Report no. RDM/WMA02/00/CON/0616

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

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

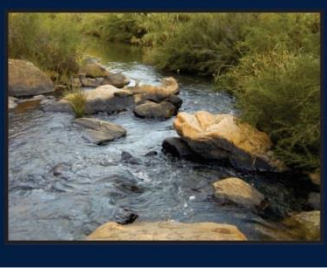
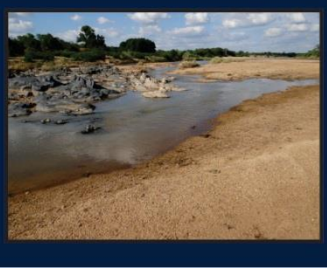
REPORT TITLE: SCENARIO EVALUATION AND CONSEQUENCES REPORT

FINAL

December 2016

water & sanitation
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

SCENARIO EVALUATION AND CONSEQUENCES REPORT

FINAL

REPORT NO.: RDM/WMA02/00/CON/0616

DECEMBER 2016

REFERENCE

This report is to be cited as:

Chief Directorate: Water Ecosystems. Department of Water and Sanitation, South Africa, December 2016. DETERMINATION, REVIEW AND IMPLEMENTATION OF THE RESERVE IN THE OLIFANTS/LETABA SYSTEM: Scenario Evaluation and Consequences Report. Report No: RDM/WMA02/00/CON/0616

Prepared by:

Golder Associates Africa

Title:	*Scenario Evaluation and Consequences Report*
Authors:	*Kylie Farrell, Retha Stassen, Wynand Vlok, Priya Moodley, Trevor Coleman*
Project Name:	*Determination, Review and Implementation of the Reserve in the Olifants/Letaba System: WP 10940*
DWA Report No:	*RDM/WMA02/00/CON/0616*
Status of Report:	*Final*
First Issue:	*December 2016*
Final Issue:	

Professional Service Providers: Golder Associates Africa/Wetland Consulting Services/ JMM Stassen and WRP Consulting Engineers

Approved for the PSP by:

……

Trevor Coleman

Study Leader

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems

Approved for DWS by:

……

Yakeen Atwaru

Director: Reseerve Determination

……

Ndileka Mohapi

Chief Director: Water Ecosystems

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

DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
DWAF	Department of Water Affairs and Forestry
EIS	Ecological importance and sensitivity
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
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
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'. With water resources in the Olifants Water Management Area (WMA 2) having been classified and Resource Quality Objectives determined (2011-2014), the preliminary Reserve determined in 2001 for the Olifants System and in 2006 for the Letaba System, was required to be superseded by the Reserve. With the preliminary Reserve having been determined nine years prior to the water resource classification, a review and update is required to ensure that the Reserve is in accordance with the water resource classes and is applicable to the current system needs and demands.

An assessment of the operational flow scenarios was conducted as part of the implementation component to evaluate the ecological consequences in order to finalise the Ecological Water Requirements (EWRs) that can be met. The primary aim of this task was to determine any consequences of the revised EWR requirements through the running of the Water Resource Yield Model (WRYM) and the Water Resource Planning Model (WRPM). The operational scenarios were defined, taking into account the scenarios that were assessed during the Water Resource Classificatuon Study (WRCS) and then tested against the system water resource balance to determine what needs to be met and its achievability. Linkages with the Olifants Reconciliation Strategy Maintenance Study was also made.

Five flow scenarios were assessed for the Olifants-Letaba System using the Water Resource Planning Model (WRPM). The ecological consequences of these scenarios at selected key and priority sites were evaluated during workshops held in August and November 2016. These were then presented to stakeholders in the catchment during meetings held on 29th and 30th November 2016, at which agreement on the recommended scenario was obtained.

It is recommended that scenario 5 be implemented, which is where all EWRs as per Scenario 3 (maintenance flows for TEC) except for Flag Boshielo and Loskop Dam where RQO EWR were used - Abstraction from dams reduced until one failure – historic firm yield. With implementing scenario 5, the f following changes to the TEC at the following sites is recommended:

- Olifants_EWR8: change TEC from C to C/D;
- Olifants_EWR1: change TEC from C to C/D;
- Olifants_SPE1: change from B/C to C;
- Olifants_EWR16: change from B/C to C; and
- Olifants before Steelpoort confluence – change TEC from C to C/D.

Overtime, as more water becomes available, release flows as per Scenario 3 (low flow EWRs for TEC and determined firm yields) and cap the flows from Flag Boshielo.

A summary of the revised results of these new flow requirements at the key sites are presented below.

EWR site	Quaternary Catchment	IUA	Water Resource	PES	REC	EIS	Final TEC	Scenarios				
								Sc1	Sc2	Sc3	Sc4	Sc5
Olifants												
Rapid 3 surveys												
Olifants-S2 (Olifants-EWR4)	B20J	2	Lower Wilge	C	B	High	B			*Only ML Flow*		*Only ML Flow*
Olifants-S5 (Olifants-EWR1)	B11J	1	Olifants	D	C/D	Moderate	D	*Only ML Flow*			*Only ML Flow*	
Olifants-S7 (Olifants-EWR2)	B32A	3	Olifants	C	B/C	High	B/C			*Only ML Flow*		*Only ML Flow*
Olifants-S10 (Olifants-EWR8)	B71D	10	Olifants	C	C	Moderate	C/D			*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-S11	B42H	8	Lower Spekboom	C	B/C	High	C	*Only ML Flow*	*Only ML Flow*	*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-S12	B60B	13	Upper Blyde	C	B	High	B					
Olifants-S13 (Olifants-EWR11)	B71J	10	Olifants	C	C	High	C/D				*Only ML Flow*	
Olifants-S14 (Olifants-EWR12)	B60J	10	Lower Blyde	C	B	High	B					*Only ML Flow*
Olifants-S16 (Olifants-EWR16)	B73H	12	Olifants	D	B/C	High	C			*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Use existing information and re-evaluate EWR												
Olifants-EWR3	B12D	3	Klein Olifants	D/E	C/D	High	C/D	*Only ML Flow*		*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-EWR5	B32D	5	Olifants	C	C	High	C			*Only ML Flow*		
Olifants-EWR6	B31G	4	Lower Elands	E	D	Moderate	D			*Only ML Flow*		
Olifants-EWR7	B51G	7	Olifants	E	D	Moderate	D	*Only ML Flow*		*Only ML Flow*		*Only ML Flow*
Olifants-EWR9	B41H	6	Steelpoort	D	C/D	High	C/D	*Only ML Flow*		*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
EWR 14b	B72K	11	Lower Ga-Selati	E	D	Moderate	D		*Only ML Flow*	*Only ML Flow*		

In conclusion, the aquatic ecosystems of the Olifants, Letaba and Shingwidzi Rivers are under stress and on a negative trajectory due to extensive water use for irrigation and domestic purposes in the various catchments, return flows from waste water treatment works and from mining activities. Afforestation in the upper catchments of the Great Letaba River also reduces the base flows in the rivers further. Large dams in especially the Olifants and Letaba catchments have a severe impact on the moderate flows (freshets), as a number of these dams do not have the release

capacities.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Water Ecosystems commissioned the study 'Determination, Review and Implementation of the Reserve in the Olifants/Letaba System' in 2015. The purpose of this study is to determine, review and implement the Reserve in the Olifants/Letaba Catchments, with the aim of specifically addressing ecological gaps and reviewing the preliminary Reserves that have been determined.

Previous relevant studies completed for these systems are:

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

As the classes of the water resources for the Olifants/Letaba systems have now been determined, the preliminary Reserve can be superseded with The Reserve and gazetted.

Four main components are being addressed through this study following the 8 step Reserve determination procedure, namely:

- The review and analysis of existing information;
- Identification and filling in of the ecological gaps identified;
- Evaluation of ecological consequences and operational considerations; and
- Setting the Reserve and defining the ecological specifications.

The review and analysis of existing information, identification of ecological gaps and the 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 have been completed. This was then followed by eco-classification of the priority sites and quantification of the Ecological Water Requirements for the identified sites.

The next step of the process required an assessment of the operational flow scenarios as part of the implementation component to evaluate the ecological consequences in order to finalise the Ecological Water Requirements (EWRs) that can be met.

1.2 PURPOSE OF THIS REPORT

An assessment of the operational flow scenarios was conducted as part of the implementation component to evaluate the ecological consequences in order to finalise the Ecological Water Requirements (EWRs) that can be met. The primary aim of this task was to determine any consequences of the revised EWR requirements through the running of the Water Resource Yield Model (WRYM) and the Water Resource Planning Model (WRPM). The operational scenarios were defined, taking into account the scenarios that were assessed during the Water Resource Classification (WRC) study and then tested against the system water resource balance to determine what needs to be met and its achievability. Linkages with the Olifants Reconciliation Strategy Maintenance Study' will be made.

Five flow scenarios were assessed for the Olifants-Letaba System using the Water Resource Planning Model (WRPM). The ecological consequences of these scenarios at selected key and priority sites were evaluated during workshops held in August and November 2016.

Furthermore, the alignment to the Classification Ecological Sustainable Base Configuration (ESBC) scenario and the ecological configurations were checked to ensure that the Reserve and the Management Classes supported each other.

The ecological consequences of the final selected scenario has been clearly stated as part of the Reserve, especially where the system might be affected negatively (a downwards trend over time) or where the Reserve can not be met. Operational rules have been defined with specific goals to improve the system as part of the Implementation and Resource management plan.

2 DESCRIPTION OF THE OLIFANTS WATER MANAGEMENT AREA

South Africa as 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 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, and from maintaining the ecological integrity of water resources. There is very little opportunity for further water resource development and future development will need to rely on local sources of water.

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) and 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.

Figure 1 and Figure 2 shows the catchment areas of the Olifants and the Letaba/Shingwedzi catchment areas indicating the EWR sites for The Reserve.

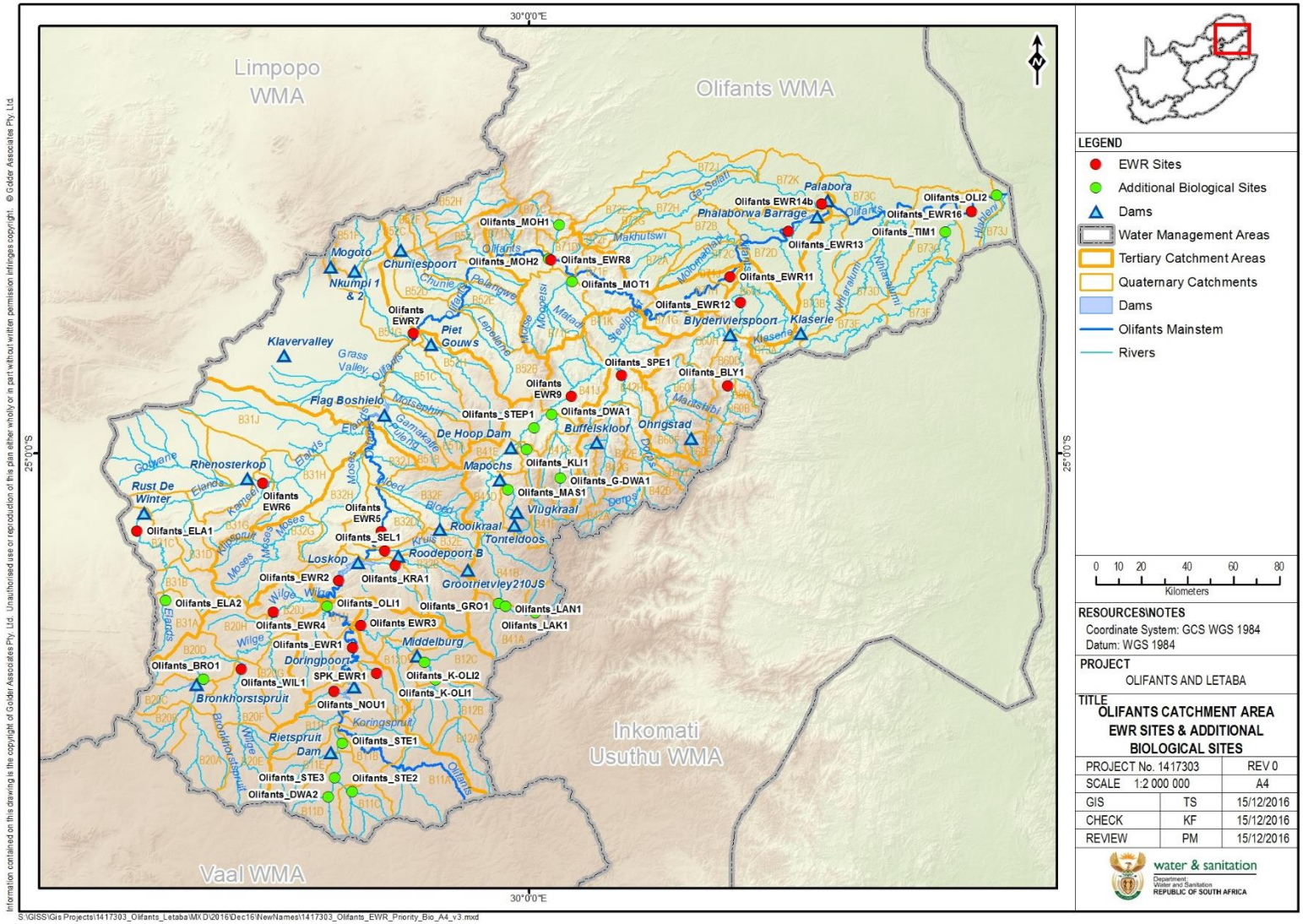


Figure 1: Map of the Olifants Catchment illustrating the EWR sites and additional biological monitoring sites

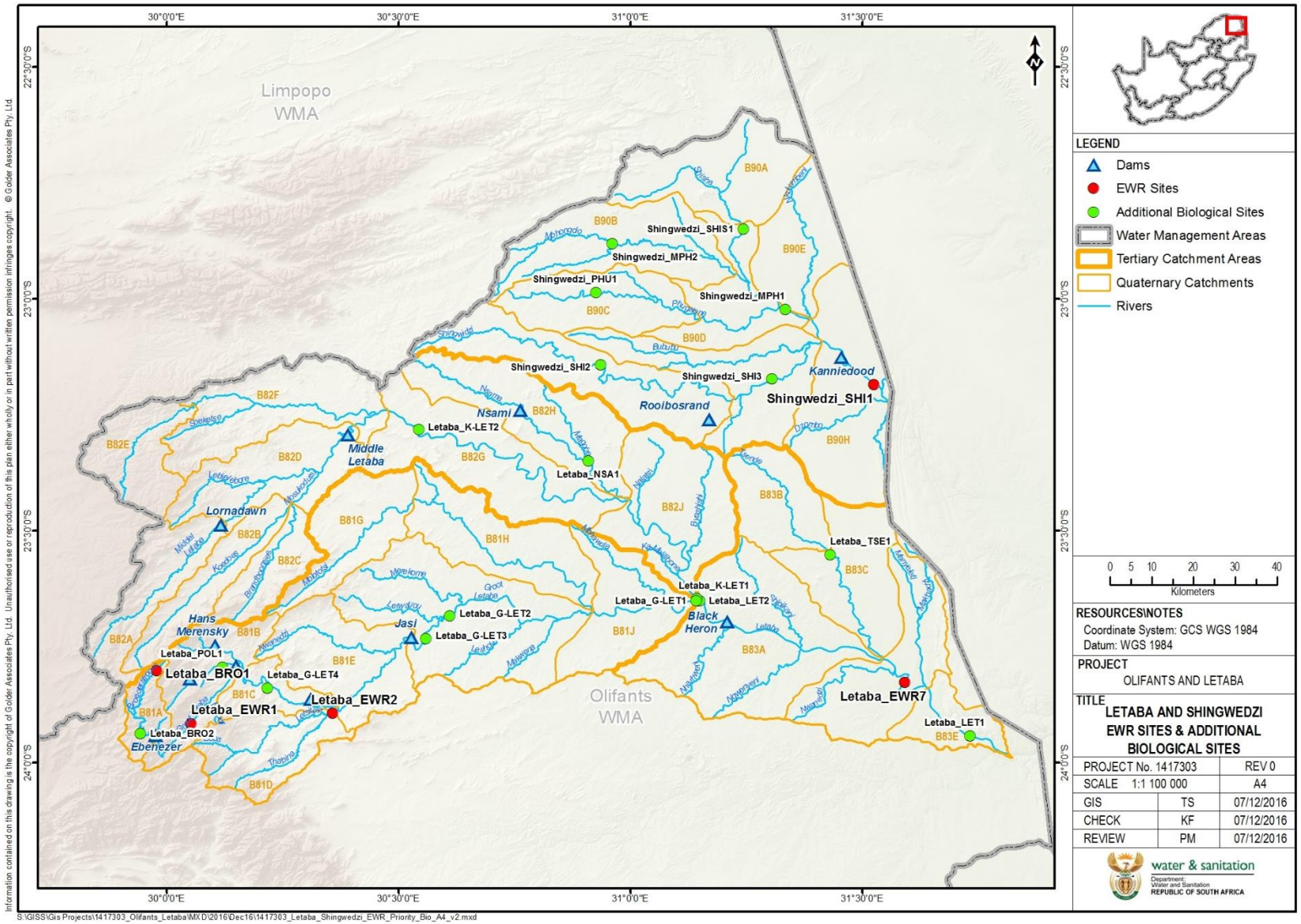


Figure 2: Map of the Letaba and Shingwedzi Catchments illustrating the EWR sites and additional biological monitoring sites

2. FLOW SCENARIOS

Specific scenarios have been defined through the study based on the outputs of Reconciliation Strategy and Classification studies for the Olifants River System. These scenarios have been assessed and evaluated in terms of ecological consequences at identified key and priority sites. The flow scenarios analysed for the Olifants River system are listed in Table 1, and described in detail further below.

The Letaba River system has been assessed in detail during the Water Resource Classification (WRC) and Resource Quality Objective (RQO) study completed in 2013. The results from the 2013 study were compared to the results obtained during this study at selected key EWR sites.

As no WRC and RQO study has been undertaken for the Shingwedzi River, only quantitative assessments were made for possible further use of the river outside the Kruger National Park (KNP).

Table 1: Scenarios analysed for the Olifants River System

Scenario	Number	Description
Natural	Reference	Use as reference with no demands.
Present day	1	Include present day demands (2015) on system with no EWR. RQO EWR (Olifants_EWR9) released from De Hoop Dam. Maximum demand on De Hoop Dam.
Present day with EWR (full)	2	Include present day demands (2015) on system with full EWRs (maintenance flows and freshets) to achieve the Target Ecological Category (TEC). RQO EWR (Olifants_EWR9) released from De Hoop Dam. Abstraction from dams reduced until one failure – historic firm yield.
Present day with EWR (low flows only)	3	Include present day demands (2015) on system with maintenance low flow EWRs for TEC (exclude floods and freshets). RQO EWR (Olifants_EWR9) released from De Hoop Dam. Abstraction from dams reduced until one failure – historic firm yield.
WRCS/RQOs	4	Include present day demands (2015) on system. EWRs from Gazetted RQOs at all sites. Abstraction from dams reduced until one failure – historic firm yield.
Combined	5	Include present day demands (2015) on system. All EWRs as per Scenario 3 except for Flag Boshielo and Loskop Dam where RQO EWRs were used. Abstraction from dams reduced until one failure – historic firm yield.

2.1 NATURAL

The natural flows were used as the reference flows at all the selected EWR and priority sites for the Olifants River system.

2.2 SCENARIO 1

This scenario is based on present day demands (2015) of the Olifants River system and includes the assumptions as specified in section 4 of this report. No EWRs were included except for De Hoop Dam. EWR releases for the downstream EWR site (Olifants_EWR9) as specified in the gazetted RQOs were included. Abstraction from dams were reduced until only one failure to

determine the historic firm yields from the dams.

This scenario will provides the worst case for the aquatic ecosystems as no flows will be released from dams and all user demands will be satisfied.

2.3 SCENARIO 2

This scenario is based on present day demands (2015) on the Olifants River system and include the assumptions as specified in section 4 of this report.

The full EWR (maintenance flows and freshets) for the TEC have been included at key and priority sites to satisfy the EWR first, then the user requirements. The RQO EWRs were included for the Steelpoort River to be released from De Hoop Dam.

Abstraction from dams were reduced until only one failure to determine the historic firm yields from the dams.

2.4 SCENARIO 3

This scenario is based on present day demands (2015) on the Olifants River system and include the assumptions as specified in section 4 of this report.

Only the maintenance flow component of the EWR for the TEC has been released from the dams to satisfy the EWR first, then the user requirements. This scenario provided an indication what the ecological consequences are if no freshets are available to the aquatic ecosystems during the wet season. The RQO EWRs were included for the Steelpoort River to be released from De Hoop Dam.

Abstraction from dams were reduced until only one failure to determine the historic firm yields from the dams

2.5 SCENARIO 4

This scenario is based on present day demands (2015) on the Olifants River system and include the assumptions as specified in section 4 of this report. The RQOs as gazetted were included for this scenario.

Abstraction from dams were reduced until only one failure to determine the historic firm yields from the dams

2.6 SCENARIO 5

This scenario is based on present day demands (2015) on the Olifants River system and include the assumptions as specified in section 4 of this report. A combination of EWRs have been included for this scenario as follows:

- RQO EWRs releases from Flag Boshielo and Loskop Dams
- The rest of the EWRs as per scenario 3

Abstraction from dams were reduced until only one failure to determine the historic firm yields from the dams

3. DATA INPUT

3.1 HYDROLOGY INFORMATION

The natural hydrology that was used as the base data for the EWR determination and the assessment of the ecological consequences for the three catchments were obtained from the following studies, namely:

(i) Olifants catchment – Development of an Integrated Water Resource Management Plan (IWRMP) for the Upper and Middle Olifants Catchment. Report No. P WMA 04/000/00/7007. DWA, Directorate National Water Resource Planning. July 2009: Hydrology supporting report.

(ii) Letaba and Shingwedzi catchments – Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System. Report No. P WMA 02/B810/00/1412/5. DWA, Directorate National Water Resource Planning. March 2014: Hydrology supporting report.

The natural flow time series obtained from these studies were used and adjusted by catchment area to obtain the natural flows at the key and priority sites. The natural Mean Annual Runoff (NMAR) per site is shown in Table 2 The final natural time series per site is available electronically.

3.2 ECOLOGICAL INFORMATION

The ecological information used during the assessment of the ecological consequences were based on the Recommended Ecological Categroty (REC) and TEC as determined for each of the key and priority sites.

The determination of the REC considers mainly the ecological importance and sensitivity, whereas the proposed TEC for the scenario analysis and determination of ecological consequences, take into account the present system requirements (dam release capacities, user requirements and yields of dams). The final REC and proposed TEC are provided in Table 2. The TECs listed in the table below are those that were proposed when the EWRs were quantified (see RDM/WMA02/00/CON/0216). During the evaluation of the ecological consequences the final TECs were determined and are listed Table 22.

The location of the selected key and priority sites for the Olifants, Letaba and Shingwedzi Rivers is shown in Figure 1 and Figure 2.

Table 2: Summary of NMAR, REC and TEC at key and priority sites for the Olifants/Letaba System
(shaded cells highlighted sites are the identified key EWR sites for The Reserve)

Node Name and Brief Description	River	EWR site name (old site name)	Sub-quaternary reach	REC	TEC	NMAR (MCM)
Olifants River						
Steenkoolspruit at B1H021	Steenkoolspruit	BN161	B11E-01297	D	D	62.9
Olifants/ Steenkool confluence	Olifants	BN669	B11B-01304	D	D	45.7
Olifants at B1H005	Olifants	BN202	B11G-01225	D	D	147.9
Spookspruit at EWR site	Spookspruit	SPK_EWR1	B11H-01161	C	C	9.322

Node Name and Brief Description	River	EWR site name (old site name)	Sub-quaternary reach	REC	TEC	NMAR (MCM)
Olifants at EWR site*	Olifants	Olifants_EWR1	B11J-01086	C/D	D	184.52
Klein Olifants above Mburg Dam	Klein-Olifants	OLI-EWR1	B12C-01153	C	C	50.7
Klein Olfants below WWTW	Klein Olifants	BN241	B12D-01118	C/D	C/D	67.3
Klein Olifants at EWR site*	Klein-Olifants	Olifants_EWR3	B12E-01078	C	C/D	81.54
Olifants above Wilge	Olifants	EWR965	B11L-01024	B/C	B/C	307.4
Upper Wilge at EWR site	Upper Wilge	Olifants_WIL1	B20F-01150	C	C	44.755
Bronkhorst above Wilge	Bronkhorstspruit	BN290	B20D-01088	B/C	B/C	79.9
Saalboomspruit	Saalboomspruit	BN272	B20G-01099	B/C	B/C	22.1
Lower Wilge at EWR site*	Wilge	Olifants_EWR4	B20J-00998	B	B	175.5
Kranspoortspruit at EWR site	Kranspoortspruit	OLI-EWR3	B32A-00950	B	B	13.258
Selons at EWR site	Selons	Olifants_SEL1	B32C-00936	C	C	33.109
Olifants at EWR site*	Olifants	Olifants_EWR2	B32A-00937	B/C	B/C	500.63
Elands above Rust de Winter Dam	Elands	Olifants_ELA1	B31C-00770	C	C	31.075
Elands at EWR site*	Elands	Olifants_EWR6	B31F-00654	C/D	D	60.3
Elands at B3H021	Elands	BN490	B31J-00648	C/D	C/D	84.1
Olifants at EWR site*	Olifants	Olifants_EWR5	B32D-00855	C	C	571.13
Bloed above Olifants	Bloed	BN798	B32F-00754	D	D	17.1
Moses at B3H005	Moses	BN2237	B32H-00698	C/D	C/D	35.5
Grootspruit	Grootspruit	BN8200	B41A-01025	B/C	B/C	28.1
Steelpoort after Laersdrift	Steelpoort	BN3310	B41D-00777	B/C	B/C	113.4
Steelpport at De Hoop*	Steelpoort	Olifants_EWR9	B41H-00610	C/D	C/D	137.4
Dwars at EWR site	Dwars	DWA-EWR1	B41H-00640	B/C	B/C	26.1
Steelpoort at EWR site	Steelpoort	Olifants_EWR10	B41K-00487	D	D	342.75

Node Name and Brief Description	River	EWR site name (old site name)	Sub-quaternary reach	REC	TEC	NMAR (MCM)
Olifants below Flag Boshielo*	Olifants	Olifants_EWR7	B51G-00482	D	D	736.9
Olifants above Steelpoort	Olifants	BN3167	B71F-00393	C	D	937.8
Dorpspruit below Lydenburg	Dorps	OLI-EWR9	B42C-00744	C/D	C/D	63.19
Watervals below Buffelskloof Dam	Waterval	BN8333	B42F-00680	B/C	B/C	28.6
Watervals at EWR site	Waterval	OLI-EWR5	B42G-00634	C	C	36.39
Spekboom at EWR site*	Spekboom	Olifants_SPE1	B42H-00553	B/C	B/C	148.196
Ohrigstad below dam	Ohrigstad	BN3343	B60E-00667	B/C	B/C	15.9
Ohrigstad above Blyderivier Dam	Ohrigstad	OLI-EWR8	B60H-00485	C	C	67.7
Olifants at EWR site*	Olifants	Olifants_EWR8	B71D-00412	C	C	813.04
Olifants at EWR site*	Olifants	Olifants_EWR11	B71G-00428	C	C	1 321.8
Lower Blyde at EWR site*	Lower Blyde	Olifants_EWR12	B60J-00444	B	B	383.5
Makhutsi	Makhutswi	BN3182	B72B-00322	B	B	44.8
Klaserie below B7R001	Klaserie	BN3233	B73A-00461	B	B	30.4
Olifants at EWR site	Olifants	Olifants_EWR13	B72D-00326	B/C	C	1 762.1
Ngwabitsi below Tours Dam	Ngwabitsi	BN3393	B72E-00291	C/D	C/D	8.4
Upper Ga-Selati at EWR site	Upper Ga-Selati	Olifants_EWR14a	B72H-00282	C	C	52.2
Lower Ga-Selati before Olifants*	Lower Ga-Selati	Olifants_EWR14b	B72K-00260	D	D	72.74
Olifants at B7H015	Olifants	BN3205	B73C-00318	C	C	1 836.4
Olifants at EWR site*	Olifants	Olifants_EWR16	B73H-00311	B/C	B/C	1 918.3
Olifants after Letaba	Olifants	BN7122	B73J-00304	C	C	2 597.9
Upper Blyde at EWR site*	Upper Blyde	Olifants_BLY1	B60B-00566	B	B	164.45
Treur at B6H003	Treur	BN3380	B60C-00581	A/B	A/B	49.3
Blyde at B6H001	Blyde	BN3359	B60B-00566	B	B	183.8

Node Name and Brief Description	River	EWR site name (old site name)	Sub-quaternary reach	REC	TEC	NMAR (MCM)
Letaba River						
Upper Broederstroom	Broederstroom	Letaba_BRO1	B81A-00242	B/C	B/C	6.683
Great Letaba at Appel*	Great Letaba	Letaba_EWR1	B81B-00264	C	C	99.8
Letsitele at EWR site	Letsitele	Letaba_EWR2	B81D-00271	D	D	116.55
Great Letaba at Hans Merensky	Great Letaba	Letaba_EWR3	B81F-00200	C	B/C	394.93
Great Letaba at Letaba Ranch	Great Letaba	Letaba_EWR4	B81J-00209	C	B/C	441.4
Little Letaba at EWR site	Little Letaba	Letaba_EWR5	B82G-00135	C	C	124.18
Letaba in KNP*	Letaba	Letaba_EWR7	B83D-00250	C	C	646.28
Shingwedzi River						
Shingwedzi at KNP border	Shingwidzi	N/A	B90F-00114	C	B/C	10.5
Shingwedzi in KNP*	Shingwidzi	Shingwedzi_SHI1	B90H-00117	B/C	B/C	86.424

* Key site

4. APPROACHES FOLLOWED FOR THE OLIFANTS RIVER CATCHMENT

4.1 WATER RESOURCES PLANNING MODEL (WRPM)

The Water Resource Planning Model (WRPM) from the Reconciliation maintenance study of the Olifants River system was used as a base for the analyses. No additional model runs were undertaken for the Letaba and Shingwedzi Rivers and only natural and present day flows were available for these two rivers.

The model was changed to historic mode for the Olifants River system with the simulation period from 1920 to 2004. Many configuration fixes and adjustments took place to correctly position each of the 49 required EWR nodes / sites. These were all highlighted on the schematic and will not be elaborated on further here.

The following assumptions regarding the WRPM were made for the study:

- De Hoop Dam on for entire simulation period, including the De Hoop EWR (Olifants_EWR9). Two sets of present day flows will be provided, one for EWR with low flows only as used in classification study, and one with new 2016 EWR maintenance flows.
- Growths: All growth factors were set to the second value (ie 2015) as per the growth file used to produce the final ORWRDP runs. Details of each channel's demand and supply

are contained in the growth spreadsheet (HIST GTH FACTS), however the 2015 constant development demand as per final reconciliation strategy has been used for all demands.

- No “planning” option used in model, i.e. drought restriction rules based on short term yield characteristics of major dams are not in place and dams therefore fail if demands are too high. Loskop Irrigation operating rule implementing restrictions depending on Loskop Dam level also not in place.
- Major Dams start level as on 1 May 2014.
- Olifants River Water Resources Development Project (ORWRDP) Study Construction Phase implementation: Assumed all demands currently on Flag Boshilo Dam remain there, and do not move onto De Hoop. The only demand on De Hoop is the Historical Firm Yield which is removed. Hovercroft and Olifants weir demands remain on the Olifants (supported by Flag Boshielo Dam), and do not move onto De Hoop Dam. Only Hovercroft mine demand is not included as that has moved over to De Hoop along with phase 2C.
- Alien plant removal. This is set as per 2015 growth factor. A small amount has been removed. Due to the uncertainty of the location, the water gained from removal has been added as an inflow to the major dams downstream of where it takes place. This is considered satisfactory for the purpose of the analyses. Details in HIST GTH FACTS spreadsheet under category “aliens”.
- Unlawful irrigation removal. No additional water gained in 2015 as a result of unlawful irrigation removal.
- Groundwater: no additional inflows from groundwater included.
- Compensation releases: this is applicable to Flag Boshielo Dam, Blyderivierpoort Dam and court orders for Witbank and Middleburg dams. Will need to check sensitivity and make a decision as to whether to include or not.
- Excess water available from upstream dams: no excess water based on final reconciliation strategy scenario.
- Phalaborwa, check support from De Hoop Dam to Phalaborwa.
- Mining assumptions: all outflows from mines are summarised in attached table.
- Return flow from urban water treatment works set not to grow for constant development level run.
- No support for Western Highveld from Rust de Winter Dam (up to 10 million m3/a included in reconciliation run). Support of 2.5 million m3/a from Loskop Dam to Western Highveld included.
- No mines in the Lower Olifants catchment have been included in the analyses.

4.2 HYDROLOGY

The natural time series, long term EWRs and the output from the WRPM for each of the scenarios

were used to prepare seasonal distribution and flow duration graphs (available electronically) at each of the key and priority sites for interpretation by the ecologists.

4.3 ECOLOGICAL CONSEQUENCES AT KEY SITES

The ecological consequences have been assessed in detail at the selected key sites (highlighted yellow) in Table 2. Based on the PES and TEC, the flow scenarios at each site were evaluated to determine if the biological component within the ecosystem will function optimally. This entail that all the different habitat types (biotopes) are present during the full hydrological period to ensure the different life stages of the fish and macroinvertebrates can be maintained. In addition, it is important to ensure that bank-full is achieved during the high flow conditions during each wet season. This is important to ensure that the habitat structure and quality is maintained and that the riparian vegetation is sustained (e.g. to ensure recruitment of plants occur).

The ecological consequences were therefore an evaluation of the different flow scenarios within the profile at each site to determine the flow depth classes and inundation of the various biotopes. The scenarios that achieved these goals were then accepted as viable for the specific site.

4.4 WATER QUALITY CONSEQUENCES AT KEY SITES

The water quality implications of each scenario were assessed based on the physico-chemical present state assessments and an understanding of the water quality trends and causes and sources of water quality changes. Qualitative predictions were then made from available data, based on an understanding of present ecological state, water quality status under the present day hydrological regime, contribution of the water quality as a driver, knowledge on the land use activites and their links to water quality, and knowledge of the relationship between water quality and flow. An assessment was made of how water quality conditions may change under the selected flow scenarios, and whether it was significant enough to result in a change in water quality status to another category.

4.5 ECOLOGICAL CONSEQUENCES AT OTHER PRIORITY SITES

Flow duration curves were used to evaluate changes in flows for the various scenarios at the other priority sites. As limited ecological and hydraulic information was available at these sites, detailed ecological consequences could not be determined.

5. ECOLOGICAL CONSEQUENCES RESULTS FOR THE OLIFANTS RIVER CATCHMENT

The flows at the key and priority sites for each of the scenarios are provided in Table 3. The detailed descriptions of the ecological consequences for the key sites are provided in Table 4 to Table 18 and a summary of the categories in Table 19.

The detailed flow time series, flow duration and seasonal graphs are available electronically.

Table 3: Summary of flows (million m^3/a) at the key and priority sites in the Olifants River catchment under different scenarios
(highlighted rows in table are identified as key EWR sites for The Reserve)

IUA	Description	River	EWR site name	NMAR m^3/a	TEC	EWR Requirement		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
						million m^3/a	% MAR					
1	Steenkoolspruit at B1H021	Steenkoolspruit	BN161	62.9	D	9.889	15.73	43.50	43.50	43.50	43.50	43.50
	Olifants/ Steenkoolspruit confluence	Olifants	BN669	45.7	D	7.089	15.5	25.59	35.75	35.75	25.59	35.75
	Olifants at B1H005	Olifants	BN202	147.9	D	23.53	15.9	99.09	109.46	109.46	98.96	109.46
	Spookspruit at EWR site	Spookspruit	SPK_EWR1	9.322	C	2.808	30.12	11.39	11.45	11.44	11.44	11.44
	Olifants at EWR site	Olifants	Olifants_EWR1	184.52	D	32.845	17.80	80.80	121.71	113.47	96.72	113.44
	Klein Olifants above Middelburg Dam	Klein-Olifants	OLI-EWR1	50.68	C	13.46	26.56	37.22	37.25	37.25	37.22	37.25
	Klein Olfants below WWTW	Klein Olifants	BN241	67.3	C/D	18.29	27.16	35.41	41.98	37.61	37.19	37.60
	Klein Olifants at EWR site	Klein-Olifants	Olifants_EWR3	81.54	C/D	16.15	19.80	47.82	54.51	50.06	49.60	50.04
	Olifants above Wilge	Olifants	EWR965	307.4	B/C	101.75	33.11	171.24	219.12	206.35	189.09	206.31
2	Upper Wilge at EWR site	Wilge	Olifants_WIL1	44.755	C	6.763	15.11	32.70	35.04	33.75	32.70	33.25
	Bronkhorstspruit above Wilge	Bronkhorstspruit	BN290	79.9	B/C	21.82	27.30	33.85	49.96	37.74	38.46	37.74
	Saalboomspruit	Saalboomspruit	BN272	22.1	B/C	8.776	39.66	18.48	19.32	19.07	18.45	19.07
	Lower Wilge at EWR site	Lower Wilge	Olifants_EWR4	175.5	B	63.69	36.28	107.22	126.79	112.87	106.79	112.85
3	Kranspoortspruit at EWR site	Kranspoortspruit	OLI-EWR3	13.258	B	4.194	30.26	12.49	12.49	12.49	12.49	12.49
	Selons at EWR site	Selons	Olifants_SEL1	33.109	C	7.237	21.86	28.38	28.36	28.36	28.36	28.36
	Olifants at EWR site	Olifants	Olifants_EWR2	500.63	B/C	149.36	29.83	295.04	362.53	335.80	312.44	335.73
4	Elands above Rust de Winter Dam	Elands	Olifants_ELA1	31.075	C	6.485	20.87	25.93	25.93	25.93	25.93	25.93

IUA	Description	River	EWR site name	NMAR m^3/a	TEC	EWR Requirement		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
						million m^3/a	% MAR					
1	Steenkoolspruit at B1H021	Steenkoolspruit	BN161	62.9	D	9.889	15.73	43.50	43.50	43.50	43.50	43.50
	Olifants/ Steenkoolspruit confluence	Olifants	BN669	45.7	D	7.089	15.5	25.59	35.75	35.75	25.59	35.75
	Olifants at B1H005	Olifants	BN202	147.9	D	23.53	15.9	99.09	109.46	109.46	98.96	109.46
	Spookspruit at EWR site	Spookspruit	SPK_EWR1	9.322	C	2.808	30.12	11.39	11.45	11.44	11.44	11.44
	Olifants at EWR site	Olifants	Olifants_EWR1	184.52	D	32.845	17.80	80.80	121.71	113.47	96.72	113.44
	Klein Olifants above Middelburg Dam	Klein-Olifants	OLI-EWR1	50.68	C	13.46	26.56	37.22	37.25	37.25	37.22	37.25
	Klein Olfants below WWTW	Klein Olifants	BN241	67.3	C/D	18.29	27.16	35.41	41.98	37.61	37.19	37.60
	Klein Olifants at EWR site	Klein-Olifants	Olifants_EWR3	81.54	C/D	16.15	19.80	47.82	54.51	50.06	49.60	50.04
	Olifants above Wilge	Olifants	EWR965	307.4	B/C	101.75	33.11	171.24	219.12	206.35	189.09	206.31
	Lower Elands at EWR site	Lower Elands	Olifants_EWR6	60.3	D	6.319	10.48	18.84	9.96	8.31	7.01	9.07
	Elands at B3H021	Elands	BN490	84.1	C/D	8.168	9.71	8.82	17.47	15.75	9.41	15.74
5	Olifants at EWR site	Olifants	Olifants_EWR5	571.13	C	71.45	12.51	183.45	299.30	248.17	250.33	260.07
	Bloed above Olifants	Bloed	BN798	17.15	D	2.230	13.01	13.77	13.77	13.77	13.77	13.77
	Moses at B3H005	Moses	BN2237	35.5	C/D	5.559	15.65	25.88	25.88	25.88	25.88	25.99
6	Grootspruit	Grootspruit	BN8200	28.1	B/C	11.86	42.19	26.96	26.96	26.96	26.96	26.96
	Steelpoort after Laersdrift	Steelpoort	BN3310	113.4	B/C	42.35	37.33	98.80	98.79	98.80	98.80	98.80
	Steelpport at De Hoop	Steelpoort	Olifants_EWR9	137.4	C/D	32.08	23.33	38.02	50.33	40.85	38.02	40.84
	Dwars at EWR site	Dwars	DWA-EWR1	26.1	B/C	8.144	31.24	17.25	17.27	17.25	17.25	17.25
	Steelpoort at EWR site	Steelpoort	Olifants_EWR10	342.75	D	43.50	12.69	200.34	216.03	226.27	200.34	200.23

IUA	Description	River	EWR site name	NMAR m^3/a	TEC	EWR Requirement		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
						million m^3/a	% MAR					
1	Steenkoolspruit at B1H021	Steenkoolspruit	BN161	62.9	D	9.889	15.73	43.50	43.50	43.50	43.50	43.50
	Olifants/ Steenkoolspruit confluence	Olifants	BN669	45.7	D	7.089	15.5	25.59	35.75	35.75	25.59	35.75
	Olifants at B1H005	Olifants	BN202	147.9	D	23.53	15.9	99.09	109.46	109.46	98.96	109.46
	Spookspruit at EWR site	Spookspruit	SPK_EWR1	9.322	C	2.808	30.12	11.39	11.45	11.44	11.44	11.44
	Olifants at EWR site	Olifants	Olifants_EWR1	184.52	D	32.845	17.80	80.80	121.71	113.47	96.72	113.44
	Klein Olifants above Middelburg Dam	Klein-Olifants	OLI-EWR1	50.68	C	13.46	26.56	37.22	37.25	37.25	37.22	37.25
	Klein Olfants below WWTW	Klein Olifants	BN241	67.3	C/D	18.29	27.16	35.41	41.98	37.61	37.19	37.60
	Klein Olifants at EWR site	Klein-Olifants	Olifants_EWR3	81.54	C/D	16.15	19.80	47.82	54.51	50.06	49.60	50.04
7	Olifants above Wilge	Olifants	EWR965	307.4	B/C	101.75	33.11	171.24	219.12	206.35	189.09	206.31
	Olifants below Flag Boshielo	Olifants	Olifants_EWR7	736.9	D	72.92	9.89	196.52	327.41	271.53	252.92	272.43
	Olifants above Steelpoort	Olifants	BN3167	937.8	C	196.57	20.96	341.58	302.79	456.58	430.14	449.67
8	Dorpspruit below Lydenburg	Dorps	OLI-EWR9	63.19	C/D	12.07	19.10	25.18	25.19	25.18	25.18	25.18
	Watervals below Buffelskloof Dam	Waterval	BN8333	28.6	B/C	8.042	28.15	26.35	26.35	26.35	26.35	26.35
	Watervals at EWR site	Waterval	OLI-EWR5	36.39	C	6.857	18.75	7.74	7.74	7.74	7.74	7.74
	Spekboom at EWR site	Spekboom	Olifants_SPE1	148.19	B/C	45.63	30.79	128.95	129.87	129.78	128.95	129.77
9	Ohrigstad below dam	Ohrigstad	BN3343	15.9	B/C	5.484	34.38	14.94	14.94	14.94	14.94	14.94
	Ohrigstad above Blyderivier Dam	Ohrigstad	OLI-EWR8	67.7	C	11.79	17.41	45.72	45.72	45.72	45.72	45.72

IUA	Description	River	EWR site name	NMAR m^3/a	TEC	EWR Requirement		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
						million m^3/a	% MAR					
1	Steenkoolspruit at B1H021	Steenkoolspruit	BN161	62.9	D	9.889	15.73	43.50	43.50	43.50	43.50	43.50
	Olifants/ Steenkoolspruit confluence	Olifants	BN669	45.7	D	7.089	15.5	25.59	35.75	35.75	25.59	35.75
	Olifants at B1H005	Olifants	BN202	147.9	D	23.53	15.9	99.09	109.46	109.46	98.96	109.46
	Spookspruit at EWR site	Spookspruit	SPK_EWR1	9.322	C	2.808	30.12	11.39	11.45	11.44	11.44	11.44
	Olifants at EWR site	Olifants	Olifants_EWR1	184.52	D	32.845	17.80	80.80	121.71	113.47	96.72	113.44
	Klein Olifants above Middelburg Dam	Klein-Olifants	OLI-EWR1	50.68	C	13.46	26.56	37.22	37.25	37.25	37.22	37.25
	Klein Olfants below WWTW	Klein Olifants	BN241	67.3	C/D	18.29	27.16	35.41	41.98	37.61	37.19	37.60
	Klein Olifants at EWR site	Klein-Olifants	Olifants_EWR3	81.54	C/D	16.15	19.80	47.82	54.51	50.06	49.60	50.04
	Olifants above Wilge	Olifants	EWR965	307.4	B/C	101.75	33.11	171.24	219.12	206.35	189.09	206.31
10	Olifants at EWR site	Olifants	Olifants_EWR8	813.04	C	169.75	20.87	230.28	396.43	337.19	318.54	338.07
	Olifants at EWR site	Olifants	Olifants_EWR11	1 321.9	C	236.02	17.85	568.46	758.35	692.19	656.32	707.97
	Lower Blyde at EWR site	Lower Blyde	Olifants_EWR12	383.5	B	119.39	31.14	235.30	303.72	304.79	275.51	247.74
	Makhutsi	Makhutswi	BN3182	44.8	B	17.39	38.79	36.44	39.08	39.56	36.47	36.44
	Klaserie below B7R001	Klaserie	BN3233	30.4	B	10.35	34.04	22.43	22.43	22.43	22.43	22.43
	Olifants at EWR site	Olifants	Olifants_EWR13	1 762.1	C	409.4	23.23	849.84	1110.81	1043.66	978.36	976.01
11	Ngwabitsi below Tours Dam	Ngwabitsi	BN3393	8.41	C/D	1.476	17.55	8.15	8.15	8.15	8.15	8.15
	Upper Ga-Selati at EWR site	Upper Ga-Selati	Olifants_EWR14a	52.2	C	14.37	27.53	40.95	43.42	43.70	40.84	40.77
	Lower Ga-Selati before Olifants	Lower Ga-Selati	Olifants_EWR14b	72.74	D	14.15	19.45	61.53	64.55	64.88	61.65	61.57
12	Olifants at B7H015	Olifants	BN3205	1 836.4	C	424.6	23.12	893.16	724.00	1107.99	1025.03	1009.63

IUA	Description	River	EWR site name	NMAR m^3/a	TEC	EWR Requirement		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
						million m^3/a	% MAR					
1	Steenkoolspruit at B1H021	Steenkoolspruit	BN161	62.9	D	9.889	15.73	43.50	43.50	43.50	43.50	43.50
	Olifants/ Steenkoolspruit confluence	Olifants	BN669	45.7	D	7.089	15.5	25.59	35.75	35.75	25.59	35.75
	Olifants at B1H005	Olifants	BN202	147.9	D	23.53	15.9	99.09	109.46	109.46	98.96	109.46
	Spookspruit at EWR site	Spookspruit	SPK_EWR1	9.322	C	2.808	30.12	11.39	11.45	11.44	11.44	11.44
	Olifants at EWR site	Olifants	Olifants_EWR1	184.52	D	32.845	17.80	80.80	121.71	113.47	96.72	113.44
	Klein Olifants above Middelburg Dam	Klein-Olifants	OLI-EWR1	50.68	C	13.46	26.56	37.22	37.25	37.25	37.22	37.25
	Klein Olfants below WWTW	Klein Olifants	BN241	67.3	C/D	18.29	27.16	35.41	41.98	37.61	37.19	37.60
	Klein Olifants at EWR site	Klein-Olifants	Olifants_EWR3	81.54	C/D	16.15	19.80	47.82	54.51	50.06	49.60	50.04
	Olifants above Wilge	Olifants	EWR965	307.4	B/C	101.75	33.11	171.24	219.12	206.35	189.09	206.31
	Olifants at EWR site	Olifants	Olifants_EWR16	1 918.3	B/C	566.6	29.54	942.50	1249.54	1157.12	1073.71	1058.35
	Olifants after Letaba	Olifants	BN7122	2 597.9	C	571.6	22.0	946.65	1178.27	1110.67	1052.92	1011.97
13	Upper Blyde at EWR site	Upper Blyde	Olifants_BLY1	164.45	B	75.78	46.08	150.60	150.60	150.60	150.60	150.60
	Treur at B6H003	Treur	BN3380	49.3	A/B	24.79	50.30	47.66	47.66	47.66	47.66	47.66
	Blyde at B6H001	Blyde	BN3359	183.8	B	83.96	45.69	168.67	168.67	168.67	168.67	168.67

5.1 ECOLOGICAL CONSEQUENCES OF FLOW SCENARIOS

The ecological consequences in the tables below are provided per scenario as follows:

- The ecological category for each scenario is provided, in comparison with the reference percentile value for the wet and dry season of the TEC;
- A general description of the impact on the biota for the wet and dry season; and
- A description of the impacts per scenario. Scenarios with the same categories were lumped together.

Table 4: Summary of ecological consequences at the key site Olifants_EWR1, Olifants River in B11J

Ecological Categories per scenario					
TEC=D	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.251	0.368	0.284	0.284	0.347	0.285
Percentile and category: wet season					
1.354	0.361	1.286	1.083	0.743	1.607
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.		
Sc1: The flow scenario for dry season meet the needs, but the wet season conditions will entail limited habitat availability and therefore the life cycles of biota will not be achieved. In addition, limited flushing of the system will result in a build-up of sediments and nutrients and the riparian zone will not be inundated. This will have long-term detrimental impacts for the habitat, the biota and riparian recruitment. Sc2: For this scenario the dry season needs are met and the wet season flows are marginally lower. The only possible impact for the lower flow can have long-term impacts on the riparian zone inundation. Sc3: For this scenario the dry season needs are met and the wet season flows are lower compared to Sc 2. The lower wet seasonal flows can have an impact on the hydroperiod inundating the broader river channel and this will have shorter wetted areas which can impact on some of the larval stages in fish in particular. As for Sc 2, the negative impact on the riparian may have a long-term negative impact on recruitment and scouring of the active channel. Sc4: Significant reductions in flows will be experienced for both flow periods – limited habitat, impacts on life stages, limited scouring and therefore negative impacts on the habitat and water quality. Sc5:					

Suitable conditions wet and dry season – will have positive impacts on water quality and the habitat and sustain the life stages of fish and macroinvertebrates and improve the riparian wetted perimenter.
WATER QUALITY
Sc1: Water quality will remain as current, PES of D will be maintained. Sc2: Water quality improvement expected and PES of a C will be attained. Dilution due to releases from Witbank Dam will improve current state. Sc3: Some water quality improvement expected due to improved flows. Maintenance flows will support improved water quality, expected PES of C/D to be achieved. Sc4: Water quality be as current, PES of D will be maintained. Sc5: Maintenance flows will support improved water quality, expected PES of C/D to be achieved.

Table 5: Summary of ecological consequences at the key site Olifants_EWR3, Klein Olifants in B12E

Ecological Categories per scenario					
TEC=C/D	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.112	0.289	0.289	0.289	0.286	0.289
Percentile and category: wet season					
0.467	0.291	0.434	0.333	0.322	0.334
BIOTA					
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.		
Sc1: The dry season flows sufficient, but the wet season conditions far below the ecological needs – will have long-term negative impacts for the habitat and biota. Sc2: Both flow conditions will sustain the minimum requirements. Sc3: The dry season flows sufficient, but the wet season conditions below the ecological needs – will have long-term negative impacts for the habitat and biota. Sc4: The dry season flows sufficient, but the wet season conditions below the ecological needs – will have long-term negative impacts for the habitat and biota.					

Sc5:

The dry season flows sufficient, but the wet season conditions below the ecological needs – will have long-term negative impacts for the habitat and biota.

WATER QUALITY

Sc1: Water quality is significantly degraded to due effluent discharges. No change in current water quality. The PES is a E category and will remain so.

Sc2: Some releases from Middelburg Dam will result in a slight improvement in water quality however this would be marginal. Non-flow management required to address impacts.

Sc3: Minimal improvement in water quality. Non-flow management required to address impacts.

Sc4: Minimal improvement in water quality. Non-flow management required to address impacts.

Sc5: Minimal improvement in water quality. Non-flow management required to address impacts.

Table 6: Summary of ecological consequences at the key site Olifants_EWR4, Lower Wilge in B20J

Ecological Categories per scenario					
TEC=B	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.690	0.376	0.731	0.649	0.376	0.649
Percentile and category: wet season					
1.861	0.215	1.636	0.801	0.213	0.801

BIOTA

Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.

Sc1:

Both flow conditions will not sustain the minimum requirements. Wet season flows far below TEC – critical for maintenance of biota and habitat.

Sc2:

The dry season flows sufficient, but the wet season conditions below the ecological needs – will have possible long-term negative impacts for the habitat diversity – can have impacts on biota in long-term.

Sc3:

The dry season flows sufficient, but the wet season conditions below the ecological needs – will have some long-term negative impacts for the habitat diversity – can have impacts on biota in long-term.

Sc4:

Both flow conditions will not sustain the minimum requirements. Wet season flows far below TEC – critical for maintenance of biota and habitat. Sc5: The dry season flows sufficient, but the wet season conditions below the ecological needs – will have possible long-term negative impacts for the habitat diversity – can have impacts on biota in long-term.
WATER QUALITY
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Water quality improvement expected with releases from Bronkhorspruit Dam. With inceased flows, PES category of B expected. Sc3: Water quality improvement expected with releases from Bronkhorspruit Dam. With inceased flows PES category of B expected. Sc4: Water quality will remain in current state, PES of C category will be maintained. Sc5: Water quality improvement expected will releases from Bronkhorspruit Dam. With inceased flows PES category of B expected.

Table 7: Summary of ecological consequences at the key site Olifants_EWR2, Olifants in B32A

Ecological Categories per scenario					
TEC=B/C	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
1.717	1.631	1.799	1.765	1.603	1.756
Percentile and category: wet season					
6.299	2.027	6.621	4.199	2.493	4.202
BIOTA					
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.		
Sc1: The dry season flows sufficient (little below TEC), but the wet season conditions well below the ecological needs – will have possible long-term negative impacts for the habitat diversity – can have impacts on biota in long-term. Sc2: Both flow conditions will sustain the minimum requirements. Sc3:					

The dry season flows sufficient, but the wet season conditions below the ecological needs – will have negative impacts for the habitat diversity (e.g. marginal vegetation and root wads and undercut banks) – can have impacts on biota in long-term. Sc4: The dry season flows sufficient (little below TEC), but the wet season conditions well below the ecological needs – will have possible long-term negative impacts for the habitat diversity – can have impacts on biota in long-term. Sc5: The dry season flows sufficient, but the wet season conditions below the ecological needs – will have negative impacts for the habitat diversity (e.g. marginal vegetation and root wads and undercut banks) – can have impacts on biota in long-term.
WATER QUALITY
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: A slight improvement in water quality is expected. PES of C will be mainted. Non-flow management required to address increased nutrient levels in river. Sc3: A slight improvement in water quality is expected. PES of C will be mainted. Non-flow management required to address increased nutrient levels in river. Sc4: Water quality be remain in current state, PES of C category will be maintained. Sc5: A slight improvement in water quality is expected. PES of C will be mainted. Non-flow management required to address increased nutrient levels in river.

Table 8: Summary of ecological consequences at the key site Olifants_EWR6, Lower Elands in B31G

Ecological Categories per scenario					
TEC=D	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.069	0.008	0.069	0.069	0.158	0.095
Percentile and category: wet season					
0.185	0.620	0.184	0.111	0.157	0.153
BIOTA					
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.		
Sc1: Both flow conditions will not sustain the minimum requirements – long-term negative impacts on the habitat, water quality and biota, including the riparian zone.					

Sc2:

Both flow conditions will sustain the minimum requirements.

Sc3:

The dry season flows sufficient, but the wet season conditions well below the ecological needs – will have negative impacts for the habitat diversity (e.g. marginal vegetation and root wads and undercut banks) – will have impacts on biota in long-term.

Sc4:

The dry season flows sufficient, but the wet season conditions well below the ecological needs – will have negative impacts for the habitat diversity (e.g. marginal vegetation and root wads and undercut banks) – will have impacts on biota in long-term.

Sc5:

The dry season flows sufficient, but the wet season conditions well below the ecological needs – will have negative impacts for the habitat diversity (e.g. marginal vegetation and root wads and undercut banks) – will have impacts on biota in long-term.

WATER QUALITY

Sc1: Water quality will remain in current state, PES of C category will be maintained.

Sc2: Water quality improvement expected with releases from Mokombo Dam. PES will be maintained. Non-flow management required to improve water quality.

Sc3: Water quality improvement expected with releases from Mokombo Dam. PES will be maintained. Non-flow management required to improve water quality.

Sc4: Water quality improvement expected with releases from Mokombo Dam. PES will be maintained. Non-flow management required to improve water quality.

Sc5: Water quality improvement expected with releases from Mokombo Dam. PES will be maintained. Non-flow management required to improve water quality.

Table 9: Summary of ecological consequences at the key site Olifants_EWR5, Olifants in B32D

Ecological Categories per scenario					
TEC=C	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.875	1.277	2.320	1.405	1.404	1.404
Percentile and category: wet season					
2.865	0.574	3.791	1.897	2.618	2.682
BIOTA					
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the		

	riparian zone.
Sc1: The dry season flows sufficient, but the wet season conditions well below the ecological needs – will have critical negative impacts for the habitat diversity. Sc2: Both flow conditions will sustain the minimum requirements. Sc3: The dry season flows sufficient, but the wet season conditions well below the ecological needs – will have negative impacts for the habitat diversity (e.g. marginal vegetation and root wads and undercut banks) – will have impacts on biota in long-term. Sc4: Both flow conditions will sustain the minimum requirements – wet season below TEC and can result in long-term impacts. Sc5: Both flow conditions will sustain the minimum requirements – wet season below TEC and can result in long-term impacts.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Minimal improvement in water quality with releases from Loskop Dam. Non-flow management required to address impacts. Sc3: : Minimal improvement in water quality with releases from Loskop Dam. Non-flow management required to address impacts. Sc4: : Minimal improvement in water quality. Non-flow management required to address impacts. Sc5: : Minimal improvement in water quality. Non-flow management required to address impacts.	

Table 10: Summary of ecological consequences at the key site Olifants_EWR9, Steelpoort in B41H

Ecological Categories per scenario					
TEC=C/D	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.326	0.351	0.401	0.401	0.351	0.401
Percentile and category: wet season					
1.163	1.055	1.237	1.084	1.055	1.084
BIOTA					
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure		

	habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: The dry season flows sufficient, but the wet season conditions below the ecological needs – can have negative impacts for the habitat diversity. Sc2: Both flow conditions will sustain the minimum requirements. Sc3: The dry season flows sufficient, but the wet season conditions below the ecological needs – can have negative impacts for the habitat diversity. Sc4: The dry season flows sufficient, but the wet season conditions below the ecological needs – will have long-term negative impacts for the habitat diversity. Sc5: The dry season flows sufficient, but the wet season conditions below the ecological needs – can have negative impacts for the habitat diversity.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Releases to remain constant as present day. With no change in flow regime, water quality will remain in present state. Sc3: Releases to remain constant as present day. With no change in flow regime, water quality will remain in present state. Sc4: Releases to remain constant as present day. With no change in flow regime, water quality will remain in present state. Sc5: Releases to remain constant as present day. With no change in flow regime, water quality will remain in present state.	

Table 11: Summary of ecological consequences at the key site Olifants_EWR7, Olifants in B51C

Ecological Categories per scenario					
TEC=D	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
1.048	1.914	1.585	1.177	0.638	1.167
Percentile and category: wet season					
3.442	1.942	8.419	2.982	2.041	2.949
BIOTA					
Dry season			**Wet season**		

Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: The dry season flows sufficient, but the wet season conditions well below the ecological needs – will impact on WQ and habitat availability with negative impacts for the biota and riparian zone. Sc2: More than adequate water under both flow conditions. Sc3: The dry season flows sufficient, but the wet season conditions below the ecological needs – can have negative impacts for the habitat diversity and biota in the long-term. Sc4: Both flow conditions will not sustain the minimum requirements with long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc5: The dry season flows sufficient, but the wet season conditions below the ecological needs – can have negative impacts for the habitat diversity and biota in the long-term.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of D category will be maintained. Sc2: Water quality improvement expected with releases from Flag Boshielo Dam. PES category of C expected, with increased flow. Sc3: Water quality improvement expected with releases from Flag Boshielo Dam. PES category of C expected, with increased flow. Sc4: Water quality will remain in current state, PES of D category will be maintained. Sc5: Water quality will remain in current state, PES of D category will be maintained.	

Table 12: Summary of ecological consequences at the key site Olifants_SPE1, Spekboom in B42H

Ecological Categories per scenario					
TEC=B/C	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.550	0.340	0.424	0.424	0.340	0.424
Percentile and category: wet season					
1.234	3.770	3.770	3.770	3.770	3.770

BIOTA	
Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: The dry season flows not sufficient – will result in habitat loss and possible impacts to biota survival in the dry season. The wet season conditions below above the ecological. Sc2: The dry season flows not sufficient – can result in habitat loss and possible impacts to biota survival in the dry season. The wet season conditions below above the ecological. Sc3: The dry season flows not sufficient – can result in habitat loss and possible impacts to biota survival in the dry season. The wet season conditions below above the ecological. Sc4: The dry season flows not sufficient – will result in habitat loss and possible impacts to biota survival in the dry season. The wet season conditions below above the ecological. Sc5: The dry season flows not sufficient – can result in habitat loss and possible impacts to biota survival in the dry season. The wet season conditions below above the ecological.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Water quality will remain in current state, PES of C category will be maintained. Sc3: Water quality will remain in current state, PES of C category will be maintained. Sc4: Water quality will remain in current state, PES of C category will be maintained. Sc5: Water quality will remain in current state, PES of C category will be maintained.	

Table 13: Summary of ecological consequences at the key site Olifants_EWR8, Olifants in B71D

Ecological Categories per scenario					
TEC=C	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
1.865	0.342	0.832	0.832	0.281	0.822
Percentile and category: wet season					

7.096	0.992	3.822	3.822	2.516	3.804

BIOTA	
Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc2: Both flow conditions will not sustain the minimum requirements with definite long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc3: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc4: Both flow conditions will not sustain the minimum requirements with definite long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc5: Both flow conditions will not sustain the minimum requirements with definite long-term negative impacts to WQ, habitat and the biota, including the riparian zone.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Slight improvement in water quality expected but no change in PES. Sc3: Slight improvement in water quality expected but no change in PES. Sc4: Water quality will remain in current state, PES of C category will be maintained. Sc5: Water quality will remain in current state, PES of C category will be maintained.	

Table 14: Summary of ecological consequences at the key site Olifants_EWR11, Olifants in B71J

Ecological Categories per scenario					
TEC=C	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
3.011	1.036	3.356	2.160	0.997	2.102

Percentile and category: wet season					
10.190	5.181	11.903	6.594	6.400	6.594

BIOTA	
Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc2: Both flow conditions will sustain the minimum requirements. Sc3: Both flow conditions will not sustain the minimum requirements with long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc4: Both flow conditions will not sustain the minimum requirements with definite long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc5: Both flow conditions will not sustain the minimum requirements with long-term negative impacts to WQ, habitat and the biota, including the riparian zone.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Slight improvement in water quality expected with increase in flow but no change in PES. Sc3: Slight improvement in water quality expected with increase in flow but no change in PES. Sc4: Water quality will remain in current state, PES of C category will be maintained. Sc5: Water quality will remain in current state, PES of C category will be maintained.	

Table 15: Summary of ecological consequences at the key site Olifants_EWR12, Lower Blyde in B60J

Ecological Categories per scenario					
TEC=B	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
2.086	0.579	2.332	3.045	2.204	2.238

Percentile and category: wet season					
4.877	3.083	7.952	6.161	4.728	3.709

BIOTA	
Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.

Sc1:

The dry season flows not sufficient – will result in habitat loss and loss to biota diversity survival in the dry season. The wet season conditions below above the ecological – definite long-term negative impacts to biota.

Sc2:

Both flow conditions will sustain the minimum requirements.

Sc3:

Both flow conditions will sustain the minimum requirements.

Sc4:

Both flow conditions will sustain the minimum requirements – TEC for wet season just not met, can have some impacts if sustained over long-term.

Sc5:

Dry season sufficient to maintain habitat and biota, but wet season flows below TEC with definite impact to habitat diversity and life stages of biota – will impact negative on riparian zone over time.

WATER QUALITY

Sc1: Water quality will remain in current state, PES of B category will be maintained.

Sc2: Slight improvement in water quality expected with increased flows however PES of B category will be maintained.

Sc3: Slight improvement in water quality expected with increased flows however PES of B category will be maintained.

Sc4: Water quality will remain in current state, PES of B category will be maintained.

Sc5: Water quality will remain in current state, PES of B category will be maintained.

Table 16: Summary of ecological consequences at the key site Olifants_EWR14b, Lower Ga-Selati in B72K

Ecological Categories per scenario					
TEC=D	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
0.172	0.083	0.245	0.255	0.093	0.085
Percentile and category: wet season					
0.742	0.168	0.672	0.344	0.168	0.168

BIOTA	
Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc2: Dry season sufficient to maintain habitat and biota, but wet season flows below TEC with definite impact to habitat diversity and life stages of biota – will impact negative on riparian zone over time. Sc3: Dry season sufficient to maintain habitat and biota, but wet season flows well below TEC with definite severe impact to habitat diversity and life stages of biota – will impact negative on riparian zone over time. Sc4: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc5: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone.	
WATER QUALITY	
Sc1: Water quality significantly impaired. PES of E category will be maintained. Sc2: Improvement in water quality expected with improved flows. PES of a D category expected. Sc3: Slight improvement in water quality. Non-flow reated management actions required to address impacts. Sc4: PES will be maintained. Non-flow reated management actions required to address impacts. Sc5: PES will be maintained. Non-flow reated management actions required to address impacts.	

Table 17: Summary of ecological consequences at the key site Olifants_EWR16, Olifants in B73H

Ecological Categories per scenario					
TEC=B/C	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
7.642	0.766	7.654	7.654	3.699	3.870
Percentile and category: wet season					
25.538	10.023	27.020	17.777	12.953	13.208

BIOTA	
Dry season	**Wet season**
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.	Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.
Sc1: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc2: Both flows will sustain biota, water quality and habitat. Sc3: Dry season sufficient to maintain habitat and biota, but wet season flows below TEC with definite impact to habitat diversity and life stages of biota – will impact negative on riparian zone over time. Sc4: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone. Sc5: Both flow conditions will not sustain the minimum requirements with severe long-term negative impacts to WQ, habitat and the biota, including the riparian zone.	
WATER QUALITY	
Sc1: Water quality will remain in current state, PES of C category will be maintained. Sc2: Water quality improvement expected with improved flows. PES category of C will be maintained. Sc3: Water quality improvement expected with improved flows. PES category of C will be maintained. Sc4: Water quality will remain in current state, PES of C category will be maintained. Sc5: Water quality will remain in current state, PES of C category will be maintained.	

Table 18: Summary of ecological consequences at the key site Olifants_BLY1, Upper Blyde in B60B

Ecological Categories per scenario					
TEC=B	**Sc1**	**Sc2**	**Sc3**	**Sc4**	**Sc5**
Percentile and category: dry season					
1.501	1.620	1.620	1.620	1.620	1.620
Percentile and category: wet season					
2.604	6.139	6.139	6.139	6.139	6.139
BIOTA					
Dry season			**Wet season**		
Low conditions needed to sustain habitat diversity and ensure the instream biota can maintain its diversity and ensure life stages can be completed.			Wet season flows important to ensure bank-full conditions at least once a year for a short period (few days to weeks) to flush the system and improve habitat and water quality. In addition, it must ensure habitat diversity for the life stages (e.g. spawning and larval growth) in specific habitat types. The high flows further critical for the maintenance of the riparian zone.		
Sc1: Both flows will sustain biota, WQ and habitat. Sc2: Both flows will sustain biota, WQ and habitat. Sc3: Both flows will sustain biota, WQ and habitat. Sc4: Both flows will sustain biota, WQ and habitat. Sc5: Both flows will sustain biota, WQ and habitat.					
WATER QUALITY					
Sc1: Water quality is good, PES category of B will be maintained. Sc2: PES category of B will be maintained. Sc3: PES category of B will be maintained. Sc4: PES category of B will be maintained. Sc5: PES category of B will be maintained.					

A summary of ecological consequences of the key sites for Olifants River catchment is provided in Table 19 with the following interpretations:

	The biota met the TEC for both wet and dry seasons
	The biota did not meet the TEC during either the wet or dry season
Only ML flow	The biota met the TEC only for the dry season and not for the wet season

Table 19: Summary of ecological consequences per scenario for key sites in the Olifants River catchment for the proposed TECs

EWR site	Quaternary Catchment	IUA	Water Resource	PES	REC	EIS	Proposed TEC	Scenarios				
								Sc1	Sc2	Sc3	Sc4	Sc5
Olifants												
Rapid 3 surveys												
Olifants_EWR4	B20J	2	Lower Wilge	C	B	High	B			*Only ML Flow*		*Only ML Flow*
Olifants_EWR1	B11J	1	Olifants	D	C/D	Moderate	D	*Only ML Flow*			*Only ML Flow*	
Olifants_EWR2	B32A	3	Olifants	C	B/C	High	B/C			*Only ML Flow*		*Only ML Flow*
Olifants_EWR8	B71D	10	Olifants	C	C	Moderate	C					
Olifants_SPE1	B42H	8	Lower Spekboom	C	B/C	High	B/C					
Olifants_BLY1	B60B	13	Upper Blyde	C	B	High	B					
Olifants_EWR11	B71J	10	Olifants	C	C	High	C			*Only ML Flow*		
Olifants_EWR12	B60J	10	Lower Blyde	C	B	High	B					*Only ML Flow*
Olifants_EWR16	B73H	12	Olifants	D	B/C	High	B/C			*Only ML Flow*		
Use existing information and re-evaluate EWR												
Olifants-EWR3	B12D	3	Klein Olifants	D/E	C/D	High	C/D	*Only ML Flow*		*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-EWR5	B32D	5	Olifants	C	C	High	C			*Only ML Flow*		
Olifants-EWR6	B31G	4	Lower Elands	E	D	Moderate	D			*Only ML Flow*		
Olifants-EWR7	B51G	7	Olifants	E	D	Moderate	D	*Only ML Flow*		*Only ML Flow*		*Only ML Flow*
Olifants-EWR9	B41H	6	Steelpoort	D	C/D	High	C/D	*Only ML Flow*		*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
EWR 14b	B72K	11	Lower Ga-Selati	E	D	Moderate	D		*Only ML Flow*	*Only ML Flow*		

It is clear from the above table that the TEC could not be met for most of the scenarios at some of the key sites, especially (i) the middle reaches of the Olifants River (Olifants_EWR8 - Olifants River just after confluence with the Mohlapitse River and Olifants_EWR11- Olifants River after the Steelpoort River confluence) and (ii) the Lower Spekboom River. The TEC could only be met for scenario 2 at Olifants_EWE16 in the KNP.

From the surveying of selected sites in the catchment, it was clear that the system is on a negative trajectory. Thus, if the status quo (scenario 1) is maintained for the Olifants River catchment, the system will become further degraded.

However, implementation of the full EWR (scenario 2) will have a severe impact on the yields of the major dams and will result in inadequate quantities of water available for water user demands as indicated in Table 20.

Table 20: Yield of major dams per scenario in the Olifants River catchment

Dam	Present Day Demand/Yield (million m^3/a) per Scenario				
	1	**2**	**3**	**4**	**5**
Witbank	50	18	26	32	26
Middelburg	16	10	14	14	14
Bronkhorstspruit	22	7	19	22	19
Loskop	195	144	144	115	115
Rust de Winter	0	8	8	8	8
Mokhombo	18	0	0	6	0
Flag Boshielo	71	0	25	57	42
De Hoop	71	59	68	68	68
Blyderivierpoort	171	88	88	88	88

It is recommended that scenario 5 be implemented, which is where all EWR as per Scenario 3 (maintenance flows for TEC) except for Flag Boshielo and Loskop Dam where RQO EWR was used - Abstraction from dams reduced until one failure – historic firm yield. With implementing scenario 5, the following changes to the TEC at the following sites is recommended:

- Olifants_EWR8: change TEC from C to C/D;
- Olifants_EWR1: change TEC from C to C/D;
- Olifants_SPE1: change from B/C to C;
- Olifants_EWR16: change from B/C to C; and
- Olifants before Steelpoort confluence – change TEC from C to C/D.

Overtime, as more water becomes available, release flows as per Scenario 3 (low flow EWRs for TEC and determined firm yields) and cap the flows from Flag Boshielo Dam.

The revised results of these new flow requirements at all key sites is presented in Table 21 and the revised detailed flow requirements of the four key sites and one priority 1 site are presented in and Table 22 and the detailed rule and summary tables are included as Appendix B.

Table 21: Summary of revised ecological consequences per scenario for key sites in the Olifants River catchment for the final TECs

EWR site	Quaternary Catchment	IUA	Water Resource	PES	REC	EIS	Final TEC	Scenarios				
								Sc1	Sc2	Sc3	Sc4	Sc5
Olifants												
Rapid 3 surveys												
Olifants-S2 (Olifants-EWR4)	B20J	2	Lower Wilge	C	B	High	B			*Only ML Flow*		*Only ML Flow*
Olifants-S5 (Olifants-EWR1)	B11J	1	Olifants	D	C/D	Moderate	D	*Only ML Flow*			*Only ML Flow*	
Olifants-S7 (Olifants-EWR2)	B32A	3	Olifants	C	B/C	High	B/C			*Only ML Flow*		*Only ML Flow*
Olifants-S10 (Olifants-EWR8)	B71D	10	Olifants	C	C	Moderate	C/D			*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-S11 (Olifants_SPE1)	B42H	8	Lower Spekboom	C	B/C	High	C	*Only ML Flow*	*Only ML Flow*	*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-S12	B60B	13	Upper Blyde	C	B	High	B					
Olifants-S13 (Olifants-EWR11)	B71J	10	Olifants	C	C	High	C/D				*Only ML Flow*	
Olifants-S14 (Olifants-EWR12)	B60J	10	Lower Blyde	C	B	High	B					*Only ML Flow*
Olifants-S16 (Olifants-EWR16)	B73H	12	Olifants	D	B/C	High	C			*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Use existing information and re-evaluate EWR												
Olifants-EWR3	B12D	3	Klein Olifants	D/E	C/D	High	C/D	*Only ML Flow*		*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
Olifants-EWR5	B32D	5	Olifants	C	C	High	C			*Only ML Flow*		
Olifants-EWR6	B31G	4	Lower Elands	E	D	Moderate	D			*Only ML Flow*		
Olifants-EWR7	B51G	7	Olifants	E	D	Moderate	D	*Only ML Flow*		*Only ML Flow*		*Only ML Flow*
Olifants-EWR9	B41H	6	Steelpoort	D	C/D	High	C/D	*Only ML Flow*		*Only ML Flow*	*Only ML Flow*	*Only ML Flow*
EWR 14b	B72K	11	Lower Ga-Selati	E	D	Moderate	D		*Only ML Flow*	*Only ML Flow*		

Table 22: Revised EWR for the key and priority sites for the final TEC (flows in million m^3 per annum)

Key site: Olifants_S10 (Olifants_EWR8)	
River	Olifants
Quaternary catchment	B71D

NMAR at EWR site	813.04	
Target Ecological Category	Scenario analysis	Final
	C	C/D
Total EWR	169.747 (20.87 %MAR)	123.525 (15.19 %MAR)
Maintenance Low flows	126.469 (15.55 %MAR)	95.791 (11.78 %MAR)
Drought Low flows	50.939 (6.26 %MAR)	50.939 (6.26 %MAR)
Maintenance High flows	43.278 (5.32 %MAR)	27.734 (3.41 %MAR)
Key site: Olifants_S13 (Olifants_EWR11)		
River	Olifants	
Quaternary catchment	B71J	
NMAR at EWR site	1 321.9	
Target Ecological Category	Scenario analysis	Final
	C	D
Total EWR	236.022 (17.85 %MAR)	169.272 (12.81 %MAR)
Maintenance Low flows	187.586 (14.19 %MAR)	130.388 (9.86 %MAR)
Drought Low flows	97.346 (7.36 %MAR)	82.805 (6.26 %MAR)
Maintenance High flows	48.436 (3.66 %MAR)	38.884 (2.94 %MAR)
Key site: Olifants_S11 (Olifants_SPE1)		
River	Spekboom	
Quaternary catchment	B42H	
NMAR at EWR site	148.19	
Target Ecological Category	Scenario analysis	Final
	B/C	C
Total EWR	45.634 (30.79 %MAR)	34.316 (23.16 %MAR)
Maintenance Low flows	25.803 (17.41 %MAR)	18.687 (12.61 %MAR)
Drought Low flows	9.346 (6.31 %MAR)	9.346 (6.31 %MAR)
Maintenance High flows	19.831 (13.38 %MAR)	15.630 (10.55 %MAR)
Key site: Olifants_S16 (Olifants_EWR16)		
River	Olifants	
Quaternary catchment	B73H	
NMAR at EWR site	1 918.3	
Target Ecological Category	Scenario analysis	Final
	B/C	C
Total EWR	566.629 (29.54 %MAR)	403.958 (21.06 %MAR)
Maintenance Low flows	461.860 (24.08 %MAR)	339.962 (17.72 %MAR)
Drought Low flows	192.106 (10.01 %MAR)	192.106 (10.01 %MAR)

Maintenance High flows	104.769 (5.46 %MAR)	63.996 (3.34 %MAR)

Priority site: Olifants before Steelpoort confluence		
River	Olifants	
Quaternary catchment	B71F	
NMAR at EWR site	937.8	
Target Ecological Category	Scenario analysis	Final
	C	C/D
Total EWR	196.567 (20.96 %MAR)	125.649 (13.40 %MAR)
Maintenance Low flows	153.289 (16.35 %MAR)	97.915 (10.44 %MAR)
Drought Low flows	65.669 (7.00 %MAR)	59.104 (6.30 %MAR)
Maintenance High flows	43.278 (4.61 %MAR)	27.734 (2.96 %MAR)

5.2 ECOLOGICAL CONSEQUENCES AT PRIORITY SITES

Flow duration tables and curves were prepared for each of the priority sites per scenario. The percentiles used for the flow duration tables are: 0.1 (large floods); 1; 5; 10; 15; 20; 30; 40; 50 (median); 60; 70; 80; 85; 90; 95; 99 and 99.9 (drought). The 90-99.9 percentiles represents the drought flows.

The following approach was used:

- A wet season and dry season month were selected for each site; and
- The corresponding EWR flows for the TEC for these months were compared to the available flow per scenario. This was done for each of the percentiles listed above to provide an indication if the EWR could be met or not.

A summary of the results are provided in Table 23 and the detailed graphs and tables are available electronically.

Table 23: Comparisons of scenarios to EWR for the priority sites in the Olifants River catchment

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
Steenkoolspruit at B1H021	Steenkoolspruit	62.9	D	15.73	**Dry season (August):** EWR could be met for all the scenarios **Wet season (January):** EWR could not be met for any of the scenarios for flows lower than the median
Olifants/ Steenkool confluence	Olifants	45.7	D	15.50	**Dry season (August):** EWR could not be met for Scenarios 1, 2 and 4 for flows between the 20 and 99.9 percentiles

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
					EWR could not be met for Scenarios 3 and 5 for flows between the 30 and 80 percentiles **Wet season (January):** EWR could not be met for any of the scenarios for flows lower than the median
Olifants at B1H005	Olifants	147.9	D	15.90	**Dry season (August):** EWR could not be met for any scenario for flows between 30 and 70 percentiles **Wet season (February):** EWR could not be met for any of the scenarios for flows lower than the 60 percentile
Spookspruit at EWR site (SPK-EWR1)	Spookspruit	9.322	C	30.12	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could be met for all the scenarios
Klein Olifants above Middelburg Dam ()LI-EWR1)	Klein-Olifants	50.7	C	26.56	**Dry season (September):** EWR could be met for all the scenarios **Wet season (January):** EWR could not be met for any of the scenarios for flows between the 50 and 90 percentiles
Klein Olfants below WWTW	Klein Olifants	67.3	C/D	27.16	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could not be met for Scenario 1 between 15 and 99 percentiles EWR could not be met for Scenario 2 between 20 and 30 percentiles EWR could not be met for Scenario 3-5 between 15 and 99 percentiles
Olifants above Wilge	Olifants	307.4	B/C	33.11	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could not be met for Scenario 1, 3, 4 and 5 between 40 and 99.9 percentiles EWR could be met for Scenario 2
Upper Wilge at EWR site (Olifants_S3)	Wilge	44.76	C	15.11	**Dry season (September):** EWR could be met for all the scenarios

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
					Wet season (February): EWR could not be met for Scenario 1 and 4 between 40 and 99.9 percentiles EWR could not be met for Scenario 3 and 5 between 90 and 99.9 percentiles EWR could be met for Scenario 2
Bronkhorstspruit above Wilge	Bronkhorstspruit	79.9	B/C	27.30	**Dry season (September):** EWR could not be met for Scenario 1 and 4 between 5 and 99.9 percentiles EWR could not be met for Scenario 2, 3 and 5 between 95 and 99.9 percentiles **Wet season (February):** EWR could not be met for Scenario 1, 3, 4 and 5 between 20 and 99.9 percentiles EWR could be met for Scenario 2
Saalboomspruit	Saalboomspruit	22.1	B/C	39.66	**Dry season (August):** EWR could not be met for any scenario for flows lower than the median **Wet season (February):** EWR could not be met for any of the scenarios for flows lower than the 30 percentile
Kranspoortspruit at EWR site (Olifants_S8)	Kranspoortspruit	13.258	B	30.26	**Dry season (August):** EWR could not be met for any scenario for flows between 30 and 99.9 percentiles **Wet season (February):** EWR could not be met for any of the scenarios for flows lower than the 40 percentile
Selons at EWR site (Olifants_S9)	Selons	33.109	C	21.86	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could be met for all the scenarios
Elands above RustdeWinter Dam (Olifants_S1)	Elands	31.075	C	20.87	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could be met for all the scenarios
Elands at B3H021	Elands	84.1	C/D	9.71	**Dry season (September):** EWR could not be met for most of the percentiles for any of the scenarios

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
					Wet season (February): EWR could not be met for Scenarios 1, 3, 4 and 5 between 15 and 99.9 percentiles EWR could be met for most of the percentiles for Scenario 2
Bloed above Olifants	Bloed	17.1	D	13.01	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could be met for all the scenarios
Moses at B3H005	Moses	35.5	C/D	15.65	**Dry season (September):** EWR could not be met for any of the scenarios between 20 and 99.9 percentiles **Wet season (February):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles
Grootspruit	Grootspruit	28.1	B/C	42.19	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could be met for all the scenarios
Steelpoort after Laersdrift	Steelpoort	113.4	B/C	37.33	**Dry season (September):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles **Wet season (February):** EWR could be met for all the scenarios
Dwars at EWR site (DWA-EWR1)	Dwars	26.1	B/C	31.24	**Dry season (September):** EWR could not be met for any of the scenarios between 10 and 99.9 percentiles **Wet season (February):** EWR could not be met for any of the scenarios for flows lower than the median
Steelpoort at EWR site (Olifants_EWR10)	Steelpoort	342.75	D	12.69	**Dry season (September):** EWR could not be met for Scenario 1, 4 and 5 between 30 and 99.9 percentiles EWR could be met for Scenario 2 and 3 for most of the percentiles **Wet season (February):** EWR could be met for all the scenarios
Olifants above Steelpoort	Olifants	937.8	C/D	20.96	**Dry season (September):** EWR could not be met for any of the

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
					scenarios for most of the percentiles **Wet season (February):** EWR could not be met for any of the scenarios for flows between 30 and 99.9 percentiles
Dorpspruit below Lydenburg (OLI-EWR9)	Dorps	63.19	C/D	19.10	**Dry season (September):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles **Wet season (February):** EWR could not be met for any of the scenarios between 15 and 85 percentiles
Watervals below Buffelskloof Dam	Waterval	28.6	B/C	28.15	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could be met for all the scenarios
Watervals at EWR site (OLI-EWR5)	Waterval	36.39	C	18.75	**Dry season (September):** EWR could not be met for any of the scenarios **Wet season (February):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles
Ohrigstad below dam	Ohrigstad	15.9	B/C	34.38	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could not be met for any of the scenarios for flows lower than the median
Ohrigstad above Blyderivier Dam (OLI-EWR8)	Ohrigstad	67.7	C	17.41	**Dry season (September):** EWR could be met for all the scenarios **Wet season (February):** EWR could not be met for any of the scenarios for flows lower than the median
Makhutsi	Makhutswi	44.8	B	38.79	**Dry season (September):** EWR could not be met for Scenario 1, 4 and 5 between 15 and 50 percentiles and between 90 and 99.9 percentiles EWR could be met for Scenario 2 and 3 for most of the percentiles **Wet season (February):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles
Klaserie below	Klaserie	30.4	B	34.04	**Dry season (September):**

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
B7R001					EWR could not be met for any of the scenarios between 10 and 99.9 percentiles **Wet season (February):** EWR could not be met for any of the scenarios between 40 and 99.9 percentiles
Olifants at EWR site (Olifants_S15)	Olifants	1 762.1	C	23.23	**Dry season (September):** EWR could not be met for Scenario 1, 2, 4 and 5 between 5 and 99.9 percentiles EWR could be met for Scenario 3 **Wet season (February):** EWR could not be met for any of the scenarios between 40 and 99.9 percentiles
Ngwabitsi below Tours Dam	Ngwabitsi	8.4	C/D	17.55	**Dry season (September):** EWR could be met for all the scenarios**,** except during severe drought (90 to 99.9 percentiles) **Wet season (February):** EWR could be met for all the scenarios, except during severe drought (90 to 99.9 percentiles)
Upper Ga-Selati at EWR site (Olifants_EWR14a)	Upper Ga-Selati	52.2	C	27.53	**Dry season (September):** EWR could not be met for Scenario 1, 4 and 5 between 5 and 99.9 percentiles EWR could not be met for Scenario 2 and 3 between 10 and 40 percentiles **Wet season (February):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles
Olifants at B7H015	Olifants	1 836.4	C	23.12	**Dry season (September):** EWR could not be met for Scenario 1, 2, 4 and 5 between 5 and 99.9 percentiles EWR could be met for Scenario 3 **Wet season (February):** EWR could not be met for any of the scenarios between 40 and 99.9 percentiles
Olifants after Letaba	Olifants	2 597.9	C	22.0	**Dry season (September):** EWR could not be met for any scenario between 5 and 99.9 percentiles **Wet season (February):** EWR could not be met for any of the scenarios between 30 and 99.9 percentiles
Treur at B6H003	Treur	49.3	A/B	50.30	**Dry season (September):**

Description	River	NMAR m^3/a	TEC	EWR as %NMAR	Summary of scenario results
					EWR could not be met for any scenario between 30 and 70 percentiles **Wet season (February):** EWR could be met for all of the scenarios
Blyde at B6H001	Blyde	183.8	B	45.69	**Dry season (September):** EWR could not be met for any scenario between 15 and 30 percentiles **Wet season (February):** EWR could be met for all of the scenarios

The results of the evaluation of the scenarios at the selected priority sites show that the EWRs for the TEC could not be met for most of the river reaches in the Olifants River catchment, especially the main stem Olifants River and the larger tributaries. Thus, the flow requirements as recommended in this study should be implemented for the Olifants River catchment to prevent further ecological degradation.

3 COMPARISONS OF EWRS IN LETABA RIVER CATCHMENT

Detail scenario analysis were undertaken as part of the study to classify the water resources of the Letaba River and to determine the Resource Quality Objectives (DWS, 2013). Thus, no further scenarios were evaluated during this study and the final EWR results were compared at the selected key sites to the results from the 2013 study in Table 24. Only three key sites were identified as part of this study, namely:

i. Great Letaba in B81B (LET16) – existing Letaba_EWR1 that was re-surveyed in April 2016.

ii. Great Letaba in B81F – existing Letaba_EWR4 that could not be re-surveyed in April 2016 due to no flows. Only a biological survey (fish) was done.

iii. Letaba in B83D (LET2) – existing Letaba_EWR7 that was re-surveyed in April 2016.

Table 24: Comparisons of EWR results with DWS, 2013 study

Key site: Letaba_EWR1		
Quaternary Catchment	B81B	
River	Great Letaba	
EWR results	2016	2013 WRCS
Target Ecological Category	C	C
NMAR at EWR site	99.84	99.84
Total EWR	24.76%	20.0%
EWR as %NMAR: Maintenance Low flows	17.58%	10.8%
EWR as %NMAR: Maintenance High flows	7.18%	9.2%
Key site: Letaba_EWR7		

Quaternary Catchment	B83D	
River	Letaba	
EWR results	2016	2013 WRCS
Recommended and Target Ecological Category	C	B
NMAR at EWR site	646.28	646.28
Total EWR	17.34%	17.8%
Maintenance Low flows	13.88%	7.8%
Maintenance High flows	3.46%	10.0%

The requirements from the DWS, 2013 study is recommended for the gazetting of The Reserve. Although not identified as a key site, the results from the new EWR site identified in the Broederstroom in quaternary catchment B81A is also recommended for inclusion in the gazette.

4 QUANTITATIVE ECOLOGICAL CONSEQUENCES FOR THE SHINGWEDZI RIVER

The water resources of the Shingwidzi River and its tributaries have not been classified and no RQOs have been determined.

Only one key site has been identified for this system in quaternary catchment B90H (SHI1). The ecological water requirements of this site has been compared to the present day flows to check if the EWR could be met. The results are summarized in Table 25.

Table 25: Comparisons between EWR and present day flows for Shingwidzi River at EWR site SHI1

Percentiles	September				February			
	NAT	EWR BC	PRS (A)	(A)-EWR	NAT	EWR BC	PRS (A)	(A)-EWR
0.1	0.750	0.002	0.605	0.604	369.694	7.771	349.905	342.134
1	0.242	0.002	0.195	0.193	155.859	7.756	142.574	134.818
5	0.000	0.000	0.001	0.001	55.275	7.749	49.179	41.430
10	0.000	0.000	0.000	0.000	26.218	7.692	23.905	16.213
15	0.000	0.000	0.000	0.000	15.738	6.830	13.487	6.657
20	0.000	0.000	0.000	0.000	7.090	5.911	6.099	0.188
30	0.000	0.000	0.000	0.000	3.208	3.141	2.613	-0.528
40	0.000	0.000	0.000	0.000	1.152	1.127	0.971	-0.156
50	0.000	0.000	0.000	0.000	0.434	0.422	0.352	-0.070
60	0.000	0.000	0.000	0.000	0.140	0.136	0.112	-0.024
70	0.000	0.000	0.000	0.000	0.014	0.014	0.013	-0.001
80	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Percentiles	September				February			
	NAT	EWR BC	PRS (A)	(A)-EWR	NAT	EWR BC	PRS (A)	(A)-EWR
99	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The above table shows that the EWR could not be met during February. Further analysis showed that the EWR could only be met during September and October. For the rest of the months, November to March, the EWR could not be met between the 30th to 70th percentiles. This is due to user water demands and a number of dams outside Kruger National Park. It must be noted that there are very seldom flows between the months of April and August due to the almost ephemeral nature of the Shingwidzi River in the Kruger National Park.

5 CONCLUSIONS

The aquatic ecosystems of the Olifants, Letaba and Shingwedzi Rivers are under stress and on a negative trajectory due to extensive water use for irrigation and domestic purposes in the various catchments, return flows from waste water treatment works and from mining activities. Afforestation in the upper catchments of the Great Letaba River also reduces the base flows in the rivers further. Large dams in especially the Olifants and Letaba catchments have a severe impact on the moderate flows (freshets), as a number of these dams do not have the release capacities.

Olifants River catchment

The scenario evaluation of the Olifants River catchment shows that the EWR could not be met at most of the identified key and priority site during present day conditions (Scenario 1). The other scenarios provided a mix of success to meet the EWR, with Scenario 2 (full EWR) giving the best results for the protection of the aquatic ecosystems. However, this scenario has a detrimental impact on the yields of the large dams, and the availability of water for the water users in the catchment.

In terms of water quality, for most part of the Olifants system the flow scenarios were not significant enough to result in a change in water quality status to another category. However the higher discharges associated with scenarios 2 and 3 will in general result in an improvement water quality. EWR sites EWR4 (Lower Wilge), EWR7 (Middle Olifants) and EWR14b (Lower Ga-Selati) is where the improve flows would impact and improve water quality status. The better quality resulting from the higher flows are due to the diluting effect of the pollution. In most cases the water quality status is driven by non flow related activities (viz. mining and industrial impacts, agricultural runoff, urbanisation and dense settlements and poorly treatment sewage effluent). The

The final recommended scenario (scenario 5) with some changes to the Target Ecological Categories of sites in the middle and lower Olifants River provided the best results to protect the aquatic ecosystems, and still has water available for the water users.

Letaba River catchment

Various scenarios have been evaluated in detail during the classification of the water resources of the Letaba River catchment. The final accepted scenario and corresponding ecological specifications as provided in the Government Gazette No. 39614, dated 22 January 2016 should

be complied with to ensure that the water resources of the Letaba River are protected.

Shingwedzi River catchment

The Shingwedzi River is an ephemeral system with almost no flows during the months of April to August. However, water use outside the Kruger National Park has impacted on the moderate flows mainly due to a number of dams not releasing the smaller freshets. The present day water use should be monitored closely and any further water use in this system should should ensure that the freshets are not reduced.

It is important that the ecological specifications (quantity, quality, habitat and biota) as specified in the various study reports be met to ensure that the resources of the Olifants, Letaba and Shingwedzi Rivers and their tributaries can provide the goods and services.

Appendix A: Rul and Tab Tables