Report no. RDM/WMA02/00/CON/0716

DEPARTMENT: WATER AND SANITATION
CHIEF DIRECTORATE: WATER ECOSYSTEMS
DIRECTORATE: RESERVE DETERMINATION

DETERMINATION, REVIEW AND IMPLEMENTATION OF THE RESERVE IN THE OLIFANTS/LETABA SYSTEM

REPORT TITLE: RESOURCE MANAGEMENT AND IMPLEMENTATION PLAN

FINAL

May 2017

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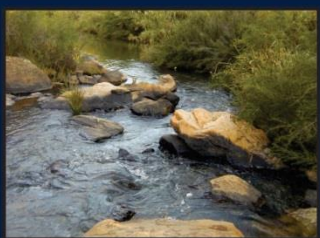
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA






DEPARTMENT: WATER AND SANITATION

Directorate: Reserve Determination

DETERMINATION, REVIEW AND IMPLEMENTATION OF THE RESERVE IN THE OLIFANTS/LETABA SYSTEM

WP10940

RESOURCE MANAGEMENT AND IMPLEMENTATION PLAN

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DOCUMENT INDEX

Reports as part of this project:

Bold type indicates this report.

REPORT INDEX	REPORT NUMBER	REPORT TITLE
1.0	RDM/WMA02/00/CON/0115	Inception Report
2.0	RDM/WMA02/00/CON/0215	Information and Data Gap Analysis Report
3.0	RDM/WMA02/00/CON/0315	Field Survey Report
4.0	RDM/WMA02/00/CON/0116	Eco-Classification Report
5.0	RDM/WMA02/00/CON/0216	Quantification of Ecological Water Requirements Report
6.0	RDM/WMA02/00/CON/0316	Groundwater Component Report
7.0	RDM/WMA02/00/CON/0416	Wetlands Component Report
8.0	RDM/WMA02/00/CON/0516	Ecological Specifications Report
9.0	RDM/WMA02/00/CON/0616	Scenario Evaluation and Consequences Report
10.0	**RDM/WMA02/00/CON/0716**	**Resource Management and Implementation Plan**

LIST OF ABBREVIATIONS

BAS	Best Attainable State
BHN	Basic Human Needs
DO	Dissolved Oxygen
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
DWAF	Department of Water Affairs and Forestry
EIS	Ecological importance and sensitivity
EC	Electrical Conductivity
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
FIFHA	Flow, Invertebrate, Fish, Habitat Assessment
FRAI	Fish Response Assessment Index
IHAS	Integrated Habitat Assessment System
MIRAI	Macro-invertebrate Response Assessment Index
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NWA	National Water Act
PES	Presentation Ecological State
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
SASS5	South African Scoring System Version 5
TDS	Total Dissolved Solids
TEC	Target Ecological Category
WUL	Water Use License
WMA	Water Management Area
WWTW	Wastewater Treatment Works

EXECUTIVE SUMMARY

The Chief Directorate: Water Ecosystems in 2015 commissioned the study 'Determination, Review and Implementation of the Reserve in the Olifants/Letaba System'. The water resources in the Olifants Water Management Area (WMA 2) have been classified and Resource Quality Objectives determined. These were gazetted in April 2016 (No. 39943 - Olifants) and December 2016 (No. 40531 – Letaba). The preliminary Reserve (Section 17 of the NWA) has been determined for the Olifants System for the first time in 2001, with updates conducted in 2010, whereas the Preliminary Reserve has been completed in 2006 for the Letaba System. As per Chapter 3, Section 16 of the NWA, as soon as the class of all or part of a water resource has been determined, the Minister must, by notice in the Gazette, determine the Reserve for all or part of that water resource. This Reserve will be gazetted and will supersede all previous Reserves as determined under Section 17.

With the water resource classes for the Olifants/Letaba system, as well as the Resource Quality Objectives (RQOs) now in place, the Reserve can be determined and gazetted. Therefore, the primary objective of this study was thus to determine, review and implement the Reserve in the Olifants/Letaba System.

The Ecological Water Requirements (EWR) were determined for the rivers in the Olifants/Letaba system. The groundwater component of the Reserve has also been determined and wetland systems have been prioritised. Based on these results and the review of the eco-classification, the objectives for the protection of the ecosystem have now been defined through Ecological Specifications (eco-specs) and monitoring requirements for the maintenance at each Ecological Water Requirement (EWR) site, for groundwater and the identified priority wetlands.

With the Reserve in place the next step in the protection framework is to achieve its implementation. Implementation of the Reserve must function within the existing environment of Integrated Water Resource Management and preferably in existing monitoring programmes and other initiatives that are already in place. This report focuses on describing the context of the resource management, the principles of an implementation plan for the Reserve, the actions required for the implementation of the eco-specs and the interventions supporting the achievement of the Reserve.

Implementation actions related to the following are specified for the attainment of the Reserve in the Olifants/Letaba System:

- Meeting of the ecological specifications;
- Flow management and operation of the system;
- Water quality management interventions;
- Management of the dam releases (operational plans);
- Achieving fish, invertebrate and habitat integrity;
- Groundwater management; and
- Management of the wetlands.

The following lists the key actions that must be achieved for implementation of the Reserve.

Action	Activity	Completion date	Duration	Responsibility
1	***Ecological specifications*** *must be met.* Monitoring and reporting within 3 months of the final Reserve being gazetted.	November 2017	Ongoing. Biannual reporting	CD: WE to lead with the support and direction to the CD: Water Monitoring and Information and the Proto-CMA. (Directorate: Compliance Monitoring & Enforcement)
2	***Flow management and Operation*** *of the system*	November 2017	6 months	CD: IWRP (Directorate: National Water Resource Planning and Water Resource Planning) to lead with the direction and support of the CD:WE
	The operation plan and flow monitoring programme must be developed			
	A real time operational model should be developed	July 2018	12 months	
3	***Water Quality interventions*:** An integrated and revised water quality monitoring network and database management system should be developed	July 2018	12 months	CD: IWRP (Sub Directorate: Water Quality Planning to lead), CD: Water Monitoring and Information and the Proto-CMA.to support implementation. CD: WE to provide input into actions and implementation plan, and assessment of reporting. (Linkages with external programmes to be established)
	Integration with the Olifants Water quality management strategy	December 2017	6 months	CD: IWRP Sub Directorate: Water Quality Planning to lead – strategy development underway. CD: WE to direct actions to be incorporated. Proto-CMA: Regulation and monitoring to address the non-flow impacts
4	***Management of releases from Dams*** :	December 2017	6 months	CD: IWRP (Sub Directorate: Systems Operation) to lead with the direction and support of the CD:WE
	Update of the dam operating rules dams must be operated as integrated and linked systems.			
	A real time operational model should be in place	July 2018	12 months	
5	*Fish, Habitat and Macro-invertebrate integrity:*	December 2017	6 months	CD: WE to lead with the support and direction to the CD: Operational Support, Coordination and Consolidation (Directorate: Integrated Water Resource Management Support) and the Proto-CMA. (Linkages with external programmes to be established)
	A biomonitoring programme must be in place			
	Eradication of alien invasive species must be incorporated into existing programmes.	July 2018	12 months	CD: WE to lead with the support and direction to the Proto-CMA and working for water.

6	*Groundwater component:* A groundwater management plan for implementation of the groundwater contribution to the Reserve must be developed. This must also include a monitoring and reporting programme	December 2018	18 months	CD: IWRP (Sub Directorate: Integrated Hydrology) to lead with the support and direction from relevant Directorates within the department, as well as external organisations
7	*Wetland component:* A management plan for protection of the wetlands in the WMA must be must be developed	December 2018	18 months	CD: WE to lead with the support and direction from relevant Directorates within the department, as well external organisations. (Linkages with external programmes to be established) (Directorate: Water Abstraction and Instream Use)

It must be noted that the implementation actions outlined cannot be undertaken in isolation but would need to be integrated into other management, strategy and regulatory processes within the water management area to ensure that implementation is achieved. An attempt is therefore made to provide this context within the integrated water resource management framework governing the Olifants/Letaba system, supported by the proposed actions that would need to be implemented for achieving the Reserve. These implementation actions would need to be integrated into the catchment management strategy. The CMS would then provide a clear overarching approach and intent for managing water resources in the WMA (incorporating the Reserve as a component of the protection framework), with a co-ordinated action plan.

In summary, implementation of the Reserve requires integration and alignment of strategies and activities within the existing environment of integrated water resource management in the Olifants WMA; which includes the following:

No	Parallel Water Resource Management Strategies, Processes and Activities	Reserve Integration/Alignment/Co-ordination required for implementation to be achieved
1	National Water Resource Strategy	To be included in next revision once gazetted – as part of water resource management framework.
2	Water Resource Class and Objectives (Water resource protection)	Integration into protection framework for Olifants WMA and be implemented in a co-ordinated and integrated manner. Needs an overarching plan. This may also require an establishment of a working committee related to implementation.
3	Catchment Management Strategy	Must be incorporated into the CMS in terms of implementation actions required for the Reserve that has to be met. Has linkages to a number of activities.
4	Maintenance of the Reconciliation Strategy.	Revise based on the Gazetted Reserve and account for implementation of the EWRs.
5	Operating Analysis and system	Integrate into operational planning and control of

	operation	infrastructure and maintenance and management of operating rules. Operating tool must be developed to support Reserve implementation. Assessment of the flow in the system and to inform release plan.
6	Institutional arrangements	Linked to a number of activities and programmes. Roles and responsibilities within and among National government, Regional and local structures must be specified so that actions can be carried out and there is accountability in terms of reporting.
7	Integrated Water Quality Management	Linkages to the WMA strategy and plans being developed so that actions supporting achievement of the Reserve may be integrated into process.
8	Regulation, Use, Control	Facilitation integration of Reserve implementation requirements in regulation, use and control activities and plans for the WMA. Reserve implementation may inform actions and regulation that may be required. Integration of actions into CMS.
9	Monitoring	Revision of monitoring networks and programmes for surface water and groundwater is required. New sites and weirs, activation of inactive sites and monitoring boreholes must be evaluated to extend the monitoring networks. Additional resources are needed. Integration of national and regional programmes. Integration of programme and actions into CMS. New monitoring networks to include wetlands are required. Integration with the SANBI programmes for wetlands should be undertaken. Geohydrological monitoring must be undertaken.
10	Ecological Water Resource Monitoring	Co-ordination and integration of the ecological monitoring of the Olifants/ Letaba Reserve (habitat and biota) into existing programs is required to optimize and ensure efficient utilization of resources and effort. All biomonitoring data is incorporated into the NAEHMP on a continuous basis to provide a solid and complete repository of information. This should be inclusive of wetland systems.
11	Transboundary Obligations	Although no specific obligation currently exists with Mozambique in terms of instream flow requirements meeting the Reserve requirements in the Olifants River will contribute to improved quality and flow into Mozambique.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 BACKGROUND

Chapter 3 of the National Water Act (Act No. 36 of 1998) (NWA) was specifically developed for the protection of the water resources of the country and requires the implementation of Resource Directed Measures (RDM) that is based on the guiding principles of sustainability and equity.

Resource Directed Measures provides for the protection of water resources through the Classification of water resources, determination of Resource Quality Objectives (RQOs) and determination of the Reserve. These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources on one hand and the need to develop and use them on the other.

The Reserve specifies the quantity, quality, habitat and biotic integrity requirements necessary for the protection of the resource and has priority over other water uses. Two components are provided for, namely:

(i) Basic human needs (BHN), ensuring that the essential needs of individuals served by the water resource in question are provided for; and
(ii) The ecological Reserve ensuring the water required to protect aquatic ecosystems of the water resource are provided for.

The ecological Reserve is not intended to protect the aquatic ecosystem *per se*, but to maintain aquatic ecosystems in such a way that their integrity remains intact and they can continue to provide the goods and services to society and is specified for groundwater, wetlands, rivers and estuaries.

The Chief Directorate: Water Ecosystems has through a recently completed study determined the Reserve for the water resources in the Olifants Water Management Area (WMA 2) specifically for the Olifants and Letaba Systems; with a preliminary Reserve being determined for the Shingwedzi catchment.

1.2 STUDY OVERVIEW

The study was aimed at specifically addressing ecological gaps and reviewing and updating the preliminary Reserves that had been previously determined.

The previous relevant studies completed for these systems were:

- Determination of the preliminary Reserve for the Olifants System (2001) and for the Letaba system (2006); and
- Classification and determination of RQOs for the water resources of the Olifants River catchment (2011-2013) and for the water resources of the Letaba River catchment (2012-2014);

Due to the preliminary Reserve having been determined in 2001 and 2006 prior to the water resource classification in 2011-2014, a review and update was required to ensure that the

Reserve is in accordance with the water resource classes and is applicable to the current system needs. In addition the hydrology applied to the Olifants preliminary Reserve in 2001, was out of date, and the Eco-Classification models and other tools did not exist or were in its infancy.

As the classes of the water resources for the Olifants/Letaba system have now been determined, the Reserve can be determined and gazetted.

The update and review of the preliminary Reserve was achieved through:

- Review and analysis of existing information;
- Filling in of the ecological gaps through Rapid III Reserve determinations and biological surveys of the priority sites identified in the Olifants, Letaba and Shingwedzi catchments. Where possible, the EcoClassification models (required to evaluate scenarios) were populated and run to obtain updated results.
- The EWRs were determined using new hydrology and in other instances adjusted EWRs considering new present day hydrology.
- Evaluation of ecological consequences and operational considerations based on the planning scenarios that considered the impact of the different ecological categories on the yield of the dams in the system;
- Adoption of the recommended scenario and defining the ecological specifications and monitoring requirements for maintenance of the Reserve for the rivers in the Olifants, Letaba and Shingwedzi catchments.
- Specifications for the groundwater resources and wetlands are also determined based on the assessments undertaken.

With the Reserve in place the next step in the protection framework is to achieve its implementation. Implementation of the Reserve must function within the existing environment of water resource management as well as existing monitoring programmes and initiatives in place.

1.3 RESOURCE MANAGEMENT AND IMPLEMENTATION PLAN

The report focuses on providing a management context to the implementation of the Reserve in the Olifants/Letaba System, and also identifies the implementation actions that should be undertaken within the integrated water resource management framework that exists.

It must be noted that the implementation actions outlined cannot be undertaken in isolation but would need to be integrated into other management, strategy and regulatory processes to ensure that implementation is achieved. The Water Resource Classes and the Reserve forms an integral component of the integrated water resource management process and informs the planning, use, development, management and control of the water resources in the water management area (WMA).

An attempt is therefore made to provide this context within the Olifants/Letaba system, supported by the proposed actions that would need to be implemented for achieving the Reserve. These implementation actions would need to be integrated into the catchment management strategy, the framework for water resource management in the Olifants WMA that is still to be developed.

The CMS would then provide a clear overarching approach and intent for managing water resources in the WMA (incorporating the Reserve as a component of the protection framework), with a co-ordinated action plan.

1.4 PURPOSE OF THIS REPORT

The main objective of this report is to:

- provide a context of the integrated water resource management environment in the Olifants WMA, and
- provide recommendations on implementation actions for the attainment of the Reserve.

The report structure comprises the following:

- Section 1: Introduction
- Section 2: Description of the Olifants WMA
- Section 3: The Reserve;
- Section 4: Water Resource Management Context within the Olifants WMA;
- Section 5: Identification of implementation actions and activities required to be included in the IWRM plan and future CMS.

2 DESCRIPTION OF THE OLIFANTS WATER MANAGEMENT AREA

South Africa is a water-constrained economy and several indicators distinguish it as one of the driest countries in the world with above average water consumption. However, many South Africans are not aware of the scarcity of water in the country and that if water is not well managed there will not be adequate supplies to meet all the demands (DWA, 2013).

The Olifants/Letaba/Shingwedzi River Systems or the Olifants Water Management Area (WMA), comprising the Olifants, Letaba and Shingwedzi catchments, falls into the above water-constrained economy, being a highly utilised and regulated catchment. Its' water resources are becoming more stressed both from a water quantity and water quality point of view, highlighting the importance of maintaining the ecological integrity of the water resources. There is very little opportunity for further water resource development within the catchment and future development will need to rely on local sources of water or large transfer schemes from adjacent catchments.

In this respect there is an urgency to ensure that water resources in the WMA are able to sustain their level of uses and be maintained at their desired states.

The Olifants WMA (WMA 2) includes the Olifants, Letaba and Shingwedzi systems. The spatial extent of the area includes tertiary drainage regions B11, B12, B20, B31, B32, B41, B42, B51, B52, B60, B71, B72 and B73 in the Olifants system, B81, B82 and B83 in the Letaba area, and B90, the Shingwedzi catchment. The map of the WMA is shown in **Figure 1**. The sub-catchment areas are set out in

Table 1.

Table 1: Sub- catchment areas (km^2)

Sub-catchment	Quaternary catchments	Area
Upper Olifants	B11A - L; B12 A – E; B20 A - J	11 461 km^2
Middle Olifants	B32 A – J; B31 A – H; B51 A- H; B52 A- H; B71 A- F	22 791 km^2
Steelpoort	B41 A – K; B42A - H	7 127 km^2
Lower Olifants	B60 A- J; B72 A – K; B71G, J and H; B73 A - J	12 612 km^2
Letaba	B81 A – J; B82 A – J; B83 A - E	14 429 km^2
Shingwedzi	B90A - H	5 310 km^2

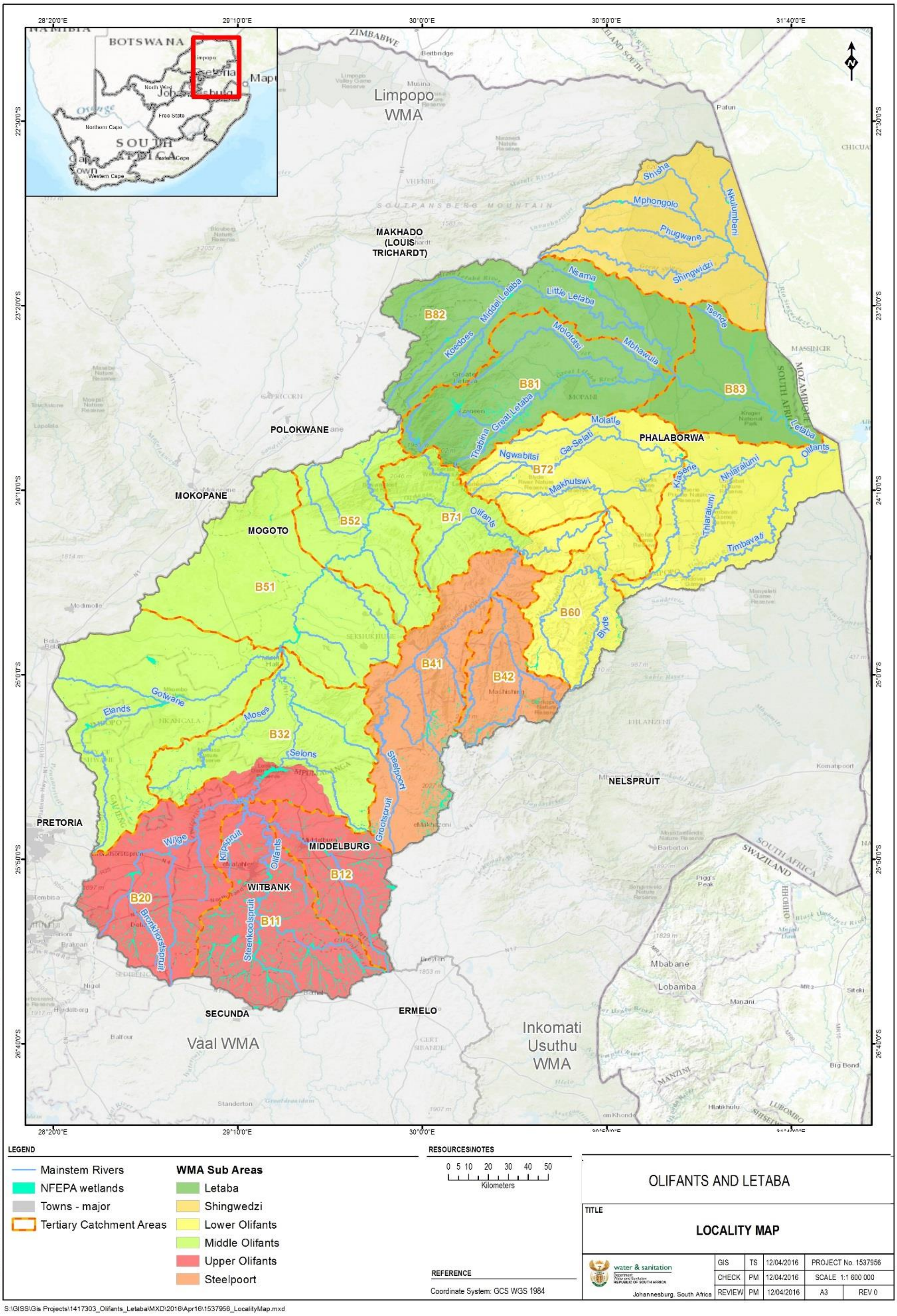

Figure 1: Olifants Water Management Area

The main tributaries of the Shingwedzi River include the Mphongolo, Phugwane, Shisha and Mashakwe Rivers. A large portion of the Shingwedzi River subcatchment (secondary catchment B9) falls within the Kruger National Park. Outside the park, land use is mainly subsistence agriculture and informal urban settlements. Several small gold mines were developed in the southwestern part of the Shingwedzi River catchment. The mines have limited impact on the local economy and have been closed down in recent years. The Shingwidzi River flows through the Kruger National Park becoming the Rio Shingwidzi in Mozambique

The Letaba catchment is located to the north of the WMA. The two main tributaries are the Klein and Groot Letaba Rivers. The Groot Letaba River catchment includes the main urban areas of Tzaneen and Nkowakowa and in the Klein Letaba River catchment, the town of Giyani. The rural population is scattered throughout the catchment area. The Letaba River catchment is highly regulated particularly in the upper catchments where most of the runoff is generated. Surface water mainly originates in the mountainous areas and is regulated by several dams (Tzaneen, Magoebaskloof, Dap Naude and Ebenezer dams) in the upper and middle reaches of the river. The Letaba River is further regulated by a series of irrigation weirs that limit the flows of water into the Kruger National Park. There are further flow regulation weirs and dams within the Kruger National Park (Mingerhout Engelhardt dams). Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment (upstream and downstream of the Middle Letaba Dam), and particularly along the Groot Letaba (downstream of the Tzaneen Dam) and Letsitele rivers. Vegetables, citrus and a variety of fruits are grown. The existing limited water resources in the catchment have been overexploited to meet the irrigation, afforestation, industry and rapidly increasing domestic water demands. A possible dam (Nwamitwa Dam) is planned on the Groot Letaba River upstream of the Klein Letaba River confluence that will further reduce the flows in the lower reaches of the Letaba River.

The Olifants system forms the major part of the WMA catchment area. Its main tributaries include the Wilge, Elands and Ga-Selati Rivers on the left bank and the Klein-Olifants, Steelpoort, Blyde, Klaserie and Timbavati Rivers on the right bank. The Olifants catchment is a highly utilised and regulated catchment and like many other in South Africa, its water resources are becoming more stressed due to an accelerated rate of development and the scarcity of water resources.

The main economic activity in the catchment is related mining. There are also large steel foundries located in Middelburg and Emalahleni (Witbank). Extensive irrigation occurs in the vicinity of the Loskop Dam, along the lower reaches of the Olifants River, near the confluence of the Blyde and Olifants rivers, as well as in the Steelpoort valley and upper Selati catchment. Much of the central and north western areas of the catchment area are largely undeveloped, with scattered rural villages where the people are mainly dependent on income from migrant workers in the Gauteng area, Emalahleni, Middelburg and Phalaborwa are the largest urban centres.

Land use in the area is characterised by rain-fed cultivation in the southern and north-western parts, with grain and cotton as main products. While most of the catchment area remains under natural vegetation for livestock and game farming as well as conservation, severe overgrazing is prevalent in many areas. Afforestation is found in some of the higher rainfall areas, with notable plantations in the upper Blyde River valley. The Kruger National Park is located at the downstream extremity of the Olifants catchment area. Most surface runoff originates from the higher rainfall southern and mountainous areas. There are a number of major dams constructed in the Olifants River and the major tributaries which regulate the flow in the river system. Priority dams in the Olifants WMA and their purpose are listed in **Table 2**.

Table 2: Priority dams in the WMA and their purpose

Dam Name	Quaternary catchment	Dam gauge number	River	Year Established	Full supply capacity (Mm³)	Purpose
Witbank	B11G	B1R001	Olifants	1971	104.0	Domestic (urban), industrial use
Doornpoort	B11J	-	Olifants	1925	9.2	Recreation, domestic (urban)
Middelburg	B12C	B1R002	Klein Olifants	1978	48.4	Domestic (urban), industrial
Bronkhorst-spruit	B20C	B2R001	Bronkhorstspruit	1950	57.9	Industrial, domestic (urban)
Wilge Dam (Premier Mine)	B20F	-	Wilge	1909	1.7	Domestic (urban), industrial, mining
Loskop	B32A	B3R002	Olifants	1939	374.3	Irrigation, domestic (rural), recreation
Roodepoort	B32B	B3R004	Selons	1968	1.8	Irrigation
Rust De Winter	B31C	B3R001	Elands	1934	27.2	Irrigation
Mkhombo/ Weltevreden Weir	B31F	B3R005	Elands	1980	205.8	Domestic (urban & rural), industrial, irrigation
Rooikraal	B32F	B3R003	Bloed	1921	2.1	Irrigation
Flag Boshielo	B51B	B5R002	Olifants	1987	103.0	Irrigation, industrial, domestic (urban & rural)
Belfast	B41A	-	Langspruit	1973	4.4	Domestic (urban)
Tonteldoos	B41C	B4R001	Tonteldoos	1954	0.6	Irrigation
Vlugkraal	B41C	B4R002	Vlugkraal	1959	0.4	Irrigation
Der Bruchen	B41G	-	Groot Dwars	1989	7.3	Irrigation, mining
De Hoop	B41H	B4R007	Steelpoort	2012	347.4	Domestic (urban & rural), mining, industrial
Lydenburg Dam	B42B	-	Sterk	1977	1.1	Domestic (urban), industrial
Buffelskloof	B42F	B4R004	Watervals	1972	5.4	Irrigation
Ohrigstad Dam	B60E	B6R001	Ohrigstad	1955	14.4	Irrigation
Blyderivier-poort	B60D	B6R003	Blyde	1974	56.5	Irrigation, domestic (urban), recreation
Tours	B72E	B7R003	Ngwabitsi	1988	5.5	Domestic
Phalaborwa Barrage	B72D	B7R002	Olifants	1966	5.7	Domestic (urban), industrial
Klaserie	B73A	B7R001	Klaserie	1959	5.8	Irrigation

The demographic characteristics of the Olifants WMA are varied from upstream to downstream with the highest diversity of demographic groups typically occurring in the southern reaches and less diverse groups in the northern reaches. This is attributed to the variation in economic development of the landscape. Toward the southern extent of the catchment urbanisation and land use intensity increases toward Gauteng province and the cities of Emalahleni and Middelburg. The northern reaches are less developed, characterised by a greater proportion of smaller towns, settlements and rural land uses.

3 THE RESERVE

The Reserve and Ecological categorisation for rivers in terms of section 16(1) of the National Water Act (Act No. 36 of 1998) is presented in From a groundwater perspective, a summary of the prioritised quaternary catchments in the Olifants – Letaba System is listed in **Table 5**. The table further indicates that 54 of the quaternary catchments assessed have limited (<1 MCM/a) groundwater reserve allocations; thus meaning that all future allocations should be evaluated using a scientific screening process considering the Category A, B and C requirements by the water users for water use license applications. A summary of the water balance on each property where a new water use is required should be required as part of the water use license application. In addition, a groundwater management plan, based on a representative monitoring programme is required.

The table lists those quaternary catchments where groundwater discharging from the aquifer systems is supporting the surface water resources. This level of information should be applied from a GIS perspective when future water use allocations are assessed. Typically, where the proposed groundwater abstraction would be within a certain distance (for argument sake 1000 m) from a perennial stream, a high-level hydrogeological investigation should be conducted.

For further detail regarding the groundwater reserve per quaternary catchment, please refer to Appendix A.

Table 3 and is applicable to the following water resource or part of the resource:

- Olifants River to approximately 6km upstream from the confluence with the Letaba River at the Olifants River Gorge (KNP Eastern border with Mozambique); and
- Letaba River.

A preliminary Reserve is applicable to Shingwedzi River before it enters Mozambique downstream of the Kannidood Dam in the Kruger National Park.

The determination is applicable to the cumulative flow at the Ecological Water Requirement (EWR) sites as listed in **Table 3**.

From a groundwater perspective, a summary of the prioritised quaternary catchments in the Olifants – Letaba System is listed in **Table 5**. The table further indicates that 54 of the quaternary catchments assessed have limited (<1 MCM/a) groundwater reserve allocations; thus meaning that all future allocations should be evaluated using a scientific screening process considering the Category A, B and C requirements by the water users for water use license applications. A summary of the water balance on each property where a new water use is required should be required as part of the water use license application. In addition, a groundwater management plan, based on a representative monitoring programme is required.

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For further detail regarding the groundwater reserve per quaternary catchment, please refer to Appendix A.

Table 3: The Reserve for the Olifants Letaba System

Key EWR Sites	Quaternary Catchment	Water Resource	PES	REC	Ecological Category which is being recommended for approval (TEC)[5]	Ecological Reserve[3]		BHN Reserve[4]		Total Reserve[2]		
						MCM	% of NMAR	MCM	% of NMAR	MCM	% of NMAR	NMAR (MCM)[1]
Olifants_ELA1	B31C	Upper Elands	C/D	C	C	6.485	20.87	0.0002	0.003	6.4852	20.873	31.08
Olifants_EWR4	B20J	Lower Wilge	C	B	B	63.698	36.28	0.00227	0.013	63.70027	36.293	175.59
Olifants_WIL1	B20F	Wilge River	C/D	C	C	6.763	15.11	0.00159	0.008	6.76459	15.118	44.76
Olifants_EWR1	B11J	Olifants	D	C/D	D	32.845	17.8	0.00673	0.052	32.85173	17.852	184.54
Olifants_EWR2	B32A	Olifants	C	B/C	B/C	149.36	29.83	0.00295	0.008	149.36295	29.838	500.63
OLI_EWR3	B32A	Kranspoortspruit	C	B	B	4.194	30.26	0.00295	0.008	4.19695	30.268	13.858
Olifants_SEL1	B32C	Selons	D	C	C	7.237	21.86	0.00196	0.02	7.23896	21.88	33.11
Olifants_EWR8	B71D	Olifants	C	C	C/D	123.53	15.19	0.00841	0.02	123.53841	15.21	813.17
Olifants_SPE1	B42H	Lower Spekboom	C	B/C	C	34.316	23.16	0.00729	0.091	34.32329	23.251	148.19
Olifants_BLY1	B60B	Upper Blyde	C	B	B	75.78	46.08	0.00479	0.005	75.78479	46.085	164.45
Olifants_EWR11	B71J	Olifants	C	C	C/D	169.27	12.81	0.00502	0.052	169.27502	12.862	1321.9
Olifants_EWR12	B60J	Lower Blyde	C	B	B	119.39	31.14	0.01041	0.052	119.40041	31.192	383.27

Key EWR Sites	Quaternary Catchment	Water Resource	PES	REC	Ecological Category which is being recomended for approval (TEC)[5]	Ecological Reserve[3]		BHN Reserve[4]		Total Reserve[2]		
						MCM	% of NMAR	MCM	% of NMAR	MCM	% of NMAR	NMAR (MCM)[1]
Olifants_EWR13	B72D	Olifants	C	B/C	C	394.26	22.37	0.01239	0.301	394.27239	22.671	1762.1
Olifants_EWR16	B73H	Olifants	D	B/C	C	403.96	21.06	0.00016	0.002	403.96016	21.062	1918.3
Letaba_EWR7	B83D	Letaba	C/D	C	C	112.05	17.34	0.00004	0	112.05004	17.34	646.28
Letaba_EWR2	B81D	Letsitele	D	D	D	20.497	17.59	0.07078	0.078	20.56778	17.668	116.55
Letaba_EWR1	B81B	Great Letaba	C/D	C	C	24.72	24.76	0.01966	0.03	24.73966	24.79	99.85
Letaba_BRO1	B81A	Broederstroom	B/C	B/C	B/C	3.257	49.22	0.00519	0.012	3.26219	49.232	6.68
Shingwedzi_SHI1	B90H	Shingwedzi	C	B/C	B/C	19.449	22.5	0.00071	0.004	19.44971	22.504	86.42
Olifants-EWR3	B12E	Klein Olifants	D	C	C/D	16.146	19.8	0.00142	0.009	16.14742	19.809	81.54
Olifants-EWR5	B32D	Olifants	C	C	C	71.449	12.51	0.00483	0.06	71.45383	12.57	571.13
Olifants-EWR6	B31G	Lower Elands	C/D	C/D	D	6.319	10.48	0.00326	0.033	6.32226	10.513	60.32
Olifants-EWR7	B51G	Olifants	E	D	D	72.915	9.89	0.0137	0.365	72.9287	10.255	736.94
Olifants-EWR9	B41H	Steelpoort	D	C/D	C/D	32.079	23.33	0.19505	3.086	32.27405	26.416	137.50
Olifants_EWR 14b	B72K	Lower Ga-Selati	E	D	D	14.15	19.45	0.00488	0.043	14.15488	19.493	72.74

Key EWR Sites	Quaternary Catchment	Water Resource	PES	REC	Ecological Category which is being recommended for approval (TEC)[5]	Ecological Reserve[3]		BHN Reserve[4]		Total Reserve[2]		
						MCM	% of NMAR	MCM	% of NMAR	MCM	% of NMAR	NMAR (MCM)[1]
SPK_EWR1	B11H	Spookspruit	C	C	C	2.808	30.12	0.00011	0.001	2.80811	30.121	9.322
DWA_EWR1	B41H	Dwars	B/C	B/C	B/C	8.144	31.24	0.19505	3.086	8.33905	34.326	26.1
Olifants_EWR10	B41K	Steelpoort	D	D	D	43.503	12.69	0.07358	0.48	43.57658	13.17	342.75
OLI_EWR8	B60H	Ohrigstad	C	C	C	11.785	17.41	0.07142	0.512	11.85642	17.922	67.79
Olifants_EWR14a	B72H	Upper Ga-Selati	C	C	C	14.37	27.53	0.00249	0.123	14.37249	27.653	52.2

1) Natural Mean Annual Runoff at EWR site.
2) The total Reserve amount accounts for both the Ecological Reserve and the Basic Human Needs Reserve.
3) The volume and % represent the long term mean based on the nMAR. If the nMAR changes, this volume will also change.
4) Represents the cumulative volume and percentage of BHN.
5) Target Ecological Category (TEC): The ultimate target to achieve a sustainable system both ecologically and economically taking into account the PES and REC.

Table 4: EWR sites and location

EWR site no	River	Coordinates Latitude	Coordinates Longitude	EcoRegion (Level 2)	Geomorphic Zone	Quaternary catchment
Olifants_ELA1	Upper Elands	28,46311	-25,303074	8	Lower foothills	B31C
Olifants_EWR4	Lower Wilge	28,999047	-25.619625	9	Upper foothills	B20J
Olifants_WIL1	Wilge	28,871978	-25,843984	11	Lower foothills	B20F
Olifants_EWR1	Olifants	29,309564	-25,759183	9	Lower foothills	B11J
Olifants_EWR2	Olifants	29,254597	-25,496324	9	Lower foothills	B32A
OLI_EWR3	Kranspoortspruit	29,475619	-25,437714	9	Upper foothills	B32A
Olifants_SEL1	Selons	29,435557	-25,379969	9	Lower foothills	B32C
Olifants_EWR8	Olifants	30.082457	-24.239917	9	Lower foothills	B71D
Olifants_SPE1	Lower Spekboom	30,361267	-24,694155	9	Upper foothills	B42H
Olifants_BLY1	Upper Blyde	30,778321	-24,734412	10	Lower foothills	B60B
Olifants_EWR11	Olifants	30,785695	-24,307563	10	Lower foothills	B71J
Olifants_EWR12	Lower Blyde	30,827404	-24,407481	3	Lower foothills	B60J
Olifants_EWR13	Olifants	31,01457	-24,12843	3	Lower foothills	B72D
Olifants_EWR16	Olifants	31,731751	-24,049426	3	Lower foothills	B73H
Letaba_EWR7	Letaba	31.59061	-23.8268	3	Lowland river	B83D
Letaba_EWR2	Letsitele	30.357356	-23.893155	3	Lower foothills	B81D
Letaba_EWR1	Great Letaba	30.05228	-23.915	9	Upper foothills	B81B
Letaba_BRO1	Broederstroom	29.97741	-23.80068	9	Upper foothills	B81A
Shingwedzi_SHI1	Shingwedzi	31.52508	-23.1849	3	Lower foothills	B90H
Olifants-EWR3	Klein Olifants	29.342	-25.6736	9	Lower foothills	B12E
Olifants-EWR5	Olifants	29.422	-25.304	9	Lower foothills	B32D
Olifants-EWR6	Lower Elands	28.9565	-25.116	9	Lower foothills	B31G
Olifants-EWR7	Olifants	29.5464	-24.5289	9	Lower foothills	B51G
Olifants-EWR9	Steelpoort	30.165	-24.775	9	Lower foothills	B41H
Olifants-EWR14B	Lower Ga-Selati	31.146667	-24.0225	3	Lower foothills	B72K
SPK_EWR1	Spookspruit	29.4029	-25.8605	11	Lower foothills	B11H

EWR	**River**	**Coordinates**		**EcoRegion**	**Geomorphic**	**Quaternary catchment**
site no		**Latitude**	**Longitude**	**(Level 2)**	**Zone**	
DWA_EWR1	Dwars	30.08345	-24.8358	9	Lower foothills	B41H
Olifants_EWR10	Steelpoort	30.399	-24.4965	10	Lower foothills	B41K
OLI_EWR8	Ohrigstad	30.73807	-24.5473	10	Lower foothills	B60H
Olifants_EWR14a	Upper Ga-Selati	30.6823	-24.0012	3	Upper foothills	B72H

Figure 2 and **Figure 3** shows the catchment areas of the Olifants WMA indicating the EWR sites.

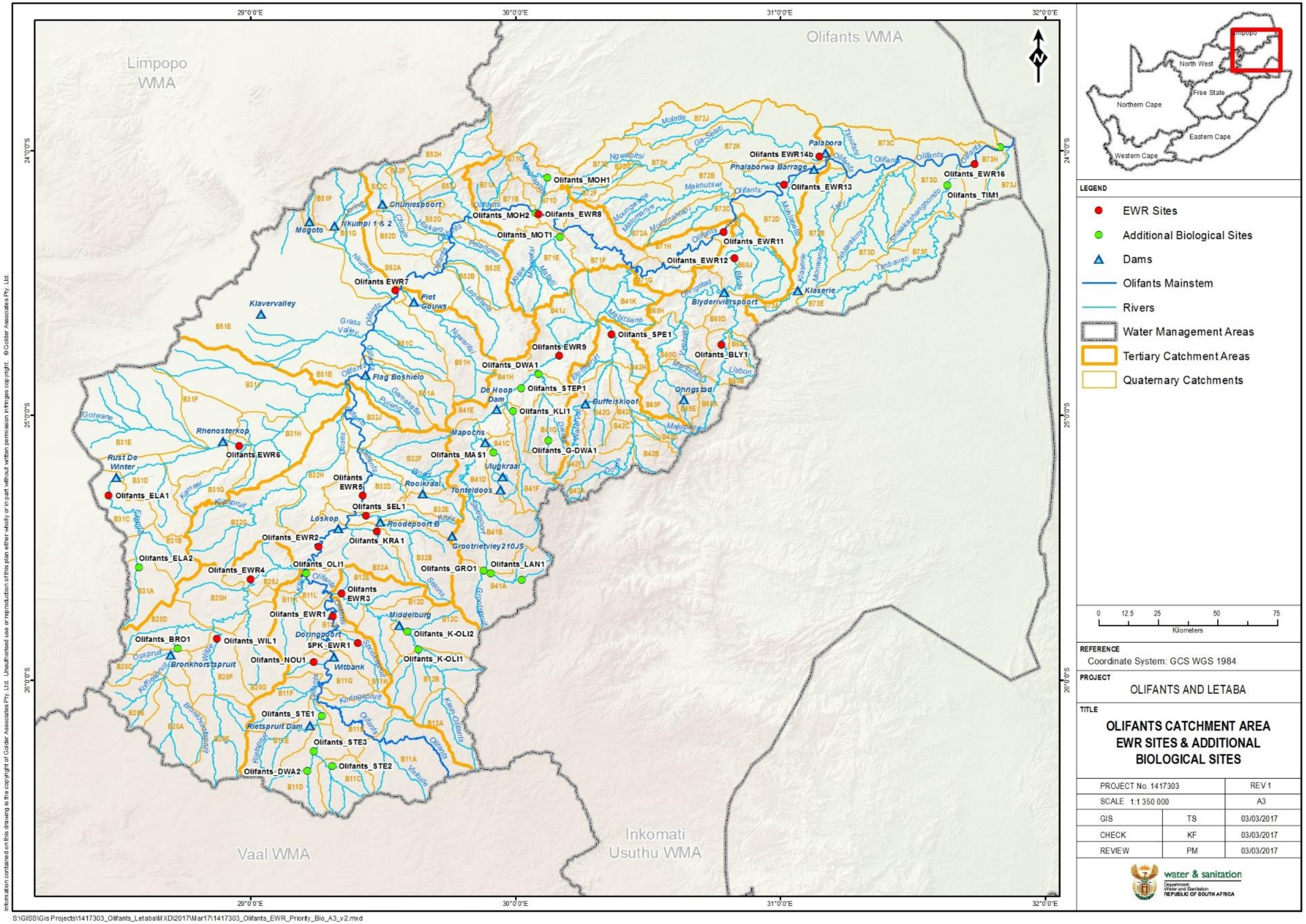

Figure 2: Map of the Olifants Catchment illustrating the EWR sites and additional biological monitoring sites

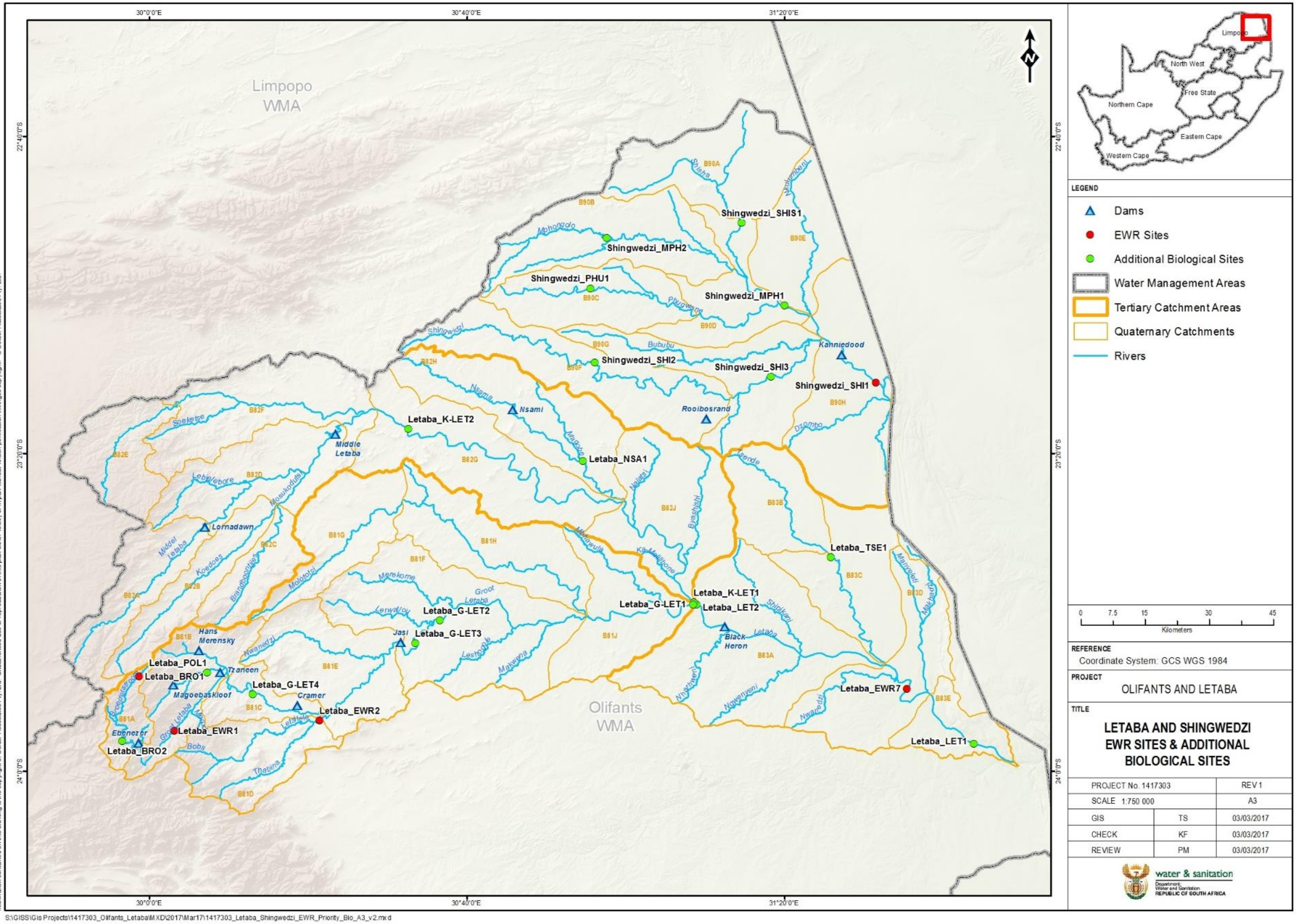

Figure 3: Map of the Letaba and Shingwedzi Catchments illustrating the EWR sites and additional biological monitoring sites

Table 5: Listing of priority quaternary catchment in terms of setting a groundwater component of the water resource reserve

Quaternary Catchment.	Status utilisation (SRK, 2009 and Ages Group, 2009)	Preliminary Groundwater Reserve Allocation (MCM/a) (WSMLeshika, 2014)	Supporting groundwater baseflow
B11F	High/Over (SI>1.0)	1.08[1]	Insignificant/negligible
B11G	Moderately (SI <0.65)	1.17[1]	Insignificant/negligible
B11J	Insignificant (SI <0.30 – 0.10)	0.00	Moderate
B11K	High/Over (SI >1.0)	2.25[1]	Moderate
B11L	Insignificant (SI <0.30 – 0.10)	1.21	Moderately
B12D	High/Over (SI >1.0)	0.00	Insignificant/negligible
B12E	Insignificant (SI <0.30 – 0.10)	2.21	Moderate
B20A (DLMT)	High/Over (SI >1.0)	0.00	High
B20B (DLMT)	High/Over (SI >1.0)	0.00	High
B20C	Insignificant (SI <0.30 – 0.10)	1.59	High
B20D	Insignificant (SI <0.30 – 0.10)	1.70	Moderate
B20E	Moderately (SI <0.65)	0.00	Moderate
B20F	Insignificant (SI <0.30 – 0.10)	2.62	Moderate
B20G	Insignificant (SI <0.30 – 0.10)	1.04	Moderate
B20H	Moderately (SI <0.65)	0.87	Moderate
B20J	Insignificant (SI <0.30 – 0.10)	1.14	Moderate
B31A	Moderately (SI <0.65)	0.00	Insignificant/negligible
B31C	Heavily (SI 0.65 – 1.00)	1.59[1]	Insignificant/negligible
B31D	High/Over (SI >1.0)	1.19[1]	Insignificant/negligible
B31G	Moderately (SI <0.65)	0.95	Insignificant/negligible
B31F	Moderately (SI <0.65)	1.59[1]	Insignificant/negligible
B32A	Insignificant (SI <0.30 – 0.10)	4.36	Moderate
B32B	Insignificant (SI <0.30 – 0.10)	3.59	Moderate
B32C	Insignificant (SI <0.30)[1]	0.00	Moderate
B32F	Moderately (SI <0.65)	0.00	Insignificant/negligible
B32G	Moderately (SI <0.65)	0.07	Insignificant/negligible
B32F	Moderately (SI <0.65)	0.00	Insignificant/negligible
B32J	Moderately (SI <0.65)	0.00	Insignificant/negligible
B41A	Insignificant (SI <0.30 – 0.10)	3.47	Moderate
B41B	Insignificant (SI <0.30 – 0.10)	2.45	Moderate
B41C	High/Over (SI >1.0)	0.90	Insignificant/negligible
B41D	Insignificant (SI <0.30 – 0.10)	0.59	Moderate
B41F	Insignificant (SI <0.30 – 0.10)	1.03	High
B41G	Moderately (SI <0.65)	0.88	High
B41J	Moderately (SI <0.65)	3.26[1]	Insignificant/negligible
B42A	Insignificant (SI <0.30 – 0.10)	0.00	High

Quaternary Catchment.	Status utilisation (SRK, 2009 and Ages Group, 2009)	Preliminary Groundwater Reserve Allocation (MCM/a) (WSMLeshika, 2014)	Supporting groundwater baseflow
B42B	Insignificant (SI <0.30 – 0.10)	1.29	High
B42D	Insignificant (SI <0.30 – 0.10)	0.99	High
B51A	Moderately (SI <0.65)	1.76	Insignificant/negligible
B51E	Heavily (SI 0.65 – 1.00)	0.00	Insignificant/negligible
B51F	Insignificant (SI <0.30 – 0.10)	0.00	Insignificant/negligible
B51G	Heavily (SI 0.65 – 1.00)	0.00	Insignificant/negligible
B52A	Moderately (SI <0.65)	1.82	Insignificant/negligible
B52B	Moderately (SI <0.65)	3.94[1]	Insignificant/negligible
B52C	Moderately (SI <0.65)	0.58	Insignificant/negligible
B52D	Moderately (SI <0.65)	0.17	Insignificant/negligible
B52H	Heavily (SI 0.65 – 1.00)	1.95	Insignificant/negligible
B60A	Insignificant (SI <0.30 – 0.10)	2.23	Insignificant/negligible
B60B	Insignificant (SI <0.30 – 0.10)	3.83	Insignificant/negligible
B60C	Insignificant (SI <0.30 – 0.10)	0.97	Insignificant/negligible
B60D	Insignificant (SI <0.30 – 0.10)	2.52	Insignificant/negligible
B60E	High/Over (SI >1.0)	1.00[1]	High
B60F	Moderately (SI <0.65)	0.00	Moderate
B60G	Moderately (SI <0.65)	0.00	Moderate
B60H	Insignificant (SI <0.30 – 0.10)	0.00	Insignificant/negligible
B60J	Insignificant (SI <0.30 – 0.10)	5.21	Moderate
B71B	Heavily (SI 0.65 – 1.00)	1.85	Insignificant/negligible
B71C	Insignificant (SI <0.30 – 0.10)	3.78	High
B71D	Moderately (SI <0.65)	1.77	High
B71E	High/Over (SI >1.0)	3.90[1]	Moderate
B71F	Insignificant (SI <0.30 – 0.10)	3.84	High
B71G	Insignificant (SI <0.30 – 0.10)	2.87	High
B72A	Insignificant (SI <0.30 – 0.10)	0.56	Moderate
B72E	Heavily (SI 0.65 – 1.00)	2.48[1]	Insignificant/negligible
B72F	Heavily (SI 0.65 – 1.00)	1.07	Insignificant/negligible
B72G	Insignificant (SI <0.30 – 0.10)	2.47	Insignificant/negligible
B73A	Heavily (SI 0.65 – 1.00)	1.04	High
B73B	Insignificant (SI <0.30 – 0.10)	0.00	Insignificant/negligible
B73E	High/Over (SI >1.0)	2.16	Insignificant/negligible
B81A	Insignificant (SI <0.30 – 0.10)	2.62	High
B81B	Insignificant (SI <0.30 – 0.10)	16.58[2]	High
B81C	Moderately (SI <0.65)	0.26	High
B81D	Heavily (SI 0.65 – 1.00)	7.12[2]	Moderate

Quaternary Catchment.	Status utilisation (SRK, 2009 and Ages Group, 2009)	Preliminary Groundwater Reserve Allocation (MCM/a) (WSMLeshika, 2014)	Supporting groundwater baseflow
B81E	High/Over (SI >1.0)	2.41	Insignificant/negligible
B81F	Moderately (SI <0.65)	10.47[2]	Insignificant/negligible
B81G	Moderately (SI <0.65)	7.39[2]	Insignificant/negligible
B81H	Moderately (SI <0.65)	6.17[2]	Insignificant/negligible
B82A	Insignificant (SI <0.30 – 0.10)	1.98	
B82B	High/Over (SI >1.0)	0.00	Insignificant/negligible
B82C	High/Over (SI >1.0)	0.00	Insignificant/negligible
B82D	Heavily (SI 0.65 – 1.00)	5.07[2]	Insignificant/negligible

[1] Required detailed assessment.
[2] Calculation of Reserve Allocation to be checked (DWA, 2014).

Several high risk areas illustrated in Figure 4, were high-lighted by a study conducted by SATAC (2009) pointing to serious groundwater quality risks in the Olifants River Catchment.

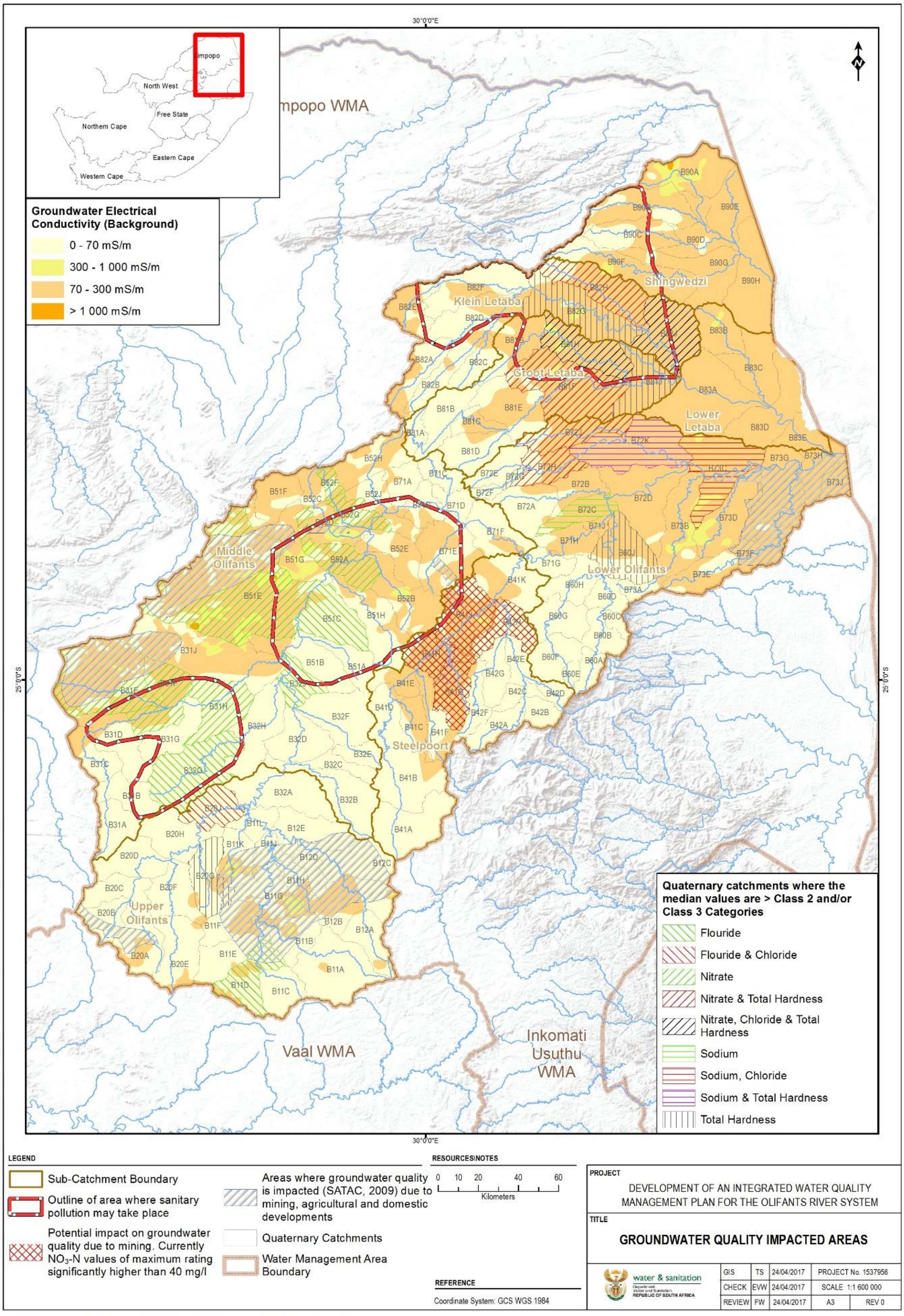

Figure 4: Groundwater areas of concern

4 WATER RESOURCE MANAGEMENT CONTEXT WITHIN THE OLIFANTS WMA

4.1 BACKGROUND

The fundamental purpose of the NWA (as outlined in Chapter 1) is to *inter alia*, ensure that water resources management must:

- meet the water needs for current and future generations;
- promote the efficient, sustainable and beneficial use of water in the public interest; and
- protect aquatic and associated ecosystems and their biological integrity.

For this to be achieved water resource management at the catchment or regional level has to be highly integrated, where water quality, quantity and the aquatic ecosystem are all interlinked and interdependent. This integration requires that various strategies should be linked together so that the many management elements comprising the water quality, water quantity and aquatic ecosystem components of the water resource are aligned into a coherent approach that aims to secure the beneficial, equitable and sustainable use of the water resource.

In order to achieve this the NWA (Act 36 of 1998) introduces a range of strategies, management instruments and regulatory measures and activities, *viz*:

- The National Water Resource Strategy (NWRS);
- Catchment Management Strategies;
- Water Resource Allocation Plans;
- Resource Directed Measures (RDM) – defining the desired level of protection for a water resource, and on that basis, setting the Reserve as well as clear numerical or narrative goals of the resource (the RQOs). These measures focus on the quality of the resource itself;
- Source Directed Controls (SDCs) – controlling impacts on the water resource through the use of regulatory measures such as registration, permits, directives and prosecution, and economic incentives such as levies and fees, in order to ensure that RQOs are met. These measures contribute to defining the limits and constraints that should be imposed on the use of water resources to achieve the desired level of protection;
- Managing demands on water resources to keep utilisation within the limits for protection; including water conservation and demand management; and
- Monitoring the status of the country's water resources to ensure that the RQOs are being met, and to enable the modification of programmes for resource management and impact control as and when necessary.

While the NWRS provides the framework for implementing the NWA, the CMSs (and associated Catchment Management Agencies responsible) for each WMA will play a critical role in managing the demand and supply of water resources through water allocation, incorporation of source directed controls such as water use authorisation and incentive measures, and through demand management and monitoring. The implementation of the RDM (protection measures) will therefore need to have close linkages with these CMSs, to ensure that they are achieved.

Chapter 3 of the NWA lays down the measures that together are intended to ensure the 'comprehensive protection of all water resources.' Part 3 of the NWA (Act 36 of 1998) deals with the Reserve, *i.e*. the Basic Human Needs (BHN) Reserve and the ecological Reserve. The Reserve refers to both the quality and quantity of the water in the resource, and will vary according to the class of the water resource. The Reserve is a protection measure that forms an integral component of the CMS and informs the various other strategies, control measures and management activities to be developed.

Given that the above water resource management framework exists, the fresh water resource in itself is a complex system comprising both water quality and quantity of groundwater and surface water (rivers, springs, dams and wetlands); and considering the impacts of rainfall, runoff from the land, infiltration into the ground and evaporation from the surface back to the atmosphere. Each of these components must be managed with regard to its inter-relationships with the others, in the broader catchment context.

Implementation of the Reserve therefore requires integration and alignment of strategies and activities within the existing environment of integrated water resource management. It is not merely independent actions that should happen in isolation, but is linked and dependent on a number of processes.

Integrated water resource management in this context encompasses planning, co-ordination, implementation, operation, maintenance, monitoring as well as control and auditing of the water resource systems.

The following activities amongst others have links with the Reserve implementation:

- Water Resource Protection informed by:
  - Water Resource Classes;
  - Resource Quality Objectives; and
  - Reserve.
- Water resource planning informed by:
  - Reconciliation Strategies (planning of interventions to increase availability and reduce water use through loss control and efficiency measures).
  - Feasibility studies and construction of infrastructure options;
  - Water quality management strategies; and
  - International agreements and treaties.
- Operational planning and implementation:
  - Operating Analysis providing decision support information;
  - The planning and execution of infrastructure maintenance activities influences operational decisions and feeds into the above function; and
  - Integrated operation and control of infrastructure on a daily basis. This is particularly relevant to achieve required flow regime specified for EWRs.
- Maintenance (planning and execution) of infrastructure influences operational decisions and feeds into the operational functions (monitoring is an important component that needs to feed into this process and yield crucial information from this process). Management of programmes and initiatives such as clearing alien vegetation, pollution control measures (treatment plants/processes); etc.
- Regulatory and control functions: water use authorisations, monitoring, compliance and auditing, prohibition of land based activities, regulatory measures to control and manage water use.
- Institutional arrangements:

- The arrangements from national, regional and local level, and amongst government departments and authorities.

4.2 OLIFANTS LETABA SYSTEM CONTEXT

The Olifants WMA is a region where the CMA has not yet been established, however a proto CMA is in place. With support from the Mpumalanga and Limpopo Regional and National DWS Offices, the Olifants proto CMA will continue to manage the water resources in the WMA.

In terms of meeting the NWA obligations the Department has initiated the development of management strategies for the various WMAs within South Africa in an attempt to provide the framework and constraints within which the water resources will be managed into the foreseeable future. These various strategies and plans have arisen out of the Internal Strategic Perspective (ISP) development process which has identified the relevant water resource management issues and concerns in each of the WMAs in South Africa.

There are a number of water resource processes that have been and are being undertaken in the Olifants WMA that will need to support the implementation of the Reserve and ultimately the CMS.

The implementation actions outlined for the achievement of the Reserve will be required to integrate into these parallel water resource management processes and activities. These include:

4.2.1 WATER RESOURCE CLASSIFICATION AND RESOURCE QUALITY OBJECTIVES

The protection framework for the water resources in the WMA have been established through the Classification of water resources that have undertaken in the Olifants System (in 2010) and Resource Quality Objectives determined in 2014. These have been finalised and gazetted in Government Gazette No 39943, 22 April 2016 (GN 546).

Classification of significant water resources and the determination of Resource Quality Objectives for the Letaba sub-catchment was undertaken in 2013 and gazetted for comment in Government Gazette No 39614, 22 January 2016 (GN 54).

The Reserve gazetted through this study will form the third pillar of the protection framework and all resource directed measures will have to be complied with. This will be the responsibility of the Department to ensure the implementation, monitoring and compliance.

The RDM as gazetted will need to be integrated into the CMS for the WMA and will have to include linkages to the strategies, actions and resourcing that will support its implementation. The responsibility for achieving and maintaining the water resource class, RQOs and Reserve will lie with the DWS, however operationalising these measures will be achieved through regional and catchment processes and structures.

This may require the establishment of working committees of national and regional personnel, to work out a co-ordinated plan of what must happen, when, how it is to be achieved and who is accountable. This process would also need to specify reporting requirements and reporting periods. Thus, it is important that the institutional roles and responsibilities be clearly understood and defined, and that the implementation be facilitated through co-ordinated approaches and activities.

4.2.2 RECONCILIATION STRATEGIES

Olifants Reconciliation Strategy

The Olifants Reconciliation Strategy Study was completed in 2012. The study recommended the most cost effective interventions to reconcile the growing water requirements and possible supply augmentation options. Once the Strategy was developed, it needed to be implemented to ensure sustainable water use in the water supply system. To support the implementation of the Olifants River Reconciliation Strategy, the DWS commissioned the Continuation of the Olifants River Water Supply System Water Reconciliation Strategy – Phase 1 Study (March 2013).

The Olifants System is a severely water stressed system with continued increase in demand on the water resources in this system. Hence water required to supply the current and future social and economic activities in the catchment will have to come from the local catchment resources (with the exception of the power stations). The Strategy specifically recommends that the Reserve be operationalized (implemented).

Letaba Reconciliation Strategy

The Letaba Reconciliation Strategy (including the Luvuvhu, Shingwedzi and Mutale catchments) was completed in September 2014. The Reconciliation Strategy incorporated approved water resource development projects such as the Groot Letaba Water Development Project (GLeWaP), which is a key initiative by the DWS to support the social and economic development strategy for the Limpopo Province. The Strategy recommended that the EWRs in the Groot Letaba for the scenario proposed by the Classification Study be implemented, once the Nwamitwa Dam starts to deliver water.

Once gazetted the Reserve requirements must be met, and the water balance and reconciliation strategies for the Olifants and Letaba would have to be updated to accommodate this. Interventions related to the water resources especially the stressed and over utilised and those in high conservation areas (such as the Kruger National Park) **will require integrated operating rules to provide the necessary release plan for achieving and maintaining the EWRs**. Improved operation of the system and management of the various impoundments and water uses will also be required, to ensure that all user requirements are met.

This will require implementation related to:

- Planning interventions;
- Operational analysis and control of infrastructure; and
- Maintenance and management operating rules.

An operational tool must be developed for the Olifants/Letaba System to manage the EWR release pattern, timing and measurements together with the releases for the other water users in the various catchments. This will determine if operational management is maintaining the EWRs through the system.

4.2.3 OLIFANTS RIVER WATER RESOURCES DEVELOPMENT PLAN

The purpose of the ongoing Olifants River Water Resources Development Project (ORWRDP) is to supply the needs for water (both domestic and mining) in the middle part of the Olifants River catchment, and the adjacent Mogalakwena and Polokwane Municipal areas.

The ORWRDP comprises two main phases:

- Phase 1 involves the raising of the Flag Boshielo Dam on the Olifants River by 5 m (ORWRDP-1) which was completed in 2005; and
- Phase 2 involves the development of additional water resource infrastructure (the De Hoop Dam on the Steelpoort River and bulk raw water distribution infrastructure) in the middle Olifants catchment (ORWRDP-2).

The project faces a number of challenges as a result of changing water requirements and difficulty to reconcile these new water requirements with the available water resources. A substantial portion of the mining water requirements have also shifted from the Sekhukhune District Municipality (DM) area to the Mogalakwena Local Municipality (LM) area since the start of the project. The configuration of the project infrastructure required changes and augmentation to water resources which needed to be investigated. It was therefore decided to do a technical review of the planning and design work done so far and where necessary recommend changes in a Technical Review Report that would be used to inform the due diligence process embarked upon by the National Treasury (NT) to consider issuing an explicit guarantee by government or fiscal funding.

To date, the ORWRDP has linked closely with the Olifants Reconciliation Strategy update and all information used has been consistent between the two studies. The infrastructure capacities as determined by the ORWRDP have been included into the planning analysis (Water Resource Planning Model) for various scenarios analysed. The ORWRDP will have to include the implementation of the Reserve requirements into the scenario assessment.

4.2.4 INTEGRATED WATER QUALITY MANAGEMENT PLAN FOR THE OLIFANTS RIVER SYSTEM

The Department is also currently underway with the Development of an Integrated Management Plan for the Olifants River System (IWQMP) Study. The main objective of the IWQMP study is to develop management measures to maintain and improve the water quality in the water resources of the Olifants WMA (as per the NWRS2) in a holistic and sustainable manner to ensure sustainable provision of water of an acceptable quality to local and international users.

The management measures will be of an overarching nature and will deal with the broader Olifants WMA while taking strategies and plans developed at sub-catchment level into account. The IWQMP will detail feasible management options for implementation in the short term (next 5 years), assess the medium term strategies (10 years) at the pre-feasibility level and longer term strategies at the reconnaissance level.

A further important deliverable from the study will be a set of integrated Water Quality Planning Limits (WQPLs) for the Olifants WMA and the individual sub-catchments that will include development of WQPLs, adjustments to the existing WQPLs and alignment to Resource Quality Objectives (RQOs).

Water quality deterioration is occurring in many areas within the Olifants Letaba catchment. Improvement in water quality is necessary to ensure sustainability and maintenance of the ecological condition and to ensure protection afforded through the Reserve. Actions related to water quality management and management of land based activities have been identified to achieve the Reserve, are proposed. This requires that the necessary liaison and linkages with the Olifants Water Quality Management Plan Development study be established and that the measures be aligned to addressing the requirements of the Reserve.

This will require linkages to the sub-catchment strategies and the proposed water quality monitoring programmes to be developed for the Upper, Middle, Lower Olifants and Steelpoort catchments as part of the project. Integration to these processes should be undertaken at this stage to ensure actions supporting the Reserve are incorporated into the wider catchment water quality management plans.

4.2.5 REGULATION AND CONTROL

The achievement of the Reserve, in addition to implementing basin wide planning, operational and water quality interventions will require regulation and control of water use and development. This will require improvement compliance and enforcement of existing authorisations. This will necessitate improved and wider monitoring, auditing and control of the water resources and their use to understand the impacts and non-compliances in the system. Based on the information provided from these programmes, compulsory licensing, increased regulatory measures, incentives, and other measures may be required to align to the operational needs of the Reserve. Management, control, use and development forms an integral part of the CMS and thus the Reserve would need to be integrated into current plans and activities. In addition operational requirements and management measures would inform new water use authorisations and development. Overall, co-operative governance must be encouraged between departments and NGO initiatives, in order to progress the relationships so one can work towards improving the existing tools used in managing and operating the catchment.

The resourcing, institutional arrangements and responsibilities for the regulation, monitoring and control of water resources occur within the integrated water resource management environment and thus a co-ordinated approach is needed to facilitate the integration of the specifications of the Reserve into existing and future strategies, operational plans and programmes.

Reporting requirements are also fundamental to informing adaptive management relating to whether the Reserve requirements are being met or not. Thus, the CMS processes and other reporting mechanisms must account for Reserve compliance information. This will require liaison and establishment of programmes amongst the Chief Directorates' Water Ecosystems, Compliance Monitoring and Water Monitoring and Information.

4.2.6 ECOLOGICAL WATER RESOURCES MONITORING

The objective of the Ecological Reserve assessment is to provide quantified and descriptive information regarding flows and associated concentrations of water quality constituents, which describe both the present state of the system and conditions for the selected Target Ecological Categories (TEC). Generally the biota and habitat are described through Ecological Specifications (ecospecs) where detailed numerical information is available for river reaches which contain EWR sites. The process also defines ecological water resource monitoring requirements (EWRM) for the maintenance of ecospecs at each EWR site.

Ecological water resource monitoring is undertaken through the River Eco-status Monitoring Programme (REMP). The REMP evolved from the River Health Programme (RHP) and is a component of the DWS National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). The REMP focuses on the monitoring of the ecological conditions in river ecosystems as it is reflected by the system drivers and biological responses (instream and riparian).

Ecological Water Resource Monitoring (EWRM) therefore measures whether the ecological objectives set according to the Ecological Reserve Process are being met. A recent development in EWRM is the Rapid Habitat Assessment Method (RHAM). The RHAM is a process to collate relevant habitat information in a cost-effective manner for EWRM monitoring.

A monitoring programme must be developed to monitor the condition/health/state of the wetlands in the catchment area. This must be done in order to determine whether or not the REC, and where appropriate, the BAS for each of the affected wetlands is being met or maintained. This should include monitoring of important biota (fauna and flora) as well as diatoms and invertebrates where appropriate. Any such monitoring strategy must be developed by a suitably qualified specialist and submitted to the DWS for review and approval. The use of appropriate wetland assessment tools should form part of the monitoring method for wetlands.

Co-ordination and integration of the ecological monitoring of the Olifants/ Letaba Reserve (habitat and biota) into existing programmes is required to optimize and ensure efficient utilization of resources and effort. In addition it is important that all biomonitoring data is incorporated into the NAEHMP on a continuous basis to provide a solid and complete repository of information. This would not only support the information needs of the Olifants/Letaba Reserve in understanding the biological responses and condition but it will serve as a source of reference for determining the health of the system. The ecological Reserve monitoring should establish linkages with other national, regional and local biomonitoring programmes in the catchment area to expand the database and knowledge available. All the data should be made available through the NAEHMP. This should be an activity that is addressed through the Chief Directorates' Water Ecosystems and the Water Monitoring and Information and implemented through the proto-CMA (to eventually comprise a component of the CMS).

4.2.7 MONITORING PROGRAMMES AND NETWORKS

Monitoring of the EWRs is a key component of Reserve implementation in order to support effective management actions ("you can only manage what you can measure"). The design and implementation of effective monitoring networks and repository databases is pivotal to ensure adequate protection of water resources is being achieved in the catchment. Monitoring of system change is crucial, but more importantly the system must be audited against the desired state, to ensure that the EWRs are met and the system is maintained in the desired state (or TEC) and if not, then DWS would need to respond with appropriate action.

More funding and resources are required at a national level to address the current monitoring information gaps. The capacity at Regional Offices on sampling, data collection, data compilation and interpretation and information reporting needs to be strengthened and expanded. This is important for rivers, groundwater and wetlands.

Currently the DWS do have national monitoring programmes in place for hydrological monitoring, water quality monitoring and groundwater monitoring. These programme would have to support the monitoring of the EWRs (quality and quantity). However at present the flow gauges, water quality monitoring sites or boreholes are at locations/sites that are not necessarily linked to EWR sites or groundwater monitoring sites specified. In many instances, where they are present, the monitoring sites may be inactive or do not support the monitoring needs of the Reserve. There are also vast gaps in data as well as a lack of integration in the monitoring programme to generate the information required. Thus, this is another integrated activity that needs co-ordination to support the implementation actions of the Reserve. Compliance geohydrological monitoring based on monitoring low flows and water levels at gauging weirs and boreholes is required.

An integrated monitoring programme is also required to monitor the condition/health/state of the wetlands in the catchment area. The use of appropriate wetland assessment tools should form part of the monitoring method for wetlands. The monitoring of the wetlands should be integrated/aligned to the programmes of the South African Biodiversity Institute (SANBI).

This integration may require the activation of monitoring at existing sites (quality, flow, groundwater), update of monitoring programmes (what should be monitoring, frequency, where), addition of new water quality sites and the building of new weirs. These activities are linked to other national and regional initiatives and activities and thus require a co-ordinated holistic approach for the Olifants WMA. It requires linkages between Chief Directorates, between the Regional and eventually the CMA. In addition other external monitoring programmes may also be aligned to the DWS monitoring networks.

The Chief Directorate Water Monitoring and Information is currently busy with a project 'Review, Evaluation and optimisation of the Water Resources Network'. This provides an opportunity for the Chief Directorate: Water Ecosystems to propose the specific monitoring requirements and programme adjustments to national monitoring programmes.

This is important to see the Reserve process through to implementation and follow up action and required action.

4.2.8 TRANSBOUNDARY OBLIGATIONS

Creating working transboundary water governance structures requires development of trust between stakeholders and an effectively functioning governance framework requires that information is easily available and accessible. The South African Development Community (SADC) strategy advocates that member states must communicate on the IWRM approach, cooperation on water management, climate change, variability and water-related disasters (SADC, 2000). To this end, there is currently a strategy underway for the Limpopo Basin to assist the basin states with its monitoring compliance. Water quality is one of the aspects to be monitored, however, it should be noted that whilst the legal framework around this for shared water courses is complex, there is evidence of strong cooperation between South Africa and Mozambique. It is hoped that this strategy promotes regular information exchange rather than exchanges due to incidences, such as crocodile deaths.

In addition, there exists the Inco-Maputo agreement between SA and Mozambique that as a specific Annexure on water quality monitoring, but to date there are no clear steps for implementing it. This has been seen with a number of agreements. There are however no specific requirements around instream flow requirements or ecological health.

Overall compliance monitoring needs to be improved and prioritised. However, the willingness for cooperation is a good foundation from which to move forward for both South Africa and Mozambique and issues around the Olifants River. The implementation of the Reserve should be met, which will contribute to the foundation that currently exists.

4.2.9 INTEGRATION, CO-ORDINATION AND LINKAGES

In summary, implementation of the Reserve requires integration and alignment of strategies and activities within the existing environment of integrated water resource management in the Olifants WMA; which includes the following:

No	Parallel Water Resource Management Strategies, Processes and Activities	Reserve Integration/Alignment/Co-ordination required for implementation to be achieved
1	National Water Resource Strategy	To be included in next revision once gazetted – as part of water resource management framework
2	Water Resource Class and Objectives (Water resource protection)	(Have been gazetted) - Integration into protection framework for Olifants WMA and be implemented in a co-ordinated and integrated manner. Needs an overarching plan. This may also require an establishment of a working committee related to implementation.
3	Catchment Management Strategy	Must be incorporated into the CMS in terms of implementation actions required for the Reserve that has to be met. Has linkages to a number of activities namely: land use activities, rural development upstream from KNP, sand mining and eradication of wetlands, will require co-operation of all catchment based organisations.
4	Maintenance of the Reconciliation Strategy.	Revise based on the Gazetted Reserve and account for implementation of the EWRs
5	Operating Analysis and system operation	Integrate into operational planning and control of infrastructure and maintenance and management of operating rules. Operating tool must be developed to support Reserve implementation. Assessment of the flow in the system and to inform release plan.
6	Institutional arrangements	Linked to a number of activities and programmes. Roles and responsibilities within and among National government, Regional and local structures must be specified so that actions can be carried out and there is accountability in terms of reporting.
7	Integrated Water Quality Management	Linkages to the WMA strategy and plans being developed so that actions supporting achievement of the Reserve may be integrated into process.
8	Regulation, Use, Control	Facilitation integration of Reserve implementation requirements in regulation, use and control activities and plans for the WMA. Reserve implementation may inform actions and regulation that may be required. Integration of actions into CMS.
9	Monitoring	Revision of monitoring networks and programmes for surface water and groundwater is required. New sites and weirs, activation of inactive sites and monitoring boreholes must be evaluated to extend the monitoring networks. Additional resources are needed. Integration of national and regional

		programmes. Integration of programme and actions into CMS. New monitoring networks to include wetlands are required. Integration with the SANBI progammes for wetlands should be undertaken. Geohydrological monitoring must be undertaken.
10	Ecological Water Resource Monitoring	Co-ordination and integration of the ecological monitoring of the Olifants/ Letaba Reserve (habitat and biota) into existing programs is required to optimize and ensure efficient utilization of resources and effort. All bio monitoring data is incorporated into the NAEHMP on a continuous basis to provide a solid and complete repository of information. This should be inclusive of wetland systems.
11	Trans boundary Obligations	Although no specific obligation currently exists with Mozambique in terms of in stream flow requirements meeting the Reserve requirements in the Olifants River will contribute to improved quality and flow into Mozambique.

5 ACTIONS/INTERVENTIONS TO ACHIEVE IMPLEMENTATION OF THE RESERVE

The determination of the Reserve as per section 16 of the NWA, now having been completed requires certain actions and/or interventions to be undertaken in order to aid in its implementation within the Olifants WMA. The following section focuses on the recommended actions and steps that should form part of an implementation process. As outlined in the previous section, the Reserve is implemented within an integrated water resource management context and thus need to align, integrate and co-ordinate with current strategies and activities that are relevant water resource protection.

For the Reserve to be implemented in the Olifants/Letaba System, the EcoSpecs specified for the biological response components (the biota and habitat) are detailed numerical information has been determined for the river reaches at the EWR sites. The EWRs (quality and quantity) which together define ecological integrity, are the targets set to be achieved. Both of which are priority indicators for monitoring status and compliance.

The above relate to specifications set for hydrology, water quality, habitat and biota of rivers and have been set for the selected Target Ecological Category (TEC). The groundwater component of the Reserve and wetlands Reserve have also been specified and require additional specific implementation actions.

The actions/interventions to achieve the implementation of the Reserve include:

- Regulation, control, enforcement, compliance monitoring interventions to ensure that the target ecological specifications determined are adhered to;
- Management of the flow and operation of the system to achieve the desired flow at the related EWR site;
- Integrated Water quality management interventions to control and manage non-flow related impacts and associated monitoring activities;
- Management of the integrated releases from the various dams in the system to achieve the EWRs;
- Actions to support habitat and biological integrity of the water resources;
- Actions and interventions related to the implementation of the groundwater Reserve; and
- Actions and interventions related to the protection and sustainable management of wetland and development in the wetlands.

A key factor for this implementation plan will be to co-ordinate among all relevant institutions involved in water resource management to ensure efficient utilisation of existing resources and ensure that monitoring is adhered to. DWS will take the leading role in formalising the appropriate links with the institutions give examples how see Komati or Letaba. Compliance monitoring must be conducted at the EWR sites with the aim to implement the recommended TEC. Further priority sites were identified during this study in order to fill the ecological gaps which will result in additional monitoring points to be monitored and maintained by the Department and or CMA.

In order for the recommended EcoSpecs to be implemented, it is important that the recommendations are taken forward within the next 2 to 15 years to

5.1 ACTION/INTERVENTION 1 – ECOLOGICAL SPECIFICATIONS MUST BE MET:

Ecological specifications defined for drivers and responses serve as the ecological objectives that must be met. Specification of the ecological attributes and the driver components would provide an indication of the attainment of the TEC. The monitoring of these specifications and the drivers would determine how a resource is changing over time and whether the Reserve is being met. If not met, management intervention may be required in order to attain the desired ecological category. Ecospecs are provided for the following components (drivers and responses):

- Flow;
- Water Quality;

Indicators

- Macro invertebrates;
- Fish; and
- Habitat Integrity.

Responses

Proposed Actions:

- The Target Ecological Specifications (in addition to the gazetted RQOs) for water quality, fish, macroinvertebrates and habitat integrity must be implemented as specified for each EWR site (as specified in the Ecological Specifications report);
- The ecological water resource monitoring programme must be established as part of the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) and implemented for the Olifants/Letaba Reserve to assess compliance and determine if the target ecological categories are being achieved. Undertake surveys and monitoring to determine any changes in the ecological categories and the trajectory of change. Determine frequencies and establish networks. Integrate with the existing structures and programmes.
- Ensure the monitoring data is loaded on the central repository (NAEHMP database), updated regularly and maintained;
- Update the temporal and spatial extent of the water quality and flow monitoring programmes to allow a higher level of confidence in the results for the EcoSpecs and RQOs especially in the middle Olifants catchment and downstream in the Kruger National Park to aim for the C category at site Olifants_EWR16;
- Required reporting and information must be generated on a periodic basis (biannually) to assess meeting of the Reserve and check if the river health is responding as expected. This is required to implement intervention if and as required in terms of the Reserve monitoring programmes namely FIFHA, PES/EIS and the Revised Desktop Reserve; and
- Resourcing and institutional arrangements regarding the monitoring activities and information management must be specified;

Time frames:

This action should be implemented as one of the first actions to be undertaken as it forms the basis of the Reserve. Once approved and gazetted the Reserve should be implemented and the monitoring and reporting must be initiated within at least 3 months thereafter

5.2 ACTION/INTERVENTION 2: FLOW MANAGEMENT AND OPERATION OF SYSTEM

The ecological specifications are encompassed in the EWRs in terms of flow. The following descriptors of the flow characteristics are used to describe the EWRs in terms of ecological specifications:

- Total Mean Annual Maintenance and drought low flow volumes;
- Monthly Mean Maintenance and drought low flows;
- Monthly exceedance curves for the low flows (excluding freshets and floods);
- Monthly exceedance curves for the complete flow regime; and
- Duration, magnitude (in daily averages), volume and timing of intra-annual floods.

A summary of the Reserve flow specifications (requirements) for the EWR sites in the Olifants WMA is provided in Section 3 of this report. The detailed information is provided in the other study reports (EWR quantification and ecological consequences reports). These have been defined as a set of Reserve assurance rules (frequency of occurrence tables of flow rates or volumes for different months of the year).

Proposed Actions:

- Integrate EWRs into the Reconciliation Strategy maintenance requirements and ensure required updates to system operational analysis, operation and control.
- A flow monitoring programme is required to ensure the recommended EWRs are met. This requires the following:
  - What: Measure flow – compare to specifications (ecospecs)
  - Where: Identify which flow gauges will form part of the monitoring programme (existing, and where required new weirs must be built. In addition, sites where *in situ* measurements are required must be confirmed). It is proposed that flow is measured at all EWR sites.
  - How: Develop an operational plan and support tool.
- An operational plan needs to be developed to identify flow releases, operate the system as an integrated system, to maintain the EWRs and to also maintain the supply to the end-users. This will require the development of an operational tool – a real time operational model that monitors flow in the system. This will allow the DWS to determine where the flows are not

met, where the losses are and where intervention or operational actions are required. Such a model or tool will allow a more precise regulation and management of the system.

- Ensure that the flows at the weirs are measured so that releases can be made in order to meet the recommended EWRs:
    - Klipspruit @ Zaaihoek (B1H004)
    - Olifants below Witbank Dam (B1H010)
    - Klein-Olifants River below Middleburg Dam (B1H015)
    - Bronkhorst Spruit @ Roodepoort (B2H001)
    - Loskop Dam (B3H017)
    - Steelpoort River @ De Hoop Upper (B4H024)
    - Olifants River @ Finale (B7H009)
    - Olifants River @ Mamba Kruger National Park (B7H015)
- Compare flows with the recommended EWR flows and ensure that flows are released accordingly to meet the requirements. Should training be required to support this action, DWS personnel need to be adequately capacitated;
- Make use of the excess water in De Hoop Dam to support ecological water requirements in the lower Olifants River while the projected water requirements grow to the dam yield.

Time frames:

This action should be immediate, once the Reserve has been approved and gazetted. The operation plan and flow monitoring programmes must be developed by 6 months after the gazette of The Reserve, and a real time operational model should be in place 6 month after the gazette.

5.3 ACTION/INTERVENTION 3: WATER QUALITY MANAGEMENT INTERVENTIONS

The water quality Ecospecs of the Ecological Reserve include a range of selected variables that provide baseline data that would provide an interpretation of biological responses and whether water quality as a driver is a problem or influencing the ecological condition of the system. Monitoring and assessment of the physico-chemical data provides an understanding of the water quality impacts in the system, and an indication of whether the water quality contributes to the ecological category of the site. The present ecological state and ecological category of some of the EWR sites and many areas in the Olifants WMA are influenced by non-flow related impacts and land based conditions, such as discharge of pollutions into water resource, erosion, alien infestation etc.

Proposed Actions:

The actions required to achieve the water quality eco-specs and the water quality interventions required to manage non-flow related impacts include the following:

- The suite of water quality parameters must be monitored at the EWR sites namely *in situ* water quality, organic, inorganic, heavy metal analyses and microbiological parameters.
- The necessary linkages with the national chemical water quality monitoring and other national programmes (e.g. microbiological) must be created to support the Reserve water quality monitoring. This may require the update or revision of existing national programmes to support the Reserve monitoring required. Integration and co-ordination must be achieved.
- Consolidation of the water quality data collected from the different water quality databases and assessments to provide a consolidated view of the water quality trends within the catchments must be undertaken.
- The available data at the points selected will need to be collated from the various databases. The existing database must be updated with the data collected to provide the water quality history at the monitoring points.
- Resourcing and institutional arrangements regarding the monitoring activities and information management must be specified.
- Integration with the Integrated Water Quality Management Plan project and with regulation and control functions must be achieved to include possible interventions to address land based activities and impacts to the water resources. This must also include the alignment of the water quality requirements to sustain the ecology in the required ecological category to the water quality requirements of the other water users along the main stem of the Olifants, Letaba and Shingwedzi Rivers.
- A monitoring programme should be set up for the irrigation schemes measuring the inflow volumes and qualities, channel supply efficiencies, application rates and the return flow drainage channels should be monitored. This action will support management of the water quality.
- The groundwater quality should also be assessed as the modelling exercise indicated that a significant portion of the salt load entering the groundwater system is not returning in the return flow.
- Where non-compliance of water quality ecospecs and RQOs are identified and where water quality is significantly impacted, an assessment of discharge standards may be required. This would need to inform the necessary processes, plans or regulatory actions.
- The development of the nutrient balance using the available instream flow and water quality data is required to understand the system. The balance must include all the point sources and estimates of the wash-off loads from urban and agricultural areas. The monitoring of the return flows from the irrigation schemes will support the nutrient balance study.

- Management of wastewater discharges and non-point source impacts in the Upper Olifants catchment related to mining and urbanisation (wastewater treatment works (WWTW) must be addressed.
- Management of return water flows from WWTW, in particular Olifants_EWR4 on the Lower Wilge, Olifants_EWR1 before the Klein Olifants confluence and site on the Klein Olifants (vicinity of EWR3) is required as urgent intervention.
- Land use management particularly in the middle Olifants where there is agricultural activities, mining activity and sprawling villages in the reach between EWR7 and EWR8 and the tributary catchments (over grazing, cultivation, run-off from villages, erosion and microbiological pollution).
- Monitoring and management measures for identified acid mine drainage.
- Continual maintenance and annual auditing of WWTWs within the catchment areas is required as a matter of priority to prevent any further water quality deterioration.

Time frames:

An integrated and revised water quality monitoring network and database management system should be developed and in place by July 2018. Integration with the Olifants Water Quality management Strategy implementation must be achieved by January 2018. In addition the activities requiring source management and regulation must be incorporated into the relevant line functions within the Department. This should be achieved by 6 months after the gazette of The Reserve.

5.4 ACTION/INTERVENTION 4: MANAGEMENT OF THE RELEASES FROM THE DAMS

Achieving the EWRs in the Olifants/Letaba system are largely reliant on dam releases. Therefore integrated system management and operation would be required. There are a number of dams in the Olifants/Letaba system that would require an update of their operating rules. This would link to the operational tool required to support the flow management component. Due to the scarcity of water in the WMA and the great demand on the water resources, dam releases would need to be operated very stringently and rigidly to ensure that the water is released only when required downstream.

Proposed Actions:

- Include EWR requirements into operational planning and control of infrastructure and maintenance and management of operating rules. Operating tool must be developed to support Reserve implementation to inform the release plan.
- Management of environmental releases from dams should mimic the natural flow pattern as specified in the EWR quantification report and gazetted Reserve template.
- Flow release management from the following major dams need to be implemented to meet the recommended EWRs:

- Witbank Bank (Upper Olifants River);
- Middelburg Dam (Klein Olifants River);
- Flag Boshielo Dam releases to Middle Olifants River);
- Mkhombo Dam (Lower Elands River);
- De Hoop Dam (Steelpoort River);
- Blyderivierpoort Dam (Blyde River);
- Smaller dams in the Olifants River system, including dams in the Bronkhorstspruit, Selons, Upper Elands, Ohrigstad and Klaserie Rivers);
- Dap Naude Dam (Broederstroom);
- Ebenezer and Tzaneen Dams (Great Letaba);
- Middle Letaba Dam (Middle Letaba River); and
- Proposed Nwamitwa Dam on middle reaches of Letaba River.

- Allow and/or manage environmental flows to maintain water quality and quantity, daily and seasonal flows, stream velocities, in-stream-, riparian and/or wetland vegetation.
- Eradicate and control alien invasive species.

Time frames:

This action should be immediate once the Reserve is approved and gazetted. Update of the dam operating rules should be completed by 6 months after the gazette of The Reserve. A real time operational model should be in place 12 months after the gazette of The Reserve.

5.5 ACTION/INTERVENTION 5: FISH, MACROINVERTEBRATES AND HABITAT INTEGRITY

The ecological integrity of the aquatic ecosystem (fish, macroinvertebrates, habitat) will be affected in several ways by flow regulation and water quality (drivers). These include both beneficial and adverse effects. Some species may increase in abundance in the rivers whereas others may be lost from a specific reach. Water quality, as a driver, would impact on the health of the ecosystem, influencing the habitat and causing changes to the fish communities.

Ecological specifications for the EWR sites within the Olifants, Letaba and Shingwedzi catchment have been specified for the biotic responses components. The target ecological categories specified for these components must be met.

Proposed Actions:

Implementation of the aquatic biodiversity, including instream and riparian habitat of the Reserve should focus on the following implementation model:

- The monitoring programme must be established as part of NAEHMP and implemented for the Olifants WMA Reserve to assess compliance and determine if the target ecological categories are being achieved.
- The bio monitoring programme to be implemented at each EWR site should include the following:
    - *In situ* water quality: Parameters that will be assessed at each of the sampling sites will include: pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), Total Dissolved Solids (TDS) and water temperature.
    - General Habitat Assessment: General description of the aquatic sampling sites. Parameters to be described include site location (GPS reading); photographs (for further identification of major changes and documentation of habitat conditions); watershed features (*i.e*., surrounding land use, sources of pollution, erosion).
    - Integrated Habitat Assessment System (IHAS - version 2). The IHAS index was developed specifically for use with rapid biological assessment protocols in South Africa (McMillan, 1998), and reflects the suitability of habitat as a percentage, where 100% represents “ideal” habitat availability. IHAS is conducted in conjunction with the South African Scoring System Version 5 (SASS5).
    - Conduct the instream and riparian habitat integrity as this is a precursor of the assessment of biotic integrity.
    - Aquatic Macroinvertebrates (SASS5): The South African Scoring System Index (Version 5) should be used to provide an indication of the state of the aquatic environment and will need to be compared to data collected during previous surveys in order to detect trends in aquatic ecosystem health.
        - The Macroinvertebrate Response Assessment Index (MIRAI) must be conducted to identify the ecostatus of the aquatic macroinvertebrates and this must be compared to the determined REC for that EWR site.
        - To be noted, SASS (South African Scoring System) for macroinvertebrate assessment is only applicable to rivers and streams – *i.e.* systems that are flowing. It is not applicable to wetlands, dams and estuaries.
        - The aquatic ecologist undertaking the SASS5 monitoring must be an accredited SASS5 practitioner. A list of accredited SASS practitioners is available on the River Health Programme website: **http://www.dwaf.gov.za/iwqs/rhp/quaiity.html** or alternatively Ms C Thirion (thirionc@dwa.gov.za) from the Directorate: Resource Quality Services, DWS, can supply this information.

- Diatoms should be analysed
- Ichthyofauna (fish): Whereas aquatic macro invertebrate communities are good indicators of short-term localized conditions in a river, fish being relatively long-lived and mobile are:
  - Good indicators of long-term influences;
  - Good indicators of general habitat conditions;
  - Integrate effects of diverse trophic levels; and
  - Consumed by humans.
- The ichthyofaunal assessment must focus on fish species diversity and abundance, fish health assessment and the presence of Red Data species.
- The Fish Response Assessment Index (FRAI) must be conducted to identify the ecostatus of the fish and this must be compared to the recommended TEC for that EWR site.

- Erosion control measures should be implemented.
- Eradicate and control alien invasive species.
- Maintain the flow for flow sensitive species (*i.e.* rheophilic species). This implementation will be in line with Section 5.4 for dam releases.

Time frames:

A biomonitoring programme must be in place by 6 months after the gazette of The Reserve. Eradication of alien invasive species must be incorporated into existing programmes.This must be achieved by 12 months after the gazette of The Reserve.

5.6 ACTION/INTERVENTION 6: GROUNDWATER COMPONENT

The groundwater Reserve includes groundwater quality and quantity indices, a groundwater quality status/trend narrative, and a groundwater quantity directive/recommendation. The groundwater Quantity Directive/Recommendation lists five levels of potential stresses on the groundwater component in the quaternary catchments, each with a specific guideline to address further groundwater allocations. Achievement of the groundwater component of the Reserve requires a number of management, control and regulation interventions that extend to the broader management of the catchment areas in the WMA. They relate largely to the development and use of the groundwater resources.

Proposed Actions:

Implementation of the groundwater component of the Reserve should focus on the following implementation actions:

- Established linkages with the overall groundwater management strategy for the WMA and to the Reconciliation Strategy Maintenance Study. The necessary updates based on the groundwater component of the Reserve must be made.
- A quaternary catchment ranking is required, *i.e*. flag those quaternary catchments where the stress index and/or allocable groundwater are >65% (0.65) and <1 MCM/a respectively.
- Updating the groundwater use figures to the actual values through annual auditing of the water use licenses (groundwater).
- Verification of the groundwater use figures according the a ranking of the quaternary catchment groundwater allocable volumes, *i.e.* starting in those quaternary catchments where the value is zero and below 1MCM/a;
- An assessment of all the quaternary catchments groundwater use sites, *i.e.* individual water use points should be performed as in several cases groundwater abstractions (and probably over-utilised) are situated in a small area, whilst the rest of the catchment is not utilised.
- Catchments where the Quantity Index falls below a C (Moderately Modified), the catchment should be flagged and all reserve should be set at ~1 MCM (this should be negotiated with other components of the quaternary catchment water balance;
- All new water use applications (volumes) should be scrutinised against (i) all local groundwater allocations – a simple local water balance (i.e. Stress Index), (ii) the estimated reserve limit (say 1 MCM/a) and (iii) the potential of the water use activity to impact on the water quality;
- In those quaternary catchments where the Stress Index is >100%/allocable to groundwater is zero, all new water use applications will have to be evaluated according a High, Moderate or Minimum level of investigations. For a Highly Stressed Index Level, detailed groundwater investigations are required, including water balance modelling, aquifer characterisation and establishment of specific monitoring programmes. A Minimum Stressed Index Level only requires a volume specification, position in terms of other water resources, site map and a monthly volume/water level/rainfall monitoring programme.
- Mitigation measures for over-utilised aquifer systems should be considered – unfortunately these are very site specific approaches and should be addressed on a water users associations and/or catchment manage agency's level.
- The groundwater quantity assessment also includes surface water impact ranking – flagging of those quaternary catchments is included in the quantity directive/recommendation narrative in the EcoSpecs specified.
- Control over the groundwater quality is difficult due to the fact that mitigation measures for groundwater are complex and timely.
- Conservation of the groundwater quality in the Olifants WMA is urgently required. As per the hydrogeological status assessment of the groundwater quality, certain areas have been mapped where groundwater quality deterioration was detected.

- A ranking of the quaternary catchments where groundwater quality issues is required, *i.e*. the Quality Index, supported by the Groundwater Quality Status/Trend narrative.

To conclude, flagging of the quaternary catchments in the study area has been achieved (Quantity and Quality Indexes) (Figure 4). The narratives of these flags must be applied when assessment of any groundwater use application is approached. Secondly, these is a range of activities that needs to be addressed to increase the value of the groundwater assessment. This will be required as in the case of the highly impacted aquifer systems, re-allocations of the groundwater will have to be considered.

Time frames:

A groundwater management plan for implementation of the Reserve must be developed by 6 months after the gazette of The Reserve. This must also include a monitoring and reporting programme

5.7 ACTION/INTERVENTION 7: WETLANDS RESERVE

Wetlands specifications including recommended protection, management and monitoring requirements have been specified as part of the Wetlands Reserve. This should be undertaken by a registered and validated wetland specialist.

Proposed Actions:

Implementation of the wetlands Reserve should focus on the following implementation actions and interventions:

- The wetland Freshwater Ecosystem Priority Areas (FEPAs) need to be validated to confirm their PES, EIS and REC. Any development applications in these areas need to take cognisance of the presence and importance of these wetlands. Such development applications will need to be accompanied by detailed baseline wetland assessment reports that include the determination of the PES, EIS and REC of the affected wetlands, as well as an impact assessment that clearly demonstrates application of the mitigation hierarchy.
- For validated FEPA wetlands that do not meet the Recommended Ecological Category (REC), and where appropriate, the Best Attainable State (BAS), it is recommended that rehabilitation plans are developed and implemented in consultation with an appropriate implementer such as Working for Wetlands, in consultation/collaboration with the local community. The plans should address cultivation, erosion/headcutting and overgrazing in these systems and make provision, not only for structural interventions, but also the development of grazing management plans for the systems and their catchments.
- Development footprints must be fenced off from wetlands;
- A fire management plan for wetlands and their buffers must be developed and implemented (specific to IUA7, Letaba IUA1, 2, 3);
- Suitable hydrological and ecological buffer zones around wetlands should be determined and implemented;

- Operations, including the crossing of wetlands by vehicles, and storage of equipment in wetlands, are to be prevented as far as possible. Where crossings of wetlands are necessary or unavoidable, suitable mitigations measures must be put in place to protect the wetlands;
- Stormwater management plans must be developed and implemented prior to all phases of mining operations. These must include measures to prevent erosion and siltation of wetlands as well as slope, bank, channel, and/or drainage stabilization measures to reinstate the pre-development hydrology (including both surface and sub-surface hydrology). Stormwater should ideally be conveyed in environmentally engineered or natural channels rather than cement lined canals or excavated trenches. Discharge points into the environment should be protected against erosion and designed to disperse flow and be subjected to regular maintenance. The stormwater management plan must be submitted to the DWS for approval prior to the commencement of any activities on site;
- In order to reduce the potential impacts associated with the introduction of contaminants, dissolved or suspended, in the runoff from infrastructure areas and construction sites, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred and management measures must be put in place to protect wetlands from such runoff;
- Potential contaminants associated with mining or other developments must be stored and managed in such a way as to prevent spills and leaks. Management plans to prevent and deal with, contain and/or clean up spills, must form part of any WUL application;
- Where applicable, disturbed areas (i.e. for those areas that will not form part of the development operational footprint but which will be disturbed as part of the construction activities) should be rehabilitated using site-appropriate measures, specific to the region and type of wetland system affected. A rehabilitation plan must be drawn up for this purpose and a suitably qualified specialist should oversee this process;
- An alien vegetation management plan must be developed and implemented covering all phases of the development project;
- Where conveyors, pipelines, culverts, roads, powerlines, drains or any other infrastructure or servitude crosses or impacts a wetland, Method Statements must be developed indicating how impacts during the construction and operational period will be minimised and managed. This must include recommendations for dealing with and rehabilitating all compacted areas or areas where flow has been diverted, concentrated or drained. Method Statements must include construction and rehabilitation management and monitoring plans;
- Seasonality must be considered as part of the construction phase of any development, whether mining or other, in order to minimise the risk to the hydrology of the wetland systems as well as to prevent excessive sediment and debris being washed into wetland areas;
- No threatened flora should be collected or harvested from wetlands and no fauna, especially threatened fauna, should be hunted or poached from wetlands. Search and rescue plans for fauna and flora must form part of any water use authorisation application;

- Wetland protection, rehabilitation and monitoring measures must be incorporated into mine closure plans as part of decommissioning and closure planning and related activities;
- No equipment including vehicles should be washed in streams, rivers and/or wetlands, and if washing facilities are provided, these must be placed outside of the buffer zones applicable to the wetlands and/or watercourses and designed so as not to impact the wetlands and streams, in terms of both water quality and quantity/flow;
- No abstraction of water from wetlands, streams and rivers should be allowed, unless specifically authorized in terms of the water use authorisation;
- No mine or industrial contaminated water should be allowed to enter wetlands and mechanisms must be put in place to protect wetlands from any form of mine-related contamination;
- Flow supplementation from water treatment plants to affected wetlands is recommended in all cases where there is an indirect loss of wetland functioning as a result of mining or industrial activities. This must be implemented according to a flow management plan which includes specific design and wetland protection measures, a schedule for the releases as well as a provision for adaptive management informed by monitoring;
- Should mitigation, via supplementation of the flows that will be lost in the affected wetlands, be unachievable resulting in a residual impact associated with the decrease in the health or PES of the wetland systems, measures must be put in place to offset the entire, or part of, the net loss expected. This must take into account both wetland functional and ecosystem conservation hectare equivalents;
- Similarly, where there is a residual impact associated with the direct loss of wetland systems, measures must be put in place to offset the entire, or part of, the net loss expected. This applies to mining-related as well as other developments. This can be achieved through a Wetland Offset or Rehabilitation Strategy. This must include the rehabilitation, protection, management and monitoring of remaining or other wetlands to achieve a suitable functional hectare equivalent target and certain ecosystem conservation targets recommended by the authorities. Wetland rehabilitation activities should be targeted to try to achieve a net gain in functional hectare equivalents. The draft SANBI Wetland Offsetting Guidelines (SANBI and DWS, 2014) or any updated revision of this approach/document should be used to guide the process of offsetting;
- A monitoring programme must be developed to monitor the condition/health/state of any wetlands affected by a proposed development. This must be done in order to determine whether or not the REC, and where appropriate, the BAS for each of the affected wetlands is being met or maintained. This should include monitoring of important biota (fauna and flora) as well as diatoms and invertebrates where appropriate. Any such monitoring strategy must be developed by a suitably qualified specialist and submitted to the DWS for review and approval. The use of appropriate wetland assessment tools should form part of the monitoring method for wetlands.

- For pans affected by a proposed development, and particularly a mining development, it is recommended that monitoring of pan water chemistry be conducted according to a specified schedule and for certain key elements including, but not limited to: pH; Electrical Conductivity; TDS; Total Alkalinity as $CaCO_3$; Sodium; Calcium; Magnesium; Sulphate; Iron; Chloride; Potassium; Magnesium; Manganese; Aluminium; Phosphorous; Silica; Ammonia; Nitrate; and Fluoride. An independent water laboratory should be used to conduct the analyses and records should be maintained for inspection by the DWS. If there are any signs of deterioration in water quality or contamination of any pan during monitoring, then the Regional Office of the DWS must be informed together with an indication of the probable cause and time span associated with the water quality problem. Mitigation measures will also need to be indicated in order to remedy the situation in the case of water quality deterioration resulting from the development. The results of the monitoring (monitoring reports) must form part of the reporting requirements in the water use authorisation;
- Similarly, for pans affected by a proposed development, it is recommended that Macroinvertebrates and diatoms should be monitored according to a specified schedule. The monitoring must be conducted by a SACNAP registered scientist suitably qualified specialist and the results of the monitoring (monitoring reports) must form part of the reporting requirements in the water use authorisation;
- The monitoring of important biota may also be relevant to a particular development, especially where endangered animal species occur in the wetlands. Records should be kept of sightings in order to help establish whether or not the wetland management practices and rehabilitation efforts are having a positive impact on these species and where appropriate, the local district conservation officer should be contacted to obtain further information on monitoring of important species;
- Where water quality impacts are expected in wetlands, water quality must be regularly monitored according to an appropriate protocol that will need to be put in place based on a regular schedule and for recommended variables. The monitoring plan must include a provision for appropriate and timeous remedial interventions in the case of non-compliance. The results of the monitoring (monitoring reports) must form part of the reporting requirements in the water use authorisations; and
- Water quality monitoring must be undertaken in accordance with the Water Quality Ecospecs where these are available. Records should be maintained for inspection by the DWS. Mitigation measures will also need to be indicated in order to remedy the situation in the case of exceedance or non-compliance.
- For the wetlands within the Shingwedzi catchment:
  - The spring mires are located within the Kruger National Park and are formally protected. However, at least of the systems are showing signs of degradation. It is therefore recommended that a monitoring plan be developed and implemented to be establish the trajectory of change of the system and to inform the development of management and rehabilitation plans for these systems, if required. An adaptive management approach

should be adopted, with results from monitoring activities used to improve management measures.

- For the valley bottom wetlands, a monitoring programme must be developed to monitor the condition/health/state of a selected sample of wetlands. This must be done in order to determine whether or not the REC, and where appropriate, the Best Attainable State (BAS) for each of the affected wetlands is being met or maintained. This should include monitoring of important biota (fauna and flora) as well as diatoms and invertebrates where appropriate. The use of appropriate wetland assessment tools should form part of the monitoring method for wetlands. For impacted systems that do not meet the REC, and where appropriate, the BAS, it is recommended that rehabilitation plans are developed and implemented for these systems in consultation with an appropriate implementer such as Working for Wetlands, in consultation/collaboration with SANParks. The plans should address the erosion/headcutting and flow concentration in these systems and make provision, not only for structural interventions, but also the development of a management plan for such structures given the likely utilisation by large animals such as elephants.

Time frames:

A management plan for protection of the wetlands in the WMA must be must be developed by 6 months after the gazette of The Reserve. This must also include a monitoring and reporting programme.

6 SUMMARY OF ACTIONS

The following lists the key actions that must be achieved for implementation of the Reserve.

<table>
<tr><th>Action</th><th>Activity</th><th>Completion date</th><th>Duration</th><th>Responsibility</th></tr>
<tr><td>1</td><td>Ecological specifications must be met. Monitoring and reporting within 3 months of the final Reserve being gazetted.</td><td>November 2017</td><td>Ongoing. Biannual reporting</td><td>CD: WE to lead with the support and direction to the CD: Water Monitoring and Information and the Proto-CMA. (Directorate: Compliance Monitoring & Enforcement)</td></tr>
<tr><td rowspan="3">2</td><td>Flow management and Operation of the system</td><td rowspan="2">November 2017</td><td rowspan="2">6 months</td><td rowspan="3">CD: IWRP (Directorate: National Water Resource Planning and Water Resource Planning) to lead with the direction and support of the CD:WE</td></tr>
<tr><td>The operation plan and flow monitoring programme must be developed</td></tr>
<tr><td>A real time operational model should be developed</td><td>July 2018</td><td>12 months</td></tr>
</table>

3	***Water Quality interventions*:** An integrated and revised water quality monitoring network and database management system should be developed	July 2018	12 months	CD: IWRP (Sub Directorate: Water Quality Planning to lead), CD: Water Monitoring and Information and the Proto-CMA.to support implementation. CD: WE to provide input into actions and implementation plan, and assessment of reporting. (Linkages with external programmes to be established)
	Integration with the Olifants Water quality management strategy	December 2017	6 months	CD: IWRP Sub Directorate: Water Quality Planning to lead – strategy development underway. CD: WE to direct actions to be incorporated. Proto-CMA: Regulation and monitoring to address the non-flow impacts
4	***Management of releases from Dams*** :			
	Update of the dam operating rules dams must be operated as integrated and linked systems.	December 2017	6 months	CD: IWRP (Sub Directorate: Systems Operation) to lead with the direction and support of the CD:WE
	A real time operational model should be in place	July 2018	12 months	
5	*Fish, Habitat and Macro-invertebrate integrity:*			
	A biomonitoring programme must be in place	December 2017	6 months	CD: WE to lead with the support and direction to the CD: Operational Support, Coordination and Consolidation (Directorate: Integrated Water Resource Management Support) and the Proto-CMA. (Linkages with external programmes to be established)
	Eradication of alien invasive species must be incorporated into existing programmes.	July 2018	12 months	CD: WE to lead with the support and direction to the Proto-CMA and working for water.
6	*Groundwater component**:*** A groundwater management plan for implementation of the groundwater contribution to the Reserve must be developed. This must also include a monitoring and reporting programme	December 2018	18 months	CD: IWRP (Sub Directorate: Integrated Hydrology) to lead with the support and direction from relevant Directorates within the department, as well as external organisations
7	*Wetland component:* A management plan for protection of the wetlands in the WMA must be must be developed	December 2018	18 months	CD: WE to lead with the support and direction from relevant Directorates within the department, as well external organisations. (Linkages with external programmes to be established) (Directorate: Water Abstraction and Instream Use)

Some of the activities needed to fulfil the requirements of the Reserve implementation relate to functions that are currently performed by different Directorates in the Department of Water and Sanitation (DWS) and other institutions. Coordination among these institutions is essential and the uptake of particular responsibilities relating to these actions need to be formalised and added to their respective business plans. Alignment with the activities with those of the Proto CMA in the Olifants WMA and integration into the CMS must also be achieved.

7 REFERENCES

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APPENDIX A: Detailed Groundwater Reserve per Quaternary Catchment

NOTE:

Class 0 This is ideal water quality, suitable for lifetime use, with no adverse health effects on the user. This class is essentially the same as the target water quality range in the 2nd edition of the *South African Water Quality Guidelines for Domestic Use* (DWAF, 1996).

Class I Water in this class is safe for lifetime use, but falls short of the ideal water quality in that there may be instances of adverse health effects, but these are usually mild, and overt health effects are almost sub-clinical and difficult to demonstrate. Water in Class I does not cause health effects under normal circumstances. Aesthetic effects may, however, be apparent.

Class II Water in this class is defined as that where adverse health effects are unusual for limited short-term use. Adverse health effects may become more common particularly with prolonged use over many years, or with lifetime use. This class represents water suitable for short-term or emergency use only, but not necessarily suitable for continuous use over a lifetime.

Class III This water has constituents in a concentration range where serious health effects might be anticipated, particularly in infants or elderly people with short-term use, and even more so with longer term use. The water in this class is not suitable for use as drinking water without adequate treatment to shift the water into a lower and safer class.

Chemical Parameter	Unit	Olifants River Catchment QC B20A			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	95	8.23	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	95	43.7	<150	48
Calcium as Ca	mg/l	95	32.1	<150	35
Magnesium as Mg	mg/l	95	22.2	<100	24
Sodium as Na	mg/l	95	10.0	<200	11
Potassium as K	mg/l	95	2.14	<50	2.3
Total Alkalinity as $CaCO_3$	mg/l	95	150.8	<330	165
Chloride as Cl	mg/l	95	15.5	<200	17
Sulphate as SO_4	mg/l	95	15.2	<400	16
Nitrate as NO_x-N	mg/l	95	0.36	<10	0.40
Fluoride as F	Mg/l	95	0.17	<1.0	0.19
				Water quality class	**Class 0**

1 Median value (calculated from population of samples in QC).
2 Upper limit of Class I water quality (DWAF et al 1998).
3 The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B31H			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	28	8.201	5.0 – 9.5	8.50
Electrical Conductivity	mS/m	28	123.85	<150	136
Calcium as Ca	mg/l	28	74.3495	<150	81
Magnesium as Mg	mg/l	28	74.3055	<100	81
Sodium as Na	mg/l	28	93.461	<200	102
Potassium as K	mg/l	28	3.2095	<50	3.5
Total Alkalinity as $CaCO_3$	mg/l	28	402.9	<330	403[4]
Chloride as Cl	mg/l	28	71.0795	<200	78
Sulphate as SO_4	mg/l	28	44.199	<400	48

Nitrate as NO_x-N	mg/l	28	25.0555	<10	25.0
Fluoride as F	Mg/l	28	0.6355	<1.0	0.7
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B31J**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	83	7.927	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	83	89.3	<150	98
Calcium as Ca	mg/l	83	64.445	<150	70
Magnesium as Mg	mg/l	83	34.851	<100	38
Sodium as Na	mg/l	83	41.59	<200	45
Potassium as K	mg/l	83	6.61	<50	7.2
Total Alkalinity as $CaCO_3$	mg/l	83	156.554	<330	172
Chloride as Cl	mg/l	83	113.12	<200	124
Sulphate as SO_4	mg/l	83	71.082	<400	78
Nitrate as NO_x-N	mg/l	83	9.768	<10	9.8
Fluoride as F	Mg/l	83	0.387	<1.0	0.5
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B32F**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	71	7.53	5.0 – 9.5	7.75
Electrical Conductivity	mS/m	71	10.9	<150	11
Calcium as Ca	mg/l	71	5.129	<150	5
Magnesium as Mg	mg/l	71	1.8	<100	1
Sodium as Na	mg/l	71	9.383	<200	10
Potassium as K	mg/l	71	2.98	<50	3.2
Total Alkalinity as $CaCO_3$	mg/l	71	30	<330	33
Chloride as Cl	mg/l	71	5	<200	5
Sulphate as SO_4	mg/l	71	4.1	<400	4
Nitrate as NO_x-N	mg/l	71	0.462	<10	0.5
Fluoride as F	Mg/l	71	0.26	<1.0	0.3
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B32H			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	10	8.07	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	10	32.75	<150	36
Calcium as Ca	mg/l	10	15.4205	<150	16
Magnesium as Mg	mg/l	10	3.919	<100	4
Sodium as Na	mg/l	10	27.375	<200	30
Potassium as K	mg/l	10	1.7715	<50	1.9
Total Alkalinity as $CaCO_3$	mg/l	10	76.44	<330	84
Chloride as Cl	mg/l	10	19.831	<200	21
Sulphate as SO_4	mg/l	10	3.1255	<400	3
Nitrate as NO_x-N	mg/l	10	2.7245	<10	2.9
Fluoride as F	Mg/l	10	0.684	<1.0	0.75
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B32J			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	20	8.1255	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	20	34.75	<150	38
Calcium as Ca	mg/l	20	25.0525	<150	27
Magnesium as Mg	mg/l	20	3.9455	<100	4
Sodium as Na	mg/l	20	36.878	<200	40
Potassium as K	mg/l	20	3.288	<50	3.6
Total Alkalinity as $CaCO_3$	mg/l	20	119.036	<330	130
Chloride as Cl	mg/l	20	22.976	<200	25
Sulphate as SO_4	mg/l	20	6.497	<400	7
Nitrate as NO_x-N	mg/l	20	0.6245	<10	0.6
Fluoride as F	Mg/l	20	2.7755	<1.0	2.8
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B41C			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	35	8.13	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	35	55.2	<150	60
Calcium as Ca	mg/l	35	66.099	<150	72
Magnesium as Mg	mg/l	35	26.2	<100	28
Sodium as Na	mg/l	35	13.01	<200	14
Potassium as K	mg/l	35	0.5	<50	0.5
Total Alkalinity as $CaCO_3$	mg/l	35	274.083	<330	275

Chloride as Cl	mg/l	35	10.8	<200	11
Sulphate as SO_4	mg/l	35	11.118	<400	12
Nitrate as NO_x-N	mg/l	35	0.703	<10	0.7
Fluoride as F	Mg/l	35	0.11	<1.0	0.12
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B41D**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	20	7.345	5.0 – 9.5	7.75
Electrical Conductivity	mS/m	20	10.78	<150	11
Calcium as Ca	mg/l	20	6.4	<150	7
Magnesium as Mg	mg/l	20	2.059	<100	2
Sodium as Na	mg/l	20	7.424	<200	8
Potassium as K	mg/l	20	2.5015	<50	2.7
Total Alkalinity as $CaCO_3$	mg/l	20	32.708	<330	35
Chloride as Cl	mg/l	20	5	<200	5
Sulphate as SO_4	mg/l	20	4.956	<400	5
Nitrate as NO_x-N	mg/l	20	0.294	<10	0.3
Fluoride as F	Mg/l	20	0.4065	<1.0	0.44
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B41E**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	37	8.028	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	37	29	<150	31
Calcium as Ca	mg/l	37	18.1	<150	19
Magnesium as Mg	mg/l	37	4.039	<100	4
Sodium as Na	mg/l	37	21.117	<200	23
Potassium as K	mg/l	37	4.456	<50	4.9
Total Alkalinity as $CaCO_3$	mg/l	37	109.16	<330	120
Chloride as Cl	mg/l	37	7.398	<200	8
Sulphate as SO_4	mg/l	37	6.603	<400	7
Nitrate as NO_x-N	mg/l	37	1.531	<10	1.6
Fluoride as F	Mg/l	37	0.379	<1.0	0.41
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B41G			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	13	8.055	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	13	59.2	<150	65
Calcium as Ca	mg/l	13	51.605	<150	56
Magnesium as Mg	mg/l	13	29.374	<100	32
Sodium as Na	mg/l	13	23.522	<200	25
Potassium as K	mg/l	13	0.796	<50	0.8
Total Alkalinity as $CaCO_3$	mg/l	13	244	<330	268
Chloride as Cl	mg/l	13	17.18	<200	18
Sulphate as SO_4	mg/l	13	10.187	<400	11
Nitrate as NO_x-N	mg/l	13	0.055	<10	0.1
Fluoride as F	Mg/l	13	0.1	<1.0	0.11
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B41H			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	109	8.187	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	109	91	<150	100
Calcium as Ca	mg/l	109	70.6	<150	77
Magnesium as Mg	mg/l	109	47.88	<100	52
Sodium as Na	mg/l	109	45.1	<200	49
Potassium as K	mg/l	109	0.995	<50	1.1
Total Alkalinity as $CaCO_3$	mg/l	109	259.5	<330	285
Chloride as Cl	mg/l	109	58.3	<200	64
Sulphate as SO_4	mg/l	109	44.6715	<400	49
Nitrate as NO_x-N	mg/l	109	5.692	<10	6.2
Fluoride as F	Mg/l	109	0.24	<1.0	0.26
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B41J			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	134	8.292	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	134	89.45	<150	98
Calcium as Ca	mg/l	134	37.69	<150	41
Magnesium as Mg	mg/l	134	71.6125	<100	78
Sodium as Na	mg/l	134	29.1	<200	32
Potassium as K	mg/l	134	1.2445	<50	1.3
Total Alkalinity as $CaCO_3$	mg/l	134	345.7	<330	346[4]
Chloride as Cl	mg/l	134	43.5825	<200	47

Sulphate as SO_4	mg/l	134	30.315	<400	33
Nitrate as NO_x-N	mg/l	134	6.5185	<10	7.1
Fluoride as F	Mg/l	134	0.1275	<1.0	0.14
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B41K**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	60	8.1035	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	60	110.75	<150	121
Calcium as Ca	mg/l	60	54.651	<150	60
Magnesium as Mg	mg/l	60	61.1175	<100	67
Sodium as Na	mg/l	60	81.835	<200	90
Potassium as K	mg/l	60	2.789	<50	3.1
Total Alkalinity as $CaCO_3$	mg/l	60	362.1	<330	362[4]
Chloride as Cl	mg/l	60	80.582	<200	88
Sulphate as SO_4	mg/l	60	40.9105	<400	45
Nitrate as NO_x-N	mg/l	60	3.9235	<10	4.3
Fluoride as F	Mg/l	60	0.484	<1.0	0.53
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B42B**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	39	7.523	5.0 – 9.5	7.75
Electrical Conductivity	mS/m	40	5.76	<150	6
Calcium as Ca	mg/l	40	4.299	<150	4
Magnesium as Mg	mg/l	40	2.176	<100	2
Sodium as Na	mg/l	40	2.19	<200	2
Potassium as K	mg/l	40	0.3275	<50	0.3
Total Alkalinity as $CaCO_3$	mg/l	40	17.932	<330	19
Chloride as Cl	mg/l	40	3.25	<200	3.
Sulphate as SO_4	mg/l	40	3	<400	3
Nitrate as NO_x-N	mg/l	40	0.6955	<10	0.8
Fluoride as F	Mg/l	40	0.104	<1.0	0.11
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

		Olifants River Catchment QC B42F

Chemical Parameter	Unit	No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	37	7.93	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	37	59	<150	64
Calcium as Ca	mg/l	37	17.146	<150	18
Magnesium as Mg	mg/l	37	52.835	<100	58
Sodium as Na	mg/l	37	14.4	<200	15
Potassium as K	mg/l	37	0.853	<50	0.9
Total Alkalinity as $CaCO_3$	mg/l	37	154.3	<330	169
Chloride as Cl	mg/l	37	53.976	<200	59
Sulphate as SO_4	mg/l	37	17.706	<400	19
Nitrate as NO_x-N	mg/l	37	8.679	<10	9.5
Fluoride as F	Mg/l	37	0.206	<1.0	0.22
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B51A			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	50	7.568	5.0 – 9.5	7.75
Electrical Conductivity	mS/m	50	14.4	<150	15
Calcium as Ca	mg/l	50	6.838	<150	7
Magnesium as Mg	mg/l	50	2.27	<100	2
Sodium as Na	mg/l	50	11.348	<200	12
Potassium as K	mg/l	50	3.835	<50	4.3
Total Alkalinity as $CaCO_3$	mg/l	50	35.5425	<330	39
Chloride as Cl	mg/l	50	6.6835	<200	7
Sulphate as SO_4	mg/l	50	2	<400	2
Nitrate as NO_x-N	mg/l	50	3.5095	<10	3.8
Fluoride as F	Mg/l	50	0.418	<1.0	0.45
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B51B			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	62	7.908	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	62	20.95	<150	23
Calcium as Ca	mg/l	62	9.1095	<150	10
Magnesium as Mg	mg/l	62	2.1195	<100	2
Sodium as Na	mg/l	62	18.919	<200	20
Potassium as K	mg/l	62	2.91	<50	3.2
Total Alkalinity as $CaCO_3$	mg/l	62	62.909	<330	69
Chloride as Cl	mg/l	62	8.565	<200	9
Sulphate as SO_4	mg/l	62	3.091	<400	3

Nitrate as NO_x-N	mg/l	62	1.0575	<10	1.2
Fluoride as F	Mg/l	62	0.9945	<1.0	1.0
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B51C**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	55	7.954	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	55	51.4	<150	56
Calcium as Ca	mg/l	55	40.544	<150	44
Magnesium as Mg	mg/l	55	8.812	<100	9
Sodium as Na	mg/l	55	47.532	<200	52
Potassium as K	mg/l	55	3.095	<50	3.4
Total Alkalinity as $CaCO_3$	mg/l	55	122.026	<330	134
Chloride as Cl	mg/l	55	41.026	<200	45
Sulphate as SO_4	mg/l	55	18.15	<400	19
Nitrate as NO_x-N	mg/l	55	3.955	<10	4.3
Fluoride as F	Mg/l	55	2.171	<1.0	2.2
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B51E**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	117	8.04	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	117	112.2	<150	123
Calcium as Ca	mg/l	117	86.1	<150	94
Magnesium as Mg	mg/l	117	54.055	<100	59
Sodium as Na	mg/l	117	61.675	<200	67
Potassium as K	mg/l	117	4.345	<50	4.8
Total Alkalinity as $CaCO_3$	mg/l	117	260.7	<330	286
Chloride as Cl	mg/l	117	74.8	<200	82
Sulphate as SO_4	mg/l	117	58.789	<400	64
Nitrate as NO_x-N	mg/l	117	23.174	<10	23
Fluoride as F	Mg/l	117	0.345	<1.0	0.4
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B51G**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**

pH	–	168	8.2285	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	168	90.6	<150	99
Calcium as Ca	mg/l	168	54.406	<150	59
Magnesium as Mg	mg/l	168	35.9285	<100	39
Sodium as Na	mg/l	168	61.381	<200	67
Potassium as K	mg/l	168	3.785	<50	4.1
Total Alkalinity as $CaCO_3$	mg/l	168	250.4975	<330	275
Chloride as Cl	mg/l	168	82.078	<200	90
Sulphate as SO_4	mg/l	168	17.7	<400	19
Nitrate as NO_x-N	mg/l	168	5.333	<10	5.8
Fluoride as F	Mg/l	168	0.2945	<1.0	0.32
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B51H**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	219	7.978	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	219	39.3	<150	43
Calcium as Ca	mg/l	219	25.6	<150	28
Magnesium as Mg	mg/l	219	5.1	<100	5
Sodium as Na	mg/l	219	33.852	<200	37
Potassium as K	mg/l	219	2.979	<50	3.3
Total Alkalinity as $CaCO_3$	mg/l	219	103.8	<330	114
Chloride as Cl	mg/l	219	27.699	<200	30
Sulphate as SO_4	mg/l	219	6.5	<400	7
Nitrate as NO_x-N	mg/l	219	2.75	<10	3.1
Fluoride as F	Mg/l	219	0.818	<1.0	1.00[4]
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B52A**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	95	8.251	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	95	116.3	<150	127
Calcium as Ca	mg/l	95	69.871	<150	76
Magnesium as Mg	mg/l	95	47.17	<100	51
Sodium as Na	mg/l	95	113.292	<200	124
Potassium as K	mg/l	95	6.052	<50	6.6
Total Alkalinity as $CaCO_3$	mg/l	95	320.786	<330	321[4]
Chloride as Cl	mg/l	95	142.676	<200	156
Sulphate as SO_4	mg/l	95	48.865	<400	53
Nitrate as NO_x-N	mg/l	95	14.852	<10	14.9
Fluoride as F	Mg/l	95	1.232	<1.0	1.23[4]

	Water quality class	Class II

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B52B			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	267	8.175	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	268	94.3	<150	103
Calcium as Ca	mg/l	268	78.1675	<150	85
Magnesium as Mg	mg/l	268	52.385	<100	57
Sodium as Na	mg/l	268	48.44	<200	53
Potassium as K	mg/l	268	0.932	<50	1.0
Total Alkalinity as $CaCO_3$	mg/l	268	336.5035	<330	337[4]
Chloride as Cl	mg/l	268	58.677	<200	64
Sulphate as SO_4	mg/l	268	23.316	<400	25
Nitrate as NO_x-N	mg/l	268	12.3475	<10	13.5
Fluoride as F	Mg/l	268	0.173	<1.0	0.19
				Water quality class	Class II

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B52C			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	15	8.12	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	15	76.4	<150	84
Calcium as Ca	mg/l	15	57.541	<150	63
Magnesium as Mg	mg/l	15	26.2	<100	28
Sodium as Na	mg/l	15	48.3	<200	53
Potassium as K	mg/l	15	2.526	<50	2.7
Total Alkalinity as $CaCO_3$	mg/l	15	259.21	<330	285
Chloride as Cl	mg/l	15	42.701	<200	46
Sulphate as SO_4	mg/l	15	15.788	<400	17
Nitrate as NO_x-N	mg/l	15	4.477	<10	4.9
Fluoride as F	Mg/l	15	0.282	<1.0	0.31
				Water quality class	Class I

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B52D			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	66	8.124	5.0 – 9.5	8.5

Electrical Conductivity	mS/m	66	129	<150	141
Calcium as Ca	mg/l	66	80.419	<150	88
Magnesium as Mg	mg/l	66	75.161	<100	82
Sodium as Na	mg/l	66	73.681	<200	81
Potassium as K	mg/l	66	3.373	<50	3.7
Total Alkalinity as $CaCO_3$	mg/l	66	368.735	<330	369[4]
Chloride as Cl	mg/l	66	155.5865	<200	171
Sulphate as SO_4	mg/l	66	68.1475	<400	74
Nitrate as NO_x-N	mg/l	66	8.625	<10	9.5
Fluoride as F	Mg/l	66	0.463	<1.0	0.50
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B52E			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	92	8.19	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	92	187	<150	<150[4]
Calcium as Ca	mg/l	92	93.099	<150	102
Magnesium as Mg	mg/l	92	99.779	<100	109
Sodium as Na	mg/l	92	130.3125	<200	143
Potassium as K	mg/l	92	0.9365	<50	1.1
Total Alkalinity as $CaCO_3$	mg/l	92	353.535	<330	354[4]
Chloride as Cl	mg/l	92	271.372	<200	271[4]
Sulphate as SO_4	mg/l	92	92.543	<400	101
Nitrate as NO_x-N	mg/l	92	20.1515	<10	20.2
Fluoride as F	Mg/l	92	0.1425	<1.0	0.16
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B52F			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	16	8.2865	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	16	63.55	<150	69
Calcium as Ca	mg/l	16	39.18	<150	43
Magnesium as Mg	mg/l	16	19.85	<100	21
Sodium as Na	mg/l	16	76.3	<200	83
Potassium as K	mg/l	16	2.86	<50	3.1
Total Alkalinity as $CaCO_3$	mg/l	16	260.7275	<330	286
Chloride as Cl	mg/l	16	26.6075	<200	29
Sulphate as SO_4	mg/l	16	8.8	<400	9
Nitrate as NO_x-N	mg/l	16	1.1595	<10	1.2

Fluoride as F	Mg/l	16	1.45	<1.0	1.5
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B52G**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	29	8.152	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	29	105.1	<150	115
Calcium as Ca	mg/l	29	84.691	<150	93
Magnesium as Mg	mg/l	29	69.516	<100	76
Sodium as Na	mg/l	29	52.144	<200	57
Potassium as K	mg/l	29	2.33	<50	2.5
Total Alkalinity as $CaCO_3$	mg/l	29	356.471	<330	356[4]
Chloride as Cl	mg/l	29	94.103	<200	103
Sulphate as SO_4	mg/l	29	31	<400	34
Nitrate as NO_x-N	mg/l	29	12.666	<10	12.7
Fluoride as F	Mg/l	29	0.253	<1.0	0.27
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B52H**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	64	8.094	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	64	91.65	<150	100
Calcium as Ca	mg/l	64	58.418	<150	64
Magnesium as Mg	mg/l	64	32.033	<100	35
Sodium as Na	mg/l	64	62.1165	<200	68
Potassium as K	mg/l	64	2.675	<50	2.9
Total Alkalinity as $CaCO_3$	mg/l	64	241.4405	<330	265
Chloride as Cl	mg/l	64	71.774	<200	78
Sulphate as SO_4	mg/l	64	26.55	<400	29
Nitrate as NO_x-N	mg/l	64	9.7805	<10	9.8
Fluoride as F	Mg/l	64	0.538	<1.0	0.59
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B52J**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	78	8.144	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	78	109.35	<150	120

Calcium as Ca	mg/l	78	69.1765	<150	76
Magnesium as Mg	mg/l	78	71.318	<100	78
Sodium as Na	mg/l	78	62.3	<200	68
Potassium as K	mg/l	78	1.63	<50	1.7
Total Alkalinity as $CaCO_3$	mg/l	78	334.125	<330	367
Chloride as Cl	mg/l	78	86.681	<200	95
Sulphate as SO_4	mg/l	78	52.3	<400	57
Nitrate as NO_x-N	mg/l	78	10.5165	<10	11
Fluoride as F	Mg/l	78	0.135	<1.0	0.14
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B60D**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	42	8.1615	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	42	44.65	<150	49
Calcium as Ca	mg/l	42	45.0725	<150	49
Magnesium as Mg	mg/l	42	26.8335	<100	29
Sodium as Na	mg/l	42	5.362	<200	5
Potassium as K	mg/l	42	0.512	<50	0.5
Total Alkalinity as $CaCO_3$	mg/l	42	211.7055	<330	232
Chloride as Cl	mg/l	42	5	<200	5
Sulphate as SO_4	mg/l	42	4.35	<400	4
Nitrate as NO_x-N	mg/l	42	2.74	<10	3.0
Fluoride as F	Mg/l	42	0.183	<1.0	0.20
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B60G**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	12	8.2325	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	12	61.6	<150	67
Calcium as Ca	mg/l	12	40.2825	<150	44
Magnesium as Mg	mg/l	12	32.098	<100	35
Sodium as Na	mg/l	12	45.8895	<200	50
Potassium as K	mg/l	12	0.6575	<50	0.7
Total Alkalinity as $CaCO_3$	mg/l	12	233.8585	<330	257
Chloride as Cl	mg/l	12	50.102	<200	55
Sulphate as SO_4	mg/l	12	14.519	<400	15
Nitrate as NO_x-N	mg/l	12	1.812	<10	1.9
Fluoride as F	Mg/l	12	0.453	<1.0	0.49
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B60H			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	26	7.998	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	26	51.25	<150	56
Calcium as Ca	mg/l	26	41.6925	<150	45
Magnesium as Mg	mg/l	26	21.389	<100	23
Sodium as Na	mg/l	26	18.465	<200	20
Potassium as K	mg/l	26	0.6945	<50	0.7
Total Alkalinity as $CaCO_3$	mg/l	26	204.4145	<330	224
Chloride as Cl	mg/l	26	15.6565	<200	17
Sulphate as SO_4	mg/l	26	10.8385	<400	11
Nitrate as NO_x-N	mg/l	26	0.916	<10	1.0
Fluoride as F	Mg/l	26	0.1825	<1.0	0.20
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B60J			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	22	7.819	5.0 – 9.5	8.00
Electrical Conductivity	mS/m	22	148	<150	150[4]
Calcium as Ca	mg/l	22	73.509	<150	80
Magnesium as Mg	mg/l	22	60.6	<100	66
Sodium as Na	mg/l	22	154.017	<200	169
Potassium as K	mg/l	22	3.585	<50	3.9
Total Alkalinity as $CaCO_3$	mg/l	22	381.78	<330	382[4]
Chloride as Cl	mg/l	22	166.4	<200	183
Sulphate as SO_4	mg/l	22	82.4675	<400	90
Nitrate as NO_x-N	mg/l	22	7.887	<10	8.7
Fluoride as F	Mg/l	22	0.62	<1.0	0.68
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B71A			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	25	8.18	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	25	75.9	<150	83
Calcium as Ca	mg/l	25	41.692	<150	45

Magnesium as Mg	mg/l	25	35.6	<100	39
Sodium as Na	mg/l	25	27.457	<200	30
Potassium as K	mg/l	25	2.488	<50	2.7
Total Alkalinity as $CaCO_3$	mg/l	25	239.8	<330	263
Chloride as Cl	mg/l	25	43.299	<200	47
Sulphate as SO_4	mg/l	25	14.9	<400	16
Nitrate as NO_x-N	mg/l	25	3.908	<10	4.3
Fluoride as F	Mg/l	25	0.2	<1.0	0.22
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B71B**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	22	8.245	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	22	116.45	<150	128
Calcium as Ca	mg/l	22	43.1465	<150	47
Magnesium as Mg	mg/l	22	86.0155	<100	94
Sodium as Na	mg/l	22	58.222	<200	64
Potassium as K	mg/l	22	2.425	<50	2.7
Total Alkalinity as $CaCO_3$	mg/l	22	393.132	<330	393[4]
Chloride as Cl	mg/l	22	111.8245	<200	123
Sulphate as SO_4	mg/l	22	39.897	<400	43
Nitrate as NO_x-N	mg/l	22	4.1535	<10	4.6
Fluoride as F	Mg/l	22	0.161	<1.0	0.17
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B71D**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	9	8.123	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	9	70	<150	77
Calcium as Ca	mg/l	9	33.574	<150	36
Magnesium as Mg	mg/l	9	18.525	<100	20
Sodium as Na	mg/l	9	18.321	<200	20
Potassium as K	mg/l	9	3.815	<50	4.1
Total Alkalinity as $CaCO_3$	mg/l	9	219.423	<330	241
Chloride as Cl	mg/l	9	35.581	<200	39
Sulphate as SO_4	mg/l	9	9.179	<400	10
Nitrate as NO_x-N	mg/l	9	0.515	<10	0.6
Fluoride as F	Mg/l	9	0.18	<1.0	0.19
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B71E			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	180	8.283	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	180	93.05	<150	102
Calcium as Ca	mg/l	180	42.4955	<150	46
Magnesium as Mg	mg/l	180	73.983	<100	81
Sodium as Na	mg/l	180	34.421	<200	37
Potassium as K	mg/l	180	1.402	<50	1.5
Total Alkalinity as $CaCO_3$	mg/l	180	363.32	<330	363[4]
Chloride as Cl	mg/l	180	55.85	<200	61
Sulphate as SO_4	mg/l	177	25.37	<400	27
Nitrate as NO_x-N	mg/l	180	10.442	<10	10.4
Fluoride as F	Mg/l	180	0.1155	<1.0	0.12
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B71F			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	46	8.2235	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	46	84.5	<150	92
Calcium as Ca	mg/l	46	74.201	<150	81
Magnesium as Mg	mg/l	46	37.6255	<100	41
Sodium as Na	mg/l	46	44.6935	<200	49
Potassium as K	mg/l	46	2.189	<50	2.4
Total Alkalinity as $CaCO_3$	mg/l	46	258.762	<330	284
Chloride as Cl	mg/l	46	88.4355	<200	97
Sulphate as SO_4	mg/l	46	51.892	<400	57
Nitrate as NO_x-N	mg/l	46	0.925	<10	1.0
Fluoride as F	Mg/l	46	0.3	<1.0	0.33
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B71G			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	16	8.216	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	16	65.6	<150	72

Calcium as Ca	mg/l	16	52.8585	<150	58
Magnesium as Mg	mg/l	16	47.3295	<100	52
Sodium as Na	mg/l	16	13.832	<200	15
Potassium as K	mg/l	16	1.1435	<50	1.3
Total Alkalinity as $CaCO_3$	mg/l	16	304.0185	<330	304[4]
Chloride as Cl	mg/l	16	16.358	<200	17
Sulphate as SO_4	mg/l	16	11.1915	<400	12
Nitrate as NO_x-N	mg/l	16	2.496	<10	2.7
Fluoride as F	Mg/l	16	0.2525	<1.0	0.27
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B71H**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	56	7.945	5.0 – 9.5	8.0
Electrical Conductivity	mS/m	56	93.6	<150	102
Calcium as Ca	mg/l	56	55.15	<150	60
Magnesium as Mg	mg/l	56	31.1	<100	34
Sodium as Na	mg/l	56	68.05	<200	74.
Potassium as K	mg/l	56	2.465	<50	2.7
Total Alkalinity as $CaCO_3$	mg/l	56	303.4585	<330	303[4]
Chloride as Cl	mg/l	56	65.056	<200	71
Sulphate as SO_4	mg/l	56	12.6	<400	13
Nitrate as NO_x-N	mg/l	56	0.741	<10	0.8
Fluoride as F	Mg/l	56	0.446	<1.0	0.49
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B72A**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	100	7.915	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	100	46.45	<150	51
Calcium as Ca	mg/l	100	33.95	<150	37
Magnesium as Mg	mg/l	100	16.7285	<100	18
Sodium as Na	mg/l	100	30.7	<200	33
Potassium as K	mg/l	100	1.8155	<50	1.9
Total Alkalinity as $CaCO_3$	mg/l	100	176.85	<330	194
Chloride as Cl	mg/l	100	23.8	<200	26
Sulphate as SO_4	mg/l	100	7.112	<400	7
Nitrate as NO_x-N	mg/l	100	1.0335	<10	1.1
Fluoride as F	Mg/l	100	0.2755	<1.0	0.30

Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B72C**			
		No. of Samples	**Ambient GW quality or median 1)**	**BHN Reserve2)**	**Groundwater Quality Reserve3**
pH	–	26	8.17	5.0 – 9.5	8.50
Electrical Conductivity	mS/m	26	125.65	<150	138
Calcium as Ca	mg/l	26	51.7	<150	56
Magnesium as Mg	mg/l	26	37.25	<100	40
Sodium as Na	mg/l	26	175.8	<200	193
Potassium as K	mg/l	26	2.63	<50	2.8
Total Alkalinity as $CaCO_3$	mg/l	26	442.65	<330	443[4]
Chloride as Cl	mg/l	26	138.187	<200	152
Sulphate as SO_4	mg/l	26	20.564	<400	22
Nitrate as NO_x-N	mg/l	26	0.66	<10	0.7
Fluoride as F	Mg/l	26	0.7885	<1.0	0.86
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B72E**			
		No. of Samples	**Ambient GW quality or median 1)**	**BHN Reserve2)**	**Groundwater Quality Reserve3**
pH	–	101	8.035	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	101	53.3	<150	58
Calcium as Ca	mg/l	101	39.2	<150	43
Magnesium as Mg	mg/l	101	26.2	<100	28
Sodium as Na	mg/l	101	26.5	<200	29
Potassium as K	mg/l	101	0.898	<50	0.9
Total Alkalinity as $CaCO_3$	mg/l	101	236.548	<330	260
Chloride as Cl	mg/l	101	13.9	<200	15
Sulphate as SO_4	mg/l	101	4.3	<400	4
Nitrate as NO_x-N	mg/l	101	1.927	<10	2.1
Fluoride as F	Mg/l	101	0.227	<1.0	0.24
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B72J**			
		No. of Samples	**Ambient GW quality or median 1)**	**BHN Reserve2)**	**Groundwater Quality Reserve3**
pH	–	47	8.038	5.0 – 9.5	8.50
Electrical Conductivity	mS/m	47	110.23	<150	121
Calcium as Ca	mg/l	47	64.86	<150	71

Magnesium as Mg	mg/l	47	69.761	<100	76
Sodium as Na	mg/l	47	69.6	<200	76
Potassium as K	mg/l	47	0.65	<50	0.7
Total Alkalinity as $CaCO_3$	mg/l	47	381.88	<330	382[4]
Chloride as Cl	mg/l	47	101.636	<200	111
Sulphate as SO_4	mg/l	47	41.281	<400	45
Nitrate as NO_x-N	mg/l	47	9.989	<10	10
Fluoride as F	Mg/l	47	0.3	<1.0	0.33
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B72K**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	61	8.21	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	61	180	<150	180[4]
Calcium as Ca	mg/l	61	61.681	<150	67
Magnesium as Mg	mg/l	61	61.2	<100	67
Sodium as Na	mg/l	61	223.785	<200	224[4]
Potassium as K	mg/l	61	5.38	<50	5.9
Total Alkalinity as $CaCO_3$	mg/l	61	459	<330	459[4]
Chloride as Cl	mg/l	61	244.7	<200	245[4]
Sulphate as SO_4	mg/l	61	54.8	<400	60
Nitrate as NO_x-N	mg/l	61	9.088	<10	9.9
Fluoride as F	Mg/l	61	0.642	<1.0	0.70
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B73A**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	25	7.67	5.0 – 9.5	8.00
Electrical Conductivity	mS/m	25	22.6	<150	24
Calcium as Ca	mg/l	25	10.3	<150	11
Magnesium as Mg	mg/l	25	3.6	<100	3
Sodium as Na	mg/l	25	28.4	<200	31
Potassium as K	mg/l	25	1.3	<50	1.4
Total Alkalinity as $CaCO_3$	mg/l	25	84.6	<330	93
Chloride as Cl	mg/l	25	9.2	<200	10
Sulphate as SO_4	mg/l	25	4.9	<400	5
Nitrate as NO_x-N	mg/l	25	0.93	<10	1.0
Fluoride as F	Mg/l	25	0.398	<1.0	0.43
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B73E			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	50	8.16	5.0 – 9.5	8.50
Electrical Conductivity	mS/m	50	80.3	<150	88
Calcium as Ca	mg/l	50	40.7885	<150	44
Magnesium as Mg	mg/l	50	21.05	<100	23
Sodium as Na	mg/l	50	102.9	<200	113
Potassium as K	mg/l	50	2.203	<50	2.4
Total Alkalinity as $CaCO_3$	mg/l	50	281.2	<330	309
Chloride as Cl	mg/l	50	55.35	<200	60
Sulphate as SO_4	mg/l	50	10.85	<400	11
Nitrate as NO_x-N	mg/l	50	3.3105	<10	3.6
Fluoride as F	Mg/l	50	0.99	<1.0	1.0
				Water quality class	**Class 1**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B73F			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	19	8.346	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	19	50.5	<150	55
Calcium as Ca	mg/l	19	15.864	<150	17
Magnesium as Mg	mg/l	19	30.272	<100	33
Sodium as Na	mg/l	19	43.2	<200	47
Potassium as K	mg/l	19	1.893	<50	2.0
Total Alkalinity as $CaCO_3$	mg/l	19	197.544	<330	217
Chloride as Cl	mg/l	19	32.906	<200	36
Sulphate as SO_4	mg/l	19	10.439	<400	11
Nitrate as NO_x-N	mg/l	19	1.443	<10	1.5
Fluoride as F	Mg/l	19	0.333	<1.0	0.36
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B81C			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	64	7.689	5.0 – 9.5	8.00
Electrical Conductivity	mS/m	64	22.6185	<150	25
Calcium as Ca	mg/l	64	13.7065	<150	15

Magnesium as Mg	mg/l	64	4.2295	<100	5
Sodium as Na	mg/l	63	16.8	<200	18
Potassium as K	mg/l	61	2.638	<50	2.9
Total Alkalinity as $CaCO_3$	mg/l	64	46.5115	<330	51
Chloride as Cl	mg/l	64	23.9395	<200	26
Sulphate as SO_4	mg/l	64	3	<400	3
Nitrate as NO_x-N	mg/l	64	3.5385	<10	3.9
Fluoride as F	Mg/l	63	0.14	<1.0	0.15
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B81D**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	178	7.827	5.0 – 9.5	8.0
Electrical Conductivity	mS/m	178	44.65	<150	49
Calcium as Ca	mg/l	178	36.9385	<150	41
Magnesium as Mg	mg/l	178	21.843	<100	24
Sodium as Na	mg/l	175	17.5	<200	19
Potassium as K	mg/l	175	0.542	<50	0.6
Total Alkalinity as $CaCO_3$	mg/l	177	187.634	<330	206
Chloride as Cl	mg/l	178	11.9215	<200	13
Sulphate as SO_4	mg/l	178	4.6	<400	5
Nitrate as NO_x-N	mg/l	177	1.949	<10	2.1
Fluoride as F	Mg/l	177	0.192	<1.0	0.21
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B81E**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	144	8.077	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	144	45.25	<150	50
Calcium as Ca	mg/l	144	27.84	<150	31
Magnesium as Mg	mg/l	144	15.55	<100	17
Sodium as Na	mg/l	144	33.4565	<200	37
Potassium as K	mg/l	144	2.6485	<50	2.9
Total Alkalinity as $CaCO_3$	mg/l	144	166.2245	<330	183
Chloride as Cl	mg/l	144	27.5525	<200	30
Sulphate as SO_4	mg/l	144	5.85	<400	6
Nitrate as NO_x-N	mg/l	144	0.784	<10	0.9
Fluoride as F	Mg/l	144	0.34	<1.0	0.37
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B81G			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	298	7.99	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	298	83.35	<150	92
Calcium as Ca	mg/l	298	44.047	<150	48
Magnesium as Mg	mg/l	298	33.068	<100	36
Sodium as Na	mg/l	298	68.3885	<200	75
Potassium as K	mg/l	298	2.0605	<50	2.3
Total Alkalinity as $CaCO_3$	mg/l	298	266.67	<330	293
Chloride as Cl	mg/l	298	63.85	<200	70
Sulphate as SO_4	mg/l	298	10.42	<400	11
Nitrate as NO_x-N	mg/l	298	3.7285	<10	4.1
Fluoride as F	Mg/l	298	0.471	<1.0	0.52
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B81H			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	169	8.208	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	169	175	<150	<175[4]
Calcium as Ca	mg/l	169	74.8	<150	82
Magnesium as Mg	mg/l	169	72.6	<100	80
Sodium as Na	mg/l	169	164.759	<200	181
Potassium as K	mg/l	169	5.781	<50	6.4
Total Alkalinity as $CaCO_3$	mg/l	169	435.6	<330	436[4]
Chloride as Cl	mg/l	169	232.193	<200	232[4]
Sulphate as SO_4	mg/l	169	27.609	<400	30
Nitrate as NO_x-N	mg/l	168	11.143	<10	12.3
Fluoride as F	Mg/l	168	0.605	<1.0	0.67
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B82A			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	59	7.854	5.0 – 9.5	8.00
Electrical Conductivity	mS/m	58	63	<150	69
Calcium as Ca	mg/l	59	38.951	<150	43
Magnesium as Mg	mg/l	59	27.147	<100	30

Sodium as Na	mg/l	59	43.935	<200	48
Potassium as K	mg/l	59	2.66	<50	2.9
Total Alkalinity as $CaCO_3$	mg/l	59	232.8	<330	256
Chloride as Cl	mg/l	59	40.451	<200	44
Sulphate as SO_4	mg/l	59	11.214	<400	12
Nitrate as NO_x-N	mg/l	59	2.506	<10	2.8
Fluoride as F	Mg/l	58	0.317	<1.0	0.35
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B82C**			
		No. of Samples	**Ambient GW quality or median** [1)]	**BHN Reserve**[2)]	**Groundwater Quality Reserve**[3]
pH	–	31	7.76	5.0 – 9.5	8.00
Electrical Conductivity	mS/m	31	33.2	<150	37
Calcium as Ca	mg/l	31	21.981	<150	24
Magnesium as Mg	mg/l	31	11.7	<100	13
Sodium as Na	mg/l	30	21.188	<200	23
Potassium as K	mg/l	30	1.3995	<50	1.5
Total Alkalinity as $CaCO_3$	mg/l	31	109	<330	120
Chloride as Cl	mg/l	31	20.489	<200	23
Sulphate as SO_4	mg/l	31	4.6	<400	5
Nitrate as NO_x-N	mg/l	31	2.878	<10	3.2
Fluoride as F	Mg/l	31	0.218	<1.0	0.24
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B82D**			
		No. of Samples	**Ambient GW quality or median** [1)]	**BHN Reserve**[2)]	**Groundwater Quality Reserve**[3]
pH	–	249	8.06	5.0 – 9.5	8.50
Electrical Conductivity	mS/m	249	76.5	<150	84
Calcium as Ca	mg/l	249	42.482	<150	47
Magnesium as Mg	mg/l	249	44.02	<100	48
Sodium as Na	mg/l	248	55.2845	<200	61
Potassium as K	mg/l	248	5.2555	<50	5.8
Total Alkalinity as $CaCO_3$	mg/l	248	260.05	<330	286
Chloride as Cl	mg/l	249	50.5	<200	56
Sulphate as SO_4	mg/l	249	14.488	<400	16
Nitrate as NO_x-N	mg/l	248	9.7535	<10	9.8
Fluoride as F	Mg/l	248	0.302	<1.0	0.33
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B82E			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	113	7.958	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	113	65.5	<150	72
Calcium as Ca	mg/l	113	34.922	<150	38
Magnesium as Mg	mg/l	113	30.514	<100	34
Sodium as Na	mg/l	108	37.64	<200	41
Potassium as K	mg/l	108	5.0595	<50	5.6
Total Alkalinity as $CaCO_3$	mg/l	113	183.846	<330	200
Chloride as Cl	mg/l	113	49.127	<200	54
Sulphate as SO_4	mg/l	113	16.067	<400	18
Nitrate as NO_x-N	mg/l	113	5.914	<10	6.5
Fluoride as F	Mg/l	113	0.197	<1.0	0.22
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B82F			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	232	8.032	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	232	63.05	<150	69
Calcium as Ca	mg/l	232	33.353	<150	37
Magnesium as Mg	mg/l	232	36.834	<100	41
Sodium as Na	mg/l	231	29.3	<200	32
Potassium as K	mg/l	231	3.831	<50	4.2
Total Alkalinity as $CaCO_3$	mg/l	228	212.5	<330	234
Chloride as Cl	mg/l	232	38.3085	<200	42
Sulphate as SO_4	mg/l	232	11.063	<400	12
Nitrate as NO_x-N	mg/l	228	6.0725	<10	6.7
Fluoride as F	Mg/l	227	0.276	<1.0	0.30
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B82G			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	220	8.19	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	220	112.85	<150	124
Calcium as Ca	mg/l	220	52.8	<150	58
Magnesium as Mg	mg/l	220	62.807	<100	69

Sodium as Na	mg/l	218	84.9	<200	93
Potassium as K	mg/l	218	3.669	<50	4.0
Total Alkalinity as $CaCO_3$	mg/l	219	368.1	<330	370[4]
Chloride as Cl	mg/l	220	92.0335	<200	101
Sulphate as SO_4	mg/l	220	17.0815	<400	19
Nitrate as NO_x-N	mg/l	218	4.6245	<10	5.1
Fluoride as F	Mg/l	217	0.469	<1.0	0.52
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B82J**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	26	8.0975	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	26	176.5	<150	177[4]
Calcium as Ca	mg/l	26	75.872	<150	83
Magnesium as Mg	mg/l	26	184.0145	<100	184[4]
Sodium as Na	mg/l	26	70.92	<200	78
Potassium as K	mg/l	26	6.5275	<50	7.2
Total Alkalinity as $CaCO_3$	mg/l	26	454.1	<330	454[4]
Chloride as Cl	mg/l	26	205.8395	<200	206[4]
Sulphate as SO_4	mg/l	26	29.3965	<400	32
Nitrate as NO_x-N	mg/l	26	9.4955	<10	10.4
Fluoride as F	Mg/l	26	0.536	<1.0	0.59
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B83B**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	22	7.5	5.0 – 9.5	8.00
Electrical Conductivity	mS/m	18	105.991	<150	117
Calcium as Ca	mg/l	22	484	<150	484[4]
Magnesium as Mg	mg/l	20	4.691	<100	5
Sodium as Na	mg/l	22	105.219	<200	116
Potassium as K	mg/l	20	3.953	<50	4.3
Total Alkalinity as $CaCO_3$	mg/l	21	484	<330	484[4]
Chloride as Cl	mg/l	22	105	<200	116
Sulphate as SO_4	mg/l	22	4.69	<400	5
Nitrate as NO_x-N	mg/l	21	3.95	<10	4.3
Fluoride as F	Mg/l	20	0.70	<1.0	0.77
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B90A			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	38	7.689	5.0 – 9.5	8.0
Electrical Conductivity	mS/m	38	17.4	<150	19
Calcium as Ca	mg/l	38	7.8745	<150	9
Magnesium as Mg	mg/l	37	7.321	<100	8
Sodium as Na	mg/l	36	15.8155	<200	17
Potassium as K	mg/l	36	1.236	<50	1.4
Total Alkalinity as $CaCO_3$	mg/l	37	49.603	<330	55
Chloride as Cl	mg/l	38	21.067	<200	23
Sulphate as SO_4	mg/l	38	3	<400	3
Nitrate as NO_x-N	mg/l	37	0.769	<10	0.8
Fluoride as F	Mg/l	36	0.1425	<1.0	0.16
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC B90B			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	87	8.16	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	87	96.9	<150	107
Calcium as Ca	mg/l	87	67	<150	74
Magnesium as Mg	mg/l	87	45.3	<100	50
Sodium as Na	mg/l	87	75.4	<200	83
Potassium as K	mg/l	87	0.994	<50	1.1
Total Alkalinity as $CaCO_3$	mg/l	87	346.8	<330	347[4]
Chloride as Cl	mg/l	87	61.303	<200	67
Sulphate as SO_4	mg/l	87	10.025	<400	11
Nitrate as NO_x-N	mg/l	87	5.938	<10	6.5
Fluoride as F	Mg/l	87	0.391	<1.0	0.43
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B90C			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	60	8.175	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	60	138.5	<150	150[4]
Calcium as Ca	mg/l	60	66.235	<150	73

Magnesium as Mg	mg/l	60	57.63	<100	63
Sodium as Na	mg/l	59	145.633	<200	160
Potassium as K	mg/l	59	1.748	<50	1.9
Total Alkalinity as $CaCO_3$	mg/l	60	423.15	<330	423[4]
Chloride as Cl	mg/l	60	130.2745	<200	143
Sulphate as SO_4	mg/l	60	14.094	<400	16
Nitrate as NO_x-N	mg/l	60	10.5865	<10	10.6[4]
Fluoride as F	Mg/l	60	0.4945	<1.0	0.54
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B90F**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	133	8.163	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	133	126.8	<150	139
Calcium as Ca	mg/l	133	60.646	<150	67
Magnesium as Mg	mg/l	133	62.7	<100	69
Sodium as Na	mg/l	133	109.742	<200	121
Potassium as K	mg/l	133	2.79	<50	3.1
Total Alkalinity as $CaCO_3$	mg/l	133	381.594	<330	382[4]
Chloride as Cl	mg/l	133	130	<200	143
Sulphate as SO_4	mg/l	133	13.677	<400	15
Nitrate as NO_x-N	mg/l	132	18.758	<10	19.0[4]
Fluoride as F	Mg/l	132	0.3675	<1.0	0.40
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC B90G**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	9	8.19	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	9	144	<150	150[4]
Calcium as Ca	mg/l	9	52	<150	57
Magnesium as Mg	mg/l	9	60	<100	66
Sodium as Na	mg/l	9	96.6	<200	106
Potassium as K	mg/l	9	2.703	<50	3.0
Total Alkalinity as $CaCO_3$	mg/l	9	395.8	<330	396[4]
Chloride as Cl	mg/l	9	105.5	<200	116
Sulphate as SO_4	mg/l	9	10.3	<400	11
Nitrate as NO_x-N	mg/l	9	22.632	<10	23.0
Fluoride as F	Mg/l	9	0.23	<1.0	0.25
				Water quality class	**Class III**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B90H			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	11	8.03	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	11	144	<150	150[4]
Calcium as Ca	mg/l	11	56.6	<150	62
Magnesium as Mg	mg/l	11	62	<100	68
Sodium as Na	mg/l	11	116.1	<200	128
Potassium as K	mg/l	11	1.16	<50	1.3
Total Alkalinity as $CaCO_3$	mg/l	11	418.8	<330	419[4]
Chloride as Cl	mg/l	11	120.6	<200	133
Sulphate as SO_4	mg/l	11	7.2	<400	8
Nitrate as NO_x-N	mg/l	11	2.49	<10	2.7
Fluoride as F	Mg/l	11	0.65	<1.0	0.72
				Water quality class	Class II

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC B90G			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	9	8.19	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	9	144	<150	150
Calcium as Ca	mg/l	9	52	<150	57
Magnesium as Mg	mg/l	9	60	<100	66
Sodium as Na	mg/l	9	96.6	<200	106
Potassium as K	mg/l	9	2.703	<50	3.0
Total Alkalinity as $CaCO_3$	mg/l	9	395.8	<330	396[4]
Chloride as Cl	mg/l	9	105.5	<200	116
Sulphate as SO_4	mg/l	9	10.3	<400	11
Nitrate as NO_x-N	mg/l	9	22.632	<10	23.0
Fluoride as F	Mg/l	9	0.23	<1.0	0.25
				Water quality class	Class III

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC A91B			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	36	7.975	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	36	31.2	<150	34

Calcium as Ca	mg/l	36	17.5	<150	19
Magnesium as Mg	mg/l	36	19.6855	<100	22
Sodium as Na	mg/l	33	11.3	<200	12
Potassium as K	mg/l	33	1.737	<50	1.9
Total Alkalinity as $CaCO_3$	mg/l	36	129.6565	<330	143
Chloride as Cl	mg/l	36	10.6885	<200	12
Sulphate as SO_4	mg/l	36	5.9235	<400	7
Nitrate as NO_x-N	mg/l	36	2.087	<10	2.3
Fluoride as F	Mg/l	36	0.147	<1.0	0.16
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC A91C**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	111	8	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	111	25.4	<150	28
Calcium as Ca	mg/l	111	14.887	<150	16
Magnesium as Mg	mg/l	111	12.7	<100	14
Sodium as Na	mg/l	107	11.088	<200	12
Potassium as K	mg/l	107	2.223	<50	2.4
Total Alkalinity as $CaCO_3$	mg/l	108	89.409	<330	98
Chloride as Cl	mg/l	110	15.574	<200	17
Sulphate as SO_4	mg/l	111	4.6	<400	5
Nitrate as NO_x-N	mg/l	109	2.322	<10	2.6
Fluoride as F	Mg/l	108	0.18	<1.0	0.20
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC A91D**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	13	7.28	5.0 – 9.5	7.5
Electrical Conductivity	mS/m	13	25.7	<150	28
Calcium as Ca	mg/l	13	14.5	<150	16
Magnesium as Mg	mg/l	13	9.6	<100	11
Sodium as Na	mg/l	13	8.9	<200	10
Potassium as K	mg/l	13	2.506	<50	2.8
Total Alkalinity as $CaCO_3$	mg/l	13	55.5	<330	61
Chloride as Cl	mg/l	13	6.635	<200	7
Sulphate as SO_4	mg/l	13	2	<400	2
Nitrate as NO_x-N	mg/l	13	2.717	<10	3.0
Fluoride as F	Mg/l	13	0.25	<1.0	0.28
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A91E			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	75	7.89	5.0 – 9.5	8.0
Electrical Conductivity	mS/m	75	26.4	<150	29
Calcium as Ca	mg/l	75	19.282	<150	21
Magnesium as Mg	mg/l	75	11	<100	12
Sodium as Na	mg/l	73	11.13	<200	12
Potassium as K	mg/l	73	1	<50	1.1
Total Alkalinity as $CaCO_3$	mg/l	74	103.5	<330	114
Chloride as Cl	mg/l	75	10.063	<200	11
Sulphate as SO_4	mg/l	75	2	<400	2
Nitrate as NO_x-N	mg/l	74	1.3125	<10	1.4
Fluoride as F	Mg/l	72	0.164	<1.0	0.18
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A91F			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	271	8.104	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	271	73.3	<150	81
Calcium as Ca	mg/l	271	55.171	<150	61
Magnesium as Mg	mg/l	271	37.265	<100	41
Sodium as Na	mg/l	271	40.428	<200	44
Potassium as K	mg/l	271	1.237	<50	1.4
Total Alkalinity as $CaCO_3$	mg/l	270	261.678	<330	288
Chloride as Cl	mg/l	271	44.379	<200	49
Sulphate as SO_4	mg/l	271	10.118	<400	11
Nitrate as NO_x-N	mg/l	269	4.659	<10	5.1
Fluoride as F	Mg/l	266	0.3	<1.0	0.33
				Water quality class	**Class I**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A91G			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	120	8.0075	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	120	41.4	<150	46
Calcium as Ca	mg/l	120	34.169	<150	38

Magnesium as Mg	mg/l	120	17.818	<100	20
Sodium as Na	mg/l	119	14.202	<200	16
Potassium as K	mg/l	119	0.419	<50	0.5
Total Alkalinity as $CaCO_3$	mg/l	119	164.632	<330	181
Chloride as Cl	mg/l	120	16.1615	<200	18
Sulphate as SO_4	mg/l	120	4.45	<400	5
Nitrate as NO_x-N	mg/l	119	2.278	<10	2.5
Fluoride as F	Mg/l	119	0.15	<1.0	0.17
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A91H			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	93	7.952	5.0 – 9.5	8.25
Electrical Conductivity	mS/m	93	42.5	<150	47
Calcium as Ca	mg/l	93	27.071	<150	30
Magnesium as Mg	mg/l	93	19	<100	21
Sodium as Na	mg/l	92	23.407	<200	26
Potassium as K	mg/l	92	0.558	<50	0.6
Total Alkalinity as $CaCO_3$	mg/l	93	167.357	<330	184
Chloride as Cl	mg/l	93	22.633	<200	25
Sulphate as SO_4	mg/l	93	3	<400	3
Nitrate as NO_x-N	mg/l	93	0.936	<10	1.0
Fluoride as F	Mg/l	91	0.18	<1.0	0.20
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A91J			
		No. of Samples	Ambient GW quality or median 1)	BHN Reserve2)	Groundwater Quality Reserve3
pH	–	10	7.672	5.0 – 9.5	8.0
Electrical Conductivity	mS/m	10	32.15	<150	35
Calcium as Ca	mg/l	10	15.259	<150	17
Magnesium as Mg	mg/l	10	8.7105	<100	10
Sodium as Na	mg/l	10	30.6395	<200	34
Potassium as K	mg/l	10	1.0505	<50	1.2
Total Alkalinity as $CaCO_3$	mg/l	10	117.0565	<330	129
Chloride as Cl	mg/l	10	31.62	<200	35
Sulphate as SO_4	mg/l	10	7.411	<400	8
Nitrate as NO_x-N	mg/l	10	0.455	<10	0.5
Fluoride as F	Mg/l	10	0.21	<1.0	0.23
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A91K			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	22	8.4115	5.0 – 9.5	9.3
Electrical Conductivity	mS/m	22	126.3	<150	139
Calcium as Ca	mg/l	22	36.493	<150	40
Magnesium as Mg	mg/l	22	53.613	<100	59
Sodium as Na	mg/l	20	164.6685	<200	181
Potassium as K	mg/l	20	1.4105	<50	1.6
Total Alkalinity as $CaCO_3$	mg/l	22	388.5465	<330	389[4]
Chloride as Cl	mg/l	22	138.0335	<200	152
Sulphate as SO_4	mg/l	22	22.288	<400	25
Nitrate as NO_x-N	mg/l	22	0.0725	<10	0.1
Fluoride as F	Mg/l	21	1.055	<1.0	1.0
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	Unit	Olifants River Catchment QC A92A			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	55	7.509	5.0 – 9.5	7.75
Electrical Conductivity	mS/m	55	15.9	<150	17
Calcium as Ca	mg/l	55	8.096	<150	9
Magnesium as Mg	mg/l	55	5.107	<100	6
Sodium as Na	mg/l	55	7.791	<200	9
Potassium as K	mg/l	55	0.579	<50	0.6
Total Alkalinity as $CaCO_3$	mg/l	55	47.227	<330	52
Chloride as Cl	mg/l	55	9.426	<200	10
Sulphate as SO_4	mg/l	55	3	<400	3
Nitrate as NO_x-N	mg/l	54	1.4905	<10	1.6
Fluoride as F	Mg/l	54	0.12	<1.0	0.13
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	Unit	Olifants River Catchment QC A92B			
		No. of Samples	Ambient GW quality or median [1)]	BHN Reserve[2)]	Groundwater Quality Reserve[3]
pH	–	66	7.67	5.0 – 9.5	8.0

Electrical Conductivity	mS/m	66	24	<150	26
Calcium as Ca	mg/l	66	10.6935	<150	12
Magnesium as Mg	mg/l	66	7.272	<100	8
Sodium as Na	mg/l	66	16.085	<200	18
Potassium as K	mg/l	66	0.7045	<50	0.8
Total Alkalinity as $CaCO_3$	mg/l	66	58.739	<330	65
Chloride as Cl	mg/l	66	18.4855	<200	20
Sulphate as SO_4	mg/l	66	3	<400	3
Nitrate as NO_x-N	mg/l	66	1.084	<10	1.2
Fluoride as F	Mg/l	66	0.138	<1.0	0.15
				Water quality class	**Class 0**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.

Chemical Parameter	**Unit**	**Olifants River Catchment QC A92C**			
		No. of Samples	**Ambient GW quality or median [1)]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	114	8.129	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	114	153	<150	153[4]
Calcium as Ca	mg/l	114	52.2595	<150	57
Magnesium as Mg	mg/l	114	70.4205	<100	77
Sodium as Na	mg/l	113	109.1	<200	120
Potassium as K	mg/l	114	2.2645	<50	2.5
Total Alkalinity as $CaCO_3$	mg/l	113	369.1	<330	369[4]
Chloride as Cl	mg/l	114	168.679	<200	186
Sulphate as SO_4	mg/l	114	26.72	<400	29
Nitrate as NO_x-N	mg/l	113	4.339	<10	4.8
Fluoride as F	Mg/l	113	0.335	<1.0	0.37
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.

Chemical Parameter	**Unit**	**Olifants River Catchment QC A92D**			
		No. of Samples	**Ambient GW quality or median [1]**	**BHN Reserve[2)]**	**Groundwater Quality Reserve[3]**
pH	–	167	8.176	5.0 – 9.5	8.5
Electrical Conductivity	mS/m	167	130.1	<150	143
Calcium as Ca	mg/l	167	47	<150	52
Magnesium as Mg	mg/l	166	72.4225	<100	80
Sodium as Na	mg/l	165	135.251	<200	149
Potassium as K	mg/l	165	3.851	<50	4.2
Total Alkalinity as $CaCO_3$	mg/l	164	406.35	<330	406[4]
Chloride as Cl	mg/l	166	156.0725	<200	172
Sulphate as SO_4	mg/l	166	21.15	<400	23
Nitrate as NO_x-N	mg/l	165	5.431	<10	6.0

Fluoride as F	Mg/l	164	0.5735	<1.0	0.63
				Water quality class	**Class II**

[1] Median value (calculated from population of samples in QC).
[2] Upper limit of Class I water quality (DWAF et al 1998).
[3] The median plus 10% for the Groundwater Quality Reserve.
[4] Natural geological conditions may cause elevated dissolved solids in groundwater.