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LITERATURE REVIEW

FINAL

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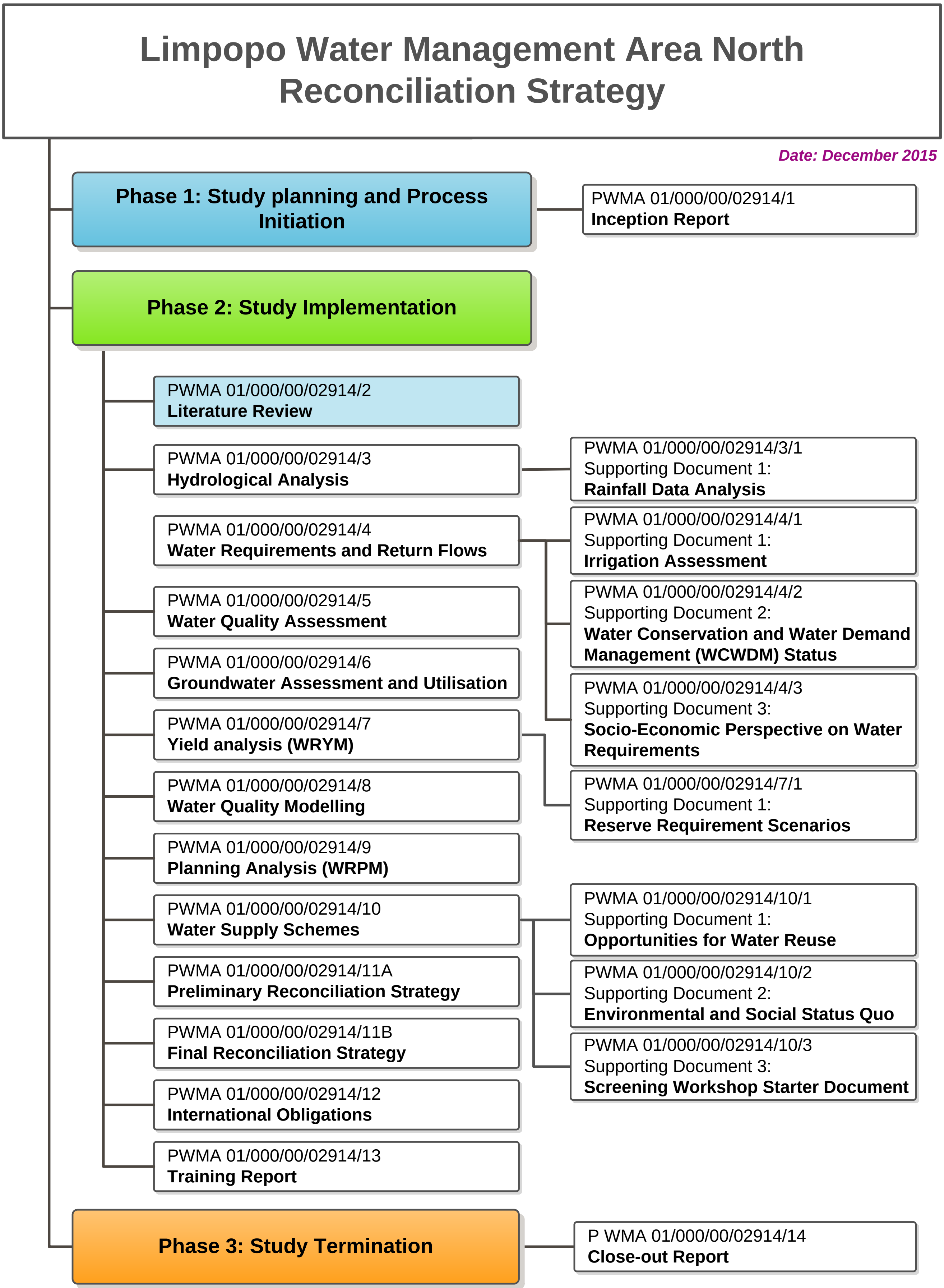
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LIST OF ABBREVIATIONS AND ACRONYMS

AECOM	AECOM SA (Pty) Ltd
AMD	Acid Mine Drainage
CMA	Catchment Management Agency
CoAL	Coal of Africa Limited
COGHSTA	Department of Cooperative Governance Human Settlement and Traditional Affairs
CRW	Crocodile River (West)
CTL	Coal-to-Liquid
CWRS	Crocodile (West) Reconciliation Strategy
D:NWRP	Directorate: National Water Resources Planning
DM	District Municipality
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
EFR	Environmental Flow Requirements
EGSAs	Ecosystem Goods, Services and Attributes
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
ES	Ecological Sensitivity
ESBC	Ecologically Sustainable Base Configuration
EWR	Ecological Water Requirements
FBC	Fluidised Bed Combustion
FEPAs	Freshwater Ecosystem Priority Areas
FFHA	Fish Frequency Habitat Assessment
FGD	Flue Gas Desulphurisation
FSL	Full Supply Level
GIS	Geographic Information System
GRAII	Groundwater Resource Assessment II
GRDM	Groundwater Resources Directed Measures
GRIP	Groundwater Resource Information Project
GWSWIM	Groundwater-Surface Water Interaction Model

HFY	Historic Firm Yield
IDP	Integrated Development Plan
IFHA	Invertebrate Frequency Habitat Assessment
IPP	Independent Power Producers
ISP	Internal Strategic Perspective
ISPD	Internal Strategic Prospect Document
IUA	Integrated Units of Analysis
IWRM	Integrated Water Resources Management
LBPTC	Limpopo Basin Permanent Technical Committee
LEGDP	Limpopo Economic Growth and Development Plan
LM	Local Municipality
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MC	Management Class
MCWAP	Mokolo and Crocodile River (West) Water Augmentation Project
MIG	Municipal Infrastructure Grant
Mutasshi	Musina to Africa Strategic Supply Hub Initiative
NFEPAs	National Freshwater Ecosystem Priority Areas
NGDB	National Ground Water Database
NWA	National Water Act
NWRS-1	National Water Resource Strategy - First edition
NWRS-2	National Water Resource Strategy - Second edition
PES	Present Ecological State
LPGDS	Limpopo Provincial Growth and Development Strategy
RainIMS	Rainfall Information Management System
RDM	Resource Directed Measures
REC	Recommended Ecologic Category
RDP	Reconstruction and Development Programme
RQOs	Resource Quality Objectives
RSA	Republic of South Africa
RWS	Regional Water Scheme
RWSS	Regional Water Supply Scheme
SADC	Southern African Development Community
SAR	Sodium Adsorption Ratio
SIP	Strategic Infrastructure Project

SOF	Stakeholders Operating Forum
TDS	Total Dissolved Solids
TWQR	Target Water Quality Range
WAA	Water Availability Assessment
WARMS	Water Authorisation Management System
WCWDM	Water Conservation and Water Demand Management
WMA	Water Management Area
WMS	Water Management System
WR2005	Water Resources of South Africa - 2005
WR90	Water Resources of South Africa - 1990
WRC	Water Research Commission
WRCS	Water Resource Classification System
WRIMS	Water Resource Information Management System
WRPM	Water Resources Planning Model
WRSM2000	Water Resources Simulation Model 2000
WRTC	Water Resources Technical Committee
WRYM	Water Resources Yield Model
WSA	Water Services Authority
WSAM	Water Situation Assessment Model
WSDP	Water Services Development Plan
WSP	Water Services Provider
WSS	Water Supply Schemes
WTW	Water treatment works
WwTW	Waste Water treatment works
ZINWA	Zimbabwe National Water Authority

LIST OF UNITS

a	annum
ha	hectare
kℓ	kilolitre
km	kilometer
km^2	square kilometre
ℓ/c/d	liter per capita per day
ℓ/s	litre per second
m	metre
m^3	cubic meter
m^3/a	cubic meter per annum
Mℓ/d	megalitre per day
mm	millimetre
$m^3/ha/a$	cubic meter per hectare per annum

1 INTRODUCTION

1.1 APPOINTMENT OF PSP

The Department of Water and Sanitation (DWS), then Department of Water Affairs (DWA) appointed **AECOM SA (Pty) Ltd** in association with three sub-consultants **Hydrosol**, **Jones and Wagener** and **VSA Rebotile Metsi Consulting** with effect from 1 March 2014 to undertake the **Limpopo Water Management Area North Reconciliation Strategy**.

1.2 BACKGROUND TO THE PROJECT

The DWS (then DWA) identified a need for the development of the *Limpopo Water Management Area (WMA) North Reconciliation Strategy*. The Limpopo WMA North refers to the Limpopo WMA described in the first edition of the *National Water Resource Strategy* (NWRS-1) published in 2004. The 19 initial WMAs were consolidated into 9 WMAs during 2012 and accepted in the second edition of the *National Water Resource Strategy* (NWRS-2) of 2013. The newly defined Limpopo WMA includes the original Crocodile (West) and Marico WMA as well as the Luvuvhu River catchment, previously part of the Luvuvhu and Letaba WMA. However, these additional areas will not be part of this Reconciliation Strategy.

The Limpopo WMA North comprises of six main river catchments; Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele and are shown in **Figure 1.1**. The very small Nwanedi River catchment forms part of the Nzhelele River catchment. Most of these river catchments rely on their own water resources and are managed independently from neighbouring catchments. This implies that some river catchments require separate and independent reconciliation strategies whilst others need integrated water management reconciliation strategies.

The main urban areas within the WMA include Mokopane, Polokwane, Mookgophong, Modimolle, Lephalale, Musina and Louis Trichardt. Approximately 760 rural communities are scattered throughout the WMA, mostly concentrated in the central region. The main economic activities are irrigation and livestock farming as well as expanding mining operations due to the vast untapped mineral resources in the area. The water resources, especially surface water resources, are heavily stressed due to the present levels of development. It is crucial that water supply is secured and well managed.

The most western area of the Limpopo WMA North, the Matlabas River catchment, is a dry catchment with no significant dams and with a low growth potential for land-use development.

The large Mokolo Dam, in the Mokolo River catchment, supplies water to the Matimba Power Station, Medupi Power Station, Grootegeluk Coal Mine, the Lephalale Local Municipality (LM) as well as a number of downstream irrigators. The dam is able to meet the bulk of the current requirements but will in future rely on transfers from other WMAs to meet the water requirements at a sufficiently high assurance of supply.

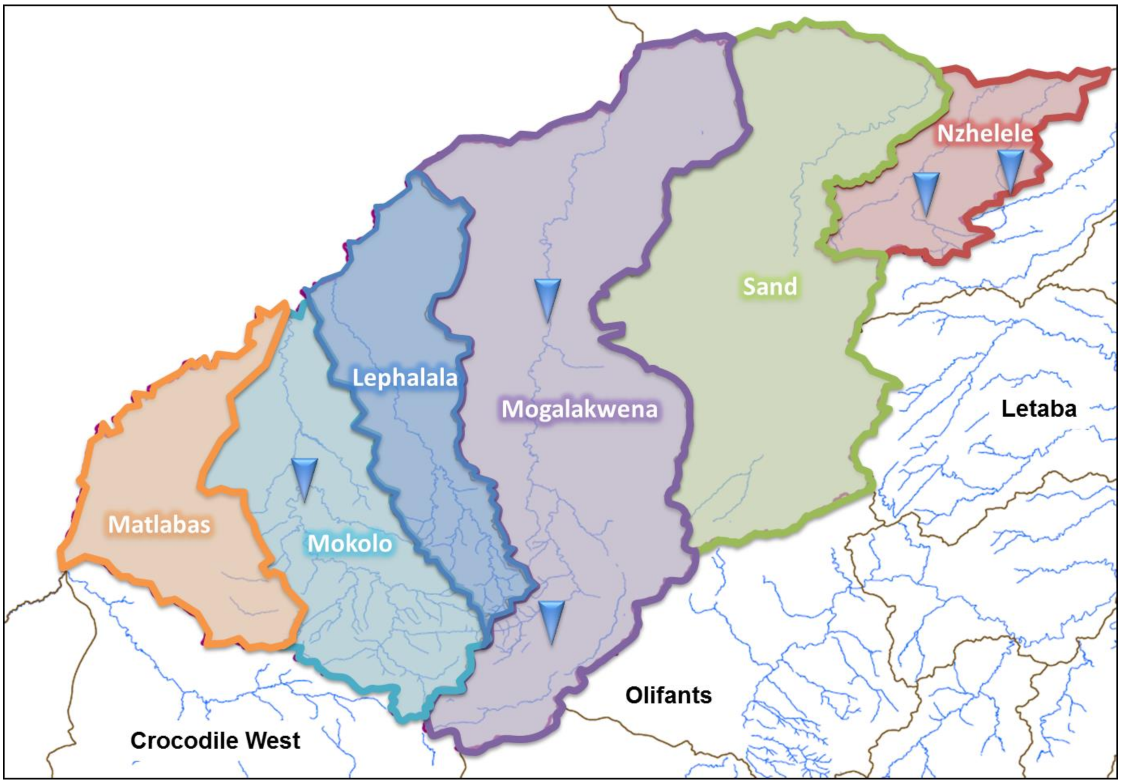


Figure 1.1: Overview of the catchments of the Limpopo WMA North

The middle reaches of the Lephalala River catchment have a high conservation value with irrigation activities dominant in the remainder of the catchment. Irrigation in this area is supplied by surface water and alluvial aquifer abstraction.

All the water resources in the Mogalakwena River Catchment have been fully developed. The Doorndraai Dam is over-allocated. Additional water to support the rapid expanding mining activities in the vicinity of Mokopane needs to be augmented by transfers from the Flag Boshielo Dam in the adjacent Olifants River Catchment. Glen Alphine Dam presently supplies water to emerging farmers, who has not yet taken up their full allocated quota, and is anticipated to supply the growing domestic requirements.

Groundwater resources in the Mogalakwena and the Sand river catchments have been extensively utilised, and possibly over-exploited by the dominating irrigation sector. The expanding urban and industrial requirements of Polokwane and Makhado LMs rely heavily on water transfers from adjacent WMAs. This includes transfers from the Ebenezer Dam, Dap Naude Dam, Flag Boshielo Dam and Nandoni Dam (which replaced the transfer from Albasini Dam) in the Olifants WMA.

Domestic and irrigation water in the small but highly developed Nzhelele River catchment is supplied through the Mutshedzi Dam Regional Water Supply Scheme (RWSS) and the Nzhelele Dam RWSS as well as extensively from groundwater resources. The inflows to the Mutshedzi and Nzhelele dams have been reduced as a result of afforestation upstream of these dams. The area is in deficit due to the over-allocation and over development of irrigation.

The Sand and Nzhelele river catchments have high coal mining potential in the Louis Trichardt area but the availability of local water resources is a limiting factor for possible future mining development.

1.3 STUDY AREA

The Limpopo WMA North is the most northern WMA in South Africa and refers to the area described as the Limpopo WMA in NWRS-1. Refer to **Figure 1.2** for the location and general layout of the study area. The areas indicated in grey show the additional catchment and WMA areas included in the Limpopo WMA as per NWRS-2 and which do not form part of the study area for this reconciliation strategy.

The Limpopo WMA North forms part of the internationally shared Limpopo River Basin which also includes sections of Botswana, Zimbabwe and Mozambique. The Limpopo River forms the entire length of the northern international border between South Africa and Botswana and Zimbabwe before flowing into Mozambique and ultimately draining into the Indian Ocean. The dry Limpopo WMA North is augmented with transfers from the adjacent Letaba, Olifants and Crocodile West river catchments. No transfers are currently made from the Limpopo WMA North to other WMAs.

The main rivers in the study area, which form the six major catchment areas, are the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele rivers. These rivers, together with other smaller tributaries, flow northwards and discharge into the Limpopo River.

The climate over the study area is temperate and semi-arid in the south to extremely arid in the north. Mean annual rainfall ranges from 300 mm to 700 mm with the potential evaporation well in excess of the rainfall. Rainfall is seasonal with most rainfall occurring in the summer with thunderstorms. Runoff is low due to the prevalence of sandy soils in the most of the study area, however, loam and clay soils are also found.

The topography is generally flat to rolling, with the Waterberg on the south and the Soutpansberg in the north-east as the main topographic features. Grassland and sparse bushveld shrubbery and trees cover most of the terrain.

The southern and western parts of the WMA are mainly underlain by sedimentary rocks, whilst metamorphic and igneous rocks are found in the northern and eastern parts. With the exception of some alluvium deposits and dolomites near Mokopane and Thabazimbi, these formations are mostly not of high water bearing capacity. The mineral rich Bushveld Igneous Complex extends across the south-eastern part of the WMA, and precious metals are mined at various localities throughout the area. Large coal deposits are found in the north-west.

Several wildlife and nature conservation areas have been proclaimed in the WMA, of which the Nylsvley Nature Reserve, Mapungubwe National Park and the Marekele National Park are probably the best known.

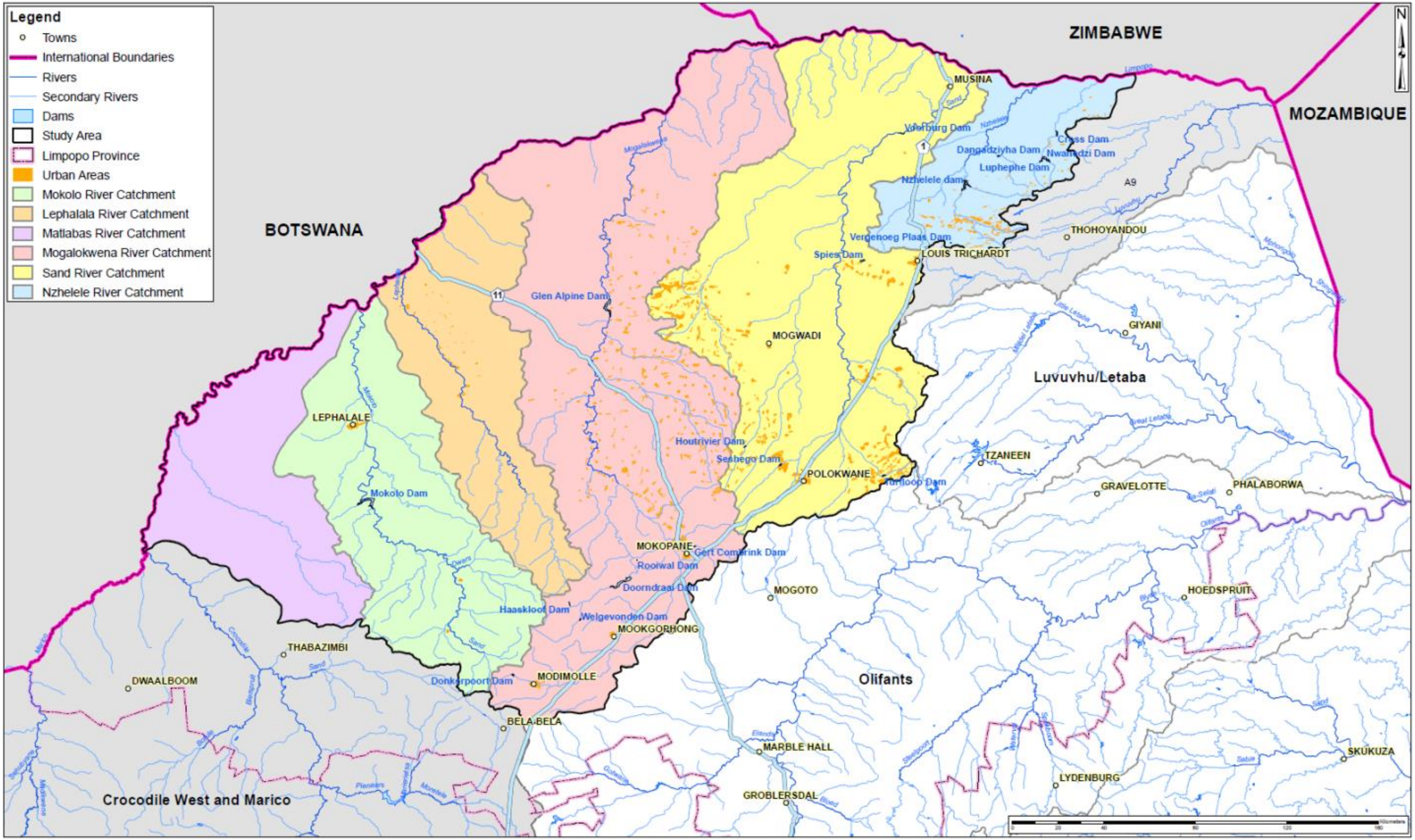


Figure 1.2: General layout of the study area

1.4 MAIN OBJECTIVES OF THE STUDY

The main objective of the study is to formulate a water resource reconciliation strategy for the entire Limpopo WMA North up to 2040. The reconciliation strategy must a) address growing water demands as well as water quality problems experienced in the catchment, b) identify resource development options and c) provide reconciliation interventions, structural and administrative/ regulatory. To achieve these objectives, the following aspects are included in the study:

- Review of all available information regarding current and future water requirements projections as well as options for reconciliation;
- Determine current and future water requirements and return flows and compile projection scenarios;
- Configure the system models (WRSM2000 rainfall-runoff catchment model, also known as the Pitman Model, the Water Resources Yield Model (WRYM) and the Water Resources Planning Model (WRPM)) in the study area at a quaternary catchment scale, or smaller, where required, in a manner that is suitable for allocable water quantification. This includes updating the hydrological data and accounting for groundwater-surface water interaction;
- Assess the water resources and existing infrastructure and incorporate the potential for water conservation and water demand management (WCWDM) and water reuse as reconciliation options; and
- Develop a preliminary short-term reconciliation strategy followed by a final long-term reconciliation strategy.

1.5 SCOPE OF THIS REPORT

The purpose of this report is to summarise the past and current studies that were reviewed to capture the most recent information on existing and potential schemes. The objective is to summarise demand projections of the various studies and reports reviewed, establish current demands and seasonal variations and ultimately to develop demand projection scenarios.

The review of studies focused on the following aspects:

- Historical and projected water use (for all water use groups) its geographical distribution in the WMA and in affected areas of the WMA.
- Existing water supply infrastructure.
- Hydrological information and concerns.
- Geohydrological information about the various aquifers.
- Water quality information and concerns.
- The Reserve requirements.
- System modelling and operational management.
- Water conservation and demand management (urban and irrigation).
- Current and potential for water reuse.
- Water use and impacts of invasive alien plant eradication.
- Trading of existing allocation (especially unutilized allocations).
- Potential surface water schemes, both local and transfer.
- Potential groundwater schemes, both local and transfer (including utilizing of treated mine water by local municipalities and Eskom).
- Potential desalination schemes.

- Other potential importation schemes and options.
- Existing institutional responsibilities and cooperative governance (including operating rules, infrastructure planning and development, tariff structure and monitoring); and
- Existing public participation in the water sector.

1.6 LAYOUT OF THE REPORT

Chapter 2 of this report provides concise descriptions of pertinent information contained in reports of past studies. Each reviewed study or stand-alone report is summarised as a sub-section providing and overview of the study/report and the main findings, with focus only on the conclusions and recommendations where possible. Studies relating to the entire Limpopo WMA North are discussed first in chronological order followed by area specific studies, municipality *integrated development plans* (IDP) and reconciliation strategies of adjacent WMAs.

Chapter 3 of this report is a synthesis of the relevant information contained in the reviewed studies and reports, addressing the aspects as listed in **Section 2**. Due to the mostly independent nature of the river catchments of the Limpopo WMA North, each river catchment is described separately as a sub-section.

2 SUMMARY OF PERTINENT INFORMATION FROM REVIEWED STUDIES AND REPORTS

2.1 DEVELOPMENT OF A RECONCILIATION STRATEGY – FOR ALL TOWNS IN THE NORTHERN REGION

Study Information: Development of a Reconciliation Strategy – for All Towns in the Northern Region. Department of Water Affairs. DWA contract number: WP 9711. Prepared by SRK Consulting. 2010 to 2011.

2.1.1 Overview

The DWA (now DWS) initiated a study for the development of first order reconciliation strategies for all towns in South Africa to ensure effective and efficient current and future management of water resources. SRK Consulting was appointed by DWS to undertake the *Development of a Reconciliation Strategy – for All Towns in the Northern Region* Study, further referred to a the *All Towns Studies* for the purpose of this report. The study area comprised of the WMAs of Limpopo, Luvuvhu and Letaba, Crocodile (West) and Marico as well as Olifants. Studies were conducted and summarised according to the relevant water supply schemes or supply areas.

For the purpose of this *Literature Review Report* as part of the Limpopo WMA North Reconciliation Strategy, focus was on the reports or water supply areas located in or relevant to the Limpopo WMA North. In total 87 All Towns Studies reports were reviewed as listed in **Table 2.1**. The reports in the table are firstly categorised per *District Municipality* (DM) and thereafter per Local Municipality (LM).

The content of each study preliminary focussed on the following components, were applicable:

- Population and demographics;
- Current water requirements and projections until 2030;
- Water resources;
- Water balances without reconciliation options;
- Water supply infrastructure;
- Sanitation;
- Reconciliation options; and
- Water balances with reconciliation options.

Due to the significant amount of information contained in the reports listed in **Table 2.1**, relevant information will not be discussed in this Literature Review Report, but will be included and summarised in the *Water Requirements and Return Flows Report (P WMA 01/000/00/02914/4)*.

Table 2.1: List of All Towns Studies

1. CAPRICORN DISTRICT MUNICIPALITY			
1.1	**Aganang Local Municipality**		
No.	**Report name**	**Contact person**	**Date**
1	First order reconciliation strategy for the Aganang East Ground Water Scheme	cterrell@srk.co.za	May-11
2	First Order Reconciliation Strategy for the Aganang North Ground Water Scheme	cterrell@srk.co.za	May-11
3	First Order Reconciliation Strategy for the Bakone Ground Water Scheme	cterrell@srk.co.za	May-11
4	First Order Reconciliation Strategy for the Bakone Ground Water Scheme	cterrell@srk.co.za	May-11
5	First Order Reconciliation Strategy for the Ga-Mokobodi Ground Water Supply Area	cterrell@srk.co.za	May-11
6	First Order Reconciliation Strategy for the Hout River Regional Water Scheme	cterrell@srk.co.za	May-11
7	First Order Reconciliation Strategy for the Moletje South Ground Water Scheme	cterrell@srk.co.za	May-11
1.2	**Blouberg Local Municipality**		
	Report name	**Contact person**	**Date**
8	First Order Reconciliation Strategy for the Alldays Ground Water Scheme	cterrell@srk.co.za	Jan-11
9	First Order Reconciliation Strategy for the Archibald Ground Water Scheme	cterrell@srk.co.za	Jan-11
10	First Order Reconciliation Strategy for the Ga-Hlako Rural Water Scheme	cterrell@srk.co.za	Apr-11
11	First Order Reconciliation Strategy for the Ga-Rawesi Ground Water Scheme	cterrell@srk.co.za	Apr-11
12	First Order Reconciliation Strategy for the Taaiboschgroet Ground Water Scheme	cterrell@srk.co.za	Apr-11
13	First Order Reconciliation Strategy for the Thalanhane Ground Water Scheme	cterrell@srk.co.za	Apr-11
14	First Order Reconciliation Strategy for the Avon Ground Water Scheme	cterrell@srk.co.za	May-11
15	First Order Reconciliation Strategy for the Blouberg Regional Water Scheme	cterrell@srk.co.za	May-11
16	First Order Reconciliation Strategy for the Gorkum Ground Water Scheme	cterrell@srk.co.za	May-11
17	First Order Reconciliation Strategy for the Senwabarwana Ground Water Scheme	cterrell@srk.co.za	May-11
18	First Order Reconciliation Strategy for the Silvermyn-Kirstenspruit Ground Water Scheme	cterrell@srk.co.za	May-11
1.3	**Lepele-Nkumpi Local Municipality**		
	Report Name	**Contact person**	**Date**
19	First Order Reconciliation Strategy for Groothoek RWS Cluster, Specon RWS Cluster and Mphahlele RWS Cluster	tlydon@srk.co.za	Nov-10
20	First Order Reconciliation Strategy for Flag Boshielo RWS/West Lepele-Nkumpi Local Municipality Cluster	tlydon@srk.co.za	Dec-10
21	First Order Reconciliation Strategy for Mafefe Individual GWS Cluster	tlydon@srk.co.za	May-11
22	First Order Reconciliation Strategy for Mathabatha Individual GWS Cluster	tlydon@srk.co.za	May-11
1.4	**Molemole Local Municipality**		

	Report name	Contact person	Date
23	First Order Reconciliation Strategy for Matoks Supply Area Cluster	cterrell@srk.co.za	May-11
24	First Order Reconciliation Strategy for Molemole Supply Area Cluster	cterrell@srk.co.za	May-11
1.5	**Polokwane Local Municipality**		
	Report name	**Contact person**	**Date**
25	First Order Reconciliation Strategy Moletje East Regional Ground Water Supply Scheme	jbuthelezi@srk.co.za	Apr-10
26	First Order Reconciliation Strategy Moletje North Individual Ground Water Supply Scheme	jbuthelezi@srk.co.za	Apr-10
27	First Order Reconciliation Strategy Moletje South Individual Ground Water Supply Scheme	jbuthelezi@srk.co.za	Dec-10
28	First Order Reconciliation Strategy Segwasi Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-10
29	First Order Reconciliation Strategy Olifants-Sand Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-10
30	First Order Reconciliation Strategy Laaste Hoop Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
31	First Order Reconciliation Strategy Mankweng Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
32	First Order Reconciliation Strategy Molepo Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
33	First Order Reconciliation Strategy Badimong Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
34	First Order Reconciliation Strategy Boyne Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
35	First Order Reconciliation Strategy Chuene Maja Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
36	First Order Reconciliation Strategy Hout River Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
37	First Order Reconciliation Strategy Mothapo Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
38	First Order Reconciliation Strategy Sebayeng-Dikgale Regional Water Supply Scheme	jbuthelezi@srk.co.za	May-11
2	**VHEMBE DISTRICT MUNICIPALITY**		
2.1	**Makhado Local Municipality**		
	Report Name	**Contact person**	**Date**
39	First Order Reconciliation Strategy for Mapuve/System N Regional Water Supply Scheme	slaj@srk.co.za	Oct-10
40	First Order Reconciliation Strategy for Buysdorp Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
41	First Order Reconciliation Strategy Sinthumule/Kutama Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
42	First Order Reconciliation Strategy Makhado Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
43	First Order Reconciliation Strategy Matshavhawe/Kunda Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
44	First Order Reconciliation Strategy Tshakuma Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
45	First Order Reconciliation Strategy Tshitale Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
46	First Order Reconciliation Strategy Valdezia Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
47	First Order Reconciliation Strategy Vhembe Individual Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11

48	First Order Reconciliation Strategy Vondo South Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-11
49	First Order Reconciliation Strategy for Nzhelele Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
50	First Order Reconciliation Strategy Tshifiri Murunwa Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
2.2	**Musina Local Municipality**		
	Report name	**Contact person**	**Date**
51	Reconciliation Strategy for Musina Town Area consisting of Musina (Messina), Harper and Nancefield in the Musina Local Municipality in the Limpopo WMA	slaj@srk.co.za cterrell@srk.co.za	Sep-11
52	First Order Reconciliation Strategy for Luphephe/Nwanedi North Regional Water Supply Scheme	slaj@srk.co.za cterrell@srk.co.za	Nov-11
2.3	**Mutale Local Municipality**		
	Report name	**Contact person**	**Date**
53	First Order Reconciliation Strategy for Luphephe Nwanedzi Main Regional Water Scheme	slaj@srk.co.za cterrell@srk.co.za	Dec-11
54	First Order Reconciliation Strategy For Luphephe/Nwanedi North Regional Water Supply Scheme	slaj@srk.co.za cterrell@srk.co.za	Dec-11
55	First Order Reconciliation Strategy for Mukuya Regional Water Supply Scheme	slaj@srk.co.za cterrell@srk.co.za	Dec-11
56	First Order Reconciliation Strategy for Masisi Regional Water Supply Scheme	slaj@srk.co.za cterrell@srk.co.za	Dec-11
57	First Order Reconciliation Strategy for Mutale Main Regional Water Scheme	slaj@srk.co.za cterrell@srk.co.za	Dec-11
2.4	**Thulamela Local Municipality**		
	Report name	**Contact person**	**Date**
58	First Order Reconciliation Strategy for Damani Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
59	First Order Reconciliation Strategy for Lambani Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
60	First Order Reconciliation Strategy for Malamulele West Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
61	First Order Reconciliation Strategy for North Malamulele East Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
62	First Order Reconciliation Strategy for Nzhelele Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
63	First Order Reconciliation Strategy for South Malamulele East Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
64	First Order Reconciliation Strategy for Tshifudi Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
65	First Order Reconciliation Strategy Vondo Regional Water Supply Scheme	jbuthelezi@srk.co.za	Dec-11
66	First Order Reconciliation Strategy for Mutale Makuya Regional Water Supply Scheme	jbuthelezi@srk.co.za	Jan-12
3	**WATERBERG DISTRICT MUNICIPALITY**		
3.1	**Bela-Bela Local Municipality**		
	Report name	**Contact person**	**Date**
67	First Order Reconciliation Strategy for The Bela-Bela Urban Supply Cluster	cterrell@srk.co.za	Aug-10
68	First Order Reconciliation Strategy for The Piennaarsrivier Supply Area	cterrell@srk.co.za	Aug-10

69	First Order Reconciliation Strategy for The Rapotkwane Supply Area	cterrell@srk.co.za	Dec-10
3.2	**Lephalale Local Municipality**		
	Report name	**Contact person**	**Date**
70	First Order Reconciliation Strategy for Lephalale Urban RWS	mhinsch@srk.co.za	May-10
71	First Order Reconciliation Strategy for Ga-Seleka RWS	mhinsch@srk.co.za	Jun-10
72	First Order Reconciliation Strategy for Mokuranyane RWS	mhinsch@srk.co.za	Sep-10
73	First Order Reconciliation Strategy for Shongwane RWS	cadd@srk.co.za	Oct-10
74	First Order Reconciliation Strategy for Witpoort RWS	mhinsch@srk.co.za	Oct-10
3.3	**Modimolle Local Municipality**		
	Report name	**Contact person**	**Date**
75	First Order Reconciliation Strategy for Mabaleng Town Cluster	cterrell@srk.co.za	Dec-09
76	First Order Reconciliation Strategy for Mabatlane Town Cluster	cterrell@srk.co.za	Aug-10
77	First Order Reconciliation Strategy for Modimolle (Nylstroom) Town Cluster	cterrell@srk.co.za	Aug-10
3.4	**Mogalakwena Local Municipality**		
	Report name	**Contact person**	**Date**
78	First Order Reconciliation Strategy for Mokopane Cluster	mhinsch@srk.co.za	May-10
79	First Order Reconciliation Strategy for Bakenberg Cluster	mhinsch@srk.co.za	Oct-10
80	First Order Reconciliation Strategy for Ga-Phahladira Cluster	cadd@srk.co.za	Oct-10
81	First Order Reconciliation Strategy for Mapela Cluster	mhinsch@srk.co.za	Oct-10
82	First Order Reconciliation Strategy for Rebone Cluster	cadd@srk.co.za	Oct-10
3.5	**Mookgopong Local Municipality**		
	Report name	**Contact person**	**Date**
83	First Order Reconciliation Strategy for The Mookgopong Regional Water Scheme	cterrell@srk.co.za	Feb-11
3.6	**Thabazimbi Local Municipality**		
	Report name	**Contact person**	**Date**
84	First Order Reconciliation Strategy for Leeupoort And Raphuti Water Supply Scheme	cadd@srk.co.za	May-10
85	First Order Reconciliation Strategy for Northam Scheme	cadd@srk.co.za	May-10
86	First Order Reconciliation Strategy for Rooiberg Water Supply Scheme	cadd@srk.co.za	May-10
87	First Order Reconciliation Strategy For Thabazimbi Urban Scheme	cadd@srk.co.za	May-10

2.2 Water Resources Situation Assessment: Limpopo Water Management Area

Report Title: Limpopo Water Management Area: Water Resources Situation Assessment: Main Report. Report no. P/01000/00/0101. Department of Water Affairs and Forestry (DWAF). Prepared by WSM in association with Ninham Shand, Parsons & Associates, Maritza Uys and GIS Project Solutions (GPS). July 2003.

2.2.1 Overview

The *Water Resources Situation Assessment* for the Limpopo WMA consists of only one report. The purpose of the study was to compile a desktop or reconnaissance level assessment of the available water resources, water quality and water requirement patterns during 1995. The study did not address water requirements beyond 1995 but does provide estimates of available yield after full development of water resources. The main purpose of this report was to determine the water resource availability, water requirements, water-related issues, water shortages, and to provide the necessary information to develop future water supply strategies. The water resource situation assessment was conducted on a quaternary catchment scale.

Other inter-related studies which supported this study include a demographic study, macro-economic study, formulation and development of a water situation assessment model and water requirements for the ecological component of the Reserve.

The report includes very detailed sections on the physical features, development status, water related infrastructure, water requirements, water resources, water balances and the cost of water resource development.

2.2.2 Main findings

This report gives extensive information on the following with regard to the Limpopo WMA:

- The geology, including detailed descriptions of the various lithological groups;
- Ecologically sensitive sites, including the procedures and methods adopted to estimate the various status and management classes of rivers and to ultimately estimate the corresponding Reserve water requirements;
- Demography and macro-economic influences;
- Land use, including detailed information on land use for irrigation, dryland sugar cane, other dryland crops, afforestation, nature reserves and urban areas per quaternary catchment;
- The water-related infrastructure which gives detailed information on the water supply schemes relevant to the Limpopo WMA;
- The water requirements, which is divided into categories such as the ecological reserve, urban and rural, bulk water use, neighbouring states, irrigation, afforestation and alien vegetation. The section further provides information on WCWDM, water allocations, existing water transfers and water losses and return flows.

2.2.3 Conclusions and recommendations

The following conclusions and recommendations were identified with regard to data availability, the Limpopo WMA and the five secondary catchments (the Mokolo secondary catchment includes the Matlabas River catchment):

a) *Available data*

Further investigation of the following was required:

- Monitoring of large water abstractions for agricultural supply from both surface and groundwater resources and the recording of these in a database. Only partial information existed about the water use on individual farms. Uncertainties regarding crop areas and crop factors existed and required verification. Crop factors will only be reliable when best management practices are implemented by the service providers to encourage responsible water use on farm level.
- The quantity and quality of effluent discharge streams from towns, industries and other sources were required to be monitored and the information recorded in data base.
- Information on sedimentation loads were required to be collected.
- It was recommended that overgrazing be discouraged to avoid the erosion of such areas.
- Outstanding information on population statistics and water supply infrastructure, especially in rural villages, were required to be collected to obtain a better estimate of water requirements.
- The river flow gauging network was recommended to be improved by placing new gauges at strategically important points in the basin and checking existing gauges for accuracy and reliability.
- Information on infiltration and seepage losses from rivers and canal distribution systems is unavailable and was required for the optimizing of water supply systems.
- A sensitivity analyses was recommended to be done on the influence of afforested areas on streamflow. This would show how significant the effect is on the results.
- Water quality was recommended to be investigated and monitored as water quality monitoring stations were insufficient.
- Information regarding groundwater contamination resulting from human wastes was required to be collected as well as monitoring data from selected areas to assess the validity of the vulnerability assessment presented in this report.

b) *Limpopo WMA*

An estimate of the total available resources and utilisation of the Limpopo River was required to properly manage the river and hence requires a study on the entire Limpopo River Basin.

Information on ecological sensitive sites were summarised within the EcoInfo database and recommended be consulted during the planning phase of new water related developments as it may impact the environment.

c) ***Mokolo catchment***

The future water requirements from the existing Mokolo Dam were recommended to be investigated since Matimba Power Station usage is constant and the Grootegeluk Coal Mine uses less water than allocated due to the mine utilising water from the pit and an adjacent well-field. Further water resources development potential exists due to the storage capacity of the Mokolo Dam being significantly less than the *mean annual runoff* (MAR). Options include:

- Raising Mokolo Dam.
- Constructing of a dam in the upper reaches of the Mokolo River.
- Diverting surplus water from the Mokolo River to demand centres.

Information on sensitive ecosystems in the Mokolo River is out dated and further studies were required.

d) ***Lephalala catchment***

The feasibility of the construction of a new streamflow gauging station in the Lephalala River near the northern border of the Lephalala Wilderness and the Phalala Dam was recommended to be investigated.

e) ***Mogalakwena catchment***

The hydro-meteorological data network was recommended to be improved by installing new rainfall gauges to improve the spatial coverage and expanding the flow gauging network by constructing additional flow stations and improving the operation of existing stream flow gauging stations.

Operating rules for water supply schemes in this river catchment were recommended to be refined and be implemented to optimize the supply of water to all users. The data compiled in this study were required to be fully integrated onto the *Geographic Information System* (GIS) of DWAF (now DWS) to be utilized for the management of the water resources. The impact of changing land use and water utilization was recommended to be monitored and evaluated on an on-going basis. Detailed studies of development possibilities were required to be undertaken for the following:

- Dam management and operation of Glen Alpine, Frikkie Geyser (now Welgevonden) and Doorndraai dams; and
- Groundwater supply at Melinda fault, Mokopane area and local/regional schemes.

Water quality management objectives were required to be set for all rivers in the basin. Institutional arrangements were required to be initiated to achieve on-going co-operation between the various regional authorities and interest groups that deal with water resource development and management.

f) ***Sand catchment***

The following studies, developments and acquiring of the necessary water rights were recommended to be undertaken by Louis Trichardt:

- Extensions to the existing well-field;
- Albasini well-field;
- Welgevonden well-fields; and
- Nooitgedacht well-field.

Feasibility studies for the following proposed development were recommended to be commissioned:

- The proposed Sand River well-field at Louis Trichardt and Kutama/Sinthumule considering water rights, aquifer yield, and well-field and pump system design. If not feasible, the feasibility and preliminary design of water from Elim was recommended to be commissioned.
- The proposed Mapungubwe Dam (and possibly of the alternative Vryheid Dam).

Monitoring of groundwater quality of the entire study area was recommended to be co-ordinated and rationalized, as well as the monitoring of effects of particularly the high nitrate concentrations in the water, on public health, especially in the Kutama/Sinthumule district. The results were required to be made available in a single database for continuous comparison with health criteria for human consumption.

g) *Nzhelele catchment*

Studies on the following were recommended to be initiated or commissioned:

- Establish the desirability and feasibility of making additional water available to the irrigators both upstream and downstream of the Nzhelele Dam by raising the dam, or by constructing either the Wyllie's Poort Dam or Tshipise Dam;
- Establish the cause of water shortages in villages in the Nzhelele River valley – be it water losses, higher than anticipated per capita water use or inadequacy of the bulk water infrastructure;
- Find additional water supplies for industrial water use, such as developing the Makhado well-field; and
- Establish the feasibility of importing water from the Mutale River or the Vondo Dam to the Nzhelele River valley, considering the long-term requirement in the donor catchments.

DWAF (now DWS) were recommended to improve the hydrological monitoring system for the valley by:

- Investigating the feasibility of constructing flow gauging stations at suitable sites on the Mutamba River near the confluence with the Nzhelele Rivers as well as a flow gauging station on the Nzhelele River near the confluence with the Limpopo River; and
- Reopening the evaporation stations at Macaoville (A7E006) and Luphephe Dam (A8E002) and establish a new station in or near Vondo Forest in the upper reaches of the Nzhelele River valley.

Databases on the water-related information for all villages, settlements and industry in the Nzhelele River catchment were required to be developed along with databases on the groundwater levels and borehole statistics pertaining to the areas where development is likely to occur, including the Makhado well-field area, Mufungudi River valley and the eastern escarpment areas.

Measures that would increase irrigation efficiency in the former Venda were required to be identified. These included additional extension work, using a pilot project as an example and attending to landownership and credit facilities.

Measurements were required to be implemented to reduce losses and conserve the water resources. This involved punitive tariff policy measures.

DWAF (now DWS) were recommended to develop a water quality management programme for the Nzhelele River basin that would deal with agricultural land-use and waste-water management to control seepage from pit latrines, oxidation ponds and solid-waste disposal sites.

2.3 LIMPOPO WATER MANAGEMENT AREA: OVERVIEW OF WATER RESOURCES AVAILABILITY AND UTILISATION

Report Title: Limpopo Water Management Area: Overview of Water Resources Availability and Utilisation. Report no. P WMA 01/000/00/0203. Department of Water Affairs and Forestry. September 2003.

2.3.1 Overview

An overview of the water resources and availability for the Limpopo WMA was conducted as one of a series of similar reports for all 19 WMAs in South Africa and results directly from work performed in preparation for the NWRS-1 (2004).

The objective of the report was to provide an overview of the then current and expected future water resources situation, highlight the key issues and to provide broad strategies for water resource management in the Limpopo WMA. The report summarised data from water resource situation assessments, demographic, economic, environmental and other related studies as well as knowledge obtained through workshops during which strategic perspectives were developed regarding water availability and requirements.

For the purpose of the report, the Limpopo WMA was divided into five sub-areas or key areas according to size and location of sub-catchments, homogeneity of natural characteristics, location of pertinent water infrastructure (e.g. dams), and economic development. These are the:

- Matlabas/Mokolo Key Area, comprising of the Matlabas and Mokolo River catchments.
- Lephalala Key Area, comprising of the Lephalala River catchment and smaller streams draining towards the Limpopo River.
- Mogalakwena Key Area, comprising of the Mogalakwena River catchment.
- Sand Key Area, comprising of the Sand River catchment and smaller streams draining towards the Limpopo River.
- Nzhelele/Nwanedi Key Area, comprising of the Nzhelele and Nwanedi River catchments.

2.3.2 Economic activity and population

Main findings regarding economic activities and the population in the Limpopo WMA are summarised below:

- Agriculture in the WMA includes cotton, grain sorghum and tobacco production, with approximately 50% of the annual national cotton yield produced in the area. However, a large part of the population is dependent on subsistence agriculture.

- Most of the WMA is covered by natural vegetation. Due to limited surface water resources to support irrigation and arid climate restricting dryland agriculture, the main land use is livestock and game farming, however, severe overgrazing is prevalent in many areas.
- Mining and power generation include the Matimba Power Station, the largest direct dry-cooled power station in the world with a design output of 4 000 MW, and the Grootegeluk opencast coal mine which supplies fuel to the power station. A new platinum smelter was under construction south of Polokwane during the compilation of the report. Platinum mining activities are expanding in the vicinity of Mokopane.
- Over 80% of the population is classified as rural with high population densities in the middle part of the Mogalakwena Key Area, southern half of the Sand Key Area and the southern extreme of the Nzhelele Key Area. Polokwane is considered the only major urban centre in the area.

2.3.3 Water requirements

The water requirement in the Limpopo WMA was determined as follows:

- The irrigation sector (dominant water use): 75%
- Urban, industrial and mining use: 16%
- Rural domestic supplies and stock watering: 9%

Table 2.2 provides a summary of the sectoral water requirements in all key areas for 2000 at a standard 98% assurance of supply.

A substantial amount of water is used non-consumptively by the urban and industrial sectors in the larger centres, making it available as effluent that can be treated and discharged back into rivers for potential re-use. Most effluent from Polokwane is used for the recharge of groundwater whereas effluent from smaller towns evaporates from maturation ponds or is absorbed by irrigation and infiltration.

Future requirements were estimated up to 2025 based on a base and high scenario as described below:

- Base scenario: High population growth scenario and more reasonable distribution of wealth leading to higher average water service levels in time.
- High Scenario: High population growth with high standard of services and high increase in economic requirements for water to provide a conservative indicator.

Table 2.2: Year 2000 water requirements (million m³/a)

Key Area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Afforestation (4)	Total requirements
Matlabas and Mokolo	48	2	2	4	7	0	63
Lephalala	39	0	3	0	0	0	42
Mogalakwena	56	8	9	6	0	0	79
Sand	69	24	9	4	0	0	106
Nzhelele and Nwanedi	26	0	5	0	0	1	32
Total	238	34	28	14	7	1	322

1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
2) Mining and bulk industrial water uses which are not part of urban systems.
3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
4) Quantities given refer to impact on yield only.
5) Estimated average irrigation water use standardised at 98% assurance of supply, however, some irrigation dependent on small farm dams and run-of-river has a very low assurance of supply.

Growth is expected in the larger urban areas, mainly Polokwane, and in places of economic importance such as mining development in the Mokopane-Mogoto area. No significant water requirement growth is expected for rural areas as well as for the irrigation sector due to limited water availability.

Table 2.3 and Table 2.4 provide the projected water requirements for 2025 for the base scenario and for the high scenario respectively.

Table 2.3: Year 2025 base scenario water requirements (million m³/a)

Key Area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Afforestation (4)	Total requirements
Matlabas and Mokolo	48	1	2	4	7	0	62
Lephalala	39	0	4	0	0	0	43
Mogalakwena	56	9	10	26	0	0	101
Sand	69	23	11	4	0	0	107
Nzhelele and Nwanedzi	26	0	6	0	0	1	33
Total	238	33	33	34	7	1	346

1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
2) Mining and bulk industrial water uses which are not part of urban systems.
3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
4) Quantities given refer to impact on yield only.

Table 2.4: Year 2025 high scenario water requirements (million m^3/a)

Key Area	Irrigation	Urban[1]	Rural[1]	Mining and bulk industrial[2]	Power generation[3]	Afforestation [4]	Total requirements
Matlabas and Mokolo	48	3	2	4	7	0	64
Lephalala	39	0	4	0	0	0	43
Mogalakwena	56	16	10	26	0	0	108
Sand	69	46	11	4	0	0	130
Nzhelele and Nwanedi	26	0	6	0	0	1	33
Total	238	65	33	34	7	1	378

1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
2) Mining and bulk industrial water uses which are not part of urban systems.
3) Includes water for thermal power generation only (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well).
4) Quantities given refer to impact on yield only.

2.3.4 Water resources

Little surface runoff is generated in the Limpopo WMA due to low rainfall with the exception of the Waterberg area from which the Mokolo and Mogalakwena Rivers originates. The WMA has no natural lakes. Nylsvlei in the south-east of the Mogalakwena catchment area is the country's largest ephemeral floodplain and has been declared a RAMSAR wetland site because of its international conservation importance and birdlife.

Table 2.5 provides a summary of the natural MAR and the estimated requirements for the ecological Reserve as obtained from national data sources to ensure compatibility of the WMA information in the NWRS-1.

Table 2.5: Natural MAR and ecological Reserve

Key Area	Natural MAR[1] (million m^3/a)	Ecological Reserve[1,2] (million m^3/a)
Matlabas and Mokolo	382	76
Lephalala	150	17
Mogalakwena	269	41
Sand	72	10
Nzhelele and Nwanedi	113	12
Total	986	156

1) Quantities given are incremental, and refer to the Key Area under consideration only. No flow and ecological requirements in the Limpopo River main stem are included.
2) Total volume given, based on preliminary estimates. Impact on yield being a portion of this.

The major dams in the Limpopo WMA include Mokolo Dam (supplying irrigation, the Matimba Power Station and Lephalale) Doorndraai Dam, Glen Apline Dam, Nzhelele Dam, Mutshedzi Dam and Luphephe Dam which all mainly supply irrigation and surrounding villages. There are no dams in the Lephalala and Sand Key Areas, however many farm dams have been constructed throughout the WMA.

Table 2.7 provides a summary of all the large dams in the Limpopo WMA.

Groundwater supplies approximately 40% of the yield from local resources and is the only dependable water resource for many users in the WMA, especially the rural domestic users in settlements and villages in the Mogalakwena and Sand Key Areas. Polokwane, Mokopane and Makhado are partially supplied from local well-fields. In the vicinity of the Limpopo River and the upper Sand Key Area large quantities of groundwater are abstracted for irrigation.

Groundwater is recharged through infiltration from sandy riverbeds, pumping near rivers such as along the Limpopo and Sand Rivers and from infiltration of treated effluent into aquifers in the vicinity of Polokwane.

Overall, in the natural state, surface water quality in the WMA is good but some pollution of surface streams are due to wash-off from rural villages and dense settlements with insufficient sanitation infrastructure. The quality of groundwater in the WMA is also considered good and no pollution has been recorded.

Water is transferred from other WMAs to augment local resources as summarised in Section 2.3.5 1.1.1b) and Table 2.6.

Table 2.6: Summary of transfers to the Limpopo WMA (million m^3/a)

Transfer from	Water source	Transfer to	Main user	Transfer amount
Luvuvhu and Letaba	Albasini Dam	Louis Trichardt	Urban	2.4
	Nandoni Dam	Louis Trichardt	Urban	5$^{(1)}$
	Ebenezer Dam	Polokwane	Urban	12$^{(2)}$
	Dap Naude Dam	Polokwane	Urban	6.5$^{(2)}$
Crocodile (West) and Marico	Roodeplaat Dam	Modimolle and Mookgopong	Urban	3
Olifants	Olifantspoort Weir	Polokwane	Urban	2.6

1) Additional allocation to supplement Albasini Dam during shortages.
2) Combined 2003 transfers from Ebenezer and Dap Naude dams is 10.1 million m^3/a.

Table 2.7: Summary of large dams in the Limpopo WMA

Dam	Full supply capacity (million m^3/a)	MAR (million m^3/a)	Historical yield (million m^3/a)	User allocations (million m^3/a)	Other relevant information
Dams located in the Limpopo WMA					
Mokolo	146	240	23	• Matimba Power Station (7.3) • Grootegeluk Coal Mine (9.9) • Lephalale Town (1.0) • Downstream Irrigation (10.4)	Constructed in the late 1970s, with a yield of 39 million m^3/a. The yield of the dam dropped to 23 million m^3/a due to rapid irrigation development upstream of the dam.
Doorndraai	44	23	8.6	• Mokopane (4.4) • Downstream Irrigation (3.7)	Construction was completed in 1953 and raised in 1975. No allowance is made for the Reserve.
Glen Alpine	20	222	5.6	• Irrigation (5.9)	The yield is limited to its small size, the ephemeral nature of the runoff into the dam and the high evaporation rates. Constructed in 1967 and 5.9 million m^3/a was allocated to irrigators of which 1.6 million m^3/a was allocated to irrigators in Lebowa but was never took up. A yield of 6.9 million m^3/a was registered as water use sourced from Glen Alpine Dam and thus the lawfulness of these registered water users have to be verified before allocating Lebowa's allocations to other users.
Nzhelele	55	66	24.5	• Irrigation (29)	29 million m^3/a is allocated to supply downstream irrigation but can only met 80% of irrigation requirements.
Houtrivier	7.5	12.5	0.6	• Domestic (rural)	Largest Dam in the Sand River Catchment, situated on the Hout River which is a tributary of the Sand River.
Seshego Dam	2.38		1.4	• Sesheho domestic users (includes water from 5 boreholes)	Water gravitates from the dam to a 3.95 Mℓ/d *water treatment works* (WTW) close to the dam

Dam	Full supply capacity (million m^3/a)	MAR (million m^3/a)	Historical yield (million m^3/a)	User allocations (million m^3/a)	Other relevant information
Mutshedzi Dam	2.4		1.5	• Domestic use for villages and Makhado Town • Makhado tomato-processing factory.	Raw water is treated a short distance downstream of the dam at a 3,6 Mℓ/d raw WTW.
Dams located outside of the Limpopo WMA					
Dap Naude Dam	2.08		5.6*		Raw water conveyed for 60 km to Polokwane and treated at an 18 Mℓ/d treatment works. Pipeline can only convey 3.6 million m^3/a.
Ebenezer Dam	70.12		21.9*	• Urban and domestic supply to Polokwane, Seshego, Haenertsberg, Dalmada plots and Mankweng (15) • Irrigation downstream in the Groot Letaba River (3.53)	Water is treated at a 42 Mℓ/d raw WTW directly downstream of the dam. Water is then pumped 20 km to Mankweng and then a further 22 km to Polokwane.
Albasini Dam	29.7			• Louis Trichardt (2.2) • Downstream irrigators	Supplies to 9.82 Mℓ/d to Louis Trichardt/Tshikota. Water is treated at the 5.7 Mℓ/d treatment works at the dam and then pumped to Louis Trichardt

2.3.5 Reconciliation of requirements and availability

Table 2.8, Table 2.9 and Table 2.10 provide the reconciliation of available water and total requirements for the year 2000, year 2025 base scenario and year 2025 high scenario respectively.

With reference to Table 2.8, deficits in the Matlabas/Mokolo, Mogalakwena and Nzhelele/Nwanedi Key Areas are due to the provision made for the ecological component of the Reserve. Excluding the ecological Reserve requirement and under the conditions as per the time of the study, the Limpopo WMA is in balance. However, some irrigators have a low assurance of supply and basic water services still need to be provided in some rural or informal settlements.

Table 2.8: Reconciliation requirements and available water for year 2000 (million m^3/a)

Key Area	Available water			Water requirements			Balance (1)
	Local yield	Transfers in(2)	Total	Local require-ments	Transfers out(2)	Total	
Matlabas and Mokolo	46	0	46	63	0	63	(17)
Lephalala	42	0	42	42	0	42	0
Mogalakwena	72	3	75	79	0	79	(4)
Sand	91	15	106	106	0	106	0
Nzhelele and Nwanedi	30	0	30	32	0	32	(2)
Total	281	18	299	322	0	322	(23)

1) Brackets around numbers indicate negative balance.
2) Transfers into and out of Key Area may include transfers between Key Area as well as transfers between WMAs. Addition of the transfers per Key Area therefore does not necessarily correspond to the total transfers in and out of the WMA.

Table 2.9: Reconciliation requirements and available water for year 2025 base scenario (million m^3/a)

Sub Area	Available water			Water requirements			Balance	Potential for develop-ment
	Local yield	Transfers in	Total	Local require-ments	Transfers out	Total		
Matlabas and Mokolo	45	0	45	62	0	62	(17)	0
Lephalala	42	0	42	43	0	43	(1)	0
Mogalakwena	73	3	76	101	0	101	(25)	7
Sand	92	15	107	107	0	107	0	0
Nzhelele and Nwanedi	29	0	29	33	0	33	(4)	1
Total	281	18	299	346	0	346	(47)	8

For the year 2025 water availability and requirements, the following were assumed or included for both the base and the high scenario:

- Local yield is based on existing infrastructure and infrastructure in the year 2000 and also includes return flows resulting from growth requirements.
- The growth of local water requirements are based on:
  - Population growth
  - General economic development
  - No general increase of irrigation
  - Provisional allowance of 20 million m^3/a for possible new mining developments in the Mokopane-Mogota area but no allowance for possible coal mining developments in Lephalale area.
- The potential for development is based on the raising of the Glen Alpine and Mutshedzi dams and the construction of Groenvley Dam.

Table 2.10: Reconciliation requirements and available water for year 2025 high scenario (million m^3/a)

Sub Area	Available water			Water requirements			Balance	Potential for develop-ment
	Local yield	Transfers in	Total	Local require-ments	Transfers out	Total		
Matlabas and Mokolo	46	0	46	64	0	64	(18)	0
Lephalala	42	0	42	43	0	43	(1)	0
Mogalakwena	76	3	79	108	0	108	(29)	7
Sand	102	20	122	130	0	130	(8)	0
Nzhelele and Nwanedi	29	0	29	33	0	33	(4)	1
Total	295	23	318	378	0	378	(60)	8

a) ***Key issues and reconciliation options***

The following key issues and water reconciliation options for the Limpopo WMA were identified in the study:

- Water resources in the WMA are nearly fully developed and utilised. Further development of especially surface water resources is limited due to the arid climate, unfavourable topography, sandy rivers as well as important conservation areas. Raising of the Glen Alpine and Mutshedzi dams are regarded as feasible options for further development of local surface water resources. The construction of the proposed Groenvley Dam and a large dam on the Upper Limpopo are considered to be impractical due to the high costs pertained to the small amount of yield gained.
- As further development of surface water is minimal, WCWDM of existing water resources should be the primary focus to supply deficits including the Reserve, rural development and poverty relief.

- The management of groundwater and the possible additional abstraction for rural supplies and community gardens may be the most practical option in some areas.
- The WMA was approximately in balance at the time of the study, however, implementation of the ecological Reserve could adversely affect the water balance particularly in the Mokolo and Mogalakwena river catchments. Detailed assessment of the Reserve and careful planning regarding the implementation thereof were considered as a priority along with the possibility of compulsory licensing in some catchments.
- Reducing afforestation in the vicinity of Louis Trichardt can increase the recharge and utilization of groundwater. Furthermore, no additional afforestation should be allowed unless the impacts can be mitigated.
- Large new mining developments in the Mokopane-Mogoto area are anticipated. Hence, the year 2025 water requirements for both the base and the high scenario (**Table 2.9** and **Table 2.10**) allow for an additional 20 million m^3/a in this regard. These new developments can initially be supplied from treated effluent from Mokopane and Polokwane and possibly through re-allocation from other water users. If constructed, the Rooipoort Dam on the Olifants River will mainly supply these mining developments as well as Polokwane.
- Water requirements for the possible development of coal-base petroleum industries and for power generation around the coalfields in the Lephalale area could be sourced from re-allocation of irrigation water from the Mokolo Dam, possible raising of Mokolo Dam or from surplus effluent return flows (estimated at 45 million m^3/a) transferred from the Crocodile (West) and Marico WMA. As the possibility of these developments were highly uncertain, water requirements have not been included in **Table 2.9** and **Table 2.10.**
- Although no significant changes are expected in the Lephalala Key Area it was recommended that focus be placed to manage the important and pristine wilderness area close to its current natural state.
- The raising of the Mutshedzi Dam will increase available yield in the Nzhelele/Nwanedi Key Area.
- Water resources and uses pertained to the Limpopo River Basin, of which the Limpopo WMA forms part of, is managed by the *Limpopo Basin Permanent Technical Committee (*LBPTC) with membership by South Africa, Botswana, Zimbabwe and Mozambique. Furthermore bilateral bodies, the Joint Permanent Technical Committee of Botswana and South Africa and the Joint Water Commission with Mozambique, have also been established to address water related issues. Thus, development of new dams or large water resource projects will be subject to national authorisation due to possible impacts on neighbouring countries.
- Urban and industrial growth will mainly be concentrated around Polokwane, larger towns such as Louis Trichardt and in the vicinity of mining activities in the Mogalakwena and Sand Key Areas. As these key areas already have limited water supply, future water requirements must firstly be supplied through WCWDM and then through additional transfers.

b) *Transfers to the Limpopo WMA*

The following reservations were made in the NWRS-1 with regard to transfers to the Limpopo WMA:

- From the Olifants River (Olifantspoort Weir) to Polokwane, up to the capacity of the existing pipeline of 5.0 million m^3/a (reserved in the Olifants WMA).
- Existing transfer of 18.5 million m^3/a maximum capacity from Ebenezer Dam and Dap Naude Dam to Polokwane (Reserved in the Luvuvhu and Letaba WMA).
- As previously stated an estimated 45 million m^3/a in effluent return flows in the Crocodile River may be required for development around the coalfields of the Lephalale area.
- The development of the Rooipoort Dam on the Olifants River is reserved for in the Olifants WMA. The dam will supply new mining developments in the Mokopane-Mogoto area and urban areas of Polokwane, however, other developments that may negatively impact the development of Rooipoort Dam will not be allowed.
- Approximately 3 million m^3/a to the capacity of the existing infrastructure from Roodeplaat Dam to Modimolle and Mookgopong (Reserved in the Crocodile (West) and Marico WMA).
- From Luvuvhu and Letaba WMA, existing transfer of 2.4 million m^3/a from Albasini Dam to Makhado and an additional 5 million m^3/a allowance from the Luvuvhu River or alternatively Nandoni Dam for future transfers (Reserved in the Luvuvhu and Letaba WMA).

2.4 INTERNAL STRATEGIC PERSPECTIVE: LIMPOPO WATER MANAGEMENT AREA VERSION 1

Report Title: Internal Strategic Perspective: Limpopo Water Management Area. Version 1. Report no. P WMA 01/000/00/0304. Department of Water Affairs and Forestry. Prepared by Goba Moahloli Keeve Steyn in association with Tlou and Matji and Golder Associates. November 2004.

2.4.1 Overview

The *Internal Strategic Perspective* (ISP) aimed to ensure synergy within the DWAF (now DWS) regarding water resource management. The ISP presented a common and consistent departmental approach to guide officials when addressing water management related queries and evaluating water license applications.

DWAF strived for an integrated planning and management approach, referred to as *Integrated Water Resources Management* (IWRM). The ultimate aim of this IWRM process was to arrive at:

- An allocation schedule that meets the requirements of the *National Water Act* (NWA) (Act 36 of 1998);
- Water resources yield and other models that are representative of the flow regime of the river systems in the area;
- Management class scenarios for the rivers (i.e. Reserve and Resource Quality Objectives set);

- A Catchment Management Strategy for each WMA.

These deliverables could only be finalised once the *Catchment Management Agencies* (CMA) assumed responsibility for managing the water resources of their respective WMA. Until then DWAF's Regional Offices were required to continue to manage the water resources in their area of jurisdiction until these management functions could be handed over to the established and fully operational CMAs. In accordance with the NWA, DWAF (the Minister) would still remain ultimately responsible for the management of the water resources.

DWAF's corporate perspective on how the water resources should be managed needed to be formally expressed in order to manage the water resources in a consistent and predictable manner. The purpose of the ISP is to document these perspectives and offer sound motivation to demonstrate appropriate and rational governance.

The Limpopo WMA was divided into eight Key Areas, which are the seven river catchments (Matlasbas, Mokolo, Lephalala, Mogalakwena, Sand, Nzhelele and Nwanedi) and the Limpopo River main stem area..

2.4.2 Internal Strategic Perspective: Limpopo Water Management Area Part A

Part A provides a general overview of the Limpopo WMA which includes information on the physical characteristics, demographics, land use, institutions, international aspects, national and regional water related plans and other legislation, the economy, water related infrastructure in the WMA and transfers.

Part A further focuses on the water resources availability, quality and requirements, key issues and management strategies as well as cooperative governance, waterworks management, monitoring and information systems, redressing inequities, support to local authorities and implementation.

2.4.3 Internal Strategic Perspective: Limpopo Water Management Area Part B

Part B comprises of the key issues identified and strategies developed for the Limpopo WMA. Two broad categories of strategies were established; strategies applicable on the whole Limpopo WMA and catchment specific strategies. Catchment specific strategies specifically addressed the reconciliation of water requirements and available resource as well as water quality. Furthermore each strategy addressed the following aspects:

- Broad management objective;
- Situation assessment;
- Overall Strategy; and
- Management actions, priorities and responsibilities.

a) ***Issues and broad management strategies applicable to the whole Limpopo WMA***

Overview and issues regarding groundwater

Groundwater resources are broadly used throughout the Limpopo WMA with the most extensive use being from the deeply weathered and fractured granite north of Polokwane (quaternary A71A) and in the area around Mogwadi (quaternaries A72A and A72G) where large amounts for irrigation and domestic supply are abstracted. Large abstractions also occur near Wiepe (quaternary A71L) from the aquifer associated with the Limpopo River.

Platinum mines west of Mokopane are also supplied by groundwater. Groundwater is the main source of water in many rural communities, especially in the old Lebowa and Venda homeland areas.

Various studies provided different groundwater use figures, implying that verification thereof is urgently required. The following groundwater use figures from different studies and individuals were obtained:

- 98 million m^3/a: NWRS-1;
- 310 million m^3/a: Information for this ISP from registered water use;
- From the *Groundwater Resource Information Project* (GRIP) the following figures were obtained for the whole of the Limpopo Province (DWAF, 2004a):
  - 550 million m3/a (Haupt, CJ: Consulting groundwater specialists);
  - 460 million m3/a (du Toit, W: Assistant director Geohydrology, DWAF)

After consultation with groundwater specialists it was concluded that registered groundwater use underestimates actual quantities, possibly due to the large increase in abstractions. The *Water Authorisation Management System* (WARMS) database underestimates the rural groundwater use as Schedule 1 use (which accommodates for most rural use) is not registered. A best guess estimate of groundwater use per sector was derived from the registration process and the NWRS-1 as shown in **Table 2.11**. There is no legislation preventing drilling of boreholes and it is estimated that 30 boreholes are drilled daily in the Limpopo WMA. It is important that the actual use be verified and unlawful use be terminated or licenced.

Table 2.11: Groundwater use per sector in the Limpopo WMA

Sector	Groundwater use (million m^3/a)
Rural	28
Industrial	5
Urban	6
Mining	5
Irrigation	266
Total	**310**

Theoretically 42% of annual groundwater recharge is used, assuming a recharge of 2% *mean annual precipitation* (MAP) or 702 million m^3/a. The exploitable potential determined by Carl Haupt (DWAF, 2003a) takes into account limitations on the full use of the recharge factors and is provided in **Table 2.12** together with the groundwater use and balance. Overall the available groundwater resources are under-utilised and can supply more than the *Reconstruction and Development Programme* (RDP) level of 25 litres per head per day.

Table 2.12: Groundwater use and exploitable potential in the Limpopo WMA

Key area	Groundwater use (million m^3/a)	Exploitable potential (million m^3/a)	Groundwater balance (million m^3/a)
Matlabas	4	28	24
Mokolo	11	47	36
Lephalala	12	37	25
Mogalakwena	55	125	70
Sand	165	95	(70)
Nzhelele	11	11	0
Nwanedi	2	3	1
Limpopo Main Stem	50	50	0
Total	**310**	**386**	**76**

The following additional concerns with regard to groundwater in the Limpopo WMA were identified:

- The Sand Key Area is heavily over-exploited and lawful groundwater use and the exploitable potential should be verified to determine if compulsory licensing is required to sustain groundwater;
- The aquifer in the mountainous areas east of Mokopane, primarily consisting of dolomite, is over exploited due to uncontrolled abstraction of large quantities by the Zebedelia Estates (quaternary A61F in the Limpopo WMA and quaternary B51E in the Olifants WMA);
- Irrigation abstractions in the Rooisloot valley and Dorps River valley as well as abstractions of 3 million m^3/a from the Mokopane well-field, west of Dorps River valley have caused a decline in the groundwater levels in the surrounding areas;
- Exploitation of groundwater in the area of the Makapan's Gat archaeological cave could induce sinkholes and if declared a World Heritage site, access to the groundwater can be limited; and
- Dolomite aquifers extend across the Limpopo WMA boundary into the Olifants WMA. The impact on these catchments when abstracting from either catchment should be determined. It is also proposed that the aquifers be managed as a unit.

Broad strategies regarding groundwater

The ISP recommended that groundwater should be the first priority resource to address the backlog in basic water services, however, appropriate mechanisms should be developed and implemented to avoid over-exploitation of groundwater resources especially in the Sand Key Area.

The following actions were recommended with regard to groundwater resources:

- Establish a groundwater monitoring programme, especially in areas with large abstractions, to monitor the quantity as well as quality of groundwater;

- Manage the dolomites east of Mokopane as a single unit, which may require shifting of the Olifants and Limpopo WMAs' boundaries;
- The urgent initiation of a groundwater assessment study to:
  - Quantify the groundwater resources and its availability at different levels of exploitation;
  - Verify groundwater use; and
  - Reconcile groundwater availability with the verified use, prioritising the Sand Key Area, and develop and implement a management plan to limit groundwater use within the exploitable potential;
- Possible compulsory licencing in the heavily stressed Sand Key Area.

International obligations

The use of water in the Limpopo River Basin and the provision for sufficient water to meet the requirements of the countries included (South Africa, Botswana, Zimbabwe and Mozambique), is governed by the *Southern African Development Community* (SADC) Protocol on Shared Watercourses. The Limpopo River Basin Commission was established in 2003 in order to ensure conformity with the SADC Protocol principles both locally and internationally. Furthermore the *Water Resources Technical Committee* (WRTC) approves terms of references and provides technical support on studies relating to shared watercourses.

The following were identified as part of the overall strategic approach from a South African perspective:

- Ensure that the water resources of the Limpopo River are managed in terms of the SADC Protocol and set South African principles on future dams and the impact of groundwater exploitation and over-abstraction on neighbouring countries whilst expecting other countries to not over-exploit the resource;
- Provide the required ecological Reserve from South African tributaries and expect other countries to contribute accordingly;
- Minimise flood damage by installing early flood warning devices in the main stem. This must be an initiative from all contributing countries;
- Develop a joint drought management plan, along with the other countries, for the whole basin to provide processes for an integrated approach to assess drought conditions and to agree on drought action levels; and
- Co-operative governance, data sharing, knowledge and skills transfer to better manage the Limpopo River Basin.

Reserve and resource quality objective

None of the rivers in the Limpopo WMA have been classified nor has the resource quality objective been determined comprehensively at the time of this ISP. Only rapid reserve determinations have been done for some rivers in the WMA based on license applications. All river systems, their tributaries and reaches were required to be classified according to the NWA. Furthermore the class and *resource quality objectives* (RQOs) were required to be determined for all river sections considered significant. The Reserve determination of Mokolo, Mogalakwena, Nzhelele and Nwanedi rivers should receive priority.

b) *Issues and broad management strategies per catchment area*

Matlabas Key Area

The Matlasbas River catchment is an undeveloped catchment with limited water resources and limited water use. Despite a MAR of 49 million m^3/a, the yield from surface water resources is negligible due to the highly erratic surface water flow and ephemeral river flow. Irrigation is the largest water use at 4 million m^3/a of which half is supplied by groundwater and rural domestic requirements are limited to 2 million m^3/a according to WARMS.

The available local yield in the Key Area amount to 4 million m^3/a, resulting in a deficit of 2 million m^3/a, but this may relate to opportunistic irrigators supplied by surface water at a very low assurance. The surface water and groundwater quality is considered good with no anticipated future issues.

The determination of the Reserve is not considered as a priority as the system is semi-pristine and the current and anticipated future development in the Key Area is low.

Little increase in future water requirements is expected and thus the Key Area is considered a low priority. Future allocations can be made from local groundwater resources as it is underutilised but not from run-of-river yield. Due to unfavourable hydrological conditions, construction of farm dams is only a possibility.

Mokolo Key Area

The Mokolo River catchment is a well-developed catchment with substantial surface water resources contributed by the Mokolo Dam, smaller dams in the upper reaches and run-of-river. Groundwater mainly supplies irrigation and domestic rural use. The water availability is summarised in **Table 2.13** and the water requirements in **Table 2.14**.

Table 2.13: Water availability in Mokolo Key Area (1:50 year assurance) in year 2003

Resources category	Available/impact (million m^3/a)
Gross surface water resource	85
Subtract ecological Reserve	17(1)
Net surface water resource	68
Groundwater	11
Return flows	4
Total local yield	**83**
Transfer in	0
Grand total	**83**

1) Estimated in the NWRS, Reserve determination for the river reach downstream of Mokolo Dam should be at an Intermediate level.

Table 2.14: Water requirements in Mokolo Key Area (1:50 year assurance) in year 2003

Water users	Quantity (million m^3/a)
Irrigation	68
Urban (Lephalale and Vaalwater)	2
Rural (Scattered settlements)	2
Kumba Resources' Grootegeluk Colliery Mine	4(1)
ESKOM Matimba Power Station	7
Total	83
Transfer out	0
Grand total(2)	**83**

1) Only 2 million m^3/a registered
2) Excludes ecological reserve of 17 million m^3/a

The Mokolo Key Area is considered to be in balance. Although the Mokolo Dam is over-allocated, the Grootegeluk mine does not use all allocated water and irrigation allocated is only at 70% assurance. This implies that the dam is in balance and will continue to supply users at high assurance until the ecological Reserve has to be supplied from the dam (See Table 2.15). Re-allocation of supply has to be done once the Reserve is implemented.

Table 2.15: Water allocations and actual use from Mokolo Dam

Allocated to	Allocated amount (million m^3/a)	Water use at equivalent 1:50 year assurance (million m^3/a)	Surplus/deficit (million m^3/a)
Matimba power station	7.3	7.3	0.0
Grootegeluk coal mine	9.9	4.0	5.9
Lephalale Town	1.0	1.0	0.0
Downstream irrigation	10.4	7.0	3.4
Total	**28.6**	**19.3**	**9.3**
Historical firm yield	23.0	23.0	0.0
Balance	**(5.6)**	**3.7**	**0.0**

Groundwater quality in the Key Area is poor due to coal and gas fields, however it can still be used by the industrial and irrigation sector. Surface water and groundwater is affected by pollution from coal mining activities and the rapid and uncontrolled growth of informal settlements around Vaalwater and Mabaleng (previously Alma). Water quality problems that could arise from the Grootegeluk coal mine include acid mine water, low pH and a concentration of *total dissolved solids* (TDS). The extent of water resource pollution must be investigated and understood through monitoring water quality at strategic points and information gathered should be applied to develop effective management strategies.

The Mokolo and Lephalala Key Areas conjunctively consist of 40% of the country's remaining coal reserves and thus development of new power stations is inevitable. Potential future requirements are further due to:

- Fast growing urban population in Lephalale and an explosion of informal settlements in and around the town of Vaalwater;
- Water required for emerging farmers in the catchment;
- Potential large scale methane gas field development around the coal reserves including petrochemical industry development;
- Ecological Reserve requirements;
- Small-scale economic development for poverty eradication; and
- Water to meet basic needs of the rural communities.

The main strategy is to maintain the catchment in its current balanced state by not issuing more irrigation water use licenses and sourcing additional water requirements from groundwater or alternatively newly constructed farm dams. Should larger requirements than expected materialise the following options need to be considered:

- Raising of the Mokolo Dam;
- Transfer surplus return flows from the Crocodile (West) and Marico WMA (45 million m^3/a provisionally reserved in the NWRS-1);
- Water trading with irrigation sector; and
- Development of large borehole networks in underdeveloped areas to supply the Key Area from groundwater.

The ISP suggested that a detailed yield analysis of the Mokolo Dam should be conducted to determine the current and future available yield and to investigate the feasibility of raising the dam. The Limpopo co-basin states in accordance with the SADC Protocol on shared water courses have to approve the raising of the Mokolo Dam. Furthermore, pre-feasibility studies on other options to secure future water supply are also urgent.

Lephalala Key Area

The Lephalala Key Area has no major dams. Irrigation is the dominant water user with a water requirement of 33 million m^3/a, supplied mostly from farm dams in the upper reaches and from an alluvial aquifer and small weirs in the lower reaches.

Surface water resources was analysed using the reconnaissance level simulation model due to anomalies in the NWRS. The water availability and water requirements for the Lephalala Key area are given in **Table 2.16** and **Table 2.17**.

As surface water resources are limited future large-scale expansion in the Key Area is expected to be low except for tourist facilities in the upper reaches.

Table 2.16: Water availability in Lephalala Key Area (1:50 year assurance) in year 2003

Resources category	Available/impact (million m^3/a)
Gross surface water resource	15
Subtract ecological reserve	3[(1)]
Net surface water resource	12
Groundwater	12
Return flows	0
Total local yield	**24**
Transfer in	0
Grand total	**24**

1) WMA report estimated Reserve as zero, however, re-assessment as part of the ISP indicated a Reserve of 3 million m^3/a

Table 2.17: Water requirements in Lephalala Key Area (1:50 year assurance) in year 2003

Water users	Quantity (million m^3/a)
Irrigation	33[(1)]
Rural	3[(2)]
Total local requirements	**36**
Transfer out	0
Grand total[(2)]	**36**

1) NWRS gave 39 million m^3/a and registered water use 52 million m^3/a which both seemed to high. Spatial analysis of registered water use indicated 13 million m^3/a is supplied by the Limpopo main stem – See Limpopo Key Area
2) Mainly supplied by groundwater
3) Excludes ecological Reserve of 3 million m^3/a

Key issues and broad strategies identified and developed for the Lephalala Key Area are summarised below:

- The area is severely stressed with an estimated deficit of 12 million m^3/a, probably due to opportunistic irrigators. Implementation of WCWDM is critical to minimize the deficit, however, if the balance is not achieved through WCWDM, compulsory licencing must be considered.
- The middle reaches of the catchment is of high conservation value due the pristine and ecologically sensitive Wilderness area, however, Reserve requirements in this area is adversely affected by irrigation development in the upper reaches and needs to be addressed.
- The potential of constructing new dams on the Lephalala River is low due to the sensitivity of the Wilderness area to development and hence additional water requirements should be supplied by groundwater.
- Water quality issues include the irrigation areas where fertilizer application is poorly managed and effluent produced by the increasing number of tourist resorts in the upper reaches of the catchment. Sewage treatment facilities at these tourist resorts were considered adequate with

no impact on the groundwater quality, however, it was highlighted that the situation be monitored.

- Scattered rural settlements in the lower reaches rely on groundwater of which some borehole heads are not protected from spillage and damage from domestic animals. The DWAF must therefore ensure that borehole heads are protected.

Mogalakwena Key Area

Mogalakwena Key Area is the most densely populated and industrialised key area in the Limpopo WMA and includes the towns of Modimolle, Mookgopong and Mokopane which is becoming increasingly economically important due to the expansion of the platinum mining industry.

The major surface water resources in the Key Area include the Doorndraai Dam, Glen Alpine Dam and run-of-river, mostly supplying irrigation. These sources have already been fully developed and although hydrologically feasible, development of new dams is constrained by the flat terrain.

The water availability and water requirements for the Mogalakwena Key Area are given in Table 2.18 and Table 2.19. Water requirements are considerably higher than given in the NWRS-1 due to the increased estimate in irrigation requirements derived from the registered water use.

At the time of this ISP, the area was considered to be in balance with the implementation of the Reserve having no significant effect. However, the Mogalakwena River system is important from a conservation perspective due to:

- Flow dependant species that occur downstream of the Glen Alpine Dam;
- Pools in the river reaches offering refuge for various species;
- The presence of the short fin barb (international red data specie); and
- The diversity of species has been lost due to the development of river reaches, and further loss should be minimised.

Table 2.18: Water availability in Mogalakwena Key Area (1:50 year assurance) in year 2003

Resource category	Available/impact (million m^3/a)
Gross surface water resource	60
Subtract ecological Reserve	5[(1)]
Subtract invasive alien plants	5
Net surface water resource	50
Groundwater	55[(2)]
Return flows	7
Total local yield	**112**
Transfer in	3[(3)]
Grand total	**115**

1) As per the NWRS, but seems low and requires a comprehensive Reserve determination.
2) Registered groundwater use is 49 million m^3/a but total supplied from groundwater is estimated at 55 million m^3/a, including Schedule 1 rural use.
3) Transferred from Apies/Pienaars system to Modimolle

Table 2.19: Water requirements in Mogalakwena Key Area (1:50 year assurance) in year 2003

Water users	Quantity (million m^3/a)
Irrigation	90
Urban	9[(1)]
Rural	9
Mining/ Industrial	6
Afforestation	0
Total local requirements	**114**
Transfer out	0
Grand total[(2)]	**114**

1) Urban requirements are mostly those of Modimolle, Mookgopong and Mokopane.
2) Excludes ecological Reserve of 5 million m^3/a and invasive alien plants of 5 million m^3/a

There are no reported serious water quality issues in the Mogalakwena Key Area. However the following pose threats to especially the groundwater quality:

- Poorly managed fertilizer application;
- Mining activities including mine water decant from old and abandoned mines;
- Poor sanitation and pollution from pit latrines in informal settlements which could result in elevated TDS and NO_3 concentrations;
- Informal settlement borehole heads not protected from water spillage and damage by animals; and
- Naturally occurring fluorides coming from the underlying granite.

The extent of pollution due to the aforementioned activities must be determined to gain an understanding of the groundwater issues. To minimise groundwater pollution, it was proposed that new boreholes supplying densely populated informal settlements must be positioned well away and the water be piped to the settlements. Furthermore, protection must be provided to existing boreholes heads in informal settlements and rural communities. The resources of the basalt in the Taaibosch Fault area are reserved to supply over 20 communities. This aquifer must be protected against over-exploitation and quality deterioration.

A moderate population growth is expected with the increase of water requirements due to:

- Fast growing urban population due to uncontrolled growth of informal settlements;
- Mining and industrial development;
- Economic development to relieve poverty;
- Emerging farmers; and
- Supplying basic water services to rural communities who are in urgent need thereof.

The following reconciliation options, in order of priority, were considered to meet future requirements:

- WCWDM, recycling of water at mines and clearing of invasive alien plants;
- Groundwater (Care must be taken to not over-exploit the resource);
- Additional transfers from other WMAs such as from the recently raised Flag Boshilo Dam; and
- Compulsory licensing (last resort).

Sand Key Area

The Sand Key Area is the driest key area in the Limpopo WMA but has the largest water requirement. Large towns include Polokwane, Makhado, Musina and Mogwadi. Surface water resources are very limited and the majority of water requirements are supplied by abundant groundwater resources and transfers from other WMAs. The sustainability of groundwater resources are doubted as it is almost over-exploited due to an above-expected growth of the irrigation sector. The water availability and water requirements are given in Table 2.20 and Table 2.21.

Table 2.20: Water availability in Sand Key Area (1:50 year assurance) in year 2003

Resource category	Available/impact (million m^3/a)
Gross surface water resource	11
Subtract ecological Reserve	1(1)
Subtract invasive alien plants	0
Net surface water resource	10
Groundwater	95(2)
Return flows	10
Total local yield	**105**
Transfer in	15(3)
Grand total	**120**

1) Ecological Reserve determination is not of high priority as there are no flow dependent species found in the Sand River system due to mostly seasonal flows only.
2) Exploitable potential, rechargeable groundwater resource estimated at 165 million m^3/a.
3) Refer to **Table 2.6** for transfers to the Limpopo WMA. A small transfer is made from the Limpopo River to the Venetia Diamond Mine in Musina.

The NWRS-1 indicated that this key area is in balance, however, from Table 2.20 and Table 2.21 the Key Area appears to be in a large deficit. This may be due to the large registered irrigation requirement which must be urgently verified as it cannot be sustained from local water resources.

Table 2.21: Water requirements in Sand Key Area (1:50 year assurance) in year 2003

Water users	Quantity (million m^3/a)
Irrigation	185(1)
Urban	24
Rural	9
Mining/ Industrial	4
Afforestation	0
Total local requirements	**222**
Transfer out	0
Grand total(1)	**222**

1) Mainly supplied by groundwater.
2) Excludes ecological Reserve of 1 million m^3/a.

A moderate population growth is expected for this area. Water requirements are expected to increase in the vicinity of Polokwane and other activities of economic importance due to:

- Potential mining development by Kumba Resources near the confluence of Sand and Diep Rivers;
- Growing urban demands;
- Growing rural communities and the provision of basic water services to all; and
- Other mining and industrial developments which include prospective diamond mining developments by De Beers, however certainty thereof is limited.

The following measures are considered to meet future water requirements:

- No more issuing of irrigation licenses and urgent verification of lawful water use;
- Growing urban demands can be met from existing transfer schemes;
- Source growing rural requirements from groundwater if not yet over-exploited, otherwise compulsory licenses need to be issued;
- Reuse of treated effluent and recycled water; and
- Implement compulsory licensing if groundwater resources are indeed over-exploited.

Groundwater quality is severely affected in the Mogwase and Vivo area by the over-exploitation and uncontrolled use of fertilizers resulting in high nitrate concentrates. Furthermore the same threats and solutions as described for the Mogalakwena Key Area apply. As groundwater is the dominant supply source, protection thereof is of high importance. Additionally the following groundwater protection measures have been highlighted:

- Develop and implement groundwater quality monitoring;
- Seal off abandoned mines, especially in the Musina area, by covering it with soil and vegetation to minimize water ingress into the workings; and
- Allocate funds to improve sanitation facilities in rural and informal settlements.

Nzhelele Key Area

The Nzhelele Key Area has higher rainfall and thus more runoff compared to other key areas. The water users of the Nzhelele River catchment are mainly supplied by Nzhelele Dam, Mutshedzi Dam, smaller farm dams and run-of-river abstractions. Makhado Centre or Town is small industrial area consisting of a vegetable processing factory, bakery and furniture factory and is supplied by the Mutshedzi Dam Regional Supply Scheme. The Siloam Hospital is supplied by the *Nzhelele RWSS*. The dominant sector is irrigation of which much is operated by emerging farmers.

The water availability and water requirements in the Nzhelele Key Area is summarised in **Table 2.22** and **Table 2.23**.

Table 2.22: Water availability in Nzhelele Key Area (1:50 year assurance) in year 2003

Resource category	Available/impact (million m^3/a)
Gross surface water resource	26(1)
Subtract ecological Reserve	2
Subtract invasive alien plants	1
Net surface water resource	23
Groundwater	11
Return flows	2
Total local yield	**36**
Transfer in	0
Grand total	36

1) Source: Nzhelele Basin Study (DWAF, 1993).
2) Exploitable potential, rechargeable groundwater resource estimated at 165 million m^3/a.

Table 2.23: Water requirements in Nzhelele Key Area (1:50 year assurance) in year 2003

Water users	Quantity (million m^3/a)
Irrigation	36(1)
Urban	0.2
Rural	4
Mining/ Industrial	0
Afforestation	1(2)
Total local requirements	41
Transfer out	0
Grand total(3)	41

1) Sourced from WARMS: Allocated area of 4800 ha but only 3160 ha were irrigated at the time of the study, implying irrigators registered entitled use instead of actual use.
2) Total area of 31 km^2 and reduces runoff by 2 million m^3/a, available yield by 1 million m^3/a.
3) Excludes ecological Reserve of 2 million m^3/a.

The upper reaches of the Nzhelele River system are perennial and support flow dependant species whereas the flow regime in the lower reaches have been altered by releases from the Nzhelele Dam. To ensure abstractions from this system do not negatively affect the aquatic environment, an intermediate ecological determination is of high priority.

The Key Area is stressed with a deficit of 5 million m^3/a which will be increase with the implementation of the Reserve. The full quota can be supplied to irrigators only 60% of the time as stated in the Nzhelele Basin Study.

Diffuse pollution from canning factories, *acid mine drainage* (AMD), poorly managed fertilizer and unprotected borehole heads can affect water quality which is currently considered to be adequate. The study highlighted that studies be undertaken to determine the extent of pollution.

Little increase in water requirements are expected due to the limited surface water resources, however implementing service delivery in rural areas to RDP standards will increase water supply. The following reconciliation options have been identified:

- Implement WCWDM measures, especially in the irrigation sector;
- Possibly apply compulsory licensing to accommodate for the reserve (not considered urgent at the time of the study);
- No new allocations to the irrigation sector; and
- Source new domestic requirements from groundwater.

Nwanedi Key Area

The Nwanedi River catchment is the smallest catchment in the Limpopo WMA with the majority of the area situated in the Soutpansberg Mountains where the rainfall is relatively high. Surface water resources include the Nwanedi and Luphephe dams and run-of-river yield. Although there is ample and underutilised groundwater resources available, water use from groundwater is limited. The water availability and water requirements in the Nwanedi Key Area is summarised in **Table 2.24** and **Table 2.25**.

Table 2.24: Water availability in Nwanedi Key Area (1:50 year assurance) in year 2003

Resource category	Available/impact (million m^3/a)
Gross surface water resource	8
Subtract ecological Reserve	1
Subtract invasive alien plants	0
Net surface water resource	7
Groundwater	2
Return flows	1
Total local yield	**10**
Transfer in	0
Grand total	**10**

Table 2.25: Water requirements in Nwanedi Key Area (1:50 year assurance) in year 2003

Water users	Quantity (million m^3/a)
Irrigation	15(1)
Urban	0
Rural	1
Mining/ Industrial	0
Afforestation	0
Total local requirements	**16**
Transfer out	0
Grand total(2)	**16**

1) Based on registered water use, but seems that actual use is more.
2) Excludes ecological Reserve of 1 million m^3/a

The deficit of 6 million m^3/a, due to over-allocation or over-development of the irrigation sector, is large relative to the size of the catchment. Additional future water requirements will be due to increasing the standards of water supply in the rural areas and can be sourced from groundwater or by raising Mutshedzi Dam.

Furthermore no new licenses should be issued for irrigation and compulsory licensing may be required to deal with the over-developed irrigation sector and the implementation of the Reserve.

The physical and chemical quality of the water released from the Nwanedi and Luphephe dams, abstractions of water from the river, and sedimentation of the river channel have had an adverse effect on the fish communities and endangered species and thus it was recommended that the whole Nwanedi River be regarded as an environmentally sensitive area (MacDonald Shand Consortium, 1991).

Limpopo Main Stem

A substantial amount of irrigation in the Limpopo WMA is supplied by the Limpopo River, however these flows are poorly quantified and have not been taken into account in the *Water Resources Situation Assessment Report* (DWAF, 2003a) and NWRS-1. The surface flow is very erratic, however, floodwaters is stored in weirs and off-channel dams and the Limpopo River forms a large alluvial aquifer from which substantial but unquantified quantities of water is abstracted from by mostly irrigators. The largest off-channel dam is the Schroder Dam. Minor users include Venetia Diamond Mine and the urban sector of Musina.

This ISP attempted to quantify water use from the main stem, but recommended that a major study be done to quantify the water resources in detail. Hence, for this ISP the assumption made that development along the Limpopo River has expanded to the limit of sustainability and that water resource availability is balanced.

The water availability and water requirements in the Limpopo Main Stem are given in **Table 2.26** and **Table 2.27**. Water availability was derived from spatial analysis of the registered water use in the Limpopo WMA. All water use within 2 km of the Limpopo River was assumed to be sourced from either surface flow or from the alluvial aquifer.

Table 2.26: Water availability in Limpopo Main Stem (1:50 year assurance) in year 2003

Resource category	Available/impact (million m^3/a)
Gross surface water resource	29
Subtract ecological Reserve	0(1)
Subtract invasive alien plants	0
Net surface water resource	29
Groundwater	50
Return flows	0
Total local yield	**79**
Transfer in	0
Grand total	**79**

1) No reserve due to ephemeral nature of the river and shared use of the Limpopo Basin need to be considered when managing the reserve.

Table 2.27: Water requirements in Limpopo Main Stem (1:50 year assurance) in year 2003

Water users	Quantity(1) (million m^3/a)
Irrigation	78(2)
Urban	1
Rural	0
Mining/ Industrial	0
Afforestation	0
Total local requirements	**79**
Transfer out	0
Grand total(3)	**79**

1) Assumed that water use balances the available water resource.
2) Based on registered water use.
3) Requirements sourced from WARMS: 31 million m^3/a directly abstracted from surface water, 49 million m^3/a abstracted from groundwater.

Although a natural occurrence, pools formed in the Limpopo River during the low flow season become inhabited by wild animals and deteriorate the water quality. The water quality is further deteriorated by upstream human development. The water quality of the alluvial aquifer is generally good but may be adversely affected by over-exploitation due to the underlying marine deposits which may cause salination.

Additional abstractions from the Limpopo River should not be permitted due to the water quality issues and international constraints. If need be additional water should be sources from groundwater 2 km away from the Limpopo River.

The ISP required that a water resources study of the Limpopo Basin be conducted to better understand the current and future water requirements of the Limpopo River with regard to the Limpopo WMA.

2.5 Groundwater Use in Parts of the Limpopo Basin, South Africa

Report Title: Groundwater use in parts of the Limpopo Basin, South Africa. ISBN: 978-960-474-148-9. ISSN: 1790-5095. Proceedings of the 3rd International Conference on Energy and Development - Environment – Biomedicine. Author: Ola Busari. 2009

2.5.1 Overview

The paper focuses on the groundwater use in the Limpopo WMA, examining the potential for meeting current and future water requirements in the area as an additional source for domestic needs, smallholder agriculture and similar productive purposes.

This paper draws on national intervention which relates to the development of ISPs within the DWA (now the DWS), as interim catchment management strategies prior to the full establishment of CMAs.

2.5.2 Main findings

Table 2.28 summarises the geo-hydrological characteristics of the six river catchments as well as that of the Limpopo River main stem, giving detailed information on the yields, borehole depths and the depth to the water for the various lithologic units in each catchment.

Table 2.28: Geo-hydrological characteristics of the Limpopo WMA

Lithologic unit	General yield (ℓ/s)	Borehole depths (m)	Depth to water (m)
Matlabas, Mokolo and Lephalala catchments			
Sandstone/conglomerate	0.5 – 2 (occasionally higher than 3 in fractured zones) Considered very good, especially around recharge zones of the Waterberg Mountains	55 - 200	20 - 90
Karoo age siltstone/ sandstone	Siltstone: < 0.5 Sandstone: < 2.5	45 - 80	20 – 45
Limpopo Mobile Belt	< 0.5 (occasionally as high as 2) Water quality is poor in some places with high TDS content and anomalous nitrate due to agricultural activities	35 - 85	10 - 45
Norite/gabbro	0.5 – 2.5 (occasionally as high as 5)	40 - 70	20 – 30

Lithologic unit	General yield (ℓ/s)	Borehole depths (m)	Depth to water (m)
Mogalakwena catchment			
Sandstone/conglomerate	0.5 – 2 (occasionally higher than 3 in fractured zones)	50 - 200	
Dolomite/sandstone	< 2 (occasionally higher than 5 in dolomitic zones)	< 100	
Granite aquifers	0.5 – 1 (occasionally higher than 5)	70 - 80	20 - 30
Basalt	0.5 – 2.5 (occasionally higher than 5)	60 - 80	20 - 30
Norite/gabbro	0.5 – 2 (occasionally as high as 5)	40 - 70	20 - 25
Clarens sandstone aquifer	> 40	> 200	
Granite/gneiss/schist	< 0.5 (occasionally as high as 2)	< 80	20 - 30
Sand catchment			
Sandstone/conglomerate	< 0.5 (occasionally higher than 3 in fractured zones)	< 150	
Granite rocks	> 5 High nitrate due to irrigated agriculture		
Karoo Basalt	< 2 (occasionally higher than 5 in structural fractures)	60 - 80	15 - 25
Granite/gneiss/schist	< 0.5 (occasionally as high as 2.5) High TDS content and nitrate levels due to intense agriculture	40 - 70	20 – 30
Nzhelele/Nwanedi catchment			
Coarse sandstone	< 0.5 (occasionally higher than 3 in structural fractures)	50 - 150	20 - 50
Karoo sandstone	< 0.5	40 - 70	20 - 30
Basalt aquifer	0.5 - 2 (occasionally higher than 5 in structural fractures supplying human settlements and intense agriculture)	65 - 85	15 - 25
Granite/gneiss/schist	< 0.5 (occasionally as high as 2 in weathered zones, faults and fractures) High TDS content and nitrate levels due to intense agriculture	40 - 70	20 – 30
Limpopo main stem			
Granite-gneiss-schist of the Limpopo Mobile Belt. (downstream of the Crocodile and Marico Rivers confluence)	1 – 2.5		15 – 25
Pontdrift-Weipe area (extensive irrigation supply)	< 30 (average yield of 16.7ℓ/s recorded at approximately 400 boreholes)		15 - 25

The water use per sector is provided in Table 2.29. The irrigated area supplied by groundwater as well as the quantity abstracted is provided in Table 2.30. The groundwater use and potential per river catchment in is summarised in Table

2.31. Data from sources indicated that groundwater abstractions in the Limpopo WMA have more than doubled from 1995 to 2009.

Table 2.29: Groundwater use per sector including the Limpopo River main stem

Sector[1]	Groundwater abstraction (million m^3/a)
Irrigation	181
Mining	10
Urban supply	12
Rural supply	55
Stock watering	3
Total[2]	**261**

1) Sourced from Government of Limpopo Province (Projects that Use Groundwater as a Water Source, 2002) and H du Toit (DWAF, 2002).
2) Total of 200 million m^3/a if Limpopo River main stem is excluded.

Table 2.30: Groundwater use for irrigation including the Limpopo River main stem

Catchment Area	Irrigated area[1] (ha)	Groundwater abstraction[1] (million m^3/a)
Northern Springbok Flats	9 000	45
Sand River	8 500	42
Pontdrift / Weipe	5 800	60
Mogwadi	4 500	23
Altona	850	7
Makhado (Louis Trichardt)	420	2
Taaibosch	180	1
Beauty / Marnitz	180	1
Total	29 430	181

1) Sourced from Government of Limpopo Province (Projects that Use Groundwater as a Water Source, 2002) and H du Toit (Update on Groundwater Use Data in the Limpopo and Luvhuvhu Letaba Water Management Areas, 2002).

Table 2.31: Groundwater use and potential excluding the Limpopo River main stem

Catchment Area	Abstraction (million m^3/a)		Potential (million m^3/a)	
	1995	2002	Initial	Available
Matlabas / Mokolo	7	8	75	67
Lephalala	4	4.5	35	30.5
Mogalakwena	15	48	125	77
Sand	71	74	85	11
Nzhelele / Nwanedi	1	1.5	14	12.5
Total	**98**	**136**	**334**	**198**

Furthermore the main findings can be summarised as follows:

- Aquifer yields from the Limpopo River main stem alluvium averages 16.7 ℓ/s.
- The groundwater use in the WMA rose from 98 million m^3/a to 136 million m^3/a (approximately 40%) between 1995 and 2002 with the highest growth recorded in the Mogalakwena River catchment due to expanding mining activities.
- Most of the rivers in the Limpopo WMA flow north toward the Limpopo River, making it the only true perennial river. Most of the water courses are mainly active during the wet season and do not consist of water bearing strata with the capacity to store and then to transmit water to rivers. Discharge in the Limpopo River is highly variable due to the seasonal nature of the rainfall.
- Irrigation constitutes the highest groundwater use. Groundwater from the Limpopo River main stem alluvium is extensively used for irrigation in the Mogwadi, Bochum, Pontdrift and Weipe areas (Sand River catchment). The groundwater levels have fallen more than 50m since 1970 in the Mogwadi area where the local aquifer has been the sole source of irrigation water supply.
- Groundwater is considered a viable resource to meet future water requirement in entire Mokolo River catchment, central areas of Moglalakwena River catchment and limited parts of the Lephalala and Sand River catchments.
- More attention should be given to the study area as part of a shared international groundwater system.

2.6 JOINT LIMPOPO RIVER BASIN STUDY

Report Title: Joint Limpopo River Basin Study: Scoping Phase: Main Report. LBPTC. Prepared by Biggon Consortium. January 2010.

2.6.1 Overview

The purpose of the *Joint Limpopo River Basin Study* was to quantify the present and future balances in the Limpopo River Basin, which include the four co-basin states; Botswana, Zimbabwe, Mozambique and South Africa, as well as to plan future water development and management options to effectively meet future requirements within the Basin. The Scoping Phase focussed on reviewing all existing studies and data as well as on identifying additional data requirements and a work programme for the subsequent phase of the study, *Water Resources Development Strategy for the Limpopo River Basin*.

An inventory of existing information was compiled which include previous studies on the Limpopo River, maps and GIS, climatic data, surface water data and reservoir levels, groundwater data and hydrogeological information, water quality and riverine sediment transport, water demand and use, socio-economic information and legal and institutional information. A large amount of data on hydrometeorology and water quality was identified.

For the purpose of this Literature Review Report only information relevant to the Limpopo WMA included in the Joint Limpopo River Basin Study are discussed.

2.6.2 Main findings

The following main findings with regard to the general overview of the South African section of the Limpopo River Basin include:

- The total population in the South African section of the Limpopo Basin for 2007 was estimated at 10 720 838 (22% of the total South African population). However no distinction has been made between the numbers in each catchment area.
- The total water demand for South Africa is 3000 million m^3/a of which:
    - 1485 million m^3/a is for irrigation;
    - 665 million m^3/a is for urban supply;
    - 140 million m^3/a is for rural supply;
    - 445 million m^3/a is for mining and power generation;
    - 45 million m^3/a is for afforestation; and
    - 250 million m^3/a is for water transfers to neighbouring river basins.
- The perspectives for the future are that water demand for urban and rural water supply in South Africa will increase, in correspondence with the increase of population and the level of service provision, while there is no significant expected increase in the other water uses.
- The impact of small dams individually on the basin hydrology is considered negligible, however, the conjunctive impact is significant and must be included in the hydrological modelling.
- The most significant impact of water demand management is associated with irrigation, main urban centres, industry and mining. Water tariff increases are one of the most utilized tools to induce an increase in water use efficiency.
- The study indicates that the Matlabas, Mokolo, Mogalakwena and Nzhelele River Catchments are stressed while the Lephalala and Sand River Catchments are in balance. It is also recommended that the newer data from the *Water Resources of South Africa 2005* (WR2005) be used to update water balances rather than the NWRS-1.
- The water quality of the Limpopo River seems to be impacted, but not severe. The water quality in the upper reaches is considered good with TDS ranging between 58 mg/ℓ to 307 mg/ℓ and the nitrate and phosphate levels below 0.5 mg/ℓ and 0.05 mg/ℓ respectively. Water quality in the middle reaches is measured at the monitoring point at Beitbridge by both South Africa and Zimbabwe. The middle reaches of the Limpopo River show that the water quality is dominated by sodium and chloride. Although the TDS concentration is 350 mg/ℓ, the impact is not severe but still visible due to upstream activities. The nitrate and phosphate concentrations are below 1 mg/ℓ.

- The South African Desktop Model can be used to analyse the *environmental flow requirements* (EFR) by inputting natural flow data and the *ecological management class* (EMC) included in a desktop study for all quaternary catchments in South Africa. See **Table 2.32** for the estimates of the EFR for the applicable sub-basins of the Limpopo River. The estimates were based on the development level in the river and thus the confidence level is very low and estimates need to be confirmed. A field study during the comprehensive river basin study was recommended.
- Development of water-related infrastructure in the four countries must be conducted with clear guidelines on allocated water and agreed minimum border flows. Similarly, mechanisms for exchange of data and information must be developed for compliance and for drought and flood emergency management.

Table 2.32: Estimates of the EFR for sub-basins of Limpopo River

Sub-catchment	Quaternary catchment at outlet	Estimated EMC	Estimated EFR (% of MAR)	Comments
Matlabas	A41D	C	20	Many farm dams and irrigation
Mokolo	A42J	C	20	Many farm dams and irrigation
Lephalala	A50H	D	13	Undeveloped but low EFR
Mogalakwena	A63J	C	20	Mining dams and irrigation
Sand	A71K	B	28	Largely natural
Nzhelele	A80G	D	13	Irrigation and dams

The **Table 2.33** provides a list of the relevant river basin studies in South Africa sourced from the DWA (now DWS) which was reviewed to determine the available data and data gaps.

Table 2.33: Relevant river basin studies in South Africa sourced from the DWA

Sub-catchment	Year	Sub-catchments included
Joint Upper Limpopo Basin Study – Joint Permanent Technical Committee.	1991	Matlabas, Mokolo, Lephalala, Mogalakwena, Upper Limpopo
Lephalala River Catchment Study: Water Resources Development Study.	1991	Lephalala
Water Resources Planning of the Mogalakwena River Basin: Situation Assessment and Development Potential.	1991	Mogalakwena
Water Resource Planning of the Sand River Basin: Study of the Development Potential And Management of the Water Resources.	1992	Sand
Water Resources Planning of the Nzhelele River Basin: Study of the Water Resources.	1993	Nzhelele
Groundwater Use in the Limpopo.	2003	Lephalala, Mogalakwena, Sand, Nzhelele
Updating the Hydrology and Yield Analyses in the Mokolo River Catchment.	2007	Mokolo
Mokolo and Crocodile River (West) Water Augmentation Project.	2010	Mokolo

With regard to data availability in the Limpopo area, the following have been determined:

- Geographical data to provide visual summaries are available for the Limpopo WMA, indicating cadastral, topography, climate, geology and hydrogeology, soils, vegetation, infrastructure, bulk water supply and land use;
- There are a great number of rainfall and runoff measuring stations (including water levels and discharges at all major dams) in the Limpopo WMA. In many cases runoff data is of poor quality due to sediment transport affecting the rating curve and it is recommended that affected rating curves be updated annually;
- According to the Scoping Report, there is a lot of general information available on the hydrogeology of the section of the Limpopo River Basin situated in South Africa;
- Water quality data of the Limpopo River Catchment in South Africa were sourced from the DWA and were concluded to be extensive;
- Water demand data for South Africa were obtained from recent studies done in the various sub-catchments of the Limpopo River Basin located in the country; and
- Socio-economic information was gathered from national censuses and from national, regional, district and municipal development plans.

2.7 Limpopo River Basin Monograph Study

Report title: Limpopo River Basin Monograph: Surface Water Hydrology. Report no. LRBMS-81137945. Limpopo Watercourse Commission. Prepared by G Howard, F Denys, N Walker and A Gorgens. September 2013.

2.7.1 Overview

The purpose of the *Limpopo River Basin Monograph Study* was to compile essential baseline information required for the analysis of potential future developments in the Limpopo River Basin and the development of the IWRM Strategy and Plan for sustainable management of the basin.

The Surface Water Hydrology Report provides detailed information on the surface water-related data assemblies, processing, catchment modelling and interpretations executed to develop the Surface Water Resources and Water Balance Components of the Limpopo River Basin Monograph Study. This includes areas of Zimbabwe, Botswana, Mozambique and South Africa.

For the purpose of this Literature Review Report only information relevant to the Limpopo WMA will be discussed.

2.7.2 Main findings

The main findings or significant information are as follows:

- Catchment models for all South African sub-basins were configured using calibrated model configurations from the WR2005 or configurations from more recent studies as listed in **Table 2.34**. No catchment model calibration was necessary and only the extension of input rainfall data sequences from 2004 to 2010 (hydrological years) were required.
- Raw rainfall data from 2004 to 2010 was obtained from the DWA's (now DWS) *Water Resource Information Management System* (WRIMS) and patched using ClassR and PatchR. Where possible, the same rainfall station groupings were used as in the sourced studies. Furthermore, data was manually assessed with special attention given to extreme values and dimensionless mass plots were used to assess the stationarity of the patched rainfall sequences. The following problems were encountered:
    - January 2011 rainfall data were missing for all rainfall gauges in the Limpopo WMA; and
    - November 2010 rainfall data were missing for the majority of the rainfall gauges in the Limpopo WMA.
- Water use directly from the Limpopo River main stem was not accounted for in the sub-catchment models but in the Limpopo River main stem model.
- Long-term streamflow sequences (1920-2010) were used to derive 1:5-year yields on a sub-basin basis, which were then used to evaluate the water balance situation of the sub-basins as well as of larger zones in the Limpopo River Basin. **Table 2.35** shows the resultant incremental MARs.
- Observed annual maximum flood peaks were assembled for gauging stations in Zimbabwe, Mozambique and South Africa and used to develop flood peak exceedance probability distributions on a sub-regional pooling basis. The recurrence interval flood peaks for the relevant sub-basins are provided in **Table 2.36**.

Table 2.34: Studies used for Limpopo River Basin Monograph Study model configurations

Sub-basin	Study configuration used
Matlabas	WR2005
Mokolo	Updating the Hydrology and Yield Analysis in the Mokolo River (DWAF, 2007)
Lephalala	WR20005
Mogalakwena[(1)]	Establishment of Operating Rules for the Glen Alpine System (DWA, 2011)
Sand	WR2005
Nzhelele	WR2005

1) Study only modelled as far as Glen Alpine Dam and thus it had to be extended to the Limpopo River main stem

Table 2.35: MARs and current-day net surface water impacts (million m^3/a)

Sub-basin	Natural MAR	Current-day MAR
Matlabas	52	46
Mokolo	210	165
Lephalala	124	67
Mogalakwena	198	127
Sand	74	40
Nzhelele	100	70
Limpopo River main stem: A5H003	759	494
Limpopo River main stem: Pafuri	2831	2030

Table 2.36: Recurrence interval flood peaks for sub-basins (m^3/s)

Sub-basin	Mean annual maximum flood peak	Recurrence interval flood peak		
		1:20 year	1:50 year	1:100 year
Matlabas	177	671	964	1192
Mokolo	156	591	848	1049
Lephalala	167	633	909	1124
Mogalakwena	118	448	644	796
Sand	126	470	688	851
Nzhelele	440	1773	2723	3550

The following information with regard to the Limpopo River main stem is of interest:

- The surface water model was set up as a simple streamflow routing module receiving inflows from various sub-basins and only accounted for water use directly from the main stem not included in the sub-basin models;

- Two gauges situated in the Limpopo River were included in the model. These are:
  - The Sterkloop gauge, a combination of RSA streamflow gauges A5H003 and A5H006 situated downstream of the Lephalala confluence. The combined record (1959-2011) had questionable values from 1980 to 1990; and
  - The Beitbridge gauge, a combination of RSA streamflow gauges A7H004 and A7H035 situated upstream of the Sand River confluence. The record length being from 1955 to 2011.
- Raw daily streamflow records were processed and patched using manual infilling and upstream and downstream gauges as reference;
- Table 2.37 provides the total area of irrigation and the associated water abstraction from surface water only. Water abstracted from boreholes causing lowering of the local water tables in the alluvial aquifers was not included in the model; and
- Transmission losses along the tributary and Limpopo main stem channels were simulated using a special loss feature in the Channel Reach Module in the WRSM2000 software. The volume of the alluvial "storage" that causes the losses and the effect of the loss function on current-day streamflow are presented in Table 2.38. Both natural and irrigation supply losses are significant.

Table 2.37: Irrigation areas and water-use on the Limpopo main stem

Reach number	Irrigation area (km^2)	Water use (million m^3/a)
Reach 1 – from Marico and Crocodile confluence to Sterkloop streamflow gauge	54	41
Reach 2 – from Sterkloop to Shashe confluence	21	20
Reach 3 – from Shashe confluence to Beitbridge streamflow gauge	70	41
Reach 4 – from Beitbridge streamflow gauge to Pafuri	6	3

Table 2.38: Alluvial storage volume and current-day mean annual losses for each main stem reach

Reach number	Alluvial "Storage" Volume (million m^3)	Mean Annual Transmission Loss (million m^3)
Reach 1 – from Marico and Crocodile confluence to Sterkloop streamflow gauge	367	243
Reach 2 – from Sterkloop to Shashe confluence	157	150
Reach 3 – from Shashe confluence to Beitbridge streamflow gauge	88	70
Reach 4 – from Beitbridge streamflow gauge to Pafuri	111	109

2.7.3 Issues and recommendations

The following issues and recommendations were identified and developed:

- The decreasing number of operational rainfall gauges, streamflow gauges and general weather stations affect the quality of the hydrological data;
- The streamflow at a number of streamflow gauges have been under-recorded due to exceedance of stage/discharge rating limits;
- Distinctions between abstractions for domestic, industrial and agricultural water supply were lacking;
- The dimensions and extent of alluvial storages in the Limpopo River main stem and some sub-basin main stems require further investigation and updating; and
- Four areas of weakness with regards to surface water hydrology were identified in the Limpopo WMA. These include:
  - Matlabas River catchment;
  - Lephalala River catchment;
  - Streamflow measuring station A5H003 on the Limpopo River; and
  - Nzhelele River catchment.

2.8 National Water Resource Strategy – Water for an Equitable and Sustainable Future. Second Edition

Report title: National Water Resource Strategy – Water for an Equitable and Sustainable Future. Second Edition. Department of Water Affairs. June 2013.

2.8.1 Overview

The purpose of the second edition of the NWRS-2 is to build on the work done through the NWRS-1, published in 2004, and to ensure the protection, development, utilisation, conservation and management of the country's water resources. The strategy recognises that South Africa is a water scarce country and that it requires careful management to ensure the resources are controlled in a sustainable and efficient manner. Water supports development, elimination of poverty and inequality, contributes to the economy and job creation and effective management of this resource will assist South Africa in achieving its development goals over the next five to ten years.

In terms of the NWA (Act 36 of 1998), the purposes of the NWRS are to:

- Facilitate the proper management of the nation's water resources;
- Provide a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole;
- Provide a framework within which water will be managed at regional or catchment level, in defined water management areas;
- Provide information about all aspects of water resource management; and
- Identify water-related development options.

Only information relevant to the Limpopo WMA is discussed in this Literature Review Report.

2.8.2 Annexure A: Perspectives per Water Management Area

This discussion examines each of the relevant independent catchments of the Limpopo WMA which feed into the main stem of the Limpopo River.

a) ***Matlabas catchment***

The Matlabas River catchment contains no significant dams and has very limited water resources available. Water requirements in the catchment are low, but the catchment is currently in deficit. However, the deficit is not crucial as there is very little growth potential in the catchment The most reliable source of water in the catchment is from groundwater, despite the boreholes having low yield. Some opportunistic irrigation does take place with very low surface water assurance levels.

b) ***Mokolo catchment***

The Mokolo River originates in the Waterberg Mountains area. The Mokolo Dam, situated in the lower reaches of the river, is the only major dam in the catchment. The catchment is predominantly rural with Lephalale town being the urban centre. The Waterberg Coalfields in the vicinity of Lephalale provides for development potential, although growth expectations have been reduced since 2010.

The land use is shifting towards game farming and there has been a drop in irrigation in the catchment, resulting in an increase in the yield of the Mokolo Dam. Currently, the dam is fully allocated but is able to meet the bulk of the current requirements. However, additional future water requirements, including that of the Medupi Power Station, will have to be sourced from other catchments. This has resulted in the planning for a pipeline from the Crocodile West River system and is referred to as *Mokolo-Crocodile Water Augmentation Project* (MCWAP). As there are very few other opportunities for further water resource development it is important that the MCWAP considers the growth potential of the catchment.

Mokolo Dam can be raised, however, international obligations with regard to the Limpopo River compromises this option. Groundwater should be considered when supplying rural communities and could also be used to supplement the supply to Lephalale.

c) ***Lephalala catchment***

The catchment has very little water resource development and there are no major dams, only farm dams and weirs. The land use comprises of rural farming communities, whilst the Wilderness nature conservation area is situated in the middle reaches of the river. The Lephalala River is mostly unregulated and flood waters enter into the Limpopo River. Irrigated agriculture is supplied mainly from surface water in the upper reaches and from groundwater (alluvial aquifers) in the lower reaches.

Additional local needs will need to be met through utilisation of groundwater or from existing local resources, as they have been in the past. Construction of a large dam on the Lephalala River is not feasible as all the existing low flows are captured.

d) ***Mogalakwena catchment***

The water resources in the Mogalakwena River catchment have been fully developed. There are two major dams in the catchment the Doorndraai Dam, which supplies Mookgophong and Mokopane, and the Glen Alpine Dam, which provides water for irrigation and emerging farmers downstream of the dam. However, emerging farmers have not been utilising their full allocation and should be made available to meet the growing domestic requirements. Modimolle is currently supplied from transfers from Roodeplaat Dam in the Crocodile West catchment.

There is a considerable amount of mining in the area. Mines around Mokopane use a large portion of the yield from Doorndraai Dam which was formerly used for irrigation. Due to the economic growth resulting from mining expansion in the area, more water is urgently required to be transferred in to the catchment. New mines should be supplied from the Flag Boshielo Dam on the Olifants River.

e) ***Sand catchment***

The Sand catchment is heavily dependent on transfers into the catchment from neighbouring systems and has a limited amount of surface water. There are extensive groundwater resources, however, these have been fully and possibly over exploited. Polokwane relies on local groundwater resources and water transferred from the Ebenezer and Dap Naude dams on the Letaba River and the Olifantspoort weir on the Olifants River. Polokwane also recycles effluent water through an innovative artificial recharge scheme. The growing future water requirements will have to be supplied from the Olifants River.

The towns in the Makhado LM receive water from the Albasini Dam and in future will abstract from the Nandoni Dam, both of which are in the Luvuvhu catchment. Currently recycled effluent is used for irrigation, however, in the future it may be necessary to use this resource for both industrial and domestic use.

There is a significant amount of groundwater in the catchment which supplies irrigation. These include areas around Mogwadi and Vivo – in the central and Northern Sand catchment. These schemes must be used in a sustainable manner as some are already over-exploited. Some communities rely solely on groundwater. Land use in the north of the catchment comprises of game farms where there are no surface water resources and no large-scale irrigation. Large coal mining potential is situated near Louis Trichardt and Musina that can only be realised if water is sourced from local sources or transferred internationally.

f) ***Nzhelele catchment***

The catchment drains north from the Soutpansberg into the Limpopo River. The catchment is dominated by irrigation with a small industrial area, known as the Makhado Centre and some forestry on the slopes of the Soutpansberg.

Two dams, Nzhelele and Mutshedzi dams, regulate the catchment. Most of the water use from these dams is for irrigation purposes and for domestic supply. The groundwater resources are suitable to meet the requirements of villages. Even without implementation of the ecological Reserve, the catchment is stressed. Both dams could technically be raised, but this would be difficult to implement considering the international obligations.

The irrigation allocation from the Nzhelele and Mutshedzi dams are currently underutilised and significant losses occur along the Nzhelele Canal system. Thus, water use efficiency and demand management procedures should be implemented before any development of surface water resource infrastructure is considered.

Some coal mining potential exists in the middle and upper reaches of the catchment. In order for this to be exploited water will need to be sourced locally from groundwater or from the existing agricultural water allocations. Effluent water transfer of from Louis Trichardt is another augmentation option but this is not supported by DWA (now DWS) as this water could be utilised by Louis Trichardt itself. Outsourcing effluent water of Louis Trichardt would result in in the town requiring additional transfers from Nandoni Dam which is already fully allocated in supplying the water requirements of the Luvuvhu catchment and the stressed Middle Letaba catchment.

g) ***Nwanedi catchment***

As with the Nzhelele catchment, the Nwanedi system is currently over allocated, although not all allocations are currently being utilised. Water for the dominating irrigation sector is sourced from two small dams (Nwanedi and Luphephe dams) and run-of-river yield.

The approach in this catchment, as in the Nzhelele, should be to reduce losses, improve efficiencies and put unused water to work.

h) ***Limpopo River main stem***

The water resources along the main stem of the Limpopo River are fully developed. The river was once a perennial river but is now highly seasonal. In the upper reaches there are a number of storage weirs across the river, whilst in the lower reaches water abstractions take place out of large sand aquifers in and alongside the river bed. These sand aquifers supply water to Musina and the Venetia Diamond Mine. New developments or expansions will have to source water from other existing sources, for example buying out irrigation water.

2.9 UPDATING THE HYDROLOGY AND YIELD ANALYSIS IN THE MOKOLO RIVER CATCHMENT

Study Information: Updating the Hydrology and Yield Analysis in the Mokolo River Catchment. Department of Water Affairs and Forestry. Prepared by WRP Consulting Engineers, DMM Development Consultants and Golder Associates. 2005 - 2008.

2.9.1 Overview

Due to extensive agricultural development upstream of the Mokolo Dam, anticipated power developments in the Lephalale area including associated increases in domestic water demand and implementation of *ecological water requirements* (EWR), DWAF (now DWS) initiated a study to determine the current water resources capability of the Mokolo River System. Furthermore, a number of intervention measures were considered to address the future water requirements, such as raising of the Mokolo Dam or to implement transfers from the CRW catchment.

The main objectives of the study were to update and extend the hydrology of the catchment to the 2003 hydrological year and to configure the WRSM2000, WRYM and WRPM for the Mokolo River system to assess the system under various scenarios.

2.9.2 Rainfall Data Analysis

Report Title: Updating the Hydrology and Yield Analysis in the Mokolo River Catchment – Rainfall Data Analysis. Report No. P WMA 01/A42/00/01107. Department of Water Affairs and Forestry. Prepared by WRP Consulting Engineers, DMM Development Consultants and Golder Associates. March 2007.

a) ***Objectives of the rainfall data analysis***

The main objectives of the rainfall data analysis were to:

- Update and extend the rainfall database of the Mokolo River catchment to cover the study period of 1920 to 2003 in hydrological years;
- Develop monthly time-series of representative sub-catchment rainfall data for later application in the WRYM and WRPM; and
- Verify that results from analysis are reliable, realistic and plausible by means of standard tests.

b) ***Rainfall data collection, patching and generation of representative catchment rainfall data***

Raw data for 41 rainfall gauges in and around the Mokolo River catchment were sourced from the DWAF's (now DWS) *Rainfall Information Management System* (RainIMS). Only gauges with record lengths longer than 15 years were selected.

The 41 gauges were visually assessed for reliability by means of standard validation tests known as the "single mass plot" and "cusum plot". Eight gauges were discarded and the 33 remaining gauges were compared to those used for the WR2005 study. To develop reliable and complete data sets, rainfall data were patched (replacing and infilling of outlier or missing data values) using the ClassR and PatchR programs.

Time-series of representative monthly rainfall data were developed for each quaternary catchment. Quaternary catchment MAPs were obtained from the *Water Resources of South Africa 1990* (WR90) for the period 1920 to 1989 and adjusted to reflect the MAPs for the period 1920 to 2003.

c) ***Conclusions and recommendations***

Apart from extending rainfall data of the Mokolo River catchment for the period 1920 to 2003 to be applied in other hydrological, stochastic and water resource system analysis, only 9 of the 33 gauges used remained open up to the end of the study period. It is thus recommended that serious consideration should be given to re-open some of the closed gauges.

2.9.3 Hydrological Analysis

Report Title: Updating the Hydrology and Yield Analysis in the Mokolo River Catchment – Hydrological Analysis. Report No. P WMA 01/A42/00/01207. Department of Water Affairs and Forestry. Prepared by WRP Consulting Engineers, DMM Development Consultants and Golder Associates. December 2007.

a) *Objectives of the hydrological analysis*

A full hydrological analysis of the Mokolo River catchment was conducted to:

- Primarily update and extend the hydrology to cover the study period of 1920 to 2003 in hydrological years;
- Generate natural monthly stream flow time-series to be applied in stochastic hydrological and water resource system analyses for defined incremental sub-catchments.

The hydrological analysis was based on modelling approaches and procedures at detail levels that coincide with the five parallel *Water Availability Assessment* (WAA) studies on the Mthlatuze, Inkomati, Berg, Crocodile (West) and Olifants river systems.

b) *Important aspects of the analysis*

Catchment developments

Information on historical irrigation, which covers more than 100 km^2 of the catchment, and characteristics of 1 400 various water bodies within the catchment was obtained from The Mokolo River Catchment – Validation and Verification of the Existing Lawful water Use (DWAF, 2007).

Water use and return flows

Irrigation is a major water user in the Mokolo catchment and covers more than 100 km^2 of the catchment. The water supply for irrigation is mostly sourced from surface water resources. Approximately 20% of the water is sourced from groundwater – 10% from boreholes and the rest from a sand aquifer on the Mokolo River, downstream of the dam. **Table 2.39** indicates the average irrigation requirements in the catchment per annum and **Table 2.40** shows the summary of the return flows.

Table 2.39: Summary of annual average irrigation requirements in the Mokolo River catchment at the 2004-development level

Quaternary catchment		Annual average irrigation requirement supplied from indicated source (million m^3/a)			
No.	Name	Surface water	Ground-water(1)	Scheme(2)	Total
A42A	Sand	7.33	0.52	0.00	7.85
A42B	Grootspruit	5.56	0.35	0.00	5.91
A42C	Mokolo u/s A4H002	5.80	0.96	0.00	6.76
A42D	Sterkstroom	1.19	0.00	0.00	1.19
A42E	Mokolo d/s A42A to A42D	7.27	0.73	0.00	8.00
A42F	Mokolo u/s Mokolo Dam	3.76	0.62	0.00	4.38
A42G	Mokolo d/s Mokolo Dam	0.01	0.00	0.37	0.38
A42H	Tambotie	0.00	0.00	0.83	0.83
A42J	Mokolo u/s Limpopo	0.00	0.00	4.86	4.86
Total		**30.92**	**3.18**	**6.06**	**40.16**

1) Only return flows from groundwater irrigation were modelled in the WRSM2000 rainfall-runoff model since these irrigation areas are located far away from river courses and would have negligible impact on the surface water flows (Schoeman, 2006)
2) Supplied through releases from Mokolo Dam to downstream sand aquifer

Table 2.40: Summary of annual average irrigation return flows in the Mokolo River catchment at the 2004-development level

Quaternary catchment		Annual average irrigation requirement supplied from indicated source (million m^3/a)			
No.	Name	Surface water	Ground-water	Scheme(1)	Total
A42A	Sand	0.59	0.04	0.0	0.63
A42B	Grootspruit	0.44	0.03	0.0	0.47
A42C	Mokolo u/s A4H002	0.52	0.09	0.0	0.61
A42D	Sterkstroom	0.10	0.0	0.0	0.10
A42E	Mokolo d/s A42A to A42D	0.58	0.06	0.0	0.64
A42F	Mokolo u/s Mokolo Dam	0.30	0.05	0.0	0.35
A42G	Mokolo d/s Mokolo Dam	0.00	0.0	0.02	0.02
A42H	Tambotie	0.0	0.0	0.12	0.12
A42J	Mokolo u/s Limpopo	0.0	0.0	0.39	0.39
Total		**2.53**	**0.26**	**0.53**	**3.32**

1) Irrigation areas supplied through releases from Mokolo Dam to downstream sand aquifer

Other water users also include:

- Matimba Power Station;
- Alien invasive vegetation;
- Urban and industrial users; and
- Mining.

Table 2.41 indicates the major requirements and return flows from particular sources in the Mokolo River catchment.

Table 2.41: Summary of major point-source water requirements, allocations and return flows in the Mokolo River system, at the 2004-development level

Name	Allocation (million m^3/a)	Actual water use		Return flows to the river system	
		Volume (million m^3/a)	Source	Volume (million m^3/a)	Location (sub-quaternary)
Vaalwater town[(1)]	0.0	0.0	Groundwater	0.0	A42C9
Grootegeluk coal mine	9.9	3.4	Mokolo Dam	0.0	A42J2
Matimba power station	7.3	3.0	Mokolo Dam	0.0	A42J2
Lephalale/ Onverwacht town	1.0	3.3	Mokolo Dam	1.0	A42H2
Marapong township		0.5	Mokolo Dam	0.3	A42J2
Downstream irrigation scheme	10.4	16.0	Mokolo Dam	0.5	A42G to J
Total	28.6	26.2		1.8	

1) Negligible impact on the overall water resource capability of the Mokolo River system

Impoundments

Mokolo Dam is the only major dam in the catchment but there are numerous small dams and weirs which are summarised in Table 2.42.

Table 2.42: Summary of impoundments in the Mokolo River catchment

Quaternary Catchment		Total full supply capacity (million m^3)	Total area at full supply capacity (km^2)	Total catchment area (km^2)
No.	Name			
A42A	Sand	2.17	1.39	545
A42B	Grootspruit	5.66	3.26	522
A42C	Mokolo u/s A4H002	3.32	2.12	614
A42D	Sterkstroom	3.68	1.18	395
A42E	Mokolo d/s A42A to D	4.90	3.14	972
A42F	Mokolo u/s Mokolo Dam	1.31	1.19	855
A42G	Mokolo d/s Mokolo Dam	0.56	0.56	793
A42H	Tambotie	1.46	1.05	674
A42J	Mokolo u/s Limpopo	0.29	0.54	675
Total Mokolo River catchment		23.36	14.43	6 046

Hydro-meteorological data

The hydro-meteorological monitoring network used was found to be of good quality. However, of the 33 rainfall gauges used in the rainfall analysis only 9 remained open and only 4 of the 13 streamflow gauges in the catchment could be utilized for the calibration of the WRSM2000 rainfall-runoff model. These streamflow gauges are as follows:

- A4H002 (Mokolo River @ Zand Riveℓ/Vaalwater)
- A4H005 (Mokolo River @ Dwaalhoek)
- A4H007 (Tambotie River @ Blakeney)
- A4H008 (Sterkstroom @ Doornspruit)

An additional gauge was constructed at the confluence between the Mokolo and the Limpopo rivers. This gauge has been recording data since February 2004.

Rainfall-runoff modelling

Rainfall-runoff modelling was completed using the WRSM2000 rainfall-runoff model. Calibration of the model aimed to achieve a situation where the simulated flows mimic the historically observed flows, for the periods where data was available at a gauging station.

The effects of groundwater – surface water interaction were modelled using Sami *Groundwater-Surface Water Interaction Model* (GWSWIM), incorporated into the WRSM2000 model.

Natural streamflow data

The development of time-series of monthly natural streamflow data was achieved through:

- Naturalising observed streamflow data for gauged catchments;

- Extension of naturalised streamflow time-series;
- Scaling of natural streamflow time-series; and
- Generation of simulated natural streamflow for ungauged catchments based on WRSM2000 calibration parameters of nearby gauges.

c) *Results*

The results are summarised in Table 2.43. The results show, as expected and similar to the WR90, that the MAR, expressed as a percentage of the MAP, is the highest in the quaternary catchment A42D, and gradually decreases downstream toward the drier, flatter sandy areas.

Table 2.43: Results of hydrological analysis of the Mokolo River catchment

Quaternary Catchment		Net catchment area[(1)] (km^2)	Statistic (over the period 1920 to 2003 hydrological years)					
			MAP (mm)	Natural MAR			SD (million m^3/a)	CV
No.	Name			million m^3/a	mm	As % MAP		
A42A	Sand	573	650	25.48	44	6.8	21.83	0.86
A42B	Grootspruit	522	666	27.80	53	8.0	2.81	0.86
A42C	Mokolo u/s A4H002	698	660	37.51	54	8.1	32.14	0.86
A42D	Sterkstroom	497	674	43.45	87	13.0	38.37	0.88
A42E	Mokolo d/s A42A to D	1007	598	43.91	44	7.3	55.32	1.26
A42F	Mokolo u/s Mokolo Dam	1022	570	35.16	34	6.0	44.29	1.26
A42G	Mokolo d/s Mokolo Dam	1207	545	34.11	28	5.2	51.41	1.51
A42H	Tambotie	1009	515	27.28	27	5.2	38.71	1.42
A42J	Mokolo u/s Limpopo	1515	427	15.79	10	2.4	27.09	1.72
Total Mokolo River catchment		8050	562	290.48	36	6.4	303.79	1.05

1) Excludes catchment areas that drain into pans and do not contribute to surface water flows

d) *Conclusions and recommendations*

The hydrological analysis returned a number of conclusions and findings as follows:

- The historical irrigation areas and practices, and the historical characteristics of water bodies information was excellent;
- The enhanced methodology for the modelling of irrigation water requirements and return flows, developed by Schoeman & Vennote, realistically mimics actual irrigation practices in the catchment;
- It is concerning that only 9 of the 33 gauges used have remained open; and
- The lack of streamflow data downstream of Mokolo Dam is a shortcoming, however, a new gauge has been installed at the confluence

between the Mokolo and Limpopo rivers. This gauge has been recording data since February 2004 and will be useful for future studies.

The hydrological analysis of the Mokolo River catchment provided the following recommendations:

- Further research should be undertaken on the validity of combining individual dams into representative dummy dams;
- A sensitivity analysis should be done with regard to the effect of GWSWIM parameters on simulated flows;
- The following actions are recommended with regard to gauges not used during the analysis:
  - A4H001 – has been closed and should remain so.
  - A4H003 – should be closed.
  - A4H006 – Should remain closed.
  - A4H009 – Should remain open, it would be useful for a localised studies and has a good record length.
  - A4R001 – this data is useful and has previously been used to patch missing flow data for high flows at the upstream A4H005.

2.9.4 Yield Analysis

Report Title: Updating the Hydrology and Yield Analysis in the Mokolo River Catchment – Yield Analysis. Report No. P WMA 01/A42/00/01307. Department of Water Affairs and Forestry. Prepared by WRP Consulting Engineers, DMM Development Consultants and Golder Associates. June 2008.

a) ***Objectives of the yield analysis***

The objective of the yield analysis was to conduct a detailed system analysis to mainly assess the yield of the Mokolo Dam in a variety of situations, based on the updated and extended hydrology. Similar modelling approaches and procedures, as well as detail levels, were used as in the aforementioned WAA studies.

b) ***Results***

The results can be summarised as follows:

- The 1:200-year yield available from the Mokolo River system for a hypothetical “natural” situation where no catchment developments are modelled in the catchment upstream of Mokolo Dam, is 67.9 million m^3/a (which is 47% of the dam’s live full supply capacity).
- The 1:200-year yield available from the Mokolo River system under current-day conditions is 39.1 million m^3/a. This is considerably higher than the total allocation from Mokolo Dam of 27.6 million m^3/a for Grootegeluk coal mine, Matimba power station, the towns of Lephalale and Onverwacht, Marapong township and the irrigation scheme downstream of the dam.
- The effect on the above yield of small dams, weirs and gravel pits, located inside the Mokolo River catchment at the 2004-development level, is 12.4 million m^3/a. This is equivalent to 56% of the total capacity of the water bodies in question.

- The effect on the above yield of surface water and groundwater due to irrigation located upstream of Mokolo Dam at the 2004-development level, is 16.4 million m^3/a. This impact is equivalent to 58% of the total net irrigation requirement applied.
- Implementation of a desktop *in-stream flow requirement* (IFR) with a Present Ecological Status Category of Class C (i.e. “moderately modified”) downstream of Mokolo Dam, with an average annual requirement of 48.51 million m^3, results in a considerable decrease in the yield from 39.1 million m^3/a to only 11.1 million m^3/a (72%).
- The benefit of raising Mokolo Dam by 12 m is 17.3 million m^3/a, at the 1:200-year recurrence interval.
- Similarly, the benefit of raising Mokolo Dam by 15 m is 21.6 million m^3/a.
- Yield results obtained from this Study are significantly higher than those from the earlier Yield Analysis of the Hans Strijdom Dam study by BKS, with the 1:200-year yield of Mokolo Dam increasing by 12.1 million m^3/a from 27.0 to 39.1 million m^3/a. This difference, however, can be attributed directly to a significant decrease in irrigation upstream of the dam over the last 15 years, from a net requirement of 74.47 million m^3/a to only 28.13 million m^3/a (62%).
- While the losses on releases from Mokolo Dam into the downstream aquifer are in the order of 60%, these may be reduced to 40% by implementing proper management practices aimed at reducing flow losses into the Limpopo River.

c) ***Recommendations***

Based on the yield analysis of the Mokolo River system and the above results, the following recommendations are made:

- While the yield results obtained from this Study are significantly higher than those from the earlier BKS study, the differences have been satisfactorily explained and it is therefore recommended that the latest yield estimates be accepted as an accurate reflection of the water resource capability of the Mokolo River system.
- The long-term yield analysis has shown that the 1:200-year yield available from the Mokolo River system, under current-day conditions, is sufficient to supply the total current allocation from Mokolo Dam. However, detailed planning analyses should be undertaken to assess the future water resource situation with consideration of alternative water requirement projections and proposed development and augmentation options.
- Based on current estimates, it is expected that the proposed transfer scheme from the *Crocodile River (West)* (CRW) catchment will only be in commission by 2014. A number of short-term management options may therefore have to be considered for bridging shortfalls to strategic users that may occur in the interim. These include:
  - “Renting” the water allocation from the irrigation scheme located downstream of Mokolo Dam.
  - Imposing forced curtailments on the irrigation water users upstream of Mokolo Dam, with consideration of various possible curtailment levels, such as 10%, 20%, etc.

- Short-term interventions to lower the water requirements of strategic, mining and urban users.

  However, while assessing the above options, all possible implications should be considered, such as whether the pipeline currently supplying water from Mokolo Dam to the users in question can accommodate the full volume of allocations. If not, then the remaining unused portion may still be used for irrigation.
- Implementation of a Class C desktop IFR downstream of Mokolo Dam causes a considerable decrease in yield. It is therefore recommended that, within the context of the national electricity crisis currently experienced in South Africa, the implementation of the IFR be postponed until the proposed Crocodile (West) transfer scheme is in place.
- As part of the Intermediate Reserve Determination process currently being undertaken by the DWAF Directorate: *Resource Directed Measures* (RDM), the considerable decrease in the yield of Mokolo Dam caused by the implementation of the above IFR must be considered before a final recommendation is made in this regard.
- A sophisticated system for the real-time monitoring and assessment of streamflow at various points in the Mokolo River system should be developed, in order to allow for the implementation of IFRs at sites other than the one downstream of Mokolo Dam.
- Releases made from Mokolo Dam into the downstream aquifer should be carefully managed to avoid high monthly releases. In this way, flows into the Limpopo River may be avoided and losses decreased from an estimated 60% to only 40%.
- The above estimates of losses on releases from Mokolo Dam may be significantly improved if more observed data became available for calibration of the aquifer model. It is therefore recommended that a monitoring system for releases from Mokolo Dam, incremental runoffs downstream of the dam, flows into the Limpopo River, actual groundwater abstractions for the irrigation scheme and groundwater levels be developed.
- Urban demands in the Mokolo River system are currently small and therefore do not warrant the consideration of further WCWDM initiatives. However, significant growth in the area is expected over the next 20 years and further investigations should be undertaken on the possibility of such interventions on the future water resource capability of the system.
- While it has been proposed that the Mokolo Dam wall could be raised by between 12 and 15 metres, further investigations still needs to be undertaken in order to determine the optimal raised level. However, such an intervention would have considerable impacts on existing international agreements and it should therefore only be considered once other options have been exhausted.

2.9.5 Planning Analysis

Report Title: Updating the Hydrology and Yield Analysis in the Mokolo River Catchment – Planning Analysis. Report No. P WMA 01/A42/00/01407.

Department of Water Affairs and Forestry. Prepared by WRP Consulting Engineers, DMM Development Consultants and Golder Associates. June 2008.

a) *Objectives of the planning analysis*

The objective of the planning analysis was to conduct a detailed system analysis to develop a detailed WRPM configuration of the entire Mokolo River system and to undertake a single analysis for a selected Base Scenario and over an analysis period from 1 May 2008 to 30 April 2030.

b) *Conclusions and recommendation*

If the Base Scenario were to realise, some form of intervention would be required by 2011, at the latest. The most likely intervention would be the transfer from the Crocodile River catchment. However, it is expected that the scheme will only be in commission by 2014 and thus a number of short-term management options may have to be considered for bridging shortfalls to strategic users that may occur in the interim.

In order to investigate these management options, it was recommended that additional WRPM scenarios be analysed as part of the MCWAP (refer to **Section 2.9** of this report). For this purpose, it is recommended that the following options be considered:

- Alternative policies for the supply of water to the irrigation scheme downstream of Mokolo Dam, including the release of its current allocation from the dam of 10.4 million m^3/a, or the release of 16.0 million m^3/a when the dam is at a level above 50% of its live FSC (which is in line with a temporary agreement between the irrigators and Exxaro – the operators of the dam).
- The impact on the supply characteristics to water users on Mokolo Dam of not applying controlled curtailments on releases made for the downstream irrigation scheme.
- The possibility of “renting” the water allocation of 10.4 million m^3/a from the downstream scheme irrigators.
- Scenarios for testing the impact of alternative water requirement projections.

Furthermore, it was recommended that:

- The water user priority classification applied in the planning analysis, which was adopted from the nearby Great Marico River system, should be confirmed with stakeholders;
- Releases made from Mokolo Dam into the downstream aquifer should be carefully managed to avoid high monthly releases. In this way, flows into the Limpopo River may be avoided and losses on the releases decreased from an estimated 60% to only 40%.
- The above estimates of losses on releases from Mokolo Dam may be significantly improved if more observed data became available for calibration of the aquifer model. It is therefore recommended that a monitoring system for releases from Mokolo Dam, incremental runoffs downstream of the dam, flows into the Limpopo River, actual groundwater abstractions and groundwater levels be developed.
- Urban demands in the Mokolo River system are currently small and therefore do not warrant the consideration of further WCWDM initiatives.

However, significant growth is expected to occur at Lephalale over the next 20 years as a result of proposed developments in the area and it is therefore of great importance that further investigations be undertaken on the possibility of and impact of such interventions on the future water resource capability of the system.

- While it has been proposed that the Mokolo Dam wall could be raised as a means of augmenting supply to water users, this options would have considerable impacts on existing international agreements and it should therefore only be considered once other options have been exhausted.

2.10 MOKOLO AND CROCODILE RIVER (WEST): WATER AUGMENTATION PROJECT

Study Information: Mokolo and Crocodile River (West): Water Augmentation Project Feasibility Study. Department of Water Affairs and Forestry. DWAF project number: WP 9528. Prepared by Africon in association with Kwezi V3 and Vela VKE, WRP Consulting Engineers and specialists. 2008 - 2010.

2.10.1 Overview

Water availability and infrastructure in the Mokolo River catchment is limited for future allocations, however, a number of major developments is expected in the Lephalale area. These developments include power stations by Eskom, the potential development of *coal-to-liquid* (CTL) fuel facilities by Sasol and the associated growth in mining activities and residential development.

The DWAF (now DWS) commissioned the MCWAP to analyse options for transferring water from the Mokolo River and Crocodile River (West), referred to as CRW, to augment future water supply in the Lephalale area. A Pre-Feasibility Study, to identify different options and recommend the preferred schemes, was followed by a Feasibility Study in 2009 to investigate the preferred schemes.

The following development phases were defined:

- **Phase 1** – Augment the supply of water from Mokolo Dam to meet the growing needs in Lephalale area.
- **Phase 2A** – Transfer water from the CRW to the larger Steenbokpan/ Lephalale area to further augment the water supplies.
- **Phase 2B** – A future phase for increased supply from the CRW to the larger Steenbokpan/Lephalale area.
- **Phase 3** – River conveyance and river management.
- **Phase 4** – Transfer water from the Klip River to the CRW depending on the eventual water requirement, effluent flows and size of Phase 2B.

A number of reports have been compiled as part of the MCWAP study and is listed in **Table 2.44**. A distinction has been made between reports completed for the pre-feasibility stage and the feasibility stage. For the purpose of this *Literature Review Report* only the *Main Report* or *Summary Report (P RSA A000/00/8109)* and information relevant to this Reconciliation Strategy are discussed.

Table 2.44: List of MCWAP study reports

Title	Report number
Inception Stage	
Inception Report	P RSA A000/00/9609
Pre-feasibility Stage	
Supporting Report 1: Water Requirements*	P RSA A000/00/8809
Supporting Report 2: Water Resources*	P RSA A000/00/8909
Supporting Report 3: Guidelines for Preliminary Sizing, Costing and Economic Evaluation of Development Options	P RSA A000/00/9009
Supporting Report 4: Dams, Abstraction Weirs and River Works	P RSA A000/00/9109
Supporting Report 5: Mokolo River Development Options	P RSA A000/00/9209
Supporting Report 6: Water Transfer Scheme Options	P RSA A000/00/9309
Supporting Report 7: Social and Environmental Screening	P RSA A000/00/9409
Feasibility Stage	
Supporting Report 8a: Geotechnical Investigations Phase 1	P RSA A000/00/8409
Supporting Report 8b: Geotechnical Investigations Phase 2	P RSA A000/00/8709
Supporting Report 9: Topographical Surveys	P RSA A000/00/8509
Supporting Report 10: Requirements for the Sustainable Delivery of Water	P RSA A000/00/8609
Supporting Report 11: Phase 1 Feasibility Stage	P RSA A000/00/8209
Supporting Report 12: Phase 2 Feasibility Stage	P RSA A000/00/8309
Main Report: MCWAP Feasibility Study Technical Module Summary Report	P RSA A000/00/8109

2.10.2 Mokolo River catchment water resources

The current as future water resources capability of the Mokolo River system was obtained from the "*Updating of the Hydrology and Yield Analysis in the Mokolo River Catchment*" Study (DWAF, 2007) as discussed in **Section 2.9**.

The WRPM configuration was used to investigate the management options available and to determine the risks associated with abstracting more water than the long-term yield for short periods and the period of recovery needed for the Mokolo Dam. The study also investigated the latest date when the CRW Transfer Scheme (Phase 2A and Phase 2B, refer to **Section 2.10.4**) will be required.

From the yield analysis conducted, the *historic firm yield* (HFY) of the Mokolo Dam is 38.7 million m^3/a. The 1:200 firm yield under current day land and water use conditions (then 2004) is 39.1 million m^3/a, and was used for planning purposes. Furthermore, during construction of the Mokolo Dam, provision was made to raise the embankment crest and *full supply level* (FSL) by 12 m and the spillway up to 7 m by means of spillway crest gates.

The existing water supply scheme from the Mokolo Dam to Lephalale, Matimba Power Station and the Grootegeluk Coal Mine consists of a pump station at the Mokolo Dam pumping water to Wolvenfontein Reservoir from where it gravitates to a T-off point at Zeeland WTW and further to Matimba. The pump station has a pumping capacity of 820 ℓ/s and the free flow capacity of the gravity main between Wolvenfontein and Zeeland WTW is 570 ℓ/s or 14.7 million m^3/a.

The DWA initiated the *Crocodile (West) Reconciliation Strategy*, referred to as CWRS (DWAF, 2008), which focused on strategies for resolving imbalances between water requirements and water availability in the CRW catchment area. The outcome of the CWRS, concluding that sufficient water may be available in the CRW to augment the shortfall in the Mokolo River catchment, formed the primary motivator for this MCWAP study and also indicated the quantity of water that could be transferred to the Lephalale area. Refer to **Section 2.20.11** for a summary of the CWRS.

Groundwater studies by the DWAF indicated that a sustainable yield from boreholes in the Waterberg – Karoo contact fault is estimated at 1.7 million m^3/a. For a short-term two year use, 7.19 million m^3/a can be abstracted but will need a few years of recovery.

The water abstracted from Mokolo Dam is considered to be of good quality and require only basic treatment to be suitable for domestic use. The water to be transferred from CRW, however, is of poor quality due to it being return flows from WTW and thus has a high organic content. This water will require treatment to render it suitable for industrial and domestic purposes. Therefore, supply to Zeeland WTWs will only be from Mokolo Dam as these works are not equipped to treat water with a high organic content. The WTW to be constructed at Steenbokpan must be designed according to the quality parameters of the CRW water. The quality of deep aquifer groundwater was found adequate for blending with domestic water.

2.10.3 Water requirements

Eight different scenarios of water requirements for the Lephalale area were developed as part of the CWRS (DWAF, 2008), based on the number of expected power stations, technology used by the power stations, proposed Sasol developments, the scale of coal mining activities associated with the different levels of industrial development, associated construction activities, and the associated growth in potable and light industrial water requirements. The water requirement growths were estimated for the period 2007 to 2030.

Scenarios 4 and 8 from the CWRS were selected for analysis as part of the Pre-Feasibility stage of MCWAP. Scenario 4 or the *Base scenario* comprises of the following developments:

- Matimba Power Station equipped with existing *fluidised bed combustion* (FBC) technology;
- Medupi Power Station equipped with *flue gas desulphurisation* (FGD) technology;
- 3 additional new power stations or *independent power producers* (IPP);
- Coal supply to 5 power stations;
- Exxaro projects;
- The associated construction activities; and
- The associated growth in Lephalale and Steenbokpan areas.

Scenario 8 or the *High growth scenario* includes all of the developments of the Base scenario and additionally the Sasol development of two CTL fuel plants, the associated mine construction activities and the associated population growth in Steenbokpan.

However, in February 2009, updated water requirements were released and Scenario 8 was superseded by Scenario 9, which was subsequently used for the Feasibility stage investigation. Scenario 9 incorporates the following water requirements and is summarised in Table 2.45:

- *Eskom* - Matimba Power Station, Medupi Power Station plus four additional coal fired power stations; or IPPs;
- *IPPs* - Equivalent of one Eskom power station (starting July 2010);
- *Exxaro* - Matimba coal supply and new coal mines;
- *Coal mining* - Allowance for four additional coal mines, each supplying a power station;
- *Sasol* - 1 CTL plant and associated coal mine (starting July 2011);
- *Lephalale and Steenbokpan* - Estimate based on projected growth in households for construction and permanent workforce.

Table 2.45: Scenario 9 water requirement projection per major user group

Year	Water requirements (million m^3/a)									
	2009	2010	2011	2012	2013	2014	2015	2020	2025	2030
Eskom	4.3	4.3	4.9	6.8	9.3	10.9	14.3	50.9	77.6	77.6
IPPs	0.0	0.4	0.9	0.9	1.5	4.4	13.2	15.6	15.6	15.6
Coal Mining	0.0	0.0	1.1	2.7	4.4	5.3	6.8	14.1	20.0	20.0
Exxaro	3.0	3.2	3.7	4.7	6.6	9.2	10.8	16.9	16.2	19.2
Sasol (Mafutha 1)	0.0	0.0	0.4	6.1	6.6	9.9	25.2	43.5	43.5	44.0
Municipality	5.6	5.9	7.7	10.4	12.0	13.6	14.5	20.4	21.2	21.6
Sub-Total	12.9	13.8	18.7	31.7	40.4	53.4	84.8	161.4	194.1	198.0
Irrigation	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Total	**23.3**	**24.2**	**29.1**	**42.1**	**50.8**	**63.8**	**95.2**	**171.8**	**204.5**	**208.4**

Eskom water use projection tables were provided by Eskom and is summarised in Table 2.46The Sasol water use projection for industrial use peaks at 84 million m3/a in 2023. Water use projection tables were provided by Sasol and is summarised in Table 2.47.

The Exxaro water use projection for industrial use peaks at 27.9 million m3/a in 2024. Water use projection tables were provided by Exxaro and is summarised in Table 2.48.

Table 2.46. Industrial use peaks at 62.6 million m^3/a in 2026.

The Sasol water use projection for industrial use peaks at 84 million m^3/a in 2023. Water use projection tables were provided by Sasol and is summarised in **Table 2.47**.

The Exxaro water use projection for industrial use peaks at 27.9 million m^3/a in 2024. Water use projection tables were provided by Exxaro and is summarised in **Table 2.48**.

Table 2.46: Eskom water use requirements

Component	Water use projection
Matimba Power Station (existing)	Current water requirement Constant **3.6 million m^3/a** from 2008 to 2030
Medupi Power Station (under construction)	Water for construction is required from 2008. Water for the first power generation unit is required from September 2010 and will increase at 6 month intervals as further units are commissioned. The requirement peaks at **14 million m^3/a** in 2016
Future Power Station 3 (CF2 with FGD)	Water required from 2012 and peaks at **15 million m^3/a** in 2018
Future Power Station 4 (CF3 with FGD)	Water required from 2017 and peaks at **15 million** m^3/a in 2023
Future Power Station 5 (CF4 with FGD)	Water required from 2020 and peaks at **15 million** m^3/a in 2026

Table 2.47: Sasol water use requirements

Component	Water use projection
Construction activities	Two construction periods from 2011 to 2013 and 2017 to 2019 with annual requirements of **0.5, 1** and **2 million m^3/a**
CTL facilities	Mafutha 1 will be commissioned over two years starting 2014 and reaching a peak requirement of **37 million m^3/a** in 2016 Mafutha 2 will be commissioned over two years starting 2020 and reaching a peak requirement of **37 million m^3/a** in 2022 Total requirement for the two facilities will be **74 million m^3/a** of which **10 million m^3/a** will be domestic effluent
Coal mining and beneficiation	Water required from 2011 and peaking at **10 million m^3/a** in 2023.

Table 2.48: Exxaro water use requirements

Component	Water use projection
Mining activities near Lephalale	The water requirement increase from 2008 and peaks at **21.816 million m^3/a** in 2018 This requirement includes the increased water usage at Grootegeluk mine to provide coal to Medupi Power Station. This requirement includes a provision of **8 million m^3/a** for IPPs.
Mining activities near Steenbokpan	The water is required from 2012 and peaks at **6.12 million m^3/a** in 2024

Contracts for coal supply to the three future power stations have not been awarded. The anticipated water usage of a typical mine supplying coal to power stations are therefore included in the water requirements as summarised in Table 2.49. Projections were sourced from the CWRS (DWAF, 2008).

Table 2.49: Other mines' water use requirements

Component	Water use projection
Mine for Eskom power station 3	Water required from 2011 and peaks at **5 million m^3/a** in 2016
Mine for Eskom power station 4	Water required from 2016 and peaks at **5 million m^3/a** in 2022
Mine for Eskom power station 5	Water required from 2019 and peaks at **5 million m^3/a** in 2020

Water use requirements for Lephalale Municipality were developed in conjunction with the DWAF Bulk Infrastructure Grant Feasibility Study. Demographic forecasts were developed by Glen Steyn Associates, using Statistics SA data. The water consumption were estimated based on Guidelines for the Development of Human Settlement Planning and Design (Red Book), stand sizes, climate, implementing of water conservation and demand management, probable water tariff increases and historic water consumption. A summary of the projected municipal water requirements is provided in **Table 2.50**.

The total water requirement per phase is summarised in **Table 2.51**.

Currently the potential quantity for water reuse is estimated at 20 million m^3/a of which 10 million m^3/a will be utilised by Sasol in the CTL Fuel Facilities.

The resource augmentation options as discussed below were considered:

a) ***Groundwater***

Artificial recharge of the secondary fractured aquifer in the Waterberg – Karoo contact fault zone with treated waste water, storm water or sewerage effluent, is considered a source of water. Other potential groundwater resources include alluvial aquifers along the Mokolo River and the CRW. However, the alluvial aquifers are recharged by river flow and therefore do not constitute significant additional resources. Groundwater is already exploited by the irrigators.

b) ***Re-allocation of irrigation water***

Irrigation water could be re-allocated (through purchase or temporary lease) to the developments in Lephalale. However, this will not be sufficient for water requirements by 2030.

c) ***Raising Mokolo Dam***

The yield of the Mokolo Dam can increase by 17 million m^3/a at a 1:200 year assurance of supply if the dam is raised by 12 m. However, this will not provide sufficient additional water and the related costs does not justify the amount of yield gained. Furthermore, extensive time is required to reach international agreements.

d) ***Inter-basin transfers from the Crocodile River (West) Basin***

The growth in water requirements in the CRW catchment will continue to be supplied from the Vaal River system and hence return flows towards the CRW and its tributaries will increase. Tributaries all converge upstream and at the confluence of the Pienaars River with the CRW, providing the opportunity for large scale abstraction, such as for the Lephalale area.

Table 2.50: Projected municipal water requirements (million m^3/a)

Component	2008	2030
Base scenario		
Current households (including Marapong)	3.127	2.906
Industrial/Commercial/Educational Development:		
At Lephalale	0.769	2..338
At Steenbokpan		0.478
Power stations:		
Medupi		0.497
Power station 3		1.432
Power station 4		1.376
Power station 5		1.322
Mining (Exxaro) (including on mine potable)	0.341	6.740
Mining (Exxaro) (Steenbokpan)		2.493
Required at Lephalale – Base scenario	4.870	12.481
Required at Steenbokpan – Base scenario		7.101
TOTAL	**4.870**	**19.582**
High scenario additionals		
Mafutha Town at Steenbokpan		11.995
Mafutha 1&2 Plant Potable		4.000
Required at Lephalale – Base scenario	4.870	12.481
Required at Steenbokpan – Base scenario		27.928
TOTAL	**4.870**	**40.409**

Table 2.51: Total MCWAP water requirement per phase (million m^3/a)

Phase	Description	Total water requirement[1]
Phase 1	Mokolo Transfer System - Interim period	50.4 million m^3/a
	Mokolo Transfer System - After CRW transfer system is commissioned	28.7 million m^3/a (incl. losses)
Phase 2A[2]	First phase of CRW Transfer System	110 million m^3/a
Phase 2B	Second phase of CRW Transfer System	81 million m^3/a

1) Excludes irrigation requirements estimated at 10.4 million m^3/a.
2) Capacity based the total combined transfer capacity required in July 2019 for High scenario (138 million m^3/a)

e) ***Inter-basin transfers from the Vaal River System***

The transfer of water from the Vaal River System for use in the CRW catchment (potable water via Rand Water network) continues to grow. However, should the need for water transfer from the CRW catchment to the Lephalale area realise, no additional transfers from the Vaal River would be required to augment supply to Lephalale.

2.10.4 Phased development

During the Pre-Feasibility stage, a phased development approach was recommended due to the high cost of the development and the uncertainty of the growth in water requirements. The following development phases were subsequently defined:

- **Phase 1** – Augment the supply of water from Mokolo Dam to meet the growing needs in Lephalale area.
- **Phase 2A** – Transfer water from the CRW to the larger Steenbokpan/ Lephalale area to further augment the water supplies.
- **Phase 2B** – A future phase for increased supply from the CRW to the larger Steenbokpan/Lephalale area.
- **Phase 3** – River conveyance and river management.
- **Phase 4** – Transfer water from the Klip River to the CRW depending on the eventual water requirement, effluent flows and size of Phase 2B.

Phases 2B, 3 and 4 were not investigated in detail as part of this MCWAP study and options developed, evaluated and reported only relate to Phases 1 and 2A. The physical layout of the system is illustrated in Figure 2.1. Phase 1 is anticipated to deliver water by March 2015 and Phase 2A by July 2020.

Phase 1 (Mokolo Dam Scheme) is to supply in the growing water requirement and also to supply more water for the interim period until a transfer pipeline from the CRW can be implemented. The system will utilise the available yield from Mokolo Dam. Phase 1 consists of the following:

- An underground pipeline parallel to the existing Mokolo pipeline (from the Mokolo Dam to Lephalale), to augment the supply from Mokolo Dam;
- New pump station at the Mokolo Dam;
- Steel rising main from Mokolo Dam to Wolvenfontein balancing dam;
- Gravity line from Wolvenfontein to Matimba Power Station;
- Gravity line from Matimba Power Station to Steenbokpan; and
- Break pressure tank at Rietspruitnek.

De-bottlenecking of the existing pipeline that stretches from Mokolo Dam to Lephalale, which belongs to Exxaro, will also be done. This entails the construction of the first 9km of the proposed underground gravity pipeline (for Phase 1) from Wolvenfontein balancing dam, with interconnections to the existing pipeline. The intention of the de-bottlenecking is to improve the hydraulic gradient at Rietspruitnek, where the existing pipeline passes over a high point.

Phase 2, the transfer scheme from the CRW at Vlieëpoort near Thabazimbi to the Lephalale area, consists of:

- A weir and abstraction infrastructure, including a balancing dam, desilting works, and a high lift pump station at Vlieëpoort (near Thabazimbi);

- Transfer system (approximately 100 km of underground pipeline): consisting of various alternative pipeline routes;
- A break pressure reservoir;
- An operational reservoir; and
- A delivery line, consisting of alternative routes for an underground gravity pipeline running from the operational reservoir to the Steenbokpan area, connecting to the Phase 1 works.

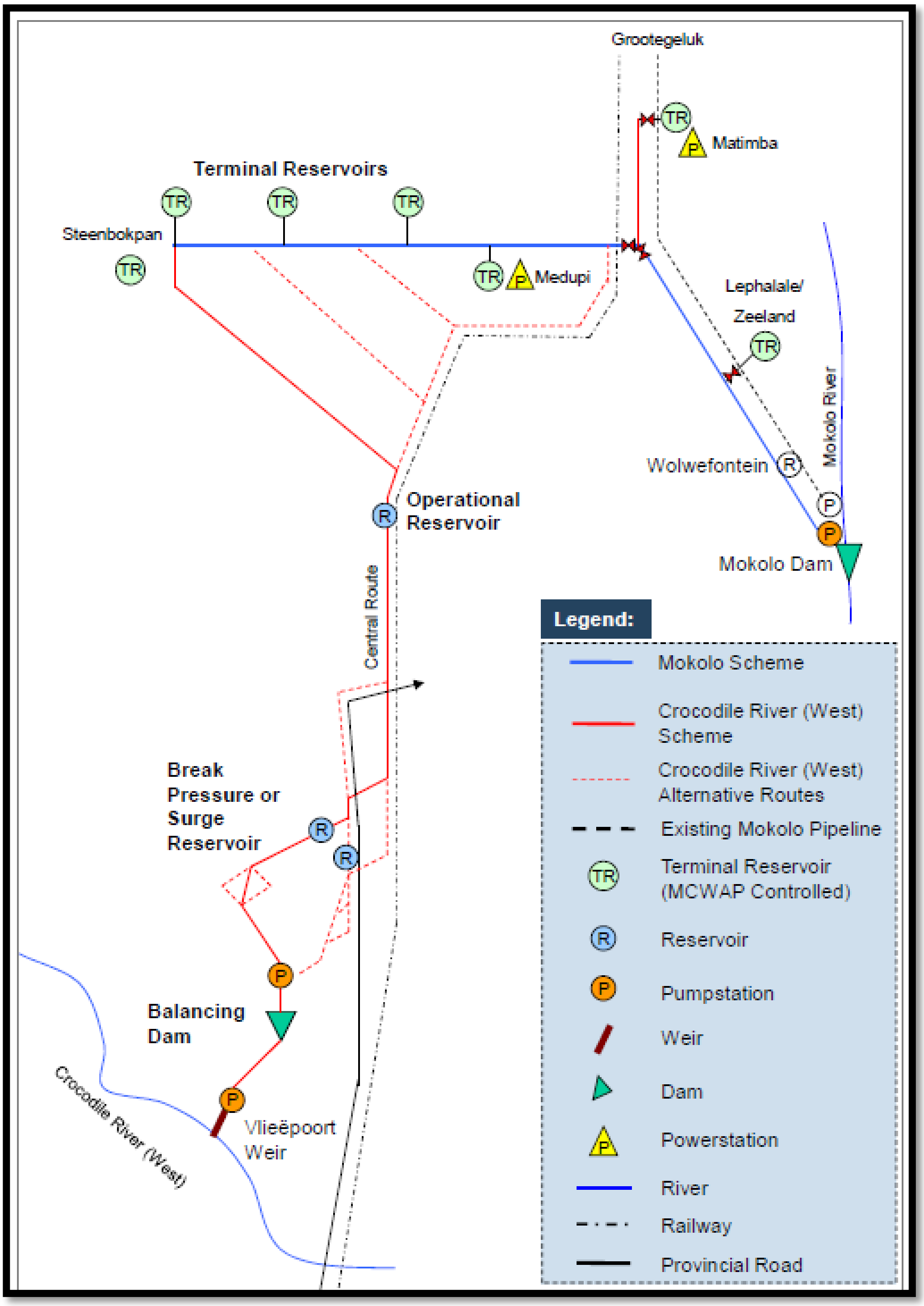


Figure 2.1: Physical layout of the MCWAP project

Note: The *Post Feasibility Bridging Study: MCWP 2A: Review Report (P RSA A000/00/18413*) has not been included in this *Literature Review Report*. But will be taken into account in the remainder of the Reconciliation Strategy.

2.11 CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS

Study information: Classification of Significant Water Resources in the Crocodile (West), Marico, Mokolo and Matlabas Catchments. Contract no. WP 10506. Department of Water Affairs. Prepared by Golder Associates, Prime Africa, Wetland Consulting Services and DWA. 2011 - 2013.

2.11.1 Overview

The DWA initiated a study to classify all significant water resources in the Crocodile (West), Marico, Matlabas and Mokolo River catchments in accordance with the *Water Resource Classification System* (WRCS). Classification of water resources, along with setting the Reserve and determination of RQOs, form part of the RDM to protect the country's water resources as well as to ensure that there is a balance between the need to protect and sustain water resources and the need to develop them.

The ultimate goal of the study is to coordinate the implementation of the seven step process of the WRCS in order to determine a suitable *management class* (MC) for the significant water resources in the study area. The MC provides clear goals relating to the quantity and quality of the relevant water resource, and conversely, the degree to which it can be utilised by considering the economic, social and ecological goals from an IWRM perspective.

The seven step process is defined as follows:

1. Delineate the units of analysis and describe the status quo of the water resource or water resources;
2. Link the socio-economic and ecological value and condition of the water resource or water resources;
3. Quantify the EWR and changes in non-water quality ecosystem goods, services and attributes;
4. Determine an *ecologically sustainable base configuration* (ESBC) scenario;
5. Evaluate scenarios within the integrated water resource management process;
6. Evaluate the scenarios with stakeholders; and
7. Gazette and implement the class configuration.

The three defined water resources MCs, considered in this study are as follows:

- *Class I*: Water resource minimally used and altered from its pre-development condition;
- *Class II*: Water resource moderately used and moderately altered from its pre-development condition; and
- *Class III*: Water resource heavily used and significantly altered from its pre-development condition.

The study area covers tertiary catchments A10, A21 - A24, A31, A41, A42 and a quaternary drainage region D41A of the Crocodile (West), Marico, Matlabas and Mokolo River catchments.

Table 2.52, below, indicates the areas of each of the sub-catchments within the study area. As well as indicating with quaternary catchments are included in those sub-catchments.

Table 2.52: Sub-catchment areas within the study area

Sub-catchment	Catchment area (km^2)	Tertiary catchments	Quaternary catchments
Upper Crocodile	6 336	A21	A-L
Elands	6 221	A22	A-J
Apies/Pienaars	7 588	A23	A-L
Lower Crocodile	9 204	A24	A-J
Marico	12 030	A31 A32	A-J A-E
Ngotwane	1 842	A10	A-C
Upper Molopo	4 300	D41	A
Matlabas	6 014	A41	A-D
Mokolo	8 387	A42	A-J

A number of reports, as listed in Table 2.53, has been compiled as part of this classification study. For the purpose of this *Literature Review Report*, only information relevant to the Limpopo WMA are discussed.

Table 2.53: Water resources classification study reports

Report title	Report number
Inception Report	RDM/WMA1, 3/00/CON/CLA/0111
Information Analysis Report: Crocodile (West) Marico WMA	RDM/WMA1,3/00/CON/CLA/0112A
Information Analysis Report: Mokolo and Matlabas catchments	RDM/WMA1,3/00/CON/CLA/0112B
Integrated Units of Analysis Delineation Report	RDM/WMA1,3/00/CON/CLA/0212
Ecological Water Requirements Report	RDM/WMA 1,3/00/CON/CLA/0312
Ecologically Sustainable Base Configuration Scenario Report	RDM/WMA1, 3/00/CON/CLA/0412
Evaluation of Scenarios Report	RDM/WMA1, 3/00/CON/CLA/0512
Management Classes Report	RDM/WMA1, 3/00/CON/CLA/0612

2.11.2 Information Analysis Report: Mokolo and Matlabas catchments

Report Title: Information Analysis Report: Mokolo and Matlabas Catchments. Report No. RDM/WMA1, 3/00/CON/CLA/0112B. Department of Water Affairs. Prepared by Golder Associates. January 2012.

a) ***Purpose of the report and findings***

Understanding of the preparatory work, the current situation and the availability of information of the Matlabas and Mokolo River catchments are required for the classification of the significant water resources in the Limpopo WMA. The purpose of this report was to provide an analysis of all the available data related to water resources as listed below:

- Water quality;
- EWRs;
- Hydrology; and
- Socio economics associated with water quality.

The information analysis relied solely on previous and then current parallel studies and initiatives. Therefore, it was imperative to also conduct an analysis of the data requirements and identify were gaps exist.

The study concluded that the Mokolo River catchment is a well-studied area. Information that is available for the area is both adequate and useful. However, few studies have been conducted on the Matlabas River catchment and thus a huge reliance will be placed on expert views and knowledge of the area.

2.11.3 Integrated Units of Analysis Delineation Report

Report Title: Integrated Units of Analysis Delineation Report. Report No. RDM/WMA1, 3/00/CON/CLA/0212. Department of Water Affairs. Prepared by Golder Associates. January 2012.

a) ***Purpose of the report***

The first step in the classification process is to delineate the units of analysis which are the spatial units defined as significant water resources for the purpose of determining the MC. The purpose of this report is thus to:

- Provide the information used to delineate the *integrated units of analysis* (IUAs);
- Detail the defined set of delineated IUAs within the study area; and
- List the biophysical nodes within the IUAs and management nodes at each IUA outlet.

The report further includes the economic rationale for delineation of IUAs and summarises the available economic data. The report also analyses the state of aquatic ecosystem services in the study area, and determines a preliminary baseline value for determining the relationships between economic value, social well-being and ecosystem characteristics.

The main objective of this report is a proposed decision-analysis framework for the analyses of scenarios in the latter steps of the study, and thus links the socio-economic and ecological value and condition of the relevant water resources.

b) *Approach to delineate IUA*

WMAs or catchments are delineated into IUAs primarily according to a number of socio-economic criteria and drainage region (catchment area) boundaries as well as ecological information.

The following was considered for the delineation of IUAs within the Mokolo and Matlabas River catchments in the Limpopo WMA and the Crocodile (West) and Marico WMA:

- Socio-economic zones;
- Catchment area boundaries;
- Similar land use characteristics/land based activities;
- Eco-regions and geomorphology;
- Ecological information;
- Present status of water resources; and
- Stakeholder input.

Biophysical nodes or hydro-nodes are established to serve as points that account for interactions between ecosystems and management nodes and thus serve as modelling points for the classification process in a catchment. The establishment of biophysical and management nodes are guided by a number of considerations as listed below:

- Significant water resources;
- Biophysical and eco-regional characteristics;
- Location of EWR sites and ecological information;
- *Ecological importance and sensitivity* (EIS) categories of water resources;
- *Present ecological state* (PES);
- Broad-scale hydrological and geomorphological characters;
- Water infrastructure; and
- Water management, planning and allocation information.

c) *Results and conclusions*

Twenty IUAs were identified for the entire study area and five for the Matlabas and Mokolo River catchments (IUA 15, 16, 17a, 17b and 17c) as listed in **Table 2.54**, along with the proposed biophysical and management nodes and quaternary catchments within each delineated IUA. The nodes proposed will be confirmed and finalised at the conclusion of Step 3 of the Classification Process.

The Reserve determination studies and the DWA desktop PES, *ecological importance* (EI) and *ecological sensitivity* (ES) study, which was undertaken during 2012 for the Crocodile (West), Marico, Matlabas and Mokolo River catchments were used to provide the PES, EI and ES per hydro-node. This was the case except when an existing EWR from a previous Reserve study site was the selected hydro-node, in which case the information was obtained through that study.

Table 2.54 thus also indicates the PES, recommended ecologic category (REC) at EWR sites, EI and ES per hydro-node selected for the Mokolo and Matlabas River catchments, as well as the consideration for selection. The PES assessment forms an important input for the ecological condition of the water resources in the study area.

Table 2.54: IUAs, biophysical nodes Hydro nodes selected for the Mokolo and Matlabas River catchments indicating the EI, ES and PES as well as the consideration for selection

IUA	No	Quaternary	Hydro-node	EI	ES	PES	Node type and considerations	
15	HN50	A42A	Sand (source) to confluence with Grootspruit	Moderate	Moderate	C	Biophysical	Quantity/quality
	HN51	A42B	Grootspruit (source) to confluence with Sand	Moderate	Moderate	C	Biophysical	Quantity/quality
	HN52	A42C	Mokolo to confluence with Dwars (MOK_EWR1a)	High	High	C/D	Biophysical	Quantity/quality
	HN53	A42D, A42E	Mokolo to confluence with Sterkstroom (MOK_EWR1b)	High	High	B/C	Biophysical	Quantity/quality
	HN54	A42D	Sterkstroom (source) to confluence with Mokolo, including Dwars	High	High	B/C	Biophysical, Ecological	Quantity
	HN55	A42F	Mokolo from Sterkstroom to Mokolo Dam (MOK_EWR2), outlet of IUA15	Very high	Very high	B/C	Biophysical	Quantity/quality
16	HN56	A42G	Rietspruit (source) to Mokolo confluence	Moderate	Moderate	B/C	Biophysical	Quantity/quality
	HN57		Mokolo below dam (MOK_EWR3) to Rietspruit confluence (MOK_EWR4)	Very high	Very high	B/C	Management, Mokolo Dam	Quantity/quality
	HN58	A42H, A42J	Mokolo from MOK_EWR4 to confluence with Limpopo, outlet of IUA16.	Very high	Very high	C	Biophysical, floodplain	Use wetlands requirements for river
17a	HN59	A41A	Mothlabatsi to confluence with Mamba	Very high	Very high	B	Biophysical, Marekele National Park	Quantity
	HN60	A41B	Mamba to confluence with Mothlabatsi, outlet of IUA17a	Moderate	Moderate	C	Biophysical	Quantity
17b	HN61	A41C	Matlabas from Mamba confluence to MAT_EWR2	High	High	B/C	Biophysical	Quantity/quality
	HN62	A41C, A41D	Matlabas from MAT_EWR2 to confluence with Limpopo, outlet of IUA17b	Moderate	Moderate	B	Management, international	Quantity/quality

2.11.4 Ecological Water Requirement Report

Report Title: Ecological Water Requirement Report. Report No. RDM/WMA1, 3/00/CON/CLA/0312. Department of Water Affairs. Prepared by Golder Associates, Prime Africa, Wetland Consulting Services and DWA. October 2012.

a) ***Purpose of the report***

This report relates to Step 3 of the WRCS – to quantify the EWRs and changes in non-water quality *ecosystem goods, services and attributes* (EGSAs). The report however, does not include EWRs for the Matlabas River catchment due to hydraulic challenges encountered during the collection of data.

In terms of the RDM data required, as part of the WRCS process, all available ecological/EWR information has been assessed and the information required for the determination of the catchment configuration scenarios are presented in this report. This RDM data includes the:

- Final identified nodes (hydro nodes) based on either management or biophysical considerations;
- EWR information available from previous Reserve determination studies;
- Additional rapid Reserve determination studies undertaken to enhance the existing information;
- Extrapolation of existing and new EWR results to all the identified hydro nodes;
- Development of the rule curves, summary tables and modified time series at each hydro node for use in the WRYM during the scenario analysis; and
- EGSAs changes at the established EWR sites and at biophysical nodes to which Reserve data can be extrapolated.

b) ***Outcomes and conclusions***

A number of studies on the Reserve requirements have been undertaken at various levels of detail, the most significant being the comprehensive studies on the Crocodile West/Marico WMA from 2010 to 2012 and on the Mokolo River catchment from 2009 to 2011. The results of these previous studies are summarised in **Table 2.55** for the Mokolo River catchment.

No Reserve study have previously been conducted in the Matlabas River catchment. Five EWR sites were initially identified in the Matlabas River catchment on which Rapid III Reserve determination studies were carried out. However, four final sites were identified for Rapid Reserve studies and due to the lack of available data Rapid II and Rapid I Reserve studies had to be conducted at some of the sites. **Table 2.56** indicates the selected EWR sites for the Matlabas River catchment determination.

Table 2.55: Information on previous Reserve Studies in the Mokolo catchment

EWR Site	River	Quater-nary	PES	EIS	REC	MAR(1) (million m^3)	%EWR(2)	Level
EWR 1a	Mokolo: Vaalwater	A42C	C/D	High	B/C	84.84	22.6	Intermediate
EWR 1b	Mokolo Tobacco	A42E	B/C	High	B	135.03	17.6	Intermediate
EWR 2	Mokolo: Ka'ingo	A42F	B/C	Very high	B	196.2	19.8	Intermediate
EWR 3	Mokolo: Gorge	A42G	B/C	Very high	B	214.5	12.5	Intermediate
EWR 4	Mokolo: Malalatau	A42G	C	Very high	B	253.3	16.5	Intermediate
EWR 5	Mokolo: Tambotie floodplain	A42G	D					

1) Natural MAR based on the updated hydrology from the DWA 2010 and 2011 studies

2) EWRs based on present day flows due to increased flows

Table 2.56: Selected EWR sites for additional rapids undertaken on the Matlabas

EWR site	River	Quater-nary	Level of deter-mination	Lat.	Long.	Eco region level 2	MAR (million m^3)
EWR 1	Matlabas Zyn Kloof	A41A	Rapid III	-24.41203	27.60324	7.04	5.23
EWR 2	Matlabas Haarlem East (A4H004)	A41B	Rapid II	-24.16014	27.47971	1.03	32.80
EWR 3	Mamba River Bridge	A41B	Rapid II	-24.2127	27.50718	1.02	9.54
EWR 4	Matlabas Phofu	A41C	Rapid I	-24.05159	27.35922	1.02	35.58

Initial hydro nodes were selected as part of the IUA report and summarised rationale per IUA provided. These identified hydro nodes in the Matlabas have subsequently been changed. These hydro nodes were selected on the basis of management of the system, outlet of IUAs, biophysical considerations or where specific water quality impacts are present. The updated PES, EI and ES information available on a sub-quaternary catchment level has been used to provide the present state per hydro node, or where EWR data was available, that was used.

Based on the above established EWR sites and identified biophysical nodes to which Reserve data can be extrapolated, the changes in relevant ecosystem aspects as they relate to identified EGSAs for the Crocodile West/Marico WMA and Mokolo and Matlabas River catchments of the Limpopo WMA were assessed.

The assessment of the ecosystem changes for the relevant EGSAs indicates that the RDM aspects considered do not have a significant effect in terms of the socio-economic consequences.

The ecological information currently available for the classification of the significant water resources of the study area is adequate to provide medium to high confidence input during the determination of the MC.

2.11.5 Ecological Sustainable Base Configuration Scenario Report

Report Title: Ecological Sustainable Base Configuration Scenario Report. Report No. RDM/WMA1, 3/00/CON/CLA/0412. Department of Water Affairs. Prepared by Golder Associates, Prime Africa, Wetland Consulting Services and DWA. June 2013.

a) ***Purpose of the report and findings***

As part of Step 4 of the WRCS, determine an ESBC scenario, the base scenario for each water resource in the study area was established. The ESBC scenario permits the maximum water use scenario.

The minimum requirements for a water resource is for the base condition to be established as a D category, or whichever higher category is required to ensure that downstream nodes are kept at least at a D category. If it is required by ecological conditions a higher *ecological category* (EC) should be set.

Once it has been confirmed that it is both ecologically and hydrologically feasible to achieve the base condition, the ESBC scenario is established. This indicates if the water balance within the study area will be in surplus or deficit after the implementation of a D category EWR.

For the Matlabas and Mokolo River catchments the selection of the EC was achieved based on the PES and the ecological/conservation importance of water resources within the IUAs. **Table 2.57** indicates the selected ESBCs for each of the IUAs within the Matlabas and Mokolo River catchments.

Using the WRYM, an ESBC scenario was tested based on the water requirements obtained from the *Updated hydrology and yield analysis of the Mokolo River catchment (present day water use)* (DWAF, 2007) for the Mokolo River catchment and the ISP documents and WR2005 information (present day water use) (DWAF, 2004b) for the Matlabas River catchment. Refer to **Sections 2.4** and **2.9** for more information in this regard. The assessment examined the changes in yield with the set PES ECs and allowed for guidelines for the selection of the IUA MC, also included in **Table 2.57**.

Table 2.57: EC (PES) for the ESBC per IUA in the Matlabas and Mokolo catchments

IUA	Catchment area	Ecological Category (ESBC)	IUA MC associated with scenario
15	Upper Mokolo	B/C	II
16	Lower Mokolo	B/C	II
17a	Mothlabatsi/Mamba	B/C	I
17b	Matlabas/Limpopo	B/C	II

2.11.6 Evaluation of Scenarios Report

Report Title: Evaluation of Scenario Report. Report No. RDM/WMA1, 3/00/CON/CLA/0512. Department of Water Affairs. Prepared by Golder Associates, Prime Africa, Wetland Consulting Services and DWA. September 2013.

a) ***Purpose of the report***

The purpose of this report is to provide the details of the final assessment and the results of the scenario analysis and evaluation of all scenarios for the Mokolo and Matlabas River catchments. This is related to the following:

- Description of the catchment scenarios assessed as part of the scenario analysis;
- Presentation of the yield analysis per scenario (results of the water balance per IUA per scenario);
- Presentation of the results of the socio-economic assessment and evaluation;
- Description of water quality implications and ecological consequences;
- Summary of the scenario analysis (proposed implications per scenario); and
- The recommended scenarios and proposed MCs for consideration by the Minister.

b) ***Groundwater component***

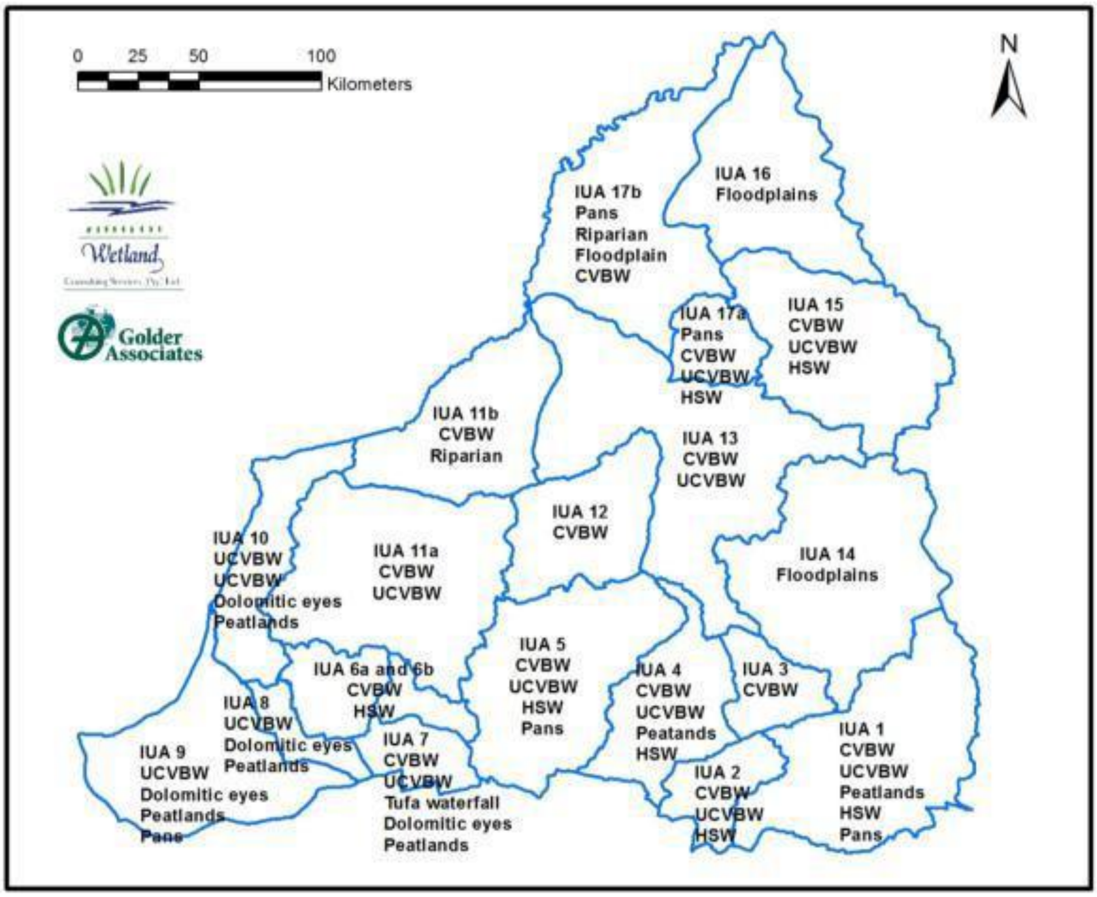
A stress index based on the groundwater usage and recharge was determined for the groundwater component in the IUA's and represents the groundwater quantity specification of the MC. The quality of the groundwater was assessed statistically and quality criteria were put in place.

The present impacted groundwater categories, or stress index, for the Mokolo River catchment are Class I and Class II's, whilst the groundwater quality categories are Class II and Class III's as a result of the poor groundwater quality (due to geological formations).

The Matlabas River catchment has a stress index of Class I for all of the impacted groundwater categories. The groundwater quality categories are Class II and Class II's. This is due to natural conditions (such as geological formations) and impacts on the actual use of groundwater (very low stress indexes).

c) ***Wetland assessment***

Figure 2.2 shows a summary map of all of the wetland types in the study area. The Mokolo catchment has been indicated by IUA 15 and 16, whilst the Matlabas catchment is shown by IUA 17a and 17b.



* CVBW – Channelled valley bottom wetland,
UCVBW – Unchannelled valley bottom wetland,
HSW – Hillslope seepage wetland, Pans, Dolomitic eyes, Peat lands

Figure 2.2: Main wetland types found and expected to occur in each IUA

Table 2.58 shows the identified *freshwater ecosystem priority areas* (FEPAs), which were discovered through the *Water Research Commission's* (WRC) 2011 *National Freshwater Ecosystem Priority Areas* (NFEPAs) Project.

Table 2.58: NFEPAs associated with the Mokolo and Matlabas River catchments

IUA	Catchment area	Quaternaries with NFEPAs		% coverage of IUA based on hydro-nodes location	Proposed IUA MC	Does the MC give effect to the NFEPAs
MOKOLO						
15	Upper Mokolo	A42A; A42B; A42D; A42C; A42F; A42E	Upstream; Fish support areas; FEPA;	75%	II	Yes
16	Lower Mokolo	A12G; A42J; A42H	FEPA; Rehabilitation FEPA;	75%	II	Yes
MATLABAS						
17a	Mothlabatsi/ Mamba	A41A; A41B	River FEPA and associated sub-quaternary catchment; Phase 2 FEPA and associated sub-quaternary catchment; Wetland FEPA; Fish support areas;	100%	I	Yes
17b	Matlabas/Limpopo	A41C; A41D	Wetland cluster	100%	II	Yes

d) ***Water balance per scenario***

Upon analysis of the WRYM from the Planning study for the Matlabas and Mokolo River catchments, the following considerations were included in the set-up of the scenarios for each of the catchments:

Matlabas Catchment:

- Present day water use for irrigation, mining, domestic, rural and afforestation as provided in the *ISP* and *WR2005* reports;
- Scouring of river – Mokolo transfer pipeline crossing.

The following options were identified in the *ISP* document and from *WR2005* information:

- Groundwater use; and
- Future mining in Steenbokpan.

Mokolo Catchment:

- Present day or future water use for irrigation, mining, domestic, rural and afforestation as provided in the water requirements and water resources report that forms part of the reconciliation strategy;
- Groundwater abstraction;
- Transfer of water to Mokolo – MCWAP;
- Mokolo Dam;
- Raising of Mokolo Dam not considered;

- Water quality – AMD, *waste water treatment works* (WwTW) of Lephalale; and
- Development of Waterberg area.

The following options were identified in the document "*Updating the Hydrology and Yield Analysis of the Mokolo River*" (2007 Report):

- Improvements to irrigation distribution systems;
- The raising of the Mokolo Dam; irrigation water could be re-allocated (through purchase) to the developments in Lephalale – this was not included here as it is no longer an options being considered;
- Such irrigation areas could be located either upstream or downstream of the proposed dam at Boschkop, or be in the Mokolo River catchment; and
- Debottlenecking of the existing Exxaro pipeline.

e) *Yield analysis for the PES (ESBC) Scenario*

Applying the PES scenario in the yield model simulations indicated that the implementation of the EWR on the Mokolo Dam would be significant. Without the EWR the dam has a yield of 38.7 million m^3/a, yet with the EWR the yield, depending on the operating rules could be only 3.48 million m^3/a.

f) *Ecological consequences*

The ecological consequences are the impacts on the EC of an EWR site, where applicable. By predicting the biota responses to each flow scenario it is possible to determine the implications of the scenario and the linked EC.

The *Fish Frequency Habitat Assessment* (FFHA) and *Invertebrate Frequency Habitat Assessment* (IFHA) were used for each of the scenarios tested to determine the ecological results of the scenarios.

g) *Water quality implications*

Water quality assessment of the Mokolo and Matlabas catchments involved a high level qualitative assessment of current in stream water quality, based on data obtained through monitoring implemented by the DWA. The water was compared to the SAWQGs and RQOs to check for compliance.

On the Mokolo River the water quality data downstream of the dam is good, as indicated by the average data from samples taken. Although, the number of samples taken indicate that there was limited data available.

The Matlabas catchment data shows that the water quality is also very good, however, at the point of measuring there are very few areas impacting on the quality. The only impacts being the runoff from game farms and the Marakele National Park.

The WRCS process requires that the effects of a change in scenario for the water quality should be assessed. On the Mokolo River there are no expected changes for the EWR sites 1a, 1b and 2, but there are for the sites below the dam (EWR sites 3 and 4). At these points the variable flows in the catchment and the unseasonal releases from the dam affect the water quality. There is also increased urbanisation, mining development, power stations which could impact negatively on the water quality unless strict regulations are implemented and followed. This is necessary to maintain category B water quality.

No changes are expected on the Matlabas. There may, however be an increase n in the TDS levels due to scouring of the pipeline. Once again in order to maintain the category B strict measures must be upheld.

h) *Results*

Scenario evaluation included assessment of different ECs and water user requirements, in different configurations to obtain results that reflect:

- A water balance (yield required to maintain ecological protection level and water use requirements – results in water surplus or deficit in the IUA)
- Ecological consequences, and
- An economic implication (cost-benefit analysis of the regional economy and social well-being).

Where there is a water deficit, the various interventions identified in the relevant reconciliation strategies, hydrology studies and ISP to achieve the required water supply were applied in the economic analysis.

Table 2.59 presents a summary of the scenarios evaluated, the key findings and the preferred scenario.

Table 2.59: Summary of scenarios per catchment, key aspects and preferred scenarios for the socio-economic assessment

Scenarios	Key Findings	Preferred Scenario
MATLABAS		
ESBC: Ecological = PES, present water use 1) REC, present water use	No additional future water possible Scouring of river – Mokolo transfer pipeline crossing	Baseline scenario (ESBC) is to be maintained.
MOKOLO		
Scenarios identified included: ESBC: Ecological = PES, present water use 1) PES, present water use (groundwater abstraction, transfer of water to Mokolo – MCWAP) 2) REC, present water use Lephalale area is expected to experience a very significant growth in coal mining, power generation and industrial economic activity, all of which require significant amounts of water. To supply these requirements a transfer from the Crocodile West River will be established. The transfer does not then interfere with the Mokolo River. Additionally, as there are no EWR sites downstream of Lephalale, any effects of increased return flows were not assessed.	Large amounts of growth and development are expected in the future around Lephalale The Mokolo River will not be affected by this development (MCWAP) IUA16 may be impacted negatively aesthetically as a result of extensive coal mining and, potentially, AMD could occur in the future.	It is unlikely that the scenario 1 envisioned PES EC of Class II will be maintained with all of the expected development occurring. Thus, the preferred scenario is a modified version of Scenario 1.

i) *Conclusions and recommendations*

The recommended scenarios for the relevant catchments are based on the scenario evaluation and consultation with stakeholders. They are as follows:

- Mokolo catchment: PES with future water use (2030); and
- Matlabas, Molopo and Ngotwane: The ESBC is to be maintained.

2.11.7 Management Classes Report

Report Title: Management Classes Report. Report No. RDM/WMA1, 3/00/CON/CLA/0612. Department of Water Affairs. Prepared by Golder Associates, Prime Africa, Wetland Consulting Services and DWA. November 2013.

a) *Purpose of this report*

The purpose of this report is to present and describe the rationale for the proposed MCs for the identified IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments, based on the outcomes of the scenario evaluation process and recommendations as described in the preceding sections.

This report specifies one of three MCs for each of the identified IUAs. Following this study these MCs will be translated into RQOs that will specify the actual targets and ranges for maintenance of a specific class of water resource.

b) *Results and recommendations*

The IUA MCs proposed for the Mokolo and Matlabas River catchments are indicated in Table 2.60.

Table 2.60: Proposed MC for the Matlabas and Mokolo River catchments

IUA	Catchment area	Ecological category (ESBC)	Recommended surface water resource class	Recommended groundwater resource class	Integrated IUA management class
15	Upper Mokolo	B/C	II	II	II
16	Lower Mokolo	B/C	II	II	II
17a	Mothlabatsi/ Mamba	B/C	I	II	I
17b	Matlabas/ Limpopo	B/C	II	II	II

Based on the results of the study, the following general requirements were proposed:

- The recommended scenario for the Mokolo River catchment maintains the PES EC at all nodes within the IUA with future water use (2030);
- The ESBC is to be maintained for the Matlabas River catchment;
- The implementation of the MCs will require management of water quality which includes source directed measures, regulatory and institutional structures;
- Concerted and regular monitoring and compliance management will be required to ensure the successful implementation of the MCs;

- The implementation and updating of the reconciliation strategies for the Crocodile (West), Marico, Mokolo and Matlabas catchments are central to the implementation of the proposed MCs;
- Integrated Water Quality Management Plans are required for the catchments; and
- A monitoring programme will need to be implemented to ensure that the MCWAP transfers reach their desired destination and limits pollution to the Matlabas River during pipe scouring.

2.11.8 Government Gazette

The final water resources classes per IUA and EC per Biophysical Node as per the Government Gazette is provided in Table 2.61.

2.12 THE ESTABLISHMENT OF OPERATING RULES FOR THE GLEN ALPINE SYSTEM

Study information: Establishment of Operating Rules for the Glen Alpine System. Department of Water Affairs. Prepared by Stuart Scott International (SSI) in association with WR Nyabeze and Associates (WRNA). 2011.

Table 2.61: Water resources classes per IUA and EC per Biophysical Node

IUA	Water resource class for IUA	Biophysical node name	Quaternary catchment	EC to be maintained	Natural MAR (million m^3/a)	EWR as % of natural MAR
15 Upper Mokolo	II	HN50	A42A	C	-	-
		HN51	A42B	C	-	-
		EWR Site MOK_EWR1a	A42C	C/D	84.84	22.6
		EWR Site MOK_EWR1b	A42D, A42E	B/C	135.03	17.6
		HN54	A42D	B/C	-	-
		EWR Site MOK_EWR 2	A42F	B/C	196.2	19.8
16 Lower Mokolo	II	HN56	A42G	B/C	-	-
		EWR Site MOK_EWR4	A42G	B/C	253.3	16.5
		HN58	A42H, A42J	C	-	-
17a Mothlabatsi / Mamba	I	HN59	A41A	B	-	-
		HN60	A41B	B/C	-	-
17b Matlabas/ Limpopo	II	EWR Site MAT_EWR2	A41C	B/C	32.80	33.23
		HN62	A41C-D	B	-	-

2.12.1 Overview

The Glen Alpine System (study area) includes tertiary catchments A61 and A62 in the Limpopo WMA. The study area contains two major dams - Doorndraai Dam and Glen Alpine Dam in catchments A61 and A62 respectively. The focus of the operating analysis undertaken was to develop operating rules for the Glen Alpine system as well as to setup and implement a decision support tool which incorporates water use priorities and the state of water availability. The operating rules include a curtailment strategy to avoid failure of water supply during dry periods when the yield is less than the requirement.

During the course of the study, it was recommended that tertiary catchment A63, downstream of Glen Alpine Dam, be included in the system as a number of downstream users rely on releases from the Dam.

A number of reports have been compiled as part of this study and is listed in **Table 2.62**.

2.12.2 Rainfall and Hydrology (Volume 2/6)

Report Title: Establishment of Operating Rules for the Glen Alpine System: Rainfall and Hydrology. Report No. P WMA 01/A42/00/02711/1. Department of Water Affairs. Prepared by Stuart Scott International (SSI) in association with WR Nyabeze and Associates (WRNA). February 2011.

Table 2.62: Glen Alpine system study reports

Report Title	Report number
Executive Summary (Volume 1/6)	P WMA 01/A42/00/02711
Rainfall and Hydrology (Volume 2/6)	P WMA 01/A42/00/02711/1
Water Quality (Volume 3/6)	P WMA 01/A42/00/02711/2
Groundwater (Volume 4/6)	P WMA 01/A42/00/02711/3
Yield Analysis (Volume 5/6)	P WMA 01/A42/00/02711/4
Decision Support System (Volume 6/6)	P WMA 01/A42/00/02711/5

The first step in the process of establishing annual operating rules for the Glen Alpine System was to do a hydrological analysis of the study area. As part of data collection, three site visits were conducted to achieve the following:

- Visit the Doorndraai and Glen Alpine dams and obtain data and information from DWA officials who manage and operate these dams;
- Understand the functioning of the Glen Alpine Dam system in an integrated set-up;
- Have discussions with farmers on factors affecting irrigation and supply of water;
- Understand and examine the extent of the approximately 30 storage weirs that farmers have constructed across the Mogalakwena River - including to obtain irrigation areas, dam surface areas and storages; and
- Give consideration to groundwater, water quality and other water resource issues.

Table 2.63 and Table 2.64 summarise the information gathered during the site visits to Doorndraai Dam and Glen Alpine Dam respectively.

Table 2.63: Doorndraai Dam information obtained during site visit

Dam name	**Doorndraai**	
Owner	DWS	
Year built	1953. Dam wall raised and gates added in 1975.	
Location	Outlet of catchment A61H on the Sterk River.	
Dam characteristics	FSC = 43.76 million m^3 HFY = 8.6 million m^3/a	
Users and allocations	Lepelle Northern Water (Mokopane Municipality WTP & Industries)	4.4 million m^3/a
	Irrigators (no WUA)	3.7 million m^3/a
	Mining	0.0 million m^3/a
	No growth in irrigation requirement over the past 8 years.	
	Pattern of water requests from users has been the same for the past 8 years.	
	Lepelle brought 2/3 of irrigation allocation in 1990.	
	Mining has applied to buy the remaining allocation to irrigation.	
	Allocations, as reported by the Dam operator, are lower than the Registered Water Use in the WARMS database.	
Outlet works	• 1.5 km pipeline for releases to Lepelle Northern Water. • 22km concrete lined canal supplies Irrigators + Lepelle. • 5 abstraction points on the canal. • High losses in the canal of about 30%.	
Flow measurements	• No flow measuring device at the dam. • Parshall flume used to measure flow in the canal. • DWAF measures releases to individual farmers using sluice gates. • Stream gauge A6H027 about 1 km downstream which is relatively reliable.	
Communication system	• The dam operator receives weekly water orders from individual irrigators • Release to Lepelle is always kept fully open	
Dam operation	• No documented operating rule for the dam • Release to farmers only possible when request is > 200m^3/hr. • Farmers receive warning letters when they are about to exceed their allocation • No restriction to Lepelle, full allocation supplied. • No releases into the river, only spills when dam is 100% full.	
Issues	• No documented operating rules for the dam. • Nylsvlei wetland in the catchment upstream of the dam may play significant role. • It seems operation of Doorndraai Dam has little effect on Glen Alpine Dam because of the large distance (about 100km). Moreover, releases from the Dam would disappear into the sand. • Donkerpoort Dam which is upstream in A61A catchment tends to be always full because users prefer Roodeplaat Dam which is cheaper.	

Table 2.64: Glen Alpine Dam information obtained during site visit

Dam name	Glen Alpine
Owner	DWA
Year built	1967
Location	Outlet of catchment A62J along the Mogalakwena River
Dam Characteristics	FSC = 19.95 million m^3 (16% of MAR) HFY = 5.6 million m^3/a
Users and allocations	• Dam is used only for irrigation • Irrigation use: – 1173 ha at 6200 m^3/ha/a = 7.27 million m^3/a – 251 ha (Department of Land Affairs) – not developed – 34 ha (Department of Land Affairs) – not developed – 811 ha under commercial farmers • Irrigation up to 70km downstream – 5.9 million m^3/a. • Each scheduled user has the right to build a storage weir of capacity 2500 m^3/ha/a with prior approval from DWA. • The last four irrigators have an allocation of 5000 m^3/ha/a. • Livestock watering exists but is not monitored. • No growth in irrigation demand since 2001.
Outlet works	• Big radial gates which can empty the dam • There is no canal to supply the irrigators- irrigators supplied from releases into the river from the dam. Framers have built their own weirs on the river for storage. They do not have off channel storage dams. Weirs for upstream framers fill first but should they not use their allocation the water is lost i.e. it's not available for downstream use. Weirs may become evaporation/siltation ponds
Flow measurements	Irrigators' weirs are sized to store 2500 m^3/ha/a There are no accurate gauge plates on the weirs There is a streamflow gauge at Leeniesrus
Communication system	Water is released as per request from the Steering Committee on a flow of 34 m^3/s to fill the weirs
Dam operation	Up to 4 releases per year 3% is always left in the dam for fish Ecological Reserve supplied from dam releases There is no formal WUA but a steering committee exists
References	DWA report GH 3423 on Geology of the area
Issues	No documented operating rules for the dam There is need to establish the capacities of the weirs and how they are operated in practice Flow routing along the river from the dam to abstraction points of the farmers Need for siltation survey Assurance of supply from the dam needs to be established Because the dam is small compared to its MAR, it is thus sensitive to any inaccuracies in yield estimation and operation.

The WR2005 was used as the basis to obtain rainfall and hydrological data which was extended to the 2007 hydrological year. Individual rainfall stations' data were patched using the PatchMP program and grouped to create catchment based rainfall data files using WRSM2000. Mass plots of all rainfall stations' data were analysed to ensure that data were acceptable.

The applicable WRSM2000 input requirements are listed below, along with the associated sources of the information:

- Evaporation – WR2005;
- Streamflow – Monthly data from the DWA website;
- Afforestation – No afforestation in the study area;
- Alien vegetation – WR2005, no growth information and thus growth was assumed to be linear;
- Major reservoirs and farm dams – WR2005, SA Dams database (Water for Africa), DWA *Water Situation Assessment Model* (WSAM) – no data on depth of small farm dams and thus depth was assumed to be 2m;
- Wetlands (Nylsvlei) – based on study completed by SSI and the University of Witwatersrand;
- Irrigation – WR2005;
- Abstractions – Donkerpoort Dam for Modimolle, Gert Combrink Dam for Mokopane, Doorndraai Dam for industry and town.

The WRSM2000 networks were established for the three tertiary catchments separately – A61, A62 and A63. Calibration parameters were initially kept the same as that of WR2005 but were refined where necessary to suit the extended and adjusted data. The following approach, as for the WR2005 and the DWA WAA studies, was adopted for calibration:

- Sami method of groundwater/surface water interaction (there are three methods available from which one should choose, namely: Pitman, Sami and Hughes);
- WQT method of irrigation (there are three methods available from which one should choose, namely: Pitman Standard, WQT and WQT/SAPWAT); and
- Pitman method of comprehensive wetlands (there are two methods available from which one should choose; the simple and comprehensive).

Calibration was carried out at all the important streamflow gauges and at the inflows to Doorndraai and Glen Alpine dams. Streamflow gauge A6H035 was adversely affected by the 1999 floods and was considered not reliable. A summary of MAR at each included gauge is given in **Table 2.65**.

The Glen Alpine Dam is sensitive to releases – if too little water is released, additional releases have to be made and if too much water is released, some is lost in the Limpopo River, reducing the dam to lower levels than necessary. This induces the risk of inadequate releases during droughts. It was concluded that the second release is extremely wasteful due to the high percentage of losses.

Rainfall stations in A61 and A62 cover the catchment fairly well and are reasonably distributed over the record period. Abstraction data are poor but of minor magnitude. Reservoir records are generally good.

Table 2.65: Summary of simulated and observed flows in the Glen Alpine System (million m^3/a)

Tertiary catchment	Gauge	Period	Observed MAR	Simulated MAR	Percentage difference between observed and emulated MARs (%)
A61	A6H006	1969-2007	6.66	5.85	12
A62	A6R002	1970-2007	104.83	118.56	13
A62	A6H029	1969-2007	95.49	110.79	16
A61	A6H012	1966-2007	6.91	5.77	17
A61	A6H010	1964-2007	2.36	2.33	-1
A61	A6R001 (Doorndraai Dam)	1955-2007	20.41	20.6	1
A61	A6H027	1952-2007	8.57	10.75	25

The study recommended the following:

- Tertiary catchment, A63, downstream of Glen Alpine Dam must be included in the development of operating rules of the Glen Alpine System as there are users up to 100km downstream of the dam and approximately 30 storage weirs across the Mogalakwena River which rely on releases from the dam;
- The 30 storage weirs across the Mogalakwena River, downstream of Glen Alpine Dam, should be modelled and analysed in WRSM2000 and WRYM – hence reliable capacity and surface area data as well as other data pertaining to these storage dams must be obtained and included in the model;
- Improved water accounting systems need to be incorporated at Glen Alpine Dam, including infrastructure to monitor releases;
- Closed rainfall stations should be considered to be reopened or new stations should be established;
- Additional streamflow gauges should be considered for A62 and A63 – this include a gauge before the confluence of the Mogalakwena River with the Limpopo River and a gauge 50km downstream of Glen Alpine Dam to measure wasted water and losses due to sandy conditions; and
- A Water User Committee should be established to manage the system effectively, monitor the water quality, sedimentation, infestation by reeds and theft of water as well as to ensure fair water distribution and to deal with complaints and issues.

2.12.3 Water Quality (Volume 3/6)

Report Title: Establishment of Operating Rules for the Glen Alpine System: Water Quality. Report No. P WMA 01/A42/00/02711/2. Department of Water Affairs. Prepared by SSI in association with WRNA and Umfula Wempilo Consulting. February 2011.

The purpose of the *Water Quality Report* was to identify water quality issues on the Mogalakwena and Sterkspruit Rivers that could possibly affect Glen Alpine and Doorndraai dams' operating rules.

Water quality data was obtained from the DWA *Water Management System* (WMS) for all stations and water quality analyses available. This study was not a catchment study and therefore excluded investigation of pollution sources and evaluation of irrigated soils, crop types, farming practices and any form of modelling. The selected water quality monitoring stations include; A6H001, A6H002, A6H009, A6H011, A6R001 and A6R002.

The major findings of the analysis are listed below:

- There is a steady incline in the salinity levels from the headwaters of the Nyl River at Mokopane to the furthest north sampling points in the Nyl and Sterkspruit rivers. However, the salinity levels are well within the *target water quality range* (TWQR). There were observed acidification effects at Nylstroom and Deelkraal in the upper reaches of the Nyl River;
- A sharp rise in the fluoride levels at Moorddrift (north of Mokopane) causes exceedance of the TWQR for irrigation 50% of the time;
- Slight acidification is observed at Doorndraai Dam 5% of the time;
- At Glen Alpine Dam the peak salinity related variables exceed the TWQRs for domestic and irrigation use;
- Elevated *sodium adsorption ratio* (SAR) levels at Glen Alpine Dam also point to the possibility of the occurrence of soil surface sealing during rainfall events;
- There is evidence that elevated phosphate concentrations have led to nuisance algal blooms;
- The observed peak unionised ammonia levels hold a small risk of impairing sensitive aquatic life forms; and
- At gauging point A6H009 similar peaks in salinity levels as those observed in Glen Alpine Dam were evident.

2.12.4 Groundwater analysis (Volume 4/6)

Report Title: Establishment of Operating Rules for the Glen Alpine System: Ground Water. Report No. P WMA 01/A42/00/02711/3. Department of Water Affairs. Prepared by SSI in association with WRNA and Ages. February 2011.

The scope of work was limited to a low resolution screening study, based on available data obtained from the *National Ground Water Database* (NGDB), the GRIP in Limpopo, the published *Internal Strategic Prospect Document* (ISPD) and the *Groundwater Resources Directed Measures* (GRDM) data. The main recommendation from the *Groundwater Report* was that the GRIP program should be extended to include areas which have not as yet been surveyed.

The following conclusions were made:

- The Mogalakwena River catchment is the most densely populated and industrialized catchment in the Limpopo WMA;
- The surface water in the area is derived mainly from the two major dams, Doorndraai and Glen Alpine dams. Run-of-river abstractions also forms a key source of surface water;
- Groundwater use in the catchment is large by any standards, supplying in excess of 55 million m^3/a to mainly the irrigation sector and the rural sector to a lesser extent;
- A detailed water quality analysis was not possible due to the scarcity of geochemical data for the study area. However, certain potential impacts on the water quality were identified. These include (i) the application of fertilizers in poorly managed agricultural lands, (ii) AMD that occurs after mining

activities stopped as well as mining activities not adhering to GN704 and (iii) uncontrolled growth in the informal settlements which places pressure in the sanitation requirements; and

- According to the stress indices derived from the GRDM method, which is a simple ground water balance model, all three of the tertiary catchments are stressed with the stress indices for A61, A62 and A63 being 29.6%, 6.4% and 37.2% respectively.

Furthermore it was recommended to investigate the effect of system operation changes on the salinity levels. Elevated salinity levels can possibly be mitigated in the Glen Alpine Dam itself and in the downstream river system by adjusting the dam release patterns. A catchment water quality study, to identify and quantify the pollution sources, was also recommended.

2.12.5 Yield Analysis (Volume 5/6)

Report Title: Establishment of Operating Rules for the Glen Alpine System: Yield Analysis. Report No. P WMA 01/A42/00/02711/4. Department of Water Affairs. Prepared by SSI in association with WRNA. April 2011.

The objective of the yield analysis were to assess the total and short and long - term resource capability or yield for defined points in a water resource system for a constant level of development, usually defined as the present day development level. The study period being from 1920 to 2007 in hydrological years. The yield of a system is derived in one of two ways. The first is through the analysis of historical observed data where the yield is expressed as the HFY. The second is through the analysis of stochastically generated data, where the assurance of supply or the risk of non-supply can be determined for a spectrum of yields. In this *Yield Analysis Report* both the analyses were conducted.

The main outcomes of the study are summarised in **Table 2.66**.

Table 2.66: Yield and demand of Glen Alpine and Doorndraai dams

Dam	HFY (million m^3/a)	1:50 year yield (million m^3/a)	Demand (million m^3/a)
Doorndraai Dam	5.1(1)	7.38	8.1
Glen Alpine	7.8(2)	10.4	13.0(3)

1) Assurance level of 1:268.
2) Assurance level of 1:173.
3) Includes transmission losses estimated 78% of the demand.

The results show that for both dams on the historical and 1:50 long term yield, the water balances are negative.

It is therefore clear from the above information derived from the yields both historic and stochastic that the demand is greater than the supply, thus intervention measures, in the form of operating rules, are required and vital to avoid failure of the dams.

The main recommendations include the following:

- Glen Alpine Dam has a low storage/MAR ratio but it experiences large changes in storage when releases are made each year. These fluctuations could be reduced by increasing the storage of the dam. A study on the impact of raising the existing dam wall on the yield availability is recommended;

- There are no provisions for environmental releases from Glen Alpine and Doorndraai dams, which are both on the Mogalakwena River and forms part of the internationally shared Limpopo River Basin. The SADC protocol places emphasis on the supply of the ecological Reserve and hence a study on the requirements for environmental releases should be conducted;
- Due to the high transmission losses (70%-80%) which are incurred from Glen Alpine Dam, it is highly recommended that a hydraulic routing study be conducted which will also consider the storage reduction of weirs and dams due to siltation. This should provide better options for scheduling resulting in reduced losses. DWA investigated the need for additional streamflow gauges downstream of Glen Alpine Dam to make this hydraulic routing study possible;
- Monitoring of inflow and rainfall is highly recommended at both the Glen Alpine and Doorndraai dams as well as the incorporation of this information into the dam operations; and
- It is recommended that DWA initiates a study to verify water use in the system, due to the significant impact that upstream impoundments have on the yield of the two major dams.

2.12.6 Decision Support System (Volume 6/6)

Report Title: Establishment of Operating Rules for the Glen Alpine System: Decision Support System. Report No. P WMA 01/A42/00/02711/3. Department of Water Affairs. Prepared by SSI in association with WRNA. May 2011.

The focus of the operating analysis undertaken was to develop operating rules for the Glen Alpine system as well as to setup and implement a decision support tool which incorporates water use priorities and the state of water availability. The operating rules include a curtailment strategy to avoid failure of water supply during dry periods when the yield is less than the requirement.

The decision support system applied on this study comprised three tools namely the HDAM-Venter graphs, the WRYM and the WRPM. The results were plotted using the HDAM Graphs.

The 1st of April was set as the annual decision date for the water resource systems in the Limpopo WMA. The priority classes were assigned for each of the three tools, as provided in **Table 2.67**.

Table 2.67: User priority classification used for the system

Water user sector	User priority classification (assurance of supply)				Total
	Low	Medium	High	Very high	
	1:20 or 95%	1:50 or 98%	1:10 or 99%	1:200 or 99.5%	
Domestic	15%	25%	30%	30%	100%
Irrigation	60%	30%	10%	0%	100%

Main findings of the study are listed below:

- Glen Alpine Dam and Doorndraai Dam were at 105% and 100% full respectively on the 1st of April 2010. Both these dams were in the upper 25th percentile of their historic storage for the month April.
- From the review of the 2010-2011 'Venter' storage, extrapolations based on lowest and median inflows and allocated demands depict that Glen Alpine Dam can be managed without application of restrictions. Furthermore the dam can recover between the months of December and February annually. The storage of Glen Alpine Dam is sensitive to changes in inflow due to the dam's low Storage/MAR ratio. As a general rule is to use the lowest inflow line for management control to avoid the storage in the Glen Alpine Dam from going below 60% in November.
- There was no need for restrictions for both dams for the period 2011/2012 according to the WRYM operating rule results.
- There was also no need to administer restrictions in the 2011/2012 planning period for both dams according to the WRPM results. The risk of restrictions on releases from Glen Alpine Dam is very low for the period until 2015 (less than 5%) but they are much higher for the releases from Doorndraai Dam.
- The results from the WRPM for the 2011/12 season are consistent with the WRYM and the HDAM "Venter" graphs.
- The FSC/MAR ratio for the Glen Alpine and Doorndraai dams are 0.28 and 1.86 respectively. Glen Alpine Dam have in the past gone from empty to full in 6 months and Doorndraai Dam in 10 years, implying that the WRYM and HDAM models are adequate tools for estimating the amount of water available for releases for the 2011/12 period.
- The forecasts issued by SARCOF provide an opportunity to review the recommendations made.

2.13 NYLSVLEY EXECUTIVE SUMMARY

2.13.1 Overview

Report title: The report to which this executive summary forms part of could not be established. However, due to the information contained therein it was decided to include it in this *Literature Review Report*.

Water quality in the Nylsvlei is poor and the wetland is deteriorating. Water bird numbers have declined by 80-90% over the last ten seasons as well as frog numbers. The aim of the study was to assist the Limpopo Province Department of Finance and Economic Development (Environmental Affairs) in compiling a management plan for the Nylsvley Nature Reserve as well as to obtain a holistic perspective of the state of the vlei and to identify impacts which could lead to further deterioration.

The project was initiated after a workshop hosted in 2000 by Dr Steve Mitchell of the WRC to identify needs with regards to bio monitoring of wetlands. The objectives of the project were to develop draft water quality guidelines in vlei areas for key variables/parameters, potential bio monitoring indices specific to vlei areas, compile a draft sustainable management programme, focusing on the biophysical aspects for Nylsvlei and to propose a strategic management plan for sustainable utilization of wetlands in the Waterberg region.

2.13.2 Main findings

Results from the water analysis indicated that total coliform and faecal coliform counts increased along the course of the Nyl River System and into the wetland, especially from the effluent outlet of the Modimolle WwTW into the Klein Nyl River. Increased faecal coliform counts can have adverse effects on the system as well as on the individuals who rely on water from the system. The increase in faecal coliform count can be described to:

- The capacity limit of the Modimolle WwTW and possible leakage of the raw sewerage pipeline which runs along the banks of the Klein Nyl River;
- Insufficient municipal services in the surrounding informal settlements which can cause increased bacteria quantities to enter the system as runoff; and
- Contaminated runoff from agricultural land, containing a significant number of livestock farmlands, which increases the nutrient levels of the system.

The Modimolle WwTW needs to be upgraded and sewerage infrastructure of informal settlements must be maintained and be connected to sewerage networks if not yet connected. Although the floodplain aids in the purification of water and decreases coliform counts, the current rate of contamination exceeds the capability of the system which can cause increased levels of coliform bacteria to contaminate groundwater resources.

Toxicity test results indicated that the water in the system is of fair quality and is suitable for sustaining aquatic life. The water throughout the system, from the source of the Klein and Groot Nyl to Moorddrift, naturally contains high concentrations of heavy metals and the water parameters such as the conductivity, oxygen content and pH also indicated little cause for concern. Although the nutrient levels in the system are on the increase, they are not of concern, as the levels of toxic ammonia are still low and hence the system can be regarded as un-impacted.

The extent of pesticide contamination in the system could not be determined adequately and further investigation is required.

Approximately 84% of frog species in South Africa depend on wetlands either as permanent habitat or for breeding and feeding during the rainy season. Deterioration of water quality poses a threat to the existence of these species, however the sensitivity of South African frog species to pollution is unknown. As Nylvlei inhabits a significant amount of frog species, the conservation of good water quality is of high importance.

2.14 FIVE-YEAR STRATEGIC PLAN FOR NYLSVLEY NATURE RESERVE, LIMPOPO PROVINCE, SOUTH AFRICA

Report Title: Five-year Strategic Plan for Nylsvley Nature Reserve, Limpopo Province, South Africa. Department of Economic Development, Environment and Tourism. 2013.

2.14.1 Overview

The Strategic Plan and Annual Plan of Operation are two complementary documents to the Reserve Management Plan which serves as a guide to the management of the Nylsvley Nature Reserve. No decisions that may potentially affect the reserve may be taken without reference to the Reserve Management

Plan. This Strategic Plan, sets out the ambitions of the reserve for the period 2013-2017.

For the purpose of this *Literature Review Report*, only information relevant to the characteristics and the hydrology of the Nylsvlei wetland, as part of the Nylsvley Nature Reserve, are discussed.

2.14.2 Characteristics and hydrology Overview of Nylsvlei

Nylsvley Nature Reserve falls within the Mookgopong LM and the Waterberg DM and is situated approximately 12 km south of Mookgopong. The reserve provides protection to a portion of 800 ha of the larger Nyl River floodplain wetland. The Nyl River floodplain extends from Middelfontein (west of Nylstroom) to Moorddrift, covering an area of 24 250 ha. The Nylsvlei floodplain wetland was declared a RAMSAR Site in 1998 and inhabits a large diversity of avifaunal species.

The area receives an average annual rainfall of 648 mm/a. The area is a summer rainfall region, receiving the maximum rainfall in November with an average monthly rainfall of 150 mm per month and the least during July with an average monthly rainfall of 3 mm per month.

The landscape can be described as gently sloping with a number of rocky outcrops. The floodplain receives most of its water from runoff through the Olifantspruit (80% contribution of the annual flow), Groot Nyl and the Klein Nyl. Water supply to the floodplain is difficult to quantify due to the dynamic nature of the runoff caused by differing flow gradients and degrees of surface water storage.

Nylsvlei floodplain wetland is classified as a seasonal floodplain wetland, subjected to seasonal flooding and fluctuation in water levels. Flood waters only occasionally persist throughout the year until the following wet season. The depth of Nylsvlei depends on the type of flooding that occurs, but seldom exceeds one meter. During the dry season the floodplain generally dries up completely, with water only occurring in permanent pools located within the main stream of the Nyl River.

Hydrologically the floodplain essentially acts as a basin by temporarily storing floodwater and then later releasing it slowly back into the main river channel. It is believed that the floodplain contributes significantly to groundwater recharge within the region, although this has not been confirmed.

Vegetation ranges between central bushveld vegetation and freshwater wetland vegetation. A number of plant species of conservation concern occur in the area as well as some, mostly category 1, invasive alien plants.

A number of threats exist with regard to the water quantity and quality of the Nylsvlei wetland. These include:

- Water quality issues due to unmaintained WwTW and agricultural activities (incl. the use of pesticides) in the catchment;
- Water abstraction for urban and agricultural purposes; and
- Proposed platinum and coal mining activities.

2.15 Proposed Establishment of an Open Cast Platinum Group Metal Mine on the Farm Volspruit 326 KR and the Farm Zoetveld 294 KR, Mokopane District, Limpopo Province

2.15.1 Overview

Sylvania Platinum Limited, as the primary holding company, and Pan Palladium South Africa, as the subsidiary company, has commissioned EScience Associate to conduct the scoping and Environmental Impact Assessment (EIA) process to assess the environmental feasibility and impact of the proposed open cast platinum group metals (PGMs) mine near Mokopane. Two separate ore bodies are proposed to be mined from two separate pits, the “North Pit” and the “South Pit”, which will be situated on the farm Volspruit 326 KR. Areas of the farm, Zoetveld 294 KR, will be used to support the above ground infrastructure. The mine will be operational for approximately 20 years.

The site for the mine is currently a “Green-fields” site consisting of mainly agriculture. The Nyl River flows through the farm Volspruit and the northern extent of the farm Zoetveld before it becomes the Mogalakwena River downstream of Mokopane. The proposed mining area falls within quaternary catchment A61E.

The potential water resources related impacts of the mine as identified during the scoping phase are:

- Water quality deterioration due to accidental leaks and spillages of wastes and hazardous materials during the operational lifetime of the mine;
- The impact of required dewatering on the surface water and especially groundwater regimes of the area.
- Impacts of mine wastes on human health and the groundwater environment.

The groundwater yield potential in the area of the Volspruit Mine ranges between 0.5 to 2 ℓ/s with more than 5 ℓ/s in localised areas. Potgietersrus Platimum Mine (now the AMPLAT Mogalakwena Platimum Mine) are permitted to abstract 1 500 m^3/day from an abandoned chrome mine in quaternary catchment A61E.

A number of specialist studies have been identified, however, only studies relevant to this Reconciliation Strategy are discussed under the subsequent sub-headings as part of this *Literature Review Report*.

2.15.2 Surface Water and Hydrological Aspects pertaining to the proposed Volspruit Platimum Mine located on the farm Volspruit 326 KR, Limpopo Province, South Africa

Report Title: Surface Water and Hydrological Aspects pertaining to the proposed Volspruit Platimum Mine located on the farm Volspruit 326 KR, Limpopo Province, South Africa. Report no. AED0202/2012. EScience Associates (Pty) Ltd. Prepared by African Environmental Development. November 2012.

a) ***Purpose of the report***

This report mainly focuses on the general surface water and hydrological aspects of the Nyl River and the associated Nyl River wetland (Nylsvlei), including the water quantities and water quality. The baseline surface water and hydrological conditions of Volspruit and the Nyl River wetland are also recorded in this report.

The report includes sections on the following:

- Description of the catchments, surface water flow patterns and water quantities;
- Surface water quality including descriptions of the sampling points and discussions of the water quality;
- AMD at the proposed Volspruit Mine;
- Water handling at the proposed Volspruit Mine;
- Drainage density;
- Potential future impact of the human activities on the surface hydrology on the Nyl River wetland proposed Volspruit Mine; and
- Impact and risk assessment.

b) ***Main findings***

The Nyl River wetland covers 24 000 ha, is 6 m wide and approximately 84km in distance. The wetland is underlain by an in-filled alluvial river valley up to 35m deep in some places. The floodplain acts as a groundwater reservoir. Quaternary catchment A61E, in which the proposed Volspruit Mine is located, has a MAP of 624.6 mm and a MAR of 46.3 mm.

The surface water flow within the Nyl River according to logic – it flows perpendicular to the expected direction and in the same direction as the contour lines. It is assumed that the current flow direction is a result of a geological event, but this needs to be verified.

A soft barrier of alluvial deposit is located at the outlet of the Nyl River floodplain. Altering the hydrological conditions at the outlet may cause the barrier confining the alluvial material within the Nyl River floodplain to erode and ultimately lead to the erosion of the wetland via the Mogalakwena River. Furthermore, only a few meters elevation separates the wetland bed from the adjacent catchment. If significant amounts of additional alluvium are deposited in the river basin, the Nyl River may change its course towards the Grass Valley River, a tributary of the Olifants River.

Several mines abstract groundwater downstream of the Nyl River. The volume of water abstracted by each mine individually has shown not to have negative impact on the surface water resources, however, in combination the mines have adverse effects on surface water.

The Nylsvlei wetland forms a single, mostly uniform entity (from a hydrological perspective) and therefore cannot be investigated as isolates sections. Surface water - groundwater interaction was initially assumed to be significant and not to be analysed independently. However, later investigations found that an aquitard separates the water on the surface of the floodplain and the groundwater in the deeper, coarser parts of the in-filled alluvium underlying the wetland. Due to the separation between surface water and groundwater in the Nyl River floodplain it is assumed that groundwater abstraction by the proposed Volspruit Mine will have little effect on the surface water environment. This assumption still needs to be verified.

The wetland is inundated on an irregular, but mostly seasonal basis. Historical records show the entire floodplain is inundated six out of ten years during the rainy season. The high evapotranspiration rate and ponding losses ensure that floodwaters do not leave the floodplain every year. Approximately 70% of the water entering the floodplain is lost through evaporation and only a small amount reaches the outflow and enters the underlying aquifer. Floodwaters can persist for months into the dry season and even into the following rainy season.

Rainfall over the catchment remained low and erratic for a long time. Rain in the vicinity occurs as thunderstorms over small areas and hence water in the tributaries do not reach the wetland simultaneously.

2.15.3 Nyl River Hydrological Modeling

Report Title: Nyl River Hydrological Analysis. Report No. W00/JNB/000029. EScience Associates (Pty) Ltd. Prepared by Royal Haskoning DHV. January 2014.

a) ***Overview***

A hydrological analysis of the Nyl River, situated in the A61 tertiary catchment, was conducted using WRSM2000 or Pitman model as part of the scoping and Environmental Impact Assessment process to assess the environmental feasibility and impact of the proposed Volspruit open cast platinum mine. The model used the WR2005 setup as a basis but incorporated more detail and updated rainfall data from 1920 to September 2010. Two additional streamflow gauges, A6H011 and A6H033, were included as well as the GWSWIM, which models and analyses groundwater-surface water interaction.

b) ***Main findings***

Land use and water requirements in the study area are limited to alien vegetation, farm dams, irrigation and abstractions from the Donkerpoort Dam to supply Modimolle (approximately 0.93 million m^3/a).

The modelled system included all nine quaternary catchments as part of tertiary catchment A61 (A61A to A61J). Some quaternary catchments were split into two or more sub-catchment depending on the location of streamflow gauges and irrigation areas. The GWSWIM groundwater parameters were entered into all runoff modules. WR2005 rainfall data was extended to September 2010 and was patched using “PatchMP”. Evaporation was used from the WR2005 study.

Dams and reservoirs modelled in WRSM2000, as well as the associated supply area, include:

- Doorndraai Dam – Urban and industrial abstractions;
- Donkerpoort Dam – Supplies Modimolle;
- Gert Combrink – Supplies Mokopane; and
- Haaskloof and Rooiwal dams.

Wetlands were originally allocated as comprehensive wetlands to channel reach modules but changed to dummy reservoir modules as the Nylsvlei wetland and Nyl River are all considered as one entity. The average depth that gave the most realistic calibration was 0.75 m.

Two streamflow gauges, A6H006 and A6H011, were used in quaternary catchment A61A, however neither of these gauges are of high accuracy. Streamflow gauge A6H033 was used as an additional gauge just downstream of Nylsvlei although it only had a 5 year record period. Other streamflow gauges included the gauge at Doorndraai Dam and A6H027 further downstream. WRSM2000 results indicated that there is a significant reduction in flow in quaternary catchment A61E due to the wetland and flow at A6H033 will only be measured when there is a flood event.

Groundwater abstraction alters the water balance of runoff by:

- Depleting base flow;
- Inducing transmission losses and
- Reducing evapotranspiration from groundwater.

Groundwater abstraction data was sourced from *Groundwater Resource Assessment II* (GRAII) for the upstream catchments and from hydrocensus and crop water modelling in the study area. Groundwater is recharged by surface water via transmission losses due to the lowering of water levels by irrigators. The increase in transmission losses increases the duration of zero flow in the Nyl River. Furthermore, evapotranspiration from groundwater is also significantly reduced. The mining activity of the proposed Volspruit Mine will result in an increase of 11% in transmission losses and a 2.5% decrease in the MAR from the sub-area.

It was recommended by the study team that further analyses of the mine water abstraction scenarios be conducted through the WARMS and MODFLOW models. This will aid in the investigation of the effects of tailings seepage and aquifer recharge at Grassvally Mine in order to ultimately inform management decisions and licence applications.

2.16 DEVELOPMENT OF A FEASIBILITY STUDY FOR THE MUTASSHI/MUSINA CORRIDOR BULK WATER SUPPLY

2.16.1 Overview

The proposed Mutasshi (*Musina to Africa Strategic Supply Hub Initiative*), also referred to as the Musina corridor, is a strategic supply hub initiative envisaged to run from Makhado, through Musina to Beitbridge. The corridor will comprise of a new infant port and freight and logistics gateway, as well as other proposed projects within the corridor, which include the following:

- The proposed Eco-Industrial Park;
- Proposed Trade Centre;
- Proposed expansion of mining activities; and
- Proposed expansion of agricultural activities in the Nzhelele Valley and surrounding areas.

The purpose of this study was to determine the feasibility of the Mutasshi/Musina corridor with regard to bulk water supply and demand after assessing the socio-economic conditions of the study area and the surface and groundwater resources. The study area comprises of the area covered by the Musina LM and a small section of Makhado LM, referred to as Makhado North.

2.16.2 Impletation Readiness Study: Musina-Makhodo Water Supply Scheme

Report Title: Impletation Readiness Study: Musina-Makhodo Water Supply Scheme: Socio-Economic Component Version 2. Department of Water Affairs. Prepared by Glen Steyn and Associates on behalf of Aphane Consulting. April 2014.

The purpose of this report was to provide strategic planning and socio-economic information as well as a water demand analysis for the Implementation Readiness Study for the Musina to Makhado Project also refered to as the *Development of a Feasibility Study for the Mutasshi/Musina Corridor Bulk Water Supply*.

The *Musina-Makhado Sub-regional Infrastructure Master Plan* (2030) is an important and recent economic planning study that was compiled in March 2013. It contains a strategic overview and quantification of infrastructure investment demand for both the Musina and Makhado LMs respectively.

a) ***Overview of Musina LM***

Vhembe DM is the designated Water Services Provider for potable water for domestic use but operation and maintenance is undertaken by the Musina LM. Water demand associated with mining and agricultural activities is managed by the DWA (now DWS).

Future development in the Musina area includes the expansion of the Venetia Diamond Mine, coal mining developments near Mapungubwe, the Special Economic Zone (SEZ) and the Limpopo Eco-Industrial Park (LEIP). The SEZ comprises of commercial and light industrial activities forming a logistics hub in proximity to Beitbridge. The LEIP will comprise of heavier industries and a dedicated rail spur further to the south.

b) ***Overview of the Makhado LM***

Vhembe DM is the designated Water Services Provider for potable water for domestic use but operation and maintenance is undertaken by 7 satellite depots across Makhado LM. Water demand associated with mining and agricultural activities is managed by the DWA (now DWS). The area of the Makhado LM included in this study is the area north of the Soutpansberg.

Coal of Africa Limited (CoAL), a coal mining company, anticipates to establish a number of new coal mines in the area between Musina and Louis Trichardt. More information on CoAL's various projects is provided in **Section 2.16.3 a)**.

c) ***Demographics***

The main economic driver for Musina is mining, with diamonds and coal being the primary commodities. The local mining sector also induces the trading sector, transport and government activities and is anticipated to grow rapidly. Government is the main economic driver for Makhado due to the public sector needs associated with the large population. Furthermore Makhado is an important food production centre with a rich game farming sector and large potential for tourist developments.

The 2011 and 2020 population figures were based on DWS household counts, 2011 Census and Statistics South Africa data as given in Table 2.68.

The population of Musina LM is expected to increase by 4% per year until 2020 and 2.5% per year until 2030. The total population in Makhado LM was 516 000 in 2011. However, the Makhado population included in the study area accounts for only 2% of the population within the municipality. Zero population growth is expected until 2015, due to emigration of young people, thereafter 2% per year until 2020 and 1.5% per year until 2030.

Table 2.68: Population growths

Project area	Base population	Planning population(1)	Projected planning population 2020
Musina LM	68 745	70 913	100 931
Makhado North	10 629	11 054	12 205
Total Project Area	79 374	81 967	113 136

1) Recommended practice in Limpopo is to add 4% to the base population to determine the planning population

d) *Water demand analysis*

Musina LM

In the absence of actual water consumption statistics for Musina, the residential water demand has been calculated as approximately 18 Mℓ/d including 30% water losses. Musina is entitled to abstract 29 Mℓ/d, according to the DWA's WARMS register, and thus the current demand is well within this limit.

All of Musina Town's water is sources from groundwater of which 97%, 10.4 million m³/a, is sourced from 16 boreholes in the sand aquifer of the Limpopo River and the remainder from other groundwater resources in the Municipality.

An effluent discharge of some 10 Mℓ/d has been estimated in the Musina urban area compared to the present treatment capacity of 7 Mℓ/d. Thus an urgent need to increase waste water treatment capacity.

The Venetia Diamond Mine requires 17 Mℓ/d and no increases are expected, despite their expansion - the new underground operation will require less run-of-mine product in the processing plant compared to the current open pit operation. Coal mining activities are only anticipated after 2020 but water demand is not yet fully determined.

A total water demand for the SEZ is preliminary assumed to be 15 Mℓ/d for 2020 and 30 Mℓ/d by 2030 but will only be verified after a feasibility study. AGES estimated the water need for the proposed LEIP at approximately 28 Mℓ/d or 10 million m^3/a by 2030. Several long and short term water supply options were considered.

Makhado North

The total residential water requirements for the Makhado LM are estimated at 52 Mℓ/d including 30% water losses, however, the demand for the area included in study area is only 1 Mℓ/d.

The main water resources for Makhado are the Albasini Dam and Nandoni Dam and these are augmented by boreholes in the rural areas and the Nzhelele Dam for irrigation. The groundwater model estimated abstraction for agriculture at 14 Mℓ/d and an irrigation allocation from Nzhelele Dam of 60 Mℓ/d.

The proposed coal mining activities in the vicinity of Makhado requires approximately 9.1 Mℓ/d by 2020 and 38.7 Mℓ/d by 2030, of which some is proposed to be supplied from water trading with the irrigation sector. CoAL will also investigate the options to increase the yield of the Nzhelele Dam.

Total water requirements

The total water requirements for the study area is summarised in Table 2.69.

Table 2.69: Estimated water demand for the Musina-Makhado project area

Area	Sector	Water requirements (Mℓ/d)		
		2011	2020	2030
Musina LM	Residential	18	25.6	32.8
	Agriculture(1)	400	400	400
	Mining(2)	18	18	20
	Other(3)	1	20.4	31
	Total	**437**	**464.1**	**483.8**
Makhado North	Residential	0.34	1.13	2.16
	Agriculture(4)	74.5	74.5	74.5
	Mining:			
	• Makhado	0	9.1	9.1
	• Chapudi	0	0	11
	• Mopane	0	0	7.6
	• Generaal	0	0	11
	Other	0	0	0
	Total	**74.9**	**84.8**	**115.4**
TOTAL		512	545	600

1) No rapid increase expected.
2) Little increase due to constant improvement on kimberlite diamonds processing resulting in reduction of water requirements.
3) Includes SEZ and LEIP, feasibility studies are still required to accurately quantify demand.
4) Sourced from the Groundwater Model developed for CoAL.

2.16.3 Draft Scoping Report

Report title: Development of Feasibility Study for the Mutasshi/Musina Corridor Bulk Water Supply: Draft Scoping Report. Department of Water Affairs. Prepared by Aphane Consulting CC.

a) ***Economic growth and development***

The following major developments are considered for the study area:

- The Nzhelele Valley Irrigation Farmers Association indicated that its irrigation water allocation from the Nzhelele Dam, for the 3000 ha of citrus irrigation, was reduced by 75% with a deficit of 4.8 million m^3/a, to accommodate new users. The Association further pointed out that the current R 1 billion per annum revenue can be doubled by increasing the irrigated area by another 3000 ha if water was available. Furthermore a proposed citrus irrigation expansion of 100 000 ha [*sic*] is also considered should the water requirement of 100 000 000 million m^3/a [*sic*] become available and will create 10 000 direct jobs;
- A *Special Economic Zone* (SEZ) comprising of a package of commercial and light industrial activities which will form a logistics hub in proximity to Beitbridge, with heavier industries and a dedicated railway further to the south. A feasibility study still has to be undertaken to quantify the water demand; and
- CoAL intends to develop the Makhado and Greater Soutpansberg Coalfields projects.

Makhado and Greater Soutpansberg Coalfields projects

CoAL intends to develop the Makhado and Greater Soutpansberg Coalfields projects. Refer to **Table 2.70** for the development stage of each project and to **Figure 2.3** for the location thereof.

Table 2.70: Great Soutpansberg coalflied projects and development stage by CoAL

Project	Collective project region	Development stage
Makhado	Makhado	Feasibility
Telema & Gray	Makhado	Pre-feasibility
Tshipise Energy Project – Coal Bed Mathane	Generaal	Pre-feasibility
Chapudi	Chapudi	Resource definition
Voorburg	Mopane	Resource definition
Mount Stuart	Genraal	Advanced exploration
Jutland	Mopane	Advanced exploration
Chapudi West	Chapudi	Early exploration
Wilderbeesthoek and General	Chapudi	Identified target

The proposed coal mines north of the Soutpansberg Mountains will require a maximum of 1.9 million m^3/a until 2018, 5.9 million m^3/a until 2032 and 9.5 million m^3/a until 2044. However, there are no viable water sources in the study area to meet the demand and it is recommended that project developers pay farmers for some of their water allocations from the Nzhelele Dam irrigation scheme. CoAL in fact announced that a memorandum of agreement was signed with the Nzhelele Catchment Water Users Association in October 2012 to allocate 1.7 million m^3/a of their irrigation allocation for use at the proposed Makhado Coal Mine. CoAL will also investigate the options to increase the yield of the Nzhelele Dam.

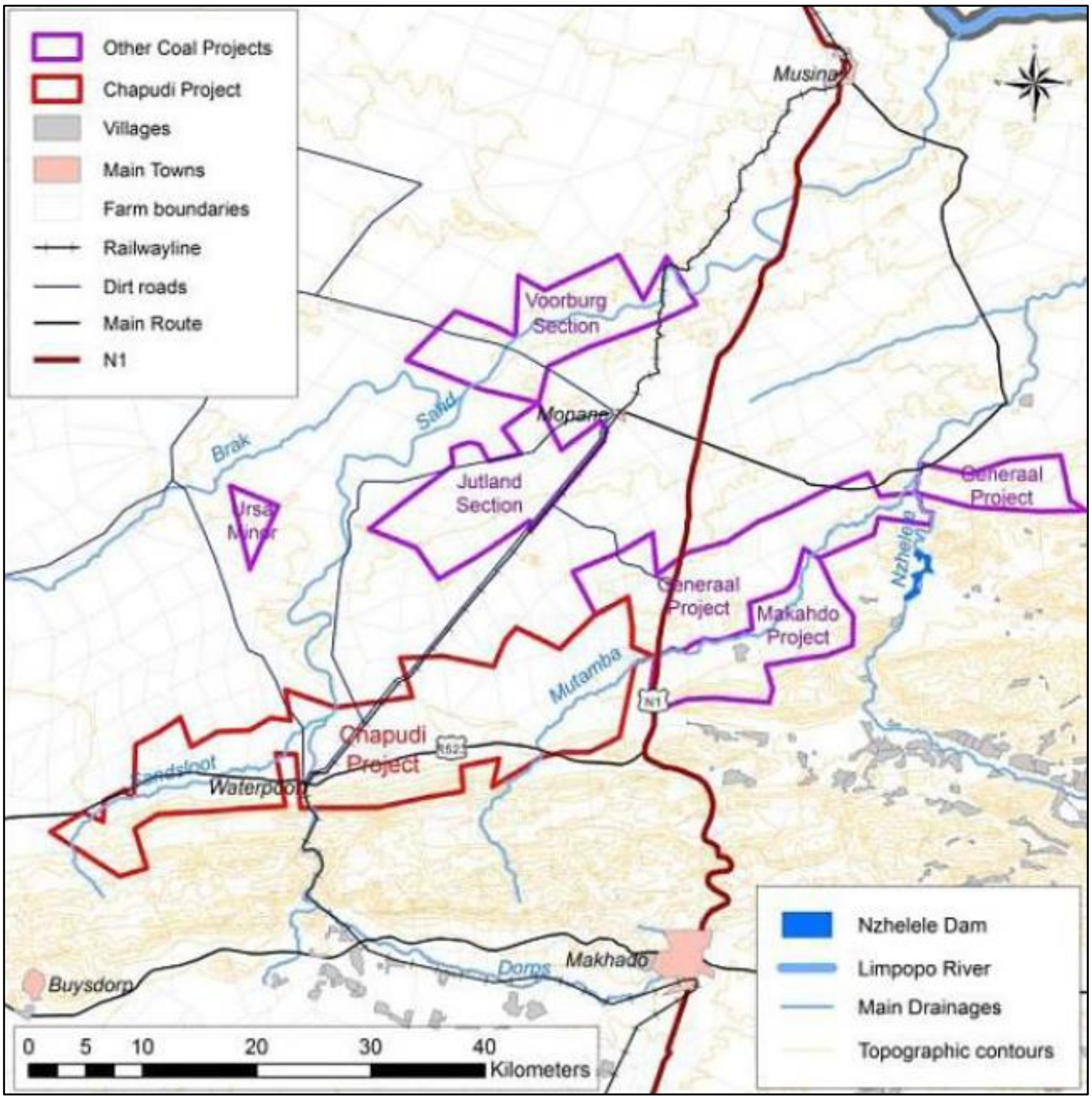


Figure 2.3: Location of the Makhado and Great Soutpansberg coalfield projects

WSM Leshika modelled the groundwater impact of the proposed coal mining activities as part of the environmental impact assessment process and concluded that impacts will be significant. These, in order of significance, include:

- Reduction in water available for abstraction and discharge i.e. lower borehole yields or drying up of boreholes and springs along the foot of the Soutpansberg Mountains within the radius of influence;
- Cross contamination of aquifers due to the disturbance of aquitard layers and the down gradient contamination due to seepage from the rehabilitated pits, discard dumps, stock piles and dirty water dams; and
- A reduction in water available for evapotranspiration. Groundwater dependant floral species around springs and seeps could be affected as the water table drops. Riverine vegetation is mostly sustained from surface flows and water stored in the alluvial deposits, however, shallow groundwater may be important during extended dry periods.

The following mitigation measures should be considered to address the impacts of the proposed mining:

- Revise the mining schedules of the proposed mines to limit the cumulative impacts;
- Enter into negotiations with surrounding land owners impacted regarding compensation or alternative water supply;
- Implement Aquifer Storage and Recovery (ASR) to minimise depletion of aquifer storage thus limiting the extent of the drawdown cone.

b) *Existing infrastructure*

Musina LM has 16 boreholes in the Limpopo River bed and 10 other within the municipality supplying Musina Town. Water from the boreholes is delivered to Limpopo River Storage Reservoir with 750 kℓ capacity after which it is pumped to the 650 kℓ Blikkiesdorp Reservoir and then to Bergview. Bergview has two reservoirs with storage capacities of 12 000 kℓ and 15 000 kℓ respectively.

RWSs in the study area operated by the Makhado LM include:

- *Tshifire RWS* – supplied from groundwater and surface water;
- *Nzhelele Valley RWS* – supplied from groundwater and surface water;
- *Nzhelele North RWS* – supplied from groundwater and surface water; and
- *Matshavhare Khunda Water project* – supplied from groundwater.

c) *Water demand analysis*

A water demand analysis has been completed by by Glen Steyn and Associates as part of the *Impletation Readiness Study: Musina-Makhodo Water Supply Scheme*. Refer to **Section 2.16.2d)**

d) *Alternative water resources*

The Zhove Dam on the Umzingwane River, Zimbabwe, and the Zambezi River were identified as two possible sources to augment water supply to the proposed Soutpansberg Coalfields projects and the expansion of citrus irrigation farming respectively.

- The Umzingwane River is a tributary of the Limpopo River with the confluence situated 10km upstream of the Beitbridge, Zimbabwe. The Zhove Dam has a storage capacity of 150 million m^3/a of which most is not allocated. Approximately 30 million m^3/a of raw water can be purchased from the *Zimbabwe National Water Authority* (ZINWA) by abstracting surface water released by Zhove Dam from the Limpopo River to augment supply to the proposed Makhado and Greater Soutpansberg Coalfield projects and 3000 ha of citrus irrigation expansion.
- Zimbabwe plans to abstract water from the Zambezi River for domestic and industrial use in Bulawayo. The project will also provide water for large scale irrigation agriculture projects between the Zambezi River and Bulawayo. Botswana is carrying out a feasibility study for commercial irrigation of 35 000 ha in the Pandamatenga area with water abstracted from the Zambezi River and the provision of a pipeline from Pandamatenga to eventually join the North South Carrier transferring the water to all the towns in the east of Botswana down to Lobatse. It is recommended that water be transferred from the Zambezi to the Shashe River basin whilst providing water to Bulawayo in a cooperative initiative between the three countries. The Shashe River flow will provide water for the North South Carrier in Botswana and the 100 000 ha of citrus irrigation in the study area. Alternatively a pipeline could be built from Bulawayo to Beitbridge to the study area.

e) *Conclusions and recommendations*

Constraints that could prevent the Musina and Makhado LMs from achieving its objectives are as follows:

- The capacity of the district and local municipalities to plan, implement and manage infrastructure is limited;
- Operation, maintenance and renewal of existing infrastructure have been lacking, resulting in assets deteriorating far more rapidly than expected; and
- Limited water resources pose a major constraint in the agricultural development and mining potential in the area.

A feasibility study must be carried out on the provision of water for the Soutpansberg Coalfield and the expansion of citrus irrigation farming in the study area to investigate the viability of the supply from Zhove Dam and the Zambezi River.

It is also recommended that more detailed study be conducted to confirm the adequacy of water in the study area for current users with emphasis on the spatial distribution of demand and supply centres.

2.16.4 Final Technical Feasibility Study Report

Report title: Development of Feasibility Study for the Mutasshi / Musina Corridor Bulk Water Supply: Final Technical Feasibility Study Report. Department of Water Affairs. Prepared by Aphane Consulting CC.

Socio-economic data was obtained in the following order; (i) desktop studies, (ii) field surveys, (iii) subnational and spatial analysis, (iv) identification of issues and challenges for successful implementation and (v) future population and major land use projections.

The water resources was assessed by (i) identifying all the surface water and groundwater resources, (ii) identifying current water supply infrastructure (iii) conducting yield assessments of water resources, (iv) conducting current and future water demand analysis and (v) evaluating water resources management efficiency.

The report comprises of sections on the geography, the current reality-situation analysis, the hydrology and surface water infrastructure, groundwater resource assessment, water resources and water demand centres in the study area.

Other than the content included in Sections 2.16.2 and 2.16.3 the following additional main findings were identified:

- At least 70 million m^3/a is abstracted from the Limpopo river alluvial aquifer for irrigation and mining in the study area as well as for Musina Town. However, no coordination of the monitoring and control of abstractions between the three riparian states, South Africa, Botswana and Zimbabwe, exist and thus a coordinated monitoring plan from the Limpopo Water Course Commission is essential to avoid over abstraction and ensure sustainability.
- An allocation of 10.4 million m^3/a is made from the Limpopo River alluvial aquifer to Musina Town which is in access of the 7.93 million m^3/a required to sustain the 2035 high growth scenario, thus implying that no augmentation is required up to 2035. This includes water requirements for the proposed inland port, transport hub and supply centre as well as the proposed eco-industrial park which will have extensive water recycling measures to ensure minimal additional water requirements to the existing Musina Town water demand.
- There are substantial losses in the water conveyance systems from Nzhelele Dam which will result in substantial savings if attended to.
- There are no water shortages at the major water demand centres in the study area except for the area supplied by the Nzhelele Dam and the proposed Makhado and Great Soutpansberg Coalfield.
- The groundwater quality around Tshipise Village is Class 4 (unacceptable water) as it has high Nitrate and TDS concentrations due to historic activities such as livestock farming, agriculture and mining.
- The development of groundwater options for the Mutasshi/Musina Corridor required the review of existing information and the use of the DWA GRDM Software to determine the availability of the resource. The groundwater resource assessment focussed on quaternary catchments A71H (Makhado) and A71K (Musina). Information was obtained from the following sources:
  - Groundwater data from DWA National Groundwater Database;
  - Groundwater use data from WARMS data base;
  - DWA 1:500 000 hydro-geological map series; and
  - Hydrogeological Reports from DWA Library.
- The following was concluded with regard to groundwater resources:
  - New groundwater infrastructure can be developed as the groundwater resources in the two quaternary catchments are under-utilized;

- Due to the complex geology of the quaternary catchments, geophysics studies should be done; and
- Consistent groundwater management should be enforced to avoid over abstraction.

2.17 Drought Operating Rules for Stand Alone Dams/Schemes Typical for Rural/Small Municipal Water Supplies – Northern Cluster

Study Information: Drought Operating Rules for Stand Alone Dams/Schemes Typical for Rural/Small Municipal Water Supplies – Northern Cluster. Department of Water Affairs. DWA Contract no. 10325. Prepared by WR Nyabeze and Associates (WRNA). 2010 - 2013.

2.17.1 Overview

The main objective of this study was to develop water supply and drought operating rules for selected dams/schemes within the Eastern Cluster. The study focussed on water use and water demand patterns in the systems of various stand-alone dams within the cluster. Also included are the state of the water resources availability and the results of decision support tools, in order to regulate the water availability in the system and hence minimise the risk of failure to supply.

A number of dams were included in the study, however, only dams located in the Limpopo WMA is discussed as part of this *Literature Review Report*.

2.17.2 Mutshedzi Dam Operating Rule Report

Report Title: Drought Operating Rules for Stand Alone Dams/Schemes Typical for Rural/Small Municipal Water Supplies – Northern Cluster: Mutshedzi Dam Operating Rule Report. Report no. P RSA 000/00/14411/NORTHERN CLUSTER/ MUTSHEDZI. Department of Water Affairs. Prepared by WR Nyabeze and Associates (WRNA). May 2012.

a) ***General overview of Mutshedzi Dam***

The Mutshedzi Dam, built in 1990, is situated in the north eastern part of the Limpopo WMA. The dam was built for the purpose of supplying domestic water to the surrounding communities after it is treated at the Mutshedzi WTW. The downstream water use is mostly for irrigation and the run-of-river abstractions benefit from the dams' releases.

b) ***Summary***

Users and allocations

Mutshedzi WTW is owned and operated by Vhembe DM supply domestic users. The total domestic allocation from the dam is 4.35 million m^3/a. Run-of-river abstractions occur downstream of the dam for irrigation, utilising the dam releases. These run-of-river abstractions are allocated at 1.41 million m^3/a. The historical and long term resource availabilities from Mutshedzi Dam are summarised in Table 2.71.

Table 2.71: Historical and long term resources availability from Mutshedzi Dam

HFY		Long term yield (million m^3/a) at indicated RI		
million m^3/a	Recurrence interval (years)	1:100	1:50	1:20
2.60	429	3.45	3.66	4.20

Issues

Growing water requirements from the domestic sector is a concern with regard to the allocations of the dam.

2.17.3 Nwanedi/Luphephe Dams System Operating Rule Report

Report Title: Drought Operating Rules for Stand Alone Dams/schemes Typical for Rural/Small Municipal Water Supplies (Northern Cluster): Nwanedi / Luphephe Dams System Operating Rule Report. Report no. P RSA 000/00/14411/NORTHERN CLUSTER/NWANEDI. Department of Water Affairs. Prepared by WR Nyabeze and Associates (WRNA). May 2012.

a) ***General overview of the Nwanedi sub-system***

The Nwanedi sub-system is inclusive of the Nwanedi, Luphephe and Cross dams. The Luphephe Dam is on the Luphephe River (at the outlet of quaternary A80H) which is a tributary of the Nwanedi River. The Nwanedi Dam (also at the outlet of quaternary A80H) and Cross Dam (A80J) is located on the Nwadedi River.

The Nwanedi and Luphephe dams are situated inside the Nwanedi Nature Reserve, these dams provide water for wildlife, irrigation and domestic usage in the surrounding areas. Cross Dam is primarily used as a balancing dam to regulate the water releases for irrigators downstream.

A new WTW has been constructed downstream of the Nwanedi and Luphephe dams due to the growing levels of domestic water requirements. The system will soon have to change supply allocations to favour the high priority domestic requirements, as it will be under pressure from the demands. Care must be taken to avoid failure of the system to protect the domestic users and the commercial irrigators.

b) ***Summary***

Users and allocations

Originally the Luphephe and Nwanedi dams were constructed for irrigation usage for downstream farmers. The combined allocation from the Nwanedi and Luphephe dams is 5.31 million m^3/a for irrigation. There is also a pipeline from the dams which supplies a camp in the Nwanedi Nature Reserve. Additionally, there is a new WTW downstream of the dams which will abstract water from the dams' releases to supply domestic users.

Issues

The future demands from the dams will increase as the plans to abstract from downstream for domestic usage are already at an advanced level. There were no documented operating rules for the dams and the yield of the dam at various assurance levels is unknown.

The historic firm yield and long-term stochastic availability, water allocations by water use type and the water allocations by water source is summarised in Table 2.72 to Table 2.74.

Table 2.72: Historical and long term resource availability for the Nwanedi system

Dam / System	HFY		Long term yield (million m^3/a) at indicated RI		
	million m^3/a	RI (years)	1:20	1:50	1:100
Luphephe Dam	5.90	429	9.45	8.14	7.2
Nwanedi Dam	2.44	406	3.88	3.39	2.94
Nwanedi system	**8.34**	**-**	**13.33**	**11.53**	**10.14**

Table 2.73: Water allocations by water use type (WARMS Database, 2011)

Water use type	Registered amount (million m^3/a)	Proportion
Irrigation	10.472	95.0%
Water supply services	0.513	4.7%
Livestock	0.033	0.3%
Total	**11.018**	**100%**

Table 2.74: Water allocations by water source (WARMS Database, 2011)

Water use type	Registered amount (million m^3/a)	Proportion
River or stream	10.081	91.5%
Borehole (groundwater)	0.938	8.5%
Total	**11.019**	**100%**

2.17.4 Nzhelele Dam Operating Rule Report

Report Title: Drought Operating Rules for Stand Alone Dams/schemes Typical for Rural/Small Municipal Water Supplies (Northern Cluster): Nzhelele Dam Operating Rule Report. Report no. P RSA 000/00/14411/NORTHERN CLUSTER/ NZHELELE. Department of Water Affairs. Prepared by W R Nyabeze and Associates (WRNA). May 2012.

a) ***General overview of Nzhelele Dam***

The Nzhelele Dam is the largest in the Nzhelele sub-system and is located in the eastern part of the Limpopo WMA. The dam is owned and operated by the DWA (now DWS).

The dam, built in 1948, was intended to provide water for the Nzhelele Government Irrigation Scheme. Weirs constructed downstream of the dam are used to abstract water released from the dam for irrigation purposes.

The catchment area of the dam contains perennial rivers and streams which support the local human settlements and run-of-river irrigation. However, the activities upstream have an impact on the water availability of the dam.

b) ***Summary***

Users and allocations

The Nzhelele Dam has a FSC of 51.23 million m^3/a and has a FSC/MAR ratio of 0.86. The total allocation for the dam is 29 million m^3/a, all for irrigators downstream. Measured data confirms that the only outflows from the dam are irrigation releases, uncontrolled spills and evaporation. Furthermore, no direct abstractions from the dam for domestic or industrial water usage occur. Actual releases, historically, are similar to the licensed allocations, however, the failure of the system to meet the licenced allocation could be attributed to depletion of storage in some years.

Table 2.75: Yield of Nzhelele Dam

HFY		Long term yield (million m^3/a) at indicated RI		
million m^3/a	RI (years)	1:100	1:50	1:20
16.25	295	18.6	20.6	25.4

Other major dams in the catchment

Upstream of the Nzhelele Dam is the Mutshedzi Dam, which is the only other major dam in the catchment and has a FSC of 2.16 million m^3/a with a FSC/MAR ratio of 0.08. Water from this dam is abstracted for domestic water supply to the local villages.

c) ***Main findings***

Main findings are as follows:

- It is important that operating rules are correctly implemented to avoid large drawdowns in the future, such as were previously experienced.
- The current level of assurance are appropriate for irrigation, however, it would need to be higher should the dam be used for domestic supply. The operating rules need to be revised should an allocation for domestic or industrial water be added.
- Decisions on whether or not restriction will be applied to the dam are made on the decision date. For no restrictions to be implemented the dam must be at FSC.
- The dam will not fail at current abstraction levels over the next 5 years of operation, provided inflows are similar to the median historical flows.

2.18 Olifants River Water Resources Development Project (ORWRDP)

Study Information: Olifants River Water Resources Development Project (ORWRDP). Department of Water Affairs and Forestry. Number of information sources. 2004 to current.

2.18.1 ORWRDP summary

The *Olifants River Water Resources Development Project* (ORWRDP) was initiated by DWAF (now DWS) in 2004 to assess the feasibility of various water resource development options in the Olifants, Mogalakwena and Sand River catchments. The project was aimed at uplifting the social and economic development needs of the region as well as to meet the future water requirements of all sectors in the aforementioned catchments, especially the growing mining sector.

Phase 1 comprised of raising of the Flag Boshielo Dam by 5 m. Construction was completed in 2006. Phase 2 the investigation and development of additional water resource infrastructure. The following development options were investigated as part of Phase 2:

- A possible new dam at Rooipoort on the Olifants River;
- A possible new dam at De Hoop on the Steelpoort River; and
- Groundwater supply.

The most feasible option was the construction of the De Hoop Dam and the associated bulk infrastructure. The bulk water distribution infrastructure includes pipelines from an abstraction weir near the town of Steelpoort or from the proposed De Hoop Dam to the Olifantspoort Weir, with a branch pipeline to Jane Furse; and a pipeline from Flag Boshielo Dam to Mokopane. For each pipeline, bulk infrastructure includes associated pump stations, balancing dams, off-takes and reservoirs.

Phase 2 is implemented per sub-phase as provide in **Table 2.76**. The table also shows the progress on each of the phases as obtained from https://www.dwa.gov.za/ORWRDP/phases.asp and adjusted were information was available.

Table 2.76: ORWRDP construction phases

Phase	Component	Construction (anticipated)	Commissioning	Progress
1	Raising of Flag Boshielo Dam	2004 – 2006	2006	Completed
2A	De Hoop Dam	2006 – 2010	2009	Completed
2B	Flag Boshielo to Mokopane pipeline	2008 – 2009	2009	Started
2C	Steelpoort Weir and abstraction works	2008 – 2009	2014	Started
2D	2nd pipeline from Steelpoort Weir to Mooihoek	2010 – 2011	2014	
2E	2nd pipeline parallel to Lebalelo Scheme	> 2025	2016	Under consideration
2F	Connect Lebalelo Scheme to Olifantspoort	2012 – 2013	2016	Under consideration
2G	2nd pipeline from Flag Boshielo to Mokopane	> 2025		Under consideration
2H	Incorporate Lebalelo Scheme	2008 – 2009	2009	Under consideration

The De Hoop Dam was constructed by the DWS and the bulk distribution system is funded and implemented by Trans-Caledon Tunnel Authority (TCTA). The engineering consultant for the project is Aurecon Ndodana Joint Venture and Basil Reed has been appointed as the construction contractor.

A schematic layout of the ORWRDP system is shown in Figure 2.4. The area supplied by Phase 2B and Phase 2G (two parallel pipelines from Flag Boshielo Dam to Mokopane) is shown in Figure 2.5. The pipeline ends at Pruissen from where a bulk distribution system was to be provided by the Mogalakwena LM. Construction of this bulk distribution system commenced in 2007 and is anticipated to start suppling by end 2015.

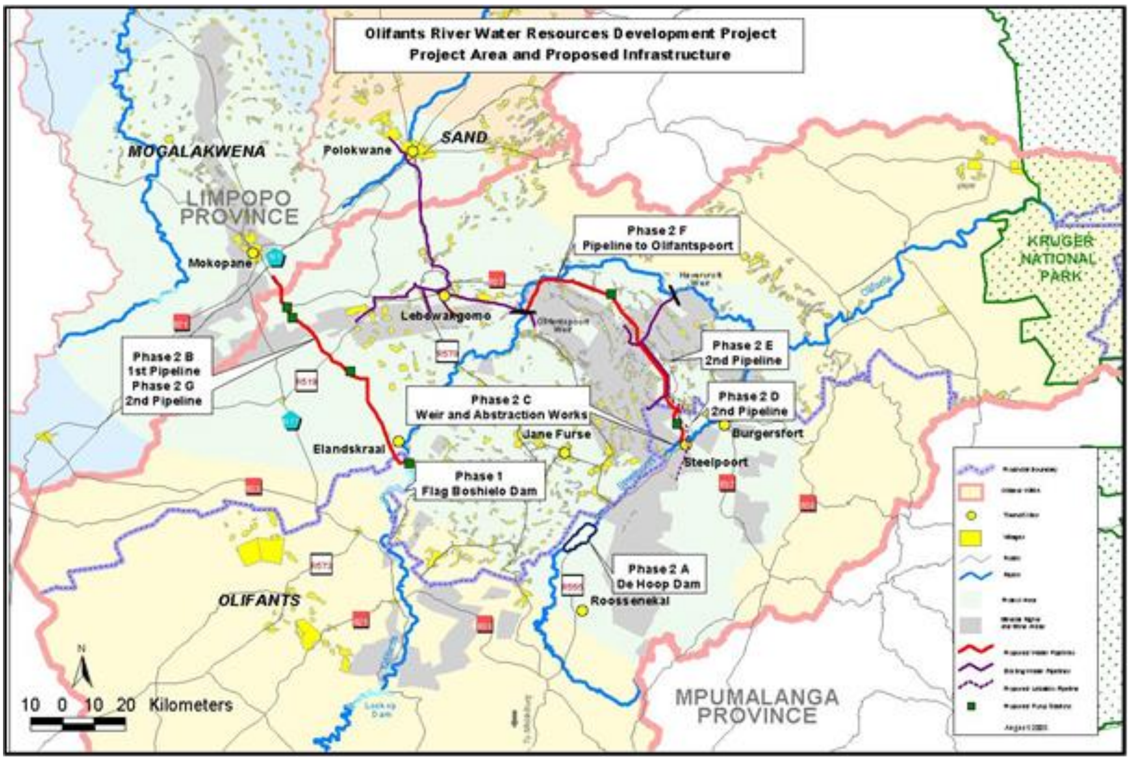


Figure 2.4: Schematic layout of the ORWRDP system

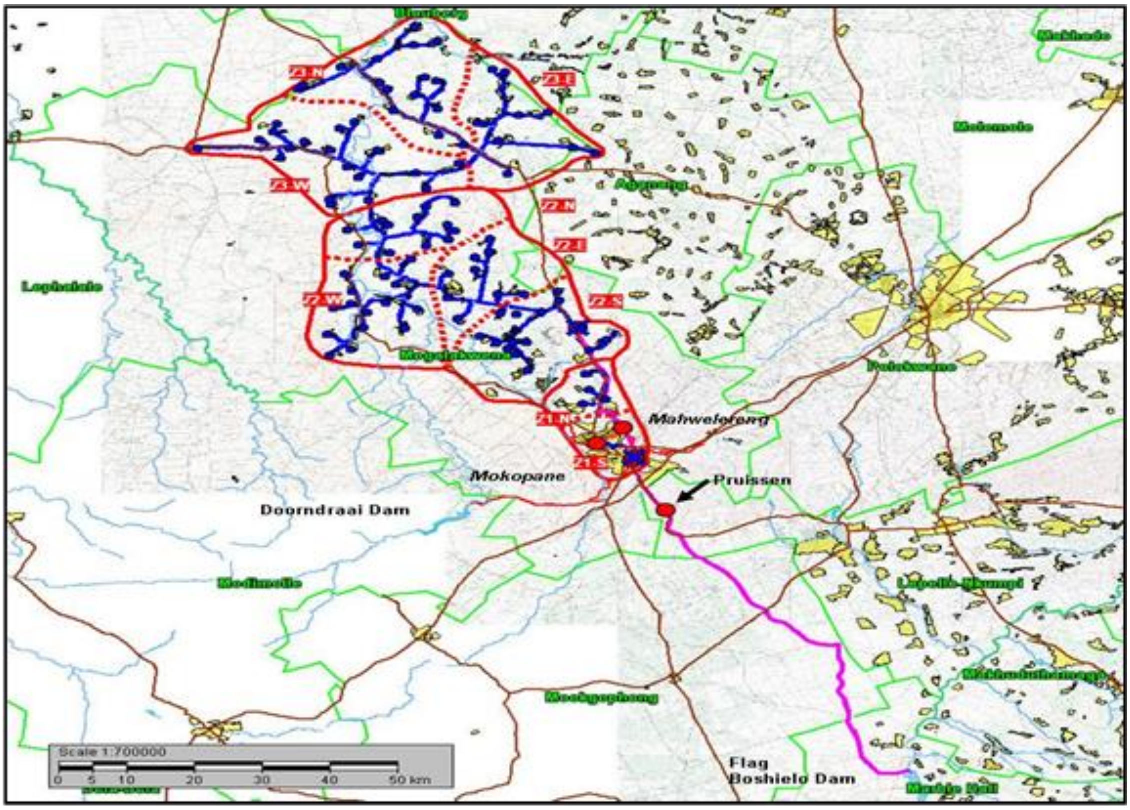


Figure 2.5: Schematic layout Mogalakwena Scheme Area

2.19 Limpopo Development Plan 2015-2019

Report Title: Limpopo Development Plan (LDP) 2015 – 2019. Limpopo Provincial Government. February 2015.

2.19.1 Overview

The Limpopo Development Plan (LDP) 2015-2019 builds on the *Limpopo Economic Growth and Development Plan* (LEGDP) 2009-2014 and the *Limpopo Provincial Growth and Development Strategy* (LPGDS) 2004-2008. The purpose of the LDP is to:

- Outline the contribution from Limpopo Province to the national MTSF1 for this period;
- Provide a framework for the strategic plans of each provincial government department, as well as the IDPs and sector plans of district and local municipalities;
- Create a structure for the constructive participation of private sector business and organised labour towards the achievement of provincial growth and development objectives; and
- Encourage citizens to become active in promoting higher standards of living within their communities.

The LDP document contains sections on the following:

- Legislative and policy context;
- Situation assessment and trend analysis;
- Strategy formulation for 2015-2019;
- Implementation action plans to achieve the targets; and
- Integrated planning framework and critical sector development plans.

For the purpose of this *Literature Review Report*, only information relevant to water resources and the future developments which will influence the water balance within the Limpopo WMA are discussed.

2.19.2 Water services

The Limpopo Province has a vast amount of coal deposits which should be exploited along with the development of 20 000 MW of renewable electricity. Both these will have a significant effect on the water resources within the province. One of the key priorities identified is to develop new water schemes to supply urban and industrial centres. The entire Limpopo Province will have an anticipated water deficit of 123 million m^3 by 2025, despite identified augmentation options. One of the main challenges is the aging infrastructure, resulting in major water losses and the high number of illegal water connections. Some settlements experience severe water shortages. Improved strategies for water resource management are therefore urgently required.

Approximately 12% of the population in the province lives in urban areas whereas 88% live in rural and non-urban areas. Rural towns and villages are mostly small and scattered across the province making adequate service delivery costly and difficult.

In 2011 86% of households in the Limpopo Province had access to piped water of which 18% have access to water inside dwellings and 34% inside yards. However, 13% of households do not meet RDP standards. Table 2.77 summarises the number of households with access to piped water from 1996 to 2011, as per Census results. The Province aims to increase the percentage of households with access to a functional water service from 85% in 2013/2014 to 90% in 2019.

Of note is that some of the municipalities extend beyond the boundaries of the Limpopo WMA and shown in Figure 2.6. Hence the number of households applicable to the Limpopo WMA North Reconciliation Strategy is less than included in Table 2.77.

Table 2.77: Household access to piped water

LM/DM	1996		2001		2011	
	Piped water	No piped water	Piped water	No piped water	Piped water	No piped water
Mutale	9 849	3 941	14 263	4 275	20 940	2 812
Thulamela	87 462	13 089	109 934	18 655	139 199	17 395
Musina	7 333	992	12 812	1 165	18 682	1 360
Makhado	75 016	13 065	100 283	12 632	117 221	17 668
Vhembe	179 660	31 087	237 292	36 727	296 042	39 235
Blouberg	21 783	8 726	30 416	8 567	34 056	7 137
Aganang	20 322	6 902	26 607	5 781	32 010	1 908
Molemole	19 688	2 862	21 629	7 312	23 542	6 501
Polokwane	67 709	17 330	112 282	23 353	171 054	6 947
Lepele-Nkumpi	27 280	16 929	32 216	20 711	45 181	14 501
Capricorn	156 782	52 749	223 150	65 724	305 843	36 994
Thabazimbi	11 259	3 607	25 268	265	23 530	1 550
Lephalale	12 147	5 792	23 267	1 116	29 080	799
Mookgopong	3 868	1 774	10 413	487	9 661	257
Modimolle	8 681	2 181	18 447	1 182	16 883	642
Bela-Bela	8 998	2 059	13 719	451	17 482	586
Mogalakwena	39 613	14 039	51 017	19 111	72 922	6 473
Waterberg	**84 566**	**29 452**	**142 131**	**22 612**	**169 558**	**10 307**

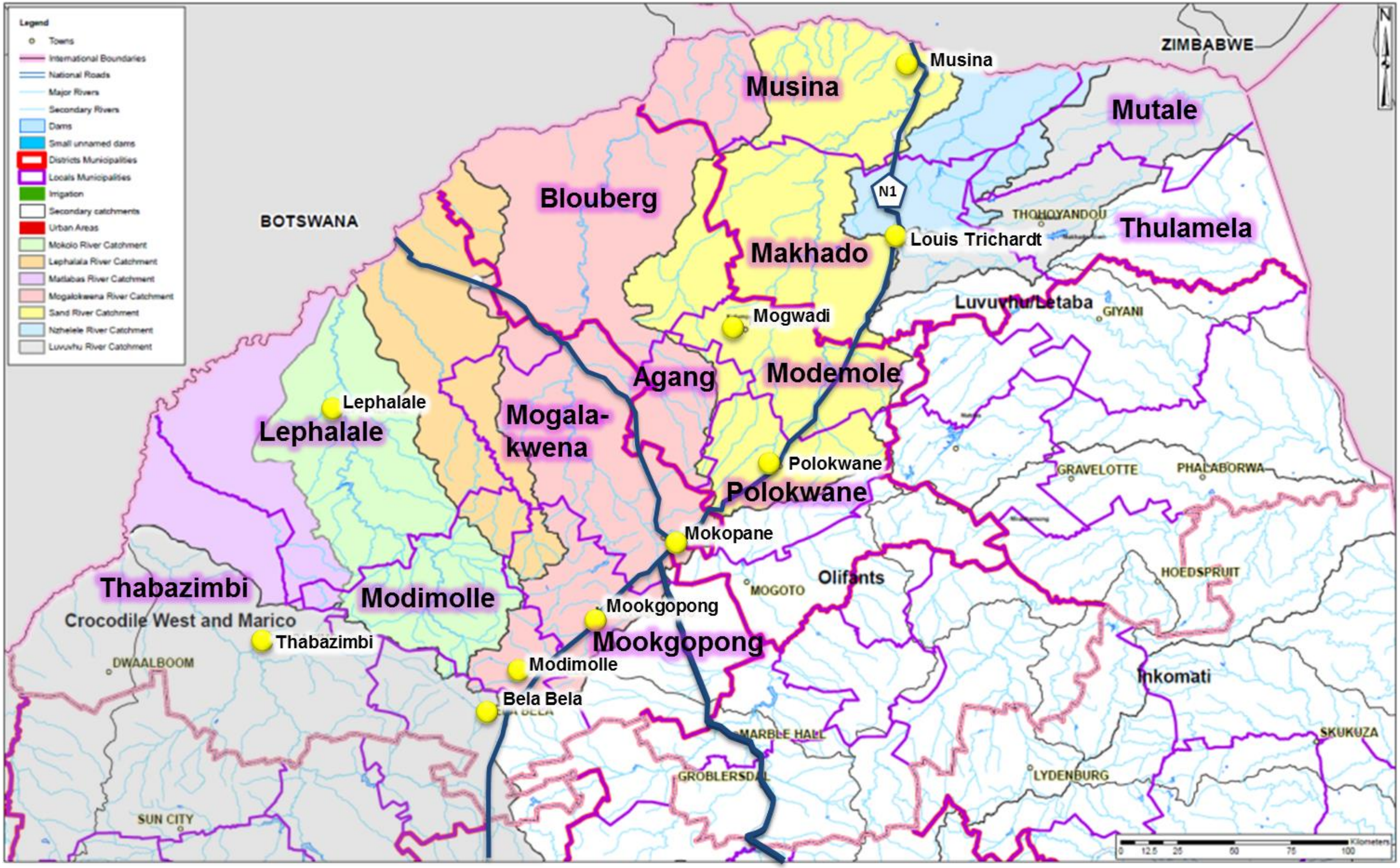


Figure 2.6: Local Municipalities in the Limpopo WMA

2.19.3 Developments

Identified growth points which fall within the Limpopo WMA, and the cluster associated with it, include:

- Lephalale Growth Point - Coal and Energy Cluster;
- Mokopane Growth Point - Platinum Cluster;
- Musina and Makhado Growth Point – Coal Mining Cluster; and
- Musina and Polokwane Logistical Hubs.

Table 2.78 shows the distribution of the provincial, district and municipal growth points within the DM relevant to the Limpopo WMA.

Table 2.78: Summary of growth points per DM

Provincial, District and Municipal Growth Points		
Capricorn District	**Total**	**Priorities**
Settlement Clusters	19	Various
Provincial Growth Points	1	Polokwane
District Growth Points	4	Lebowakgomo, Mankweng, Soekmekaar and Dendron.
Municipal Growth Points	8	Chloe A, Alldays, Avon, Bochum, Eldorado, Magatle, Mphakane and Sebayeng.
Vhembe	**Total**	**Priorities**
Settlement Clusters	18	Various
Provincial Growth Points	3	Musina, Makhado and Thohoyandou
District Growth Points	2	Makwarela, Waterval and Malamulele
Municipal Growth Points	59	Hhlanganani, Rabali, Vuwani, Madombidzha, Bungeni, Masisi, Tshandama and Mhinga
Waterberg	**Total**	**Priorities**
Settlement Clusters		
Provincial Growth Points	6	Mokopane, Lephalale, Bela Bela, Thabazimbi, Modimolle, Mookgopong
District Growth Points	0	
Municipal Growth Points	6	Rebone, Bakenberg, Roedtan, Pienaarsrivier, Vaalwater, Northam

The development opportunities within each of the identified growth points are summarised in Table 2.79.

The National Infrastructure Plan identified 18 national *strategic infrastructure projects* (SIPs) of which SIP 18 relates to water and sanitation infrastructure. In addition to the SIP-related infrastructure projects, other priority infrastructure projects (relevant to the Limpopo WMA) include the reticulation from Nandoni Dam, purified water supply to Modimolle and Mookgopong LMs and adequate maintenance for all existing infrastructure.

Table 2.79: Development opportunities in the growth points

Municipality	Competitive advantage	Population size	Pop. Growth (2001-2011) %	Development or infrastructure issues
Lephalale	Coal and Gas	115 767	3.10	• Medupi Power Station • Mining • Railway line • Air field • Two provincial hospitals
Musina	Coal, Gas, Diamond and Logistics	20 043	5.69	• N1 • Beit Bridge and Pont Drift border posts • Two air strips • Stadium • Mapungubwe World Heritage Site • Mining • Proposed multi modal transport transfers • SEZ
Mogalakwena	Platinum and Iron Ore	307 682	-1.78	• N1, N11 and R518 • Mining • Agriculture • Three hospitals • Three stadia • Makapan Valley World Heritage Site
Polokwane	Logistics and Service hub	628 999	2.15	• Capital City • Provincial hospital, District hospital and tertiary hospital • Three Universities • Airport • Industrial area • N1, R81, R71, R37, R521, R567
Makhado	Horticulture and Coal	516 031	2.27	• N1, R523, • Limpopo River • Air force base

2.20 MUNICIPAL INTEGRATED DEVELOPMENT PLANS

2.20.1 Overview

The Limpopo WMA comprises of 13 LMs, either the entire LM or a section of it. All municipalities are required to set up an IDP for a five-year period, which is reviewed annually as stipulated in the Municipal Systems Act. Integrated Development Planning is a process through which municipalities prepare a strategic development plan to address issues such as municipal budgets, land management, social and economic development and Institutional transformation in a consultative, systematic and strategic manner. Municipalities must not only deliver on present demands for services, but also anticipate future demands and identify actions to provide services in an effective, efficient and sustainable manner over the short, medium and long term.

For the purpose of this *Literature Review Report*, a number of municipal IDPs are summarised in the following sections. The summaries only include information which is relevant to this Reconciliation Strategy.

2.20.2 Lephalale Municipality Integrated Development Plan 2013-2016

a) *Water services*

The Lephalale LM is the designated *water service authority* (WSA) and the *water service provider* (WSP) with the assistance of Exxaro, which supplies bulk drinking water to Onverwacht and Lephalale Town, and Eskom, which supplies drinking water to Marapong. The municipality has a Water Service Development Plan which was adopted by council in 2009 and reviewed regularly.

All of the water for the urban requirements of the Lephalale LM is currently supplied from the Mokolo Dam. Water is pumped from the dam to the Wolvefontein storage dam, from where it gravitates down to Zeeland WTW and the purification plant at Matimba power station. Lephalale and Onverwacht are supplied with purified water from the Zeeland WTW. Bulk raw water gravitates down to the Grootegeluk mine. The effluent gets treated at Paarl WwTW.

The current water infrastructure within the Lephalale LM is summarised in **Table 2.80**.

Table 2.80: Lephalale LM water infrastructure

Infrastructure type	Unit	Quantity
Boreholes	Number	138
Reticulation pipelines	Length (m)	424 973
Bulk pipelines	Length (m)	34 693
Reservoirs	Number	121
WTW	Number	2
Pump stations	Number	38

The rural areas obtain water from groundwater sources. Approximately 38 rural villages receive water through one of four water services schemes, consisting of a network of 138 boreholes of which 85% is from boreholes and 15% from well field type boreholes in riverbed aquifers. The water is pumped to storage reservoirs and then distributed to the consumers. The four water services schemes and the potential supply of each scheme, includes:

- Mokuruanyane RWS (1.950 Mℓ/d);
- Witpoort RWS (0.930 Mℓ/d);
- Ga-Seleka RWS (0.820 Mℓ/d); and
- Ga-Shongoane RWS (0.300 Mℓ/d).

The surety of the current water supply from boreholes, however, is not known. It is also not known what the actual volume of water is provided to the community. Also, the yields from boreholes are very poor.

The current Blue Drop and Green Drop Scores of the municipality are 92.84% and 19.1% respectively.

Approximately 35.6% of the rural community's water supply does not fall within RDP standards. In Lephalale, 33% make use of communal standpipes while the rest have access to water in the dwelling or yard. In Marapong 20% make use of communal standpipes while the rest have access to water in the dwelling or yard. In Lephalale Town 75% of households have access to water inside their dwelling, while 20% have a tap in the yard and the remainder makes use of community stand pipes.

The municipality is currently facing the following water related challenges:

- The catchment in which Mokolo Dam is located is currently in deficit;
- Poor borehole yields in rural areas;
- Bulk water services in urban areas have reached full utilization;
- Aged infrastructure;
- Illegal connections in rural areas;
- Lack of accountability to water losses; and
- Non availability of groundwater in rural areas.

b) *Future water requirements*

The Mokolo River catchment is currently in deficit and future requirements will be supplied through the MCWAP. However, the first phase will have to be commissioned before any major development can take place as the current bulk water services have reached full utilization capacity.

The total urban water loss is estimated at 23% or 0.77 million m^3/a and thus WCWDM urgently have to be implemented.

c) *Anticipated projects and programmes*

A number of water related projects are anticipated for the Lephalale municipal area. The most significant are summarised in Table 2.81.

Table 2.81: Water related projects in the Lephalale LM

Strategic Projects / Initiatives / Output	Source of funding	2013-2018 fund allocation (R)
MCWAP 1 pipeline to Mogol	DWA	9.3 billion
Provision of bulk services, water, sanitation, electricity- Alstoodstyd	CoGHSTA	908 000 000
WwTW Steenbokpan	Lephalale LM	4 000 000
Water reservoirs Steenbokpan	Lephalale LM	27 000 000
New 400mm dia pipe taking treated effluent from Paarl WwTW	Lephalale LM	59 500 000
Construction of new 12 Mℓ/d sewage works at Steenbokpan	*Municipal Infrastructure Grant* (MIG)	75 000 000
Upgrading of Zongesien WwTW to 10 Mℓ/d	ResGen	160 000 000

A number of other anchor projects are anticipated for the municipality which will increase the current water demand, most of which have been included in the MCWAP Feasibility Study (refer to Section 2.10 for more detail). In summary these anchor projects include:

- Mining which include:
  - Medupi power station (2010);
  - Sasol Mafutha CTL plant and Sekoko coal (2012-2014); and
  - Exxaro new coal mine for export, development of Mmamabula coal field and power station in Botswana, Anglo Coal coal bed methane extraction and Boikarabelo Coal mine and independent power plant (2015-2020).
- Tourism activities;
- Agricultural activities; and
- Manufacturing of small, medium and macro enterprises support.

2.20.3 Modimolle Local Municipality Integrated Development Plan 2015/2016

a) *Water services*

Modimolle LM is the WSA. Water is supplied to Modimolle from Donkerpoort Dam and the Magalies Water pipeline from the Klipdrift WTW as well as from a number of boreholes. The borehole locations as well as the status of the boreholes are as follows:

- Perdelaagte borehole in Modimolle;
- Four boreholes at Modimolle – All in working condition;
- Five boreholes at Mabaleng – Two are not working; and
- Eight boreholes at Mabatlane – Two are not working.

Modimolle Town and Phagameng receives water from the Donkerpoort WTW, of which Magalies Water is the WSP. The Modimolle reservoir has a capacity of 24 Mℓ but there is a need for at least another 24 Mℓ. Actions have been identified to increase the capacity of Donkerpoort Dam and WTWs have been upgraded to 10 Mℓ/d but are constrained by the raw and final water pipeline capacities. Vaalwater is supplied by boreholes and is currently experiencing water shortages to such an extent that water has to be supplied with water carts.

The 2010/2011 Blue Drop and Green Drop Statuses were 81.71% and 38.1% respectively, but have decreased since then.

Of the 19 804 registered households within the municipality, 10% make use of communal standpipes, 50% have yard connections and 36% have access to water inside the dwelling. Approximately 4.7% of households within the municipal area do not meet RDP standards and have no access to piped water.

Modimolle WwTW is currently running at its full capacity of 3 Mℓ/d treating an average of 4.5 Mℓ/d. The Vaalwater area is currently using oxidation ponds. These ponds, however, ponds are over flowing and pose an environmental challenge, especially in rainy seasons, due to the close proximity to the Mokolo River. A 0.5 Mℓ/d package plant has been installed to mitigate the situation and to avoid contamination of groundwater. Mabaleng presently has no WwTW.

Water and sanitation related challenges include:

- Ageing Infrastructure;
- Lack of staff;
- Lack of funding for capital projects;
- Shortage of quality and quantity water;
- Informal settlements uses pit latrine that poses health risk;
- WwTW operating beyond design and operating capacities; and
- Lack of tools, equipment, machinery and vehicles for operation and maintenance.

2.20.4 Mookgopong Local Municipality Integrated Development Plan 2011/2012

a) ***Water services***

Approximately 50% of the municipality falls within the Limpopo WMA and the remainder mainly in the Olifants WMA.

Mookgopong Municipality is supplied by the Welgevonden Dam (previously the Frikkie Geyser Dam) and groundwater. Twelwe boreholes are located in the Mookgopong area and four in the vicinity of Roedtan. There is an annual shortage of water, especially during September. This alters the economic development.

A number of informal settlements (14% of the municipal population) receive water via communal standpipes and water tankers. Approximately 70% receive piped water from either inside the dwelling or the yard. The remainder receives water from boreholes or springs.

The main challenges that the municipality face are the shortage of water and the aging infrastructure.

The municipality has one WwTW, receiving waste water from Naboomspruit town and Mookgopong Township. Roedtan/Thusang has one pond and the farming community uses septic tanks.

b) ***Development***

A number of development strategies have been identified to address the current water and sanitation challenges. Some of these include:

- The upgrading of Welgevonden WTW (MIG is the implementing agent);
- Obtaining water from Magalies Water and the Flag Boshielo Dam; and
- Upgrading of water pipelines, sludge ponds and other infrastructure.

2.20.5 Mogalakwena Local Municipality Integrated Development Plan 2012-2016

a) ***Water services***

The main urban areas within the Mogalakwena LM are supplied by the following:

- Doorndraai Water Resources System (Private owned);
- Uitloop Farm (Private owned); and
- Weenen/Planknek (Municipal owned).

Villages are mainly supplied by the following *water supply schemes* (WSSs) or *regional water schemes* (RWSs):

- Sefakaola WSS;

- Glen Alpine WSS;
- Mapela RWS - 25 boreholes;
- Bakenberg RWS - 40 boreholes;
- Inkidikitlana RWS - 15 boreholes; and
- Salem RWS - 12 boreholes.

Mogalakwena LM owns no WTW for potable water production – water is treated to potable standards (Class 1) before it is provided to the municipality. In rural areas, it has been noted that water tastes “salty” and in some cases the water is of Class 2 quality.

The water supply system is stressed and under a constant threat of water shortages. The aging infrastructure is prone to bursts and leaks, resulting in major water losses. In general, groundwater is available for use, however, the quality and yield tends to be variable.

The majority of rural areas rely on standpipes. At the 2010-deelopment level 14% of households had no access to piped water, whereas 44% have access point inside the yard or inside the dwelling and the remainder have access points outside the yard.

b) ***Developments***

Mining is the main economic driver in the Mogalakwena LM. The current and future mining activities within the municipality is summarised in **Table 2.82**.

Table 2.82: Mining activities in the Mogalakwena LM

Project name	Pre-investment action	Location	Description
Mogalakwena Platinum Mine	Done	Overysel 815 LR; Vaalkop 819 LR; (Mokopane)	Expansion of the existing open pit mine
Platreef Project	Feasibility study	Drenthe 778 LR;Awaitrivier 777 LR (Mokopane)	Re-evaluation and mining of platinum resources (PGM)
Vanadis Project	Done	Molendraai (Mapela)	Extraction of vanadium bearing magnetite deposits
Haaspan Granite	Feasibility study	Haaspan (Bakenberg)	Granite mining
Matlala Stone Crushers	Done	Bakenberg and Matlala region	Production of stone aggregates from dolerite
Bestaf Granite	Done	Kadichuene village (Bakenberg)	Extraction of granite stone
African Red Granite	Done	Leyden village (Bakenberg)	Extraction of granite stone
Lonmin	Feasibility study	Mapela area	Mining of Platinum
Babirwa Tshabang Tlala Cooperatives	Done	Taueatswala	Pebbles Collections
Setlhatlha Sand Mining	Done	Marulaneng	Sand Mining
Kadikgatlho Stone Crushers	Done	Kadichuene village (Bakenberg)	Production of crushed stones and sand out of waste production from Bestaf Granite Mine

From a municipal perspective it was identified that adequate water and sanitation supply is the top priority of the municipality. Almost 80 water and sanitation related projects have been identified, most of which will be funded by MIG. This includes the construction of the ORWRDP, funded by DWA (now DWS), which is anticipated to start in 2015.

2.20.6 Blouberg Municiaplity Integrated Development Plan 2011-2016

a) *Water services*

Blouberg Municipality serves as the WSP for the municipal area and Capricorn DM the WSA. The main sources of water are from boreholes, which are not sustainable and most of the equipment has aged, not functioning properly in some cases. Water is supplied by means of water tankers in areas of water shortages.

Theft of water supply equipment, vandalism of water infrastructure and illegal connections to main water supply pipelines poses major water supply challenges. Another challenge in the area is the growing unplanned settlements because of illegal occupation of land in areas like Senwabarwana and Alldays. This makes it difficult to not only deliver basic services, but to plan for it as well.

Intervention options with regard to water supply, amongst others, include the following:

- The WSA has to allocate sufficient funds to perform the much required maintenance on water infrastructure;
- Illegal connections need to be identified and reduced;
- Resources and personnel responsible for operations and maintenance must also be increased;
- Improved cost recovery strategies have to be in place in order to sustain provision of water and/or water supply to communities;
- Augment water supply from the Glen Alpine Dam. The DWA (now DWS) has initiated a feasibility study to transfer irrigation water to domestic water;
- Refurbishment of the Glenfirness (Blouberg) Dam, which previously supplied Blouberg Municipality, in order to augment supply to communities; and
- Water catchment facilities, such as rainwater harvesting, should be constructed in the mountainous, higher rainfall regions.

Currently 87% of the households within the Blouberg municipal area have access to water at the level of RDP.

b) ***Developments***

Opportunities for development exist in the Senwabarwana, Eldorado, Alldays and Tolwe areas. Puraspan-Avon-Indermark-Vivo Corridor connects the municipality to areas such as Makhado Town to the rest of the settlements within the municipal area and will serve as a conveyor belt to link the Vhembe, Capricorn and Waterberg areas.

Game farming, especially in Alldays, is expanding which attracts a massive tourist influx and hence result in development opportunities in the surrounding areas of Alldays, Vivo, Tolwe, Maastroom and Baltimore areas.

There is also a huge potential for sand mining in the municipality, especially in the Indermark and Eussorinca areas.

Mega projects within the municipality include:

- Soutpan solar project by Sun Edison mining in Zuurbult Vivo area;
- Platinum and iron ore mining development by Haccra Mining (Pty) Ltd in the Harriswhich, Aurora and Cracouw area;
- Methane gas exploration by Umbono Mining in Wards 13, 15 and 16;
- Venetia underground development project by De Beers and Anglo American; and
- Retail development by Flying Flacon in the Eldorado, Senwabarwana and Langlaagte area.

A number of service delivery projects have been identified which are related to water supply in the municipality. These include, amongst others, bulk supply and reticulation projects in rural areas and small towns, such as the Tolwe Phase 1 and 2 Water Project, Indermark Water Project, Avon Water Project, Senwabarwana Water Project etc.

2.20.7 City of Polokwane Integrated Development Plan 2012 - 2013/2015

a) *Water and sanitation services*

Polokwane LM, referred to as the City of Polokwane, is supplied through 14 RWSs from a number of water sources as summarised in Table 2.83. More than 60% of Polokwane's water is sourced from outside the boundaries of the municipality, making it a water scares area. The municipality takes care to ensure the sustainability of water resources and hence have a water conservation awareness campaign.

Table 2.83: Polokwane RWS - sources, supply areas and capacities

Water source	RWS supplied	Area supplied	Average daily supply (Mℓ/d)	Source capacity (Mℓ/d)
Ebenezer	Mankweng RWS		10	43
	Olifants Sand RWS	Polokwane City, Seshego	23	
	Mothapo RWS, Molepo RWS, Segwasi RWS, Boyne RWS, Badimong RWS, Sebayeng Dikgale RWS	Rural	9	
Olifants Sand	Chuene/Maja RWS, Olifants Sand RWS	Seshego, portions of Polokwane City	15.22	27
Dap Naude Dam	Olifants Sand RWS	Polokwane City	13.5	16
	Seshego Dam Olifants Sand RWS	Seshego	1.5	1.5
Boreholes	Augment water from dams	Rural	16.0	25.33
Houtriver Dam	Houtriver RWS	Rural	1.6	1.6
Chuene/Maja Dam	Chuene Maja RWS	Rural	1.2	2.7
Molepo Dam	Molepo RWS	Rural	2.5	6
Total			93.55	123.13

The limited utilisation of water in the catchment is mainly underground water abstraction via boreholes. There are a multitude of boreholes pumping into a number of reservoirs and tanks of various sizes in the municipal area. This aquifer is under threat from two major pollution sources, namely, the Polokwane Cemetery and the Seshego sewerage works.

Two of the five WTWs are the responsibility of Polokwane LM whereas the others are currently being operated by DWS.

Theft and vandalism of boreholes are some of the major challenges with regard to sustainability of water, as well as the irregularity of available surface water. Other challenges faced by the Municipality to provide water include:

- Lack of sustainable water sources for future supply of the municipal area;
- Lack of cost recovery in some areas;
- Ageing water infrastructure in the CBD; and
- Limited operation and maintenance of infrastructure.

Approximately 12% of the municipality's water supply does not fall within RDP standards. In Mankweng/Sebayeng, 68% is above the RDP level whereas 60.7% and 44% of the water supply services is above the RPD level for Moletjie and Maja/Chuene/Molepo respectively.

Polokwane LM is the WSA. Lepelle Northern Water Board is the bulk service provider for the Pietersburg Governmental RWS (Ebenezer pipeline) and the Olifants-Sand Bulk Water Transfer Scheme. DWS is the WSP to all rural areas not served by Lepelle Northern Water Board. Polokwane LM operates the Dap Naude Dam Water Supply Scheme.

The water quality within the municipality overall is high as summarised in Table 2.84.

Table 2.84: Water quality rating within the Polokwane LM

Water supply system	DWAE rating (%)
Polokwane (City)	95.1
Seshego	89.7
Mankweng	95.2
Molepo RWS	79.9
Houtrivier RWS	76.6
Chuene - Maja RWS	81.4

The municipality has three WwTWs in Polokwane, Seshego and Mankweng. Polokwane WwTW is the biggest with 28 Mℓ/d capacity and with the current utilisation at 24.6 Mℓ/d. Plans are in place with limited budget to construct the Regional WwTW that will carry all Polokwane Municipal sewage load and cater for new developments.

The city of Polokwane has a number of stormwater retention dams and stormwater channels that eventually discharge into the Sand River via the Sterkloop Spruit and open storm water channels. There are a number of important wetland areas which support rare or endangered frog species and plant and red data bird species.

b) *Water Services Development Plan*

Polokwane LM is mainly supplied through three water transfers from outside the municipal boundaries, namely the Dap Naude, Ebenezer and Olifants-Sand transfer schemes of which the latter two are operated and maintained by the Lepelle-Northern Water Board.

Ebenezer pipeline route will need to be upgraded to meet the future demand growth. Groundwater sources are the only source for the single, distant rural communities but have, in general, low potential. High production aquifers occur in the Polokwane/Seshego area as well as the Sebayeng and Molepo areas. Due to the fact that major surface water schemes provide water to these areas the underdeveloped groundwater constitutes an important reserve.

Reticulation leaks are the major contributing factor in water losses in urban areas. In rural areas, illegal connections and reticulation leaks are the major cause of water losses.

2.20.8 Molemole Municipality Integrated Development Plan 2013/2014

a) *Water services*

The majority of the municipality falls within the Limpopo WMA (91.3%) and the remainder within the Luvuvhu and Letaba WMA (8.7%).

The municipality's main water source is groundwater. However, supply from boreholes is unreliable and 27.2% of the municipal population receives water from tankers as there are no local water resources.

The municipality face the following challenges with regard to water supply:

- Aging infrastructure;
- Unreliability of water sources;
- Lack of cost recovery on water and sanitation services;
- Lack of sustainable water sources for future supply;
- Unavailability of funds to reduce the current water and sanitation backlog; and
- No constant supply of water.

2.20.9 Makhado Municiaplity Integrated Development Plan 2012/2013 – 2016/2017

a) *Water sources*

The WSA for the Makhado LM area is the Vhembe DM. There are a range of sources from which households in the Makhado LM obtain water from. These have been summarised in **Table 2.85** and shows the number of households in the municipality supplied through each water source type.

Table 2.85: Households water sources in Makhado LM

Water service level	Households
Regional/local water scheme (operated by water service provider or municipality)	79 321
Borehole	23 165
Spring	3 681
Rain water tank	603
Dam / pool / stagnant water	8 597
River/stream	3 982
Water vendor	9 147
Water tanker	2 740
Other	3 653
Total	**134 889**

The Makhado LM has a number of water resources available. These are listed along with the quantity supplied and the managing authority where information is available:

- Albasini Dam: 2.89 million m^3/a;
- Makhado Town groundwater well field : 1.83 million m^3/a;
- Ledig (Lepelle) boreholes (under management of the Vhembe DM) – 0.32 million m^3/a;
- Sinthumule/Kutama boreholes (under management of the Vhembe DM);
- Air Force Base boreholes (under management of the Department of Public Works);
- Vleifontein boreholes;
- Tshakuma Dam;
- Nzhelele Dam;
- Mutshedzi Dam; and
- Other groundwater sources (eg: springs and fountains).

The total average water consumption is 5.04 million m^3/a. However, the aforementioned resources are insufficient to accommodate the current demand. Furthermore, the municipality has no WCWDM plan and a great need exists for the implementation thereof. Illegal connections, bursting of plastic tanks, damages and theft of manhole covers and padlocks and leakages broaden the water crisis in the municipality.

Furthermore, boreholes are drying up in some areas. The Makhao Air Force Base has and extremely high water consumption, sourced from groundwater, which places a severe burden on the water source.

Challenges that relate to water services include:

- The Makhado LM has inadequate and fragmented water service provision with different standards and plans. The inadequate water provision implies that less water will be available for agricultural use, which is one of the main drivers of the economy;

- Most of the pit latrines in the rural areas have been improperly constructed;
- Unauthorised water connection is also amongst the key challenges of the municipality;
- The water systems are not metered and monitored on continuous basis; and
- The overall sanitation system needs improvement there is no system to adequately address the plight of filled VIP toilets.

b) *Hydrology*

The rivers passing through the Makhado LM are for a part of two major river catchments, namely the Limpopo and the Olifants River catchments. Other larger rivers in these catchments, which are also within the Limpopo WMA, include the Sand and Hout River systems as well as the Nzhelele River system.

The situational analysis lists the upper reaches of the Sand and Hout rivers as being endangered and the Nzhelele River system as being critically endangered. This is important to know for future planning and protection of the water source.

c) *Agriculture*

Only a small percentage (8.54%) of land is highly suited to arable agriculture. These areas, along with the areas of commercial farming, are found only in the following four areas:

- In the West (south of the Soutpansberg);
- North-west (north of the Soutpansberg);
- Central (Witvlag road – on the Soutpansberg); and
- South-east (Levubu area).

d) *Mining*

At present, only the Pafuri coal field is exploited by the Tshikondeni Mine, which produces coking coal for ISCOR's Vanderbijlpark plant. There are other potential mines in the Municipal area, namely, the Mopane coal field and the Tshipise manganite field. However, these are made less profitable by the large distances between them and the markets.

e) *Infrastructure Cluster Strategies and projects*

The development strategies for the water infrastructure in the municipal area are covered in detail and **Table 2.86** indicates the development strategies, key performance indicators and required actions.

The report details numerous district and sector projects, however, only those relevant to this study have been included in **Table 2.87**.

All of the projects described fall within the Vhembe DM and Makhado LM.

2.20.10 Musina Municipality Integrated Development Plan 2012/2013 - 2017

a) *Water services*

Musina LM is the WSP and Vhembe DM is the WSA. Water is the highest priority issue in the infrastructure sector for Musina LM.

Table 2.86: Water infrastructure development strategies

Development strategies	Key performance indicators	Actions
Finalise Nandoni bulk water system	Number of households with access to basic level of water	Bulk water infrastructure network
Upgrading of bulk water system	Number of households with access to basic level of water	Bulk water distribution network
Pipelines constructed to extend the internal reticulation to newly developed settlements	Number of households with access to basic level of water	Internal water reticulation network
Refurbishment and upgrading of existing water infrastructure	Number of water supply interruptions	Improved level of service
Installation of yard connection for proper water management purposes	Percentage reduction in yard water connection backlog	Water supply yard connection
Provision of water and sanitation to all clinics	Percentage of clinics provided with water and sanitation	Improved level of service
To develop a comprehensive integrated infrastructure plan	Plan developed	Comprehensive integrated plan
Strengthen institutional capacity on planning management and of infrastructure	Percentage of projects completed on time and to specifications	Completed infrastructure development projects
Conduct research on alternative reliable water source	Percentage of households with access to basic water supply	Water supply augmentation infrastructure
Municipality to apply for WSA status	Makhado LM to be declared a WSA	Makhado LM to be declared a WSA

Table 2.87: Water infrastructure cluster projects

Project description	Location (Towns / Villages)	Agent
a. Source: Drill and test for boreholes; b. Extend reticulation & connector bulk; c. Refurbish mech / electr equipment & system; d. Musekwas and well: Refurbish chlorination	Nzhelele North Scheme: Extensions & Refurbishment (NN13)	Vhembe DM
a. Source: Drill and test for boreholes; b. Extend reticulation & connector bulk; c. Refurbish mech/el equipment & system; d. Nzhelele WTW: refurbish booster pump #2 & meters; e. New WTW at Kalavha: 2.5 Mℓ/d package plant	Nzhelele North Scheme: Extensions & Refurbishment (NN14)	Vhembe DM
a. Refurbish equipment & system b. Albasini WTW: Investigate refurbish	Makhado scheme: Extensions & refurbishment (NN5)	Vhembe DM

There are a number of issues with regard to water supply in the municipality. Residents in Ward 1 (Madimbo, Malale, Domboni, Tanda, Tshikhudini, Tshipise, Doreen and Esme' Four) have complained about a sour taste to the water, no water supply for up to four days and in general the area does not meet RDP standards. Other challenges include:

- Poorly managed sewage systems;
- Drought in the area;

- Alien vegetation invasion;
- Imbalance between supply and demand for water; and
- Inadequate monitoring.

The following document the state of water supply in the Municipality:

- Presently, all households have access to water;
- There are 7879 households in Musina urban area with yard connections;
- In Madimbo, Malale and Domboni 1037, 700 and 127 households have standpipes of RDP standards, respectively;
- In Tanda 156 and in Tshikhudini 192 households are on RDP standards;
- In urban areas 2459 households in receive basic water for free; and
- In Madimbo, Malale, Dombino, Tshikhudini and Tanda 523 households receive free basic water.

b) ***Development***

The Municipality contains a number of nature reserves, conservancies and game farms which creates a comparative advantage over other Municipalities in the District. Economically this is also the case as the Municipality has scope for more agriculture, mining, manufacturing and transport activates than others in the District do.

There is a particularly strong agricultural presence, with more than half of the employed population of the Municipality working in this sector. There are opportunities for development in this sector and the expansion of manufacturing industries could be achieved through agro-processing and other activities.

Although the agricultural sector contributes hugely to employment, it only provides 7% of the local economies GDP. Thus, for the betterment of the Municipality it is important for the existing agricultural workforce to become involved in higher order agricultural activities such as agro-processing.

2.20.11 Thabazimbi Municipality Integrated Development Plan 2013/2014

Approximately 50% of the Matlabas River catchment is covered by the Thabazimbi LM. The majority of the landuse (90%) is for game and cattle farming with little to no settlements in the covered area. The Marakele National Park is located within the LM and a number of game lodges is scattered around the area. Thabazimbi is identified as the only growth point within the municipality and does not fall within the Limpopo WMA.

The municipality is the designated WSA and WSP. No significant water supply services exist in the Matlabas Rvier catchment area of the Municipality due to the very few and scattered settlements in the area.

2.21 DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE CROCODILE WEST WATER SUPPLY SYSTEM

Study Information: Development of a Reconciliation Strategy for the Crocodile West Water Supply System (CWRS). Project No. W8147. Department of Water Affairs and Forestry. Prepared by BKS in association with Arcus Gibb, Schoeman & Vennote and AGES. 2006 - 2009.

2.21.1 Overview

The CRW is one of the most developed and most influenced rivers by human activities in the country. Major urban and industrial areas occur in northern Johannesburg and Pretoria, extensive irrigation downstream of Hartbeespoort Dam and large mining developments north of the Magaliesberg.

Natural water resources are fully developed and most of the tributaries and the Crocodile River main stem are well regulated. Water is transferred from the Vaal River system via Rand Water to supply metropolitan areas and some mining developments, resulting in large quantities of effluent discharged into the river system after treatment, for re-use downstream. Effluent return flows amounts to a large portion of the water availability in the catchment and is thus an important resource. However, water quality in many of the streams and impoundments is severely compromised by the return flows.

The CWRS was developed and published in 2008 by the DWA to ensure sufficient water supply at an appropriate quality for current and future requirements.

The study area includes the whole Crocodile West River catchment as well as the Lephalale area, in the Mokolo River catchment, that needs to be augmented from the Crocodile River catchment.

A number of reports, similar in content to that required for this Limpopo WMA North Reconciliation Strategy, have been prepared as listed in **Table 2.88**.

Table 2.88: Crocodile West Reconciliation Strategy reports

Title	Report number
Inception Report	P WMA 03/000/00/3307
Summary of Previous and Current Studies	P WMA 03/000/00/3408
Current and Future Water Requirements and Return Flows and Urban Water Conservation and Demand Management	P WMA 03/000/00/3508
Water Resource Reconciliation Strategy: Version 1	P WMA 03/000/00/3608
WRPM Analyses	P WMA 03/000/00/3708
Executive Summary	P WMA 03/000/00/3908
Water Requirements and Availability Scenarios for the Lephalale Area	P WMA 03/000/00/4008

Only a summary of the reconciliation strategy is provided in this report. Refer to the reports listed in **Table 2.88** and available on the DWS website, for more detailed information.

2.21.2 Reconciliation Strategy Summary

a) ***Water requirements***

In total the water requirements of all the users within the Crocodile River catchment was expected to grow from about 1 100 million m^3/a in 2005 to 1 300 - 1 500 million m^3/a in 2030. Urban water users account for approximately 50% of all water use. Between 40% and 55% of the total water requirements is/will be supplied from the Vaal River system via Rand Water.

An additional 185 million m^3/a will have to be supplied to the Lephalale area by 2030.

Four future water requirements scenarios were developed on which development scenarios for the Lephalale area were later super imposed:

- High population growth, medium efficiency WCWDM;
- Base population growth, medium efficiency WCWDM;
- Low population growth, medium efficiency WCWDM; and
- High population growth, high efficiency water demand management.

The total future water requirements for the aforementioned scenarios are summarised in Table 2.89.

b) *Inter-basin transfers*

Existing inter-basin transfers include a supply of 3 million m^3/a to Modimolle from the Roodeplaat Dam.

c) *Water resources*

Local water resources comprises of surface water (155 million m^3/a at 1:50 assurance of supply) and groundwater (82 million m^3/a).

Table 2.89: 2008 Crocodile River catchment strategy total water requirements

Scenario	Water requirements (million m^3/a)					
	2005	2010	2015	2020	2025	2030
High population growth, medium efficiency WCWDM	1 121	1 191	1 276	1 355	1 409	1 480
Base population growth, medium efficiency WCWDM	1 112	1 170	1 237	1 299	1 344	1 404
Low population growth, medium efficiency WCWDM	1 110	1 147	1 190	1 221	1 232	1 255
High population growth, high efficiency water demand management	1 121	1 196	1 228	1 275	1 308	1 376

Most surface water (streamflow) originates in the southern and higher rainfall part of the Crocodile River catchment. Several large dams were built in the past and very few, if any, sites for further regulation remain. Furthermore, urban runoff, additional to the natural runoff, has increased by approximately 40 million m^3/a, due to large amounts of paved areas in the urban and industrial sector.

Magalies Water and Rand Water are the bulk suppliers of potable water in the study area. The City of Tshwane supplies some of its own requirements through abstractions from the Rietvlei Dam, Rietvlei Springs and Sterkfontein Springs.

Groundwater is also used as a supplementary water source, particularly by rural authorities. Large groundwater yields are abstracted from dolomitic aquifers mainly in the southern part of the catchment, whilst sandy aquifers occur along the lower reaches of the main Crocodile River.

Large scale transfers from the Vaal River system, supply the urban and mining sector and were expected to increase from 555 million m^3/a in 2005 to 805 million m^3/a in 2030.

Return flows from urban areas constitute a large and growing source of water for re-use. Return flows are expected to grow from 315 million m^3/a to between 360 – 490 million m^3/a in 2030.

d) *Future water balances*

Without demand management, small deficits could be experienced in the Crocodile River catchment, however, if medium demand management is implemented, a positive water balance is expected into the foreseeable future. No specific or urgent actions are therefore required in order to meet the growing water requirements. The surplus of available water would augment the supplies to the Lephalale area.

Various scenarios were considered for the Lephalale area. The high scenario, which is currently being used for the planning purposes, provides for five Eskom power stations, a CTL Fuel plant, the water requirements of the coal mines and associated secondary and tertiary developments, as well as growth in domestic requirements in the Lephalale area. The combined Mokolo Dam yield plus the Crocodile River surplus is not sufficient to supply the growing water requirements in the Lephalale area. Additional augmentation from the Vaal River system will therefore be required.

e) *General strategies*

The following general strategies have been identified:

- *Increased water requirements* – Water requirement growth should be monitored on an ongoing basis to determine water requirements with more accuracy and reliability.
- *WCWDM* - Primary focus should be on the urban/industrial sector to minimise leaks followed by the reduction in consumptive use. WCWDM should be a priority action of municipalities and should be accompanied by funding through the proposed Funding Facilitation Unit (FFU), a DWAF mechanism to technically and financially assist local government with WCWDM implementation.
- *Direct recycling of effluent* - Direct recycling of effluent with respect to process water for mining and industries should be promoted. Grey water recycling should be applied where possible.
- *Indirect re-use of effluent* - Process water for mining and some industrial uses and irrigation water should be supplied through the re-use of effluent discharged to rivers. Effluent should preferably be discharged at the most feasible upstream location and upstream of a regulation point, to facilitate the optimal opportunity for re-use.
- *Groundwater development* – Compulsory licensing are required where over-abstraction occurs, an active and reliable data base on groundwater use and aquifer performance should be developed to identify potential problem areas. Pumping from induced recharge from rivers should also be investigated and controlled. Groundwater development in unstressed aquifers for small scale town and community water supply should be pro-actively promoted as well as for mining purposes. Appropriate

preventative or remedial measures need to be taken where the dewatering of mines could impact on existing users.

- *Water quality* – Water quality is severely compromised due to the large volumes of return flows. Priority should be given to proper enforcement of effluent standards followed by the establishment of water quality objectives for all major streams and impoundments.
- *Implementation of the Reserve* - Should be done in accordance with the provisions in the NWRS.
- *Alien vegetation* - Should be removed as part of the "Working for Water" programme.

f) *Specific strategies*

The following specific strategies were developed or identified:

- *Regulation of return flows* - Efficient control and re-use of return flows are of primary importance. Return flows and new developments are concentrated in the upper reaches, however, the greatest potential for re-use occurs in the middle and downstream parts of the catchment. The correct quantities of water to be abstracted for transfer to Lephalale must reach the abstraction point, hence illegal abstraction should be prevented and the possibility of a small regulation dam should be considered as part of the MCWAP. A new regulation dam on the Crocodile River main stem at a location downstream of the last main tributary that contributes return flows was recommended and identified on farm Boschkop, immediately downstream of the confluence of the Moretele River with the Crocodile River.
- *Re-use below Hartbeespoort Dam* - Most effluent return flows are discharged to the river system upstream of Hartbeespoort Dam, resulting in the surplus availability of water at that point, and which is shown to further increase in under most future scenarios. It was recommended that mining activities be supplied by water abstracted from Hartbeespoort Dam. Hence, more high quality potable water could be allocated to urban use.
- *Water supply to Madibeng and Rustenburg* – Madibeng and communities around Hartbeespoort Dam abstracts raw water from the Crocodile River and from the dam respectively for own treatment and distribution, resulting in small treatments plants not sophisticated to constantly produce high quality potable water. It is recommended that these small plants be rationalised and upgraded. Alternatively these communities should be supplied from Rand Water. Rustenburg water supplies could be augmented from Magalies Water (from the Crocodile River catchment) or from Rand Water. Mines could use water from Hartbeespoort Dam, resulting in more potable water available for domestic use.
- *Water supply to the Lephalale area* – Water to be transferred to Lephalale could be abstracted from the main stem of the lower Crocodile River. However, water supplied from the Crocodile River catchment will not meet the demand and hence augmentation from the Vaal River system is recommended. Re-allocation of irrigation water, either in the Mokolo or Crocodile River catchments, to the developments in the Lephalale area could reduce the demand from the Vaal River system.

- *Water supply to Mookgophong and Modimolle Local Municipalities* – Preliminary findings indicate that water can be transferred from either the existing Magalies Water pipeline from Klipdrift WTW, or from a proposed new WTW and pipeline from the Klipvoor Dam.

2.22 Support to the Implementation and Maintenance of the Reconciliation Strategy for the Crocodile West River System

Study Information: Support to the Implementation and Maintenance of the Reconciliation Strategy for the Crocodile West Water Supply System. Project No. WP 10198. Department of Water Affairs. Prepared by BKS in association with DMM Development Consultants, Golder Associates, WRP Consulting Engineers and Zitholele Consulting. 2010 - 2012.

2.22.1 Overview

The successful implementation of the Reconciliation Strategy for the Crocodile West Water Supply System (as developed and published in 2008, refer to **Section 2.20.11**) requires continuous monitoring, review and revision through co-operation amoung water institutions which is driven by the Strategy Steering Committee (SSC). The *Support to the Implementation and Maintenance of the Reconciliation Strategy of the Crocodile West Water Supply System*, provides continuation of the administrative, technical and organisational support for DWA and the collaborating institutions represented on the SSC.

The 2012 revision of the CWRS updates and refines the 2008 Strategy based on new information and continued stakeholder involvement. The planning period extended to 2040.

A number of reports, similar in content to that required for this Limpopo WMA North Reconciliation Strategy, have been prepared as listed in **Table 2.90**.

Table 2.90: Support to the Implementation and Maintenance of the CWRS reports

Title	Report number
Inception Report	P WMA 03/A31/00/6110/1
Water Quality Modelling	P WMA 03/A31/00/6110/2
Water Resource Planning Model Analyses	P WMA 03/A31/00/6110/3
Crocodile West River Reconciliation Strategy 2012	P WMA 03/A31/00/6110/4

Only a summary of the reconciliation strategy is provided in this report. Refer to the reports listed **in** Table 2.90, and available on the DWS website, for more detailed information.

2.22.2 2012 Reconciliation Strategy Summary

a) ***Water requirements within the CRW catchment***

Water requirements, water availability and the water balance was calculated using the WRPM. Water requirements per sector are summarised in **Table 2.91**.

Table 2.91: Water requirements of the Crocodile West River catchment

Water use sector	Water requirements (million m^3/a)						
	2010	2015	2020	2025	2030	2035	2040
Domestic	674	694	766	820	885	927	970
Irrigation	268	268	268	268	268	268	268
Mining, power and industry	93	116	131	133	134	134	133
TOTAL	**1 035**	**1 078**	**1 165**	**1 221**	**1 287**	**1 328**	**1 371**

The following is of note:

- Domestic water requirements include medium efficiency (15% savings) WCWDM.
- Irrigation water requirements for the large irrigation boards and Government Water Schemes are shown.
- Mining water requirements include those supplied by surface water within the catchment. Some additional mining in the catchment exists that receives water directly from Rand Water or groundwater and does not directly impact the water balance of the Crocodile West River catchment.

b) *Inter-basin transfers*

The two main future transfers have been included in the water balance assessment. These are from the Crocodile West River catchment to:

- *Modimolle and Mookgopong* - Approximately 8.5 million m^3/a will be additionally required by 2040 to meet the growing domestic water demand and will be supplied by either Roodeplaat Dam or Klipvoor Dam on the Pienaars River.
- *Lephalale (Proposed MCWAP-2 transfer scheme)* - Major coal mining activities in the Waterberg area and a coal transportation rail from there to power stations in the Highveld and Mpumalanga are anticipated. Long term transfer volumes are 45 and 80 million m^3/a for the Base Scenario (3 power stations, 2 phases of coal exports) and the High Scenario (4 power stations, 4 phases of coal exports) respectively.

c) *EWR (Reserve)*

A comprehensive Reserve determination has been conducted for the catchment. Volumes of return flows are well in excess of the natural runoff in the main stem as well as tributaries – hence the provision for the Reserve has little impact on the yield from reservoirs and the availability of water.

d) *Water availability*

Local water resources include surface water and groundwater as well as effluent return flows. Water transfers of 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 2010 transfer volume is 523 million m^3/a and projected to increase to 765 million m^3/a by 2040.

e) ***Water conservation and water demand management***

A medium WCWDM scenario with 15% savings was chosen for the preferred planning scenario. The 15% savings were included to be achieved in 2015, within 5 years starting in 2010.

f) ***Water quality***

Due to the large volume of return flows and other activities such as irrigation and mining, the water quality is significantly affected. The DWA is monitoring water quality in the catchment and setting preliminary RQOs

g) ***Water balances and future developments***

There is a water surplus in the catchment due to the growing effluent return flows from the large urban areas.

With regard to the water balances for the Crocodile-Mokolo system (MCWAP), a conveyance loss of 10% was assumed for the river stretch between the upstream dams in the Crocodile West River catchment, where the surplus is located, and the transfer abstraction point at Vlieëpoort (near Thabazimbi) in the Lower Crocodile sub-catchment.

The shortfall of surplus in the Crocodile River catchment to meet the transfer requirements to the Lephalale area 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. For the Lephalale Base demand scenario, interventions to address the shortfall will be required during 2022 - 2027 and for the Lephalale High scenario during 2021 and 2040.

Phase 1 of MCWAP, a pipeline parallel to the existing pipeline from Mokolo Dam to users, was expected to be completed in 2013. Phase 2 of MCWAP, a water transfer scheme from the Crocodile River near Thabazimbi to the Lephalale area, should proceed to ensure that the power stations have access to water from more than one source. However, this phase and the other phases will only be initiated when required.

The Medupi power station will be commissioned one unit at a time, starting from 2013 up to 2019 when all six units will be operational. Each unit will require 1 million m^3/a water – thus 6 million m^3/a for the entire power station.

h) ***Specific reconciliation strategies***

The abridged revised 2012 Reconciliation Strategy for the CRW system entails the following:

- The Rand Water service area will continue to be supplied from the Vaal River system in the future;
- Additional re-use will be considered only when the surplus becomes available;
- Increased treated effluent from the metropolitan areas will serve as the future water source for the area outside of the Rand Water service area, north of the Magaliesberg;
- Optimal use of local resources in the Waterberg area, will continue and surplus water in the Crocodile River Catchment will be transferred to the Lephalale area;

- Groundwater resources must be used in areas where possible and opportunities for conjunctive surface/groundwater utilisation should be explored; and
- Possible interventions to supply the future temporary shortfall 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;
    - Trading (re-allocation) of irrigation water;
    - Development of groundwater (localised small potential);
    - Removal of alien vegetation; and
    - Increase transfers from the Vaal River system.

Other water resource management activities include:

- Development and application of system operating rules – DWA study;
- Validation and verification of water use – DWA study;
- Water use classification of significant water resources in the Mokolo-Matlabas catchments and the Crocodile West and Marico WMA – DWA study aiming to set ecological classes for rivers in the study area, hence formalisation of the Reserve;
- WCWDM initiatives of municipalities in the area.

The implementation of the strategy will rely on the following recommended activities:

- Mining sector to provide annual updates of water requirement projections;
- Continuous coordination of planning between bulk water service providers;
- Annual monitoring of water requirements and return flows and review water balance – consider revising long term projections;
- Undertake Annual Operating Analyses and engage water users through System Operating Forum; and
- Complete validation and verification of existing lawful use and review water balance.

2.23 DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE OLIFANTS RIVER WATER SUPPLY SYSTEM

Study Information: Development of a Reconciliation Strategy for the Olifants River Water Supply System. Project No. WP10197. Department of Water Affairs. Prepared by Aurecon in association with ILISO Consulting, MBB Consulting Services (Nelspruit), WFA Aquatic Ecology, Chuma Development Consultants, WFA Water Resources. 2010 - 2012.

2.23.1 Overview

The water requirements in the Olifants WMA and the adjacent areas of Polokwane and Mokopane, which are supplied from the Olifants, have increased substantially over the last number of years. The Olifants River catchment is heavily stressed with regard to water quantity and quality.

A reconciliation strategy, aimed at alleviating the current water deficits and ensuring a sustainable water supply for the foreseeable future, was required for the basin and its water users.

A number of reports, similar in content to that required for this Limpopo WMA North Reconciliation Strategy, have been prepared as listed in Table 2.92.

Table 2.92: Development of a Reconciliation Strategy for the Olifants River Water Supply System reports

Title	Report number
Inception Report	P WMA 04/B50/00/8310/1
Summary Report	P WMA 04/B50/00/8310/2
Extent of Invasive Alien Plants and Removal Options	P WMA 04/B50/00/8310/3
Future Water Reuse and other Marginal Water Use Possibilities	P WMA 04/B50/00/8310/4
Possible Water Conservation and Demand Management Measures	P WMA 04/B50/00/8310/5
Water Requirements and Water Resources	P WMA 04/B50/00/8310/6
Water Quality	P WMA 04/B50/00/8310/7
Preliminary Screening and Schemes to be nvestigated	P WMA 04/B50/00/8310/8
Management and Development Options and Cost Alternatives	P WMA 04/B50/00/8310/9
Groundwater Options	P WMA 04/B50/00/8310/10
Evaluation of Ecological Consequences of Various Scenarios	P WMA 04/B50/00/8310/11
Environmental Screening Report	P WMA 04/B50/00/8310/12
Preliminary Reconciliation Strategy	P WMA 04/B50/00/8310/13
Final Reconciliation Strategy	P WMA 04/B50/00/8310/14
Main Report with Executive Summaries of Reconciliation Strategies	P WMA 04/B50/00/8310/15
Yield Assessment of De Hoop and Flag Boshielo Dam	P WMA 04/B50/00/8310/16
Liability of the Responsible Authority for Changes in Yield Assessment	P WMA 04/B50/00/8310/17
Eco-Classification of the 1999 Assessment at EWR Sites in the Olifants River	P WMA 04/B50/00/8310/18

Only a summary of the reconciliation strategy is provided in this report. Refer to the reports listed in Table 2.92, which are also available on the DWS website, for more detailed information.

2.23.2 Reconciliation Strategy Summary

Key elements of the Reconciliation Strategy are summarised in the following subsection.

a) *The Reserve*

An Olifants Comprehensive Reserve Study was undertaken during 1999 and the Eco-Classification was repeated in 2010. The 1999 study made provision to release small floods (called freshets) from the dams during the spawning season for fish. However, existing dams do not have sufficient release capacity for these small floods, but can be generated from the tributaries and the catchment below the dam. Provision has only been made for the portion of the Reserve that is practically implementable which reduces the yield for the whole system by 157 million m^3/a. The full Reserve with the flood component would have reduced the available yield by 221 million m^3/a.

b) *Current and future water requirements*

The current water use in the irrigation, domestic and industrial, mining, power generation and forestry sectors is summarised in Table 2.93. The projected total high and low growth water requirement figures for 2035 are shown in 00. These high and low growth water requirement figures have been used for the reconciliation scenarios developed.

Table 2.93: Summary of water requirements of the Olifants River water supply system

Water use sector	Water use (million m^3/a)
Irrigation	486
Urban	178
Rural	29
Industrial	9
Mining	86
Power Generation	228
TOTAL	1 016

Table 2.94: Total high and low growth water requirements of the Olifants River water supply system

Water use sector	2010 Requirement (million m^3/a)	Future 2035 requirement (million m^3/a)	
		Low growth	High growth
Irrigation	486	486	486
Urban	178	221	255
Rural	29	39	51
Industrial	9	9	9
Mining	86	128	140
Power Generation	228	229	229
TOTAL	1 016	1 112	1 170

The water requirements for Polokwane and Mokopane areas at the 2010-development level are summarised in Table 2.95.

Table 2.95: Water requirements for Polokwane and Mokopane areas

Water use sector	2010 Water requirement	2035	
		High growth	Low growth
Polokwane urban	34.3	56.3	44.0
Polokwane mines	0.0	3.6	2.9
Polokwane total	**34.3**	**59.9**	**46.9**
Mokopane urban	8.2	19.5	12.0
Mogalakwena LM Rural	8.9	16.4	11.5
Mokopane mines	10.3	28	24
Mokopane Total	**27.4**	**63.9**	**47.5**

An overview of the mining water requirements and water supply sources of mines in the Mogalakwena LM are provided in Table 2.96: Water requirements for mines in Mogalakwena LM.

Table 2.96: Water requirements for mines in Mogalakwena LM

Mine	Water source	Water requirement (million m^3/a)
Overysel	Groundwater	0.77
Blinkwater	Groundwater	0.80
Commandodrift	Groundwater	0.51
Sandsloot	Rain water harvesting	0.51
Mogalakwena	Polokwane effluent	2.56
Doornkraal	Polokwane effluent	5.11
Total		**10.26**

c) *Water availability*

Groundwater

Groundwater is available throughout the Olifants WMA, although varying in quantities depending upon the hydrogeological characteristics of the underlying formations. The overall results of the Groundwater Yield Model indicated that there is a surplus of groundwater in the order of 70 million m^3/a.

Groundwater development in unstressed aquifers must be encouraged. A possible RWS with the Malmani dolomites as resource should be investigated. The impact of groundwater abstraction from the Malmani dolomites must be explored further in order to establish whether there is any impact on the surface water base flow in the Olifants River.

Surface water

Polokwane and Mokopane are currently supplied by dams that are outside of the study area. Polokwane is supplied by Dap Naude Dam and Ebenezer Dam with 1:50 year yield allocations of 6.2 and 12.0 million m^3/a respectively.

Doorndraai Dam, with a 1:50 year yield allocation of 4.4 million m^3/a, supplies Mokopane.

One of the mines in Mogalakwena has already entered into an agreement with Polokwane LM to purchase 8 million m^3/a of treated effluent from Polokwane.

d) ***Water quality***

The water quality in the study area does not affect the management or availability of the resource (i.e. dilution is not required as yet) although there are limited locations where the water quality is only tolerable and is unacceptable at two sampling points. At many stations however, there is an upward trend in pollution.

Localised water quality problems must be addressed by intensified compliance monitoring and enforcement and by reducing pollution at the source.

An issue that will require specific attention is the increasing decant of AMD. On the one hand it represents a potential source of water if treated properly, while on the other hand it represents a threat to future water quality if uncontrolled decanting is allowed to occur.

e) ***Water balance***

The projected future water balance is shown graphically in **Figure 3.5** and represents the situation if water requirements are allowed to increase and there is no further water resources development.

The increase in the water resource is due to the construction of the De Hoop Dam, phased in over 5 years to allow for filling. The ecological Reserve that reduces the system yield by 157 million m^3/a, was assumed to be operationalized from 2016. This is illustrated by the drop in available yield.

The conclusion can therefore be drawn that the system runs into deficit by 2017, and that by then interventions be required to have been implemented and to be effective.

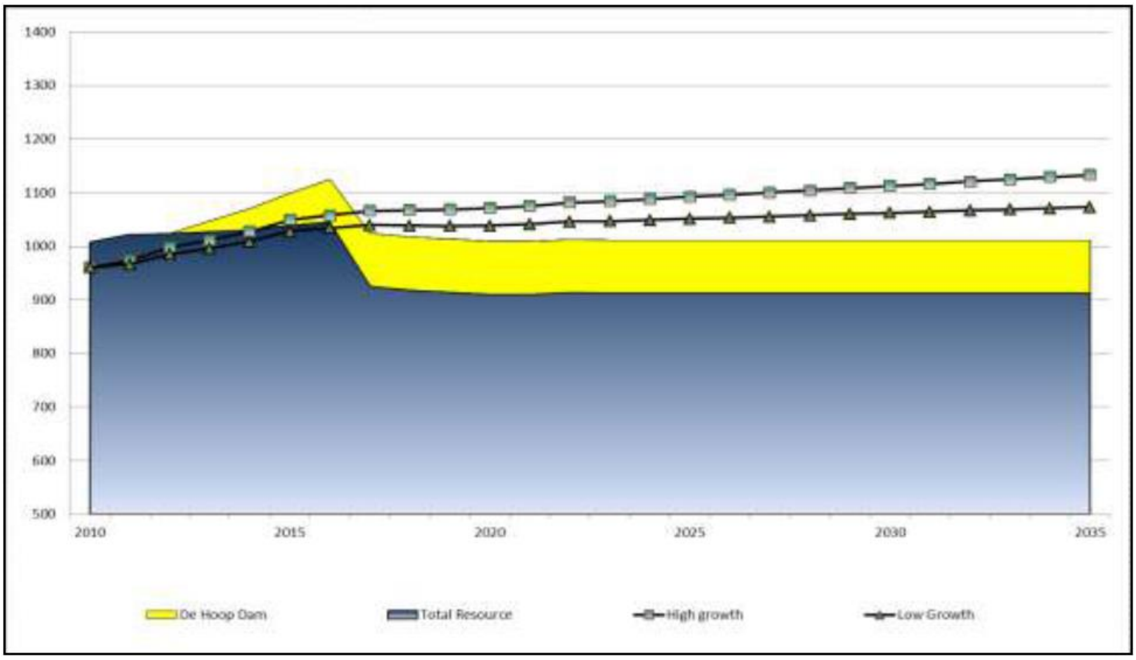


Figure 2.7: Projected future water balance of the Olifants River water supply system (million m^3/a)

f) *Possible Intervention Scenarios*

The reconciliation options that can reduce water requirements and increase water supply that were considered during the study are summarised in Table 2.97.

Table 2.97: Reconciliation options of the Olifants River water supply system

Option	Yield / water saving (million m^3/a)
Reconciliation options that will reduce water requirements	
Eliminating unlawful irrigation use	8.7
WCWDM: Urban	19.8
WCWDM: Irrigation	17
WCWDM: Mining	5
Compulsory licensing	35
Water trading – partial water entitlements	35
Removal of Invasive Alien Plants	15
Reconciliation options that can increase system yield	
Removal of IAPs	10.5
Development of Groundwater Schemes	35
Rooipoort Dam*	59
Dam in Olifants Gorge: Godwinton Chedle	 100 100
Dam in Lower Olifants: Epsom Madrid	 286 440
Raising of Blyderivierspoort Dam	110
Water Transfer of treated effluent from the East Rand (ERWAT)	38.3
Transfer from Vaal Dam	160
Transfer from Crocodile (West): Pienaars – Flag Boshielo Dam Crocodile – Flag Boshielo Dam Crocodile – Mokopane**	 30 60 25
Transfer from Massingir Dam	50
Desalination and transfer of Sea Water	100
Treatment of decanting water from the coal mines in the Witbank Dam Catchment	12
Treatment of decanting water from the coal mines in the Middelburg Dam Catchment	10
Polokwane and Mokopane sewage water reuse by Mogalakwena mines***	11

* The additional yield gained from the proposed Rooipoort Dam does not rectify the cost pertained to the construction thereof – much of the yield will be allocated to meeting the EWR.

** Alternative to the ORWRDP-2B (pipeline from Flag Boshielo Dam to Mokopane).

*** 4 million m^3/a of treated effluent can be immediately made available by 2010 and 10.7 million m^3/a by 2035, included a 20% loss factor.

The following additional reconciliation options, that can increase the water supply, were also considered:

- Refinements to system operating rules;
- Rainfall enhancement through Cloud Seeding; and
- Utilising the AMD in the Upper Olifants.

The following aspects were taken into account and formed the basis for water reconciliation:

- South Africa will meet its international obligations;
- The water for basic human needs (BHN) will be supplied;
- The Reserve is a priority – EWR to meet the REC will be maintained;
- All unlawful water use will be eliminated;
- Water for strategic users for the benefit of the country must receive priority before any other economic development;
- Water for socio-economic development within the policy parameters of the government will be provided;
- There will be no increase in total water allocations for irrigation; and
- There will be no increase in forestry areas.

2.24 RECONCILIATION STRATEGY FOR THE LUVUVHU AND LETABA WATER SUPPLY SYSTEM

Study Information: Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System. Department of Water Affairs. Prepared by WRP Consulting Engineers in association with DMM Development Consultants, Golder Associates Africa, Worley Parsons, Kyamandi, Hydrosol and Zitholele Consulting. 2012 - current.

2.24.1 Overview

The DWA has identified the need for the Reconciliation Study for the Luvuvhu-Letaba WMA. The WMA is almost fully developed and demands from the Letaba River currently exceed the yield capability of the system. Regulation for the Letaba is mainly provided by Middle Letaba, Ebenezer and Tzaneen Dams. The recently completed Nandoni Dam as well as the Albasini, Vondo and Damani dams will be managed as one system. It is expected that the total yield from this combined system will be fully utilized by around 2020, considering only the current planned projected demands.

The reconciliation strategy has not yet been completed at the time of this literature review. However, the team members of both studies will liaise on a continuous basis to ensure all information is shared.

3 SYNTHESIS OF AVAILABLE INFORMATION

3.1 APPROACH

Chapter 2 of the report summarises information relating to the water resource and supply systems of the Limpopo WMA North. The documentation reviewed covers a wide range of aspects that make up the components required for integrated water resource management and form a solid knowledge base for the development of the water supply reconciliation strategy.

The summaries given in **Chapter 2** were given by study or by individual reports, where applicable. The information was interpreted and assessed to form a synthesised view of the current status of integrated water resource management and to identify the themes or topics that need to be covered in the reconciliation strategy.

Chapter 3 provides a synthesis of the information reviewed and is structured according to river catchments, namely Matlabas, Mokolo, Lephalale, Mogalakwena, Sand and Nzhelele area. For each of the six river catchments a description is provided in accordance with the following topics where information was available:

- Description of the river catchment;
- Current water availability and supply situation;
- Water requirements;
- Water resource management issues;
- Possible structural and management interventions; and
- Perspective on water resources.

It should be noted that the water resource management synthesis given in this chapter are based on the view of the information at hand and aims to guide the formulation of the strategy and the associated technical tasks. The perspective indicated here will be investigated during the course of this Reconciliation Strategy and will be amended, changed or can even be discarded in the final Reconciliation Strategy documentation.

3.2 MATLABAS RIVER CATCHMENT

3.2.1 Description of river catchment

The Matlabas River catchment falls within tertiary catchment A41 and forms part of the A4 secondary catchment along with the Mokolo River catchment (A42). The Matlabas covers an area of 6 014 km^2. The upper reaches of the catchment are situated in the Waterberg area. The catchment is located within a predominantly flat area of the Limpopo WMA North.

The largest land use recorded in the *Water Resources Situation Assessment Report* (DWAF, 2003a) is nature reserves, including national parks such as the Marakele National Park, wilderness areas and similar. Most of the catchment is still covered by natural vegetation.

The catchment is mostly undeveloped with limited water resources and water users and hence water related infrastructure is a minimum. There are no large dams and also no water transfers in or out of the catchment. The catchment is, generally, less stressed than other catchments and still contains some pristine areas.

3.2.2 Current water availability and supply situation

The Matlabas River catchment has a MAR of 49 million m^3/a, but due to the highly erratic surface water flow, the yield from surface water amount to only 4 million m^3/a, which is almost negligible. Irrigation is the dominant water user in the catchment of which half of the requirement is supplied by surface water and the other by groundwater. Domestic requirements are minimal. However, the catchment has a small deficit which may relate to opportunistic irrigators supplied by surface water at a very low assurance.

Water quality in the catchment is considered good, with little impact. The only impacts being the runoff from game farms and the Marakele National Park. Groundwater resources are underutilised as only 4 million m^3/a of the 28 million m^3/a exploitable potential is abstracted for supply (DWAF, 2003a).

3.2.3 Water requirements

With reference to the *Water Resources Situation Assessment Report* (DWAF, 2003a), population estimates and water use projections from the 1995 baseline population to 2025 were obtained from a national study as part of the NWRS-1. The study used a number of sources to determine the 1995 baseline population. These include the Development Bank of Southern Africa, the Demographic Information Bureau, Bureau for Market Research and local authority estimates. The results of the 1996 census was used as an additional check and used to revise significant discrepancies in the database as the census provided improved information.

The total population within the catchment were determined to be just more than 10 000. All of the population fall under rural conditions and there are no urban settlements. Previous studies indicated and approximately only 50% of the population have access to water meeting the RDP standards. Migration out of the WMA to larger industrial and urban centres is driven by an unemployment rate of 47%.

Water requirements are low. The irrigation requirement was estimated at 4 million m^3/a and domestic rural requirements at 2 million m^3/a during 1995. No significant growth in water requirements is expected for rural areas as well as for the irrigation sector due to limited water availability. Thus the catchment is considered a low priority.

More recently as part of the MCWAP study and the CWRS, it was identified that Sasol anticipates to develop two CTL fuel plants and Exxaro to develop mining activities in the Steenbokpan area, increasing the population growth and hence water requirements in the area. It should be recognised, however, that Steenbokpan falls within close proximity of the Mokolo River catchment.

The Mafutha 1 CTL fuel plant is expected to require 0.4 million m^3/a in 2011 and growing to 44 million m^3/a by 2030. Mining activities in the Steenbokpan area can increase to 6.12 million m^3/a by 2024. The municipal requirements at Steenbokpan can increase to 28 million m^3/a, should the Sasol CTL fuel plants realise. These additional water requirements will be mainly supplied by the

MCWAP – transferring water from the CRW catchment in the Crocodile (West) and Marico WMA (refer to **Section 2.10**).

The Lephalale LM has allocated R 4 million for the construction of a WTW and R 27 million for the construction of water reservoirs at Steenbokpan. MIG further allocated R 75 million for the construction of a new sewer treatment works at Steenbokpan.

Few studies have been conducted in the Matlabas River catchment regarding ecological Reserve requirements or EWRs. With reference to the *Water Resources Situation Assessment Report* (DWAF, 2003a), a so-called desktop method has been developed (Hughes & Münster, 1999) to classify main stem rivers and to provide a low confidence estimate of the quantity of water required for the ecological Reserve. The EC of the Matlabas and Steenbokpan Rivers were both determined as class C – Moderately modified. The respective EWRs for the Matlabas and Steenbokpan Rivers are 6.7 million m^3/a and 1.4 million m^3/a.

The estimated EWR as recorded in the *Limpopo Water Management Area: Overview of Water Resources Availability and Utilisation* (DWAF, 2003b) for the Matlabas and the Mokolo River catchments combined is 76 million m^3/a.

The Classification Study discussed in **Section 2.11** did not include EWRs for the Matlabas River due to hydraulic challenges during data collections. However, 5 EWR sites were initially identified on which Rapid III reserve studies had to be carried out but due to lack of data only four sites were assessed to Rapid II and Rapid I study level. The EWR for the Matlabas river catchment were estimated as 10.9 million m^3/a. Matlabas River catchment has a B/C PES and is recommended to be maintained at that level. The proposed MCs for the upper and lower reaches of the Matlabas River are I and II respectively.

3.2.4 Water resource management issues and perspectives

Approximately 40% of the Matlabas River catchment falls under the Thabazimbi LM and the 60% under the Lephalale LM, with the Matlabas River forming the boundary between the two LMs. Both these municipalities are the WSA and WSP for the designated municipal areas. The scattered nature of small rural villages complicates adequate water service delivery in the catchment.

The Matlabas River catchment contains no significant dams and has very limited water resources available. Water requirements in the catchment are low, but the catchment is currently in deficit. As there is very little growth potential in the catchment this deficit is not critical. The most reliable source of water in the catchment is from groundwater, despite the boreholes having low yields. Some opportunistic irrigation does take place with very low surface water assurance levels.

Major future Sasol and Exxaro developments are anticipated in the Steenbokpan area, adjacent to the Mokolo River catchment boundary, which falls under the Lephalale LM. These developments will be supplied by the MCWAP transfer scheme from the Crocodile (West) and Marico WMA. However, this may impact the Matlabas River – scouring at the crossing of the Mokolo pipeline should be monitored and mitigated if necessary.

3.2.5 Possible structural and management interventions

The river catchment is considered a low priority as little increase in future water requirements is foreseen. Future allocations can be made from local groundwater resources as they are currently underutilised but not from run-of-river yield. Due to unfavourable hydrological conditions, the possibility of constructing farm dams is low. New developments in the Steenbokpan area will be supplied thought the MCWAP transfer scheme.

3.3 Mokolo River Catchment

3.3.1 Description of river catchment

The Mokolo River catchment falls within tertiary catchment A42 and forms part of the A4 secondary catchment. The catchment covers an area of 8 387 km^2 and stretches from the Waterberg mountains to the Limpopo River. The catchment has a number of smaller tributaries, including the Tambotie, Sterkstroom, Poer-se-Loop and Rietspruit rivers, which connect to the main stream of the Mokolo River prior to its confluence with the Limpopo River. The annual rainfall in the upper regions of the catchment (in the Waterberg area) are between 670 and 600 mm and in the lower regions, which are flatter, sandier and drier, the annual rainfall ranges between 550 and 430 mm.

The largest land use in the catchment, recorded in the *Water Resources Situation Assessment Report* (DWAF, 2003a) is dryland crops although most of the catchment is still covered by natural vegetation. Small scale yellow fish, which is specific to the environment, is found in the upper reaches of the Mokolo River.

The catchment is predominantly rural, although the Waterberg Coalfields exist in the vicinity of Lephalale. The main industrial development relates to the Grootegeluk Coal Mine and the Matimba Power Station, which is the largest direct dry cooled power station in the world with a generating capacity of 3 690 MW.

The Mokolo and Lephalala River catchments conjunctively consist of 40% of the country's remaining coal reserves. Development of new power stations and mining facilities are inevitable. Medupi Power Station in the Lephalale area is anticipated to start supplying power by 2016. Furthermore, a number of other power stations, CTL fuel facilities by Sasol and mining activities by Exxaro are anticipated in the area, which will increase the population growth and water demand significantly for the area.

The Mokolo Dam is the largest dam in the Limpopo WMA North and currently supplies Matimba Power Station, Grootegeluk Coal Mine, Lephalale Town and downstream irrigators. The Mokolo Dam is able to meet the bulk of the current demand but will in future rely on water transfers from other WMAs.

A number of detailed studies related to water resources have been undertaken in the Mokolo River catchment in preparation of the MCWAP. Studies include:

- Updating the Hydrology and Yield Analysis in the Mokolo River catchment (**Section 2.9**);
- MCWAP Pre-Feasibility and Feasibility Study (**Section 2.10**);
- Classification of Significant Water Resources in the Crocodile (West), Marico, Mokolo and Matlabas Catchments (**Section 2.11**);

- Crocodile (West) Water Supply System Reconciliation Strategy (Section 2.21 and Section 2.22); and
- The Lephalale LM IDP (Section 2.20.2).

3.3.2 Current water availability and supply situation

The Mokolo River catchment is developed in terms of water resources. The catchment has a natural MAR of 290 million m^3/a. The 1:200 year yield available from the Mokolo River catchment is 67.9 million m^3/a and the yield under current-day conditions is 39.1 million m^3/a (DWAF, 2007).

The Mokolo Dam is the largest dam in not only the Mokolo River catchment but in the whole Limpopo WMA North with a FSC of 146 million m^3. The dam was constructed in the late 1970s, with a yield of 39 million m^3/a which dropped to 23 million m^3/a due to rapid irrigation development upstream of the dam. There are over 1 400 smaller water bodies in the catchment, including farm dams, weirs and gravel pits, with a combined FSC of 23.36 million m^3 at the 2004-development level. The total yield from these dams is 12.4 million m^3/a, equivalent to 53% of the total capacities of the water bodies.

The Matimba Power Station, Grootegeluk Coal Mine, Lephalale and adjacent urban water as well as irrigation downstream of the Mokolo Dam are supplied by the Mokolo RWSS. Raw water is abstracted from the Mokolo Dam and pumped to the Wolwefontein balancing dam. Raw water gravitates from the Wolwefontein reservoir to the 17 Mℓ/d Zeeland WTW before being supplied to Lephalale and Onverwacht. Raw water drawn from the balancing dam is also delivered to Grootegeluk Coal Mine and Matimba Power Station where it is treated by Eskom for own use and potable water to Marapong. Effluent from the aforementioned supply points is treated at the Paarl WwTW.

There are over 51 boreholes around Lephalale, however, the yield from these boreholes is poor. An additional eight boreholes have recently been drilled in the vicinity of Lephalale with a yield of 1.4 million m^3/a. Vaalwater, supplied by boreholes, is currently experiencing water shortages to such an extent that water has to be supplied with water carts.

Irrigation is the major water user and is supplied mainly by surface water – by small farm dams in the upper region and releases from the Mokolo Dam downstream. Approximately 20% of irrigation is supplied by groundwater, of which 10% is supplied by boreholes and the remainder by a sand aquifer.

The total use from groundwater resources are approximately 11 million m^3/a and contributes to return flows of 4 million m^3/a. The exploitable potential is estimated at 47 million m^3/a. A sustainable yield from boreholes in the Waterberg – Karoo contact fault is estimated at 1.7 million m^3/a. For a short-term two year use, 7.19 million m^3/a can be abstracted but will need a few years of recovery.

Groundwater quality in the catchment is poor due to coal and gas fields, however, it can still be used by the industrial and irrigation sector. Surface water and groundwater is affected by pollution from coal mining activities and the rapid and uncontrolled growth of informal settlements around Vaalwater and Mabaleng. The Vaalwater area is currently using oxidation ponds in close proximity to the Mokolo River. These ponds overflow, especially during the rainy season, and pose a threat to the water quality in the surrounding area. A 0.5 Mℓ/d package plant has been installed to mitigate the situation and to avoid contamination of groundwater. Mabaleng presently has no WwTW.

Major mining and power developments are expected in the Lephalale and Steenbokpan areas. The Mokolo Dam can supply the current water requirements, however, detailed planning analyses should be conducted to assess the future water resource situation. The MCWAP was identified to meet the future water requirements and will be able to supply 185 million m^3/a to the catchment by 2030. Earlier studies recommended that the increase in rural domestic requirements be supplied by groundwater.

3.3.3 Water requirements

Irrigation is the major water user in the Mokolo River catchment, covering more than 100 km^2 and has a total water requirement of 40 million m^3/a at the 2004-development level as determined in previous studies. Approximately 77% is supplied from surface water, mainly from small farm dams and weirs in the upper regions of the catchment and from the Mokolo Dam in the lower region. Groundwater supplies approximately 8% and 15% are supplied by schemes – which are supplied through releases from Mokolo Dam to the downstream sand aquifer. The total return flows from irrigation are estimated at 3.3 million m^3/a.

There has been a drop in irrigation in the catchment as land use is shifting towards game farming. Hence, no significant increase in irrigation water requirements is expected for the future in the catchment.

Other major surface water users in the catchment include Matimba Power Station, Grootegeluk Coal Mine and urban and industrial users which require a combined total of 10.2 million m^3/a. Table 3.1 summarises the allocations made from the Mokolo Dam as well as the actual use by the various major users.

Table 3.1: Summary of allocation and actual water use from the Mokolo Dam

Name	Allocation (million m^3/a)	Actual water use (million m^3/a)
Grootegeluk coal mine	9.9	3.4
Matimba power station	7.3	3.0
Lephalale/ Onverwacht town	1.0	3.3
Marapong township		0.5
Downstream irrigation scheme	10.4	16.0
Total	**28.6**	**26.2**

The *Updating the Hydrology and Yield Analysis in the Mokolo River Catchment* (DWAF, 2007) concluded that the implementation of a desktop in-stream flow requirement (IFR) with a PES Category of Class C (i.e. “moderately modified”) downstream of Mokolo Dam, with an average annual requirement of 48.5 million m^3, results in a considerable decrease in the yield from 39.1 million m^3/a to only 11.1 million m^3/a. The more recent classification study (DWA, 2013a) concluded that the estimated EWR for the Mokolo River catchment is 41.7 million m^3/a. The The REC is Class B for the entire catchment, except in the Vaalwater area where the REC is Class C. However, the PES ranges between Class B, C and D.

Approximately 36% of the rural population in the entire Lephalale LM, which covers the majority of the Mokolo River catchment, does not have access to water that meets RDP standards. Upgrading the water services will contribute to an increase in water requirements.

Extensive development and an increase in water requirements are expected in the future in the Lephalale and Vaalwater region as well as the Steenbokpan area in the Matlabas River catchment. This is mainly due to large scale coal mining developments, methane gas developments around the coal reserves and power stations, including Medupi and IPPs. The MCWAP was identified to augment supply to the Mokolo River catchment to meet the future water requirements. The total water requirements in the catchment, and used for feasibility design of the MCWAP, are anticipated to increase from 23.3 million m^3/a in 2009 to 208.4 million m^3/a in 2030. An additional 185 million m^3/a will be supplied to the Lephalale and Steenbokpan areas through the MCWAP.

3.3.4 Water resource management perspective and issues

The majority of the Mokolo River catchment falls within a portion of the Lephalale LM, which is the designated WSA and WSA with the assistance of Exxaro and Eskom. The remainder of the catchment falls within the Modimolle LM.

Bulk water services in the urban areas have reached full utilisation and the situation is worsened by the aged infrastructure, large number of illegal connections and the lack of accountability to water losses. Current groundwater development is not a reliable source of water for the rural community. Also groundwater quality is poor in the vicinity of the coal and gas fields. A great concern is the water shortages in the Vaalwater area. Furthermore, the oxidation ponds in the area overflow during the summer and pose an environmental threat to the Mokolo River.

The potential development of coal mining activities could have an aesthetically negative impact on the catchment and, potentially, AMD could occur in the future. The extent of the pollution potential induced to both surface and groundwater by mining activities must be investigated and understood through monitoring water quality at strategic points.

Raising of the Mokolo Dam could be postponed by the approval of the Limpopo River co-basin states in accordance with the SADC Protocol on shared water courses.

Hydro-meteorological monitoring are of concern, considering that only nine of the 33 usable rainfall gauges within the catchment have remained open and only 4 of the 13 stream flow gauges could be used for WRSM calibration purposes in the *Updating the Hydrology and Yield Analysis in the Mokolo River Catchment* (DWAF, 2007). Improving the current monitoring system will aid in better estimates of the water resources available. This includes a monitoring system for the releases from Mokolo Dam, incremental runoffs downstream of the dam, flows into the Limpopo River, actual groundwater abstractions and groundwater levels.

3.3.5 Possible structural and management interventions

The Mokolo River catchment is currently in deficit and unable to provide extra yield internally. A number of additional water resources have to be utilised to meet the requirements of major expected future economic developments in the Lephalale area.

The main water resource intervention identified in previous studies is the MCWAP. The MCWAP comprises of a pipeline parallel to the existing Mokolo to Lephalale pipeline (Phase 1), which is anticipated to supply by end 2015, and a transfer scheme from the CRW at the Vlieëpoort near Thabazimbi to the Lephalale and Steenbokpan areas (Phase 2). A number of interim interventions have also been identified. These include:

- Water trading or “renting” from the downstream scheme irrigators;
- Losses on releases from the Mokolo Dam into the downstream aquifer are in the order of 60%, which may reduce to 40% by implementing proper management practices aimed at reducing flow losses into the Limpopo River; and
- Upgrading the current monitoring system to improve the estimated losses from the Mokolo Dam.

The possibility of raising the Mokolo Dam has also been investigated. Yield analyses of recent studies showed that if the dam is raised by 12 m, the 1:200 year yield will increase by 17.3 million m^3/a and similarly by 21.6 million m^3/a if raised by 15 m. However, the cost pertained to the raising of the dam does not justify the small amount of yield that will be obtained. Furthermore, the raising of the dam would have to be approved by the Limpopo River co-basin states in accordance with the SADC Protocol. This can delay the implementation of raising the dam significantly. The raising of the Mokolo Dam should only be considered once all other options have been exhausted.

Groundwater is under-utilised and hence development of large borehole networks to supply the underdeveloped areas from groundwater has also been identified. However, water quality information gathered should be applied to develop effective management strategies.

The IDPs of Lephalale LM and Modimolle, which cover the Mokolo River catchment area, required that WCWDM be implemented urgently. The total urban loss for the urban areas is estimated to be 23%. Considering the coverage of the Lephalale LM and the small water requirements in the Mokolo River catchment, the yield obtained through WCWDM initiatives is negligible. However, WCWDM may have a significant impact on the future water resource capability of the Mokolo system considering the expected growth in the catchment.

Eradication of IAP will not have a significant influence on the available water within the catchment as it does not significantly contribute to runoff reduction.

3.4 LEPHALALA RIVER CATCHMENT

3.4.1 Description of river catchment

The Lephalala River Catchment falls within tertiary catchment A50. The Lephalala River originates in the Sandrivier Mountains which forms part of the Waterberg Mountains. There are a number of smaller tributaries in the lower reaches of the river. The catchment has a moderately high MAP in the upper reaches, ranging between 700 to 550 mm, and is semi-arid in the downstream areas. An endoergic area between the Lephalala and Mokolo river catchments limits runoff in the lower reaches of the Lephalala River.

The largest land use in the catchment are recorded in the *Water Resources Situation Assessment Report* (DWAF, 2003a) was dry land agriculture followed by nature reserves and tourist resorts. Rural communities are mostly scattered in the lower regions in close proximity of the Lephalala River. The Wilderness area, situated in the middle reaches, is of high conservation importance. The relatively undeveloped river and tributaries inhabits several flow and pool dependant species, including red data species such as the short fin barb.

The catchment is mainly undeveloped in terms of water resources. No major dams exist in the catchment and the majority of water bodies are located in the upper, higher rainfall regions. The Lephalala River is mainly unregulated and floodwaters enter into the Limpopo River.

Few water resources related studies have been undertaken in the catchment and is mainly included in studies pertaining to the entire Limpopo WMA.

3.4.2 Current water availability and supply situation

Previous studies estimated the natural MAR of the Lephalala River catchment between 124 to 150 million m^3/a and the current-day MAR at the 2000-development level is 67 million m^3/a. There are no major dams and surface water resources are limited to farm dams in the upper reaches and small storage weirs further downstream. More than 530 farm dams have been constructed in the catchment and have a combined FSC of 9.5 million m^3. The yield from surface water resources, determined in previous studies, are 15 million m^3/a.

Irrigation is the major water user and is supplied mainly by the farm dams in the upper regions. Less irrigation occurs in the lower reaches of the Lephalala River due to limited runoff and is supplied by small weirs and an alluvial aquifer. The population is predominantly rural and located in the lower reaches of the Lephalala River.

Basic domestic and stock water needs of 38 villages are supplied by one of five local groundwater schemes, namely the Shongwane RWS, Mokuranyane RWS, Ga-Seleka RWS, Ga-Phahladira Cluster and the Witpoort RWS. In total these schemes consist of 138 boreholes with a combined available supply of 4.3 million m^3/a. The estimated exploitable groundwater potential is in the order of 35 to 37 million m^3/a as determined in previous studies. However, the current groundwater yield available, limited by groundwater supply infrastructure, is 12 million m^3/a.

Water quality in the middle reaches, in the vicinity of the Wilderness area, is pristine. The current state of water quality is threatened by poorly managed fertilizer application in irrigation areas, effluent produced by the increasing number of tourist attractions and unprotected borehole heads in the scattered rural settlements.

The PES ranges between Class B, C and D. The REC is Class B for the entire catchment, except in the Vaalwater area where the REC is Class D.

3.4.3 Water requirements

The irrigation and rural domestic sector are the only water users within the catchment with the year 2000 projected water requirements of 39 million m^3/a and 3 million m^3/a respectively (as recorded in *Limpopo Water Management Area: Overview of Water Resources Availability and Utilisation* (DWAF, 2003b)). More recent data could not be obtained at the time of compiling this report.

The estimated requirements for the ecological Reserve for the Lephalala River catchment is 17 million m^3/a as recorded in the *Limpopo Water Management Area: Overview of Water Resources Availability and Utilisation* (DWAF, 2003b). However, the Reserve requirement were reassessed in the ISP and found to be only 3 million m^3/a. The need therefore exists to verify the Reserve requirements.

Assuming a Reserve of 3 million m^3/a, the total water requirements are 36 million m^3/a. Considering an available yield of only 27 million m^3/a, the catchment is in serious deficit.

No major developments are anticipated for the area, except for the expanding tourist facilities. The current water requirements are expected to remain the same. Emphasis has, however, been placed on the maintenance of the Wilderness area at its current pristine state.

3.4.4 Water resource management perspective and issues

Approximately 50% of the Lephalala River catchment falls under the eastern section of the Lephalale LM and the remainder under sections of the Mogalakwena, Mookgopong and Modimolle LMs.

Due to the dispersed nature of rural settlements, water supply to RDP standards is an issue. Boreholes in some rural settlements are unprotected and can contaminate groundwater resources. A need for WCWDM in the irrigation sector is critical to alleviate the current deficit in the area. Focus must be placed in the Wilderness area to ensure it remains in its current pristine condition.

From a hydrological modelling perspective, the catchment is considered a weak spot due to the lack of hydrological monitoring points. It was recommended that the feasibility of constructing a new river flow gauging station in the Lephalala River near the northern border of the Wilderness area and the Phalala Dam should be investigated (DWAF, 2003a).

3.4.5 Possible structural and management interventions

There are no significant developments expected in the Lephalala River catchment due to limited water resources available, however, the catchment has a severe deficit which needs to be reduced.

Surface water development in the upper reaches is restricted due to the flat nature of the typography and the ecological sensitivity of the Wilderness area. Implementation of WCWDM in the irrigation sector is critical to minimize the large deficit due to the lack of surface water development potential. Compulsory licencing should be considered if WCWDM cannot restore the water balance.

Groundwater is under-utilized and development of groundwater schemes should be considered for rural domestic supply.

3.5 MOGALAKWENA RIVER CATCHMENT

3.5.1 Description of river catchment

The Mogalakwena River catchment, also known as Glen Alpine system, covers tertiary catchments A61, A62 and A63 and has a total catchment area of 19 314 km^2. The Sterk River and the Nyl River converge to form the Mogalakwena River in the upper region of the catchment. Other smaller tributaries include the Klein Mogalakwena, Matlala and Seepabana rivers, which connects to the Mogalakwena River before it drains into Limpopo River. The MAP reduces from 630 mm in the upper Waterberg regions to 350 mm in the vicinity of the Limpopo River. Surface water resources in the catchment are limited and have been fully developed, the major dams being the Doorndraai and Glen Alpine dams. Large groundwater resources exist but have been extensively exploited by the irrigation sector.

The largest land use in the catchment, recorded in the *Water Resources Situation Assessment Report* (DWAF, 2003a), are dry land agriculture followed by nature reserves which include national parks, wilderness areas and similar areas. Nylsvlei in the south-east of the catchment is the country's largest ephemeral floodplain and has been declared a RAMSAR wetland site because of its international conservation importance and birdlife. From a conservation perspective the catchment is important due to:

- Flow dependant species that occur downstream of the Glen Alpine Dam;
- Pools in the river reaches offering refuge for various species;
- The presence of the short fin barb (international red data specie); and
- The diversity of species has been lost due to the development of reaches, and further loss should be minimised.

Urban centres in the catchment include Modimolle, Mookgopong and Mokopane. The central part of the catchment is densely populated with more than 80% of the population classified as rural. Numerous small mines as well as the large AMPLAT Mogalakwena Platinum Mine are located in the catchment. Due to the high requirement and limited water resources, the some areas rely on transfers from adjacent catchments outside the Limpopo WMA North. The urban water requirement of Modimolle is supplied by transfers from Roodeplaat Dam in the adjacent CRW catchment.

The irrigation sector, as with the other catchments, is the main water user. Irrigation is concentrated in the Moorddrift area near Mokopane, Gillimburg area in the central parts of the catchment and in the Glen Alpine Dam area.

Mining activities are rapidly expanding in the Mokopane area and future water supply will be augmented by from transfers from the Flag Boshielo Dam in the Olifants River catchment. These future mining developments, however, pose a threat to the Nylsvlei wetland.

The most recent water resources related study undertaken in the Mogalakwena catchment is the *Establishment of Operating Rules for the Glen Alpine System* (DWA, 2011). Refer to **Section 2.12**. The study consists of a hydrological assessment, water quality assessment, groundwater analysis and yield analysis in order to establish operating rules for the Doorndraai and Glen Alpine Dam.

3.5.2 Current water availability and supply situation

The Mogalakwena River catchment is extensively developed in terms of water resources. The natural MAR, as determined in the *Establishment of Operating Rules for the Glen Alpine System* (DWA, 2011), is 198 million m^3/a and the current-day MAR at the 2007-development level is 127 million m^3/a.

Surface water in the catchment consists of primarily six major dams with combined FSC of 86.34 million m^3. These dams are, in order from largest to smallest; Doorndraai, Glen Alpine, Haaskloof, Rooiwal, Gert Combrink and Donkerpoort dams. These dams supply a variety of sectors. More than 700 farm dams have been constructed to improve the level of assurance for irrigation and more that 30 storage weirs are located downstream of Glen Alpine Dam. The estimated local surface water yield from the Glen Alpine system is 72 million m^3/a as determined in previous studies at the 2000-development level (DWAF, 2003b). Recent studies determined that the 1:50 yields from the two major dams, Doorndraai and Glen Alpine, are 7.38 and 10.4 million m^3/a respectively. However, the water requirements from these dams are more than the available yield.

Domestic, urban and irrigation water supply infrastructure, such as several medium sized dams, well-fields and the Sterk River and Glen Alpine Irrigation Schemes, were developed by municipalities and the state during the 1950s and 1960s to support the growing population.

Modimolle is supplied by Donkerpoort Dam and the Magalies Water Roodeplaat Dam scheme after being treated at a 3.4 Mℓ/d Klipdrift WTW. Water is transferred from the Roodeplaat Dam in the Crocodile (West) and Marico WMA by means of a pipeline which has reached its full capacity in 2003. Modimolle Town and Phagameng receives water from the Donkerpoort WTW but due to the high water tariff pertained to using Donkerpoort Dam, water use has reduced resulting in the dam being under-utilised. Modimolle WwTW is currently running at its full capacity of 3 Mℓ/d treating an average of 4.5 Mℓ/d.

The Greater Mokopane Regional WSS provides water to Mokopane, Mahwelereng, Amplats Mogalakwena Platinum mine, irrigation on the Sterk River Irrigation Scheme and several denser settlements. The scheme consists of the following components:

- *Doorndraai Dam* – The dam supplies water for domestic and industrial uses in Mokopane and the Sterk River Irrigation Scheme, which comprises of an extensive canal system, however, losses are estimated at 30% to 40%;
- *Planknek well-field* – Comprises of 19 production boreholes located in Dorps River supplying to Mokopane and Mahwelereng. The combined yield from the boreholes is 1.6 million m^3/a;
- *Dispersed boreholes* - More than 50 production boreholes, supplying about 0.8 million m^3/a, have been developed in Mahwelereng and the denser settlements to meet critical water shortages. The Rooisloot wellfield, which

lies within this area, is out of production due to vandalism and over exploitation;

- *AMPLAT Mogalakwena Platimum Mine well-fields* – Owned and operated by the mine and comprise of separate groundwater developments at Zwartkop, Blinkwater and Commandodrift, supplying a combined sustainable yield of the well fields amounts to about 1.6 million m^3/a; and
- *Treated sewage effluent* from Mokopane and Mahwelereng is fully reused in the process plant of AMPLAT Mogalakwena Platinum Mine (currently purchasing 8 million m^3/a from Polokwane LM), to irrigate sports fields and the golf course, and to produce lucerne for the zoological gardens.

Effluent from Mokopane is treated in 3.4 Mℓ/d WwTW, next to the Nyl River, before it is pumped to maturation ponds and thereafter to the various users. Sewage effluent from Mahwelereng is treated in two separate sets of oxidation ponds before being routed through the Mokopane WwTW and pumped to the maturation ponds for reuse. Approximately 3 Mℓ/d of treated sewerage effluent are recovered from the Mokopane WwTW.

Water supply to Mookgopong is obtained from groundwater (mainly from the Nyl well-field) and Welgevonden Dam (previously the Frikkie Geyser Dam). The Nyl well-field comprises of 12 production boreholes with sustainable yield of about 0.75 million m^3/a. Four additional boreholes are located in Roedtan. The possibility of augmenting supply to Mookgopong from either the Roodeplaat Dam or Klipvoor Dam in the CRW system is being investigated. One WwTW receives waste water from Naboomspruit town and Mookgopong. Roedtan/Thusang has one pond and the farming community uses septic tanks.

Smaller urban centres, such as Alldays and Marken, obtain water from locally developed groundwater sources. Villages are mainly supplied from smaller groundwater supply schemes.

Glen Alpine Dam is predominantly used for irrigation purposes and emerging farmers. However, emerging farmers have not been utilising their full allocation. Water is released up to 4 times per year in slugs of which each release amounts to about 20% of the total storage capacity of the dam. The released water is stored temporarily in about 30 storage weirs constructed by irrigators in the river and on adjacent properties. Each scheduled user has the right to build a 2 500 m^3/ha/a storage weir with the approval of DWS. About 70% of the water released is lost into the Limpopo River. It is believed that the ecological Reserve is supplied from dam releases.

Groundwater exploitable potential in the catchment is estimated at 125 million m^3/a, of which only half is currently used. However, stress indexes for tertiary catchments A61 and A63 are in the order of 30%. The aquifer in the mountainous areas east of Mokopane, primarily consisting of dolomite, is over exploited due to uncontrolled abstraction of large quantities by the Zebedelia Estates. Irrigation abstractions in the Rooisloot valley and Dorps River valley as well as abstractions from the Mokopane well-field, west of Dorps River valley, have caused a decline in the groundwater levels in the surrounding areas.

The water quality, especially groundwater is threatened by the following:

- Poorly managed fertilizer application;
- Mining activities including mine water decant from old and abandoned mines;

- Poor sanitation and pollution from pit latrines in informal settlements which could result in elevated TDS and NO_3 concentrations;
- Informal settlement borehole heads not protected from water spillage and damage by animals; and
- Naturally occurring fluorides coming from the underlying granite.

The major surface water quality issues in the Glen Alpine system is as follows:

- There is an incline in the salinity levels in the Nyl River, in the area of Mokopane, and the Sterk River but are still within TWQR;
- Fluoride levels are elevated in the Moorddrift area;
- Slight acidification is observed at Doorndraai Dam; and
- The peak salinity related variables at Glen Alpine Dam exceed the TWQRs for domestic and irrigation use.

The total coliform and faecal coliform count increases along the course of the Nyl River and into the Nylsvlei wetland. This is due to the effluent outlet of the Modimolle WwTW into the Klein Nyl River and possible leakage of the sewerage pipeline as the capacity thereof is exceeded.

3.5.3 Water requirements

Irrigation has the largest water requirement in the Mogalakwena catchment with a total estimated annual requirement of 100 million m^3. The main concentrations of irrigation occur in the Moorddrift area near Mokopane, Gillimburg area in the central parts of the catchment and in the Glen Alpine Dam area. Water supply is obtained equally from surface water and groundwater sources. The irrigation allocation from Doorndraai Dam was reduced to only 3.74 million m^3/a in 1990. However, the irrigation use, supplied by releases from the dam amounts to 8.08 million m^3/a. Glen Alpine Dam has an irrigation allocation of 7.27 million m^3/a and irrigation up to 70 km downstream of the dam uses 5.9 million m^3/a. The total abstraction downstream of Glen Alpine Dam is estimated at 13 million m^3/a.

Domestic water requirements, the sources from which it is supplied as well as the allocation from these sources, where available, are summarised in Table 3.2.

Table 3.2: Summary of other water uses in the Mogalakwena River catchment

Description	Source	Allocation (million m^3/a)	Average water requirement (million m^3/a)
Mokopane	Gert Combrink Dam*		3.22
Mokopane	Mokopane well-field		9.6
Mokopane	Doorndraai Dam	4.38	1.96 (industrial)
Modimolle	Donkerpoort Dam		0.04
Mookgopong	Nyl Well-field		0.94
Mookgopong	Welgevonden Dam		0.50
Modimolle and Mookgopong	Roodeplaat Dam (CRW catchment)	3.00	1.95 (Modimolle)
Mahwelereng	50 production boreholes		0.80

* Not included in All Town Studies, abstractions stopped in 2008.

Groundwater use in the catchment at the 2003-development level were estimated at 55 million m^3/a. Earlier studies concluded that the ecological Reserve ranges between 37 and 41 million m^3/a, resulting in a reduction in the 1:50 yield of 5.3 million m^3/a.

The mining and industrial water requirement was estimated at 6 million m^3/a at the 2003-development level and 10.3 million m^3/a at the 2010-development level. Mining activities are expanding in the Mokopane-Mogoto area and is identified as the platinum growth point of the Limpopo Province. Earlier studies estimated the additional water requirements due to these developments to be in the order of 20 million m^3/a, which can possibly be supplied by treated effluent or re-allocation of water. The possibility of constructing the Rooipoort Dam has also been considered as an additional supply source. Construction of the infrastructure to transfer water from the Flag Boshielo Dam, in the Olifants WMA, to the new mining areas in Mokopane started in 2012. This forms part of the ORWRDP.

The growing domestic demand in the Modimolle and Mookgopong will require an additional 8.5 million m^3/a by 2040 which will be supplied by either the Roodeplaat Dam or Klipvoor Dam on the Pienaars River (CRW system).

In the lower regions of the catchment opportunities for development exist in the Senwabarwana, Eldorado, Alldays and Tolwe areas. Game farming, especially in Alldays, is expanding which attracts a massive tourist influx. There is also a huge sand mining potential in the area.

3.5.4 Water resource management issues and perspectives

The Mogalakwena River catchment mainly falls within the Blouberg and Mogalakwena LMs and is also covered by sections of the Agang, Mookgopong and Modimolle LMs. In the Blouberg municipal area, the municipality serves as the WSP and Capricorn DM as the WSA.

The main challenges in the catchment are the aging infrastructure, water shortages, WwTWs operating beyond its capacity, water quality issues as well as illegal connections and abstractions. Growing unplanned settlements alters basic services delivery and the planning thereof. Furthermore, these settlements do not have adequate sanitation services and poses a threat to the surrounding surface and groundwater quality. There are serious water quality issues in the vicinity of the Nylsvlei wetland associated the limited capacity of the Modimolle WwTW. There is thus an urgent need for the WwTW to be upgraded.

The Glen Alpine Dam is sensitive to its releases and results in high transmission losses in the order of 70% to 80%. A hydraulic routing study is recommended to be conducted to determine the storage reduction of weirs and dams due to siltation as this should provide better options for release scheduling. Another 30% to 40% of releases made from the Doorndraai Dam are lost through the canal system.

A Water User Committee or a *Stakeholders Operating Forum* (SOF) should be established to manage the Glen Alpine system effectively, monitor the water quality, sedimentation, infestation by reeds and theft of water as well as to ensure fair water distribution and to deal with complaints and issues.

DWS investigated the need for additional stream flow gauges downstream of Glen Alpine Dam as well as monitoring of inflow and rainfall at both the Glen

Alpine and Doorndraai dams in order to improve the monitoring of the system and to incorporate this information into the dam operations. Furthermore, operating rules and restrictions for dry periods are imperative to meet all the water requirements (DWA, 2011).

The dolomite aquifer east of Mokopane extends across the Limpopo WMA into the Olifants WMA. Earlier studies recommended that this aquifer be monitored as a unit to effectively determine the impact of the abstraction. Furthermore the aquifer is over-exploited due to large uncontrolled abstraction by the Zebedelia Estates.

The Mogalakwena River catchment consists of several sites of cultural and historical importance for which permission to develop water related infrastructure in the vicinity of the site must be granted by the National Momuments Council. Sites include Moorddrift, Makapansgat, Makgabeng and Nylsvlei wetland.

From a hydrological modelling perspective, the Nylsvlei wetland is of high importance as it intercepts and absorbs runoff from the Waterberg Mountains resulting in delayed and decreased flows passing the end of Nyl River into the Mogalakwena River. The correct modelling thereof is thus critical.

3.5.5 Possible structural and management interventions

As part of the ORWRDP, the construction of the infrastructure to transfer water from the Flag Boshielo Dam in the Olifants WMA, to supply the new mining areas in Mokopane started in 2012. A number of additional phases are being investigated to meet the growing water requirements, but these will only be implemented if required. As an alternative to ORWRDP-2B, the possibility of supplying the Mokopane mining developments directly from the Crocodile River via an abstraction just downstream of the Moretele River confluence was investigated in the Olifants River Reconciliation Strategy. Both these options can supply 25 million m^3/a. Comparison of URVs for the different options, however, indicated that the ORWRDP-2B is less expensive.

Magalies Water is investigating the possibility to augment supply to Modimolle and Mookgopong from either the Roodeplaat Dam or Klipvoor Dam on the Pienaars River in the Crocodile (West) and Marico WMA. Approximately 8.5 million m^3/a will be necessary to meet the 2040 domestic requirements.

A number of other development strategies have been identified to address the current water and sanitation challenges. Some of these include:

- The upgrading of Welgevonden WTW;
- Increasing the capacity of Donkerpoort Dam and upgrading the WTW to 10 Mℓ/d – however, these are constrained by the raw and final water pipeline capacities;
- Upgrading of water pipelines, sludge ponds and other infrastructure;
- Illegal connections need to be identified and reduced;
- Refurbishment of the Glenfirness (Blouberg) Dam, which previously supplied Blouberg Municipality, in order to augment supply to communities;
- Water catchment facilities, such as rainwater harvesting, should be constructed in the mountainous, higher rainfall regions; and

- Constructing the Rooipoort Dam – however, the additional yield gained does not rectify the construction cost as much of the yield will be allocated to meeting EWRs.

Overall the available groundwater resources are under-utilised and can supply more than the RDP level of 25 litres per head per day. However, measures must be identified to reduce the over-abstraction of the dolomite aquifer in Mokopane. The implementation of WCWDM initiatives may also result in the reduction of current water use – especially in the urban centres.

Operating rules and the establishment of a water user committee are necessary to manage the Glen Alpine system effectively. The monitoring network should be upgraded to facilitate the determination of the current quantity and quality of water resources as well as to improve planning for the future. This includes the construction of additional stream flow gauges downstream of Glen Alpine Dam as well as monitoring of inflow and rainfall at both the Glen Alpine and Doorndraai dams, to establish improved operational measures of these dams and ultimately to reduce losses.

Institutional arrangements should be initiated to achieve on-going co-operation between the various regional authorities and interest groups that deal with water resource development and management. Water quality management objectives should be set for all rivers in the basin.

3.6 SAND RIVER CATCHMENT

3.6.1 Description of river catchment

The Sand River catchment falls within secondary catchment A7 and tertiary catchments A71 and A71. The catchment covers an area of 15 769 km^2 and stretches from Polokwane to the Limpopo River. The rainfall within the catchment ranges between 300 and 400 mm/a. The two main tributaries to the Sand River are the Hout and Brak rivers. A number of smaller rivers included in the catchment flow directly into the Limpopo River. The water requirements are large compared to the rest of the Limpopo WMA North. However, water resources, especially surface water resources, are very limited and the catchment consists of no major dams. The large groundwater reserves have been fully and possibly over-exploited in some areas.

The largest land use in the catchment, recorded in the *Water Resources Situation Assessment Report* (DWAF, 2003a) is dryland crops, followed by nature reserves, irrigation and urban land uses. A small area of afforestation is also found in the Soutpansberg area. The land use in the north of the catchment is predominantly game farms.

The main urban centres in the catchment include Polokwane, Louis Trichardt and Musina as well as smaller urban areas such as Mogwadi (previously Dendron) and Soekmekaar. Major industrial water users include the South African Breweries (SAB) and a platinum smelter in Polokwane. Mining industries include the Venetia Diamond Mine and the Vele Coal Mine (currently in a maintenance phase), both in the northern region of the catchment. Major coal mining developments are expected in the Louis Trichardt and surrounding areas. Polokwane and Louis Trichardt rely heavily on transfers from other WMAs as well as groundwater to some extent. Musina, situated in the northern part of the catchment, receives the majority of its water from alluvial aquifers next to the Limpopo River. Major expected industrial development in the Musina area include the Musina SEZ and LEIP, however, the water requirements and sources are yet to be confirmed. Soekmekaar and Mogwadi obtain water from developed groundwater sources. Rural villages in the former Seshego and Bochum districts of Lebowa, rely solely on groundwater. Extensive irrigation occurs in the middle reaches of the catchment near Mogwadi and Vivo. This irrigation is almost exclusively supplied by groundwater.

A limited number of recent studies have been conducted in the Sand River catchment area and focus mostly on the water supply situation in the areas where extensive mining development is expected.

3.6.2 Current water availability and supply situation

Water resources in the catchment are extremely limited. The MAR in the catchment is approximately 58 million m^3/a. There are no major dams in the catchment and surface water resources are limited to the small Seshego and Houtrivier dams and run-of-river abstractions. The yield available from surface water is only 11 million m^3/a. Groundwater resources, however, have a yield of 95 million m^3/a but is over-exploited in most areas as the total use amounts to over 165 million m^3/a at the 2000-development level and could have increased significantly since.

Water supply to urban centres is augmented by transfers from other WMAs as summarised in Table 3.3. These transfers all form part of the Olifants-Sand and Letaba Regional WSSs.

Table 3.3: Summary of transfers to the Sand River catchment (million m^3/a)

Transfer from	Water source	Transfer to	Main user	Allocated transfer amount
Luvuvhu and Letaba	Albasini Dam(1)	Louis Trichardt	Urban	2.4
	Nandoni Dam	Louis Trichardt	Urban	5(2)
	Ebenezer Dam	Polokwane	Urban	12
	Dap Naude Dam	Polokwane	Urban	6.5
Olifants	Olifantspoort Weir	Polokwane	Urban	5.4

1) The transfer from Albasini Dam was replaced by the transfer from the Nandoni Dam.
2) Maximum transfer, current allocation is 3.82 million m^3/a from Louis Trichardt.

There are a number of WSSs that supply Polokwane, Seshego, Lebowakgomo, Mankweng, numerous villages and major industries, the main scheme being the *Olifants-Sand RWSS* which consists of the following components:

- *Dap Naude Dam* – Water is drawn from the Dap Naude Dam and conveyed to Polokwane where it is treated at a rate of 18 Mℓ/d.
- *Ebenezer Dam* – Water is drawn from Ebenezer Dam and purified at a 42 Mℓ/d WTW just downstream of the dam. From there water is pumped to Mankweng and further to Polokwane, Seshego, Haenertsburg, Dalmada plots and Makweng.
- *Olifantspoort Weir* – Water is drawn from the Olifantspoort Weir in the Olifants River where it is treated at a 38 Mℓ/d WTW before it is pumped to

Polokwane (5.4 million m^3/s allocated) via Lebowakgomo. Water is supplied to Polokwane, Seshego, Perskebult adjacent to Seshego and numerous villages in the Groothoek-Lebowakgomo area. Possible future plans to increase the water availability in the Olifants River is to raise Arabie Dam, to construct Rooipoort Dam and hence to upgrade the associated treatment and conveyance systems.

Other water resources include:

- *Blood River Dam* – Water gravitates from the Blood River Dam (Seshego Dam) to a 3.95 Mℓ/d WTW near the dam. Supply to domestic users in Seshego is supplemented by water abstracted from five boreholes.
- *Polokwane well-fields* – Consists of several concentrations of boreholes supplying approximately 5.7 million m^3/a:
    - Sand River North boreholes – 22 production boreholes with a yield of 12.3 Mℓ/d. The aquifer is recharged by treated effluent form Polokwane.
    - The Penina Park and Marshall Street boreholes are located along the Sterkloop River adjacent to Polokwane. The scheme consists of six production boreholes and has a sustainable yield of 2.0 Mℓ/d.
    - The Westenburg borehole scheme is located west of Polokwane and the Sand River Borehole Scheme is located between Polokwane and the Sand River, but both are no longer in production.

Polokwane also recycles effluent water through an innovative artificial recharge scheme. The recycled effluent is used as urban irrigation water, however, in the future it may be necessary to use this resource for both industrial and domestic use. Three WwTW are located in Polokwane, Seshego and Mankweng, of which the one in Polokwane is the largest (28 Mℓ/d capacity and 24.6 Mℓ/d utilization).

The *Louis Trichardt Regional WSS* transfers 2.2 million m^3/a from the Luvuvhu and Letaba WMA to augment supply to Louis Trichardt. Water is drawn from the Albasini Dam (allocation of 2.4 million m^3/a) on the Luvhuvhu River and treated at the 5.7 Mℓ/d WTW at the dam before being pumped to Louis Trichardt/Tshikota. Water is also abstracted from the Dorps River well-field located adjacent to Louis Trichardt which comprises of 12 production boreholes and has a sustainable yield of 0.24 million m^3/a. Currently 3.2 million m^3/a is transferred from the Nandoni Dam in the Luvuvhu and Letaba WMA which has a total allocation of 5 million m^3/a to accommodate future additional.

Groundwater is the only dependable water source for many rural settlements and villages. Sinthumule/Kutama comprises of 39 villages which is supplied by 19 production boreholes scattered throughout the area. Water is also drawn from two perennial streams with a yield of about 0.17 million m^3/a. The water is pumped to central reservoirs from where it is reticulated to the users.

In the vicinity of the Limpopo River and the upper catchment area large quantities of groundwater is abstracted for irrigation. Furthermore, dispersed irrigation occurs throughout the Sand River catchment with the main concentrations occurring along the Sand River near Polokwane and south and north of the Soutpansberg in the vicinity of Mogwadi and Vivo in the western parts of the catchment. Some 8 600 hectares have been developed for irrigation and is supplied mainly by groundwater resources.

Groundwater is recharged through infiltration from sandy riverbeds, pumping near rivers such as along the Limpopo and Sand rivers and from infiltration of treated effluent into aquifers in the vicinity of Polokwane.

3.6.3 Water requirements

The Sand River catchment has the largest water requirement of all the catchments in the study area. The total estimated water requirement is 222 million m^3/a at the 2003-development level, determined in earlier studies. Similar to the other catchments, irrigation is the major water user, with a water requirement estimated at 185 million m^3/a. Due to the limited surface water resources, the majority of the water requirements are supplied by groundwater and transfers from other WMAs.

The main urban areas within the catchment are Polokwane, Louis Trichardt and Musina. A large number of rural villages are scattered in the middle reaches of the catchment and relies almost solely on groundwater resources. The total rural and urban (excluding mining and industry) water requirement was estimated at 33 million m^3/a at the 2003-development level and has increased substantially over the last decade. Polokwane LM is supplied through 14 RWSs from a number of water sources as summarised in Table 3.4. Note that the study area however, does not cover the entire Polokwane LM.

Table 3.4: Domestic supply requirements in the vicinity of Polokwane

<table>
<tr><th>Water source</th><th>RWS supplied</th><th>Area supplied</th><th>Average Supply (million m³/a)</th><th>Source Capacity (million m³/a)</th></tr>
<tr><td rowspan="3">Ebenezer</td><td>Mankweng RWS*</td><td></td><td>3.65</td><td rowspan="3">15.70</td></tr>
<tr><td>Olifants Sand RWS</td><td>Polokwane City, Seshego</td><td>8.40</td></tr>
<tr><td>Mothapo RWS, Molepo RWS*, Segwasi RWS*, Boyne RWS*, Badimong RWS, Sebayeng Dikgale RWS</td><td>Rural</td><td>3.29</td></tr>
<tr><td>Olifantspoort Weir</td><td>Chuene/Maja RWS, Olifants Sand RWS</td><td>Seshego, portions of Polokwane City</td><td>5.56</td><td>9.86</td></tr>
<tr><td>Dap Naude Dam</td><td>Olifants Sand RWS</td><td>Polokwane City</td><td>4.93</td><td>5.84</td></tr>
<tr><td></td><td>Seshego Dam Olifants Sand RWS</td><td>Seshego</td><td>0.55</td><td>0.55</td></tr>
<tr><td>Boreholes</td><td>Augment water from dams</td><td>Rural</td><td>5.84</td><td>9.25</td></tr>
<tr><td>Houtriver Dam</td><td>Houtriver RWS</td><td>Rural</td><td>0.58</td><td>0.58</td></tr>
<tr><td>Total</td><td></td><td></td><td>24.40</td><td>41.78</td></tr>
</table>

* Does not fall within the study area

The total water requirement for the portion of Polokwane LM that falls within the Study Area was estimated to be 34.3 million m^3/a at the 2010-development level (DWA, 2011). The total water requirement for Musina town is 10.4 million m^3/a and is sourced mainly from 16 boreholes in the sand aquifer of the Limpopo River. The residential water requirement for Musina LM is estimated at 6.57 million m^3/a, including 30% water losses.

Venetia Diamond Mine requires 4.2 million m^3/a which is sources from the sand aquifers along the Limpopo River. Vele Coal Mine has a water allocation of 2.45 million m^3/a – also sourced from the Limpopo River sand aquifers.

Future development in the Musina area includes the expansion of the Venetia Diamond Mine, the SEZ and the LEIP. No increase in the water requirement of Venetia mine is anticipated as water use efficiencies have increased. The SEZ comprises of commercial and light industrial activities forming a logistics hub in proximity to Beitbridge. The LEIP will comprise of heavier industries and a dedicated rail spur further to the south. Combined, the estimated total water requirement of these developments is 10 million m^3/a. The water requirements for the SEZ still need to be verified by means of a feasibility study.

The water requirement for Louis Trichardt and surrounding areas is estimated at 3.5 million m^3/a of which 2.2 million m^3/a is supplied from Albasini Dam, 0.24 million m^3/a by boreholes and the remainder from Nandoni Dam. Note that Makhado Town does not fall within the Sand River catchment.

CoAL has identified a number potential new coal mining sites in the area between Musina and Louis Trichardt. This includes the Greater Soutpansberg Projects and the Makhado Project. The latter, however, falls within the Nzhelele River catchment. The Greater Soutpansberg projects, will require between 0.9 to 1.8 million m^3/a by 2030, however, the water source is still to be determined. Bulk water sources to be investigated, include the Musina and Makhado WTW, Nzhelele valley transfer scheme, Zimbabwe transfer scheme and aquifer storage and recovery.

The Matoks and Molemole West supply areas falls within the Molemole LM. These supply areas have a combined water requirement of 4.5 million m^3/a, supplied by local groundwater aquifers. The current resources as fully utilised and will not be able to meet future water requirements.

The Reserve requirements estimated in previous studies ranges between 10 to 18 million m^3/a. The ecological class of the rivers in the Sand River Catchment ranges between Class D in the upper regions to Class B in the lower regions. There are a number of important wetland areas which inhabit rare or endangered frog species and plant and red data bird species.

3.6.4 Water resource management issues and perspectives

The Sand River catchment falls under sections of the Polokwane, Molemole Makhado and Musina LMs, as well as small portions of the Blouberg and Agang LM. Approximately 50% of the catchment falls under the Capricorn DM and the other 50% under the Vhembe DM. Lepelle Northern Water Board is the bulk service provider for the Pietersburg Governmental RWS (Ebenezer pipeline) and the Olifants-Sand Bulk Water Transfer Scheme. DWS is the WSP to all rural areas not served by Lepelle Northern Water Board. Polokwane LM operates the Dap Naude Dam Water Supply Scheme.

Some of the main challenges municipalities are faced with include:

- A large number of illegal yard connections;
- Aging infrastructure;
- Lack of recovery cost resulting in limited operation and maintenance of water supply infrastructure;
- The unreliability of water sources and major lack of sustainable water resources for future supply;
- Reticulation leaks causes major water losses; and
- Inadequate metering and monitoring.

The catchment has significant development objectives, however, there are a number of constraints that could prevent the Musina and Makhado LM from achieving these. These are:

- The capacity of the district and local municipality to plan, implement and manage infrastructure is limited;
- Operation, maintenance and renewal of existing infrastructure has been lacking, resulting in assets deteriorating far more rapidly than expected; and
- Groundwater resources are over-exploited, especially in the Mogwadi and Weipe areas.

In some areas boreholes are drying up to such an extent that water has to be supplied through tankers, especially in the Molemole LM. It is important that the groundwater availability is reconciled with verified use. It is also necessary to develop and implement a management plan to limit groundwater use within the exploitable potential. Compulsory licencing may need to be implemented to sustain groundwater.

The water quality in the Polokwane LM is considered good with an average DWAE rating of 86%. Residents in Musina have noted that water tastes sour. Groundwater quality is severely affected in the Mogwadi and Vivo area by the over-exploitation and uncontrolled use of fertilizers resulting in high nitrate concentrates. Poor sanitation infrastructure throughout the catchment also poses a threat to the groundwater quality.

3.6.5 Possible structural and management interventions

WCWDM was identified as the main intervention activity in the Sand River catchment due to the already stressed groundwater resources and limited surface water. Illegal connections, reticulation leakages and damage to water supply infrastructure need to be addressed.

The City of Polokwane has water conservation awareness campaigns and educational programmes as part of their *Water Services Development Plan* (WSDP). A five year strategy to repair leaks, authorize and meter illegal connections and implement a cost recovery system to reduce wastage was initiated. In the City of Polokwane IDP it was highlighted that the Ebenezer pipeline route be upgraded to meet the future requirements.

The *Water Resource Situation Assessment* (DWAF, 2003a) identified several well-fields in the vicinity of Louis Trichardt with development potential. These include the Albasini, Welgevonden and Nooitgedacht well-fields. Other alternative water resource developments include the proposed Mapungubwe Dam, Vryheid Dam and the proposed Sand River well-field in Louis Trichardt.

Reducing afforestation in the vicinity of Makhado can increase the recharge and utilization of groundwater. Furthermore, no additional afforestation should be allowed unless the impacts can be mitigated (DWAF, 2003b).

Extensive development is anticipated in the Musina and Louis Trichardt areas. Developments include the Musina SEZ, LEIP and Greater Soutpansberg coal projects. Water sources for these developments have not yet been finalised but options include the Musina and Makhado WTW, Nzhelele valley transfer scheme, Zimbabwe transfer scheme and aquifer storage and recovery.

DWS has indicated that a supply line from Glen Alpine Dam has been identified to augment domestic water supply to the Molemole West supply area. A volume of 2.02 million m^3/a is potentially available from the dam to supply the area. The supply to the Matoks area can be augmented by Nandoni Dam via a pipeline (5 million m^3/a allocated).

3.7 NZHELELE RIVER CATCHMENT

3.7.1 Description of river catchment

The Nzhelele River catchment (tertiary catchment A80) is a rural catchment draining northwards into the Limpopo River. The Mutamba River is a main tributary of the Nzhelele River, which originates in the higher rainfall Soutpansberg area. For the purposes of this Study, the small Nwanedi River catchment (quaternary catchments A80H and A80J) is included in the Nzhelele River catchment. The catchment has a total area of 4 201 km^2. The rainfall distribution is variable across the catchment, characterised by the high rainfall region (900 mm/a) on the slopes of the Soutpansberg Mountains and the dry Nzhelele Valley with an annual rainfall of less than 300 mm.

The largest land use in the catchment, recorded in the *Water Resources Situation Assessment Report* (DWAF, 2003a), is dry land agriculture followed by nature reserves and irrigation. A small area of afforestation, equal to 31 km^2, is also prevalent in the Soutpansberg area.

A number of settlements are located in the high rainfall regions, including Makhado Town, Dzanani and Siloam. Initial surface water supply infrastructure was constructed to support irrigation which has expanded significantly since the construction of the Nzhelele and Nwanedi Irrigation Schemes - supplied by the Nzhelele, Nwadedi and Luphephe dams. Irrigation is the major water user in the catchment and is concentrated downstream of the Nzhelele Dam. Approximately 4800 ha are allocated to irrigation, although not all is being used due to limited water resources.

Numerous flow dependant species including red data species inhabits the upper reaches of the Nzhelele River. The endangered snake catfish occurs in the Nwanedi River. The 2000 floods have washed away several small weirs and dams in the lower reaches of the Nzhelele River allowing migration of fish into the Limpopo River (DWAF, 2003a).

The Nzhelele River catchment has high coal mining potential and a number of coal mining projects along the Mutamba River have been identified by CoAL. However, water resources are limited and will govern the development of these projects.

Water resources related information is outdated and recent available studies mainly focus on sourcing potential water resources for mining development.

3.7.2 Current water availability and supply situation

The river catchment is developed in terms of water resources. The natural MAR of the catchment, determined by previous studies, ranges between 100 to 120 million m^3/a and the current-day MAR between 70 to 89 million m^3/a. The majority of the runoff is generated in the high rainfall Soutpansberg region.

Surface water resources consist mainly of run-of-river abstractions and four dams; the Nzhelele, Mutshedzi, Nwanedi and Luphephe, with a combined FSC of 77 million m^3. Cross Dam serves as a balancing dam downstream of the Nwanedi and Luphephe dams. The FSC and the yield of the dams are summarised in Table 3.5. These dams, excluding the Mutshedzi Dam, mainly supply the dominating irrigation sector of which a considerable amount is operated by emerging farmers.

Table 3.5: Historic and firm yields of dams in the Nzhelele River catchment

Dam	FSC	HFY	Yield (million m^3/a) at indicated RI		
	million m^3	million m^3/a	1:20	1:50	1:100
Luphephe	13.98	5.90	9.45	8.14	7.20
Nwanedi	5.56	2.44	3.88	3.39	2.94
Nwanedi sub-system	19.54	8.34	13.33	11.53	10.14
Nzhelele	51.23	16.25	25.40	20.60	18.60
Mutshedzi	2.16	2.60	4.20	3.66	3.45
Cross	2.16				

Ample and underutilised groundwater resources are available in the catchment, especially in the Nwanedi River catchment. However, water use from this resource is limited. Some 18 villages located near the Nzhelele Dam obtain water from dispersed boreholes. The total yield available, from both surface water and groundwater, at the 1:50 year assurance is 46 million m^3/a (DWAF, 2004b).

The *Nzhelele RWS* supplies water to approximately 55 villages, the Siloam Hospital and irrigation. The scheme supplies the majority of domestic water requirements in the Nzhelele River catchment. The scheme comprises of the following components:

- *Nzhelele Dam* – Water is drawn from the dam and supplied to approximately 2 100 ha of mainly citrus and cash crop irrigation (29 million m^3/a allocation) via a canal system as part of the Nzhelele government irrigation scheme. Tshipise Holiday Resort also obtains its water from the Nzhelele Dam. The resort covers 55 ha and has an allocation of 0.5 million m^3/a**.**
- *The Nzhelele weir* - Located in the upper reaches of the Nzhelele River with a capacity of 2 million m^3/a). The abstracted water is conveyed under gravity in a pipe network to some 21 villages.
- *Mutshedzi Dam* – Water is drawn from the dam and treated at a 3.6 Mℓ/d WTW and delivered to 28 villages, including Makhado Town and the Makhado tomato-processing factory (allocation of 4.35 million m^3/a). Run-of-

river abstractions occur downstream of the dam for irrigation, utilising the dam releases (allocation of 1.41 million m^3/a).

- *Tshifire scheme* - The scheme comprises of two weirs, one on the Tshifire River and another on a tributary. The Tshifire River is a tributary of the Mutshedzi River, which in turn is a tributary of the Nzhelele River. Water is conveyed under gravity from the weirs to six villages, after rudimentary treatment at a 1.73 Mℓ/d WTW.

The *Nwanedi irrigation scheme* comprises of the Luphephe and Nwanedi dams, from which bulk water for irrigation is obtained, and Cross Dam which serves as a balancing dam. Water is released from the dams into a canal system which distributes the water to the irrigators. A new WTW was recently constructed close to the Nwanedi Dam to supply water for domestic use but is not yet operational. There is also an existing pipeline which supplies the Nwanedi Nature Reserve camp.

The Makhado-Dzanani ponds and the Siloam ponds are the only WwTW in the catchment with a combined capacity of 1.2 Mℓ/d.

A number of red data and endangered species inhabit the upper reaches of the Nzhelele River and the Nwanedi River. Hence, it is important that water resources development do not negatively affect the aquatic environment. No recent Reserve study has been conducted in the catchment, however it is of high importance. Afforestation reduces the yield of the catchment by approximately 1 million m^3/a and the runoff by approximately 2 million m^3/a.

The catchment is considered to be in deficit, even without the implementation of the Reserve, due to the over-allocated and over developed irrigation sector. It is therefore recommended that no new irrigation licenses should be issued and compulsory licensing may be implemented. In the small Nwanedi River catchment surface water resources are severely limited by the small size of the catchment and the lack of water resource development.

A number of coal mining activities are anticipated in the area but are limited by water availability. Water should either be sourced locally from groundwater reserves or from the existing agricultural water allocations. A number of options outside of the catchment boundaries are being investigated.

3.7.3 Water requirements

The irrigation sector has the largest water requirement, estimated at 51 million m^3/a at the 2003-development level. The majority of irrigation is concentrated downstream of the Nzhelele Dam from which it is supplied (allocation of 29 million m^3/a). The irrigation allocation from Mutshedzi Dam is 1.41 million m^3/a and the combined allocation from the Nwanedi and Luphephe dams is 5.31 million m^3/a. However, due to water resource limitations, only 80% of the irrigation water requirement can be supplied. The 2003 registered WARMS figures estimated a water allocation to 4 800 ha of irrigation, however, only 3 160 ha was being irrigated at the time of registration. This probably occurred as a result of irrigators registering their entitled or allocated use as opposed to their actual use.

Other major water users in this area include the small industrial area known as the Makhado Town (includes a vegetable processing factory, bakery and furniture factory) and the Siloam Hospital. These users, including the majority of the domestic users within the Nzhelele River catchment, are supplied via the Nzhelele RWS from the Mutshedzi Dam and a number of boreholes. The 2007 domestic and small industry water requirement from this scheme was estimated at 3.73 million m^3/a. The Nzhelele Dam also supplies 0.5 million m^3/a to the Tshipise Holiday Resort. The estimated domestic water requirement from the *Luphephe/Nwadeni North RWS*, sourced from boreholes, is 0.32 million m^3/a at the 2010 development level. The total rural, urban and industrial water requirement at the 2007-development level was approximately 5 million m^3/a (DWA, 2011).

The EC of the Upper and Lower Nzhelele River as well as the Nwadeni River is Class D (largely modified) due to the presence of the Nzhelele Dam and the Nwanedi and Luphephe dams. The estimated EWR is 14.3 million m^3/a with an impact of 1.9 million m^3/a on the 1:50 year yield (DWAF, 2003a). This is in line with the 12 million m^3/a EWR indicated in other reports (DWAF, 2003b).

Major coal mining developments are anticipated in the Nzhelele River catchment. Two coal mining projects initiated by CoAL, the Makhado Project and the Generaal Project, are located in the southern region of the catchment along the Mutamba River. The feasibility study for the Makhado Project is near completion. The water requirements for the Makhado Coal Mine are approximately 2.48 million m^3/a by 2020 and 3.32 million m^3/a by 2030. Water will be sourced from water trading with the irrigation sector. The Generaal Project is still in an exploration phase and water requirement are estimated at 4 million m^3/a by 2030. Water sources have not yet been identified but potential sources include water reuse from the Musina and Makhado WwTW, transfers from the Nzhelele Valley, transfers from Zimbabwe and aquifer storage and recovery.

The Nzhelele Valley Irrigation Farmers Association indicated that the irrigation water allocation from the Nzhelele Dam, for the 3000 ha of citrus irrigation, was reduced by 75% with a deficit of 4.8 million m^3/a, to accommodate new users. The association also indicated that citrus irrigation will expand significantly if water resources are made available – increasing the annual revenue generated in the catchment and creating jobs opportunities.

3.7.4 Water resource management issues and perspectives

The Nzhelele River catchment is covered mainly by the Musina and Makhado LMs as well as a small section by the Mutale LM. The individual LMs are the WSP and Vhembe DM the WSA.

Water losses, due to illegal connections, aged infrastructure and reticulations leaks are a major concern. A significant amount of water, estimated up to 60%, is lost along the Nzhelele Canal. The total amount of water lost in the Nzhelele River catchment is estimated at 21.3 million m^3/a (DWAF, 2004b). Furthermore, water systems are not metered and monitored on a continuous basis. There are currently no WCWDM initiatives by the associated LMs, however, implementation thereof, especially in the irrigation sector, is critical.

Water abstraction for irrigation in the upper reaches occurs 24 hours per day in contradiction to the allowed 12 daytime hours (N'Jelele Act of 1948) which results in adverse effects on the yield of Mutshedzi Dam and Nzhelele Dam.

Water resources are limited in some areas, especially in the dry Nzhelele Valley. Rural areas in the north-eastern region do not meet RDP standards and have no water supply for periods up to four days due to boreholes drying up. The catchment is considered to be in a deficit, even without the full implementation of the Reserve.

Surface water and groundwater quality in the Nzhelele River catchment is considered to be of good standard. However, improper application and management of fertilisers and unprotected boreholes in rural areas pose a threat to the groundwater quality. There are numerous areas of extensive agricultural activity such as along Nzhelele River, up and downstream of the dam. The standard of the surface water quality should also be monitored closely as there is potential for pollution from canning factories and AMD in the catchment.

3.7.5 Possible structural and management interventions

Increasing irrigation water use efficiencies and reducing water losses should be the main intervention option in the Nzhelele River catchment. A significant amount of water is lost through the conveyance system from the Nzhelele Dam and should be attended to.

Once WCWDM have been implemented the next step in the aim of achieving a positive water balance would be to reallocate irrigation allocations. It may be necessary to implement a compulsory licencing strategy in order to control the over-development irrigation sector and to implement the ecological Reserve. In the interim additional domestic requirements should be sourced from groundwater as there is still unexploited potential. Furthermore, no new allocations should be allowed for irrigation.

The hydrological monitoring system for the Nzhelele Valley must be enhanced in order to improve water resources planning. Flow gauging stations should be constructed on the Mutamba River, before the confluence with the Nzhelele River as well as on the Nzhelele River before the confluence with the Limpopo River. It was also proposed that the evaporation stations at Macaoville (A7E006) and Luphephe Dam (A8E002) be reopened and a new station in or near Vondo Forest in the upper reaches of the Nzhelele Valley be establish (DWAF, 2003a).

Reducing afforestation in the vicinity of Makhado Town can increase the recharge and utilization of groundwater. Furthermore, no additional afforestation should be allowed in the catchment unless the impacts can be mitigated.

Development of surface water resource infrastructure must only be considered should the implementation of WCWDM not suffice to improve the current water imbalance. Surface water development options in the Nzhelele River catchment include:

- Raising the Nzhelele Dam – to alleviate the deficit in irrigation supply, up and downstream of the dam;
- Raising the Mutshedzi Dam – to increase the yield available for domestic use resulting in increased supply standards throughout the catchment;
- Constructing either the Wyllie's Poort Dam or the Tshipise Dam;
- Establish the feasibility of importing water from the Mutale River or the Vondo Dam to the Nzhelele River valley, considering the long-term requirement in the donor catchments; and
- Transfer water from the Zhove Dam in Zimbabwe to supply the coal mining developments and to augment irrigation supply. Approximately 30 million m^3/a can be purchased from the ZINWA.

Plans have been drafted to supply 43 villages with treated water from the Luphephe and Nwanedi dams. The associated WTW have been constructed, but the supply area and allocation not yet confirmed.

A possible intervention option identified by CoAL is to utilise transferred treated effluent water from Louis Trichardt and Musina. These transfers of treated effluent from Louis Trichardt are not supported by DWS as this water could be utilised by the town itself. Removing effluent from Louis Trichardt may result in additional transfers required from the already fully allocated Nandoni Dam in the Luvuvhu River catchment. The company has also expressed an interest in the possibility of replacing the Nzhelele Canal with a pipeline in order to increase assurance of supply to the local farmers and to provide additional water to the Makhado Coal Mine (CoAL, 2014).

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