CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE OLIFANTS WATER MANAGEMENT AREA: (WMA 4) - WP 10383

ECOLOGICAL WATER REQUIREMENTS REPORT

FINAL

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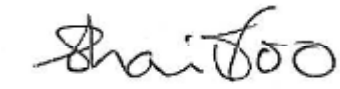

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Shane Naidoo

Director: Water Resource Classification

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Reports as part of this study:

Bold type indicates this report.

LIST OF ABBREVIATIONS AND ACRONYMS

CD: RDM	Chief Directorate: Resource Directed Measures
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DBSA	Development Bank of South Africa
EC	Electrical Conductivity
EGSAs	Ecosystem Goods, Services and Attributes
EIS	Ecological importance and sensitivity
EMC	Ecological Management Class
EMF	Environmental Management Framework
ESBC	Ecologically Sustainable Base Configuration
EWR	Ecological Water Requirements
IUA	Integrated Unit of analysis
IWRM	Integrated Water Resource Management
IWRMP	Integrated Water Resources Management Plan
KNP	Kruger National Park
MC	Management Class
NFEPA	National Freshwater Ecosystem priority areas
NWA	National Water Act
PES	Presentation Ecological State
RDM	Resource Directed Measures
RHP	River Health Programme
RO	Regional Office
RQOs	Resource Quality Objectives
RQS	Resource Quality Services
RWQOs	Resource Water Quality Objectives
TDS	Total Dissolved Salts
WMA	Water Management Area
WRC	Water Research Commission
WRCS	Water Resource Classification System
WRYM	Water Resources Yield model
WRPM	Water Resources Planning Model

EXECUTIVE SUMMARY

Background

The Chief Directorate: Resource Directed Measures (RDM) has initiated the Classification of Significant Water Resources Study for the Olifants Water Management Area. The purpose of this study is to coordinate the implementation of the 7 step process of the Water Resource Classification System (WRCS) in the Olifants WMA in order to determine a suitable management class (MC) for all significant water resources and in so doing deliver the IWRM template with recommendations for presentation to the delegated authority. As part of the Classification process Step 3 requires that the Ecological Water Requirements (EWRs) be quantified.

The objective of step 3 of the WRCS is to provide the necessary ecological and Reserve data to enable the determination of the MC of all the significant water resources of the Olifants River catchment (WMA 4) by quantifying the EWRs and describing the changes in non-water ecosystem goods, services and attributes (EGSAs) at the established EWR sites and at biophysical nodes to which Reserve data can be extrapolated.

Approach

The process followed in terms of quantification of EWRs and EGSA changes was that described in the WRCS Guidelines, Volumes 1 and 2 (Overview and the 7-step classification procedure; and Ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, February 2007a and 2007b).

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

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

EWR Quantification

A number of Reserve studies have been undertaken since 2001 on various levels of detail. The most significant study was the comprehensive study undertaken during 2001 to 2003. This study included 16 EWR sites on a comprehensive level and focussed on the main stem Olifants River and its major tributaries. Some of the results from this study have recently (DWA, 2011) been re-

assessed to update the PES and EIS information. One intermediate and two rapid level 3 Reserve studies have also been undertaken during the last few years. These studies were undertaken mainly to address specific water use license applications and they were focused on smaller tributaries.

Additional rapid Reserve determination studies have been undertaken to enhance the existing information and to enable the extrapolation of EWRs to all the identified hydro nodes. A total of 9 additional rivers have been identified where no or very little information was available for further use during the classification of the significant water resources of the Olifants River catchment.

All EWR all sites (existing and additional Rapid sites) are listed in Table E1 and E2 below.

Table E1: Information on previous Reserve studies in the Olifants catchment

EWR site	River	Quaternary catchment	PES	EIS	REC	VMAR [1] (10^6m^3)	%EWR	Level
EWR1	Olifants	B11J	E (D)	Moderate	C	184.52	18.6	Comprehensive
EWR2	Olifants	B32A	C	High	B	500.63	23.8	Comprehensive
EWR3	Klein Olifants	B12E	D (D)	Moderate	C	81.54	27.0	Comprehensive
EWR4	Wilge	B20J	B (C)	High	B	175.50	29.9	Comprehensive
EWR5	Olifants	B32D	C (C)	High	C	570.98	19.1	Comprehensive
EWR6	Elands	B31G	E (D)	Moderate	D	60.30	17.9	Comprehensive
EWR7	Olifants	B51G	E	Moderate	D	726.52	12.7	Comprehensive
EWR8	Olifants	B71B	E (C/D)	Moderate	D	813.04	15.2	Comprehensive
EWR9	Steelpoort	B41J	D (C/D)	High	D	120.17	15.2	Comprehensive
EWR10	Steelpoort	B41K	D	High	D	336.63	12.1	Comprehensive
EWR11	Olifants	B71J	E	High	D	1321.8	13.7	Comprehensive
EWR12	Blyde	B60J	B (B/C)	High	B	383.70	34.5	Comprehensive
EWR13	Olifants	B72D	C (C)	Moderate	B	1760.7	23.6	Comprehensive
EWR14a	Ga-Selati	B72H	C	Moderate	C	52.20	31.2	Comprehensive
EWR14b	Ga-Selati	B72K	E	Moderate	D	72.74	24.8	Comprehensive
EWR16	Olifants	B73H	C (C)	Very high	B	1916.9	21.6	Comprehensive
TRE-EWR1	Treur	B60C	A/B	Very high	A/B	49.28	45.4	Rapid 3
NOU-EWR1	Noupoortspruit	B11G	C/D	Moderate	C/D	4.28	25.9	Rapid 3
DWA-EWR1	Dwars	B41H	B/C	High	B/C	31.43	25.9	Intermediate

1) VMAR – Virgin Mean Annual Runoff is based on the updated hydrology from the DWA 2009 study

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Table E2: Selected EWR sites for additional rapids

EWR site	Quaternary catchment	River	Level of determination	Latitude	Longitude	Ecoregion level 2	MAR ($10^6 m^3$)
OLI-EWR1	B12C	Upper Klein Olifants	Rapid 3	S 25.8169°	E 29.5904°	11.05	44.46
OLI-EWR2	B41B	Upper Steelpoort	Rapid 3	S 25.3831°	E 29.8383°	9.05	63.46
OLI-EWR3	B32A	Kranspoortspruit	Rapid 3	S 25.4376°	E 29.4758°	11.01	4.71
OLI-EWR4	B41F	Klip	Rapid 1	S 25.2249°	E 30.0523°	9.02	5.20
OLI-EWR5	B42G	Watervals	Rapid 3	S 24.8912°	E 30.3105°	9.02	36.39
OLI-EWR6	B42D	Upper Spekboom	Rapid 3	S 25.0094°	E30.5003°	9.02	28.04
OLI-EWR7	B73A	Klaserie	Rapid 3	S 24.5427°	E31.0349°	3.07	25.54
OLI-EWR8	B60H	Ohrigstad	Rapid 2	S 24.5403°	E 30.7223°	9.02	65.49
OLI-EWR9	B42B	Dorpspruit	Rapid 1	S 25.0758°	E 30.4399°	9.02	63.19

Initial hydro nodes were selected as part of the IUA report and summarised rationale provided. These identified hydro nodes have been revised after discussions with various specialists and especially with the information that is available after the additional rapid Reserves have been undertaken for selected tributaries of the Olifants River where no or very little information is available.

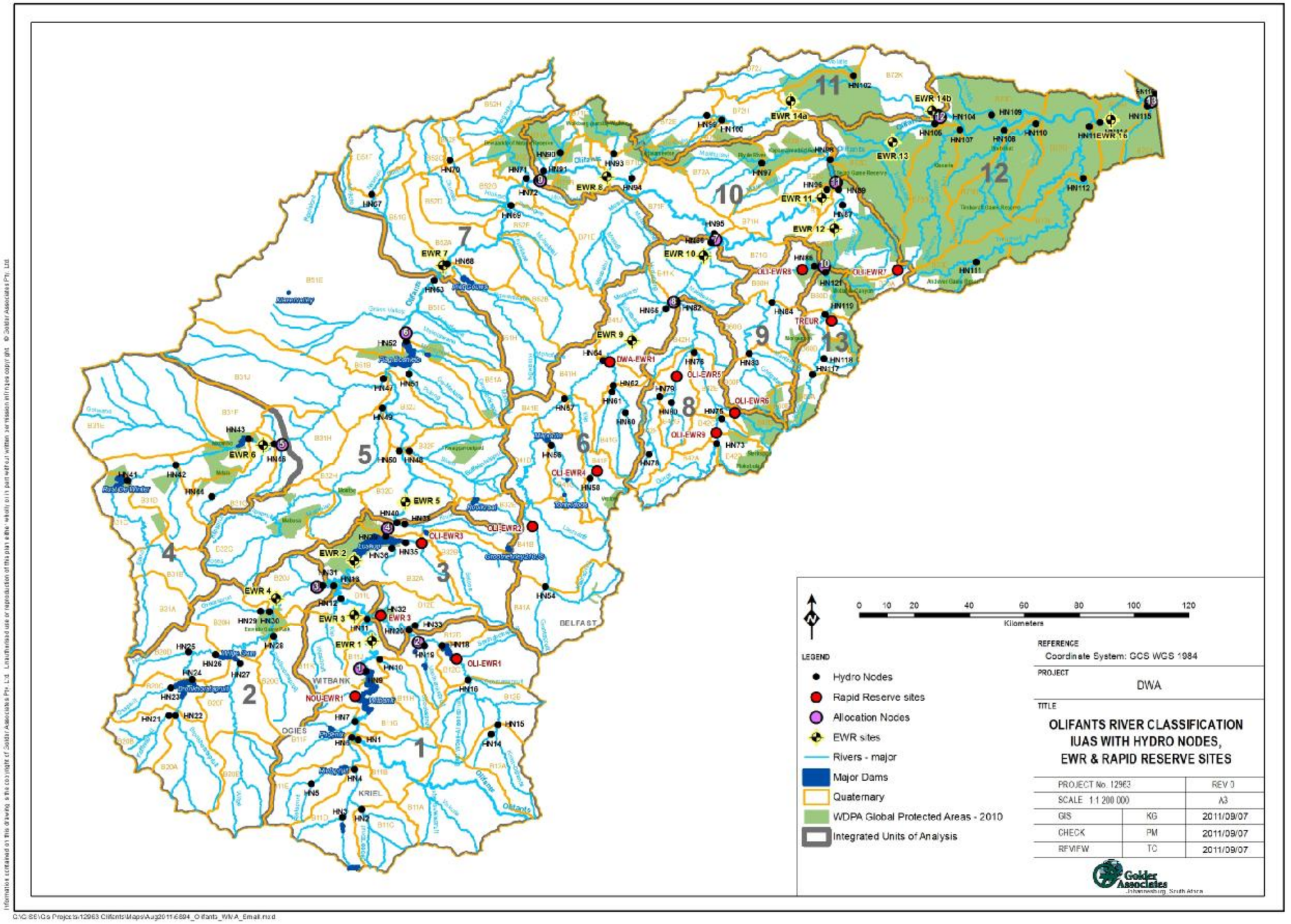
The Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) per hydro node have been provided by the desktop PES, EI and ES study that was undertaken for the Olifants River during April to May 2011. In situations where the selected hydro node is an existing EWR site from a previous Reserve study, the PES and EIS information provided was obtained from these studies.

The EWR sites (from the previous Reserve studies and additional Rapid sites) final selected hydro nodes (121) and are indicated in the map below.

Quantification of the changes in Ecosystem Goods, Services and Attributes (EGSAs)

Based on the above established EWR sites and identified biophysical nodes to which Reserve data can be extrapolated, the changes in relevant ecosystem aspects as they relate to identified EGSAs for the Olifants WMA were assessed.

The relevant EGSAs for the WMA are listed with the RDM aspects to be considered identified. The possible ecosystem changes as they relate to the EGSAs and RDM aspects are then described.



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Olifants WMA indicating IUAs with location of hydro nodes and EWR sites

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1 INTRODUCTION

The Olifants River originates at Trichardt to the east of Johannesburg and initially flows northwards before gently curving in a generally eastward direction through the Kruger National Park and into Mozambique, where it joins the Limpopo River before discharging into the Indian Ocean. The Olifants water management area (WMA) corresponds with the South African portion of the Olifants River catchment (excluding the Letaba River catchment). It falls within three provinces, *viz*. a small part to the west within Gauteng, with the southern part mainly in Mpumalanga and the northern part in Limpopo Province. The main tributaries are the Wilge, Elands and Ga-Selati Rivers on the left bank and the Steelpoort, Blyde, Klaserie and Timbavati Rivers on the right bank (Figure 1).

Distinct differences in climate occur; from cool Highveld in the south to subtropical, east of the escarpment. Mean annual rainfall is in the range of 500 mm to 800 mm over most of the WMA.

The main economic activity in the WMA is related to coal, platinum, vanadium, chrome, copper and phosphate mining. The coal mining is located in the upper reaches of the catchment around Witbank, Middelburg and Delmas. There are large thermal coal fired power stations associated with the coal mining. The platinum, chrome and vanadium mines are located in the Steelpoort and middle areas of water management area while the copper and phosphate mining occurs in the lower Olifants around Phalaborwa. There are also large steel foundries located in Middelburg and 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 water management area are largely undeveloped, with scattered rural villages where the people are mainly dependent on income from migrant workers in the Gauteng area, Witbank, Middelburg and Phalaborwa are the largest urban centres. Land use in the water management 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 water management 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.

With the Olifants River flowing through the Kruger National Park, which is located at the downstream extremity of the water management area, the provision of water to meet ecological requirements is one of the controlling factors in the management of water resources throughout the water management area (2004).

Most surface runoff originates from the higher rainfall southern and mountainous areas. There are 9 major dams constructed in the Olifants River and the major tributaries which regulate the flow in the river system.

Large quantities of groundwater are abstracted for irrigation in the north-west of the water management area, as well as for rural water supplies throughout most of the area. Potential for increased groundwater utilisation has been identified on the Nebo Plateau north-east of Groblersdal. Substantial amounts of water are transferred into the water management area as cooling water for power generation, while smaller transfers are made to neighbouring water management areas.

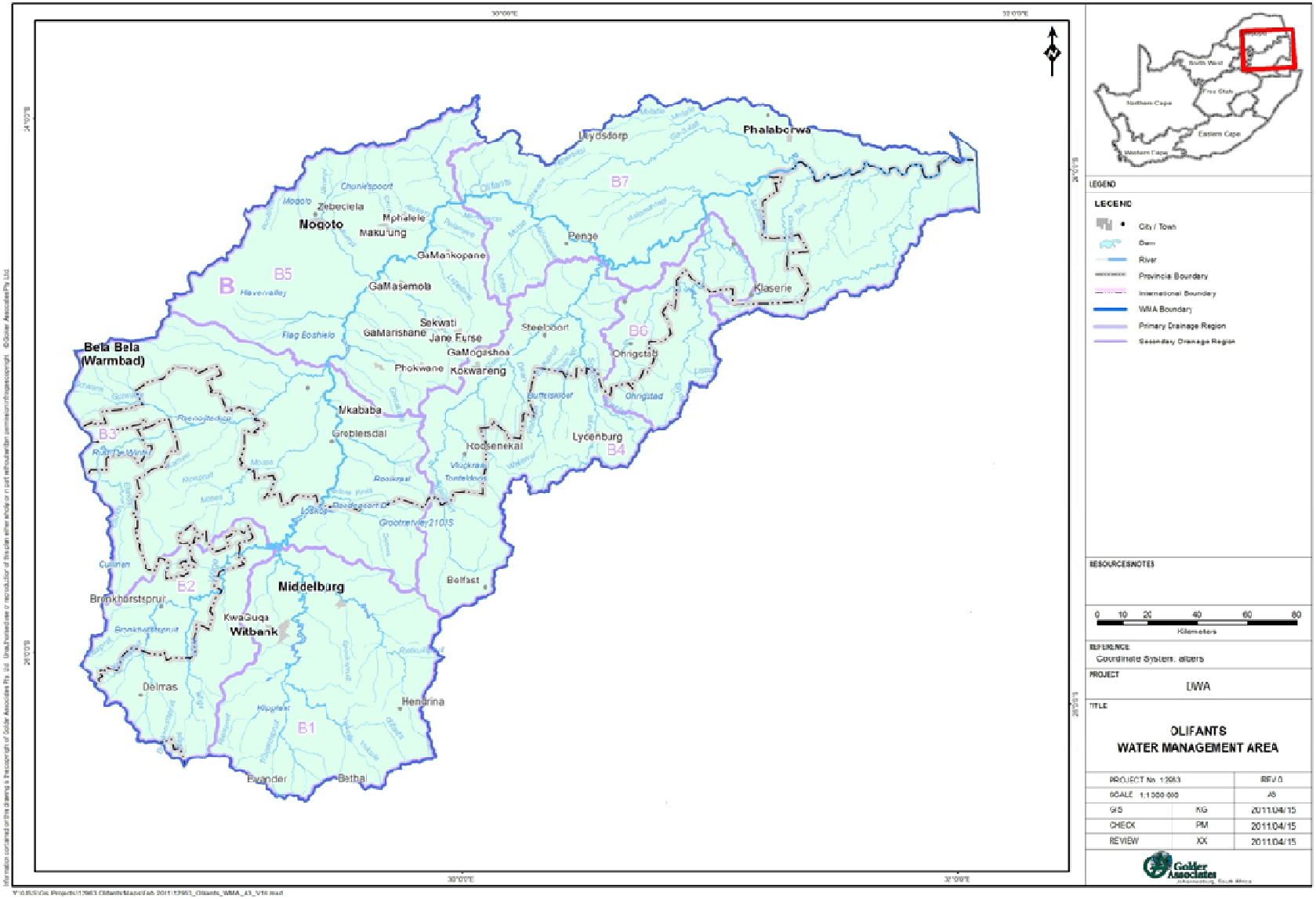

Figure 1: The Olifants WMA

The Olifants WMA is a highly utilised and regulated catchment and like many other WMAs in South Africa its water resources are becoming more stressed due to an accelerated rate of development and changing weather patterns resulting in the scarcity of water resources. There is an urgency to ensure that water resources in the Olifants River catchment area are able to sustain their level of uses and be maintained at their desired states. The determination of the Management Classes (MC) of the significant water resources in Olifants River System will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users. The MC of the water resource will therefore set the boundaries for the volume, distribution and quality of the Reserve and RQOs, and thus the potential allocable portion of a water resource for use.

2 CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE OLIFANTS WMA

The National Water Act (Act No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without seriously affecting the functioning of the water resource systems. In order to achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of resource directed measures (RDM). As part of the RDM, a management class (MC) has to be determined for a significant water resource, as the means to ensure a desired level of protection. The purpose of the MC is to establish clear goals relating to the quantity and quality of the relevant water resource.

The classification system, the Reserve and RQOs together are intended to ensure comprehensive protection of all water resources. An important consideration in the determination of RDM is that they should be technically sound, scientifically credible, practical and affordable.

The Chief Directorate: Resource Directed Measures (CD:RDM) of the Department of Water Affairs (DWA) is tasked with the responsibility of ensuring that the water resources are classified in terms of the Water Resource Classification System (WRCS) to ensure that a balance is sought between the need to protect and sustain water resources on one hand and the need to develop and use them on the other. The CD: RDM has identified the need to undertake the classification of significant water resources (rivers, wetlands, groundwater and lakes) in the Olifants WMA in accordance with the WRCS.

The MC and associated resource quality objectives (RQOs) will assist the DWA make more informed decisions regarding the authorisation of future water uses, operation and management of the system and the evaluation of the magnitude of the impacts of the present and proposed developments.

The purpose of this study is to coordinate the implementation of the 7 step process of the WRCS to classify all significant water resources the Olifants WMA in order to determine a suitable MC for the relevant water resources and in so doing deliver the IWRM template with recommendations for presentation to the delegated authority.

The determination of the MC is necessary to facilitate a balance between protection and use of water resources. In determining the class, it is important to recognise that different water resources will require different levels of protection. In addition to achieving ecological sustainability of the

significant water resources through classification, the process will allow due consideration of the social and economic needs of competing interests by all who rely on the water resources. The WRCS will be applied taking account of the local conditions, socio-economic imperatives and system dynamics within the context of South African conditions. The process will also require a wide range of complex trade-offs to be assessed and evaluated at a number of scales.

There study approach for the determination of the MC includes:

- An assessment of the Olifants WMA to understand the status quo assessment with regard to water resource quality, water resource issues, existing monitoring programmes, infrastructure, institutional environment, socio-economics, sectoral water uses and users, etc.
- The delineation of the WMA into integrated units of analysis (IUAs) based on identified criteria and system understanding and characteristics;
- The application of the WRCS within each IUA, *i.e.* establishing the MC by integration of the economic, social and ecological goals through a suitable analytical decision-making system (trade-offs).
- Population of the classification templates.

The study approach is defined by 6 tasks depicted in Figure 2**.**

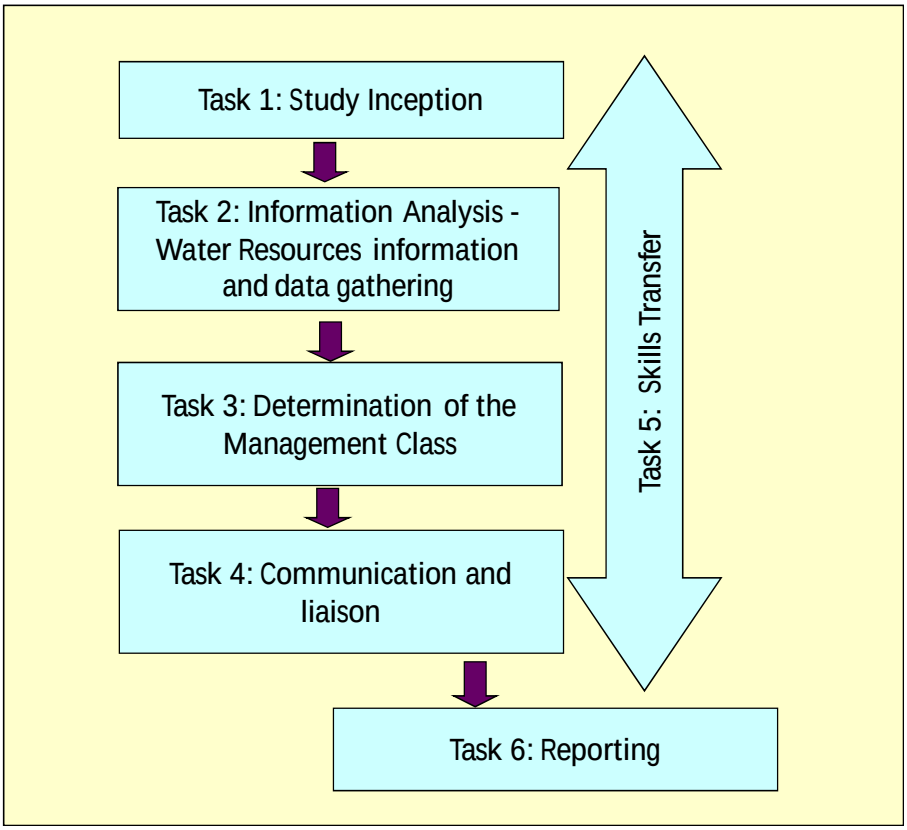

Figure 2: The study tasks

2.1 THE QUANTIFICATION OF ECOLOGICAL WATER REQUIREMENTS (TASK 3: STEP 3)

In order that the Department is able to effectively classify the significant water resources of the Olifants WMA a Reserve determination has to be undertaken as part of the WRC process. The Reserve determination requires the quantification of EWRs which forms an integral component of the classification process. With respect to the Olifants WMA, the classification process is being undertaken in catchment with an existing preliminary Reserve, thus the existing Reserve information will be used. In addition extrapolation of EWRs to identified nodes is required.

This task has been undertaken in compliance with the requirements of the study terms of reference that specify that the classification process is required to build from existing and current initiatives undertaken in support of integrated water resource management.

The determination of the MC and application of the WRCS requires in Step 3, that the Ecological Water Requirements (EWRs) be quantified at identified nodes.

2.2 SPATIAL EXTENT OF STUDY

The spatial extent for the classification study includes secondary drainage regions B1 to B7, the catchment area of the Olifants WMA. This includes the Upper, Middle and Lower Olifants and Steelpoort River sub-catchment areas within the Olifants WMA (see Figure 3). The Letaba River catchment area is not included in the study area.

2.3 OBJECTIVES OF STEP 3 OF THE WRCS

The objective of step 3 of the WRCS is to provide the necessary ecological and Reserve data to enable the determination of the MC of all the significant water resources of the Olifants River catchment (WMA 4). The purpose of step 3 of the process is to specifically quantify the EWRs and describe the changes in non-water ecosystem goods, services and attributes (EGSAs) at the established EWR sites and at biophysical nodes to which Reserve data can be extrapolated.

The following activities have been undertaken as part of Step 3 of the WRCS, the quantification of the EWRs and changes in non-water quality Ecosystem Goods, Services and Attributes (EGSAs):

- Identification of the nodes to which Resource Directed Measures (RDM) data can be extrapolated and extrapolate.
- Development of the rule curves, summary tables and modified time series for each node.
- Quantification of the changes in relevant ecosystem components, functions and attributes for each ecological category for each node.

The process followed is that described in the WRCS Guidelines, Volumes 1 and 2 (Overview and the 7-step classification procedure; and Ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, 2007a and 2007b).

Figure 3: Olifants WMA indicating four sub-catchment areas

2.4 PURPOSE OF THE REPORT

This purpose of this report is to provide the rationale and the results of the following:

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

3 ECOLOGICAL WATER REQUIREMENTS

3.1 THE APPROACH ADOPTED

The approach followed to provide the information as required in step 3 of the WRCS will be discussed in sections 3.2 to 3.5. All information and results are summarised in tables and the rationale for the various decisions included. The detail information, e.g. rule tables for the various categories per hydro is provided in electronic format.

3.2 FINALISATION OF HYDRO NODE SELECTION

Initial hydro nodes were selected as part of the IUA report and summarised rationale provided. This is described in section 4 of the following report:

Directorate Water Resource Classification. Department of Water Affairs, South Africa, July 2011. Classification of Significant Water Resources in the Olifants Water Management Area (WMA 4): Integrated Units of Analysis (IUA) Delineation Report. Report No: RDM/WMA04/00/CON/CLA/0311.

These identified hydro nodes have been revised after discussions with various specialists and especially with the information that is available after the additional rapid Reserves have been undertaken for selected tributaries of the Olifants River where no or very little information is available.

The Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) per hydro node have been provided by the desktop PES, EI and ES study that was undertaken for the Olifants River during April to May 2011. In situations where the selected hydro node is an existing EWR site from a previous Reserve study, the PES and EIS information provided was obtained from these studies.

A number of the EWR sites that were selected as part of the 2001 comprehensive Reserve determination study have been re-assessed during the development of the reconciliation strategy for the Olifants River water supply system (DWA 2011). The revised PES and EIS from this study was used for these sites.

Table 1 summarises the selected hydro nodes (also see Figure 4) for further analysis during the scenario analysis. All the EWR sites (from the previous Reserve studies and additional Rapid sites) are indicated in Figure 4.

Table 1: Final selected hydro nodes for the Olifants River catchment

IUA	Node no	Quaternary catchment	Nodes	EI	ES	PES	Node Type and considerations
1	HN1	B11A, B11B	Olifants (confluence with Steenkoolspruit)	High	High	C	Management Unit, biophysical, water quality impacts
	HN2	B11C	Piekespruit (confluence with Steenkoolspruit)	High	High	B	Biophysical
	HN3	B11D	Dwars-indie-Wegspruit (confluence with Trichardtspruit)	High	High	C	Biophysical
	HN4	B11D	Steenkoolspruit (outlet of quaternary)	Moderate	High	D	Management Unit, water quality impacts
	HN5	B11E	Blesbokspruit (confluence with Rietspruit)	High	High	B	Biophysical
	HN6	B11E	Steenkoolspruit (confluence with Olifants)	Moderate	High	D	Management Unit, water quality impacts
	HN7	B11F	Olifants (outlet of quaternary)	Moderate	High	D	Management Unit, impacts of Klippoortjie & Tweefonteinspruit
	HN8	B11G	**Noupoortspruit (EWR site – NOU-EWR1)** (existing)	**EIS=Moderate**		**C/D**	Management Unit, water quality impacts on Witbank Dam
	HN9	B11G	Olifants (releases from Witbank Dam)	Moderate	High	D	Downstream Witbank Dam – releases from dam
	HN10	B11H	Spookspruit (confluence with Olifants)	High	High	C	Biophysical
	HN11	B11J	**Olifants (EWR site 1 – EWR1)** (existing)	**EIS= Moderate**		**D**	Biophysical
	HN12	B11K, B11L	Klipspruit (confluence with Olifants)	High	Moderate	D	Management Unit, water quality impacts
	HN13	***B11L***	***Olifants (outlet of IUA1)***	***Very high***	***Very high***	***B***	***Biophysical & outlet of IUA1***
	HN14	B12A	Boschmansfontein (confluence with Klein Olifants)	Moderate	High	C	Biophysical
	HN15	B12A	Klein Olifants (outlet of quaternary)	High	High	C	Biophysical
	HN16	B12B	Klein Olifants (outlet of quaternary)	Moderate	High	D	Impacts of mining in tributary catchments
	HN17	B12C	**Klein Olifants (EWR site – OLI-EWR1)** (Rapid site)	**EIS=Low**		**C**	Impacts from upstream mining and agricultural activities
	HN18	B12C	Klein Olifants (releases from Middelburg Dam)	High	High	C	Biophysical, releases from Middelburg Dam
	HN19	B12D	Vaalbankspruit (confluence with Klein Olifants)	Moderate	High	D	Biophysical
	HN20	B12D	Klein Olifants (outlet of quaternary)	Moderate	High	D	Management Unit, impacts fromdam and Middelburg town
2	HN21	B20A	Bronkhorstpruit (outlet of quaternary)	Moderate	High	C	Management Unit, biophysical, impacts from Delmas area
	HN22	B20B	Koffiespruit (confluence with Bronkhorstspruit)	Moderate	High	C	Biophysical

IUA	Node no	Quaternary catchment	Nodes	EI	ES	PES	Node Type and considerations
	HN23	B20C	Osspruit (inflow to Bronkhorstspruit Dam)	Moderate	High	D	Biophysical
	HN24	B20C	Bronkhorstpruit (outlet from Bronkhorstspruit Dam)	High	High	C	Management Unit, biophysical
	HN25	B20D	Hondespruit (confluence with Bronkhorstspruit)	High	High	C	Biophysical
	HN26	B20D	Bronkhorstpruit (confluence with Wilge)	High	Very high	C	Management Unit, biophysical, impacts from Bronkhorstspruit
	HN27	B20E, B20F	Wilge (confluence with Bronkhorstspruit	High	Very high	C	Management Unit, biophysical
	HN28	B20G	Saalboomspruit (confluence with Wilge)	Moderate	High	C	Management Unit, future mining impacts
	HN29	B20H	Grootspruit (confluence with Wilge)	High	Very high	C	Biophysical
	HN30	B20H	Wilge (outlet of quaternary)	High	Very high	B	Management Unit, biophysical
	HN31	***B20J***	***Wilge (EWR site – EWR4, outlet of IUA2)*** (existing)	***EIS=High***		***C***	***Biophysical & outlet of IUA2***
3	HN32	B12E	Doringboomspruit (confluence with Klein Olifants)	High	High	B	Biophysica
	HN33	B12E	Keeromspruit (confluence with Klein Olifants)	High	High	C	Biophysical
	HN34	B12E	**Klein Olifants (EWR site – EWR3)** (existing)	**EIS =Moderate**		**C**	Biophysical, Management Unit
	HN35	B32A	**Kranspoortspruit (EWR site – OLI-EWR3)** (Rapid site)	**EIS=Very high**		**B**	Biophysical, inflow to Loskop Dam
	HN36	B32A	Boekenhoutloop (inflow to Loskop Dam)	High	High	B	Biophysical
	HN37	B32A	**Olifants (EWR site – EWR2)** (existing)	**EIS=High**		**C**	Management Unit, biophysical
	HN38	B32B, B32C	One node at confluence of Selons with Olifants in B32C. Included: Klipspruit (confluence with Selons) Kruis (confluence with Selons) Selons (confluence with Olifants)	 High High High	 High High Very high	 B B C	 Biophysical Biophysical Biophysical
	HN39	B32C	Olifants (releases from Loskop Dam)	High	High	D	Management of system
	HN40	***B32C***	***Olifants (outlet of quaternary – outlet of IUA3)***	***High***	***High***	***D***	***outlet of IUA3***
4	HN41	B31A, B, C	One node at outlet of B31C, releases from Rust de Winter Dam. Included:				

IUA	Node no	Quaternary catchment	Nodes	EI	ES	PES	Node Type and considerations
			B31A (Elands)	High	High	C	Biophysical
			B31B (Hartbeesspruit)	High	Very high	C	Biophysical
			B31C (Elands)	High	Very high	C	Biophysical, management of system releases from dam
	HN42	B31D	Enkeldoringspruit (confluence with Elands)	High	High	C	Biophysical
	HN43	B31F	Elands (releases from Mkumbe Dam)	High	High	C	Management Unit, biophysical, releases from dam
	HN44	B31G	Kameel (upper part only	Moderate	High	D	Biophysical, before impacts of town and villages
	HN45	B31G	**Elands (EWR site – EWR6)** (existing)	**EIS=Moderate**		**D**	Biophysical
	HN46	***B31G***	***Elands (outlet of quaternary – outlet of IUA4)***	***Low***	***Moderate***	***E***	***Management Unit & outlet of IUA4***
5	HN47	B31H, B31J	Elands (outlet of quaternary, confluence with Olifants))	Moderate	Moderate	D	Management Unit
	HN48	B32E, B32F	One node at confluence with Olifants in B32F Included: B32E (Bloed) B32F (Doringpoortloop, Diepkloof and Bloed)	 Moderate High	 High Moderate	 B C	 Biophysical Biophysical
	HN49	B32G, H	One node at outlet of B32H, confluence with Olifants Included: B32G (Moses) B32H (Mametse and Moses)	 High High	 High High	 C D	 Biophysical Biophysical
	HN50	B32D	**Olifants (EWR site – EWR5)** (existing)	**EIS=Moderate**		**C**	Management Unit, biophysical, confluence with Elands
	HN51	B51B	Puleng (upper part only)	High	High	B	Biophysical
	HN52	B51B	Olifants (releases from Flag Boshielo Dam)	Moderate	High	D	Management of system
	HN53	***B51D, B51E***	***Olifants (outlet of quaternary– outlet of IUA5)***	***Moderate***	***High***	***D***	***Management Unit & outlet of IUA5***
6	HN54	B41A	One node at outlet of B41A. Included: Grootspruit (outlet of quaternary) Langspruit, including Lakenvleispruit and Kleinspruit	 High High	 High Very high	 C D	 Biophysical Biophysical
	HN55	B41B	**Steelpoort (EWR site – OLI-EWR2)** (Rapid site)	**EIS=Moderate**		**D**	Biophysical
	HN56	B41C	Masala (confluence with Steelpoort), including Tonteldoos and Vlugkraal)	High	High	C	Biophysical

IUA	Node no	Quaternary catchment	Nodes	EI	ES	PES	Node Type and considerations
	HN57	B41D, B41E	Steelpoort (inflow to De Hoop Dam)	High	Very high	C	Biophysical & management unit
	HN58	B41F	Draaikraalspruit (confluence with Klip)	High	Very high	B	Biophysical
	HN59	B41F	**Klip (EWR site – OLI-EWR4)** (Rapid site)	**EIS=Moderate**		**C**	Biophysical, inflow to De Hoop Dam
	HN60	B41G	Kraalspruit (confluence with Groot Dwars)	High	Very high	B	Biophysical
	HN61	B41G	Klein Dwars (Confluence with Groot Dwars)	High	High	D	Biophysical
	HN62	B41G	Upper reaches of Dwars (before mining impacts)	High	Very high	C	Biophysical
	HN63	B41H	**Dwars (EWR site – DWA-EWR1)** (existing)	**EIS=High**		**B/C**	Biophysical, mining impacts, confluence with Steelpoort
	HN64	B41H	Steelpoort	**EIS=Moderate**		**C/D**	Biophysical, releases from De Hoop Dam
	HN65	B41J	**Steelpoort (EWR site – EWR9)** (existing)	**EIS=High**		**D**	Biophysical
	HN66	***B41J, B41K***	***Steelpoort* (EWR site – EWR10)** (existing) ***(confluence with Olifants – outlet of IUA6)***	***Moderate***	***High***	***D***	***Management Unit & outlet of IUA6***
7	HN67	B51F	Nkumpi (outlet of quaternary)	High	Moderate	C	Biophysical
	HN68	B51G	**Olifants (EWR site – EWR7)** (existing)	**EIS=Moderate**		**E**	Biophysical & management unit
	HN69	B52E	Palangwe (confluence with Olifants)	High	High	C	Biophysical
	HN70	B52F	Hlakaro (outlet)	High	High	C	Biophysical
	HN71	B52J	Mphogodima (confluence with Olifants)	High	High	C	Biophysical
	HN72	***B52A, E, G, J***	***Olifants (outlet of quaternary – outlet of IUA7)***	***Moderate***	***High***	***D***	***Management Unit & outlet of IUA7***
8	HN73	B42A, B42B	One node for Dorpspruit at outlet of B42B. Included: Hoppe se Spruit (confluence) Doringbergspruit (confluence)	 Moderate High	 High High	 C C	 Biophysical Biophysical
	HN74	B42B	**Dorpspruit (EWR site – OLI-EWR9)** (Rapid site)	**EIS=Low**		**C/D**	Biophysical, water quality impacts from Lydenburg
	HN75	B42C	Potloodspruit (confluence with Dorps)	High	High	C	Biophysical
	HN76	B42D, B42E	Dorps (confluence with Spekboom) Spekboom (confluence with Dorps)	High High	High Very high	C C	Biophysical, water quality impacts from Lydenburg Biophysical
	HN77	B42D	**Spekboom (EWR site – OLI-EWR6)** (Rapid site)	**EIS=High**		**C**	Biophysical

IUA	Node no	Quaternary catchment	Nodes	EI	ES	PES	Node Type and considerations
	HN78	B42F	Potspruit (confluence with Watervals)	High	High	C	Biophysical
	HN79	B42F	Watervals (releases from Buffelskloof Dam)	High	Very high	C	Biophysical & management unit
	HN80	B42G	Rooiwalhoek-se-Loop (confluence with Watervals)	High	Very high	B	Biophysica
	HN81	B42G	**Watervals (EWR site – OLI-EWR5)** (Rapid site)	**EIS=Moderate**		**C**	Biophysical, confluence with Spekboom
	HN82	***B42H***	***Spekboom (outlet of quaternary – outlet of IUA 8)***	***High***	***Moderate***	***B***	***Confluence with Steelpoort & outlet of IUA8***
9	HN83	B60E, B60F	One node at outlet of B60F. Included: Kranskloofspruit (confluence with Ohrigstad) Mantshibi (confluence with Ohrigstad) Ohrigstad (outlet of quaternary)	 High High Moderate	 Very high Very high Very high	 C C D	 Biophysical Biophysical Biophysical & management unit
	HN84	B60G	Vyehoek (confluence with Ohrigstad)	High	Very high	C	Biophysical
	HN85	B60H	**Ohrigstad (EWR site – OLI-EWR8)** (Rapid site)	**EIS=Moderate**		**C**	Biophysical
	HN86	***B60H***	***Ohrigstad (outlet of quaternary – outlet of IUA9B)***	***High***	***Very high***	***D***	***Inflow to Blyderivierpoort Dam & outlet of IUA9***
10	HN87	B60J	Sandspruit, including Rietspruit and Qunduhlu	High	Moderate	B	Biophysical, confluence with Blyde
	HN88	B60J	**Blyde (EWR site – EWR12)** (existing)	**EIS=High**		**B/C**	Biophysical & releases from Blyderivierpoort Dam
	HN89	B60J	Blyde (confluence with Olifants)	Very high	Very high	C	Biophysical
	HN90	B71A	Paardevlei (confluence with Tongwane)	High	Very high	B	Biophysical
	HN91	B71A	Tongwane (confluence with Olifants)	High	High	B	Biophysical
	HN92	B71B	**Olifants (EWR site – EWR8)** (existing)	**EIS=Moderate**		**C/D**	Biophysical & management unit
	HN93	B71C	Mohlapitse (upper reaches)	Very high	Very high	B	Biophysical, conservation area
	HN94	B71D	Kgotswane (confluence with Olifants)		Moderate	B	Biophysical
	HN95	B71D, B71F	Olifants (confluence with Steelpoort)	High	Very high	D	Biophysical & management unit
	HN96	B71G, H, J	**Olifants (EWR11, confluence with Blyde)** (existing)	**EIS=High**		**E**	Biophysical & management unit
	HN97	B72A	Makhutswi, including Moungwane and Malomanye	High	High	C	Biophysical
	HN98	***B72C***	***Olifants (outlet – outlet of IUA10)***	***High***	***High***	***C***	***Biophysical, management unit & outlet of IUA10***
11	HN99	B72E	Ngwabatse (confluence with Ga-Selati)	High	Very high	D	Biophysical
	HN100	B72F, G	Ga-Selati (outlet of quaternary)	High	Very high	C	Biophysical

IUA	Node no	Quaternary catchment	Nodes	EI	ES	PES	Node Type and considerations
	HN101	B72H	**Ga-Selati (EWR site – EWR14a)** (existing)	**EIS=Moderate**		**C**	Biophysical
	HN102	B72J	Molatle (confluence with Ga-Selati)	Moderate	Moderate	B	Biophysical
	HN103	B72K	**Ga-Selati (EWR site – EWR14b)** (existing)	**EIS=Moderate**		**E**	Biophysical, management unit & outlet of IUA11
	HN104	***B72K***	***Ga-Selati (outlet of quaternary – outlet of UIA11)***	***High***	***High***	***E***	***Management, confluence with Olifants & outlet of IUA11***
12	HN105	B72D	**Olifants (EWR site – EWR13)** (existing)	**EIS=Moderate**		**C**	Biophysical & management unit
	HN106	B73A	**Klaserie (EWR site – OLI-EWR7)** (Rapid site)	**EIS=High**		**B/C**	Biophysical & management unit
	HN107	B73B	Klaserie (confluence with Olifants)	High	High	C	Biophysical, releases from Klaserie Dam
	HN108	B73C	Tsiri (confluence with Olifants)	High	Low	B	Biophysical
	HN109	B73C	Tshutshi (confluence with Olifants)	High	Low	B	Biophysical
	HN110	B73D	Nhlaralumi, including Machaton, Nyameni and Thlaralumi	High	Low	B	Biophysical
	HN111	B73E	Sesete (confluence with Timbavati)	High	Low	B	Biophysical
	HN112	B73F	Timbavati (outlet of quaternary)	High	Moderate	B	Biophysical
	HN113	B73G	Timbavati, including Shisakashonghondo	High	Moderate	B	Biophysical
	HN114	B73G, B73H	**Olifants (EWR site – EWR16)** (existing)	**EIS=High**		**C**	Biophysical & management unit
	HN115	B73J	Hlahleni (confluence with Olifants)	High	Low	A	Biophysical
	HN116	***B73J***	***Olifants (outlet of quaternary – outlet of IUA12)***	***High***	***Low***	***C***	***Biophysical, management unit & outlet of IUA12***
13	HN117	B60A	Blyde (confluence with Lisbon)	High	Very high	C	Biophysical
	HN118	B60B	Lisbon, including Heddelspruit and Watervalspruit	High	Very high	B	Biophysical
	HN119	B60B	Blyde (outlet of quaternary)	High	Very high	B	Biophysical
	HN120	B60C	**Treur (EWR site – TRE-EWR1)** (existing)	**EIS=Very high**		**B**	Biophysical
	HN121	***B60D***	***Blyde (inflow to Blyderivierpoort Dam – outlet of IUA13)***	***High***	***Very high***	***B***	***Biophysical, dolomitic fountains, conservation area including Kadishispruit, Belvedere, Muilhuisspruit,***

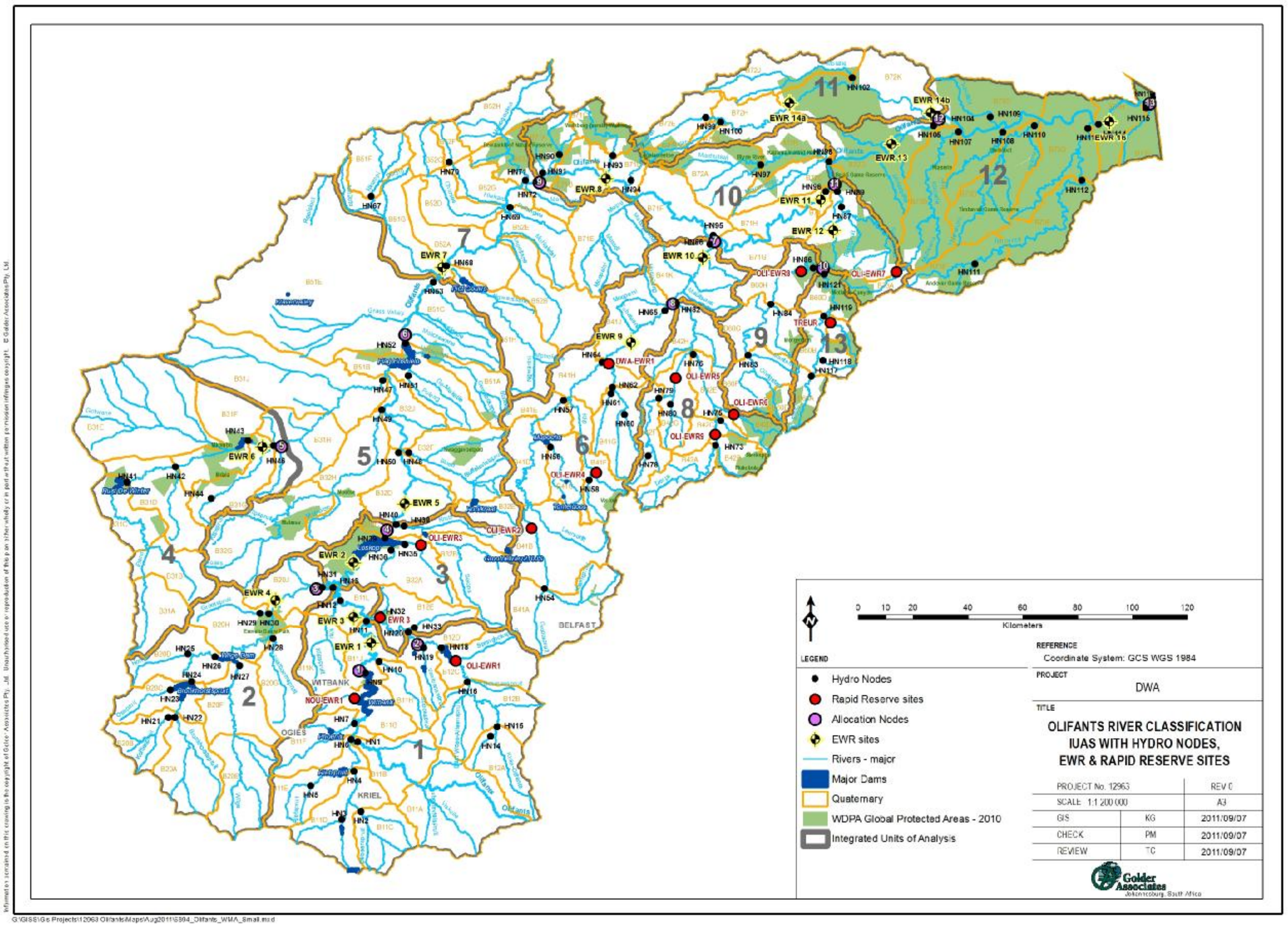

Figure 4: Final selected hydro nodes and EWR sites for the Olifants River catchment

3.3 EWR INFORMATION FROM PREVIOUS STUDIES

A number of Reserve studies have been undertaken since 2001 on various levels of detail. The most significant study was the comprehensive study undertaken during 2001 to 2003. This study included 16 EWR sites on a comprehensive level and focussed on the main stem Olifants River and its major tributaries. Some of the results from this study have recently (DWA, 2011) been re-assessed to update the PES and EIS information.

One intermediate and two rapid level 3 Reserve studies have also been undertaken during the last few years. These studies were undertaken mainly to address specific water use license applications and they were focused on smaller tributaries.

Table 2 provides a summary of these studies that were undertaken. The original PES information is provided in the table with the revised in brackets for those EWR sites that were re-assessed.

Table 2: Information on previous Reserve studies in the Olifants catchment

EWR site	River	Quaternary catchment	PES	EIS	REC	VMAR [1)] (10^6m^3)	%EWR	Level
EWR1	Olifants	B11J	E (D)	Moderate	C	184.52	18.6	Comprehensive
EWR2	Olifants	B32A	C	High	B	500.63	23.8	Comprehensive
EWR3	Klein Olifants	B12E	D (D)	Moderate	C	81.54	27.0	Comprehensive
EWR4	Wilge	B20J	B (C)	High	B	175.50	29.9	Comprehensive
EWR5	Olifants	B32D	C (C)	High	C	570.98	19.1	Comprehensive
EWR6	Elands	B31G	E (D)	Moderate	D	60.30	17.9	Comprehensive
EWR7	Olifants	B51G	E	Moderate	D	726.52	12.7	Comprehensive
EWR8	Olifants	B71B	E (C/D)	Moderate	D	813.04	15.2	Comprehensive
EWR9	Steelpoort	B41J	D (C/D)	High	D	120.17	15.2	Comprehensive
EWR10	Steelpoort	B41K	D	High	D	336.63	12.1	Comprehensive
EWR11	Olifants	B71J	E	High	D	1321.8	13.7	Comprehensive
EWR12	Blyde	B60J	B (B/C)	High	B	383.70	34.5	Comprehensive
EWR13	Olifants	B72D	C (C)	Moderate	B	1760.7	23.6	Comprehensive
EWR14a	Ga-Selati	B72H	C	Moderate	C	52.20	31.2	Comprehensive
EWR14b	Ga-Selati	B72K	E	Moderate	D	72.74	24.8	Comprehensive
EWR16	Olifants	B73H	C (C)	Very high	B	1916.9	21.6	Comprehensive
TRE-EWR1	Treur	B60C	A/B	Very high	A/B	49.28	45.4	Rapid 3
NOU-EWR1	Noupoortspruit	B11G	C/D	Moderate	C/D	4.28	25.9	Rapid 3
DWA-EWR1	Dwars	B41H	B/C	High	B/C	31.43	25.9	Intermediate

1) VMAR – Virgin Mean Annual Runoff is based on the updated hydrology from the DWA 2009 study

As these studies were mainly focused on the main stem and the major tributaries, the results could not be used to determine the EWRs for the smaller tributaries where hydro nodes were identified with high levels of confidence. A number of additional rivers were identified, mainly from an eco-regional perspective where additional rapid Reserve studies should be undertaken to improve the

confidence in the final requirements per hydro node. The results of the existing studies and the additional studies have been used for the extrapolation to all the identified hydro nodes.

3.4 ADDITIONAL RAPID RESERVE DETERMINATION STUDIES

Additional rapid Reserve determination studies have been undertaken to enhance the existing information and to enable the extrapolation of EWRs to all the identified hydro nodes. A total of 9 additional rivers have been identified where no or very little information was available for further use during the classification of the significant water resources of the Olifants River catchment.

These rivers have been assessed during 8th to 12th August 2011 on various levels of detail ranging from rapid 1 to rapid 3. The details of the selected EWR sites per river are provided in Table 3.

Table 3: Selected EWR sites for additional rapids

EWR site	Quaternary catchment	River	Level of determination	Latitude	Longitude	Ecoregion level 2	MAR ($10^6 m^3$)
OLI-EWR1	B12C	Upper Klein Olifants	Rapid 3	S 25.8169°	E 29.5904°	11.05	44.46
OLI-EWR2	B41B	Upper Steelpoort	Rapid 3	S 25.3831°	E 29.8383°	9.05	63.46
OLI-EWR3	B32A	Kranspoortspruit	Rapid 3	S 25.4376°	E 29.4758°	11.01	4.71
OLI-EWR4	B41F	Klip	Rapid 1	S 25.2249°	E 30.0523°	9.02	5.20
OLI-EWR5	B42G	Watervals	Rapid 3	S 24.8912°	E 30.3105°	9.02	36.39
OLI-EWR6	B42D	Upper Spekboom	Rapid 3	S 25.0094°	E30.5003°	9.02	28.04
OLI-EWR7	B73A	Klaserie	Rapid 3	S 24.5427°	E31.0349°	3.07	25.54
OLI-EWR8	B60H	Ohrigstad	Rapid 2	S 24.5403°	E 30.7223°	9.02	65.49
OLI-EWR9	B42B	Dorpspruit	Rapid 1	S 25.0758°	E 30.4399°	9.02	63.19

The detail report is attached as Appendix A and the supporting information is available electronically. The electronic information available includes additional photos, hydraulic survey data and modelling results and datasheets used for the macro-invertebrates sampling.

3.5 EXTRAPOLATION AND EWRs FOR HYDRO NODES

The information available from sections 3.3 and 3.4 has been used for extrapolation to all the identified hydro nodes. Table 4 list all the hydro nodes with the EWR sites that were used for extrapolation. The eco-region level 2 information as well as discussions with specialists were used as a guide during this process.

The rule and summary tables and the long term EWR time series as generated with the Desktop Reserve Model in SPATSIM is provided as electronic data. This information will be used during steps 4 and 5 of the WRCS.

The PES and REC information from the desktop study, the re-assessment of the comprehensive EWR sites, existing EWR sites and the additional rapid studies were used as the basis for extrapolation as indicated in Table 4.

Table 4: Hydro nodes and associated EWR sites used for extrapolation

IUA	Node no	Quaternary catchment	Nodes	EWR sites used for extrapolation
1	HN1	B11A, B11B	Olifants	OLI-EWR1
	HN2	B11C	Piekespruit	OLI-EWR1
	HN3	B11D	Dwars-indie-Wegspruit	OLI-EWR1
	HN4	B11D	Steenkoolspruit	OLI-EWR1
	HN5	B11E	Blesbokspruit	OLI-EWR1
	HN6	B11E	Steenkoolspruit	OLI-EWR1
	HN7	B11F	Olifants	NOU-EWR1
	HN8	B11G	Noupoortspruit	NOU-EWR1
	HN9	B11G	Olifants	EWR1
	HN10	B11H	Spookspruit	NOU-EWR1
	HN11	B11J	Olifants	EWR1
	HN12	B11K, B11L	Klipspruit	NOU-EWR1
	HN13	B11L	Olifants	EWR1
	HN14	B12A	Boschmansfontein	OLI-EWR1
	HN15	B12A	Klein Olifants	OLI-EWR1
	HN16	B12B	Klein Olifants	OLI-EWR1
	HN17	B12C	Klein Olifants	OLI-EWR1
	HN18	B12C	Klein Olifants	EWR3
	HN19	B12D	Vaalbankspruit	OLI-EWR1
	HN20	B12D	Klein Olifants	EWR3
2	HN21	B20A	Bronkhorstpruit	EWR4
	HN22	B20B	Koffiespruit	EWR4
	HN23	B20C	Osspruit	EWR4
	HN24	B20C	Bronkhorstpruit	EWR4
	HN25	B20D	Hondespruit	EWR4
	HN26	B20D	Bronkhorstpruit	EWR4
	HN27	B20E, B20F	Wilge	EWR4
	HN28	B20G	Saalboomspruit	EWR4
	HN29	B20H	Grootspruit	EWR4
	HN30	B20H	Wilge	EWR4
	HN31	B20J	Wilge	EWR4
3	HN32	B12E	Doringboomspruit	EWR3
	HN33	B12E	Keeromspruit	EWR3
	HN34	B12E	Klein Olifants	EWR3
	HN35	B32A	Kranspoortspruit	OLI-EWR3
	HN36	B32A	Boekenhoutloop	OLI-EWR3
	HN37	B32A	Olifants	EWR2
	HN38	B32B, B32C	Selons, Klipspruit,Kruis	OLI-EWR3
	HN39	B32C	Olifants	EWR5

IUA	Node no	Quaternary catchment	Nodes	EWR sites used for extrapolation
	HN40	B32C	Olifants	EWR5
4	HN41	B31A, B, C	Elands, Hartbeesspruit	EWR6
	HN42	B31D	Enkeldoringspruit	EWR6
	HN43	B31F	Elands	EWR6
	HN44	B31G	Kameel	EWR6
	HN45	B31G	Elands	EWR6
	HN46	B31G	Elands	EWR6
5	HN47	B31H, B31J	Elands	EWR6
	HN48	B32E, B32F	Bloed, Doringpoortloop, Diepkloof and Bloed	OLI-EWR3
	HN49	B32G, H	Moses, Mametse	EWR6
	HN50	B32D	Olifants	EWR5
	HN51	B51B	Puleng	No extrapolation sites. Use Desktop requirements
	HN52	B51B	Olifants	EWR7
	HN53	B51D, B51E	Olifants	EWR7
6	HN54	B41A	Grootspruit, Langspruit, Lakenvleispruit and Kleinspruit	OLI-EWR2
	HN55	B41B	Steelpoort	OLI-EWR2
	HN56	B41C	Masala, Tonteldoos and Vlugkraal)	OLI-EWR2
	HN57	B41D, B41E	Steelpoort (inflow to De Hoop Dam)	OLI-EWR2
	HN58	B41F	Draaikraalspruit	OLI-EWR4
	HN59	B41F	Klip	OLI-EWR4
	HN60	B41G	Kraalspruit	OLI-EWR2
	HN61	B41G	Klein Dwars	OLI-EWR2
	HN62	B41G	Upper reaches of Dwars	OLI-EWR2
	HN63	B41H	Dwars	DWA-EWR1
	HN64	B41H	Steelpoort	EWR9
	HN65	B41J	Steelpoort	EWR10
	HN66	B41J, B41K	Steelpoort	EWR10
7	HN67	B51F	Nkumpi	No extrapolation sites. Use Desktop requirements
	HN68	B51G	Olifants	EWR7
	HN69	B52E	Palangwe	No extrapolation sites. Use Desktop requirements
	HN70	B52F	Hlakaro	No extrapolation sites. Use Desktop requirements
	HN71	B52J	Mphogodima	No extrapolation sites. Use Desktop

IUA	Node no	Quaternary catchment	Nodes	EWR sites used for extrapolation
				requirements
	HN72	B52A, E, G, J	Olifants	EWR7
8	HN73	B42A, B42B	Hoppe se Spruit, Doringbergspruit	OLI-EWR9
	HN74	B42B	Dorpspruit	OLI-EWR9
	HN75	B42C	Potloodspruit	OLI-EWR9
	HN76	B42D, B42E	Dorps	OLI-EWR6
	HN77	B42D	Spekboom	OLI-EWR6
	HN78	B42F	Potspruit	OLI-EWR5
	HN79	B42F	Watervals	OLI-EWR5
	HN80	B42G	Rooiwalhoek-se-Loop	OLI-EWR5
	HN81	B42G	Watervals	OLI-EWR5
	HN82	B42H	Spekboom	OLI-EWR5
9	HN83	B60E, B60F	Kranskloofspruit, Mantshibi, Ohrigstad	OLI-EWR6
	HN84	B60G	Vyehoek	OLI-EWR6
	HN85	B60H	Ohrigstad	OLI-EWR8
	HN86	B60H	Ohrigstad	OLI-EWR8
10	HN87	B60J	Sandspruit, Rietspruit and Qunduhlu	EWR12
	HN88	B60J	Blyde	EWR12
	HN89	B60J	Blyde	EWR12
	HN90	B71A	Paardevlei	No extrapolation sites. Use Desktop requirements
	HN91	B71A	Tongwane	No extrapolation sites. Use Desktop requirements
	HN92	B71B	Olifants	EWR8
	HN93	B71C	Mohlapitse	No extrapolation sites. Use Desktop requirements
	HN94	B71D	Kgotswane	No extrapolation sites. Use Desktop requirements
	HN95	B71D, B71F	Olifants	EWR8
	HN96	B71G, H, J	Olifants	EWR11
	HN97	B72A	Makhutswi, Moungwane and Malomanye	EWR14a
	HN98	B72C	Olifants	EWR11
11	HN99	B72E	Ngwabatse	EWR14a
	HN100	B72F, G	Ga-Selati	EWR14a
	HN101	B72H	Ga-Selati	EWR14a
	HN102	B72J	Molatle	EWR14a
	HN103	B72K	Ga-Selati	EWR14b
	HN104	B72K	Ga-Selati	EWR14b

IUA	Node no	Quaternary catchment	Nodes	EWR sites used for extrapolation
12	HN105	B72D	Olifants	EWR13
	HN106	B73A	Klaserie	OLI-EWR7
	HN107	B73B	Klaserie	OLI-EWR7
	HN108	B73C	Tsiri	OLI-EWR7
	HN109	B73C	Tshutshi	OLI-EWR7
	HN110	B73D	Nhlaralumi, Machaton, Nyameni and Thlaralumi	OLI-EWR7
	HN111	B73E	Sesete	OLI-EWR7
	HN112	B73F	Timbavati	OLI-EWR7
	HN113	B73G	Timbavati, Shisakashonghondo	OLI-EWR7
	HN114	B73G, B73H	Olifants	EWR16
	HN115	B73J	Hlahleni	OLI-EWR7
	HN116	B73J	Olifants	EWR16
13	HN117	B60A	Blyde	TRE-EWR1
	HN118	B60B	Lisbon, Heddelspruit and Watervalspruit	TRE-EWR1
	HN119	B60B	Blyde	TRE-EWR1
	HN120	B60C	Treur	TRE-EWR1
	HN121	B60D	Blyde	TRE-EWR1

4 QUANTIFICATION OF CHANGES IN RELEVANT ECOSYSTEM GOODS, SERVICES AND ATTRIBUTES

The quantification of the changes in the relevant ecosystem components, functions and attributes for each ecological category for each node supports the evaluation of the socio-economic and ecological components in Step 4 of the classification procedure (DWAF, 2007a). The ecosystem changes at different ecological categories allow for the consideration of ecological and socio-economic information at different scales and enables the evaluation of various ecological catchment configurations. Thus in terms of the socio-economic evaluation of scenarios it is important to understand what the EGSAs for the IUAs are, the nodes at which the changes can be provided and the changes that occur based on different characteristics within the water resource.

EGSA information can only be provided if the node is an EWR site, if Reserve data can be extrapolated to a node from a site with high confidence data and if the EGSA was considered during the Reserve determination (DWA, 2007b).

As per the WRCS guidelines the required information on changes in ecosystem components can be related to hydrological characteristics, biological components and processes, physical components and processes, structure and organisation of aquatic ecosystems and water quality characteristics.

This section details the EGSAs information required for socio-economic evaluation and the ecosystem changes that relate to these EGSAs considered for Olifants WMA. The EGSAs aspects considered were assessed based on a change in ecological category. The significance of the change is described in terms of the socio-economic assessment. In many instances the ecosystem changes will be quantified in the assessment of the scenarios (catchment configurations).

4.1 EGSAs CONSIDERED FOR THE OLIFANTS WMA

The EGSAs considered for the Olifants WMA are listed in Table 4. These have been derived primarily from the previous DWA study 'The Nature, distribution and value of aquatic ecosystem services of Olifants, Inkomati and Usutu to Mhlatuze WMAs' (DWA, 2010).

Table 4: EGSAs considered for the Olifants WMA for rivers

Ecosystem Service	Description of Value	Aspects Considered	Output from RDM studies
Domestic water use	Subsistence use of water	Loss of river use: Replacement cost of water shipped via containers	Yield model – changes in yield/supply Water quality – change fitness for use
Grazing	Grazing	Loss of available grazing land: Replacement cost of buying fodder in winter months	Loss of riparian habitat (non-flow) – index of change

Ecosystem Service	Description of Value	Aspects Considered	Output from RDM studies
Livestock watering	Livestock watering	Replacement cost of boreholes	Drought and maintenance low flows
Harvested products	Sand & clay	Building sand & clay for making bricks/households	Loss of riparian habitat (non-flow) and in-stream habitat
	Fuel wood	Amount harvested/ households	Loss of riparian habitat (non-flow) – index of change
	Raw Materials	Amount harvested/ households	
	Wild foods & medicines	Amount harvested/ households	
	Hunting	Amount harvested/ households	Not provided
	Fishing	Amount harvested/ households	Index of change in abundance (non-flow)
Water regulation		Maintenance of base flows	Yield model (EWR)
Carbon Sequestration	Riparian vegetation has the ability to store carbon	Amount of riparian habitat	Not provided
Tourism	Rafting, adventure tourism	Benefits accrued by tourism operators	Hydraulics/Yield model
Aesthetic value	House prices	Amount of houses near rivers and wetlands	Ecostatus
Education	Peer reviewed journal output	Peer reviewed journal subsidy	Not provided

Table 5: EGSAs considered for the Olifants WMA for wetlands

Ecosystem Service	Description of Value	Aspects Considered	RDM output
Livestock watering	Livestock watering	Replacement cost of boreholes	Drought and maintenance low flows
Harvested products	Sand & clay	Building sand & clay for making bricks/households	Loss of riparian habitat (non-flow) and in-stream habitat
	Fuel wood	Amount	Loss of riparian habitat

Ecosystem Service	Description of Value	Aspects Considered	RDM output
		harvested/households	(non-flow) – index of change
	Raw Materials	Amount harvested/households	
	Wild foods & medicines	Amount harvested/households	
	Hunting	Amount harvested/households	Not provided
	Fishing	Amount harvested/households	Index of change in abundance (non-flow)
Flood attenuation	Ability of wetlands to lessen the impact of flooding	Replacement cost from flood damage	EWR High flows
Groundwater recharge	Ability of wetlands to contribute to groundwater recharge. Utilised through boreholes and wells during dry months	Replacement cost of dam construction	Baseflow contribution
Water purification	Wetlands absorb and breakdown organic and inorganic pollutants	Treatment cost abatement curve	Water Quality – change in fitness for use
Carbon Sequestration	Wetlands seen as a carbon sink	Amount of carbon sequestered by different wetland types	Not provided
Angling	Freshwater angling.	Value of trout industry and other fishing industries	Hydraulics/Yield model
Tourism	Ecotourism value	Tourism market sizing	Not provided

4.2 IDENTIFIED CHANGES IN ECOSYSTEM COMPONENTS, FUNCTIONS AND ATTRIBUTES

4.2.1 Hydrological Characteristics

In terms of yield, the yield model calculates the consequence of the nMAR-EWRs. This hydrological EGSA will be assessed in detail in Step 4 of the classification procedure, the determination of the ESBC.

Other hydrological aspects of relevance in the Olifants WMA for the EGSAs assessment include domestic water use, livestock water and rafting/adventure tourism. The hydrological components considered were the dry and maintenance low flows.

The change in volume for subsistence water use and livestock watering is insignificant in most of the IUAs and does not reflect any substantial change in the ecological categories.

Currently, the only rafting/adventure tourism occurs below the Blyderivierspoort Dam (IUA 10, B60J catchment). The rafting/adventure tourism is dependent on the seasonal high flows from July to September. Insufficient information is available to assess the percentage change of flow on the ecological categories.

4.2.2 Biological components and functions

Biological EGSAs of relevance to the Olifants WMA include:

- Grazing
- Harvested products – sand and clay, fuel wood, raw materials, wild foods and medicines and fishing.

The aspects considered with respect to the above include riparian vegetation and fish abundance and are mostly non-flow related.

The risk to grazing is low. The consequence of a change in ecological category could be insignificant and is extremely unlike to change stock numbers. The risk to harvested products is low. A change in ecological category could have a minor consequence and is very unlikely to change the type and number of products which can be harvested. It is also unlike to change wetland area.

A change in the ecological category of fish abundance and riparian vegetation will have a negligible effect and therefore did not require quantification.

4.2.3 Structure and organisation of Biological Communities

The estimated retained functioning and biodiversity relative to the established EWR sites is provided in Table 6.

Table 6: Estimated retained functioning and biodiversity relative to the established EWR sites

Node (EWR site)	Quaternary catchment	% Retained of natural functioning and biodiversity		
		PES	REC	Estimated Change
HN 11	B 11J	37.4%	77.4%	All benefits of ecosystems services will increase with an improvement in ecological condition.
HN 17	B12C	57.4%	77.4%	
HN 31	B20J	87.4%	87.4%	
HN 37	B32A	77.4%	87.4%	

Node	Quaternary catchment	% Retained of natural functioning and biodiversity		
		PES	REC	Estimated Change
HN 45	B31G	37.4%	57.4%	
HN 50	B32D	77.4%	77.4%	
HN 68	B51G	37.4%	57.4%	All benefits of ecosystems services will increase with an improvement in ecological condition.
HN 85	B60H	37.4%	57.4%	
HN 65	B41J	57.4%	57.4%	
HN 66	B41J, B41K	57.4%	57.4%	
HN 96	B71G, H, J	37.4%	57.4%	
HN 88	B60J	87.4%	87.4%	
HN 105	B72D	77.4%	87.4%	
HN 101	B72H	77.4%	77.4%	
HN 103	B72K	37.4%	57.4%	
HN 114	B73G, B73H	77.4%	57.4%	
HN 120	B60C	92%	92%	

4.2.4 Water Quality Characteristics

The water quality characteristic that is of relevance to the EGSAs is a 'change in fitness for use' of water quality which impacts on the requirements of users. The present day water quality status for water users in the Olifants WMA are described in this section.

4.2.4.1 The water user sectors

The Water Requirements and Water Resources Report of 'Development of a Reconciliation Strategy for the Olifants River Water Supply System Study' (DWA 2011) contains the most up to date description of the water users in the WMA. These are water requirements are indicated in Table 7 below. The Water Requirements of the Reconciliation Strategy report delineates the Olifants WMA into catchments Upper-, Middle- and Lower Olifants.

Table 7: Summary of water requirements (units: million m^3/year) for the Olifants WMA

Sub-catchment	Power Generation	Industrial	Urban	Rural	Mining	Irrigation	Total
Upper	228	8	62	37	25	249	609
Middle	0	0	21	6	10	81	118

Lower	0	0	28	1	31	152	212
Total	**228**	**8**	**111**	**43**	**66**	**482**	**939**

Strategic Water Requirements

Power stations in the Upper Olifants zone use 228 million m^3/a for cooling purposes, from the upper Komati or the Vaal Systems. The new Kusile power station near Emalahleni will use a dry cooling process, which is more water efficient, and thus water strategic demand is expected to reduce by 2014.

Irrigation Water Requirements

The total irrigated area in the Upper Olifants River catchment is 69,500 ha. Of this, 24,800 ha form part of irrigation schemes, while the remainder are defined as diffuse source irrigation. Although irrigation schemes are not as abundant or as active in the Middle Olifants sub-catchment as the Upper Olifants sub-catchment, irrigation remains a significant water using sector. Irrigation in the Lower Olifants is extensive with nearly 12,000 ha within irrigation schemes and another approximately 8,500 ha uncontrolled irrigation within the Selati River catchment.

Urban and Industrial Water Requirements

In the Upper Olifants, the major towns within the Upper Olifants sub-catchment are Emalahleni, Middelburg, Bronkhorstspruit, Marble Hall, Groblersdal, Cullinan and Delmas.

Emalahleni currently has a consumptive water use of 43.8 million m^3/year and is supplied from the Witbank Dam and from recycled mine water decant.. Marble Hall and Groblersdal have use 0.85 and 2.0 million m^3/year respectively, from the Loskop canal. The Bronkhorstspruit Dam supplies 3.2 million m^3/year to Bronkhorstspruit. Middelburg uses 12,6 million m^3/year from the Middelburg Dam with small contributions from the Pienaars and Kruger dams. Cullinan lies on the watershed of the Olifants and Crocodile West WMA and receives water from the Wilge River Dam. Delmas receives 1.8 million m^3/year from Rand Water (transferred from the Vaal System) and the remainder of its requirements from groundwater while the towns of Hendrina and Kriel form part of the water supply to the power stations, which receive their water from the Komati and Vaal system. There two significant towns in the Lower Olifants River zone are Phalaborwa and Hoedspruit and source their water from the Phalaborwa Barrage but can be supplemented by releases from the Blyderivierpoort Dam.

Rural Water Requirements

In the Upper Olifants, the Western Highveld, formerly Kwandabele, consists of numerous villages and towns with a large water requirement. The Weltevreden weir located on the Elands River, supplies the northern part of this area, including the town of Siyabuswa. The Mkombo Dam and the Loskop Dam supplements this supply. The total current abstraction for the northern Western Highveld is 22 million m^3/year. The Bronkhorstspruit Dam supplies the southern Western Highveld via the Rand Water pipeline from Mamelodi. The current abstraction from the Bronkhorstspruit Dam is 13.4 million m^3/year to the Western Highveld. Other rural water use within the Upper Olifants sub-catchment is limited and supplied mostly from local sources, *i.e*., boreholes and farm

dams.

In the Middle Olifants, in Sekukhune, most villages obtain their water from groundwater or local source but level of service is inadequate. In addition, four rural water supply schemes exist: Makhuduthamang, Leeufontein, Fetagoma, Lebelolo North, and Olifantspoort South. The current demands of this settlements is 2,3 million m^3/year and significant growth to 3,8 million m^3/year is expected by 2030 (DWA, 2010). The Fetagoma and Lebelolo North settlements currently obtain their water from groundwater but could be supplied from the De Hoop Dam in future.

In the Lower Olifants, is supplied from the Thabina Dam in the neighbouring Groot Letaba catchment to villages in the Selati River catchment. All other rural water requirements are supplied from groundwater.

Mining Water Requirements

Coal mines source the bulk of their water from their underground operations and from own dams. Platinum mining water use within the Middle Olifants is estimated at about 20 million m^3/year. The Phalaborwa Barrage on the Olifants River, supplemented from the Blyderivierpoort Dam and the Groot Letaba River, supply the water requirements to mining activities around Phalaborwa.

4.2.4.2 Resource water quality objectives (RWQOs)

The key water user sectors in the Olifants WMA are irrigation, industrial and domestic water use. The RWQOs used for the compliance assessment (Table 8) were derived using the Resource Water Quality Objectives (RWQOs) Model (Version 4.0) (DWAF, 2006) which uses as its basis the South African Water Quality Guidelines (DWAF, 1996), Quality of Domestic Water Supplies: Assessment Guide, Volume 1 (WRC, 1998) and Methods for determining the Water Quality Component of the Reserve (DWAF, 2008) and are based on the strictest water user criteria (thus represent fairly conservative limits).

Table 8: Resource Water Quality Objectives used for the present day water quality assessment

Variable	Units	Bound	Ideal	Sensitive user	Acceptable	Sensitive user	Tolerable	Sensitive user
Alkalinity ($CaCO_3$)	mg/l	Upper	**20**	AAq	**97.5**	AAq	**175**	AAq
Ammonia (NH_3-N)	mg/l	Upper	**0.015**	Ecological	**0.044**	Ecological	**0.073**	Ecological
Calcium (Ca)	mg/l	Upper	**10**	Dom	**80**	BHN	**80**	BHN
Chloride (Cl)	mg/l	Upper	**40**	In2	**120**	In2	**175**	In2
EC	mS/m	Upper	**30**	In2	**50**	In2	**85**	Ecological
Fluoride (F)	mg/l	Upper	**0.7**	Dom	**1**	Dom	**1.5**	Dom
Magnesium (Mg)	mg/l	Upper	**70**	Dom	**100**	Dom	**100**	Dom
NO_3 (NO_3-N)	mg/l	Upper	**6**	AIr	**10**	AIr	**20**	AIr
pH	units	Upper	**≤ 8**	In2	**<8.4**	In2		
		Lower	**≥6.5**	AIr AAq In2	**>8.0**	AIr AAq In2		
Potassium (K)	mg/l	Upper	**25**	Dom	**50**	Dom	**100**	Dom
PO_4-P	mg/l	Upper	**0.005**	Ecological	**0.015**	Ecological	**0.025**	Ecological
SAR	mmol/l	Upper	**2**	AIr	**8**	AIr	**15**	AIr
Sodium (Na)	mg/l	Upper	**70**	AIr	**92.5**	AIr	**115**	AIr
SO_4	mg/l	Upper	**80**	In2	**165**	In2	**250**	In2
TDS	mg/l	Upper	**200**	In2	**350**	In2	**800**	In2
Si	mg/l	Upper	**10**	In2	**25**	In2	**40**	In2

Basic Human Needs	BHN	Agriculture - Aquaculture	AAq
Domestic use	Dom	Industrial - Category 2	In2
Agriculture - Irrigation	AIr		

4.2.4.3 Water quality data collection

The primary source of data for the water quality analysis was the Directorate Resource Quality Services of the Department. Historical data for water quality monitoring points in the Olifants WMA was obtained from the national monitoring network (Water Management System). Routine DWA river and reservoir water quality monitoring points for the Olifants WMA are listed in **Error! Reference source not found.** and indicated in Figure 5 . The water quality monitoring data at these sites have different time scales, different sampling frequencies, variation in the water quality variables monitored and different laboratories and analytical methods used. In addition many of the tributary catchments points have monitoring data records are poor. There were gaps in the available data.

4.2.4.4 Water quality data analysis

The water quality status assessment has been based on the routine monitoring conducted by the Department in recent years and it must be borne in mind that this is a high level qualitative assessment of historical water quality in the Olifants WMA making use of the data available to the study team.

The present day water quality status at these points for the period 2006 to 2009 was assessed by determining the compliance of the current water quality state to the RWQOs as listed above (Table 9) in terms of 'fitness for use'. The median and 95th percentile values were calculated for seven water quality variables that are of concern to the key water user sectors (irrigation, domestic and industrial) and for which data is available.

The variables include Electrical Conductivity (EC), Orthophosphate (PO_4-P), Ammonia (NH_3-N), Nitrate (NO_3+NO_2-N), (Chloride (Cl^-), Sulphate (SO_4^{2-}) and pH.

The selection of the variables was based on the following reasoning:

- Electrical Conductivity (EC) (mS/m): provides an indication of salinisation of water resources;
- Orthophosphate (PO_4-P) (mg/l) and Nitrate (NO_3+NO_2-N) (mg/l): are indicators of the nutrient levels in water resources.
- Sulphate (SO_4^{2-}) (mg/l): is an indicator of mining impacts;
- Chloride (Cl^-) (mg/l): in an indicator of agricultural impacts, sewage effluent discharges and industrial impacts;
- Ammonia (NH_3-N) (mg/l): is an indicator of toxicity; and
- pH (pH units): is a indicator for mining impacts as well as natural variability.

The results of the compliance assessment are provided in Table 10.

Table 9: Water quality monitoring points in the Olifants WMA used for the present day water quality assessment

WQ Monitoring Sites	Latitude	Longitude	Drainage Region
B1H002 AT ELANDSPRUIT ON SPOOKSPRUIT	-25.818333	29.337778	B11H
B1H004Q01 KLIP SPRUIT AT ZAAIHOEK	-25.673333	29.171111	B11K
B1H005Q01 OLIFANTS RIVER AT WOLVEKRANS	-26.006389	29.253889	B11F
B1H006 RIETFONTEIN ON TRICHARDSPRUIT	-26.355833	29.214167	B11D
B1H010Q01 WITBANK DAM ON OLIFANTS RIVER: DOWN STREAM WEIR	-25.891667	29.304167	B11J
B1H012Q01 AT RONDEBOSCH U/S MIDDELBURG ON KLEIN OLIFANTS	-25.808056	29.586667	B12C
B1H015Q01 MIDDELBURG DAM ON LIT. OLIFANTS RIV: DOWN STREAM	-25.773333	29.543611	B12D
B1H017Q01 AT AANGEWYS D/S ISIBONELO COLLIERY ON STEENKOOLSPRUIT	-26.305556	29.274167	B11C
B1H018Q01 OLIFANTS RIVER AT MIDDELKRAAL	-26.216667	29.459167	B11A
B1H019 NAAUWPOORT 335 JS ON NOUPOORTSPRUIT	-25.939722	29.2575	B11G
B1H020Q01 AT VAALKRANZ U/S VANDYKSDRIFT ON KORINGSPRUIT	-26.105833	29.330833	B11B
B1H021Q01 STEENKOOL SPRUIT AT MIDDELDRIFT	-26.136111	29.27	B11E
B1H022Q01 TRICHARDT D/S TRICHARDSFONTEIN DAM ON TRICHARDSPRUIT	-26.495	29.241111	B11D
B1H032Q01 AT BLESBOK ON BLESBOKSPRUIT	-25.821667	29.206111	B11K
B1R001Q01 WITBANK DAM ON OLIFANTS RIVER: NEAR DAM WALL	-25.891667	29.304167	B11J
B1R002Q01 MIDDELBURG DAM ON KLEIN OLIFANTS RIVER: NEAR DAM W	-25.775	29.545833	B12C
B2H003Q01 AT BRONKHORSTSPRUIT ON BRONKHORSTSPRUIT	-25.798889	28.735833	B20D
B2H004Q01 OS SPRUIT AT BOSCHKOP	-25.924722	28.585556	B20C
B2H006Q01 OS SPRUIT AT WITPOORT	-25.966667	28.550833	B20C
B2H007Q01 AT WAAIKRAAL ON KOFFIESPRUIT	-25.994722	28.662778	B20B
B2H008Q01 AT RIETVALEI ON TRIBUTARY OF KOFFIESPRUIT	-26.078889	28.562778	B20B
B2H014Q01 AT ONVERWACHT ON WILGERIVIER	-25.826667	28.880833	B20F
B2H015Q01 AT ZUSTERSTROOM ON WILGERIVIER	-25.616111	29.016111	B20J
B2R001Q01 BRONKHORSTSPRUIT DAM ON BRONKHORSTSPRUIT NEAR WALL	-25.8875	28.725	B20C

WQ Monitoring Sites	Latitude	Longitude	Drainage Region
B3H001Q01 OLIFANTS RIVER AT LOSKOP NORTH	-24.916667	29.384167	B32J
B3H007Q01 MOSES RIVER AT UITSPANNING/DENNILTON	-25.269444	29.184722	B32H
B3H017Q01 LOSKOP DAM ON OLIFANTS RIVER: DOWN STREAM WEIR	-25.416667	29.358333	B32C
B3H021Q01 ELANDS RIVER AT SCHERP ARABIE	-24.925278	29.324444	B31J
B3R001Q01 KLIPRAND 76 JR - RUST DE WINTER DAM ON ELANDSRIVIER: NEAR DAM WALL	-25.2343	28.5172	B31C
B3R002Q01 LOSKOP 81 JS - LOSKOP DAM ON OLIFANTSRIVIER: NEAR DAM WALL	-25.4183	29.3599	B32A
B3R005Q01 RHENOSTERKOP 157 IR - RHENOSTERKOP DAM ON ELANDSRIVIER: NEAR DAM WALL	-25.0983	28.9177	B31F
B4H003Q01 STEELPOORT RIVER AT BUFFELSKLOOF	-25.028889	29.856667	B41D
B4H005Q01 WATERVAL RIVER AT MODDERSPRUIT	-25.037778	30.219167	B42F
B4H007Q01 LITTLE SPEKBOOM RIVER AT POTLOODSPRUIT	-25.008056	30.499444	B42D
B4H009Q01 DWARS RIVER AT DWARSRIVIER	-24.9125	30.103333	B41G
B4H010Q01 AT LYDENBURG NATURE RESERVE ON DORPSRIVIER	-25.075278	30.438889	B42B
B4H011Q01 STEELPOORT RIVER AT ALVERTON	-24.552778	30.373333	B41K
B4H016Q01 TONTELDOOS DAM ON TONTELDOOS RIVER: DOWN STREAM W	-25.279167	29.941667	B41C
B4H017Q01 VLUGKRAAL DAM ON VLUGKRAAL RIVER: DOWN STREAM WEI	-25.229167	29.95	B41C
B4H021Q01 BUFFELKLOOF DAM ON WATERVAL RIVER: DOWN STREAM WE	-24.954167	30.266667	B42G
B4R001Q01 MAPOCHSGRONDE 500 JS - TONTELDOOS DAM ON TONTELDOOSLOOP NEAR DAM WALL	-25.2797	29.942	B11G
B4R002Q01 MAPOCHSGRONDE 500 JS - VLUGKRAAL DAM ON VLUGKRAALRIVIER: NEAR DAM WALL	-25.2316	29.9493	B41C
B4R004Q01 BUFFELKLOOF 382 KT - BUFFELSKLOOF DAM ON WATERVALRIVIER: NEAR DAM WALL	-24.9552	30.2651	B42G
B5H004Q01 ARABIE DAM ON OLIFANTS RIVER: DOWN STREAM WEIR	-24.774444	29.422222	B51E
B5R002Q01 ARABIE 685 KS - FLAG BOSHIELO (ARABIE) DAM ON OLIFANTSRIVIER: NEAR DAMWALL	-24.7809	29.42640278	B51B
B6H001Q01 BLYDE RIVER AT WILLEMSOORD	-24.679167	30.8025	B60D
B6H003Q01 WILLEMSOORD ON TREURRIVIER	-24.686111	30.815	B60C

WQ Monitoring Sites	Latitude	Longitude	Drainage Region
B6H004Q01 BLYDE RIVER AT CHESTER	-24.458611	30.8275	B60J
B6H006Q01 KRANSKLOOF SPRUIT AT KRUGERSPOST	-24.9275	30.546111	B60F
B6H011Q01 OHRIGSTAD DAM ON OHRIGSTAD RIVER: DOWN STREAM WEIR	-24.933333	30.616667	B60F
B6H014Q01 BLYDERIVIERSPOORT DAM ON BLYDE RIVER: D/S FLOW SE	-24.933333	30.616667	B60F
B6R001Q01 OHRIGSTADDAM NATUURRESERVAAT - OHRIGSTADDAM ON OHRIGSTADRIVIER: NEAR DAM WALL	-24.9333	30.6322	B60E
B7H002Q01 NGWABITSI RIVER AT TOURS	-24.091944	30.275278	B72E
B7H004Q01 KLASERIE RIVER AT FLEUR DE LYS	-24.555278	31.032222	B73A
B7H007Q01 AT OXFORD ON OLIFANTS RIVER	-24.183889	30.823889	B72D
B7H010Q01 NGWABITSI RIVER AT HARMONY	-24.035	30.433333	B72H
B7H013Q01 MOHLAPITSE RIVER AT MAFEFES/HORN GATE	-24.1725	30.103056	B71D
B7H014Q01 SELATI RIVER AT CALAIS	-24.123889	30.353611	B72G
B7H015Q01 OLIFANTS RIVER AT MAMBA/KRUGER NATIONAL PARK	-24.058889	31.237222	B73C
B7H017Q01 OLIFANTS RIVER AT BALULE REST CAMP/KRUGER NAT PAR	-24.051667	31.731389	B73H
B7H019Q01 GA-SELATI RIVER AT LOOLE/FOSKOR	-24.034167	31.123611	B72K
B2H016 @ WATERVAL ON WILGERIVIER	-25.57877778	29.12747222	B20J
B6H017 MIDDLESEX ON BLYDE	-24.31388889	30.85594444	B60J

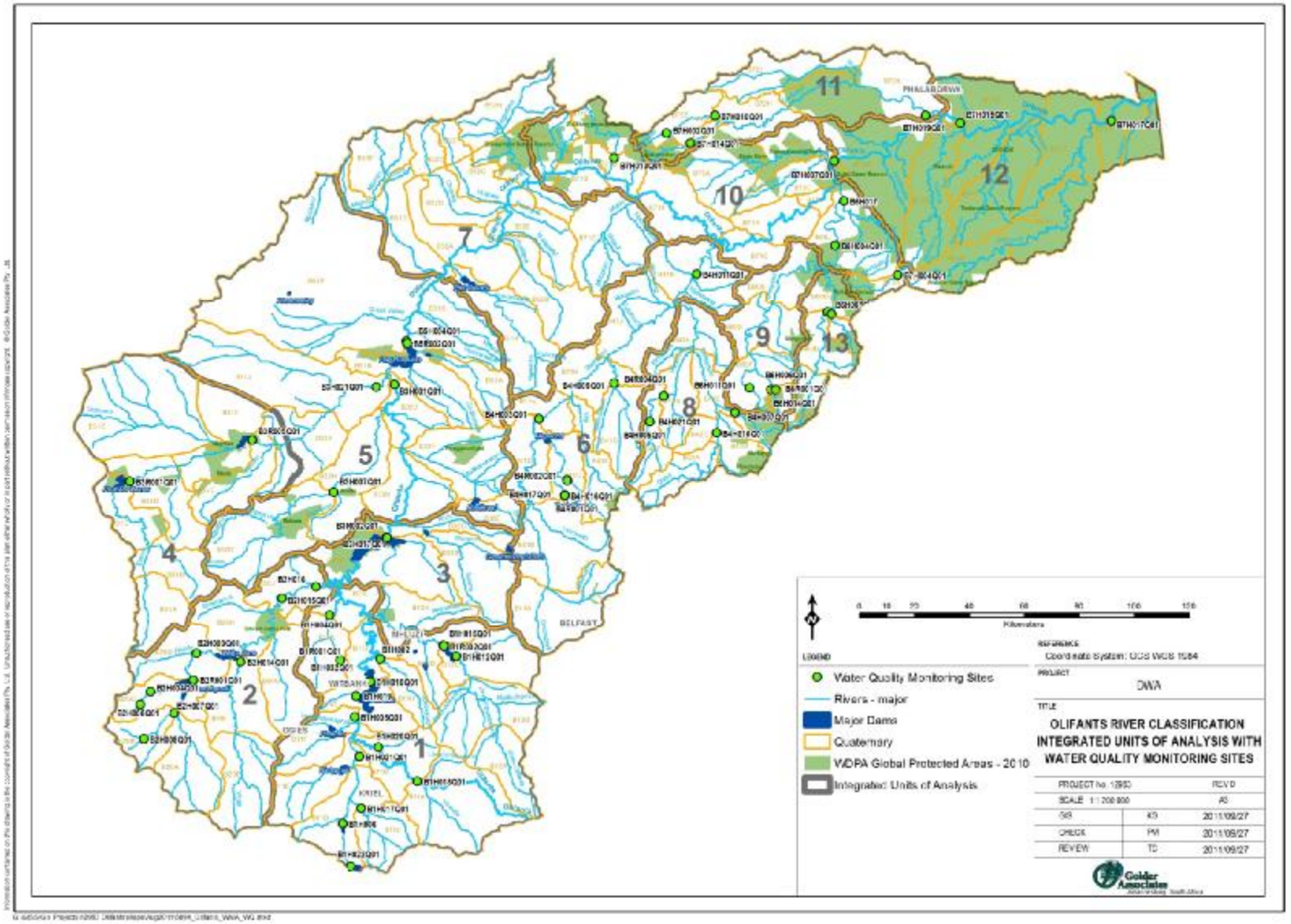

Figure 5: Location of the routine water quality monitoring points in the Olifants WMA

Table 10: Present day "fitness for use" classification of selected water quality variables at selected water quality monitoring points in the Olifants WMA

Monitoring Point	Chloride	Electrical Conductivity	Ammonia	Ortho-Phosphate	Sulphate	pH	Nitrate
	95th Percentile	95th Percentile	95th Percentile	50th Percentile	95th Percentile	95th Percentile	95th Percentile
B1H002 AT ELANDSPRUIT ON SPOOKSPRUIT	20.161	251.000	0.193	0.014	1606.205	7.920	0.386
B1H004Q01 KLIP SPRUIT AT ZAAIHOEK	59.238	137.000	1.030	0.013	580.067	7.438	4.121
B1H005Q01 OLIFANTS RIVER AT WOLVEKRANS	28.722	106.820	0.196	0.027	444.472	8.467	0.363
B1H006 RIETFONTEIN ON TRICHARDSPRUIT	11.637	28.640	0.134	0.025	30.823	8.127	0.241
B1H010Q01 WITBANK DAM ON OLIFANTS RIVER: DOWN STREAM WEIR	19.944	62.470	0.137	0.020	203.050	8.182	0.244
B1H012Q01 AT RONDEBOSCH U/S MIDDELBURG ON KLEIN OLIFANTS	35.275	232.100	0.178	0.017	1341.994	8.310	0.380
B1H015Q01 MIDDELBURG DAM ON LIT. OLIFANTS RIV: DOWN STREAM	25.079	117.725	0.263	0.016	639.487	8.240	0.277
B1H017Q01 AT AANGEWYS D/S ISIBONELO COLLIERY ON STEENKOOLSPRUIT	40.293	73.155	0.141	0.023	86.189	8.482	0.206
B1H018Q01 OLIFANTS RIVER AT MIDDELKRAAL	43.415	66.160	0.099	0.022	183.794	8.424	0.187
B1H019 NAAUWPOORT 335 JS ON NOUPOORTSPRUIT	25.679	101.300	0.245	0.020	433.583	8.139	0.373
B1H020Q01 AT VAALKRANZ U/S VANDYKSDRIFT ON KORINGSPRUIT	45.789	145.000	0.165	0.024	601.645	8.404	0.271
B1H021Q01 STEENKOOL SPRUIT AT MIDDELDRIFT	38.769	88.000	0.975	0.102	272.752	8.572	2.585
B1H022Q01 TRICHARDT D/S TRICHARDSFONTEIN DAM ON TRICHARDSPRUIT	16.516	32.930	0.149	0.021	34.431	8.135	0.229
B1H032Q01 AT BLESBOK ON BLESBOKSPRUIT	137.499	265.450	13.468	0.028	1243.353	4.082	0.425
B1R001Q01 WITBANK DAM ON OLIFANTS RIVER: NEAR DAM WALL	18.698	58.495	0.139	0.020	204.016	8.173	0.119
B1R002Q01 MIDDELBURG DAM ON KLEIN OLIFANTS RIVER: NEAR DAM W	24.833	103.500	0.329	0.016	430.398	8.176	0.121
B2H003Q01 AT BRONKHORSTSPRUIT ON BRONKHORSTSPRUIT	16.983	34.020	0.158	0.024	19.797	8.309	0.373
B2H004Q01 OS SPRUIT AT BOSCHKOP	18.461	32.510	0.141	0.023	19.784	8.348	0.522
B2H006Q01 OS SPRUIT AT WITPOORT	14.704	31.660	0.154	0.020	27.015	8.197	0.657
B2H007Q01 AT WAAIKRAAL ON KOFFIESPRUIT	10.798	24.030	0.127	0.021	23.655	8.223	0.936
B2H008Q01 AT RIETVALEI ON TRIBUTARY OF KOFFIESPRUIT	10.695	25.310	0.103	0.015	27.624	8.609	0.387

Monitoring Point	Chloride	Electrical Conductivity	Ammonia	Ortho-Phosphate	Sulphate	pH	Nitrate
	95th Percentile	95th Percentile	95th Percentile	50th Percentile	95th Percentile	95th Percentile	95th Percentile
B2H014Q01 AT ONVERWACHT ON WILGERIVIER	16.840	37.365	0.152	0.023	85.492	8.131	0.365
B2H015Q01 AT ZUSTERSTROOM ON WILGERIVIER	23.231	94.920	0.130	0.019	517.239	7.929	0.365
B2R001Q01 BRONKHORSTSPRUIT DAM ON BRONKHORSTSPRUIT NEAR WALL	18.493	35.980	0.241	0.025	20.358	8.419	0.130
B3H001Q01 OLIFANTS RIVER AT LOSKOP NORTH	136.954	138.100	0.130	0.020	265.646	8.501	0.578
B3H007Q01 MOSES RIVER AT UITSPANNING/DENNILTON	37.815	35.140	0.114	0.018	22.972	8.118	0.371
B3H017Q01 LOSKOP DAM ON OLIFANTS RIVER: DOWN STREAM WEIR	18.118	50.500	0.310	0.019	148.231	7.989	0.350
B3H021Q01 ELANDS RIVER AT SCHERP ARABIE	554.340	278.600	0.153	0.032	335.246	8.587	1.216
B3R001Q01 KLIPRAND 76 JR - RUST DE WINTER DAM ON ELANDSRIVIER: NEAR DAM WALL	26.308	27.300	0.231	0.015	14.428	8.112	0.135
B3R002Q01 LOSKOP 81 JS - LOSKOP DAM ON OLIFANTSRIVIER: NEAR DAM WALL	31.647	53.320	0.909	0.018	160.400	8.214	0.564
B3R005Q01 RHENOSTERKOP 157 IR - RHENOSTERKOP DAM ON ELANDSRIVIER: NEAR DAM WALL	47.120	50.200	0.129	0.018	18.168	8.338	0.171
B4H003Q01 STEELPOORT RIVER AT BUFFELSKLOOF	15.310	37.370	0.106	0.017	18.435	8.485	0.401
B4H005Q01 WATERVAL RIVER AT MODDERSPRUIT	7.349	19.480	0.109	0.016	9.754	8.114	0.197
B4H007Q01 LITTLE SPEKBOOM RIVER AT POTLOODSPRUIT	6.089	17.740	0.119	0.014	7.537	8.119	0.109
B4H009Q01 DWARS RIVER AT DWARSRIVIER	11.034	49.800	0.292	0.018	23.509	8.469	7.140
B4H010Q01 AT LYDENBURG NATURE RESERVE ON DORPSRIVIER	11.596	19.875	0.162	0.018	14.112	8.150	0.345
B4H011Q01 STEELPOORT RIVER AT ALVERTON	134.554	81.680	0.110	0.026	46.220	8.571	0.799
B4H016Q01 TONTELDOOS DAM ON TONTELDOOS RIVER: DOWN STREAM	8.841	21.345	0.170	0.017	14.196	8.243	0.234
B4H017Q01 VLUGKRAAL DAM ON VLUGKRAAL RIVER: DOWN STREAM WEI	6.657	30.630	0.120	0.015	10.791	8.384	0.296
B4H021Q01 BUFFELKLOOF DAM ON WATERVAL RIVER: DOWN STREAM WE	7.661	21.710	0.125	0.018	11.038	8.244	0.275
B4R001Q01 MAPOCHSGRONDE 500 JS - TONTELDOOS DAM ON TONTELDOOSLOOP NEAR DAM WALL	7.794	21.015	0.161	0.017	12.087	8.260	0.311
B4R002Q01 MAPOCHSGRONDE 500 JS - VLUGKRAAL DAM ON VLUGKRAALRIVIER: NEAR DAM WALL	7.374	19.870	0.126	0.015	8.888	8.215	0.321

Monitoring Point	Chloride	Electrical Conductivity	Ammonia	Ortho-Phosphate	Sulphate	pH	Nitrate
	95th Percentile	95th Percentile	95th Percentile	50th Percentile	95th Percentile	95th Percentile	95th Percentile
B4R004Q01 BUFFELKLOOF 382 KT - BUFFELSKLOOF DAM ON WATERVALRIVIER: NEAR DAM WALL	6.373	22.090	0.155	0.016	11.136	8.241	0.211
B5H004Q01 ARABIE DAM ON OLIFANTS RIVER: DOWN STREAM WEIR	33.820	56.085	0.135	0.020	118.057	8.203	0.224
B5R002Q01 ARABIE 685 KS - FLAG BOSHIELO (ARABIE) DAM ON OLIFANTSRIVIER: NEAR DAMWALL	34.541	57.220	0.153	0.018	117.365	8.292	0.234
B6H001Q01 BLYDE RIVER AT WILLEMSOORD	14.998	22.450	0.250	0.013	20.672	8.226	0.428
B6H003Q01 WILLEMSOORD ON TREURRIVIER	9.213	23.475	0.119	0.014	14.606	8.016	0.200
B6H004Q01 BLYDE RIVER AT CHESTER	7.936	20.580	0.154	0.013	20.532	8.213	0.371
B6H006Q01 KRANSKLOOF SPRUIT AT KRUGERSPOST	6.856	15.830	0.094	0.017	7.757	7.943	0.109
B6H011Q01 OHRIGSTAD DAM ON OHRIGSTAD RIVER: DOWN STREAM WEI	5.582	7.950	0.163	0.014	7.052	7.921	0.172
B6H014Q01 BLYDERIVIERSPOORT DAM ON BLYDE RIVER: D/S FLOW SE	9.208	20.475	0.124	0.016	14.267	8.085	0.329
B6R001Q01 OHRIGSTADDAM NATUURRESERVAAT - OHRIGSTADDAM ON OHRIGSTADRIVIER: NEAR DAM WALL	6.574	7.848	0.136	0.015	7.817	7.989	0.123
B7H002Q01 NGWABITSI RIVER AT TOURS	9.082	18.310	0.119	0.015	10.633	7.885	0.207
B7H004Q01 KLASERIE RIVER AT FLEUR DE LYS	11.737	13.480	0.114	0.020	12.145	7.954	0.240
B7H007Q01 AT OXFORD ON OLIFANTS RIVER	51.366	57.450	0.165	0.020	71.728	8.553	0.652
B7H010Q01 NGWABITSI RIVER AT HARMONY	12.800	24.800	0.121	0.016	10.164	8.102	0.135
B7H013Q01 MOHLAPITSE RIVER AT MAFEFES/HORN GATE	8.767	31.200	0.108	0.016	8.547	8.393	0.151
B7H014Q01 SELATI RIVER AT CALAIS	16.165	30.580	0.105	0.016	9.366	8.294	0.214
B7H015Q01 OLIFANTS RIVER AT MAMBA/KRUGER NATIONAL PARK	55.298	65.190	0.122	0.022	76.679	8.557	0.736
B7H017Q01 OLIFANTS RIVER AT BALULE REST CAMP/KRUGER NAT PAR	61.303	65.715	0.168	0.023	91.858	8.472	0.634
B7H019Q01 GA-SELATI RIVER AT LOOLE/FOSKOR	276.942	272.250	0.214	0.425	790.741	8.582	0.730
B2H016 @ WATERVAL ON WILGERIVIER	17.343	76.600	0.120	0.019	319.453	7.954	1.013
B6H017 MIDDLESEX ON BLYDE	24.047	38.600	0.126	0.019	35.175	8.300	0.348

Fitness for use indicator — Ideal | Acceptable | Tolerable | Unacceptable

4.2.4.4 Water quality implications

The assessment of the water quality implications on water users which requires simulating the TDS concentrations at the outflows of the IUAs is addressed in next the steps of the WRCS procedure during the evaluation of the catchment configuration scenarios.

5 CONCLUSIONS

A number of Reserve studies on various levels of detail have been undertaken for the Olifants catchment. These studies have focused on the main stem of the Olifants River and on major tributaries. For the purposes of the classification of the significant water resources of the Olifants catchment, more detailed information is required. Additional rapid Reserve studies have been undertaken on some of the smaller tributaries to provide the necessary information on a higher level of confidence that is currently available.

A total of 121 hydro nodes were selected through a process of consultation with a number of role players and specialists. These hydro nodes were selected on the basis of management of the system, outlet of IUAs, biophysical considerations or where specific water quality impacts are present. The updated PES, EI and ES information available on a sub-quaternary catchment level has been used to provide the present state per hydro node.

Summary and rule tables have been developed for all the hydro nodes to be used during steps 4 and 5 of the WRCS.

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

The ecological information currently available for the classification of the Olifants catchment is adequate to provide medium to high confidence input during the determination of the management class.

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APPENDIX A

RAPID ECOLOGICAL RESERVE DETERMINATION STUDIES FOR THE OLIFANTS (WMA 4) CATCHMENT

R Stassen, A Jordanova, C Todd & J Engelbrecht