly effective in achieving the water use efficiency objectives.

National Treasury has been very vocal on the dependency of municipalities on grant funding and has emphatically expressed the need for municipalities to actively demonstrate a commitment to proper budgeting, planning and cost recovery with a focus on demand side management as a first step in managing and more effectively utilising the available resources. The aforementioned require closer monitoring of consumers, particularly the top consumers, an effective system to capture and refer billing related complaints and progressive payment of services in the municipalities which must be supported and preceded by proper community awareness and education, and wide spread public engagement.

4.4.4 Technical strategy

The assessment conducted revealed two primary issues of water scarcity in the study area. The first is the challenge of broken infrastructure which must be rectified through asset management, proper operations and maintenance. The second however relates to absence of WC/WDM programmes which should be the driving force behind all operation and maintenance of the water supply network. One of the primary challenges is the availability of management information which must be rectified as a matter of priority. Measurement of the system input volumes as a first step is required to come to grips with the extent of water losses in the study area, particularly in Madibeng. Zoning and zone metering and monitoring is also required in the majority of the municipalities in the WMA to aid in the micro management of the system once bulk metering has taken place.

It is an observed trend that even in municipalities where management information structures are in place, nothing is done with the data obtained from the devices. The data is neither captured nor analysed in a meaningful way which would aid in generating the required management reports with the NRW KPI's included. The installation of meters is thus only the first step and will be altogether useless if the information is not captured and monitored monthly.

Proper budgets must also be set aside for proactive infrastructure asset maintenance. There is a substantial maintenance backlog in the municipalities in the study area with a significant number of access challenges being caused simply by the age of the existing infrastructure. Simply replacing the network will however not resolve all the challenges which will require greater community participation and cooperation to achieve. Passive leak detection through community reporting would greatly enhance the ability of the WSPs to monitor the network and explore potential for pressure

management in selected areas experiencing frequent pipe bursts. The location of infrastructure also needs to be clarified in order to identify aspects of the network which are in a state that compromises the ability to provide services to the consumers.

In this regard, there is a need to develop digital as built drawings of the network which must be accompanied by the development of a comprehensive asset register; that must incorporate critical information such as the age of the infrastructure, replacement period and cost, as well as the location of the assets. Through such interventions, substantial community based employment can be created where indigent residents can be appointed and utilised to clean and locate the infrastructure.

4.4.5 Potential savings from WC/WDM

The objective of this task was to establish the potential for WC/WDM, in each participating municipality, through a first order assessment of NRW and water losses. Higher confidence evaluations were possible in cases where detailed WC/WDM investigation studies were carried out and in areas where the RRU programme has taken place.

The WC/WDM targets are based on the following principles:

Efficiency

- Target 180 to 200 litres per capita per day;
- A maximum of 20 to 30% reduction in system input volume is considered achievable.

Efficiency affects water security and augmentation.

Non-revenue water

- If NRW is >50%, a target of 40% is considered achievable;
- If NRW is between 30% and 50%, a target of 25% is considered achievable;
- If NRW is <30%, a target of 15% is considered achievable.

NRW impacts on revenue and water use efficiency

Water losses

- Same as for NRW with unbilled consumption not more than 5% of system input volume.

Financially and environmentally not acceptable

Based on this information, KPIs were calculated per municipality as shown in **Table 4.3**

Water loss and efficiency targets, and consolidated in order to formulate the strategy for the WMA.

The key performance indicators show estimated water losses of approximately 40% and average consumption of 282 l/c/d for the study area. The water loss and average consumption are above the national averages of 31.8% and 235 l/c/d respectively.

Based on the unit consumption it is clear that WC/WDM should be implemented, as a matter of priority, in most municipalities. The NRW is high considering the formal supply area and infrastructure in most municipalities. A water loss figure of below 20% would be considered acceptable for the supply area as an initial target.

Table 4.3 Water loss and efficiency targets

Municipality	Population served	Water use (million m ³ /a)	Current unit consumption (ℓ/c/d)	Target unit consumption (ℓ/c/d)	Current water loss (%)	Target saving (%)	Water saved (million m ³ /a)
City of Johannesburg	1 773 931	201.7	312	242	29.2%	22%	45
City of Tshwane	2 921 488	303.6	285	274	22.4%	4%	11.5
Ekurhuleni	1 059 490	118.6	307	290	33.9%	5%	6.5
Madibeng	477 381	22.6	130	107	41.3*	18%	4
Rustenburg	549 575	45.4	226	192	46.1%	15%	6.8
Mogale City	181 211	14.4	218	207	29.2%	5%	0.7
Randfontein	149 286	9.8	180	173	23.7%	4%	0.4
Thabazimbi	85 234	4.9	158	141	37%*	10%	0.5
Bela Bela	66 500	3.2	132	107	34%	19%	0.6
Kgetlengrivier	51 049	2.7	145	107	37%*	26%	0.7
Moretele	186 947	9.1	133	114	73%*	14%	1.3
Moses Kotane	242 554	11.8	133	113	73%*	15%	1.8
Total	7 264 096	748	282	252		11%	80

Note* Estimated data, based on national averages for similar municipalities, were used where no information is available

4.4.6 Critical risk factors

There are a number of potential risks that exist, with regard to the implementation of WC/WDM, which are considered to be as follows:

Insufficient capacity to implement and spend allocated budgets:

One of the key problem areas which has been identified in the municipalities has not only been the non-prioritisation and deficient funding for implementation of WC/WDM measures but, more importantly, the glaring lack of capacity to spend even grant funding and budgets allocated for these activities. This is a crucial risk because unless the appropriately skilled individuals are appointed to fill the correct positions and supported with continuous training, the status quo of poor service delivery in some areas and high NRW will remain unchanged for the foreseeable future.

Inadequate political will to support WC/WDM

A further pervasive risk, which has been encountered in a number of municipalities, is the distinct lack of political will to actively support the implementation of WC/WDM measures. This fact attests to perhaps a lack of understanding of the importance and value in implementing these measures, as well as a lack of urgency in some cases, as the reality of water scarcity has not dawned on some municipalities.

The importance of municipal political support for WC/WDM cannot be stressed enough, as this significantly impacts on how the consumers view water conservation (taking a cue from the political leaders and gatekeepers to the community) and affects the budgeting processes within municipalities. In the absence of such support and prioritisation, WC/WDM will neither be sustained, nor implemented successfully in municipalities over the short and long term.

Inadequate tariffs which do not support WC/WDM

A key concern throughout the assessments conducted has been the inadequacy of water tariffs to not only encourage water conservation, but also to sustain municipal financial management and service delivery. Most of the municipalities surveyed made mention of the fact that the cost of water, charged to the consumer, in many cases does not reflect the cost of providing water services. This is a pertinent risk, as municipalities have no hope of future sustainability if the revenue cannot sustain the cost of services. It is acknowledged that many municipalities have high levels of indigent population, however, a more cost reflective tariff is required to promote water conservation and ensure the sustainability of the municipality.

Inadequate billing and metering

It is a reality that billing and metering of consumers is one of the most effective measures to encourage WC/WDM. Whilst this is not feasible in certain areas, it has been observed that a number of municipalities are not billing and recovering revenue even in areas which are metered and can be billed. Proper billing and metering of all consumers is essential for the sustainability of a municipality and for the delivery of good quality services, which will allow infrastructure to be serviced and maintained. Unless all consumers are properly metered and billed, municipalities run the very real risk that the water demands will continue to rise, as consumers will not be encouraged to change or adapt water use practices in the absence of some consequence for wasteful behaviour.

4.5 SUMMARY AND CONCLUSIONS

Results from the study are summarised as follows:

- There is a large part of the study area which has formal infrastructure which enables effective metering and billing.
- The average consumption in the urban areas is very high and there is scope for reduction which is expected to reduce the total demand and non-revenue water.
- The rural areas are characterised by intermittent supply with limited cost recovery and consumers revert to illegal connections to obtain water.

- The average consumption in the rural areas is within the acceptable range but there is huge inequality of supply. Any reduction will be redistributed with limited or no reduction in the total demand;
- The greatest potential for WC/WDM exists in Metros and secondary cities;
- The lack of information in Category B1 and B2 municipalities is concerning as these are areas of high economic impact and any water restrictions could be detrimental to the local economy;
- The water tariffs in certain areas are not cost reflective and not promoting water conservation and water demand management
- The municipality lack funding to implement WC/WDM;
- The municipalities require additional staff to address and implement WC/WDM.
- Asset management lacks in some of the areas which impact on the assurance of supply;
- Municipalities are grant dependent and have very high debtors;

Based on the above the following key strategic focus areas are recommended:

- Raise WC/WDM awareness within the organisation by setting-up a WC/WDM task team, chaired by senior officials, or at management committee meetings to meet on monthly basis to address WC/WDM issues;
- Fill vacant positions and provide training and capacity building
- Improve metering, meter reading, billing and cost recovery;
- Improve the availability of macro and micro management information;
- Review the water tariff structure to be cost reflective and promote WC/WDM;
- Improved tariff structures and cost recovery will increase revenue for the municipality which can be used to address the backlog in maintenance and improve service delivery;
- Implementing metering and cost recovery in the rural areas do present several challenges and fixing internal plumbing leakage using local plumbers are recommended until such time the system have stabilised and service delivery has improved;
- Implement awareness campaigns across all consumers to use water efficiently; and
- Improve management information through proper monthly reporting and records keeping.

These reports should be discussed at the monthly management meetings.

4.6 IRRIGATION WC/WDM

4.6.1 Background

Irrigation WC/WDM was not addressed as a specific task as part of this project. Feedback by Mr Nico Benadé, on the results of a project undertaken by the Water Research Commission NB Systems and the NEPAD Business Foundation, was given at this study's Strategy Steering Committee Meeting on 26 August 2015.

A proposal was made to the SWPN to implement the Water Administration Release Module on the Western Canal of the Hartbeespoort IB. A Cello logger was installed at a water measuring station at the Hartbeespoort West Canal in January 2015 to measure water releases and losses. During the period January to June 2015 this exercise resulted in water savings of 6%. Aquatic weeds in the canals are the main cause of the high water losses, currently about 50%. The Hartbeespoort Irrigation Board needs financial assistance to control the aquatic weeds.

4.6.2 Water loss targets as in the Water Management Plan for the Hartbeespoort Irrigation Board

a) Short-term water saving targets

For the short-term, which has been assumed at 3 years, the total water savings that can be achieved through implementing of flow measurement, monitoring plans and aquatic weed control is some 8 million m³/a.

b) Long-term water saving targets

For the long-term a further 21 million m³/a saving is envisaged by optimizing the operations and refurbishment of the canal infrastructure. The long-term target is to reduce the water losses to approximately 27% of the total diversion.

Aquatic weeds in the canals are the main cause of the high water losses, currently estimated at about 50%. The Irrigation Board needs financial assistance to control the aquatic weeds.

It is recommended that follow-up interaction with this project's team be maintained during the following phases of the Reconciliation Strategy.

5. WATER QUALITY

Water quality in the catchment is a significant issue due to the large volumes of return flows and urban runoff, and associated nutrients. Other activities such as mining and irrigation also impact negatively on the water quality.

The Department is monitoring water quality in the catchment and setting preliminary Resource Water Quality Objectives (RWQO's). To accompany this effort a water quality model (WQT) model has been configured and calibrated to simulate salts in the catchment. The salinity modelling capabilities have been added to the WRPM to allow for the assessment of salt build up for different development scenarios. This will continue to be a valuable tool in the maintenance of the Strategy, and in particular to assess the impact of further re-use of treated effluent return flows.

A *Water quality assessment of the Crocodile (West) Water Supply System* study was done and presented at a Strategy Steering Committee meeting in March 2015. This study included the following:

- Literature review (2012 to 2013).
- Desktop Resource Water Quality Objectives (RWQOs) during 2013.
- Water quality compliance and trends analysis with data for the period 2010 to 2013.
- Identification of areas of concern and parameters of concern.
- A water quality report on annual status assessment for 2012 to 2014 is available.
- A water quality compliance map for the 2012 to 2014 period is also available.

A request to use Professional Service Providers (PSPs) for the *Development of an Integrated Water Quality Management Plan (IWQMP) for the Crocodile (West) and Marico river Catchment* project has been submitted for approvals to the relevant DWS approval authorities. The scope of work will include the following:

- Catchment assessment
- Review of current desktop preliminary water quality planning limits (Resource Water Quality Objectives)
- Evaluation of management options and scenario development.
- Development of management plans for each sub-catchment constituting thematic strategies
- Establishment of an overarching Integrated Water Quality Management Plan (IWQMP)

Close liaison between this proposed study and follow-up phases of the Crocodile (West) Reconciliation Strategy Studies is essential.

The Water Resources Planning Model (WRPM) has a sub-routine to model water quality (in terms of total dissolved solids). This sub-routine is active in the WRPM, but there was not a specific focus on assessing the water quality during the execution of this phase of the project.

It is recommended that more attention be paid into modelling and interpreting the water quality output (in terms of total dissolved solids) in follow-up phases of this Strategy. Specific points of interest should be around Rietvlei, Roodeplaat, Hartbeespoort dams and at Bospoort Dam (on the Elands River) near Rustenburg, as well as at the proposed abstraction point in the Lower Crocodile (West) River at Vlieëpoort, where water will be abstracted for transfer to the Lephalale area in the Mokolo River catchment.

6. DEVELOPMENT SCENARIOS

6.1 BASE SCENARIO

It is anticipated that the current development trends will continue for the foreseeable future. Strong growth in the urban/industrial sectors is expected to continue in and around the existing metropolitan areas located in the upper parts of the catchment (and contributing to growing return flows downstream).

New mining developments is expected mainly in the middle and lower parts of the catchment, whilst a strong need also exists for the abstraction of water in the lower parts of the Crocodile (West) River for transfer to new proposed developments in the Lephalale area which is located in the Mokolo River catchment, through the *Mokolo and Crocodile River (West) Water Augmentation Project Phase 2 (MCWAP2)*.

The City of Tshwane Metro has planned their Water Augmentation Program which entails significant in-direct re-use of return flows, and this is coupled with a reduction in the water requirements from the Vaal River system in some areas (City of Tshwane, 2011). The majority of the interventions are planned from 2017 onwards. This will impact the water balance, and as such was included in the base scenario, analysed with the WRPM and reported back at Strategy Steering Committee meetings during the three years duration of this study.

The primary elements that would impact on the growth in water requirements are concisely summarised below. The base scenario adopts the population growth and medium efficiency WC/WDM savings. These water requirements were presented in Section 2 of this report.

6.2 ALTERNATIVE SCENARIOS

6.2.1 Higher growth in the Metropolitan areas

We need to add this as the main alternative scenario. The two below are alternatives for the areas

6.2.2 Higher growth in the Magalies Water Supply area

During discussions with officials of Magalies Water on their Regional Bulk Water Planning initiative it became apparent that alternative growth to the Base Scenario is expected by them for a few specific areas in the catchment. This was predominantly in the area around Roodeplaat Dam which, although now part of the City of Tshwane Metro, was previously part of the Nokeng Tsa Taemane LM. The alternative scenario with much higher growth suggested by Magalies Water was based on the Nokeng Tsa Taemane LM *Water Services Development Plan*. This scenario was analysed using the WRPM to assess the impacts of this alternative water requirement growth scenario.

7. WATER BALANCES

The water balances for the Crocodile (West) River system were calculated using the Water Resources Planning Model (WRPM). Water balances were calculated taking into account the future growth in water requirements and return flows for two scenarios:

- Base scenario
- Alternative higher growth scenario

Both these scenarios also capture the supply and return flows of the revised Metro area of Tshwane as well as the Magalies Water requirement projections included as an alternative future scenario for areas to the north of the Magaliesberg.

The water balances were calculated taking into account water availability in the catchment with transfers into the Crocodile (West) River catchment from the Vaal River system via Rand Water, water requirements of all users within the Crocodile (West) River catchment, transfers out to Bela Bela, Modimolle and Mookgopong, as well as the Lephalale area to support water requirements for MCWAP Phase 2.

7.1 SCENARIO 1: BASE SCENARIO

The water balance for this scenario is summarised in **Error! Reference source not found.** As can be seen there is a surplus in the catchment due mostly to the growing effluent return flows from the large urban areas.

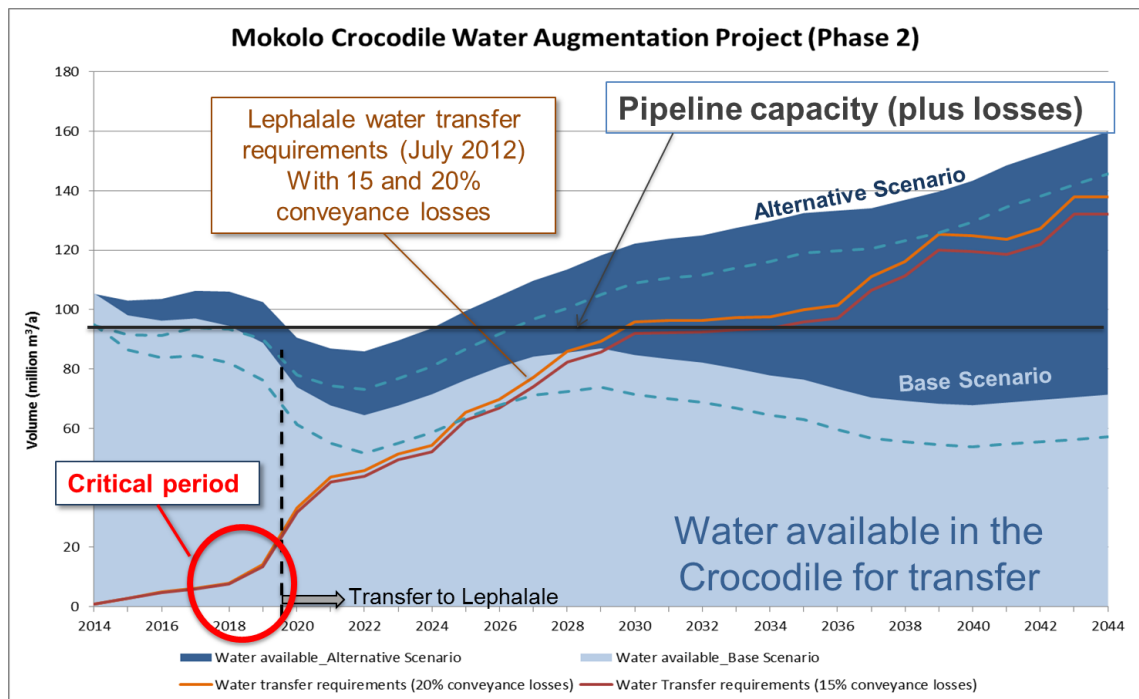


Figure 7.1 Water balance for the Crocodile (West) River catchment for Scenario 1

The water requirements of the area around Roodeplaas Dam that differed in the Magalies Water scenario now fall under the City of Tshwane’s jurisdiction. The water requirement growth rates adopted from the old Nokeng Tsa Taemane LM Water Services Development Plan were outdated and reviewed in the City of Tshwane’s Water Augmentation Program. This scenario highlighted the need to review water requirement growth projections, particularly for Tshwane, and that if very high growth in the Roodeplaas Dam surrounding area realises then the surplus in the Apies-Pienaars sub-catchment will be impacted.

The Tshwane Re-use Scenario highlighted how the potable water augmentation planned by the City of Tshwane will use the projected surplus in the catchment, particularly for the period between 2017 and 2025 when the catchment would experience a short-term deficit. The timing of this program will need to be reviewed as shown by the water balance including the water transfer to the Lephale area, as discussed in Section 11.1.

7.2 SCENARIO 2: BASE SCENARIO AND HIGHER ALTERNATIVE GROWTH IN THE METROPOLITAN AREAS

The total water balance for the Crocodile (West) River catchment, taking into account water transfer requirements to Lephale, is shown in **Figure 7.2** Water balance for the Crocodile (West) River catchment for Scenario 2.

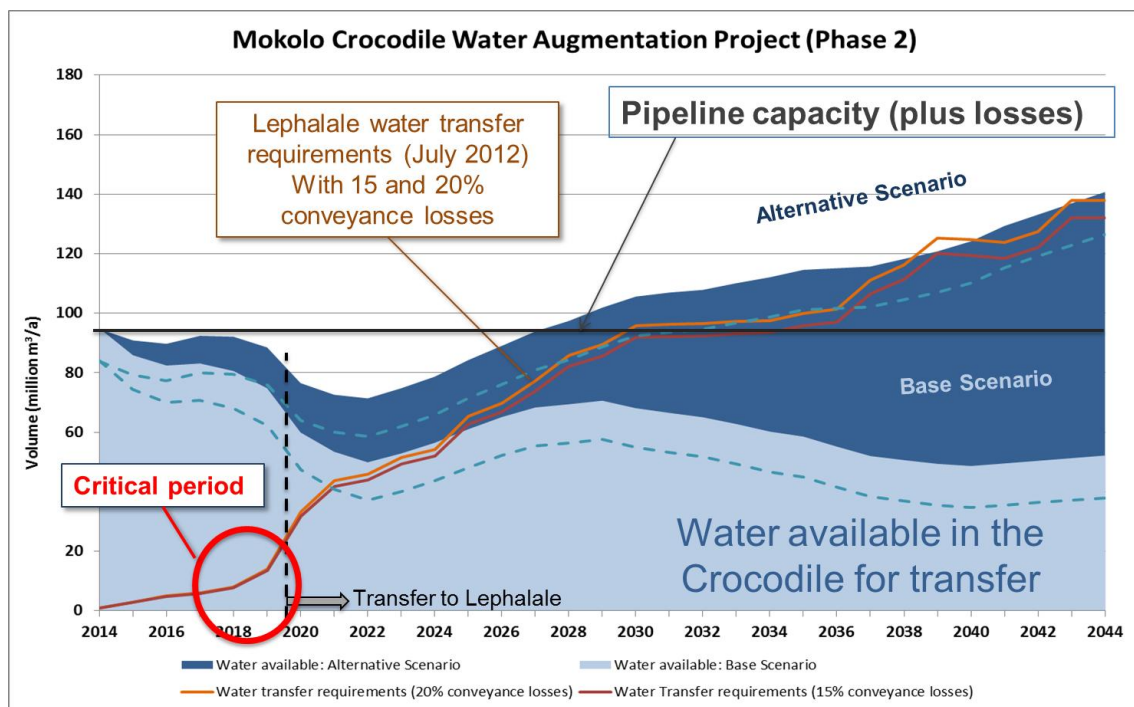


Figure 7.2 Water balance for the Crocodile (West) River catchment for Scenario 2

Zooming into the top part of the water balance graph, the extent to which the surplus in the Crocodile (West) River can meet the transfer requirements to the Lephalale area can be observed. As can be seen the shortfall in surplus is small and also temporary. As return flows continue to grow in the Crocodile (West) River catchment in future the surplus is projected to again exceed the transfer requirements.

Since the start of the original Reconciliation Strategy in 2005, the water balance for the Mokolo-Crocodile system changed considerably. The 2008 Strategy reported shortages of up to 130 million m³/a with water requirements in the Lephalale area of about 190 million m³/a. The 2012 Strategy Report included lower water requirements in the Lephalale area of maximum 120 million m³/a with no water shortages.

It is recommended that the water balances be updated before the SSC Meetings with new updated available data on water requirements and return flows in future phases of the Crocodile (West) Reconciliation Strategy project.

8. WATER TARIFF

A revised National Raw Water Resource Pricing Strategy is currently being drafted. The Department has considered a National Approach to tariff setting in place of the current Scheme Based tariff. The latest, not yet gazetted version, of the draft strategy proposes a hybrid National-Systems Tariff model in the following terms:

Hybrid tariff approach – *The pricing strategy provides for a combination of nationally and water management specific charges to facilitate the development of affordable tariffs to all users; some elements of the water charge will be levied on the basis of a national charge for a particular sector(s), and some on the basis of a scheme based or catchment level charge.*

This component of the Strategy discusses the implication of various tariff options in the Crocodile (West)River catchment, and makes a strategic recommendation on how such an approach should be implemented in the Crocodile (West)River catchment with special emphasis on the MCWAP charge.

8.1 BRIEF OVERVIEW OF THE CROCODILE RIVER WATER RESOURCES

The water balance of the total Crocodile (West)River catchment is shown in **Table 8.1**. The figures refer to a water balance based on 2014 figures.

Table 8.1 Water balance of the total Crocodile (West) River catchment (2014)

Water requirements	Volume (million m³/a)
Domestic water requirements (Rand Water)	556.5
Domestic water requirements (own sources)	149.3
Mining water requirements (own sources)	53.5
Irrigation Boards and Irrigation Schemes	268.0
Diffuse irrigation (private farmers etc.)	125.0
Power and industry (supplied individually)	40.0
Total water requirements	1192.3
Water availability	
Urban return flows (generated from supply from all resources)	380.8
Estimated yield from local resources	370.7
Rand water supply (excluding mines in Rustenburg area)	556.5
Total availability	1308.0
Water balance (surplus)	115.7

*Note: The above figures does **not** include any transfers from the Crocodile (West) River to Lephalale*

The following observations can be made from Table 8.1:

- The users supplied by Rand Water are already paying the Vaal River tariff through the Rand Water tariff.
- Urban return flows exceed the estimated yield of local resources.
- Urban return flows are mainly returned by users who are supplied from the Vaal River system by Rand Water, approximately 295 of the total return flows of 381 million m³/a.
- The users supplied from the Vaal River system (about 295 million m³/a) exceed the combined domestic water requirements from own sources (about 149 million m³/a) and the mining water requirements from own sources (about 54 million m³/a).
- The combined irrigation requirements of Irrigation Boards and diffuse irrigation exceed the supply from local resources.
- If it is assumed that local resources are allocated to irrigation users then it can be argued that the domestic and mining users not supplied by Rand Water (i.e. from the Vaal River) are fully reliant on Vaal River return flows.
- It could further be argued that a system based pricing strategy should take cognizance of the value of the Vaal River return flows to these domestic and mining users.

8.2 CURRENT APPLICATION OF THE PRICING STRATEGY

The current application of the pricing strategy for domestic and industrial users considers each dam independently, as shown in the **Table 8.2** (water resources management charges are ignored for this part of the exercise).

Table 8.2 Current application of the pricing strategy for domestic and mining users

Source (excluding groundwater, supplies directly from WWTW)	Volume (million m ³ /a)	Raw water tariff 2015/16 (R/m ³)	Amount 2015/16 (R million)
Domestic supply from Hartbeespoort Dam	19.86	0.0985	1.95
Domestic supply from Roodeplaas Dam	28.59	0.3398	9.71
Domestic supply from Vaalkop Dam	28.05	0.7426	20.83
Domestic supply from Leeukraal Dam	19.71	0.0464	0.91
Domestic supply from Bospoort Dam	4.30	1.1140	4.79
Domestic supply from Kosterrivier and Swartruggens dams	5.00	1.0651	5.33
Subtotal - local supply	105.51		43.53
Mining supply from Hartbeespoort Dam	18.38	0.0985	1.81
Mining supply from Vaalkop Dam	36.24	0.7426	26.91
Subtotal - local supply	54.62		28.72
Total (excluding Vaal River)	160.13	0.4512	72.25

The weighted average tariff for water supplied from Government Water Works is approximately **45c/m³** at 2015/16 charges.

There are, however, other water users who are not being charged domestic and mining raw water charges, either because they either own and operate the dams from which they are being supplied, or because they re-use water directly from a WWTW. These users, summarised in **Table 8.3**, are, however, also enjoying the benefit of return flows.

Table 8.3 Water users who are not being charged domestic and mining raw water charges

Water users	Requirements (million m³/a)
Domestic supply from Rietvlei Dam	15.6
Mining supply directly utilising effluent (Rustenburg)	9.1
Power and industry direct from return flows	40.0
Total	64.7

Users of ground water (approximately 27 million m³/a) have been ignored for this exercise and thought should still be given as to a suitable ground water tariff.

8.3 VALUE OF RETURN FLOWS

Users in the Middle and Lower Vaal River catchments abstract water which includes a certain percentage of return flows, say 15%. These users pay for all the water that they abstract at the Vaal River tariff. There is no distinction between the raw water charge for natural Vaal River flows, for return flows, or for that matter for flows transferred from the Lesotho Highlands Project (LHWP). All domestic and mining water taken from the Vaal River are charged at the same blended price.

An economic argument can be made that the value (or opportunity cost) of the return flows from Vaal River originated water is the same, whether those return flows are discharged back into the Vaal River, or alternatively into the Crocodile (West) River catchment. If this argument is followed, then some recognition must be given to the value of the Vaal River return flows in the Crocodile River catchment.

Three possible approaches for a systems tariff have been discussed in a series of internal consultations.

8.3.1 Option 1: A systems based raw water use charge for a combined Crocodile (West) and Vaal River system

This water use charge option involves a full systems integration approach. DWS would merely lump all of the Crocodile River catchment costs together with the Vaal River costs and recover both costs over the full sales from the combined Vaal and Crocodile (West) River catchments. The revenue generated would simply be allocated to cost centres in the respective catchments. As far as water use charges are concerned it would not matter whether a user was taking water from the Vaal River or from the Crocodile (West) River.

8.3.2 Option 2: No payment for current return flows, but payment for later direct transfers

This option recognises that all return flows of Vaal River water to the Crocodile (West) River catchment is generated by consumers who have already paid the Vaal River tariff through its incorporation in the Rand Water bulk potable tariff. Under this option it is argued that the Crocodile River catchment should **not** be charged the Vaal River tariff a second time. The users in the catchment have already paid for the water that has been transferred via the Rand Water pipelines and return flows.

However, should a direct transfer of Vaal River water to the Crocodile (West) River catchment be required in future, because future requirements in the Crocodile (West) River catchment exceeds the available return flows, then that water should be paid for at the point of abstraction in the Vaal River at the Vaal River raw water charge.

8.3.3 Option 3: Incorporating the Vaal River return flows into a Crocodile (West) systems tariff

As an alternative to Option 1, it could be argued that a fully integrated systems approach might not be implemented in the short-term. Under this option a portion of the Vaal River tariff, or the full Vaal River tariff, should be passed on to the Crocodile (West) River catchment users through the return flows. However, on equity considerations it would perhaps not be justifiable to simply add the Vaal River tariff on the volume of return flows to the Crocodile (West) River tariff.

Rather to simulate Option 1, it could be argued that no user in the Crocodile (West) River catchment should pay more than the Vaal River tariff. The existing dams in the Crocodile (West) River catchment will cost the same to own and operate (capital and operation and management costs) whether or not a system charge is introduced. The cost of these existing sources must be paid for out of the systems tariff. If these principles are applied, then the domestic and mining system based charge in the Crocodile (West) River catchment would be determined as reflected in **Table 8.1**.

Table 8.4 Domestic and mining system based charge in the Crocodile (West) River catchment

Item	(R/m ³)
Trans-Caledon Tunnel Authority(TCTA) charge	2.3200
Vaal River charge	0.5768
Sub-total	2.8968
Minus Portion of charge allocated to Crocodile (West) River system to own and operate existing sources	0.4505
Portion of tariff allocated to Vaal River system	2.45

8.4 COMPENSATING CROCODILE (WEST) USERS FOR POORER QUALITY OF WATER

It could be argued that users in the Crocodile (West) should be compensated for the difference in quality between the Vaal River return flows and the quality of water in the Vaal River.

The Report “*WDCS Business Plan: Upper Crocodile Hartbeespoort Catchment, October 2013*” estimates that the amortised cost of reducing the phosphate (PO_4) loads in point source effluents in the Crocodile (West) River catchment to 0.3 mg/l is R55 million/a and to reduce the phosphate loads to 0.15 mg/l would be R152 million/a. While this is not the actual cost of improving the quality of the return flows, it could be used as a rough surrogate for such a cost.

It could be argued that the R152 million/a amortised cost of reducing the phosphate load should be distributed over the 160 million m^3/a requirement on which the domestic and mining raw water charge is currently being charged, as well as the 64.7 million m^3/a requirement of users who are currently not being charged a raw water domestic and mining charge, because they carry their own infrastructure costs. The compensation so calculated would equate to a water quality rebate of **R0.6761/ m^3** .

8.5 MCWAP1 AND MCWAP2

The capital and operational cost of the *Mokolo and Crocodile River (West) Water Augmentation Project* (MCWAP) is in the order of R16/k ℓ . There are two options for analysing the MCWAP costs.

In the **first option** the Vaal-Crocodile (West) water use charge system would be extended to include the recipients or beneficiaries of MCWAP transferred water. If the water use charge system is extended to include MCWAP, then the costs of the MCWAP would be included in the sum of the costs that must be recovered through water sales across the Vaal, Crocodile and MCWAP systems, i.e. for raw water charge purposes the MCWAP costs would be lumped together with costs associated with the LHWP, dams in the Vaal River system as well as dams in the Crocodile (West) River catchment. Under this option there would be a single charge for the Vaal-Crocodile (West) River – and MCWAP.

There is, however, an opposing or alternative argument that the MCWAP cost must not be confused with the cost of taking or abstracting water from a stream; but rather that the MCWAP should be likened to the cost of the Vaal-Gamagara Pipeline or the VRESSAP pipeline. In both those cases the cost of the conveyance infrastructure are charged to recipient users over and above the raw water charge associated with abstraction from the source.

In this **second option** the MCWAP charge would be a separate charge over and above the charge for abstracting water from the Crocodile, regardless of the treatment of Vaal River charges in the Crocodile (West) River.

8.6 IMPACT ON THE VAAL RIVER TARIFF OF A VAAL RIVER – CROCODILE (WEST) SYSTEMS TARIFF

Rand Water alone pays approximately R3600million for raw water purchased from the Vaal River system. It is estimated that the portion of the Crocodile (West)River catchment's System Tariff allocated to the Vaal River system of R392 million (160 million m³ X R2.45) would be less than 10% of the Vaal Revenue received from Rand Water.

8.7 RAW WATER USE CHARGES FOR IRRIGATION

Raw water use charges for irrigation were based on the status quo, where irrigation users do not pay the full cost of water.

8.8 CONCLUSIONS AND RECOMMENDATIONS FOR A PROPOSED TARIFF STRATEGY FOR THE CROCODILE (WEST) RIVER SYSTEM

In light of the previous reported indicative calculations, the following is concluded and recommended:

- DWS's long term strategy is to move closer towards a National Tariff and away from individual scheme tariffs, with a medium-term strategy of hybrid National-Systems tariffs.
- The intention underlying this Strategy is to obtain a certain level of cross-subsidisation from existing schemes to enhance the affordability of new schemes serving marginalised areas.
- It is uncertain how far these policies would have been implemented by the time MCWAP is implemented.
- The cost of water from the fully developed MCWAP will be far higher than the Vaal River tariff, and indications are that MCWAP could cost in the order of R16/kℓ, compared with a Vaal River tariff of R2.89/kℓ (including TCTA charge).
- It would be extremely punitive to add the full Vaal River tariff to the MCWAP tariff and this would be contrary to the medium and long-term DWS intentions of homogenising tariffs on a system or national basis.
- It is recommended that if users in the Crocodile River system, including the MCWAP users, are required to contribute to the Vaal River tariff, they be given a rebate on the Vaal River tariff equal to their contribution for in-Crocodile (West) water resource costs. This rebate would imply that users in the Crocodile (West)River system who incur costs greater than the Vaal River tariff (e.g. MCWAP users) would not contribute to the Vaal River tariff at all, while users who incur in-basin costs of less than the Vaal River tariff would not be required to pay more than the Vaal River tariff in total.
- The above suggestion would be a move towards DWS's long-term policy of a hybrid system and national tariffs.

- It is recommended that the Water Tariff be reviewed (and updated if necessary) after approval of the latest National Raw Water Resource Pricing Strategy.

9. KEY FACTORS INFLUENCING THE WATER BALANCE

Long-term planning in general, and water requirements scenario in particular, are inherently uncertain, which make it essential to identify and monitor those key variables that could influence the projected water balances.

In the Crocodile River system and its linked systems, the following factors will influence the water balances and ultimately the Reconciliation Strategy:

- Urban water requirements and return flow growth.
- Growth in water requirements of mining and related industries (platinum and coal). The rate of mining development is highly influenced by global economic outlook and commodity prices.
- Power generation and related developments on the Waterberg coal fields in the Lephalale area.
- Success of water conservation and water demand management measures, both in terms of the volumes of water abstracted and the return flows (treated wastewater).
- Classification of water resources and ecological monitoring.
- Dynamic institutional arrangements, such as the extension of Tshwane's jurisdiction of responsibility, now including areas such as Nokeng Tsa Taemane and Kungwini Local Municipalities. Tshwane also requested Magalies Water to take over the water supply to Moretele. The proposal of Magalies Water is to supply water from their Klipdrift water treatment plant (WTP) as well as a new proposed WTP at Klipvoor Dam.
- Assumptions of how the return flows will reduce due to the implementation of water conservation and water demand management. The City of Tshwane expressed concern and requested a review of the assumptions made. This should be done for the greater Gauteng as it will also influence the Vaal River Reconciliation Strategy.
- Water quality assessment guided by a proposed Steering Committee to evaluate and ensure fitness for use.

10. CURRENT WATER RESOURCES MANAGEMENT PROJECTS

10.1 CROCODILE WEST ANNUAL OPERATING ANALYSES

The objective of this continuing DWS operating analyses study is to develop and implement annual operating rules (by providing operating decision support) for the Crocodile River system. A System Operating Forum (SOF) has been established and consists of organisations representing users who have a direct interest in the operation of the dams, abstraction works and conveyance infrastructure in the system.

Risk-based simulation analyses are undertaken to evaluate alternative operating scenarios and annual water allocations to be motivated and presented to the SOF for consideration and approval. The focus of the analyses were on the main reservoirs in the system, which includes Hartbeespoort, Roodekopjes, Roodeplaat, Klipvoor, Vaalkop, Buffelspoort, Rietvlei, Bospoort, Koster, Lindleyspoort and Olifantsnek dams.

A 40% operating rule for the Roodekopjes-Vaalkop Canal was applied: water will be released for transfers from Roodekopjes Dam to Vaalkop Dam to keep Vaalkop Dam at a minimum operating level of 40% of the live storage volume.

Another operating rule that was used in the analyses was to operate Roodekopjes Dam below 85% of the live storage volume during the summer months (November to February). This will support flood management for the operators of the dam to release water from the dam in such a way to prevent high water levels downstream of the dam during flood conditions.

Water releases from Hartbeespoort Dam to augment Roodekopjes Dam will only be required when Phase 2 of the *Mokolo-Crocodile (West) Water Augmentation Project* (MCWAP2) is implemented.

The results from the analyses undertaken by the Department during May 2015 confirmed no water restrictions to users from Vaalkop, Roodekopjes, Hartbeespoort, Klipvoor, Roodeplaat, Bospoort and Rietvlei dams.

At Kosterrivier Dam, with the adopted operating rules of the dam, water restrictions are required when the dam storage drops below 100%, which is actually all the time, with only the intensity increasing from higher storage volumes going down to lower storage volumes. For the period 1 May 2015 to 30 April 2016 only 65% of the domestic and 27% of the irrigation water requirements could be allocated.

At Swartruggens Dam, with the adopted operating rules of the dam, water restrictions are required when the dam storage drops below 80%. For the period 1 May 2015 to 30 April 2016 only 90% of the domestic water requirements could be allocated.

At Lindleyspoort Dam, 15% water restrictions had to be implemented on the irrigation requirements.

10.2 VALIDATION AND VERIFICATION OF WATER USE

Verification is a process to check the volume of water registered by existing users and its lawfulness under previous legislation, so as to certify the extent of existing lawful use.

Validation is the process through which the Department compares the volume of water use registered against how much water was actually used, and how much is currently being used.

A study on the validation and verification of lawful water use is currently being undertaken by the Department in the Crocodile River catchment. This process aims to identify water users who have:

- Registered their water use entitlements correctly (correct registration).
- Registered water uses they are not entitled to (over-registration or unlawful use).
- Omitted to register water use they are entitled to (under-registration or terminated use).
- Failed to register water use.

The progress, as reported at the last Strategy Steering Committee meeting on 26 August 2015 is summarised in **Table 10.1**.

Table 10.1 Progress of the validation and verification of water use as reported Strategy Steering Committee meeting no. 9 on 26 August 2015

Process	Item	Agriculture	Other	Total
COMPLETED TASKS				
Validation	Number of files	5 393	379	5 772
	Validations completed	5 393	142	5 535
Verification	Applications for verification (mail/by hand)	3 658	89	3 747
	Feedback received	1 772	89	1 861
	No Feedback received (including 312+ "Return to Sender") #1	1 886	0	1 886
	Water use confirmed	1 531	68	1 599
OUTSTANDING TASKS				
Validation		0	237	237
Verification	Section 35 process not initiated at all	1 735	290	2 025
	Section 35 initiated - in process	2 127	0	2 127
	Total	3 862	290	4 152

Note: #1 Due to Post Office strikes

It is recommended that the results from this *Validation and Verification Study*, once completed, be incorporated into and updated in, where applicable, the Water Resources Planning Model input data files in the follow-up phases of this study.

10.3 WATER RESOURCES CLASSIFICATION IN THE MOKOLO-MATLABAS, CROCODILE WEST AND MARICO CATCHMENTS

This study, executed by the Department's Directorate: Resource Directed Measures, has run its course to the point of Gazetting the water resources classes and Ecological Water Requirements (EWR) at 16 sites throughout the Crocodile (West) River catchment.

Previously the impact of the EWRs in the catchment was based on preliminary Reserve studies for the catchment, and decisions made for the time up until the classification process has been concluded.

The Gazetted EWR information is recorded in **Table 10.2**. The location of the EWR sites is reflected in **Figure 10.1**.

Refer to Section 10.3 of this report summarising the *Water Resources Classification in the Mokolo-Matlabas, Crocodile (West) and Marico catchments*.

Table 10.2 Gazetted EWR information in the Crocodile West River catchment

EWR site	Name	Quaternary	River	Coordinates	PES	EIS	REC	Level of determination
CROC_1	Hartbeespoort Dam inflow	A21H	Crocodile (West)	S 25.8004	D	Moderate	D	Intermediate
				E 27.896				
CROC_2	Jukskei	A21C	Jukskei	S 25.9539	E	Moderate	D	Intermediate
				E 27.9621				
CROC_3	Hartbeespoort Dam outflow	A21J	Crocodile (West)	S 25.7168	C/D	High	C/D	Intermediate
				E 27.8431				
CROC_4	Quat outlet below Roodeplaat	A23B	Pienaars	S 25.4155	C	High	C	Intermediate
				E 28.312				
CROC_5	Klipvoor Dam	A23J	Pienaars/ Moretele	S 25.12657	D	High	C	Intermediate
				E 27.80457				
CROC_6	Bospoort Dam	A22J	Hex	S 25.5214	D	Moderate	D	Intermediate
				E 27.3749				
CROC_7	Lower Croc @ Koedoeskop	A24C	Crocodile (West)	S 24.88661	D	Moderate	D	Intermediate
				E 27.51743				
CROC_8	Lower Croc @ Vlieëpoort	A24H	Crocodile (West)	S 24.64476	C	Moderate	C	Intermediate
				E 27.32569				
CROC_9	Below Maloney's eye	A21F	Magalies	S 26.01689	B	Very high	B	Rapid III
				E 27.56581				
CROC_10	Elands above Swartruggens	A22A	Elands	S 25.72655	C	High	B/C	Rapid III
				E 26.72044				
CROC_11	Buffelspoort Dam	A21K	Sterkstroom	S 25.80739	C	High	C	Rapid III
				E 27.4784				
CROC_12	Bela- Bela tributary	A23G	Buffels	S 24.8304	B/C	Moderate	B/C	Rapid III
				E 28.2224				
CROC_13	Lindleyspoort Dam outlet	A22E	Elands	S 25.48108	C	Low	C	Rapid III
				E 26.69039				
CROC_14	Tributary d/s Olifantsnek	A22H	Waterkloof-spruit	S 25.7414	B/C	Low	B/C	Rapid III
				E 27.2568				
CROC_15	Magalies at Hekpoort	A21F	Magalies	S 25.8969	C/D	Low	C/D	Rapid III
				E 27.5982				
CROC_16	Above Rietvlei Dam	A21A	Rietvlei	S 26.01885	C	Low	C	Rapid III
				E 28.30442				

PES Present ecological state

EIS Ecological importance sensitivity

REC Recommended ecological class

EWR site CROC_4 could have an impact on Tshwane's re-use programme.

EWR site CROC_8 is upstream of the proposed Vlieëpoort Weir site and will be inundated when MCWAP2 is implemented. It is recommended that this specific issue be addressed in the follow-up phase of Reconciliation Strategy project.

11. STATUS OF INFRASTRUCTURE PLANNING

11.1 MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT

Further implementation and planning of the *Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP)* was presented to the SSC. No new information on required transfer volumes needed from the Crocodile (West) River to the Lephalale area (Phase 2 of the MCWAP) were identified over the last year. As such, the water requirement projection scenario as presented in November 2013 is still relevant.

The objective of MCWAP is to supply water requirements to the Lephalale area in the Waterberg, to Eskom, independent power producers (IPP), coal mining and to domestic users. This will be possible by utilising available yield from the existing Mokolo Dam and as well as transferring return flows from Gauteng being discharged into the Crocodile (West) River catchment to the Lephalale area in the Mokolo River catchment. This is a key project of SIP-1 (the Government's Strategic Integrated Projects), unlocking the Northern mineral belt with the Waterberg as the catalyst.

Phase 1 of MCWAP includes a pumping station from Mokolo Dam and a 44 km pipeline, parallel to the existing pipeline from Mokolo Dam, to users in the Lephalale area. Environmental authorisation was granted in December 2010, a contractor was appointed in September 2011 and the water delivery milestone was achieved in May 2015.

Phase 2 of MCWAP (a water transfer scheme from the Crocodile (West) River near Thabazimbi to the Lephalale area) should proceed to ensure that the power stations have access to water from more than one source (other than only the Mokolo Dam). The transfer capacity of this phase will be 75 million m³/a (2035 horizon), but there is still a possibility that a capacity 100 million m³/a (2050 horizon) could be preferred. The construction period is currently scheduled from April 2017 to July 2021.

The Department's EIA (environmental impact assessment) project commenced in August 2015 after the previous EIA was terminated during the Scoping stage.

A *River Management Plan* is proposed for the Lower Crocodile River to monitor and manage releases from the system downstream of Hartbeespoort and Klipvoor Dams (see Section 13 of this report).

11.2 TSHWANE WATER RESOURCES MASTER PLAN

The *Tshwane Water Resources Master Plan* was completed in 2014. The study assessed the possible upgrading / extension of Tshwane's own water resources, to reduce the dependence on imports from the Vaal River system via the Rand Water supply system. It will have an impact on the Crocodile (West) River catchment, which receives sewer return flows from Tshwane that has an impact on the yields from the local water resources and water allocations to downstream users.

The Location of the City of Tshwane Metropolitan Municipality is presented in **Figure 11.1**.

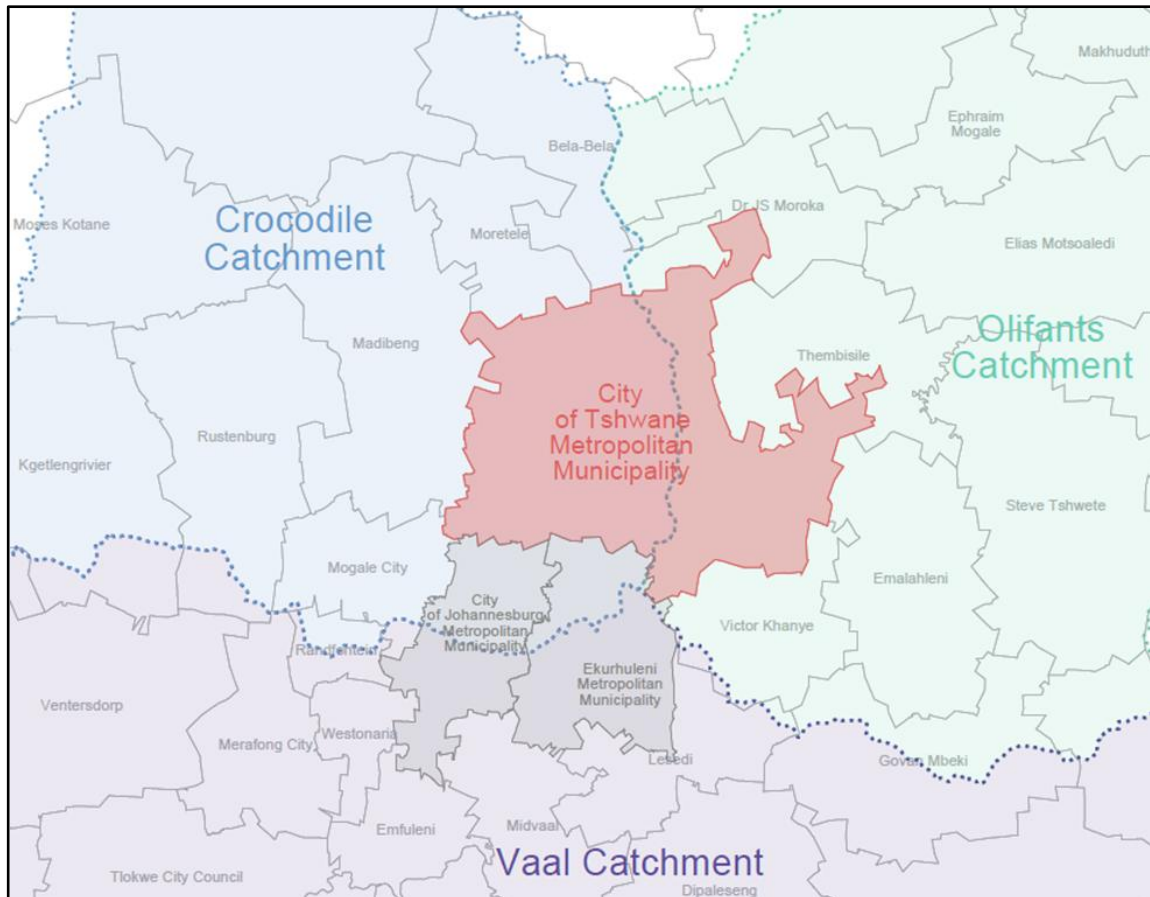


Figure 11.1 Location of City of Tshwane Metropolitan Municipality

(from *City of Tshwane Water Resources Master Plan, 2014*)

11.2.1 Existing and future water resources

City of Tshwane has 50 connections to the Rand Water supply system, supplying water mostly under pressure into the city's reservoirs and water towers, but sometimes the pressure is used to supply directly into reticulation networks. This is the bulk source of water, supplying 715 Ml/d, or 72.5% of the total water requirements. Tshwane has several water treatment plants (WTPs) supplying water to its users.

The existing water resources of the City of Tshwane, together with planned future water resources and expansions of water treatment plants, are summarised in

Table 11.1 Existing and future water resources of the City of Tshwane.

A simplified schematic of the existing City of Tshwane water resource system is presented in **Figure 11.2**.

11.2.2 Existing and future wastewater treatment works

The wastewater treatments works operated by City of Tshwane is summarised in **Table 11.2**.

Table 11.1 Existing and future water resources of the City of Tshwane

Resource	Source	2014 capacity (Mℓ/d)	AADD (kℓ/d)	%	Future planned capacity (Mℓ/d)	AADD (kℓ/d)	Comment
Rand Water	Vaal River system		715053	72.5		1 815778	Via bulk connection points
Rietvlei WTP (no transfers from Olifantsfontein WWTW)	Rietvlei Dam	40	43758	4.4	65 Mℓ/d in 2020 90 Mℓ/d in 2030 115 Mℓ/d in 2040 140 Mℓ/d in 2050	139861	Include Rietvlei Springs supply
Rietvlei WTP (with transfers from Olifantsfontein WWTW)	Rietvlei Dam	40	43758	4.4	140 Mℓ/d in 2020 190 Mℓ/d in 2033 245 Mℓ/d in 2045	239 861	Include Rietvlei Springs supply
Rietvlei Springs							Included in Rietvlei WTP supply
Roodeplaat WTP	Roodeplaat Dam	60	40673	4.1	90 Mℓ/d in 2014 140 Mℓ/d in 2025 190 Mℓ/d in 2035 240 Mℓ/d in 2045	218 444	
Temba WTP	Leeukraal Dam	60	51197	5.2	120 Mℓ/d in 2016 150 Mℓ/d in 2035 180 Mℓ/d in 2045	183 411	
Klipdrift WTP		18	8035	0.8		9 075	Owned by Magalies Water
Wallmannsthal WTP		12	11733	1.2		11 623	Owned by Magalies Water
Cullinan WTP		16	12652	1.3		14 909	Owned by Magalies Water
Bronkhorstspuit WTP		54	48880	5.0		50 308	
Bronkhorstbaai WTP		0.55	250	0.0	2.6 Mℓ/d in 2016 4.3 Mℓ/d in 2030 5.5 Mℓ/d in 2045	4 165	
Summerplace WTP			104	0.0		0	Abandon in favour of extended Bronkhorstbaai WTP
Kungwini Country Estate WTP			712	0.1		0	
Aqua Vista WTP			315	0.0		0	
Clover Hill WTP			400	0.0		0	
Fountains			085	4.4		32 086	
Bayadam WTP						823	Future WTP
Sterkfontein Spring	Spring						Included in Fountains supply
Rietvlei Borehole	Groundwater		073	0.6		6 171	
Varsfontein Borehole	Groundwater		051	0.2		2 059	Assumed unreliable in future
Onverwacht Boreholes	Groundwater		606	0.1		734	
Sokhulumi Boreholes	Groundwater		1236	0.1		1 971	
TOTALS			986813	100.0		2 591 416	

(from City of Tshwane Water Resources Master Plan, 2014)

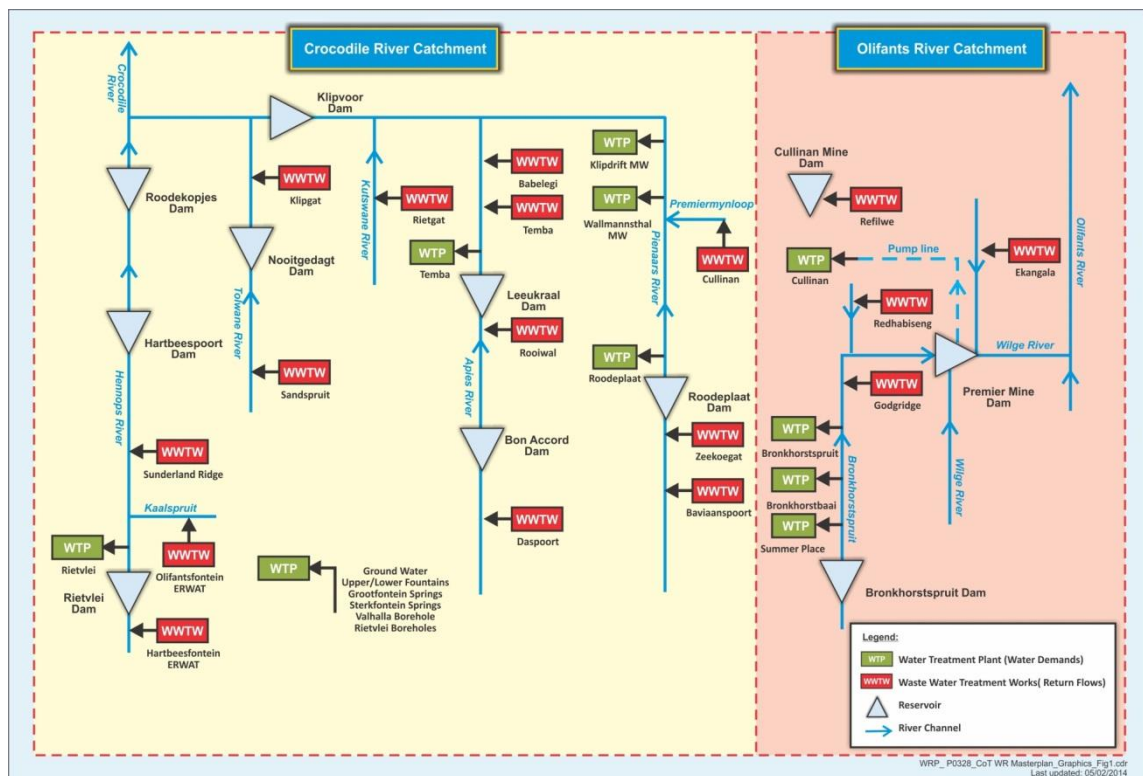


Figure 11.2 Simplified schematic of the City of Tshwane water resource system
(from *City of Tshwane Water Resources Master Plan, 2014*)

Table 11.2 Wastewater treatment works of the City of Tshwane
(from *City of Tshwane Water Resources Master Plan, 2014*)

Name	2014 capacity (Mℓ/d)	Future capacity (Mℓ/d)	Return flows discharge point
Sunderland Ridge	95	209	Hennops River
ERWAT Olifantsfontein	105	157	Olifantspruit upstream of the Hennops tributary in the Crocodile (West) River
Schurveberg	0	55	Hennops tributary just upstream of its confluence with the Crocodile (West) River
ERWAT Hartbeesfontein	45	45	Rietvlei tributary in the Crocodile (West) River
ERWAT Rietvlei		193	Rietvlei Dam
Baviaanspoort	60	305	Pienaars River upstream of the Roodeplaat Dam
Zeekoegat	30	161	Roodeplaat Dam
Daspoort	60	60	Apies River upstream of Bon Accord Dam
Rooiwal	245	492	Apies River upstream of Leeukraal Dam
Temba	12	33+87	Apies River upstream of Klipvoor Dam
Babelegi	3	3	Apies River upstream of Klipvoor Dam
Rietgat	27	119	Soutpan upstream of Klipvoor Dam
Sandspruit	20	60	Sandspruit downstream of Nooitgedacht Dam
Klipgat	55	91	Sandspruit downstream of Nooitgedacht Dam
Cullinan	2	0	Pienaars River (to be abandoned in future)

11.3 MAGALIES WATER – BULK WATER EXPANSION PLANS AND REGIONAL STUDY/PLANNING

The latest status on the expansion plans of Magalies Water is that there are significant additional requirements for bulk water supply in the area from mining, industry and housing developments and billions of rand are being spent on infrastructure development.

Magalies Water has early in 2015 completed a study entitled *Bulk Water Supply Infrastructure Master Planning for the Magalies Water Area of Supply*. There were continuous liaison and discussions between Magalies Water representatives and members of the Study Team to exchange information and data. This was done in order to make sure that the data and plans of Magalies Water were taken into consideration in the WRPM input data files as well as in the preparation and update of this 2015 Reconciliation Strategy for the Crocodile (West) River system.

Magalies Water concentrated on the following activities at their Bulk Water Schemes at Vaalkop, Klipdrift, Wallmansthal and Cullinan:

- Support WC/WDM interventions at municipal level.
- Ensure economical bulk water supply to all.
- The planned Pilanesberg Water Scheme and the proposed Klipvoor Bulk Water Supply Scheme.
- Eradication of both bulk and retail backlogs.
- Providing co-operation on water and sanitation provision in its area of operation.
- Efficient use of existing bulk infrastructure.

The water requirements of individual municipalities supplied by Magalies Water are reflected in **Figure 11.3**.

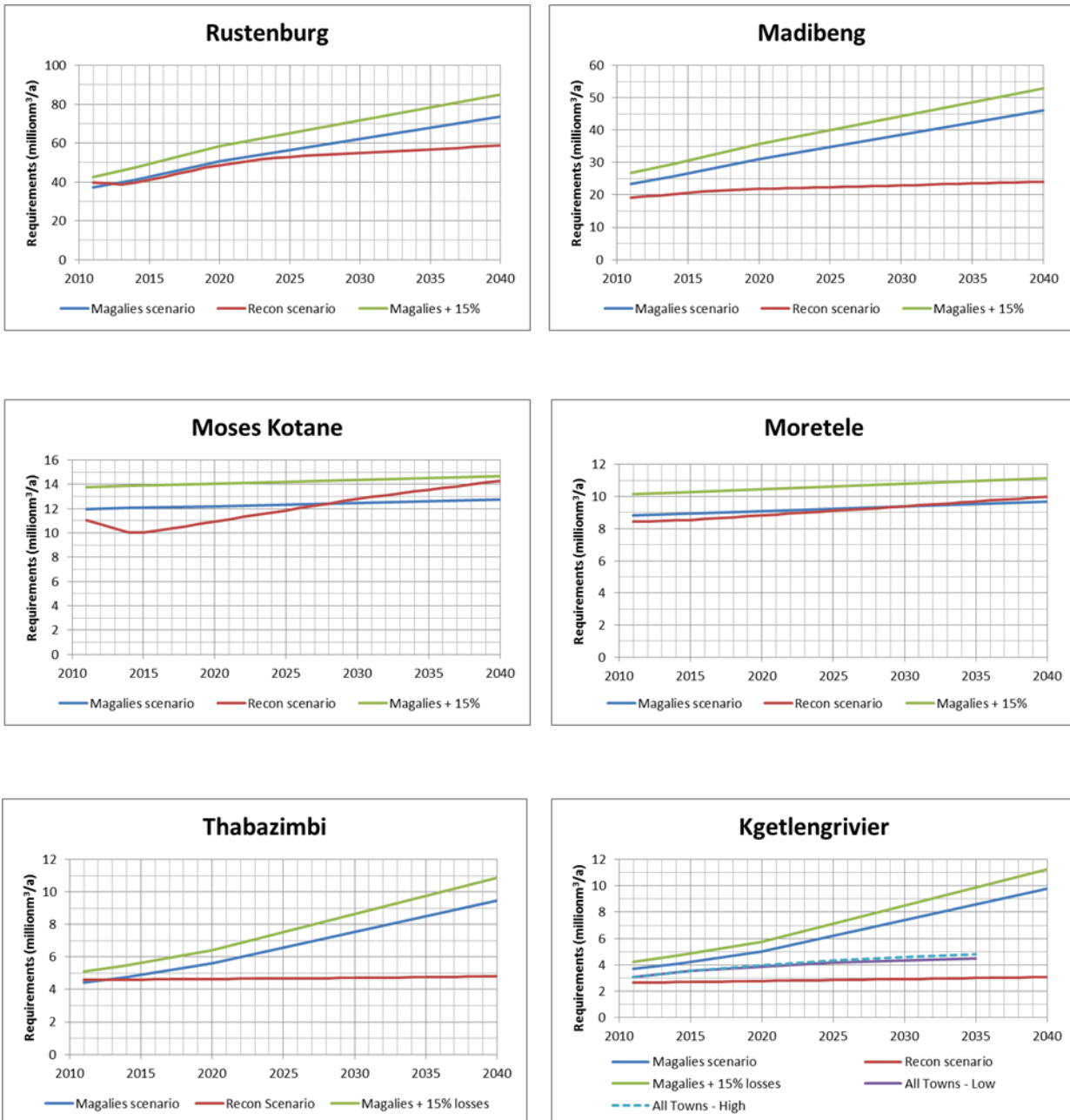


Figure 11.3 Water requirements of municipalities supplied by Magalies Water

The total water requirements of municipalities supplied by Magalies Water are reflected in **Figure 11.4**.

More details about this project should be available from Magalies Water once the reports of the study were approved and signed off for public availability.

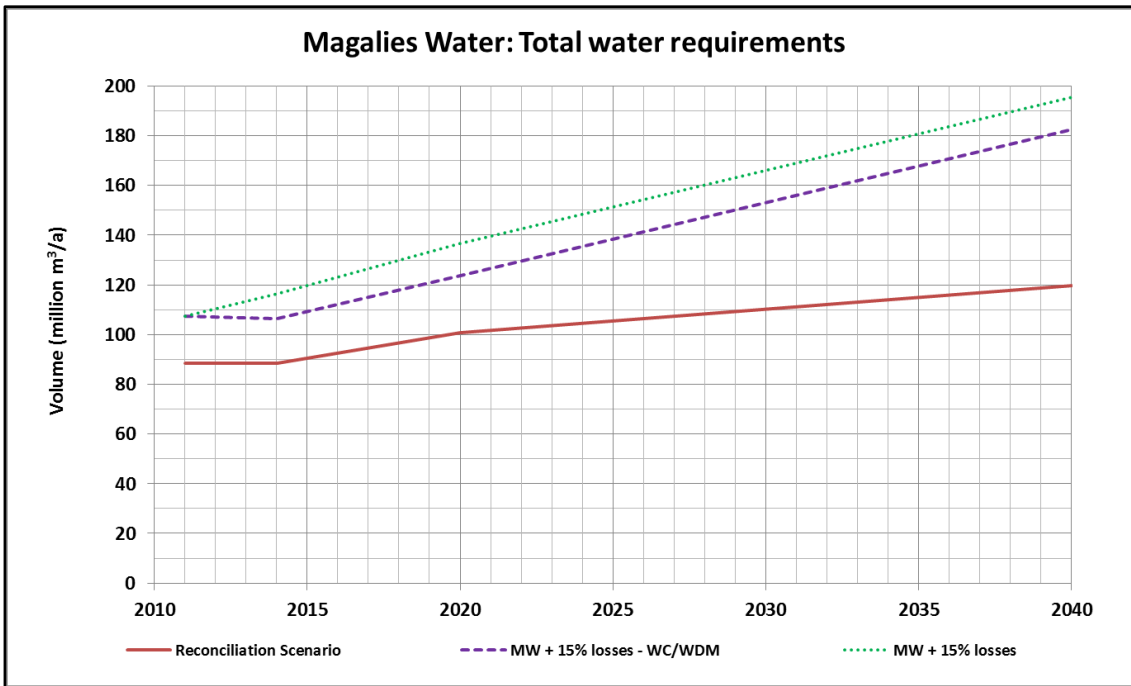


Figure 11.4 Total water requirements of municipalities supplied by Magalies Water

12. PROPOSED RIVER MANAGEMENT PLAN FOR THE LOWER CROCODILE (WEST) RIVER

The need was identified in the MCWAP project to manage the Lower Crocodile (West) River for future transfers from the Crocodile (West) River to the Lephalale area in the Mokolo River catchment to support water supply to the growing water requirements of the users.

The objective of a river management plan is the efficient operation of releases from upstream dams in the Crocodile (West) River for abstraction at Vlieëpoort. A River Management Plan is proposed to be in operation before the implementation of Phase 2 of the MCWAP project.

12.1 WHAT WILL A RIVER MANAGEMENT PLAN ENTAIL?

Operating rules of the Lower Crocodile (West) system with MCWAP2 releases will be complex due to:

- Multiple users along the river stretch (irrigation, transfer and ecological reserve), with varying assurance of supply criteria
- Multiple dams from which releases for users need to be made
- Cascading releases of water for transfer from Vlieëpoort
- Dynamic water requirements and availability (e.g. return flows)
- Limited current gauging locations on Lower Crocodile (West) River
- Some uncertainty around conveyance losses (including surface water groundwater interactions - sand aquifers).
- Limited storage potential to regulate water releases at Vlieëpoort
- Water quality concerns

The factors to be taken into consideration in the Crocodile River Management Plan are shown in **Figure 12.1**.

12.2 OUTLINE OF RIVER MANAGEMENT PLAN

- Confirm/define the scope of River Management Plan
- Adapt current operation (release) to include EWRs and transfer requirements
- Confirm existing and identify additional gauging locations for monitoring
- Identify institutional arrangement, communication methods and abstraction control requirements
- Calibrate the model through pilot application and monitoring
- Synchronise the river model and Water Resource Planning Model

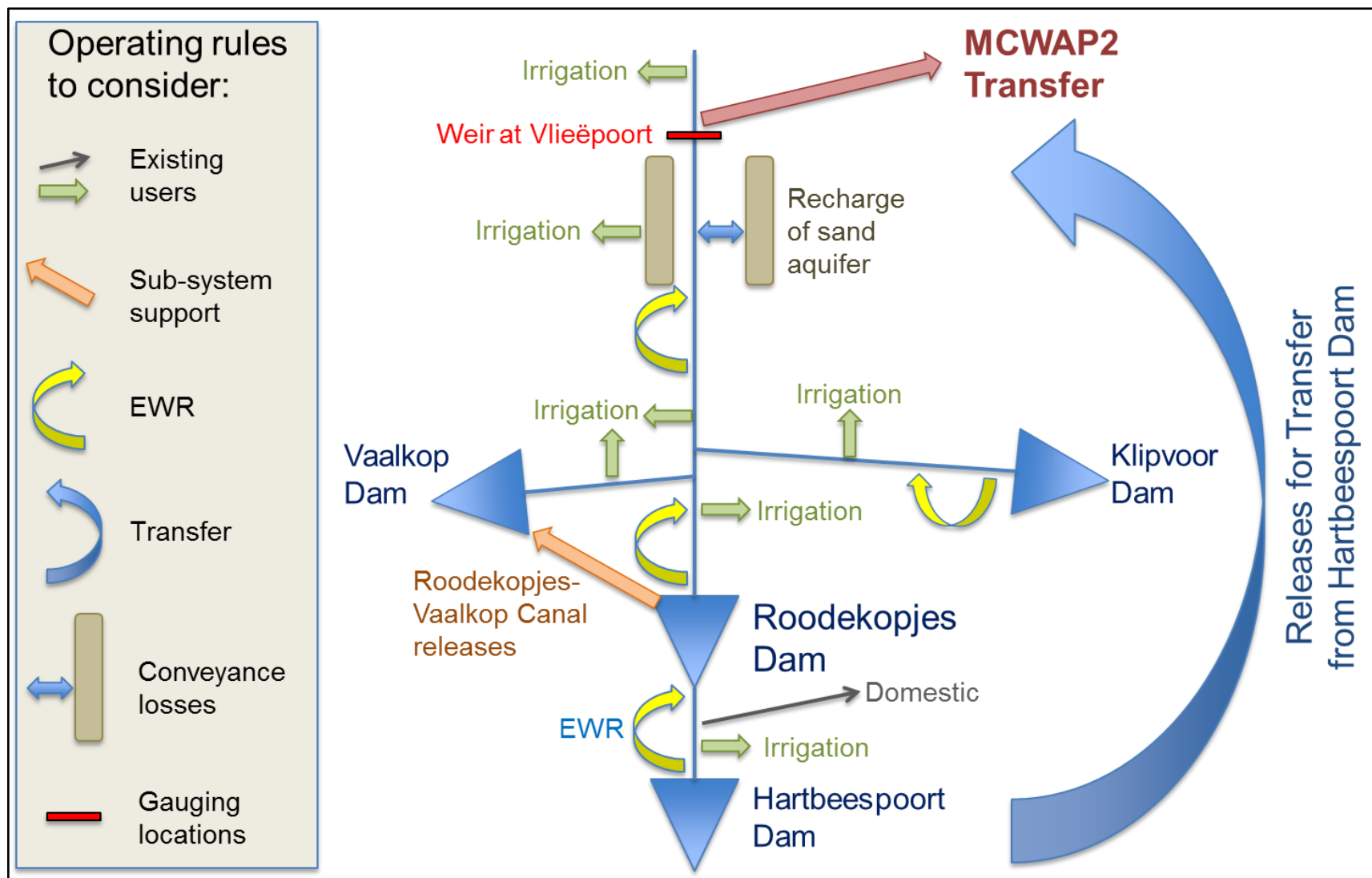


Figure 12.1 Factors be taken into consideration in the Crocodile (West) River Management Plan

12.3 SYSTEM COMPONENTS

The river management system will comprise the following components:

- Four existing dams: Hartbeespoort, Roodekopjes, Vaalkop and Klipvoor dams
- A new river outlet at Hartbeespoort Dam
- A new river outlet at Roodekopjes Dam
- The 13 existing river gauging stations – see location in **Figure 12.2**.
- Four new river gauging stations – see location in Figure 12.2.
- New weir at Vlieëpoort on the Lower Crocodile (West) River (near Thabazimbi)
- Smart metering of direct abstractions
- Smart metering of indirect abstractions (boreholes)
- Conveyance capacity in Crocodile (West)River channel
- Primary data communication network
- Secondary data communication network (GSM)
- Integrated operational centre

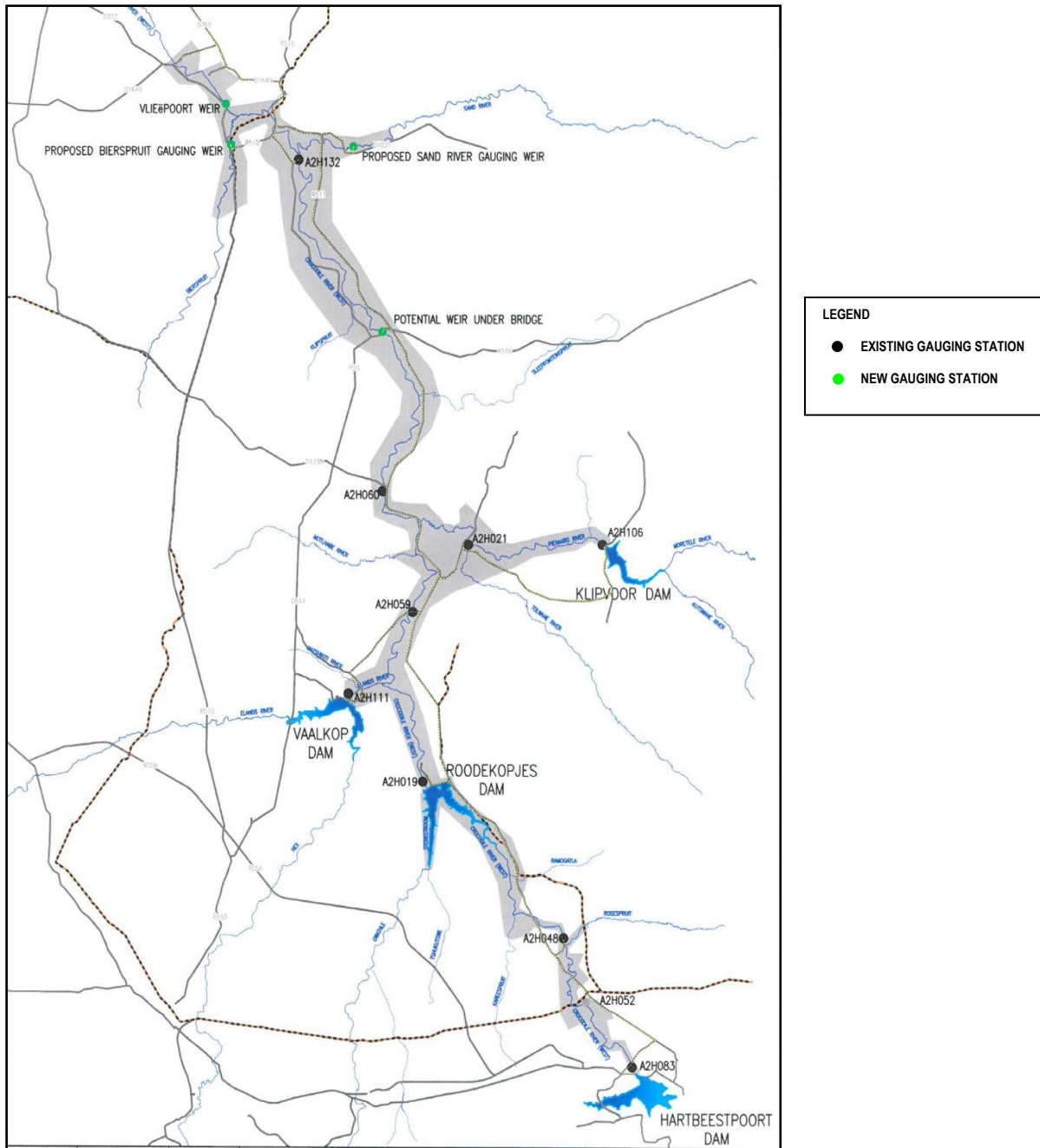


Figure 12.2 Location of 13 existing and four new river gauging stations

13. RECONCILIATION AND MANAGEMENT STRATEGY

The objective of the Water Resource Reconciliation and Management Strategy is “to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner”. The Strategy is targeted at water related issues and addresses options, interventions and actions towards achieving the above. It is cognisant of the possible future development scenarios and of the impacts and risks/uncertainties associated with the various options.

The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should be both flexible and robust under changing conditions.

The Strategy comprises:

- (1) certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy; and
- (2) specific strategies, other than the above, for addressing of other key issues.

These are covered in the sections that follow.

13.1 GENERAL ITEMS AND ONGOING ACTIVITIES

Certain elements of the Strategy are common to all scenarios and are of general application towards improved water resource management. These include:

- The validation and verification of water use licenses, and confirmation of actual abstraction and use. This has already been embarked upon in a separate study and should be completed in the near future. The impact of the outcome of the study should be assessed, taken into account and updated in the data used to determine the water balances.
- Regular review as well as constant monitoring and enforcement of water use licenses. Without proper enforcement much of the water resource management strategies will be futile. These activities appear to have been neglected in recent years.
- Setting of assurance of supply requirements for different categories of water users, reflection of such in the water use licenses, and management of the water resources accordingly to ensure that the optimal utilisation is achieved.
- The allocation and management of water resources to meet user quality objectives.
- Management of the water resources in the Crocodile (West) River catchment in order to minimise discharges of excess water into the Limpopo River as well as to minimise the overall transfers from the Vaal River system.

13.2 SPECIFIC RECONCILIATION STRATEGIES

The revised 2015 Reconciliation Strategy for the Crocodile River system entails the following:

- The Rand Water service area in the Crocodile (West) River catchment will in future continue to be supplied from the Vaal River system and additional re-use within the catchment will be considered only when surplus becomes available.
- The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the Metropolitan areas as a future source of water.
- In the Waterberg area, north of the Crocodile (West) River catchment, the future optimal utilisation of local resources will continue and surplus water in the Crocodile (West) River catchment will be transferred to the Lephalale areato augment the growing water supply to the users in the Mokolo River catchment. The current water surplus in the Crocodile River catchment, after supplying their own users as well as transferring water to Bela Bela, Modimolle and Mookgopong in future, is sufficient to supply the total projected volume of water required to supplement total water requirements of the Lephalale area.
- Interventions to supply a possible future temporary projected shortfall will be evaluated by investigating water demand management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile (West) River catchment. Some of these interventions may include:
 - Monitoring, review and enforcement of water use licenses.
 - Improved water resources management, with negotiated assurance of supply requirements.
 - Management and allocation of water resources in order to meet user quality requirements.
 - Re-allocation of irrigation water.
 - Development of groundwater (localised small potential).
 - Removal of alien vegetation; and
 - Increase transfers from the Vaal River system.
- The mining sector should provide annual updates of historic water use and future water requirement projections.
- Continuous coordination of planning between bulk water service providers.
- Annual monitoring of actual water requirements and return flows and with a coinciding review of the water balance, to consider revising possible long-term projections.
- Continue with the Crocodile (West) Annual Operating Analyses and engage water users through the System Operating Forum associated with that project.

14. RECOMMENDATIONS

The following recommendations were listed as actions for analyses and discussion at Strategy Steering Committee meetings:

- The mining sector should provide annual updates of water requirement and return flow projections.
- Continuous coordination of planning between bulk water service providers.
- Water tariffs in the Crocodile (West) River catchment are low in comparison to some other parts of the country, which is partly attributable to the high proportion of return flows that may not properly be accounted for. The tariff structure need to be investigated and consideration should be given to bringing it in line with water tariffs in the Vaal River area. This has been investigated as part of the 2015 reconciliation Strategy. It is recommended that the Water Tariff be reviewed (and updated if necessary) after approval of the latest National Raw Water Resource Pricing Strategy.
- Continued discussions must be held with the City of Tshwane to improve on projected water requirement and return flow information.
- Annual monitoring of water requirements and return flows as well as the review of the water balance – consider revising long-term projections.
- The Department should undertake a Water Quality Assessment Study guided by a proposed Steering Committee to evaluate and ensure fitness of water for use.
- Continue to undertake annual operating analyses and engage water users through the System Operating Forum.
- Complete validation and verification of existing lawful use and review the water balance after completion.
- The continuation of monitoring and reporting through Strategy Steering Committee meetings.
- All municipalities must make a concerted effort to improve their WC/WDM strategies to reach the targeted 15% saving of water. The City of Tshwane is currently the only municipality in the study area achieving this milestone. Sufficient funding to municipalities for WC/WDM remains the main obstacle in achieving the potential savings in water use.
- More information on this study can be found at the following link:
<http://www.dwa.gov.za/Projects/crocodilemaintenance/default.aspx>

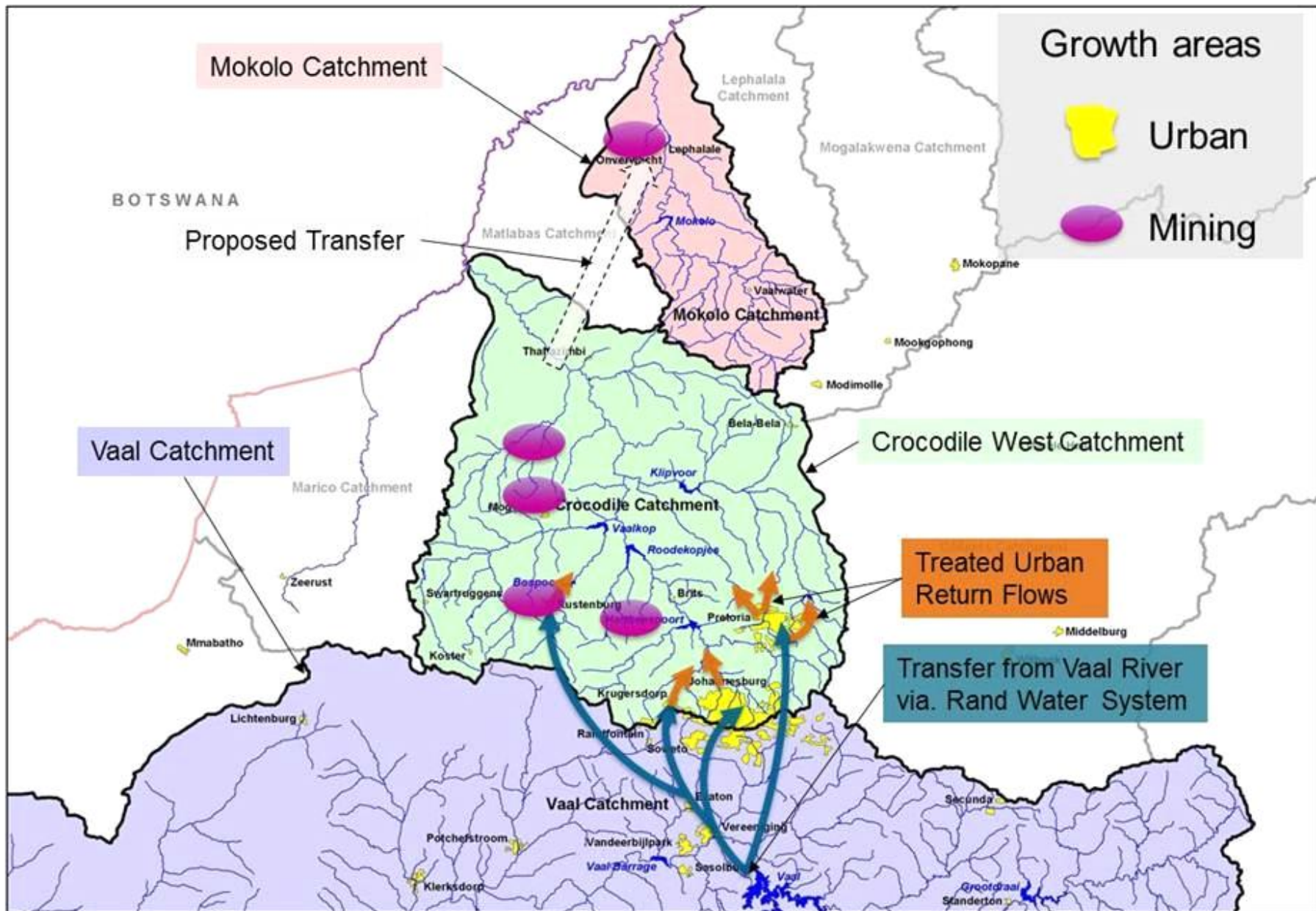
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Appendix A

*Locality Map: Crocodile (West) River
catchment and proposed transfer
to the Lephale area*



Appendix B

Executive Summary of the Reconciliation Strategy Version 1 (2008)

Reconciliation and Management Strategy

Potential options to reconcile the requirements for water with the availability thereof are covered in Chapter 9 of the report. Water quantity as well as water quality are taken into account, with due cognisance also to geographic location. These options form the core elements from which Version 1 of the Strategy was distilled.

The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should cater for a spectrum of plausible future scenarios, and also be both flexible and robust under changing conditions.

The Strategy as formulated comprises:

- (1) certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy;
- (2) strategies of general nature, directed at key issues or components, and
- (3) specific strategies, other than the above, for addressing of other key issues.

The general items and ongoing activities include:

- The validation and verification of water use licenses.
- Regular review as well as constant monitoring and enforcement of water use licenses.
- Setting of assurance of supply requirements for different categories of water users.
- The allocation and management of water resources to meet user quality objectives.
- Management of the water resources in the Crocodile (West) River catchment in order to minimise excess discharges to the Limpopo River as well as to minimise the overall transfers from the Vaal River system.

The general strategies provide broad directives for dealing with the following items or issues:

- Increased water requirements
- Water conservation and demand management
- Direct recycling of effluent
- Indirect re-use of effluent
- Groundwater
- Water quality
- Implementation of the Reserve
- Alien vegetation

Specific strategies are proposed with respect to the following:

- **Regulation of return flows:** *The efficient control and re-use of return flows is of primary importance with respect to the proper management of water resources in the Crocodile River catchment. To facilitate this, it is proposed that a new regulation dam be investigated on the main stem of the Crocodile (West) River at a location downstream of the confluence of the Moretele River, which is the last main tributary that contributes return flows.*
- **Re-use of effluent below Hartbeespoort Dam:** *Most of the effluent return flows in the Crocodile catchment are discharged to the river system upstream of Hartbeespoort Dam, with the resultant surplus availability of water at that point. Most of the mining developments north of the Magaliesberg can best be supplied with water from the Hartbeespoort Dam. This will lessen the need for use of higher quality potable water from Rand Water, which could better be allocated to urban use.*
- **Water supply to Madibeng and Rustenburg municipalities:** *Potable water supply to these areas should best be from Rand Water and Magalies Water. The number of small wastewater treatment plants should be rationalised, and the option be investigated of routing effluent to downstream of Hartbeespoort Dam.*
- **Water for transfer to the Lephalale area:** *The abstraction of water from the Crocodile (West) River for the augmentation of resources in the Lephalale area could (probably best) be made at or downstream of the proposed new balancing dam. However, sufficient water (from return flows) will not be available in the Crocodile (West) River to meet all the needs with respect to the water requirement scenarios for the Lephalale area.*

For the higher water use scenarios in the Lephalale area, additional water will have to be transferred from the Vaal River system. Several options need to be investigated in this respect.

Other smaller scale as well as interim options to augment the resources include:

- *The raising of the Mokolo Dam;*
- *Freeing up of water through improvements to irrigation distribution systems in the Crocodile (West) River catchment;*
- *Re-allocation (purchase) of water from irrigation in the Crocodile and/or Mokolo River catchments; and*
- *Interim use (purchase) of irrigation water in the Crocodile (West) and/or Mokolo River catchments.*

Appendix C

Executive Summary of the Crocodile (West) River Reconciliation Strategy 2012

Background

The catchment area of the Crocodile West River is one of the most developed in the country. It is characterized by the sprawling urban and industrial areas of northern Johannesburg and Pretoria, extensive irrigation downstream of Hartbeespoort Dam and large mining developments north of the Magaliesberg. As a result, the Crocodile (West) River is one of the rivers in the country that has been most influenced by human activities, and where more specific management strategies are of paramount importance.

The water resources that naturally occur in the catchment have already been fully developed and most of the tributaries as well as the main stem of the Crocodile (West) River are highly regulated. Much of the water supplied to the metropolitan areas and some mining developments is transferred from the Vaal River system via Rand Water. This in turn results in large quantities of effluent from the urban and industrial users, most of which is discharged to the river system after treatment, for re-use downstream. In many of the streams and impoundments, water quality is severely compromised by the proportionate large return flows. The effluent return flows constitute a large portion of the water availability in the catchment and are an important resource.

Water balance

The water balance in the Crocodile (West) River system was assessed by undertaking sophisticated risk analyses, including salinity modelling. Projected water balances were compiled for the planning period until the year 2040. It was found that the system has surplus water originating from growing treated wastewater generated in the urban areas of Northern Gauteng.

This water balance makes provision for the growing water needs of the mining sector (mainly around Rustenburg and north of the Magaliesberg and the Pilanesberg), the sprawling urban developments of Tshwane's northern areas, Madibeng as well as the areas served by the expansion plans of Magalies Water, primarily outside of the Rand Water supply area. The water requirements of the agricultural sector were also taken into consideration. Special attention was given to ensure that the assurance of water supply to irrigators, such as the Crocodile (West) Irrigation Board and the Makoppa area, was maintained.

The water balance scenarios made provision that the source of water for the Rand Water supply area remains to be the Vaal River system, effectively representing an increasing inter-basin transfer taking place through the bulk supply pipelines of Rand Water.

The possible utilisation of the projected surplus water in the Crocodile (West) River system could be for transfer to the Lephalale area or for reuse schemes within the catchment that will reduce the transfer from the Vaal River system, such as the proposed Tshwane Potable Water Augmentation Program. Due to the priority placed by Government on the Strategically Important Projects (SIPs) which includes the

Lephalale mineral belt, it was prudent to formulate the Strategy so that priority can be given to the future water needs of the Lephalale area in support of the national development imperatives.

The resulting water balance for the Crocodile (West) River system, including the transfers to the Lephalale area, indicated that shortages could occur over the medium-term planning period. These shortages, however, are relatively small in volume and only temporary as the return flows in the Crocodile (West) River continue to grow. These shortfalls will require further interventions that could be in the form of infrastructure developments (further transfers from the Vaal River system) or water demand management measures.

Reconciliation Strategy

The objective of the Water Resource Reconciliation and Management Strategy is “to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner”. The Strategy is targeted at water related issues and addresses options, interventions and actions towards achieving the above. It is cognisant of the possible development scenarios and of the impacts and risks/uncertainties associated with the various options.

The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should be both flexible and robust under changing conditions.

The Strategy comprises:

- (1) Certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy; and*
- (2) Specific strategies, other than the above, for addressing of other key issues.*

General items and ongoing activities

Certain elements of the Strategy are common to all scenarios and are of general application towards improved water resource management. These include:

- The validation and verification of water use licenses, and confirmation of actual abstraction and use. This has already been embarked upon and should receive high priority, with particular focus on irrigation water.*
- Regular review as well as constant monitoring and enforcement of water use licenses. Without proper enforcement much of the water resource management strategies will be futile. These activities appear to have been neglected in recent years.*
- The allocation and management of water resources to meet user water quality objectives.*

- *Management of the water resources in the Crocodile (West) River catchment in order to minimise both the discharges of excess water into the Limpopo River as well as the overall transfers from the Vaal River system.*

Specific reconciliation strategies

The revised 2012 Reconciliation Strategy for the Crocodile (West) River system entails the following:

- *The Rand Water service area in the Crocodile (West) River catchment will in future continue to be supplied from the Vaal River system and additional re-use within the catchment will be considered only when surplus becomes available.*
- *The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the metropolitan areas as a future source of water.*
- *In the Waterberg area, north of the Crocodile (West) River catchment, the optimal utilisation of local resources will continue and surplus water in the Crocodile (West) River system will be transferred to the Lephalale area.*
- *Interventions to supply the projected future temporary shortfall will be evaluated by investigating demand side management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile (West) River system. Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface / groundwater utilisation should be explored.*
- *Mining sector should provide annual updates of historic water use and future water requirement projections.*
- *Continuous coordination of planning between bulk water service providers.*
- *Annual monitoring of actual water requirements and return flows and review of the water balance – consider revising long-term projections.*
- *Undertake Annual Operating Analyses and engage water users through the Crocodile (West) River System Operating Forum.*
- *Complete validation and verification of existing lawful use and review the water balance.*