CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS (WP 10506)

MANAGEMENT CLASSES OF THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS REPORT

FINAL

REPORT NO.: **RDM/WMA1, 3/00/CON/CLA/0612**

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DOCUMENT INDEX

Reports as part of this study:

Bold type indicates this report.

Report Index	Report number	Report title
1	RDM/WMA1,3/00/CON/CLA/0111	Inception Report
2a	RDM/WMA1,3/00/CON/CLA/0112A	Information Analysis Report : Crocodile (West) Marico Catchments
2b	RDM/WMA1,3/00/CON/CLA/0112B	Information Analysis Report : Mokolo and Matlabas Catchments
3	RDM/WMA1,3/00/CON/CLA/0212	Integrated Units of Analysis Delineation Report
4	RDM/WMA 1,3/00/CON/CLA/0312	Ecological Water Requirements Report
5	RDM/WMA1, 3/00/CON/CLA/0412	Ecologically Sustainable Base Configuration (ESBC) Scenario Report
6	RDM/WMA1, 3/00/CON/CLA/0512	Scenarios Report
7	**RDM/WMA1, 3/00/CON/CLA/0612**	**Management Classes Report**

LIST OF ABBREVIATIONS AND ACRONYMS

CD: RDM	Chief Directorate: Resource Directed Measures
DBSA	Development Bank of South Africa
DWA	Department of Water Affairs
EEAs	Environmental Economic Accounting
EIS	Ecological Importance and Sensitivity
ESBC	Ecologically Sustainable Base Configuration
ERE	Environmental and Resource Economics
EWR	Ecological Water Requirements
GDP	Gross Domestic Product
ha	Hectares
HN	Hydro-node
IUA	Integrated Unit of analysis
IWRM	Integrated Water Resource Management
MAR	Mean Annual Runoff
MC	Management Class
NWA	National Water Act
PES	Present Ecological State
PGM	Platinum Group Metals
PSC	Project Steering Committee
REC	Recommended Ecological Category
RDM	Resource Directed Measures
RQOs	Resource Quality Objectives
WMA	Water Management Area
WRC	Water Resource Classification
WRCS	Water Resource Classification System
WRYM	Water Resources Yield model
WRPM	Water Resource Planning Model

GLOSSARY

Some key terms and definitions as for Water Resource Classification as applied in the study:

Ecological Importance and Sensitivity (EIS)	Key indicators in the ecological classification of water resources. Ecological importance relates to the presence, representativeness and diversity of species of biota and habitat. Ecological sensitivity relates to the vulnerability of the habitat and biota to modifications that may occur in flows, water levels and physico-chemical conditions.
Ecological Water Requirements (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
Ecological Water Requirement Sites	Specific points on the river as determined through the site selection process. An EWR site consists of a length of river which may consist of various cross-sections for both hydraulic and ecological purposes. These sites provide sufficient indicators to assess environmental flows and assess the condition of biophysical components (drivers such as hydrology, geomorphology and physico-chemical) and biological responses (*viz*. fish, invertebrates and riparian vegetation).
Integrated unit of analysis (IUAs)	The basic unit of assessment for the classification of water resources. The IUAs incorporate socio-economic zones and are defined by catchment area boundaries.
Management Class (MC)	The MC is representative of those attributes that the DWA (as the custodian) and society require of different water resources (consultative process). The process requires a wide range of trade-offs to assessed and evaluated at a number of scales. Final outcome of the process is a set of desired characteristics for use and ecological condition each of the water resources in a given catchment. The WRCS defines three management classes, Class I, II, and III based on extent of use and alteration of ecological condition from the predevelopment condition.
Present Ecological State (PES)	The current state or condition of a water resource in terms of its biophysical components (drivers) such as hydrology, geomorphology and water quality and biological responses *viz*. fish, invertebrates, riparian vegetation). The degree to which ecological conditions of an area have been modified from natural (reference) conditions.
Recommended Ecological Category (REC)	The Recommended Ecological Category is the future ecological state (Ecological Categories A to D) that can be recommended for a resource unit depending on the EIS and PES. The REC is determined based on ecological criteria and considers the EIS, the restoration potential of the

system and attainability there-of.

River Node (Hydro-node)	These are modelling point's representative of an upstream reach or area of an aquatic eco-system (rivers, wetlands, estuaries and groundwater) for which a suite of relationships apply.
Scenario	Scenarios, in the context of water resource management and planning, are plausible definitions (settings) of factors (variables) that influence the water balance and water quality in a catchment and the system as a whole. Each scenario represents an alternative future condition, generally reflecting a change to the present condition.
Significant Water Resources	Water resources that are deemed to be significant from a water resource use perspective, and/or for which sufficient data exist to enable an evaluation of changes in their ecological condition in response to changes in their quality and quantity of water. Water resources are deemed to be significant based on factors such as, but not limited to, aquatic importance, aquatic ecosystems to protect and socio-economic value.
Sub-nodes	Finer scale of modelling points defined within a particular IUA at which flows and water qualities will be set to protect a particular ecological subarea that is identified as important and sensitive.
Sub-quaternary catchments	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments). The update of the PES and EIS (2010) status has been determined per sub-quaternary.
Trade-offs	Balancing of all factors in relation to the water resource and/or and IUA(s) that are not necessarily attainable at the same which may involve a giving up of one benefit, advantage, etc. in order to gain another regarded as more desirable. This may include balancing of those factors between use and protection (which may or may not be conflicting), between downstream impacts and upstream uses and vice versa, between possible use of resources within a catchment and between catchments, and between possible resource uses between different parts of the country. Decisions on these trade-offs will have different implications for different stakeholders at local, regional and national levels.
Water Resource Planning Model (WRPM)	The Water Resources Planning Model (WRPM) is a planning model capable of modelling demands which increase with time as well as changing system configuration. It can be used both as a planning tool to assess the likely implementation dates of new schemes or resources

and also as an operational tool for the month to month operation of a system. The WRPM was used in the scenarios assessments for the classification of water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments.

Water Resource Yield Model

The WRYM is a network based water resources model used to analyse complex water systems under various operating and growth scenarios. The WRYM is used to assess the long-term yield capabilities of a water resource system for a given operating policy. It is used to analyse a system at constant development level, i.e. the system and the water requirements remain constant throughout the simulation period.

EXECUTIVE SUMMARY

Introduction

In 2010, the Department of Water Affairs (DWA) identified the need to undertake the classification of significant water resources in the Crocodile (West), Marico, Matlabas and Mokolo catchments in accordance with the Water Resource Classification System (WRCS). Classification of water resources aims to ensure that a balance is reached between the need to protect and sustain water resources on one hand and the need to develop and use them on the other. The ultimate goal of the study is the implementation of the WRCS which has as its final product the selection of one of three Management Classes (MCs) for the 20 Integrated Units of Analysis (IUAs) that were identified in the Crocodile West/Marico WMA and the Mokolo and Matlabas catchments. The purpose of the MC is to establish clear goals relating to the quantity and quality of the relevant water resource, and conversely, the degree to which it can be utilised by considering the economic, social and ecological goals from an integrated water resource management (IWRM) perspective.

The WRCS places the following principles at the forefront of implementation:

1) Maximising economic returns from the use of water resources;

2) Allocating and distributing the costs and benefits of utilising the water resource fairly; and

3) Promoting the sustainable use of water resources to meet social and economic goals without detrimentally impacting on the ecological integrity of the water resource.

The Crocodile West/Marico WMA and Mokolo and Matlabas catchments' WRC study was initiated in November 2011. The study has been primarily of a technical nature guided by identified stakeholder groups in the study area constituting the Project Steering Committee (PSC) (Appendix C). The Crocodile (West), Marico, Mokolo and Matlabas catchments classification study is now at the final stage in terms of the WRCS process, the proposed MCs.

Study Area

The study area comprises the Crocodile (West), Marico, Mokolo and Matlabas catchments. The following sub-catchments make up the study area.

Sub-catchment	Catchment Area (km^2)	Quaternary catchments
Upper Crocodile (A21)	6 336	A21 A – L
Elands (A22)	6 221	A22 A – J
Apies/Pienaars (A23)	7 588	A23 A – L
Lower Crocodile (A24)	9 204	A24 A – J;

Sub-catchment	Catchment Area (km^2)	Quaternary catchments
Marico (A31 and A 32)	12 030	A32 A – E; A31 A – J
Ngotwane (A10)	1 842	A10 A – C
Upper Molopo (D41))	4 300	D41 A
Matlabas (A41)	6 014	A41A – E
Mokolo (A42))	8 387	A42 A – J

Purpose of the Report

The purpose of this report is to present and describe the rationale for the proposed MCs for the identified IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments, based on the outcomes of the scenario evaluation process and recommendations (DWA, 2012a). The proposed MCs or class configurations form the final deliverable of the study. The MCs presented in this report will be incorporated into the classification component of the IWRM template for the Crocodile (West), Marico, Mokolo and Matlabas catchments and will be presented to the Minister for consideration. Certain rivers were identified due to their conservation importance or sensitivity that require a higher level of protection than that specified for the overall IUA. These are mentioned with these final recommendations on the MC in order that specific conditions are afforded to them to ensure that a higher level of protection is maintained.

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

The RQO development process is a separate process that has recently been initiated by the DWA and will run on from the outcome of the classification study.

Approach

To classify a water resource, the WRCS lays out a set of procedures grouped together in 7 steps that when applied to a specific catchment will result in the determination of a MC. In terms of the process:

- 20 IUAs, several nodes and the significant water resources were defined for the Crocodile (West), Marico, Mokolo and Matlabas catchments. This has been based on the socio-economics of the areas, water use and users, envisaged level of protection required and significance of the resource. Availability of representative Ecological Water Requirement (EWR) sites, catchment boundaries and catchment modelling schematics were also considered. A status quo assessment of each IUA was undertaken to understand ecological status, socio-economic conditions, ecosystem services and water resource infrastructure and availability.

- An evaluation and decision analysis framework was defined once the status quo of the WMA

was understood and the IUAs and network of significant water resources was delineated. An economic model was developed based on this framework to assess the implications of different catchment scenarios at an IUA level on economic prosperity, social wellbeing and ecological condition.

- Ecological water requirements (EWR) were then quantified for the EWR sites and nodes in the system. These were taken from previous Reserve studies or results were obtained through rapid assessments undertaken for the purpose of this classification study. Where limited ecological information was available extrapolation using information from the previous studies was done, especially in those smaller tributaries where protection is required. The updated PES and EIS as at 2012 of the water resources was obtained from a recently completed DWA study and was used where no other information was available. During this step the information on the river Freshwater Ecosystem Priority Areas (FEPAs) identified through the National Freshwater Ecosystem Priority Areas Project of the Water Research Commission (WRC, 2011), was assessed to determine if they were adequately protected through the PES categories for the nodes in these catchments. FEPAs have been identified as those areas that are important for sustaining the integrity and continued functioning of their related ecosystems.

- The ecologically sustainable base configuration (ESBC) scenario was then established and tested. The ecological categories used as the base scenario was the PES as determined during previous Reserve studies as well as the 2010 PES at all the EWR sites in the Crocodile (West), Marico, Mokolo and Matlabas catchments. For the Marico and Matlabas catchments the Water Resources Yield Model (WRYM), and for the Crocodile West and Mokolo catchments, the Water Resources Planning Model (WRPM), were run based on the EWR and water balance outputs were fed into the economic modelling assessment.

- Once appropriate levels of ecological protection are established for the water resources; the measures required to achieve these protection levels, can then be assessed in terms of the overall implications to the IUAs and the WMA. This forms the scenario evaluation component of the WRCS process. To support the decision making process for the Crocodile (West), Marico, Mokolo and Matlabas catchments towards MCs, between 2 and 4 additional catchment scenarios were then analysed and assessed as part of the scenario evaluation step (Step 5). These scenarios represent alternate ecological categories and growth scenarios for the Crocodile (West), Marico, Mokolo and Matlabas catchments, and have been analysed to determine the water balances, socio-economic implications and ecological consequences of each. The outcome of this step was to inform the selection of scenarios for presentation to stakeholders.

- Based on the scenario evaluation and consultation with the stakeholders, it was recommended that the go forward options are those which supply the PES ecological categories and meet the future growth in water requirements in the WMA. In terms of the definition of these scenarios it is proposed as the outcome of the WRCS process that the PES ecological water requirements must be met at the EWR sites and selected nodes within the IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments.

- The IUA MCs associated with these scenarios are presented in this report. The approach

applied to determining the proposed MCs for each of the IUAs was to follow the guidelines of the WRCS (DWA, 2007).

Towards a Management Class

The determination of the MC (Table E1) for the identified water resources in Crocodile (West), Marico, Mokolo and Matlabas catchments will essentially describe the desired ecological condition of the resource, and conversely, the degree to which it can be utilised.

The WRCS guidelines (DWA, 2007) recommend that the MC be determined based on the ECs of the biophysical nodes located in an IUA. The approach applied to determining the proposed MCs for each of the IUAs was to follow the guidelines of the WRCS.

This categorisation is based largely on the main stems of the Crocodile, Marico, Mokolo and Matlabas rivers and major tributaries. Where a sub-node in a tributary catchment is different to the overall IUA MC the ecological category is accounted for by the implementation of this ecological water requirement at the sub-node. Where such instances occur the necessary explanations are provided in this report.

The proposed MCs are supported by the study PSC and are recommended for implementation. This report presents the set of ecological categories (% distribution of biophysical nodes) that define the MC per IUA. A MC for an IUA will guide water resource management and its planning. Based on the specific ecological configuration within a quaternary catchment the management objectives within an IUA may also differ.

The implementation of the MCs (the ecological categories) will be realised to the RQOs that are in the process of being developed.

Table E1: Management classes for water resources

Management Class Descriptions	
Class I	**Minimally used** Water resource is one which is minimally used and the overall condition of that water resource is minimally altered from its pre-development condition
Class II	**Moderately used** Water resource is one which is moderately used and the overall condition of that water resource is moderately altered from its pre-development condition
Class III	**Heavily used** Water resource is one which is heavily used and the overall condition of that water resource is significantly altered from its pre-development condition

Conclusion and Study Recommendations

The IUA MCs proposed for the Crocodile (West), Marico, Mokolo and Matlabas catchments are indicated in Table E2 and Figure E1.

Table E2: Proposed Management Classes for the Crocodile (West), Marico, Mokolo and Matlabas catchments

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
CROCODILE (WEST)	**1**	Upper Crocodile/Hennops/ Hartebeespoort	III	75	15	10	80	**Preferred Scenario: Ecological category = REC + future water use as per the Crocodile-West Reconciliation Strategy** Future Water Requirements driven by: • Future urban expansion in Gauteng, leading to significantly increased return flows; • Additional future mining activities in the Rustenburg area, primarily related to platinum mining; and • Future water use requirements around Lephalale, which would necessitate a water transfer from the Crocodile directly to Lephalale • Water supply, does not constrain the future growth and development of the economy, with the exception of agriculture. • The Recommended (REC) ecological category for the Crocodile West catchment is achievable. • From 2018 onwards, the augmentation of the water supply system through using the surplus water stored in dams would start reducing dam water levels in especially the Hartbeespoort Dam, Roodeplaat Dam and Rietvlei Dam during the dry winter seasons. • There are potential future costs associated with the treatment of AMD and nutrient loads in the Crocodile West River. • With this scenario the economy grows and there is no net loss of river and wetland ecosystem services.
	2	Magalies	II	60	33	7	8	
	3	Crocodile/ Roodekopjes	III	95	5	0	-	
	4	Hex/Waterkloofspruit/ Vaalkop	II	77	9	14	90	
	5	Elands/Vaalkop	II	75	5	20	90	
	12	Bierspruit	III	80	20	0	20	
	13	Lower Crocodile	III	68	25	7	20	
	14	Tolwane/Kulwane/ Moretele/Klipvoor	III	65	15	20	75	

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
MARICO	6a	Klein Marico/ Kromellemboog	II	75	25	0	90	**Preferred Scenario: Ecological category = REC + present water use** Future water use and river flows are driven by: • Possible future urban expansion in towns, leading to marginal increased demands for domestic water • No large scale additional future use is envisaged and additional future water uses are to be achieved through water demand management and well planned and managed groundwater supply schemes. • In this scenario the water economy stays stable and there is no net loss of river and wetland ecosystem services.
	6b	Groot Marico/Marico Bosveld Dam	II	90	10	0	90	**Preferred Scenario: PES, AIP clearing, present water use (incl emerging farmers)** • No additional significant future water supply is possible in the Groot Marico; • The key water source here is the dolomitic outflow, and this supply is current used at a maximum rate, both in the Groot Marico and towards the south towards Lichtenburg; and • In this scenario the water economy stays stable and there is no net loss of river and wetland ecosystem services.
	7	Kaaloog-se-Loop	I	35	35	30	90	
	8	Malmaniesloop	III	0	70	30	0	
	9	Molopo	II	5	70	25	0	
	10	Dinokana Eye/Ngotwane Dam	III	15	70	15	0	

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
	11a	Groot Marico/Molatedi Dam	III	80	20	0	60	**Preferred Scenario: ESBC: Ecological = PES, present water use** • Groundwater supply adequate; and • In this scenario the water economy stays stable and there is no net loss of river and wetland ecosystem services.
	11b	Groot Marico/seasonal tributaries	III	75	20	5	80	
MOKOLO	**15**	Upper Mokolo	II	74	10	16	75	**Preferred Scenario: PES with future water use (2030)** • The Lephalale area is forecast to experience a very significant growth in coal mining, power generation and industrial economic activity; • This will not directly affect the Mokolo River; • The water required for this expansion is significant;

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
	16	Lower Mokolo	II	60	20	20	75	• These water requirements are to be met through a water transfer from the Crocodile West River, directly to the Lephalale; • Extensive coal mining IUA 16 could affect aquifers and could lead to AMD in future; • The aesthetic appeal of IUA 16 may be negatively affected; and • In this scenario the water economy grows significantly however there may be some negative impact on ecosystem services.
MATLABAS	17a	Mothlabatsi/Mamba	I	95	5	0	100	**Preferred Scenario: ESBC is to be maintained** • No change in economic results and ecosystem services
	17b	Matlabas/Limpopo	II	75	20	5	100	

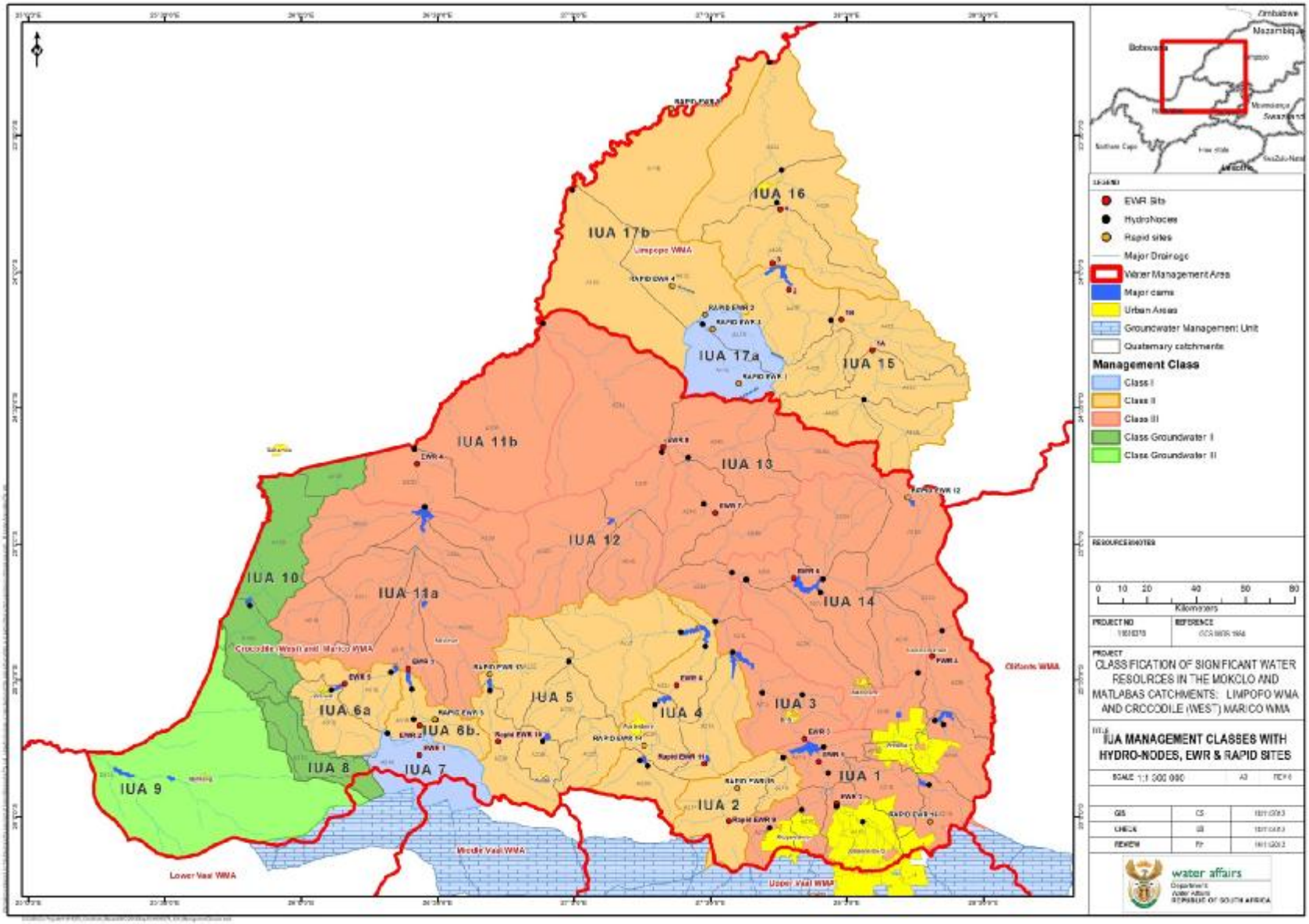

Figure E1: The Crocodile (West), Marico, Mokolo and Matlabas catchments indicating proposed IUA MCs

In terms of the MCs proposed for the 20 IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments:

- 2 IUAs falls within a MC I (IUAs 7 and 13),
- 8 IUAs fall within a MC II (IUAs 2, 4, 5, 6a, 6b, 11a, 11b, 15, 16 and 17b);
- 2 IUAs fall with a MC II related to groundwater (IUAs 8 and 10); and
- 7 IUAs fall within a MC III (IUAs 1, 3, 12,13 and 14); and
- 1 IUA falls with a MC I related to groundwater (IUA 9).

The level of confidence of the data used in the study was high in the Crocodile (West) catchment, medium to high in the Marico and Mokolo catchments and low in the Matlabas catchment.

Based on the results of the study, the following general recommendations are proposed:

- Crocodile West catchment: scenarios which supply the PES ecological category, which in the context of the Crocodile West catchment is equal to the REC ecological category, and meet the future growth in water requirements (2030) in the WMA;
- Marico catchment: the scenario in the Klein Marico is the REC with present water use (2030); the scenario in the Groot Marico is the REC with present water use (2015);
- Mokolo catchment: PES with future water use (2030);
- Matlabas, Molopo and Ngotwane: the ESBC is to be maintained;
- The implementation of the MCs will require management of water quality which includes source directed measures, regulatory and institutional structures;
- Concerted and regular monitoring and compliance management will be required to ensure the successful implementation of the MCs;
- The implementation and updating of the reconciliation strategies for the Crocodile (West), Marico, Mokolo and Matlabas catchments are central to the implementation of the proposed MCs;
- Integrated Water Quality Management Plans are required for the catchments;
- A monitoring programme will need to be implemented to ensure that the MCWAP transfers reach their desired destination and limits pollution to the Matlabas River during pipe scouring; and
- Recommendations specific to the sensitive areas of wetlands are set out in the report and general recommendations for the wetlands are:

- If a wetland is located at a proposed development site, or where the development footprint is within 500m of the wetland (see GN 1199), or the nature of the impact or proposed use of the resource is such that a Water User Licence is required (in terms of the National Water Act, Act 36 of 1998), then the developer should be advised to proceed with a WULA application in conjunction with the standard EIA study where appropriate;
- Due to the current state of loss of wetlands across the country, and in line with the proposed SANBI wetland offset guideline principles (as contained in Macfarlane, von Hase and Brownlie, 2012), the principle of 'no net loss' of wetlands should be applied as far as is reasonably possible within the study area. The draft Guideline document and principles contained therein are in the process of being reviewed by DWA and it is expected to be endorsed by the Department following a public review and comment process. Any developments, including of the water resource, that may impact on wetlands should thus follow the mitigation hierarchy and in cases where a residual loss of wetland function cannot be avoided, the principle of 'no net loss' should be applied via a wetland offset strategy developed in line with the guidelines contained in Macfarlane *et al*. (2012);
- In addition, where information relating to flow and potential flow related impacts is not available for a particular priority wetland where there is a development application that could potentially affect the wetland, then it is recommended that the Environmental Water Requirements (EWRs) should be assessed and quantified as part of as part of a Wetland Reserve Study;
- In relation to applications where there may also be non-flow related impacts on wetlands, suitable buffer zones should also be provided for (a draft buffer zone guideline document is currently being developed by DWA in conjunction with the Water Research Commission) to limit impacts on the wetlands; and
- Resource Quality Objectives (RQOs) should be developed and set for the priority

The implications for implementation are set out in the table below.

Table E3: Implications for Implementation

Implementation Plan aspect	Task	Timeframe
Resource Quality Objectives	• The RQOs must be developed; • Update water quality and quantity monitoring programmes to allow higher level of confidence for the RQOs project, especially in the Marico and Matlabas catchments; • Assess discharge standards to align with RQOs; • Assess approved Reserve to see whether it needs to be updated	2 years 2-5 years 2-5 years 5-10 years
Ecological aspects	• Implement the EWRs; • Eradication of Alien vegetation especially in IUAs 6a and 6b; • Eradication of unlawful water use in all catchments; • Assess the impacts on habitats due to increased return	5-15 years 5-10 years 5-20 years

Implementation Plan aspect	Task	Timeframe
	flows from WWTW	
Monitoring programmes	• Water Quality Management Plans for all the catchments in the study area to be developed starting with the Crocodile (West), Marico and Lower Mokolo focussing specifically on: o TDS reduction and WWTW discharges in IUAs 1, 2, 6a, 9 and 14. • Monitoring programmes for dolomite aquifer systems (specifically IUAs 1 and 2) must be reviewed and upgraded if necessary within the next 2 years; • Localised pollution impacts (especially from mine discharge and industries) on the aquifer systems in IUAs 1 and 2 to be investigated; • Status of contribution to base flow needs to be evaluated in IUAs 8 and 10; • Sustainability of resources in close proximity of rivers with base flow requirements needs to be assessed in IUA 16 (Lower Mokolo); and • Monitoring of the RQO compliance once implemented.	5-10 years
Source Directed Control	• Review trends of current standards for WWTW and industries against WDCS implementation in the Crocodile (West) catchment;	5-10 years
Reconciliation Strategies	• Implement and maintain the Reconciliation Strategy for the Crocodile (West) catchment; • Update/develop the Reconciliation Strategies for the Marico and Mokolo catchments;	2-5 years 5-10 years
Conservation Areas	• As part of the RQO process ensure that RQOs are set to protect conservation areas; • Take cognisance of those areas that have high conservation status and where specific statements have been made relating to limiting mining activities, for example in IUA2; and • Review the NFEPAS in areas where there is no or little correlation, this is especially relevant in IUAs IUAs 1 and 2 where some wetland areas are not covered and 6a and 6b which has wetland areas indicated where there are none.	5 -10 years
Cooperative governance	• Assess areas where DWA can work closely with DMR or other relevant Government Departments that may have a part in implementing the MC or RQOs. This is particularly relevant where integrated water use licences would be issued	5-10 years
Monitoring and enforcement	• Improve on the monitoring and enforcement of water use authorisation conditions.	2-5 years
Economic aspects	• Assess the economic aspects associated with implementing the above; and • Prioritise those aspects that will give quick wins at least cost.	2-5 years

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

Chapter 3 of the National Water Act (NWA, Act 106 of 1998) provides for the protection of water resources through the implementation of Resource Directed Measures (RDM) which includes the Classification of water resources, setting the Reserve and determination of Resource Quality Objectives (RQOs). Classification of water resources aims to ensure that a balance is reached between the need to protect and sustain water resources on one hand and the need to develop and use them on the other.

In 2011, the Department of Water Affairs (DWA) identified the need to undertake the classification of significant water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments in accordance with the Water Resource Classification System (WRCS).

Except for the Matlabas catchment the Crocodile (West), Marico and the Mokolo catchments are highly utilised and regulated catchments and like many other WMAs in South Africa, the water resources are already stressed due to an accelerated rate of development and the scarcity of water resources. There is an urgency to ensure that water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments and are able to sustain their level of use and be maintained at their desired states. The ultimate goal of the study was to determine the management class (MC) for the water resources by implementing the WRCS. The purpose of the MC once set, will be to establish clear goals relating to the quantity and quality of the relevant water resource to facilitate a balance between protection and use of water resources.

The study area comprises the Crocodile (West), Marico, Mokolo and Matlabas catchments (Table 1 and Figure 1).

The Mokolo and Matlabas catchments

The Mokolo catchment stretches from the Waterberg Mountains through the upper reaches of the Sand River, and includes the Mokolo Dam and a number of small tributaries that join the main Mokolo River up to its confluence with the Limpopo River, including the Tambotie, Poer-se- Loop, and Rietspruit rivers.

The Matlabas catchment is situated in a predominantly flat area of the Limpopo WMA. Matlabas River originates in the Waterberg mountain range and the altitude varies from 1 400 m to approximately 840 m at the confluence with the Limpopo River. The catchment is largely undeveloped with limited water resources and limited water use.

Crocodile (West) and Marico catchments

The two major river systems are the Crocodile (West) and Marico, which give rise to the Limpopo River at their confluence The Marico catchment borders on Botswana (north-west).

These two major rivers form the south-western part of the Limpopo River basin (Drainage Region A), eventually draining into the Indian Ocean in Mozambique. The WMA also includes the headwaters of the Molopo River, a tributary of the Orange River which drains westwards to the Atlantic Ocean. The

area includes the tertiary drainage regions A10, A21 to A24, A31, A32 and quaternary drainage region D41A.

The area covers a total catchment area of 47 565 km^2 (Table 1). The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of the Crocodile River which together make up the A20 tertiary drainage catchment, with 39 quaternary catchments. The Crocodile River contributes to the flow of the Limpopo River, which has an international river basin shared with Botswana, Zimbabwe and Mozambique.

Table 1: The sub-catchment areas within the study area

Sub-catchment	Catchment Area (km^2)	Quaternary catchments
Upper Crocodile (A21)	6 336	A21 A – L
Elands (A22)	6 221	A22 A – J
Apies/Pienaars (A23)	7 588	A23 A – L
Lower Crocodile (A24)	9 204	A24 A – J;
Marico (A31 and A 32)	12 030	A32 A – E; A31 A – J
Ngotwane (A10)	1 842	A10 A – C
Upper Molopo (D41))	4 300	D41 A
Matlabas (A41)	6 014	A41A – E
Mokolo (A42))	8 387	A42 A – J

Economic activity across the Crocodile (West) Marico WMA diverse with the area stretching across three provinces: Gauteng, Northwest and Limpopo and comprises the Crocodile and Groot Marico Rivers. The Upper Crocodile sub-catchment (A21) and the urban areas of the Pienaars sub-catchment (A23) comprise a well-developed manufacturing and general commercial urban economy. Rustenburg in the Elands River sub-catchment (A22) is well known for its extensive platinum mining activities. The rural parts of the Pienaars River sub-catchment (A23); the Lower Crocodile River (A24); and the Groot Marico (A3) economies are dominated by agriculture and eco-tourism activities.

Mining operations in the Crocodile (West) Marico WMA is dominated by platinum and the platinum group metals, gold, chrome, manganese, iron ore, diamonds, dimension stone and mineral sands, as well as smaller quantities of vanadium, limestone and andalusite (an aluminium nesosilicate mineral). The entire western section of the mineral-rich Bushveld Igneous Complex is situated here, resulting in intense mining activity in that region

Irrigation occurs mostly in the Crocodile catchment, immediately downstream of the Hartbeespoort Dam and also further downstream towards the south of Thabazimbi. Irrigation is done at

Lichtenberg with water sourced from the Grootfontein dolomitic compartments. Dry land crops, mostly maize, are grown in the higher rainfall south and south-eastern parts of the WMA. Stock and game farming dominate land-use in the drier northern and western regions.

There are several heavy industries in the WMA. These include Pelindaba and Valindaba (direct abstractions from the Crocodile River upstream of Hartbeespoort Dam), and the Dwaalboom cement factory at Thabazimbi (supplied by Magalies Water from the Vaalkop Dam). Three relatively small power stations, Rooiwal, Pretoria West and Kelvin, are present in the WMA.

Although the Crocodile (West) Marico WMA is not as renowned for its tourism activities as other provinces (e.g. Mpumalanga, KwaZulu-Natal, Eastern Cape and Western Cape), tourism nevertheless plays an important role in stimulating accommodation, transport and retail sectors. Of special interest is the Hartbeespoort Dam, a significant hub for various forms of recreation and tourism.

The Mokolo catchment falls within the south western portion of the Limpopo WMA and Limpopo Province. Exxaro's Grootegeluk Colliery is currently the only commercial coal mining operation in the Waterberg Basin. At present the annual production of Grootegeluk coal mine is 15.3 Mt/a. It is the largest open cast coal mine of its kind in the world. The mine is now being expanded to supply the new Medupi Power Station with coal. Additional to Matimba and Medupi three new Eskom power stations CF3, CF4 and CF5 are envisaged for the future.

The Lephalale area has been selected by Sasol to access the vast coal reserves in the Waterberg coal fields for its Maphuta coal to liquid fuel projects (Mafutha) however this is currently on the backburner.

The Steenbokpan area, quaternary catchment A41E in the Matlabas catchment, is part of the Lephalale coalfield and numerous mining developments are foreseen for this region. Current and future developments around the available coal reserves in the Steenbokpan area will require adequate planning for future water needs.

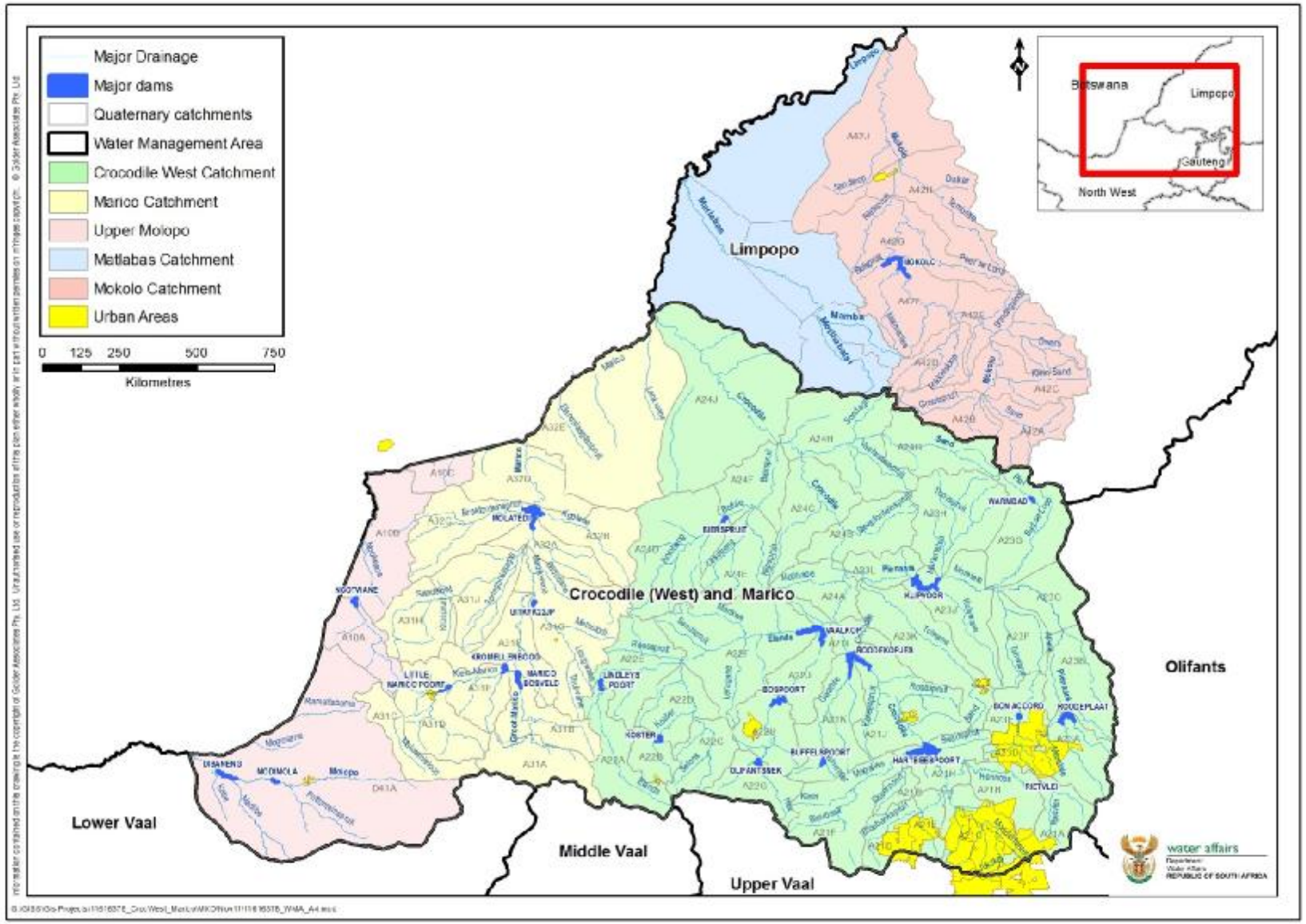

Figure 1: Study area

1.2 THE STUDY PROCESS

To classify a water resource, the WRCS lays out a set of procedures grouped together in 7 steps that when applied to a specific catchment will result in the determination of a MC. The study process has been completed and a set of MCs is now recommended. The DWA will be initiating a study to set the Resource Quality Objectives (RQOs) based on the MCs set. The RQOs and MCs will be gazetted together at the conclusion of the RQO study. This classification study has been primarily of a technical nature and has been guided by stakeholder participation and engagement.

The main components that have been addressed through the study process (Figure 2) include:

- Study scope definition and water resource information and data gathering;
- Definition of the Integrated Units of Analysis (IUAs) and significant water resources;
- Status quo assessment of the WMA (such as assessment of present state water resource quality, identification of water resource issues, determination of the institutional environment, assessment of the socio-economic);
- The application of the WRCS, *i.e.* establishing the MC by integration of the economic, social and ecological goals through a suitable analytical decision-making system (scenario analysis);
- Stakeholder engagement and consultation processes; and
- Recommendation of management classes.

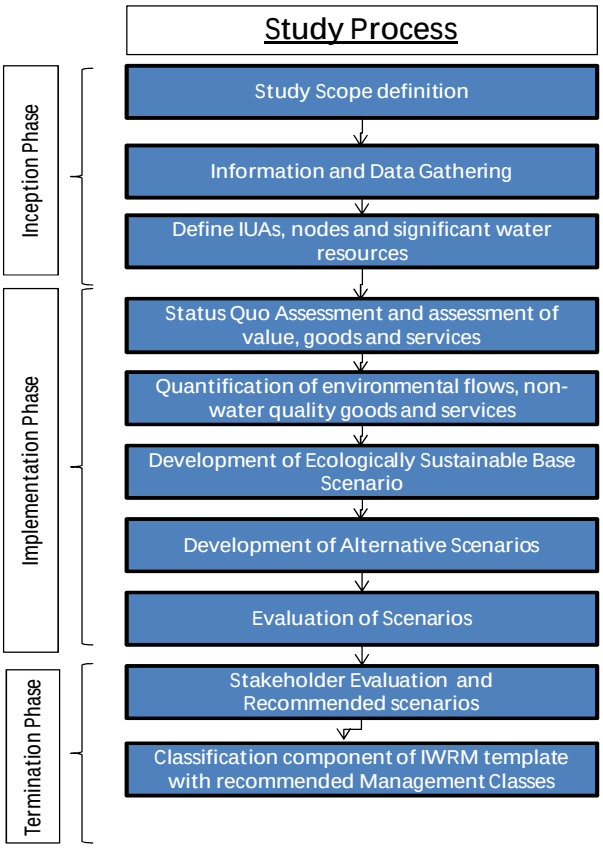

Figure 2: Study process followed for classification of water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments

In terms of the above process, the approach undertaken by the study team for implementation has included the following.

- As part of the inception phase, the IUAs, nodes and significant network of water resources were finalised (July 2012) once confirmed with Project Steering Committee (PSC) members at the second PMC held in February 2012. The feedback obtained was incorporated into IUA delineation (Figure 3).
- The status quo assessment of the WMA, valuation of water resources, and ecological water requirements (EWR) quantification and related flows at each node was completed for the Crocodile West and Marico catchments by November 2012. However, the EWR data for the Matlabas catchment was only finalised in April 2013. The updated Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the water resources were obtained from the recently completed DWA study (DWA, 2012).
- A base scenario with a set of the EWRs based on the present ecological state (PES) at each EWR site was then established. The ecological categories used as the base scenario was based on the 2007 Reserve determination studies conducted for the Crocodile West/Marico and the 2010 Reserve determination for the Mokolo catchment. The water resources yield models (WRYM) for the Crocodile (West), Marico, Mokolo and Matlabas catchments, were set up and run for the ESBC scenario to evaluate the changes in yield that would result with the EWRs for the PES ecological category.This formed the ecologically sustainable base configuration scenario (ESBC).
- The base scenario was then proposed to the PSC in May 2013. This scenario with the proposed ecological categories per IUA was accepted by the PSC members. At the meeting a further three alternate catchment scenarios were confirmed except for the Matlabas catchment where only one additional scenario was proposed. It was proposed that the scenarios be assessed using the Water Resources Planning Model (WRPM) for the Crocodile (West) and Mokolo catchments and not the Water Resources Yield Model (WRYM). The WRYM would still be used for the Marico and Matlabas catchments.
- Depending on the catchment, two three alternate scenarios were subsequently taken forward through the modelling processes and the ecological consequences and economic implications of each were assessed. The ecological assessment of responses to various flow scenarios were based on the approach developed by Louw et al (2004) for application in the Habitat Flow Stressor Response Model. The scenarios were evaluated to determine if they are sustainable, economically viable and meet the requirements of the users in the catchment. The evaluation of the scenario results were reported back to the PMC at a meeting in July 2013.
- The final set of scenarios was evaluated by consultation with the PSC and TTG members during August 2013 and with broader stakeholders at public meetings during October 2013.
- The outcome of this process has resulted in the recommendation of scenarios and proposed MCs for each of the twenty IUAs in the Crocodile West/Marico WMA and Mokolo and Matlabas catchments. These scenarios and associated MCs were based on what is practical and achievable; while at the same time ensuring the water resources of the WMA are not degraded.
- The classification component of the Integrated Water Resources Management (IWRM) summary template with recommended scenarios, proposed classes and supporting information

was completed by December 2013.

- The recommended scenarios and proposed MCs will be submitted to the Minister for consideration. The final proposed MCs together with the established Resource Quality Objectives (RQOs) for the Crocodile West/Marico WMA and Mokolo and Matlabas catchments will be gazetted together when both processes have been completed. The gazetting process includes a 60 day public comment period.

- Based on the scenario evaluation and consultation with the stakeholders, it was recommended that the go forward options are the following scenarios:

    - Crocodile West catchment: scenarios which supply the PES ecological category, which in the context of the Crocodile West catchment is equal to the REC ecological category, and meet the future growth in water requirements (2030) in the WMA;

    - Marico catchment: the scenario in the Klein Marico is the REC with present water use (2030); the scenario in the Groot Marico is the REC with present water use (2015);

    - Mokolo catchment: PES with future water use (2030); and

    - Matlabas, Molopo and Ngotwane: the ESBC is to be maintained

- The IUA MCs associated with these scenarios are presented in this report. The approach applied to determining the proposed MCs for each of the IUAs was to follow the guidelines of the WRCS (DWA, 2007).

- The recommended scenarios and proposed MCs will be submitted to the Minister for consideration. The final proposed MCs together with the established Resource Quality Objectives (RQOs) for the Crocodile (West), Marico, Mokolo and Matlabas catchments will be gazetted together at the end of the RQO study. This will include a 60 day public comment period.

The above has been conducted in terms of the prescribed steps of the WRCS as outlined in the DWA guidelines (DWA, 2007) as best suited to circumstances and conditions that prevailed.

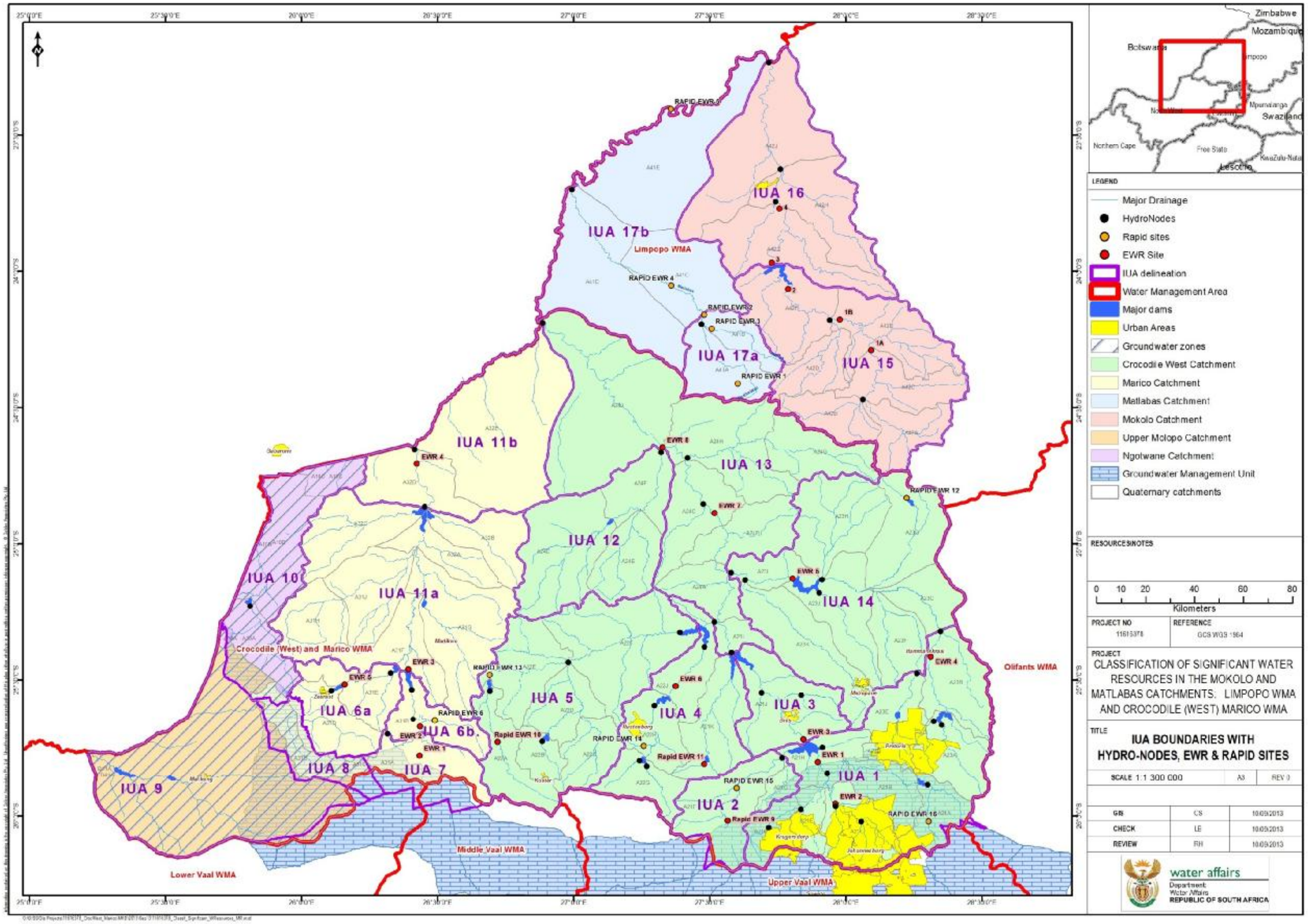

Figure 3 : Integrated Units of Analysis, hydro nodes and EWR sites within Crocodile (West), Marico, Mokolo and Matlabas catchments

1.3 PURPOSE OF THE REPORT

The purpose of this report is to present and describe the rationale for the proposed MCs for the identified IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments based on the outcomes of the scenario evaluation process and recommendations (DWA, 2012a).

The proposed MCs or class configurations form the final deliverable of the study, the class configuration. The MCs presented in this report will be incorporated into the classification component of the Integrated Water Resource Management (IWRM) template for the Crocodile (West), Marico, Mokolo and Matlabas catchments which will be presented to the Minister for consideration.

The NFEPA and PES study as well as stakeholders identified specific river systems within an IUA as being environmentally important and sensitive. These systems require a higher level of protection than the overall MC set for the IUA. Nodes have been established for these river reaches for which RQOs need to be set to afford the required level of protection for these systems.

2 APPROACH TO DETERMINATION OF MANAGEMENT CLASSES IN THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS

The determination of a management class for a water resource represents the first stage in the water resource protection process. The MC essentially describes the desired condition of the resource, along with the degree to which it can be utilised. In terms of the WRCS, the MCs will range from minimally used to heavily used.

Regulation 810 (Government Gazette No. 33541, September 2010) that establishes the WRCS defines three water resource MCs:

- ***Class I*** - minimally used and configuration of ecological categories of that water resource minimally altered from its pre-development condition;
- ***Class II*** - moderately used and configuration of ecological categories of that water resource moderately altered from its pre-development condition; and
- ***Class III*** - heavily used and configuration of ecological categories of that water resource significantly altered from its pre-development condition.

The implementation of the WRCS, in the Crocodile (West), Marico, Mokolo and Matlabas catchments, has to this point presented recommended scenarios specifying an ecological condition per IUA (ecological categories based on the scenario analysis and evaluation). The final step requires the summarising of this data into an IUA Class.

The WRCS guidelines (DWA, 2007) states "*To ensure consistency, summarising these data into an IUA Class will eventually need to be governed by a set of agreed guidelines. It is recommended that the nature and content of these guidelines be developed through implementation of the WRCS, as it is important to have a clear understanding of all their implications before finalisation. To assist with the development of the guidelines, a preliminary set of guidelines has been developed.*"

The WRCS guidelines recommend that the MC be determined based on the ecological categories (ECs) of the biophysical nodes in an IUA. Among other methods, the guidelines recommend the application of Table 2 below, where the percentage of biophysical hydro-nodes falling into the indicated EC groups determines the IUA's MC.

Table 2: Preliminary guidelines for determining the IUA class for a scenario

		Percentage (%) nodes in the IUA falling into the indicated groups				
		A or A/B	B or B/C	C or C/D	D	>D
Class I		60	40	20	1	-
Class II			60	30	5	-
Class III	Either			70	20	-
	Or				100	-

In order to apply the preliminary guidelines of the WRCS (Table 2) to arrive at a MC, the desired ecological conditions of the water resources in the WMA need to be determined within the context of the integrated water resource management dynamics in the catchment. Various configurations of ecological condition, socio-economics, water resource availability and water quality were therefore assessed by the scenario evaluation task of the study (DWA, 2012a). Results for this are being collated.

The recommended scenarios are associated with an ecological condition (ECs at each node) for the water resources and this is translated into the MC for the IUA.

Based on Table 2, the PES EC representations for each node within an IUA (Figure 4) are summarised into a MC for the IUAs within the Crocodile (West), Marico, Mokolo and Matlabas catchments. This is presented in Section 3 of the report. The EC and MC that is presented for the IUAs is associated with the implications summarised above.

To broadly interpret the preliminary guidelines indicated above, the link between ecological categories and the MCs may be defined as follows:

- Class I – Mostly B ecological category water resources and higher;
- Class II - Mostly C ecological category water resources; and
- Class III - Mostly D ecological category water resources.

The MC categorisation for the Crocodile West/Marico WMA and Mokolo and Matlabas catchment IUAs is based largely on the ecological condition of the main stem rivers and major tributaries. Where the EC of a sub-node in a tributary catchment is different to the overall IUA MC (Figure 5), this ecological category is accounted for by the implementation of the required ecological flows at the sub-node. Based on the specific ecological configuration, the management objectives within an IUA may also differ.

This report presents the set of ecological categories (% distribution of biophysical nodes) that define the MC per IUA. A MC for an IUA will guide water resource management and its planning.

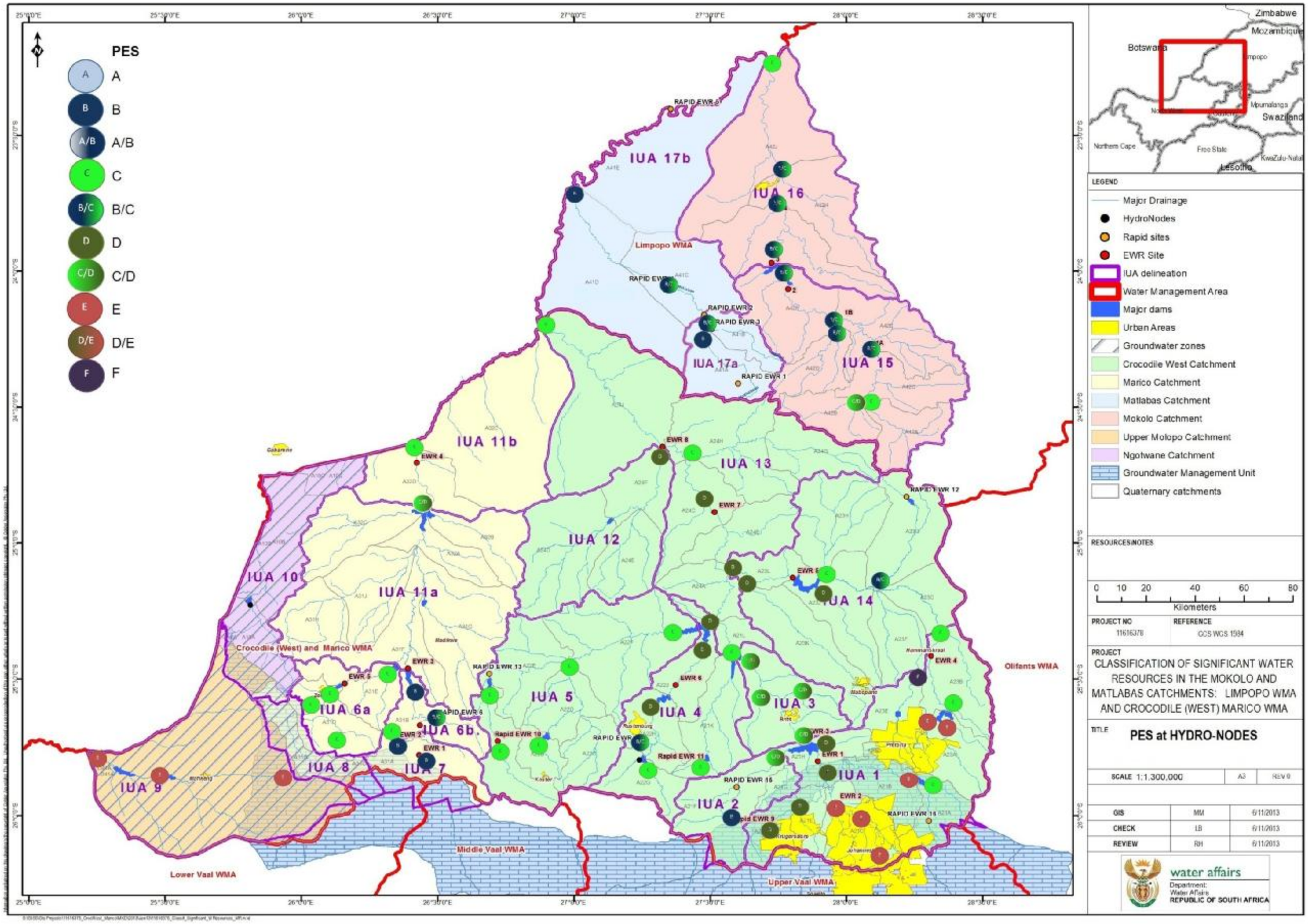

Figure 4: PES ecological category of the selected hydro nodes within the Crocodile (West), Marico, Mokolo and Matlabas catchments

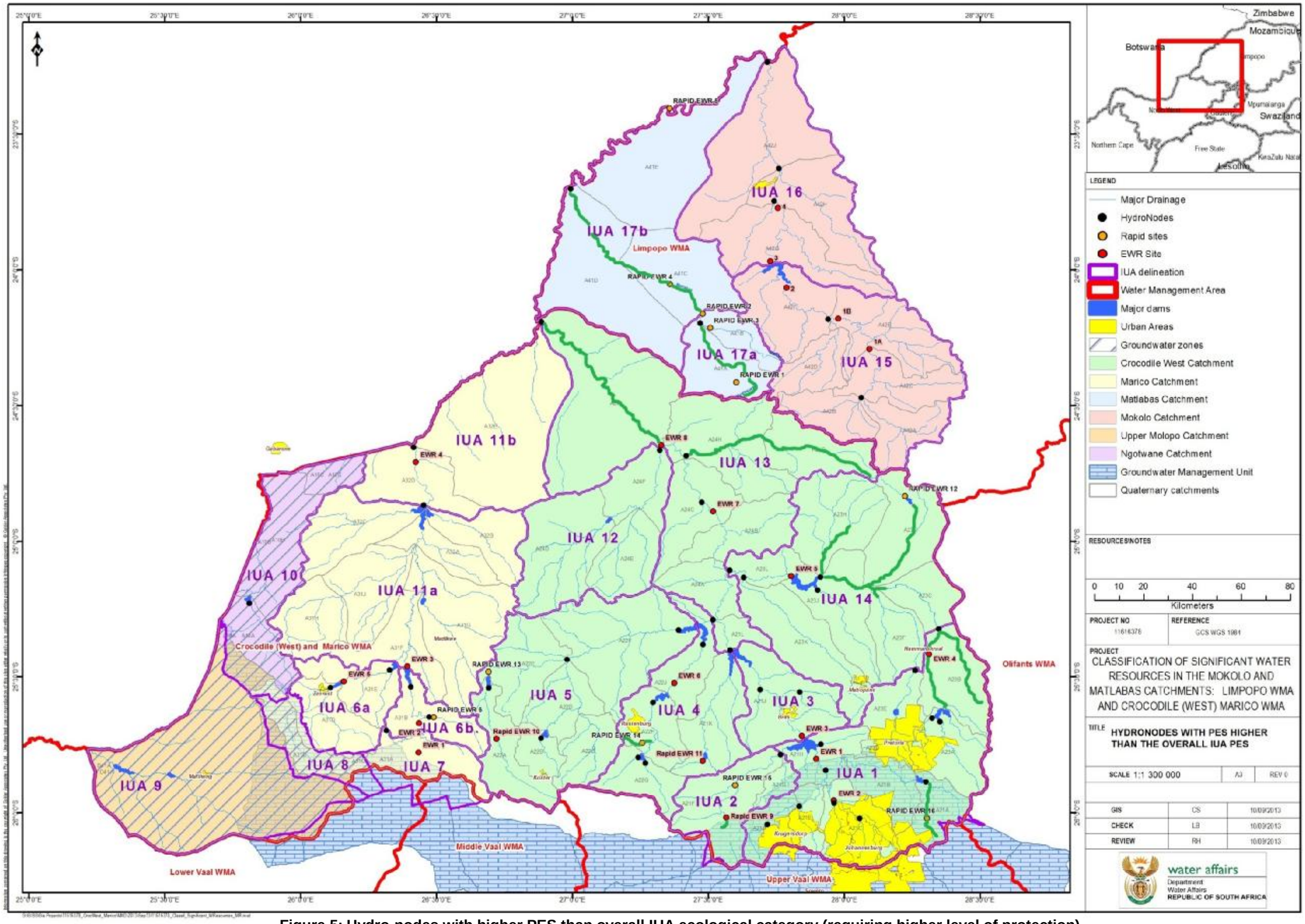

Figure 5: Hydro-nodes with higher PES than overall IUA ecological category (requiring higher level of protection)

3 MANAGEMENT CLASSES OF THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS

3.1 OVERVIEW

The establishment of MCs for the significant water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments and its implementation in the near future will set the framework for the level of water resource protection, and conversely, the degree to which the water resources can be utilised. The MCs will form the basis for management strategy development and direct water resource management and its planning. By the establishment of MCs for the water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments as per the scenario configurations, the following objectives are achieved:

- Implementation of a certain protection level of water requirements for the ecology (river health) (maintenance or improvement of present status);
- Protection of identified tributaries and conservation areas;
- Maintenance of the main stem Crocodile, Marico, Matlabas and Mokolo rivers (and larger tributaries) in a sustainable condition, while supporting the developmental needs of the catchments; and
- Provision of water requirements for future socio-economic growth.

In all three MCs, aquatic ecosystem conditions (or Resource Quality Objectives) need to be set to ensure that the MC is maintained into the future. These conditions depend on water flow characteristics, water quality characteristics and terrestrial conditions. Generally speaking, MC III IUAs are characterised by heavy water use and maximum utilisation of the allocatable water quality, whereas Class I IUAs are characterised by very low water use and minimum utilisation of the allocatable water quality. During the WRCS process, several scenarios were developed which envisaged different permutations of MCs for the IUAs. Some of the scenarios envisaged heavier use characteristics (*i.e.* more Class III IUAs) and others envisage lesser use characteristics (*i.e.* more Class II IUAs).

Based on the scenario evaluation process in the study area, the MC permutations for each IUA that are being recommended are those scenarios which supply the PES ecological categories and meet the future growth in water requirements in the WMA. It is proposed as the outcome of the WRCS process that the PES ecological water requirements (maintenance low and drought flows only) must be met at the EWR sites and selected nodes within the IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments. Please refer to other deliverables of this WRC study for detailed information on the scenario evaluation process (DWA, 2012).

IUAs 1 and 9 in the Crocodile (West), Marico, Mokolo and Matlabas catchments are currently in a state worse than a Class III. This is not ecologically sustainable, is unacceptable and needs to be corrected.

3.2 INTEGRATED UNITS OF ANALYSIS

Twenty IUAs were defined for the Crocodile (West), Marico, Mokolo and Matlabas catchments (Figure 3). The process followed in terms of IUA delineation is described in the WRCS

Guidelines, Volumes 1 and 2 (Overview and the 7-step classification procedure; and Ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, February 2007b). The IUAs delineated in this study are indicated in Table 3.

Table 3: Catchment areas of the thirteen IUAs defined for the Crocodile (West), Marico, Mokolo and Matlabas catchments

IUA ID No.	Main river system/proposed IUA name	Quaternary catchments
1	Upper Crocodile/Hennops/Hartebeespoort	A21A, A21B, A21C, A21D, A21E, A21H, A23A, A23B,A23D, A23E
2	Magalies	A21F, A21G
3	Crocodile/Roodekopjes	A21J
4	Hex/Waterkloofspruit/Vaalkop	A21K, A22G, A22H, A22J
5	Elands/Vaalkop	A22A, A22B, A22C, A22D, A22E, A22F
6a	Klein Marico	A31D, A31E
6b	Groot Marico	A31B
7	Kaaloog-se-Loop	A31A
8	Malmaniesloop	A31C
9	Molopo	D41A
10	Dinokana Eye/Ngotwane Dam	A10A
11a	Groot Marico/Molatedi Dam	A31F, A31G, A31H, A31J, A32A, A32B, A32C, A10B
11b	Groot Marico/seasonal tributaries	A10C, A32D, A32E
12	Bierspruit	A24D, A24E, A24F
13	Lower Crocodile	A21L, A24A, A24B, A24C, A24G, A24H, A24J
14	Tolwane/Kulwane/Moretele/Klipvoor	A23C, A23F, A23G, A23H, A23J, A23K, A23L
15	Upper Mokolo	A42A, A42B, A42C, A42D, A42E, A42F
16	Lower Mokolo	A42G, A42H, A42J
17a	Mothlabatsi/Mamba	A41A, A41B
17b	Matlabas	A41C, A41D, A41E

3.3 ECONOMIC DEVELOPMENT AND WATER USE

The development of the Crocodile (West), Marico, Mokolo and Matlabas catchments economy is to a large extent, dependent upon the agricultural and mining sectors. South Africa's National Development Plan identifies South Africa's mineral wealth as a key driver of economic development and also identifies the agriculture sector as the key sector for developing an inclusive rural economy. Both these sectors, and their respective value chains, are dependent on water as an input into production.

Economic activity across the study area is diverse. The Upper Crocodile sub-catchment (A21) and the urban areas of the Pienaars sub-catchment (A23) comprise a well-developed manufacturing and general commercial urban economy. Rustenburg in the Elands River sub-catchment (A22) is well known for its extensive platinum mining activities. The rural parts of the Pienaars River sub-catchment (A23); the Lower Crocodile River (A24); and the Groot Marico (A3) economies are dominated by agriculture and eco-tourism activities.

Mining operations in the Crocodile (West) Marico WMA is dominated by platinum and the platinum group metals (PGM), gold, chrome, manganese, iron ore, diamonds, dimension stone and mineral sands, as well as smaller quantities of vanadium, limestone and andalusite. The entire western section of the mineral-rich Bushveld Igneous Complex is situated here, resulting in intense mining activity in that region. Coal mining occurs in the Mokolo catchment.

Irrigation occurs mostly in the Crocodile catchment, immediately downstream of the Hartbeespoort Dam and also further downstream towards the south of Thabazimbi. Irrigation is done at Mmabatho with water sourced from the Grootfontein dolomitic compartments. Dry land crops, mostly maize, are grown in the higher rainfall south and southeastern parts of the WMA. Stock and game farming dominate land-use in the drier northern and western regions.

There are several heavy industry firms in the study area. These include Pelindaba and Valindaba (direct abstractions from the Crocodile River upstream of Hartbeespoort Dam), and the Dwaalboom cement factory at Thabazimbi (supplied by Magalies Water from the Vaalkop Dam). Three relatively small power stations, Rooiwal, Pretoria West and Kelvin, are present in the Crocodile (West) Marico WMA.

Although the study area is not as renowned for its tourism activities as other provinces (e.g. Mpumalanga, KZN, Eastern Cape and Western Cape), tourism nevertheless plays an important role in stimulating accommodation, transport and retail sectors. Of special interest is the Hartbeespoort Dam, a significant hub for various forms of recreation and tourism.

The lower Marico, as well as the Upper Molopo and Ngotwane catchments are considered the poorest of all catchments within the Marico catchment. The economy is characterised by the primary sectors of agriculture on the dolomites of the Upper Molopo and the Marico catchment as well as mining around Zeerust, with some secondary industries such as cement manufacturing at Slurry. The tourism sector is growing, particularly in the lower Marico in the vicinity of Madikwe Game Reserve.

The economy of both the Matlabas and the Mokolo is characterised by the agricultural sector. Power generation is an important sector in the Mokolo catchment with the Matimba and Medupi (under construction) power stations found here. Three new Eskom power stations CF3, CF4 and CF5 are envisaged for the future. Coal mining in support of power generation activities is also an important sector, and both catchments have been earmarked for future coal mining developments.

3.4 TOURISM ECONOMY

While not as developed as other WMAs, the tourism economy of the study area is an important contributor to regional GDP (GDP-R). Of particular importance to the study area are the Cradle of Humankind World Heritage Site, The Marakele National Park, the area containing the dolomitic eyes in the upper Marico catchment and the Hartebeespoort Dam and surrounds.

Hunting is also an important sector, with large portions of land in the Mokolo catchment and the lower Crocodile River Catchment associated with hunting activities.

3.5 WATER USE IN THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS

3.5.1 Crocodile (West) River Catchment

The Crocodile (West) catchment is one of the most developed catchments in the country. The catchment is characterised by the sprawling urban and industrial areas of northern Johannesburg and Pretoria, extensive irrigation downstream of Hartbeespoort Dam and large mining developments north of the Magaliesberg.

Due to the extensive developments and high level of human activity in the catchment, water use in the catchment exceeds the water available from the local sources. Most of the water used in the catchment is therefore supplied from the Vaal River system via Rand Water, mainly to serve the metropolitan areas and some mining developments. This results in large quantities of effluent from urban and industrial users, most of which is discharged to the river system after treatment, for re-use downstream. In many of the streams and impoundments, water quality is severely compromised by the proportionate large return flows.

The water requirement values for the Crocodile West Catchment are taken from the Crocodile (West) River Reconciliation Strategy (DWA 2008) and are based on four growth scenarios (Table 4):

1. Scenario D High: medium water demand management efficiency, high population growth
2. Scenario D Base: medium water demand management efficiency, base population growth
3. Scenario D Low: medium water demand management efficiency, low population growth
4. Scenario C High: high water demand management efficiency, high population growth

Table 4: Summary of water requirements (units: million m^3)

Scenario	2005	2010	2015	2020	2025	2030
D: High	1 121	1 191	1 276	1 355	1 409	1 480
D: Base	1 112	1 170	1 237	1 299	1 344	1 404
D: Low	1 110	1 147	1 190	1 221	1 232	1 255
C: High	1 121	1 196	1 228	1 275	1 308	1 376

The Crocodile (West) catchment contains the largest urban centres in South Africa. Of particular importance are:

- The north, north east and north-west portions of the Johannesburg metropole in the upper Crocodile River Catchment;
- The Midrand area also in the upper Crocodile River Catchment;

- Tshwane Municipality including the city of Pretoria, mainly in the Pienaars River catchment; and
- The Rustenburg area in the Elands River Catchment.

The total urban water requirements (as per the four growth scenarios listed above) are given in Table 5.

Table 5: Urban water requirements (units: million m^3)

Scenario	2005	2010	2015	2020	2025	2030
D: High	579	604	673	736	790	850
D: Base	570	586	640	689	733	782
D: Low	568	565	597	615	626	638
C: High	579	609	626	657	688	746

Population projections were estimated (Table 6) for the rural areas of the Crocodile River catchment for high, base and low growth scenarios (DWA 2008).

Table 6: Rural population projections 2005-2015 (Source: DWA 2008)

Population Growth	2005	2010	2015
High	1 029 640	1 062 190	1 092 439
Base	1 021 543	1 043 424	1 039 056
Low	1 013 493	1 024 953	1 010 518

Taking these population projections into consideration, rural water requirements (Table 7) were calculated based on stepped per capita water requirements. The increase in per capita rural water requirements to 2010 is in line with commitment of DWA to increase the minimum level of water supplied to at least 50//capita/day to clear the sanitation backlog and eradicate the bucket system (DWA 2008).

Table 7: Rural water requirements (units: million m^3)

Population Growth	2005	2010	2015
High	15	23	23
Base	15	23	22
Low	15	22	22

Irrigation is the single largest water user in the Crocodile River catchment using approximately 375,5 m^3/annum (DWA 2008). According to DWA (2008) Irrigation areas and irrigation water requirements are expected to remain constant between 2005 and 2030. Distribution losses are a major concern in the study area and in some areas are estimated as high as 50%.

The irrigation water requirements, the estimated irrigation area, distribution losses and irrigation return flows are summarised per sub-area in Table 8.

Table 8: Irrigation water requirements (units: million m^3)

Sub catchment	Irrigation Area	Irrigation Requirement	Distribution losses	Total Irrigation Requirement		Irrigation Return Flows
				Volume	1:50 assurance	
Unit	ha	million m^3/annum				million m^3/a
Upper Crocodile	20 260	115	57	172	147	11
Elands	1 514	8	2	10	8	1
Apies-Pienaar	6 164	32	3	36	30	3
Lower Crocodile	28 036	153	76	229	191	15
Total	55 974	308	138	447	376	30

The mining sector is an important contributor to GDP-R in the study area. Of particular importance is the large number of platinum deposits in the Elands sub-catchment, which are the largest PGM deposits in the world.

The total mining water requirements for the Crocodile River catchment are summarised in Table 9. The Reconciliation Strategy identified three scenarios: high, base and low (DWA 2008).

Table 9: Mining water requirements (units: million m^3)

Scenario	2005	2010	2015	2020	2025	2030
High	92	129	145	152	152	151
Base	92	126	139	144	145	145
Low	92	124	136	142	142	142

There are three power stations in the Crocodile River catchment: Kelvin in the Upper Crocodile sub-catchment and Pretoria-West and Rooiwal in the Apies-Pienaars sub- catchment. The water requirements of the Kelvin, Pretoria-West and Rooiwal power stations are 11 million m^3/annum, 6 million m^3/annum and 17 million m^3/annum respectively.

The water requirements for stock watering occur throughout the catchment and the total water requirements are 22 million m^3/annum (DWA 2008).

3.5.2 Marico River Catchment (Including the Upper Molopo and Ngotwane Catchments)

The Marico, Upper Molopo and Upper Ngotwane catchments are part of the Crocodile (West) and Marico WMA. The economy is mainly the primary sectors of agriculture on the dolomites of the Upper Molopo and the Marico catchment as well as mining around Zeerust, with some secondary industries such as cement manufacturing at Slurry.

Water requirement data is sourced from the ISP for Marico, Upper Molopo and Upper Ngotwane Catchments (DWAF 2004a).

The main water user sectors in the three catchments are:

- Commercial irrigation farming in all three catchments;
- Urban water use in the main towns of Mafikeng, Zeerust, Groot Marico and Itsoseng; and
- Rural domestic water use.

The major water user in the Marico is irrigation (at 32 million m^3/a) along the Groot Marico River and the Klein Marico as well as downstream of Marico Bosveld and Klein Maricopoort. This is followed by rural water use of 12 million m^3/a.

In the Upper Molopo sub-area irrigation and urban water use are the major water users utilising 24 million m^3/a, and 13 million m^3/a respectively. The sources of supply are the dolomitic aquifers of the Grootfontein compartment and Molopo springs.

Irrigated agriculture is the dominant water user in the Upper Ngotwane sub- area (5 million m^3/a) followed by rural water use of approximately 3 million m^3/a.

The total water requirements for the Marico, Upper Molopo and Ngotwana catchments for different users are given in Table 10 (DWAF 2004b).

Table 10: Total water requirements for the Upper Molopo and Ngotwane catchments

Sub Area	Irrigation	Urban	Rural	Mining & Bulk Industry	Transfers Out	Total
Marico	32	9	12	5	7	65
Upper Molopo	24	13	6	5	0	48
Upper Ngotwane	5	2	3	0	0	10

3.5.3 Mokolo and Matlabas catchments

Both the Mokolo and Matlabas catchments are part of the Limpopo WMA, which is a semi-arid region, with economic activity centred on livestock farming, irrigation and future mining developments.

The Matlabas catchment is a dry catchment with non-perennial flow and therefore limited sustainable yield form surface water. The limited water use in the catchment is from groundwater, which is under exploited (DWAF 2004c). According to the Limpopo ISP (DWA 2004c) there are no major water resources or water supply issues within the catchment.

In terms of a water resource point of view, the Mokolo catchment is well-developed. The Mokolo Dam is situated in the catchment and provides water to a number of users including the Matimba Power Station and the Grootgeluk coal mine.

Irrigation is the largest water user in the Matlabas catchment with an approximate requirement of 4 million m^3/a of which 2 million m^3/a is sourced from groundwater sources and 2 million m^3/a is sourced from surface water resources.

Irrigation, is the largest user in the Mokolo catchment, takes place mostly upstream of the Mokolo Dam, with water sourced from farm dams and run-of-river. There is an allocation of 10,4 million m^3/a (at 70% assurance) from the Mokolo Dam to irrigators downstream of the dam. Other allocations from the dam are 9,9 million m^3/a to the Grootgeluk mine and 7,3 million m^3/a to the Matimba power station. The towns of Lephalale and Vaalwater constitute the urban requirements in the catchment (DWAF 2004c).

The water requirements for the Matlabas and Mokolo catchments are given in Table 11 (DWAF 2004c).

Table 11: Water requirements in the Matlabas and Mokolo catchments (at 1:50 year assurance) in the year 2003 (units: million m^3)

Catchment	Irrigation	Urban	Rural	Mining	Power Generation	Transfers Out	Total
Matlabas	4	0	2	0	0	0	6
Mokolo	68	2	2	4	7	0	83

The DWA Olifants Reconciliation Strategy Report (2011) summarises future water use for 2016 and 2035. Future demand for irrigation, power generation and heavy industrial use are expected to remain stable. Urban and Rural water requirements are expected to grow with population growth and improved service level. The largest increase in water requirements is expected within the mining sector, and especially the PGM mining sector.

3.6 ECOSYSTEM SERVICES

Ecosystem services collectively refer to environmental goods and services. Ecosystem services are the benefits provided to both households and firms by ecosystems. These services include provisioning services (including the production of fresh water, foods, fuels, fibres and biochemical and pharmaceutical products), cultural services (including non-consumptive uses of the ecosystem for recreation, amenity, spiritual renewal, aesthetic value and education) and regulating services (including the absorption of pollutants, storm buffering, erosion control and the like). The estimation of the value of aquatic ecosystem services is done through environmental and resource economics (ERE) studies which seek to value the stream of benefits delivered by the set of ecosystem services associated with an ecosystem. An estimation of the value of ecosystem services produced by the water resources of the Crocodile (West), Marico, Mokolo and Matlabas catchments was undertaken through the Classification study (DWA, 2012b).

The water resources (rivers and wetlands) in the Crocodile (West), Marico, Mokolo and Matlabas catchments provide a variety of provisioning, regulating and cultural ecosystem services *viz*. domestic water use, grazing, livestock watering, harvested products, carbon sequestration, tourism, recreation, aesthetic value, education, flood attenuation and angling (DWA, 2012b).

The results of the scenario evaluation process indicate:

- Crocodile (West) catchment: with the preferred scenario implemented the economy grows and there is no net loss of river and wetland ecosystem services;
- Marico catchment: with the preferred scenario implemented the water economy stays stable and there is no net loss of river and wetland ecosystem services;
- Mokolo catchment: with the preferred scenario implemented the water economy grows significantly however there may be some negative impact on ecosystem services; and
- Matlabas catchment: with the preferred scenario implemented there will be no change in economic results and ecosystem services.

4 MANAGEMENT CLASSES

4.1 MANAGEMENT CLASS IUA 1: UPPER ROCODILE/HENNOPS/HARTBEESPOORT

IUA Description

IUA 1 contains the Metropolitan Municipalities of Tshwane (full), Johannesburg (part) and Ekurhuleni (part) and the town of Krugersdorp. The IUA constitutes a large portion of South Africa's commercial, financial, industrial and manufacturing sectors and is an important contributor to National GDP. The population of IUA is 4 660 835 (Census, 2011).

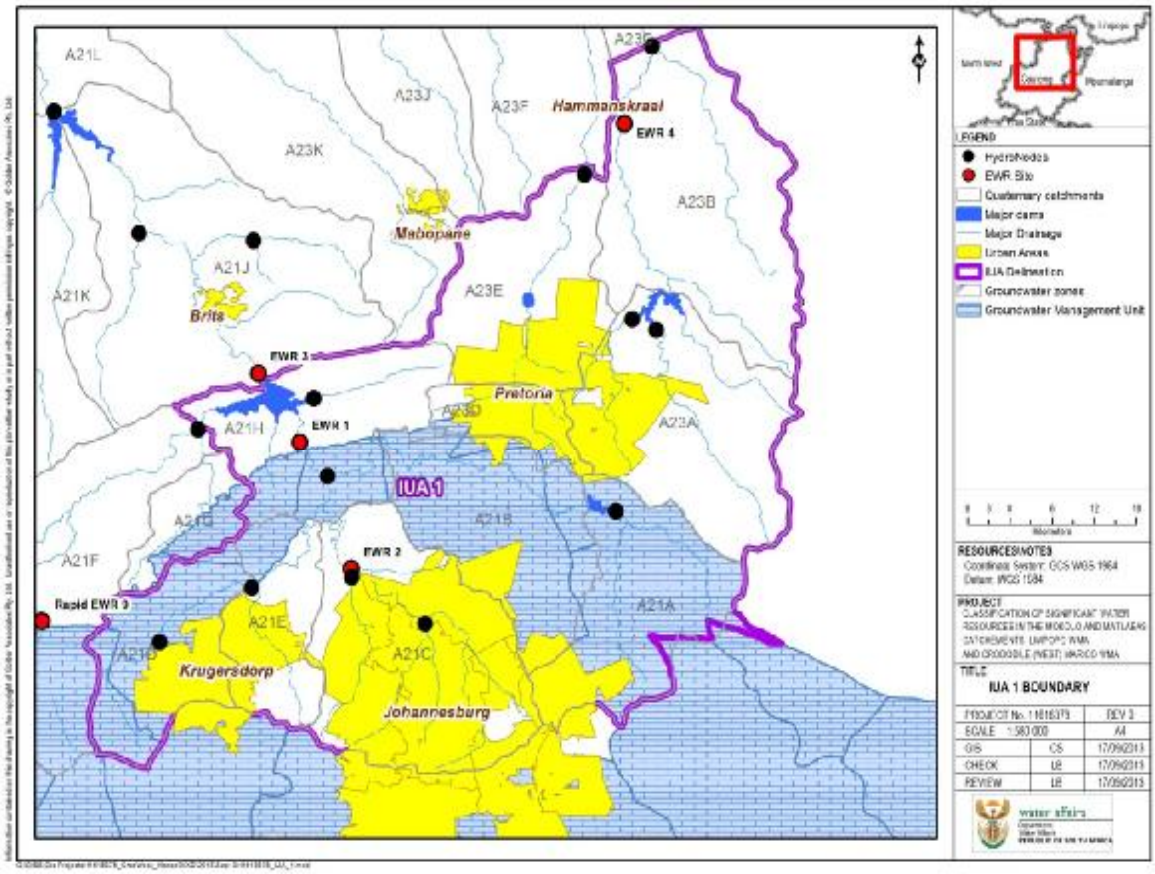

Figure 6: IUA1 Upper Crocodile/Hennops/Hartbeespoort

Groundwater use

The current groundwater use in this IUA is estimated at 75.3 Mm^3/a. Based on the groundwater categorisation, it is categorised as follows (Table 12).

Table 12: IUA 1 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	Groundwater use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 1	5823	212.736	75.300	35%	**II**	**II**	**I**

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 13. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 13: IUA 1 Upper Crocodile/Hennops/Hartbeespoort: Summary of Eco-classification and EWR

IUA	No	Quat	Hydro node	EI	ES	PES	REC	Default REC [1]	Natural *MAR (mcm/a)	EWR as % of natural MAR [2]	Recommended Class
1	HN1	A21A	**Rietspruit (source) to Rietvlei Dam (CROC_EWR16)**	Low	Low	**C**	**C**	**D**	**4.79**	**27.83**	**III**
	HN2	A21B	**Sesmylspruit with its' tributaries to confluence with Hennops**	Mod	Mod	**E**		**C**	**-**	**-**	
	HN3	A21C	**Modderfonteinspruit to confluence with Jukskei**	Mod	Mod	**E**	**D**	**C**			
	HN4		**Klein Jukskei at confluence with Jukske**	Mod	Mod	**E**	**D**	**C**	**34.4**	**29.19**	
	HN5		**Jukskei River at CROC_ EWR2**	Mod	Mod	**E**	**D**	**C**			
	HN6	A21D	**Bloubankspruit and tributaries (outlet of quaternary/confluence with Crocodile)**	Mod	Mod	**D**		**C**	**-**	**-**	
	HN7	A21A, B, H	**Hennops (source) to confluence with Crocodile**	Mod	Mod	**D**		**C**	**-**	**-**	
	HN8	A21H	**Swartspruit to Hartbeespoort Dam**	Mod	Mod	**D**		**C**			
	HN9	A21E, H									
	HN10	A21H, J	**Crocodile (source) to CROC_EWR1**	Mod	Mod	**D**	**D**	**C**	**87.8**	**24.07**	
			Crocodile at Hartbeespoort Dam, outlet of IUA1	High	High	**C/D**		**B**	**-**	**-**	
	HN11	A23A	**Pienaars(source) and including Moreletaspruit and Edendalespruit to outlet of Roodeplaat Dam**	Low	Low	**E**		**D**	**-**	**-**	
	HN12	A23B	**Pienaars from Roodeplaat Dam to outlet of quaternary catchment (outlet of IUA1) (CROC_EWR4)**	High	High	**C**	**C**	**B**	**28.2**	**20.98**	
	HN13	A23B	**Boekenhoutspruit to confluence with Pienaars**	High	High	**C**		**B**	**-**	**-**	
	HN14	A23D	**Skinnerspruit (source) to confluence with Apies**	Low	Low	**E**		**D**	**-**	**-**	
	HN15	A23D, E	**Apies (source) to Bon Accord Dam, below the dam at outlet of IUA1**	Low	Low	**F**		**D**			

***MAR: Mean Annual Run-off; [1] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update**

[2] Based on EWR for maintenance and drought flows only

Rivers: Bloubankspruit, Hennops, Crocodile

Water resources presently in a D category due to urbanization, return flows (increased flows) and poor water quality. However *Barbus rappax* is still present in the system. Rietvlei Dam is situated *in the upper reaches of the Hennops River.*

Rivers: Modderfontein, Sandspruit, Jukskei

Water resources presently in an E category due to urbanization, industrialization, return flows (increased flows) and poor water quality.

Rivers: Apies, Pienaars, Moreletta, Bloubankspruit

The upper parts of the catchment are impacted by urbanization, irrigation in some areas; water treatment works releases and increased flows. Roodeplaat Dam on the Pienaars and Bon Accord Dam on the Apies contribute to changes in the flow regime. The present state of the Pienaars River downstream of Roodeplaat Dam is in a C category and the EIS is high. This reach of the river provides for the colonization of several fish species no longer found in other tributaries and the system is important for fish movement, especially with Roodeplaat Dam upstream and Klipvoor Dam downstream. No EWR site is situated on the Apies River.

The Tweelopiespruit flows into the Bloubankspruit and forms part of the Krugersdorp Game Reserve and the Cradle of Humankind World Heritage Site.

The EWR sites are:

- Intermediate on Crocodile: Upstream of the Hartbeespoort Dam - EWR 1 (A21H);
- Intermediate on Jukskei: Heron Bridge School - EWR 2 (A21C);
- Intermediate on Pienaars: Downstream of Roodeplaat Dam - EWR 4 (A23B); and
- Rapid III upstream Rietvlei Dam – EWR16 (A21A)

Wetlands

Based on the current conditions, an understanding of the geomorphology, drainage patterns, and soils in the remaining relatively undisturbed open space areas of this IUA, five wetland types are encountered, namely pans, hillslope seepage wetlands, unchannelled valley bottom wetlands, channelled valley bottom wetlands and floodplains. Large parts of this IUA have been converted from grasslands to accommodate industrial and housing estates. This has taken place at the expense of grasslands and their associated hillslope seepage wetlands and secondarily on previously unchannelled valley bottom wetlands. Many historically unchannelled valley bottom systems have become channelled as a result of post-development changes in

hydrology. Increased surface runoff as a result of the development of the catchments of many of these systems has resulted in erosion and the development of headcuts and channelling in most of these systems in the urban environment.

Pans are also fairly well represented in the IUA, mainly towards the south-east with approximately 24 occurring between Midrand and Kempton Park. Pans are recognized as being important for biodiversity support and more recently their links to other wetland systems in relation to landscape hydrology have also been highlighted. Pans are also unique in terms of their individual biogeochemical attributes. The pans in the Midrand and Kempton Park area are considered important, mainly from a biodiversity perspective as they support related bird and amphibian populations. Those that still have some of their catchments intact or that still have associated hillslope seepage wetlands such as Bullfrog pan in Glen Austin are thought to support some of the last remaining populations of the Giant bullfrog (Pyxicephalus adspersus) on the Highveld. The remaining pans and their associated hillslope seepage wetlands are thus regarded as critical habitat for these populations. The wetlands including the pans in this area are all threatened by impacts from urbanization. Wetland habitat loss continues as urbanization expands and the hydrology of the related systems and catchments change due largely to stormwater management or lack thereof.

While the pans only occupy less than 1% of the area of wetlands, they have been recognised as being of high conservation value (EIS of all the systems are expected to be High to Very High) and as such the pan basins and their contributing catchment should be excluded from development in order to try to protect the remaining systems.

The Rietvlei wetland system is situated immediately upstream of the Rietvlei Dam within the Rietvlei Dam Nature Reserve. The wetland is a peatland. Peatlands are defined as peat-accumulating fresh water wetlands which develop in areas where there is a net surplus of water with an accreting substrate comprising a high percentage of undecomposed organic plant material (usually with more than 20 - 35% organic matter on a dry weight basis - Mitsch and Gosselink, 1986).

The dam has provided Pretoria with drinking water since 1934, producing approximately 41 million litres per day, or 3% of the city's current requirement. Historically the Rietvlei wetlands were heavily eroded and desiccated, having been drained for cultivation and peat mining before the area was proclaimed a nature reserve. In recent years, the dam has become overloaded with nutrients and other pollutants, as its highly urbanized catchment has received increasing volumes of treated domestic sewage and industrial effluent. Partly in response to this situation, and recognising that the wetlands were degraded, Working for Wetlands (WfW) formed a partnership with the Tshwane municipality in 2000 to rehabilitate the wetlands upstream of the dam. The primary objective was to try to improve their ability to treat the water flowing into the dam. Interventions included gabion, concrete and earthen structures to control erosion, re-wet the organic soils, increase retention time of water and ensure even distribution of flow across the wetland. Monitoring results tend to show that there has been some improvement of the quality of water flowing into the dam since the rehabilitation was implemented (Masupa,

Makhado, Coetzee and Marais, WfW Gumboot Newsletter, 2008) and that the rehabilitation interventions have has resulted in the re-establishment of reeds throughout the wetland (WfW website).

Another important wetland that occurs within the urban setting in this IUA is the Colbyn Valley wetland. It is approximately 15 ha in extent and is situated on shales of the Silverton Formation. The key point of the wetland is the quartzite ridge of the Daspoort Formation in the north and the wetland occurs behind this where the Hartbeesspruit flows through the poort. Localised back flooding of the Hartbeesspruit as a result of restricted flow through the poort and flow from seeps upstream above the poort resulted in the formation of the wetland and the accumulation of peat under the associated favourable conditions (WCS, 2000).

The peat in the wetland is a medium fibrous to fine reed-sedge peat and is approximately 1.05 ha in extent representing approximately 7% of the total wetland area. The maximum peat thickness is 2.4 m (Grundling and Marneweck, 1999) and the *in situ* volume is estimated at approximately 15 000 m^3. This wetland with its associated peat is a scarce wetland type in the Pretoria region and as such has an intrinsic conservation value. In terms of species composition, diversity and abundance however, the Colbyn Valley wetland is not unique in the region (Grundling and Marneweck, 1999). The uniqueness value is therefore a result of the peat resource it contains. Since the peat has developed in response to specific physical and biological conditions, it can be argued that factors such as the hydrological regime, slope and low energy environment which have created conditions favourable for the accumulation of peat are in their own right rare features in the area. Peat therefore is the product of the features which make this type of wetland scarce or rare in the region. The system has been impacted as a result of adjacent land-use and hydrological changes and is considered to be largely modified with a PES of D. The EIS on the other hand is regarded as High to Very High due to the uniqueness of the system in the region.

A number of floodplain wetlands also occur in the region, including the Apies River floodplain which has been canalised and straightened in the urban areas. This has resulted in higher flows which in turn have also altered channel and bed shape in the floodplain area lower down in the system. Urban runoff, sewage spills and litter from settlements impact heavily on water quality and the functional integrity of the river. Most of the riparian vegetation has been cleared due to high levels of development and where this remains, it is generally associated with steep banks and terraces that are scoured. Alien vegetation encroachment is high in some areas with mulberries, jacaranda, seringa and sesbania being some of the more common species. Across much of this area, watercourses are not afforded the opportunity of self-adjustment to accommodate changes to the imposed hydrology because of encroachment of buildings and other infrastructure such as parking lots and roads. This severely limits opportunities to effectively manage the wetlands.

Table 14: IUA 1 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Pans	C/D to E	Very High	Mesic Highveld Grassland Group 4 - **CR**	Some Notably Glen Austin Pan and pans associated with Rietvlei River Highveld Grassland - **CR**	Some	Endorheic seasonal grass-sedge depressions
-	Valley bottom wetlands	A/B to D/E	Moderate	Mesic Highveld Grassland Group 4 – **CR** Dry Highveld Grassland Group 5 - **LT**	Many occur in the Egoli Granite Grassland - **EN**	Mainly those associated with the Rietvlei River	-
-	Hillslope seepage wetlands	C/D to E/F	High	Mesic Highveld Grassland Group 4 – **CR** Dry Highveld Grassland Group 5 - **LT**	Many occur in the Egoli Granite Grassland - **EN**	None	High botanical diversity
Rietvlei wetland complex	Peatland	C/D to D/E	High to Very High	Mesic Highveld Grassland Group 4 – **CR** Central Bushveld Group 2 - **VU**	Rietvlei River Highveld Grassland - **CR**	Yes	Peatlands
Colbyn Valley wetland	Peatland	D	High to Very High	Mesic Highveld Grassland Group 4 – **CR** Central Bushveld Group 2 - **VU**	Marikana Thornveld - **VU**	No	Peatlands

Economy

IUA 1 is by far the most populous of all IUAs as it includes the Metropolitan Municipalities of Tshwane (full), Johannesburg (part) and Ekurhuleni (part) and the town of Krugersdorp. The IUA constitutes a large portion of South Africa's commercial, financial, industrial and manufacturing sectors and is an important contributor to National GDP. The IUA is also a major hub for commercial, financial and industrial sectors for South Africa as well as Africa.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes, except at those sites where the ecologically condition is an E EC (refer to Figure 4). At these sites where improvement is required the PES is increased to the D EC, and will be managed to this ecological condition. A MC III is recommended for IUA 1 (Table 15).

Table 15: IUA Class for the Upper Crocodile/Hennops/Hartebeespoort (IUA 1) based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C	D	E	Management Class
% representation	26	27	47	III

Additional considerations to be noted and recommendations to be taken forward

In respect of the Bloubankspruit it should be noted that:

- The inter-Ministerial Committee on AMD has approved neutralisation of AMD from the Western Basin as the preferred method of treatment;
- It is expected that an estimated 60ML/d of sulphate contaminated water will be discharged via the Tweelopiesspruit to the Bloubankspruit for the immediate and short term (up to 7 years); and
- The transfer of water to the Mokolo may result in increased draw down from dams.

Table 16: Proposed Management Actions and Implications for IUA 1

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Localised pollution impacts (especially from mine discharge and industries) on the aquifer system to be investigated; • Maintain the Hartbeespoort Dam rehabilitation programme; • Upgrade WWTW as necessary to reduce nutrient loads and improve on overall effluent quality;	• DWA is responsible for ensuring flows are maintained from the Haretbeespoort Dam, Rietvlei Dam (with Tshwane Municipaliy), Roodeplaat Dam and Bon Accord Dam and especially once the transfer pipeline to Mokolo is in place; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The DWA must set RQOs to ensure the conservation areas are protected; this is important where the Tweelopiespruit flows into the Bloubankspruit and forms part of the Krugersdorp Game Reserve and the Cradle of Humankind World Heritage Site and may require stricter RQO to improve the status to a B. • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads once it is in place; • The DWA Regional Office must maintain and

	improve as necessary the Hartbeespoort Dam rehabilitation programme; • Municipalities must assess the WWTWs in terms of nutrients being discharged and bacterial pollution;

4.2 MANAGEMENT CLASS IUA 2: MAGALIES CATCHMENT AREA

IUA Description

This IUA includes the upper reaches of the Magalies River. The IUA contains the Magaliesburg conservation area as well as the Cradle of Humankind World Heritage site, both of which are important for tourism and conservation activities. There are also agricultural activities in the IUA. The population of IUA 2 is 44 565 (Census, 2011).

Groundwater use

Groundwater use in IUA 2 is estimated at 39.917 Mm^3/a. The categorisation of the groundwater in this IUA is as follow.

Table 17: IUA 2 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	Groundwater use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)
IUA 2	1 472	79.267	39.917	50%	**II**	**II**

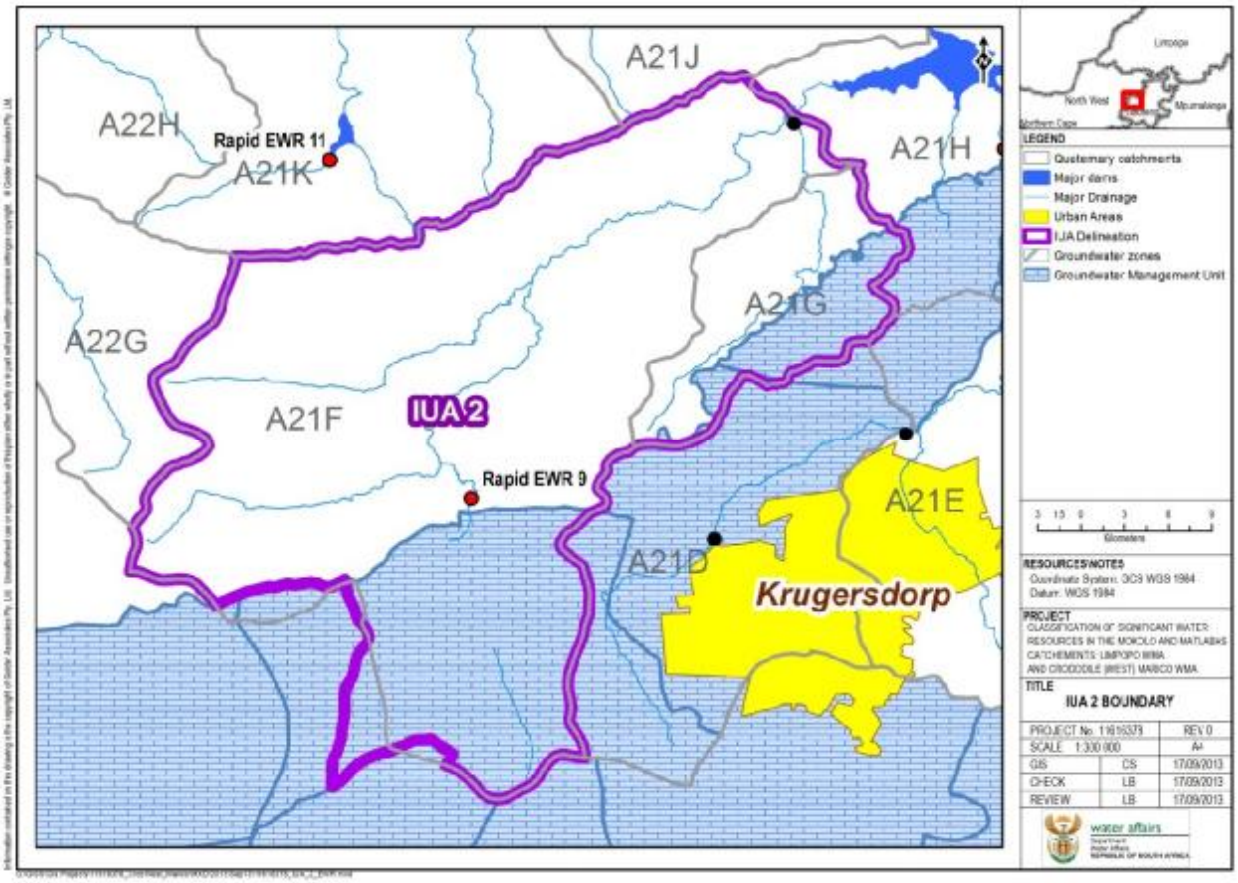

Figure 7: IUA2 Magalies catchment

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 18. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 18: IUA 2 Magalies River Catchment: Summary of Eco-classification and EWR

Node	Quart	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN16	A21F	Magalies below Maloney's Eye at CROC_EWR9	Very high	Very high	B	B	A	14.7	45.6	II
HN17 HN18	A21G, F	Magalies (CROC_EWR15) Skeerpoort at outlet of IUA2	Low Low	Low Low	C/D C/D	C/D	D	21.89	21.18	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2010 PES update (DWA, 2010).

[2)] Based on EWR for maintenance and drought flows only

Rivers: Magalies, Skeerpoort

The present state of the Magalies River is in a B category, especially with Maloney's Eye situated in the upper reaches. The EIS is very high due to the presence of the rare *Barbus motebensis* in the system. The Magalies River is an important provincial conservation area and has been identified as a sensitive catchment in the Gauteng conservation plan. The lower reaches of the Magalies and Skeerpoort Rivers are impacted by water abstraction for irrigation.

EWR sites:

- Rapid III on the Magalies: downstream of Maloney's Eye - EWR 9 (A21F); and
- Rapid III on lower Magalies – EWR 15 (A21F)

Wetlands

Maloney's Eye, the source of the Magalies River, a tributary of the Skeerpoort River upstream of Hartebeespoort Dam, is a unique dolomitic eye in the upper Crocodile West system and should be regarded as a priority system (DWA, 2012). The Gauteng Department of Agriculture and Rural Development's Conservation Plan Version 3.3 has indicated that major areas associated with Maloney's Eye are defined as Irreplacable and the area is defined in terms of Mogale City Local Municipality Spatial Development Plan (SDF) as being important for tourism. Any forms of mining activities or other developments which could negatively impact the upper reaches of Maloney's Eye are considered incompatible with the SDF and would potentially

threaten the Class B status of the river and the EIS of the associated eye and wetlands along its course. Wetlands are mostly confined to the banks of the Magalies River and hillslopes adjacent to the river.

The general water quality in the wetland systems is very good and can be considered to be close to natural in most areas, particularly in the upper watershed. In the upper reaches of the Magalies River, water is predominantly alkaline due to the local geological and biological processes and the overall integrity of many of the systems in the watershed can be considered to have a PES that is unmodified or natural (A) or largely natural (B). The EIS of the wetlands associated with the river and around the eye would be regarded as High to Very High. The surrogate PES analysis of the mapped wetlands shows PES categories of D for many of the larger systems in the IUA mainly due to agricultural impacts associated with cultivation.

Priority wetlands in this IUA are set out in Table 19.

Table 19: IUA 2 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Pans	-	High	Dry Highveld Grassland Group 5 - **LT**	Some occur on the Soweto Highveld Grassland - **VU**	One	Endorheic seasonal grass-sedge depressions
-	Valley bottom wetlands	-	Moderate	Central Bushveld Group 5 - **VU**	Some occur in the Witwatersberg Skeerpoort Mountain Bushveld – **EN** Others on the Soweto Highveld Grassland - **VU**	None	-
-	Hillslope seepage wetlands	-	High	Central Bushveld Group 5 - **VU**	Some occur in the Witwatersberg Skeerpoort Mountain Bushveld – **EN** Others on the Soweto Highveld Grassland - **VU**	None	High botanical diversity
Maloney's eye	Dolomitic eye and peatland	B	Very High	Central Bushveld Group 5 - **VU**	No	No	Dolomitic eye

Economy

The main economic activities in IUA 2 are tourism and agriculture. IUA 2 contains the Magaliesburg conservation area as well as the Cradle of Humankind World Heritage Site: both important for tourism and conservation activities.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC II is recommended for IUA 2 (Table 20).

Table 20: IUA Class for the Magalies River catchment (IUA 2) based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B	C	Management Class
% representation	33.3	66.7	II

Additional considerations to be noted and recommendations to be taken forward

- The Magalies River is an important provincial conservation area and has been identified as a sensitive catchment in the Gauteng conservation plan;
- The Mogale City Local Municipality, Department Integrated Environmental Management, has put out a position statement, signed by the Executive Mayor Cllr KC Seerane (2013/02/05), regarding prospecting and mining in Magaliesberg and environs. The recommendation is made that no further prospecting and/or mining within the Magaliesberg environs be supported by the Mogale City Local Municipality.

Table 21: Proposed Management Actions and Implications for IUA 2

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Limit further mining/industrial development in upper reaches; • Implement water use licences; • Set RQOs; • Implement water use authorisations; • Implement the EWRs; • Localised pollution impacts (especially from mine discharge and industries) on the aquifer system to be investigated;	• DWA is responsible for ensuring flows are maintained from Maloney's Eye; • The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are met, assess surface water quality and to assess impacts on the aquifer system; • Mogale City Local Municipality has put out a statement that further mining will not be supported in this IUA: DWA needs to support this if realistic; • The Regional Office or CMA must ensure that water users are authorised correctly, audited as required and that water use licences issued are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads when it is put in place;

4.3 MANAGEMENT CLASS IUA 3: CROCODILE/ROODEKOPJES CATCHMENT

IUA Description

IUA 3 includes the area downstream from Hartbeespoort Dam, an important agricultural area and considerable tourism activities exist on the Crocodile River. The town of Brits is located in this IUA. The population of IUA 3 is 244 330 (Census, 2011).

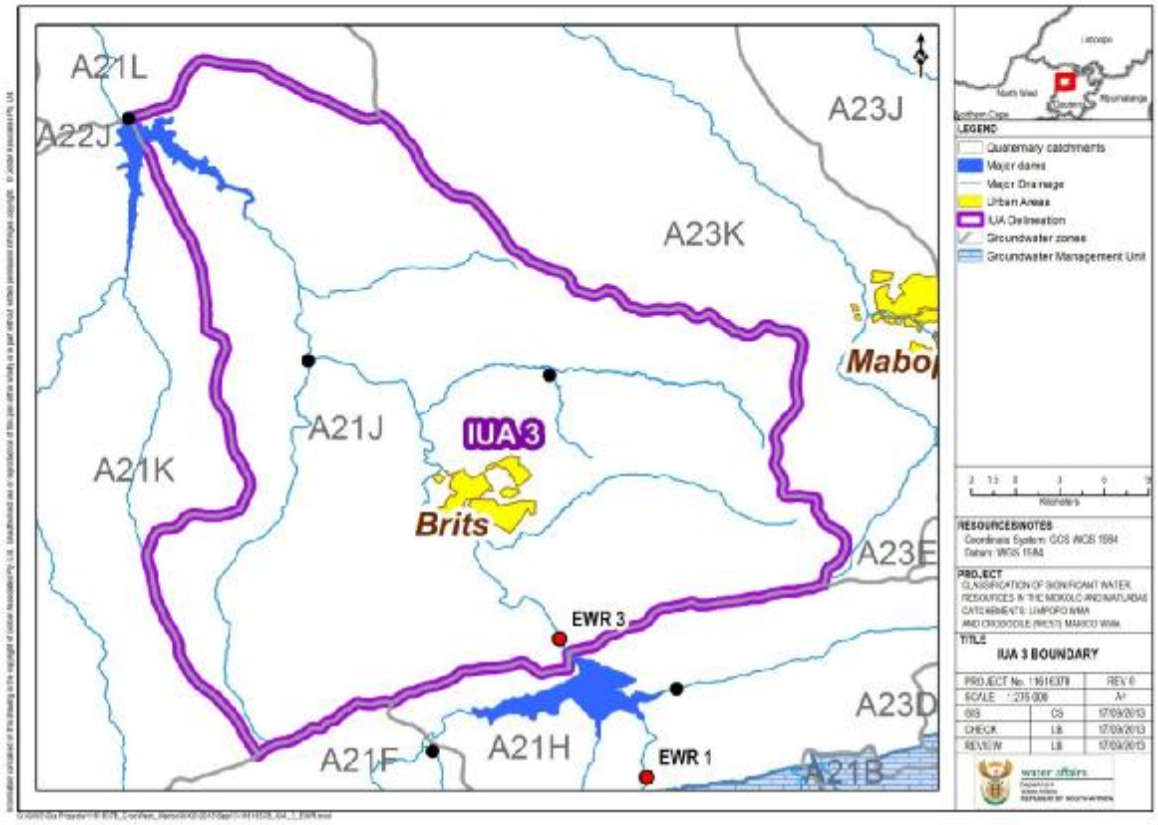

Figure 8: IUA 3 Crocodile/Roodekopjes catchment

Groundwater use

Groundwater use in the IUA is estimated at 13.7 Mm^3/a. Groundwater categorisation in the IUA is set out in Table 22.

Table 22: IUA 3 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 3	1150	29.893	13.700	46%	**II**	**II**	**I**

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 23. The EWRs listed are based on maintenance low and drought

flows only for the PES as indicated in the table.

Table 23: IUA 3 Crocodile/Roodekopjes Catchment: Summary of Eco-classification and EWR

Node	Quart-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN19 HN20	A21J	Rosespruit at confluence with Crocodile Crocodile from Hartbeespoort Dam to upstream Roodekopjes Dam, outlet of IUA3	High Mod	High Mod	C/D D		B C	153.6	25.02	**III**

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Rivers: Crocodile and smaller tributaries (Rosespruit, Kareespruit)

The water resources are in a degraded state (C/D to E category) due to changes in the flow regime as a result of Hartbeespoort Dam just upstream of this IUA and the poor water quality from IUA1. Roodekopjes Dam is situated at the outlet of this IUA.

There is one EWR site (Intermediate) on the Crocodile downstream of Hartbeespoort Dam in Mount Amanzi - EWR 3 (A21J)

Wetlands

Apart from the Langberg, the topography is relatively flat, and in places the heavy vertic soils preclude subsurface seepage which is generally integral to wetland formation. Wetlands are therefore mostly associated with incised drainage lines and streams and low lying depressions, and are widely dispersed.

Due to the topography and soil type, the entire landscape tends to take on the hydrological function associated with wetland habitat. During the dry season the smectitic clays shrink as they desiccate, resulting in deep cracks in the soil surface. Once the clays are saturated and seal following rainfall, water flow becomes surface driven. The flat topography, however, means that water sits on the surface and is stationary within the landscape with the dominant water losses being to evaporation and evapotranspiration. Water does not have the opportunity to infiltrate the soil and accumulate for long enough periods to impart hydromorphic characteristics to the soil profile. It is also likely that any hydromorphy is masked by magnesium oxides and organic matter in the dark soils. This explains the relative scarcity of wetlands in this landscape. It is likely that there is subsurface movement of water laterally across the landscape at depth through the interface between the soil and parent material.

Economy

Irrigation occurs mostly in the Crocodile catchment, immediately downstream of the Hartbeespoort Dam.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC III is recommended for IUA 3 (Table 24).

Table 24: IUA Class for the Selons River catchment including Loskop Dam (IUA 3) based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C	D	Management Class
% representation	25	75	III

Additional considerations to be noted and recommendations to be taken forward

- Upstream water quality needs to be addressed;
- All discharges to the catchment need to adhere to the RQO that will be set; and
- Irrigation channels need to be maintained to prevent water losses.

Table 25: Proposed management Actions and Implications for IUA 3

Management Actions to improve the EC	Implications
• Develop an adequate monitoring programme (flow and quality); • Maintain flows; • Improve water quality; • Set RQOs; • Implement water use authorisation; • Stop unlawful water use; • Reduce losses from irrigation channels; Maintain the Hartbeespoort Dam rehabilitation programme; • Assess nutrient loads (and capability to reduce) from WWTW and upgrade as needed;	• DWA is responsible for ensuring flows are maintained from the Hartbeespoort Dam and Roodekopjes Dam; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are met, assess surface water quality and to assess impacts on the aquifer system; • The DWA must set RQOs to ensure the conservation areas are protected; • The DWA must set RQOs to ensure the conservation areas are protected; • The Regional Office or CMA must ensure that water users are authorised correctly, audited as required and that water use licences issued are in line with RQOs; • The DWA Regional Office must work with the irrigation farmers/water user associations to limit water losses from the irrigation channels; • The DWA Regional Office must maintain and improve as necessary the Hartbeespoort Dam rehabilitation programme; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads when it is put in place; • Municipalities must assess and upgrade the WWTW as necessary to reduce nutrient loads and bacterial pollution;

4.4 MANAGEMENT CLASS IUA 4: HEX/WATERKLOOFSPRUIT/VAALKOP CATCHMENT

IUA Description

Rustenburg is the main town found in this IUA. The western limb of the Bushveld Igneous Complex (BIC), the largest platinum group metals (PGM) deposit worldwide, is found in this IUA. There is also substantial granite mining in the area. The population in IUA 4 is 471 919 (Census, 2011).

Groundwater use

Groundwater use in IUA is estimated at 22.772 Mm^3/a. Groundwater categorisation for this IUA is set out in Table 26.

Table 26: Groundwater categorisation for IUA 4

IUA	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 4	2534	65.398	22.772	35%	**II**	**II**	**I**

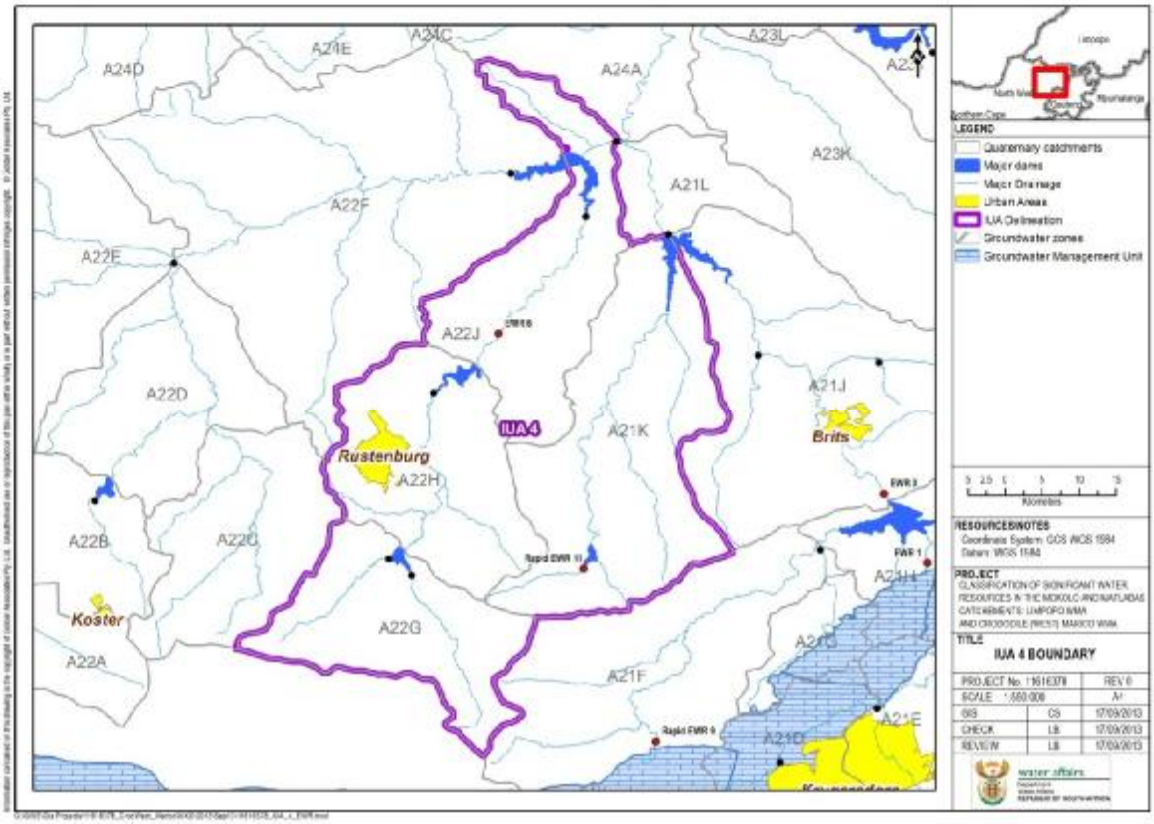

Figure 9: Hex/Waterkloofspruit/Vaalkop catchments

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 27. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 27: IUA 4 Hex/Waterkloofspruit/Vaalkop Catchment: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC [1)]	Natural MAR (mcm/ a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN21 HN22	A21K	Sterkstroom (source) to Buffelspoort Dam (CROC_EWR11) Sterkstroom from Buffelskloof Dam to Roodekopjes Dam, outlet of IUA4	High High	High High	C C	C	B B	14	28.41	
HN23	A22G	Hex (source) to Olifantsnek Dam	Mod	High	C		B/C	-	-	
HN24 HN25	A22H	Waterkloofspruit (CROC_EWR14) to confluence with Hex Hex from Olifantsnek Dam to Bospoort Dam	Low Mod	Low Mod	B/C D	B/C	D C	5.47	28.27	**II**
HN26 HN27	A22J	Hex from Bospoort Dam to Vaalkop Dam (CROC_EWR6) Elands from Vaalkop Dam to confluence with Crocodile, outlet of IUA4	Mod Mod	Mod Mod	D D	D	C C	26.9	14.96	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Rivers: Hex, Waterkloofspruit

The water resources of the Hex River have been degraded due to the Olifantsnek, Bospoort and Vaalkop Dams situated on the river. Rustenburg and extensive mining in the middle reaches of the catchment further impacts on the water resources, both quantity and quality. The Waterkloofspruit (mostly wetland) is still in a very good condition and forms part of a conservation area. Vaalkop Dam is situated at the outlet of this IUA.

Rivers: Sterkstroom

The present state of the water resources is in a C category. Some irrigation is present in the upper reaches of the system. Buffelskloof Dam and part of Roodekopjes Dam is situated in the catchment. The EIS is high due to the presence of the vulnerable *Barbus motebensis* and the high abundance of the unique *Amphilius uranoscopus* and *Barbus motebensis* upstream in catchment.

Wetlands

A number of wetland types occur in this IUA (Table 28), with most containing clear wetland hydromorphic characteristics. In particular depression wetlands and channelled and unchannelled valley bottom systems are quite common. Many of the unchannelled wetlands, driven mostly by diffuse inputs from relatively flat, large, inward-draining catchments, are undergoing channel incision, often as a result of road crossings or other impacts that result in the concentration of flow. In parts of this IUA there are coarse-grained, sandy, shallow soils within a gently undulating topography, attributes which are conducive to the formation of valley bottom and seepage wetland systems. Unchannelled valley bottom wetlands in these areas are mostly dominated by temporary and seasonal wetland zones, and driven predominantly by subsurface seepage of water through the shallow, sandy catchment soils. Channelled valley bottom wetlands generally incorporate a central channel with adjacent seepage zones on either side, mostly consisting of temporary wetland with a patchy mosaic of seasonal wetland. These are driven predominantly by longitudinal and lateral surface flow and lateral subsurface seepage.

Typical unchannelled systems with perennial watercourses dominated by *Phragmites australis* and a well-established riparian fringe are also found in this IUA. Seepage wetlands are usually situated on slopes or at the head of larger drainage systems and are mostly temporary zone wetlands, with patches of seasonal wetland forming if the surrounding catchment is large enough. These are driven almost exclusively by subsurface lateral seepage.

An important wetland in this IUA is the Waterval Valley mire (peatland) in the Kgaswane Nature Reserve (Figure 10). This has been subject to rehabilitation as part of WfW programme.

Figure 10: Photograph of the Waterval Valley peatland in Kgaswane Nature Reserve outside Rustenburg

Table 28: IUA 4 priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Waterval Valley Bottom Mire (peatland)	Unchannelled valley bottom	-	Very High	Central Bushveld Group 1 - **CR**	No	Yes	Peatland

Economy

The economy of the area is mainly mining. Rustenburg is the main town found in this IUA. The western limb of the Bushveld Igneous Complex (BIC), the largest platinum group metals (PGM) deposit worldwide, is found in this IUA. There is also substantial granite mining in the area.

Conclusions and Proposed MC

In the Strerkstroom the EWR is met partially in September for Sc1. Rest of scenarios met for both Mar and Sep. The recommended scenario maintains the PES EC at all nodes. A MC of II is recommended for IUA 4 (Table 29).

Table 29: IUA 4 Class for the Elands River catchment based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B	C	D	Management Class
% representation	14	43	43	II

Additional considerations to be noted and recommendations to be taken forward

- Upper reaches to Olifantsnek still in better condition and important to keep it that way to attain the MC;
- The EIS is high due to the presence of the vulnerable *Barbus motebensis* and the high abundance of the unique *Amphilius uranoscopus* and *Barbus motebensis* upstream in the catchment; and
- Need to include special RQO's for upstream areas and the Waterkloofspruit that should attain an A/B category as they are important for NFEPA and conservation.

Table 30: Proposed Management Actions and Implications for IUA 4

Management Actions to improve the EC	Implications
• Develop an adequate monitoring programme (flow and quality); • Maintain flows; • Improve water quality especially in lower reaches; • Set RQOs; • Implement water use authorisation; • Stop unlawful water use; • Limit development in upper reaches especially in Waterkloofspruit area; • Assess nutrient loads (and capability to reduce) from WWTW and upgrade as needed;	• DWA is responsible for ensuring flows are maintained from the Olifantsnek, Bospoort and Vaalkop dams; • The DWA must set RQOs to ensure the conservation areas are protected (especially in the Waterkloofspruit area); • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are met, assess surface water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are authorised correctly, audited as required and that water use licences issued are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads when it is put in place; • Municipalities must assess and upgrade the WWTW as necessary to reduce nutrient loads

Management Actions to improve the EC	Implications
	and bacterial pollution;

4.5 MANAGEMENT CLASS IUA 5: ELANDS/VAALKOP

IUA Description

The IUA contains the towns of Koster and Swartruggens. Major socio-economic activities include agriculture, private owned conservation areas and some tourism activities. The population of IUA 5 is 222 033 (Census, 2011).

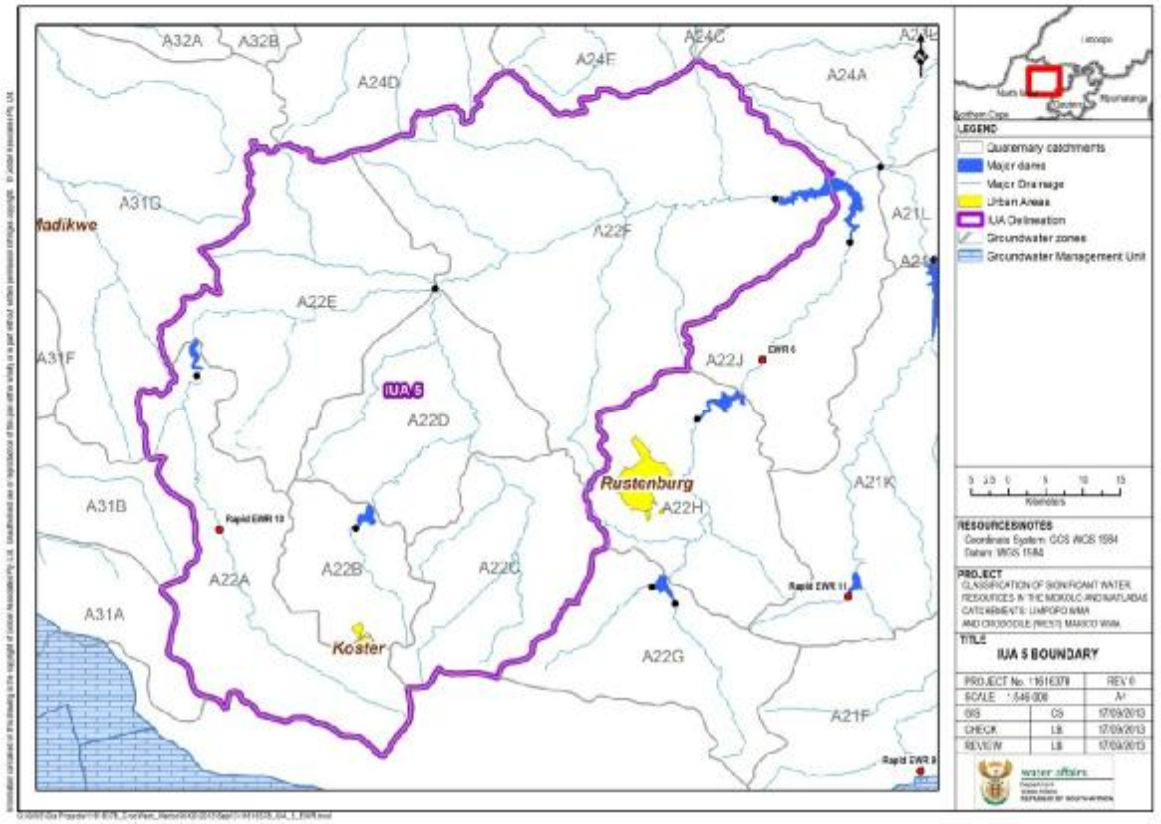

Figure 11: Elands/Vaalkop catchment

Groundwater use

Groundwater use in IUA 5 is estimated at 15.174 Mm^3/a. The groundwater categorisation for this IUA is set out in Table 31.

Table 31: IUA 5 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	[1]Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 5	4546	117.239	15.174	13%	**I**	**II**	**I**

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 32. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 32: IUA 5 Elands/Vaalkop catchment: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN28 HN29	A22A	Elands (source) to Swartruggens Dam (CROC_EWR10) Elands from Swartruggens Dam to Lindleypoort Dam	High Mod	High High	C C	B/C	B C/B	10.1	30.48	II
HN30	A22B	Koster (source) to Koster Dam	Mod	High	C		B/C	-	-	
HN31	A22C, A22D	Selons to confluence with Elands	Mod	High	C		B/C	-	-	
HN32	A22E, A22F	Elands from Lindleypoort Dam (CROC_EWR13) to Vaalkop Dam, outlet of IUA5	Low	Low	C	C	D	18.77	21.90	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Rivers: Koster, Selons, Elands and some smaller tributaries in the lower reaches of the IUA

The water resources in the upper catchment of the Elands River are in a C category. This deteriorates further downstream with the presence of Swartruggens and Lindleyspoort dams, due to slate and diamond mining, irrigation and return flows from wastewater treatment works. The presence of the vulnerable *Barbus motebensis* contributes to a high EIS for the upper reaches. This reach also serves as a refugia as the downstream catchment and river has been degraded. The unique Pilanesberg area is situated in the middle reaches of the IUA. Vaalkop Dam is situated at the outlet of this IUA.

The EWR sites are:

- Rapid III on the Elands: Upstream Swartruggens Dam - EWR 10 (A22A); and
- Rapid III on Elands: Downstream Lindleyspoort Dam – EWR 13 (A22E)

Wetlands

Based on an understanding of the geomorphology, drainage patterns, and soils in this IUA, four wetland types occur, namely pans, hillslope seepage wetlands, unchannelled valley bottom wetlands and channelled valley bottom wetlands.

A large pan complex (groups of pans) occurs to the south of Koster (a complex of approximately 24 pans). A number of hillslope seepage and valley-bottom wetlands are also associated with these pans. Pans are recognized as being important for biodiversity support

and more recently their links to other wetland systems in relation to landscape hydrology have also been highlighted. Pans are also unique in terms of their individual biogeochemical attributes. This combination of an extensive network of pans, hillslope seepages and valley-bottom systems, and also that they are unaffected by urbanization and not found elsewhere in any of the other IUA's in such a cluster in this study, renders this an important water resource in the study area. It is likely that populations of the Giant bullfrog may occur or be found in the pans in this IUA.

The pans appear to be mainly fresh (low salinity systems) and dominated by grasses and sedges. These pans are all associated with hillslope seepage wetlands and probably receive water from both surface runoff and lateral seepage via a perched aquifer. The possibility exists that these pans could contribute towards the local aquifer that supports other wetland systems, particularly the valley bottom systems in the area. These pans and their associated hillslope seepage wetlands represent good examples of specific types of wetlands which occur in the Highveld region, an area not well represented outside of IUA1 in this study area. They are therefore an important feature contributing towards the maintenance of the the ecological diversity of the region. Threats are mainly from agricultural activities including agricultural pollutants such as fertilizers, pesticides and herbicides. Road crossings also intersect the pans and disrupt the movement of water. Runoff water from roads also contributes towards the silt load that is built up in these pans. Current potential effects on the integrity of pans and associated hillsope seepage wetlands include cultivation, accumulation of pesticide residues, direct impacts from ploughing, and road related impacts. While the pans in particular have a High to Very High EIS, the PES categories are mostly D due to the related agricultural impacts.

Priority wetlands for this IUA are set out in Table 33.

Table 33: IUA 5 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Pans	-	Very High	Mesic Highveld Grassland Group 4 - **CR**	Rand Highveld Grassland - **VU**	None	Endorheic seasonal grass-sedge depressions
-	Valley bottom wetlands	-	Moderate	Mesic Highveld Grassland Group 4 - **CR**	Rand Highveld Grassland - **VU**	None	-
-	Hillslope seepage wetlands	-	High	Mesic Highveld Grassland Group 4 - **CR**	Rand Highveld Grassland - **VU**	None	High botanical diversity

Economy

The IUA contains the towns of Koster and Swartruggens. Major socio-economic activities include agriculture, slate and diamond mining and privately owned conservation areas and some tourism activities.

Conclusions and Proposed MC

The recommended scenario maintains the PES EC at all nodes A MC of II is recommended for IUA 5 (Table 34).The flow scenario assessment indicated that the EWR flows can be met in the system in March for all scenarios; however, EWR only partially met in September for scenarios Prs, ESBC and Sc1.

Table 34: IUA 5 Class for the Elands/Vaalkop catchment based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C	Management Class
% representation	100	II

Additional considerations to be noted and recommendations to be taken forward

Table 35: Proposed Management Actions and Implications for IUA 5

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Limit development in upper reaches around Koster where sensitive areas are located;	• DWA is responsible for ensuring flows are maintained from the Swartruggens, Lindleyspoort and Vaalkop dams; • The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads once it is in place;

4.6 MANAGEMENT CLASS IUA 6a: KLEIN MARICO CATCHMENT

IUA Description

The town of Zeerust is located in this IUA. The main rivers are Rhenosterfontein, Malmaniesloop, Klein Marico and Kareespruit. The population of IUA 6 (a and b) is 31 316 (Census, 2011).

Groundwater use

The town of Zeerust is dependent on groundwater abstraction from compartments in Malmaniesloop. Groundwater use in IUA 6 (a and b) is estimated at 6 857 Mm^3/a. the groundwater categorisation for this IUA is set out in Table 36.

Table 36: IUA 6 Groundwater categorisation

IUA	QC's	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 6		1901	54.17	6.857	12.7%	**I**	**I**	**I**

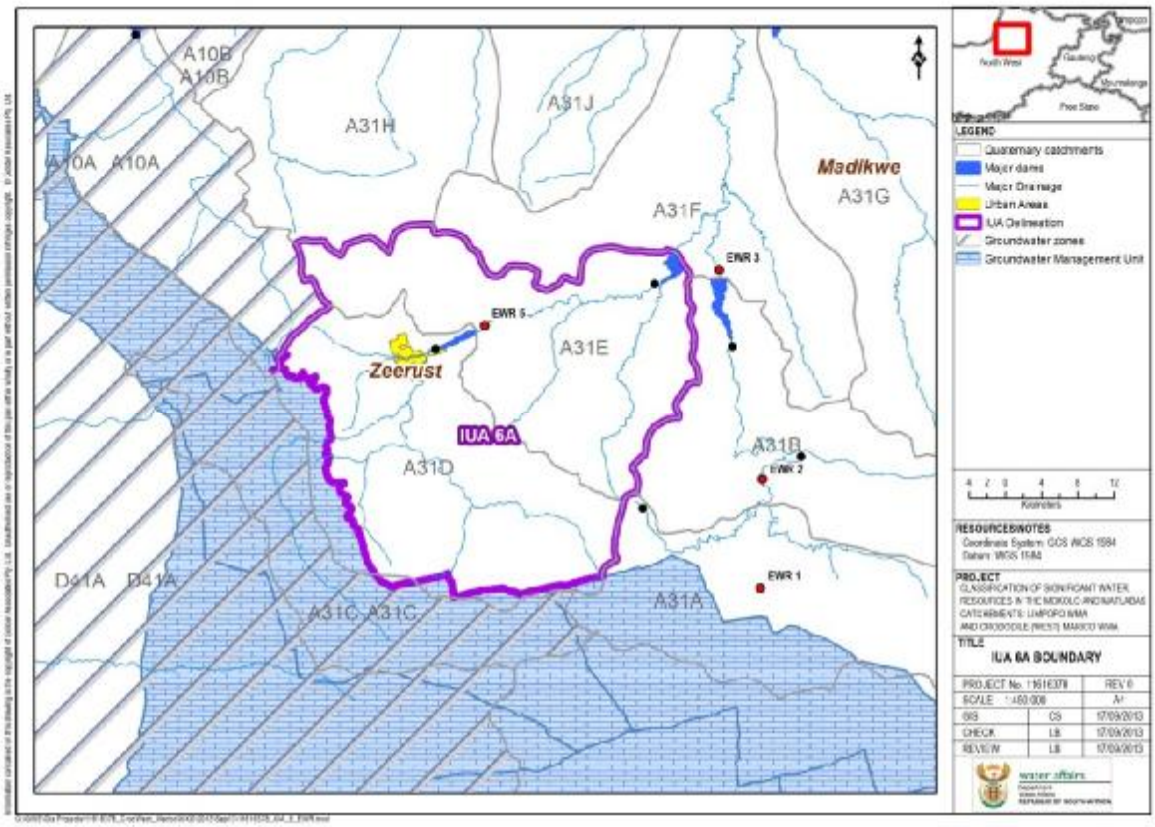

Figure 12: IUA 6a Klein Marico catchment

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage natural MAR) is indicated in Table 37. The EWRs listed are based on maintenance low and drought

flows only for the PES as indicated in the table.

Table 37: IUA 6a Klein Marico River Catchment: Summary of Eco-classification and EWR

Node	Quarte -nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/ a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN64	A31D	Malmaniesloop to confluence with Klein Marico Klein Marico and tributaries upstream of Zeerust	High	High	C	C	B	29.42	4.67	II
HN35	A31D	Klein Marico from Zeerust to Klein Maricopoort Dam	High	High	C		B			
HN65	A31E	Klein Mario from Klein Maricopoort Dam to Kromellemboog Dam (MAR_EWR5), outlet of IUA6a	High	High	C		B			
HN36	A31E		Mod	Mod	C		C			

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

The water resources are in a C category due to the impacts of Zeerust WWTW and the Klein Maricopoort Dam (irrigation) in the upper reaches of the catchment. Kromellenboog Dam, mainly being used for irrigation is situated in the lower Klein Marico River just before the confluence with the Groot Marico.

There is one Rapid III EWR site on Klein Marico downstream Klein Maricopoort Dam.

Wetlands

Given the available information and due to the topography and soil type, there do not appear to be many wetlands in this IUA. Where wetlands occur, they are mostly associated with drainage lines and streams and low lying depressions and are widely dispersed. Based on examination of the aerial imagery, it appears that the SANBI probability map and NFEPA wetland coverage exaggerates the wetland extent and distribution in the south central section of this IUA and as such this representation is probably not accurate.

Economy

The IUA contains the town of Zeerust. Major socio-economic activities include agriculture, light manufacturing, conservation and tourism. There have been rumours of nickel mining prospecting rights granted in the area.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC II is recommended for IUA 6a (Table 38).

Table 38: IUA 6 Class for the Klein Marico River Catchment based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C	Management Class
% representation	100	II

Additional considerations to be noted and recommendations to be taken forward

Table 39: Proposed Management Actions and Implications for IUA 6a

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Eradicate alien vegetation; • Assess WWTWs capability and upgrade if necessary; • Implement WCDM;	• DWA is responsible for ensuring flows are maintained from the Kromellenboog and Maricopoort dams (for irrigation) and must work with irrigation farmers (existing and emerging to see how best to utilise the irrigation water); • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The DWA must set RQOs to ensure the conservation areas are protected, particularly at HN64 at the N4 bridge and to maintain good water quality for irrigation farmers and for recreational purposes; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • Working for Water must work with the communities to eradicate alien vegetation; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads once it is in place; • Municipalities must assess and upgrade the WWTW if necessary to improve overall effluent quality being discharged; • DWA and Local municipalities must ensure that any additional future water uses are achieved through water demand management and well planned and managed groundwater supply schemes

4.7 MANAGEMENT CLASS IUA 6b: GROOT MARICO

IUA Description

The main town in this IUA is Groot Marico. The rivers are the Polkadraaispruit and Groot Marico River. The population of IUA 6 (a and b) is 31 316 (Census, 2011).

Groundwater use

Groundwater use in IUA 6 (a and b) is estimated at 6 857 Mm^3/a. the groundwater categorisation for this IUA is set out in Table 36 under Section 4.6.

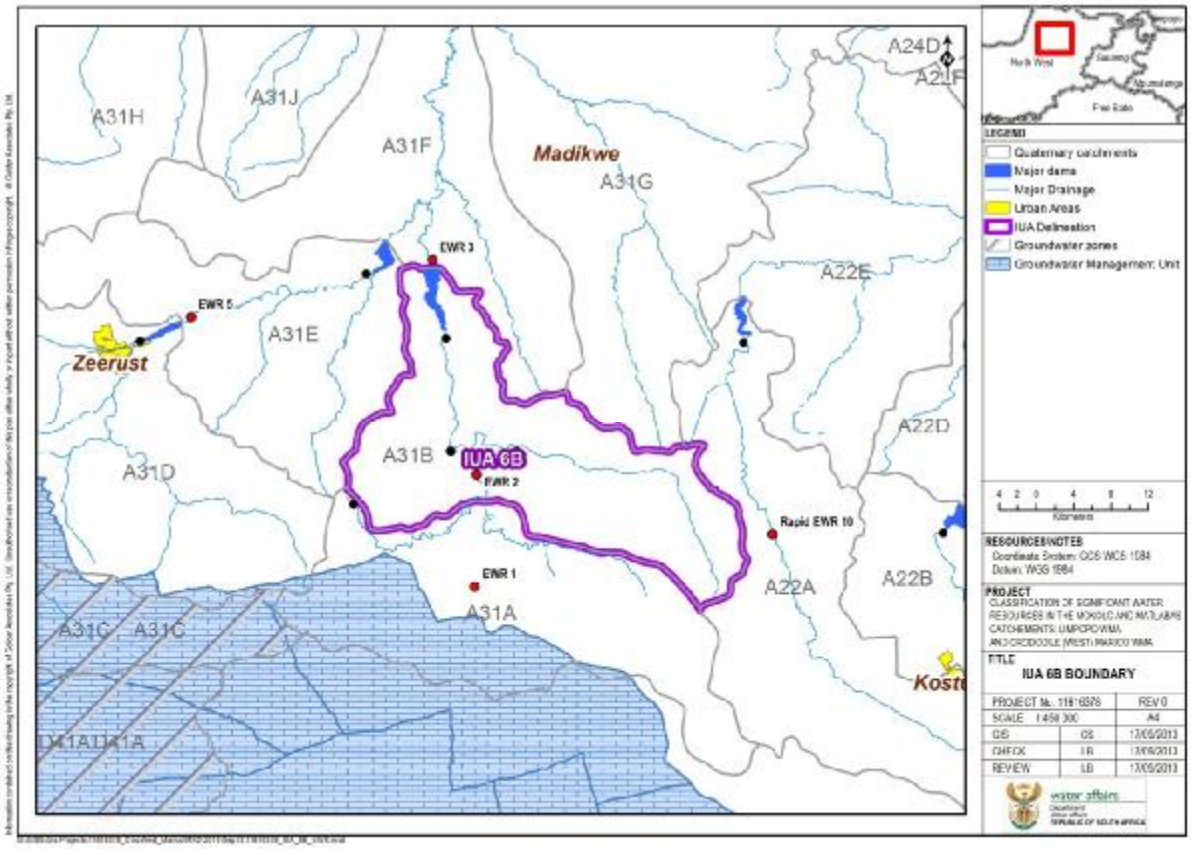

Figure 13: IUA 6b Groot Marico catchment

Ecological condition and the Ecological Reserve

The water resources are in a B category with some impacts due to irrigation and degraded riparian zone and alien invasive plants. The EIS is very high mainly due to the unique Blepharoceridae, locality of aquatic lampyridae as well as a large number of inverts and fish sensitive to water quality changes. The Marico Bosveld Dam is situated at the outlet of this IUA.

The EWR sites are on the Groot Marico upstream of the confluence with Polkadraaispruit and EWR 3 is situated at the outlet of this IUA.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 40. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 40: IUA 6b Groot Marico catchment: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC [1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN33	A31B	Polkadraaispruit to confluence with Marico (MAR_EWR6)	Mod	Mod	B/C	B	C	9.89	31.87	II
HN34		Marico from MAR_EWR2 to N4 road at town	Very High	Very High	B		A			
HN63		Marico from N4 road to Marico-Bosveld Dam, outlet of IUA6b	Very High	Very High	B	B	A	42.08	50.26	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Economy

The IUA contains the small town of Groot Marico. Major socio-economic activities include agriculture, conservation and tourism. There have been rumours of nickel mining prospecting rights granted in the area.

Conclusions and Proposed MC

The hydrological modelling conducted showed that it is not possible to implement either a PES ecological category or a REC ecological category at EWR site 3 without a significant trade-off with existing water users, principally irrigation agriculture. The recommended scenario maintains the PES EC at the nodes. A MC of II is recommended for IUA 6b (Table 41).

Table 41: IUA 6b Class for Groot Marico based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B	B/C	Management Class
% representation	66.7	33.3	II

Additional considerations to be noted and recommendations to be taken forward

Table 42: Proposed Management Actions and Implications for IUA 6b

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt	• DWA is responsible for ensuring irrigation flows are maintained in the Marico Bosveld Dam and must work with irrigation farmers (existing and emerging to see how best to utilise the irrigation water);

Management Actions to improve the EC	Implications
loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Eradicate alien vegetation; • Maintain HN34 at the N4 bridge at default REC of A; • Assess use of earth channels for irrigation water transfer	• Working for Water must work with the communities to eradicate alien vegetation; • The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • Working for Water must work with the communities to eradicate alien vegetation; • DWA or the CMA must ensure that Hydronode (HN34) at the N4 bridge is maintained as a default REC of A. This is very important both for conservation (including NFEPA) as well as for good quality water for irrigators from the Marico Bosveld Dam and recreational water based activities on the Dam; • DWA and the irrigation farmers must consider and implement, if necessary, changes to the existing earth channels to limit loss of irrigation water;

4.8 MANAGEMENT CLASS IUA 7: KAALOOG-SE- LOOP

IUA Description

The main water resources in this IUA are Kaaloog-se-Loop and Vanstraatenvlei. The population of this IUA is 6 394 (Census, 2011) and is largely rural in nature with game farms and commercial agriculture present.

Groundwater use

Groundwater use in IUA 7 is estimated at 2.986 Mm^3/a. The groundwater categorisation is set out in Table 43.

Table 43: IUA 7 Groundwater categorisation

IUA	QC's	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)
IUA 7		1162	55.165	2.986	5.4%	**I**	**I**

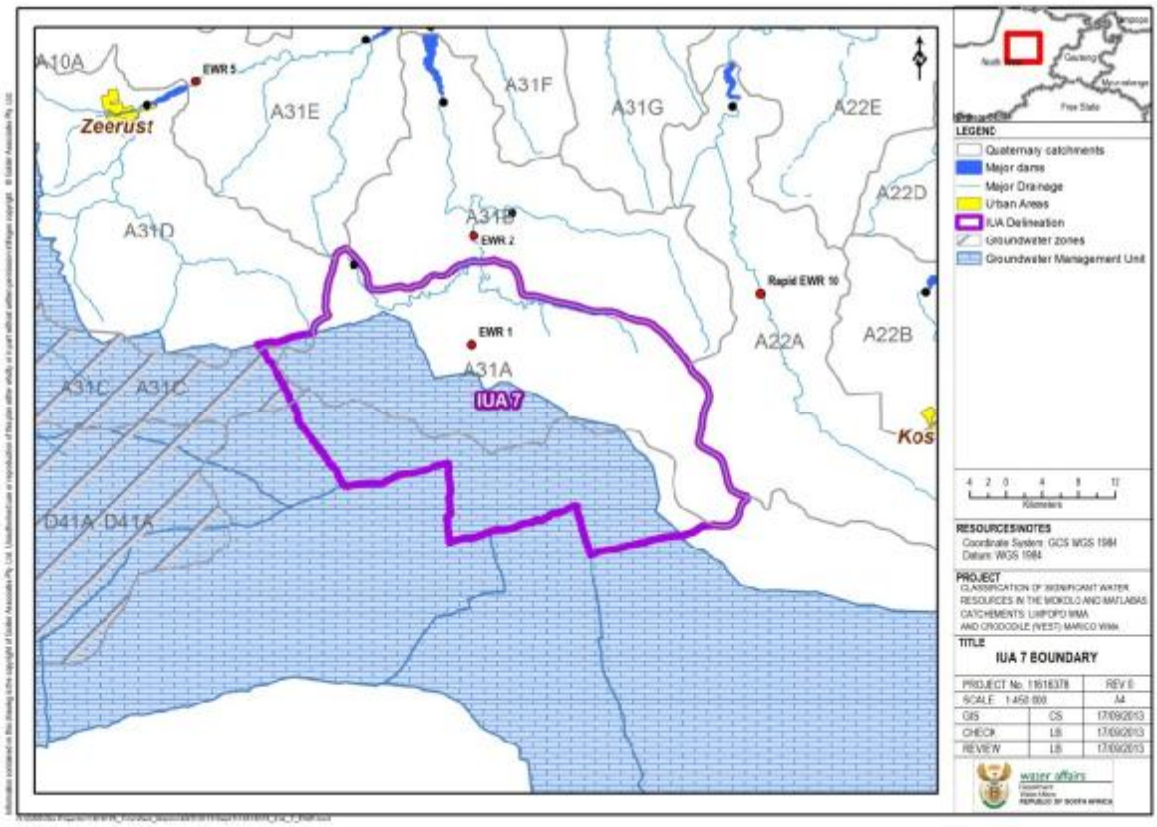

Figure 14: IUA 7 Kaaloog-se-Loop

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 44. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 44: IUA 7 Kaaloog-se-Loop: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN37 HN38	A31A A31A	Kaaloog-se-Loop (MAR_EWR1) to concluence with Groot Marico Vanstraatenvlei and tributaries at confluence with Kaaloog-se-Loop, outlet of IUA7	Very High High	Very High High	B B	B	A A	10.54	76.32	I

[1)] **Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update**

[2)] **Based on EWR for maintenance and drought flows only**

Ecological condition and the Ecological Reserve

The water resource is in a B category and is situated close to the source of the Marico River.

The EIS is very high with the presence of the rare and endangered *B motebensis and B waterburg* and the very high taxon richness of inverts (>45). The area has been identified as a national priority area for protection/conservation due to the dolomitic eyes and associated fauna

and flora.

There is one EWR site on Kaaloog-se-Loop below the gorge.

Wetlands

This IUA includes two ecoregions, namely Highveld and Western Bankenveld. Agriculture is an important sector in this IUA with conservation in the form of game farming also occurring. Five wetland types occur, namely hillslope seepage wetlands, unchannelled and channelled valley bottom wetlands, dolomitic eyes and two tufa waterfalls (Bokkraal and Kuilfontein). Seepage wetlands are common in the upper reaches of the Bokkraal and the Ribbokfontein se loop. Channelled valley bottom wetlands are the most common system in this IUA and in the upper reaches of the Marico River these form broad wetlands in some reaches. Impacts on these wetlands occur mainly in the form of invading exotic vegetation (Grey poplar, Seringa, Wild Senna, Wattle, and Giant Reed), agricultural activities, road crossings and small farm dams.

Unchannelled valley bottom wetlands also occur in this IUA with a good example being the upper reaches of the Rietspruit.

A special feature of this IUA is the tufa waterfall at Bokkraal and a second at Kuilfontein. This is a waterfall composed of limestone or calcium carbonate formed by the precipitation of carbonate minerals. It is a very rare type of waterfall in South Africa and as such can be considered as having a Very High EIS.

Also found in this IUA is the dolomitic eye (Kaaloog or Marico eye) at the source of the Kaaloog-se-loop (headwaters of the Marico River). As with the other eyes in the region, it comprises a peat wetland system fed by groundwater originating from fractures in the underlying dolomite. The system has a PES of B/C as a result of surrounding agricultural influences but the EIS is considered Very High. Priority wetlands are set out in Table 45.

Table 45: IUA 7 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Valley bottom wetlands	C/D	Moderate to High	Mesic Highveld Grassland Group 4 - **CR**	Rand Highveld Grassland - **VU**	No	-
-	Pans	D	High	Mesic Highveld Grassland Group 4 - **CR**	Rand Highveld Grassland - **VU**	No	-
-	Tufa waterfall	B	Very High and very sensitive to water quality changes	Mesic Highveld Grassland Group 4 - **CR**	No	No	Waterfall composed of limestone or calcium carbonate formed by the precipitation of carbonate minerals. Very rare type of waterfall in SA
Marico eye (Kaaloog se Loop)	Valley bottom Peatland	B/C	Very High	Mesic Highveld Grassland Group 4 - **CR**	No	No	Dolomitic eye

Economy

The IUA is largely rural in nature with game farms and commercial agriculture present. The area is an important tourism area due to the dolomitic eyes found there.

Conclusions and Proposed MC

The recommended scenario maintains the PES EC at all the nodes. A MC of I is recommended for IUA 7 (Table 46).

Table 46: IUA Class for the Kaaloog-se-loop catchment based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B	Management Class
% representation	100	I

Additional considerations to be noted and recommendations to be taken forward

Table 47: Proposed Management Actions and Implications for IUA 7

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows around the eyes to ensure conservation areas are protected; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Limit development around the eye;	• DWA is responsible for ensuring flows around the eyes and that used to supply domestic use; • The DWA must set RQOs to ensure the conservation areas are protected (especially the two tufa systems) and especially related to water abstraction out of the dolomitic compartments that feed the river system; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • Working for wetlands should work with the Conservation Groups in the area to maintain the ecological importance status;

4.9 MANAGEMENT CLASS IUA 8: MALMANIESLOOP

IUA Description

This IUA is dominated by one ecoregion, namely Highveld. Agriculture is an important sector in this IUA and is mainly groundwater related around Malmanie's Eye. There is also a Provincial Nature Reserve around the eye. The population of this IUA is 5 707 (Census, 2011).

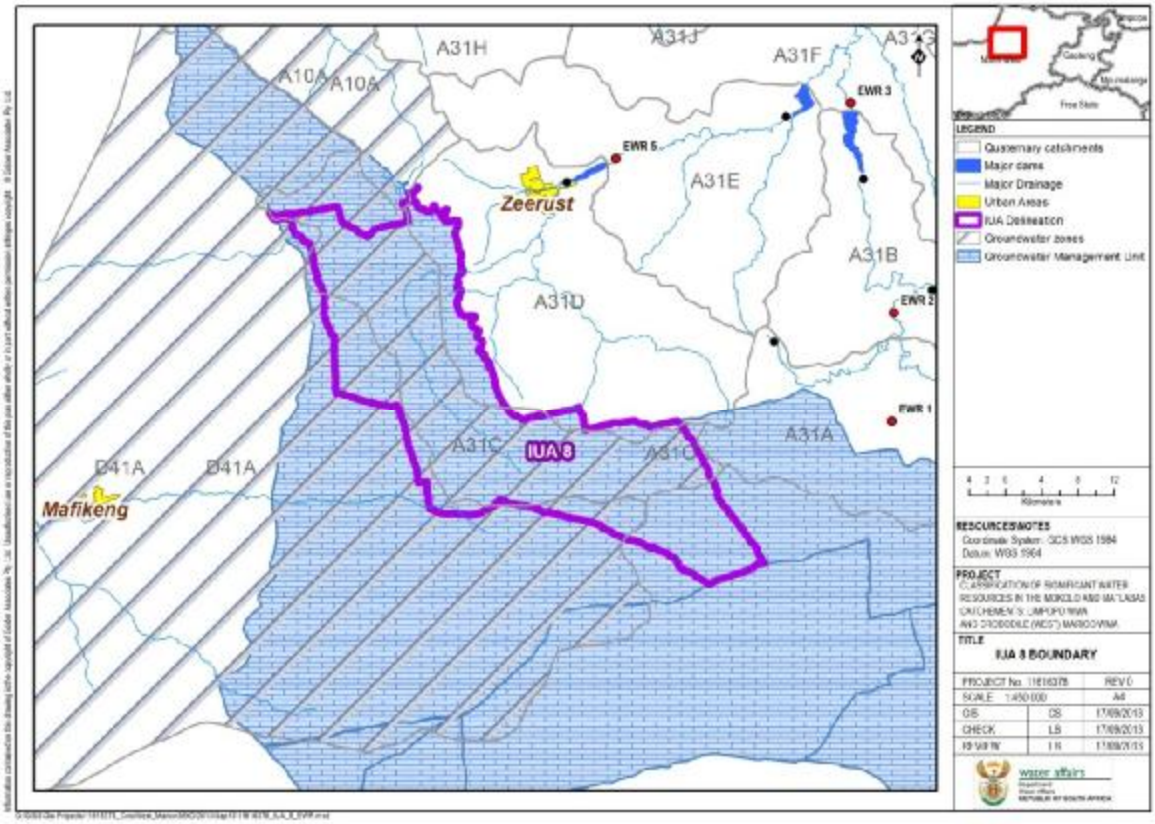

Figure 15: IUA 8 Malmaniesloop

Groundwater use

The groundwater use for IUA 8 is estimated at 3.089 Mm^3/a. the groundwater categorisation of this IUA is set out in Table 48.

Table 48: IUA 8 Groundwater use

IUA	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 8	485	15.045	3.089	21%	**I**	**II**	**I**

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 49. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 49: IUA 8 Malmaniesloop: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC [1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
-	A31C	Groundwater	-	-	-	-	-	-	-	**I***

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2010 PES update (DWA, 2010).

[2)] Based on EWR for maintenance and drought flows only

***Groundwater classification**

Wetlands

This IUA is dominated by one ecoregion, namely Highveld. Agriculture is an important sector in this IUA. An important wetland dominates this IUA, namely the system associated with the Malmanie River which runs south to north across the IUA. Dolomite forms the main watershed of the Malmanie River in the central portion of this IUA. The source of the Malmanie River is the Malmanie eye which comprises a wetland system fed by groundwater originating from fractures in the underlying dolomite. The water from the eye is typically alkaline (pH range from 7.5 to 9.3) having picked up magnesium and calcium carbonates through solution from the parent dolomite. Being perennial, the wetland system associated with, and downstream of, the eye forms peat. This peatland forms part of the Highveld peat ecoregion (Marneweck, Grundling and Muller, 2001).

The peat wetlands that fall within the Highveld Peat ecoregion have developed over long periods ranging between 7000 to 15000 years (depending on peat depth) with peat accumulation rates of between 0.3 to 0.6mm/year (Grundling and Marneweck, 1999; Marneweck *et. al.*, 2001).

Peatlands in general, and more specifically those associated with the dolomitic eyes, are rare in South Africa and southern Africa in general. Those associated with the dolomites in the Malmanie as well as Molopo and Marico Rivers in particular comprise unique ecosystems characterised by a high degree of endemicity (species which are found only there). The results from both morphological and genetic studies of the fish species showed that the indigenous cichlid populations inhabiting these dolomitic wetlands are unique, with a number of populations having differentiated to the extent where they may be considered as separate species (DEA&T, 1995).

Studies on the aquatic invertebrates of these dolomitic wetlands have also produced several new distribution records for South Africa and also 21 new species to science (DEA&T, 1995). For this reason, dolomitic eyes and their associated peatlands are regarded as sensitive systems. Most of these systems are also important water supply sources and thus the associated ecosystems have been impacted by water abstraction. They are also threatened by groundwater contamination from agriculture, industry and mining, habitat transformation and invasions by alien species (particularly exotic plants e.g. poplars and fish species e.g. black bass) and some have been mined for peat.

These groundwater dependent ecosystems are facing increasing pressure from pollution and consumptive uses for agriculture and commercial developments. Collectively, anthropogenic changes in the groundwater regime pose a significant, but largely unknown threat to these important groundwater dependent ecosystems. Seepage areas can occur along the margin of these wetlands with the presence of both seasonally and temporary wet zones. A characteristic deposit of white sulphur reducing bacteria often also occurs in the substrate of the eyes. Typical riparian species associated with rocky habitat also occur around the eyes with terrestrial habitat immediately adjacent to the wetland area.

Priority wetlands in IUA 8 are set out in Table 50.

Table 50: IUA 8 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Malmanie Loop	Valley bottom mire or peatland	B to C/D	Very High	Dry Highveld Grassland Group 5 - **LT**	No	Yes	Dolomitic eye with a valley bottom peatland downstream. Unique biota associated with the dolomitic eye.

Economy

The IUA is largely rural in nature with game farms and commercial agriculture present. The area is an important tourism area due to the dolomitic eyes found there.

Conclusions and Proposed MC

The recommended scenario is related to the groundwater categorisation and should be maintained at a groundwater Class II.

Additional considerations to be noted and recommendations to be taken forward

Table 51: Proposed Management Actions and Implications for IUA 8

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows around Malmanies Eye; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Status of contribution to base flow needs to be evaluated;	• DWA is responsible for ensuring flows around the eyes and that used to supply domestic use; • The DWA must set RQOs to ensure the conservation areas are protected and groundwater abstraction is well managed; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement

Management Actions to improve the EC	Implications
	Directorate must ensure that all water users are acting within the law; • Working for wetlands should work with the Conservation Groups in the area to maintain the ecological importance status;

4.10 MANAGEMENT CLASS IUA 9: MOLOPO

IUA Description

AS for IUA 8, IUA 9 is mainly groundwater related around Molopo Eye. Water from the eye is diverted for use and only a small volume is released into the Molopo River.

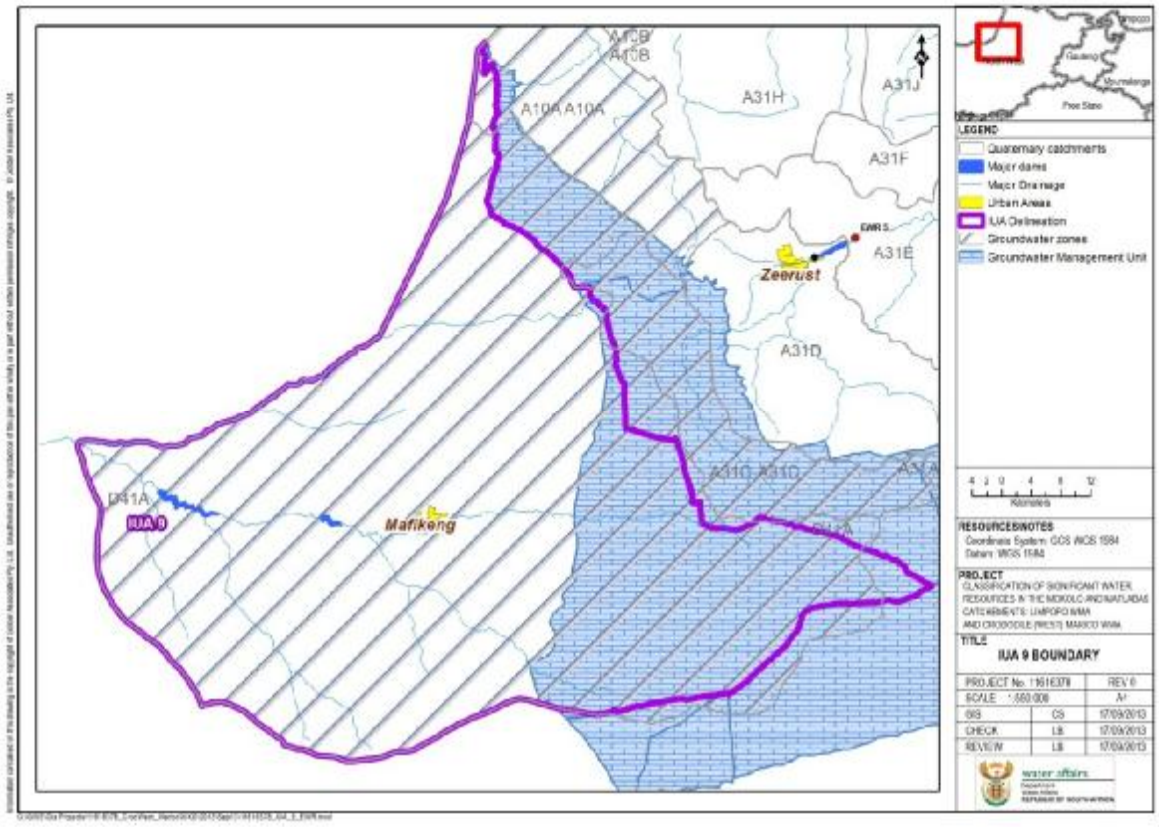

Figure 16: IUA 9: Molopo

Groundwater use

The D41A catchment consists of two different aquifers systems, viz. on the eastern side, almost flat lying dolomites of the Chuniespoort Group occurs, whilst the western side is underlain by collection of Basement Formations (Granites) and Ventersdorp Supergroup (Lavas and sedimentary rocks), covered in places with Kalahari Group sediments (windblown sands and calcrete horizons).

The western portion of Upper Molopo catchment is underlain by Basement granite. This is covered with an increasing thickness of Kalahari sand/calcretes to the west. A mostly intrusive

volcanic rock assemblage (Allanridge lava) lies to the east of Mahikeng. Significant aquifers are present locally north of Slurry (open cast lime producing, northeast of Mahikeng). Several smaller, open cast (alluvial) diamond mining activities occurs in the Bakerville area. The aquifers tend to be relatively shallow. Groundwater is the only source of water supply for the rural population.

The total registered water use for IUA 9 (D41A) is 53.76 million m^3/a, of which 11 million m^3/a is for water supply to Mahikeng. The remaining 43 million m^3/a is used for rural water supplies, mining and irrigation practices.

The categorisation of groundwater in this IUA is set out in Table 52.

Table 52: IUA 9 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	Groundwater use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 9- D41A (Dolomite Aqf.)	973	50.79	53.47	105%	**III**	**III**	**I**
IUA 9- D41A (Other Aqf.)	2987	23.75	0.29	1.2%	**I**	**I**	**II**
IUA 9	3960	74.54	53.76	72%	**III**	**III**	**II**

Ecological condition and the Ecological Reserve

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 53.

Table 53: IUA 9 Molopo: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN66 HN67 HN39	D41A	Molopo at outlet of wetland Molopo at Modimola Molopo at outlet of IUA9	- Low Low	- Low Low	- E E		- D D	-	-	**II***

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only; *Groundwater classification

Wetlands

This IUA is also dominated by two ecoregions, namely Highveld to the east and Southern Kalahari to the west. Agriculture is an important sector in this IUA. A number of important wetlands occur in this IUA. These include the dolomitic eyes and peatlands associated with the two arms of the upper Molopo River which run east to west across the IUA. Again dolomite forms the main watershed of the Molopo River to the east of this IUA. Each of the arms of the Molopo River has peatlands and eyes at their source. The main Molopo eye feeds the arm to the north. The southern arm is referred to as the Droë Molopo River. The PES category of this

arm is C/D, mainly due to agricultural impacts whereas that of the main northern arm ranges from A/B to C/D. The EIS of both these arms is considered Very High. This is mainly due to the unique biodiversity associated with these systems as well as the fact that the wetlands represent a rare type of wetland in South Africa which is also unique to this particular region.

One cyprinid species in particular, *Barbus cf. brevipinnis* (a type of ghieliemientjie) is endemic to the Molopo and is currently under high risk of extinction due to loss of habitat as a result of reduced flows to the wetland area. Similarly, the ostracod diversity from the Molopo system showed that of all the species found in the area at the time of the survey, 30% were new to southern Africa and one species was new to science (DEA&T, 1995). The Molopo eye is also an important water supply source and thus the associated ecosystems and downstream wetland have been impacted by water abstraction. As with all the dolomitic peatlands in the region, it too is threatened by groundwater abstraction, contamination from agriculture, industry and mining, habitat transformation and invasions by alien species (particularly exotic plants e.g. poplars and fish species e.g. black bass). Tourism development in the form of clearing of natural habitat for grass lawns, braai areas, slip ways, terraces, etc. has also contributed towards the loss of natural habitat on the periphery of the eye. Working for Wetlands (WfWetlands) started doing rehabilitation work in the Molopo catchment in 2001 including in the headwaters. It has long been recognized that an integrated management strategy is required for conserving or maintaining these unique wetland systems.

The Mareetsane wetland near Mafeking also provides important ecosystem services for people, livestock and wildlife, including water supply and livelihoods support. It is on the Mareetsane River, which flows into the Molopo River. WfWetlands has been undertaking wetland rehabilitation work on this system. These projects were undertaken in partnership with the Local Municipality and Tribal Authority.

To the south is the Bodibe peatland along what is shown as the Potfonteinspruit on the 1:50000 topographic maps. As a result of a drop in groundwater levels in the dolomite, the peatland at the eye of the Bodibe system has dried and the peat started to burn. The system has been burning for a few years and this has not only resulted in the loss of the peatland, but also poses a health and safety hazard for people and livestock living adjacent to the peatland. Working for Wetlands (WfW) has done some work at the eye, mainly trying to prevent the fire from spreading west by creating a soil barrier across the system. This has not been successful and the system continues to burn. As a result of the degradation of the system, the PES category is D/E. The system would have had a High to Very High EIS but as a result of the desiccation, its biodiversity value has deteriorated.

Another feature of this IUA is an abundance of small pans. Inundation of these is characteristically ephemeral. Some of the pans can stand dry for years between temporary flooding (DWA, 2010). Water loss from pans is largely due to evaporation. The depressions and pans can receive both surface and groundwater flows, which accumulate in the depression owing to a generally impervious underlying layer which prevents the water draining away (DWA,

2010). The relative contributions of these different water sources may vary considerably amongst different depressions. Although the pans are not inundated for long periods at a time, they are still a good example of a specific type of wetland which occurs in this region.

Threats are mainly from agricultural activities including agricultural pollutants such as fertilizers, pesticides and herbicides. Road crossings intersect pans and disrupt hydrological movement of water. Runoff water from roads also contributes towards the silt load built-up in these pans. Pans in general have received little attention and this also applies to the systems associated with this IUA. No information could be found in the literature review relating to these systems and so very little is known about their hydrology or biogeochemistry. Further studies would be required on these systems to get a better understanding of their role and ecological importance in the region.

Priority wetlands in this IUA are set out in Table 54.

Table 54: IUA 9 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Pans	-	High	Dry Highveld Grassland Group 5 - LT	Western Highveld Sandy Grassland - CR	None	Endorheic temporary to seasonal depressions
-	Pans	-	High	Eastern Kalahari Bushveld Group 1 - LT	Mafikeng Bushveld – VU	Some	Endorheic seasonal grass-sedge depressions
-	Valley bottom wetlands	-	Moderate	Dry Highveld Grassland Group 5 - LT	No	No	-
-	Valley bottom wetlands	-	Moderate	Eastern Kalahari Bushveld Group 1 - LT	No	No	-
Molopo	Unchannelled valley bottom wetlands and peatlands	B to D	Very High	Dry Highveld Grassland Group 5 - LT	No	Yes	Molopo Eye and peatland. Is important for water supply and biodiversity support
Bodibe peatland	Unchannelled valley bottom wetlands	E/F	Very High	Dry Highveld Grassland Group 5 - LT	No	No	Potfontein eye and Bodibe peatland.

Economy

The IUA contains the town of Mafikeng, which is the capital of the North West Province and is an important regional hub. Socio-economic activities include commercial agriculture, dry-land and subsistence farming and limited tourism activities.

Conclusions and Proposed MC

The ecological category gives a recommended scenario that will be managed to a Class III (Table 55), and based on the groundwater categorisation it is recommended that it be managed to a groundwater Class III. A class III means that the water can still be developed.

Table 55: IUA Class for the Molopo based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	E	Management Class
% representation	100	III

Additional considerations to be noted and recommendations to be taken forward

Table 56: Proposed Management Actions and Implications for IUA 9

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows around Molopo Eye; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Status of contribution to base flow needs to be evaluated; • Assess municipal WWTW and industrial discharges in the area;	• DWA is responsible for ensuring flows around the eye and that used to supply domestic use; • The DWA must set RQOs to ensure the conservation areas are protected (must consider vulnerability of fires when peat dries out due to over-abstraction); • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • Working for wetlands should work with the Conservation Groups and Communities in the area to maintain the ecological importance status; • DWA and the local municipality must assess any discharges from industries and domestic WWTW to ensure that they adhere to the RQOs that will be set

4.11 MANAGEMENT CLASS IUA 10: DINOKANA EYE/NGOTWANE DAM

IUA Description

This IUA is mainly groundwater related to the Dinokana Eye. The water from the eye flows to the Ngotwane Dam at the border of Botswana and is mainly used for domestic purposes. The population of IUA 10 is 49 716 (Census, 2011).

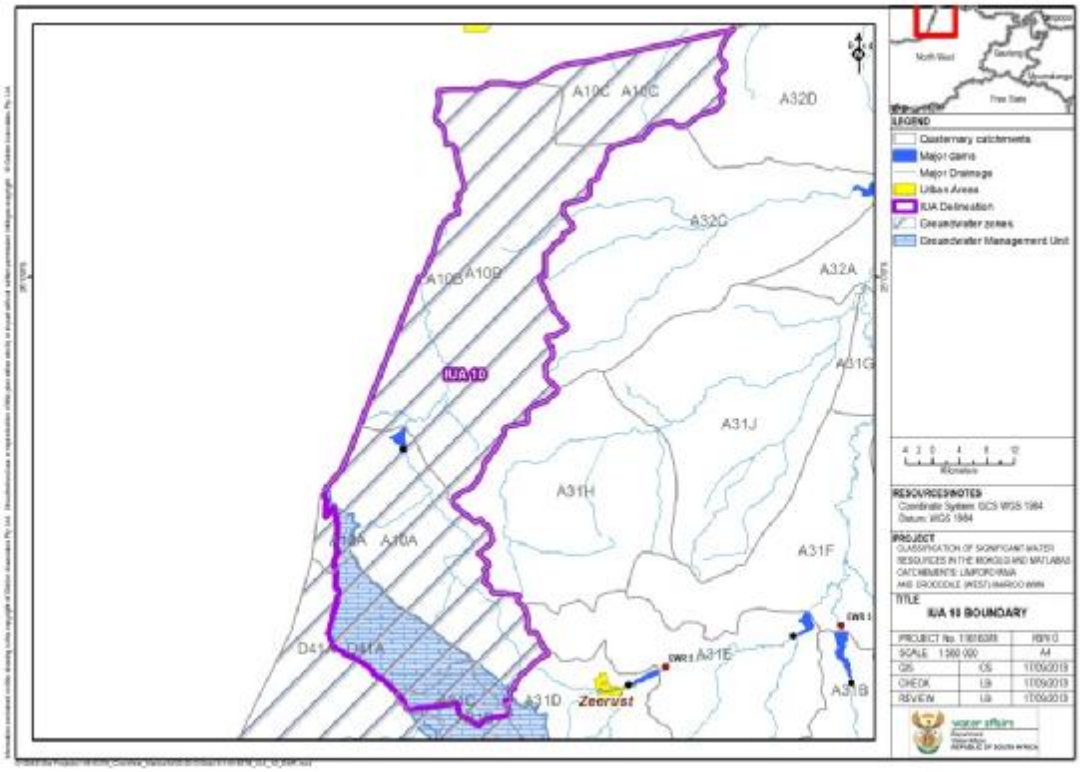

Figure 17: IUA 10 Dinokana Eye/Ngotwane Dam

Groundwater use

The estimated groundwater use in this IUA is 0.672 Mm^3/a. Groundwater categorisation is set out in Table 57.

Table 57: IUA 10 Groundwater

IUA	Area (Km^2)	Recharge Mm^3	Groundwater use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 10	832	19.945	0.672	3.4%	**I**	**II**	**-**

Wetlands

There are not many wetlands in this IUA but two important systems do occur, namely the Dinokana eye and associated wetland and the Ngotwana wetland. Both these wetlands provide important ecosystem services for people, livestock and wildlife, including water supply and livelihoods support. These wetlands are also the type localities of various animals, plants and fish. The PES category of the former D/E, mainly due to the impacts associated with the surrounding settlements and land degradation. The PES category of the latter ranges from A/B to C/D mainly as the area upstream is severely eroded due to overgrazing. The EIS of both these systems is considered to be High to Very High. This is mainly due to the unique biodiversity associated with these systems as well as the fact that the wetlands, *albeit* that they are quite different, each represent a particular type of wetland in which is also unique to this particular region.

Priority wetlands are set out in Table 58.

Table 58: IUA 10 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Ngotwana Wetland	Unchannelled valley bottom wetland and spring	B to D/E	High to Very High	Central Bushveld Group 2 - **VU**	No	No	High biodiversity wetland in semi-arid climate with its source in Botswana. Important grazing and water resource for local community
Dinokana eye and Wetland	Unchannelled valley bottom, spring and hillslope seepage wetlands	C to D/E	High to Very High	Central Bushveld Group 2 - **VU**	No	No	High biodiversity wetland and important for water supply

Economy

The IUA is largely rural in nature and contains dry land and subsistence agriculture.

Conclusions and Proposed MC

Based on the groundwater categorisation, it is recommended that this IUA be managed to a groundwater Management Class II.

Additional considerations to be noted and recommendations to be taken forward

Table 59: Proposed Management Actions and Implications for IUA 10

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater (more importantly) • Manage groundwater abstraction; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Status of contribution to base flow needs to be evaluated;	• DWA is responsible for ensuring flows around the eye (Dinokana) and that used to supply domestic use from the Ngotwane Dam; • The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess water quality and to assess impacts on the aquifer system and contributions to base flow; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law;

4.12 MANAGEMENT CLASS IUA 11a: GROOT MARICO/MOLATEDI DAM

IUA Description

The main river is the Groot Marico and a number of seasonal streams. The population of IUA 11a is a large rural population of 109 412 (Census, 2011).

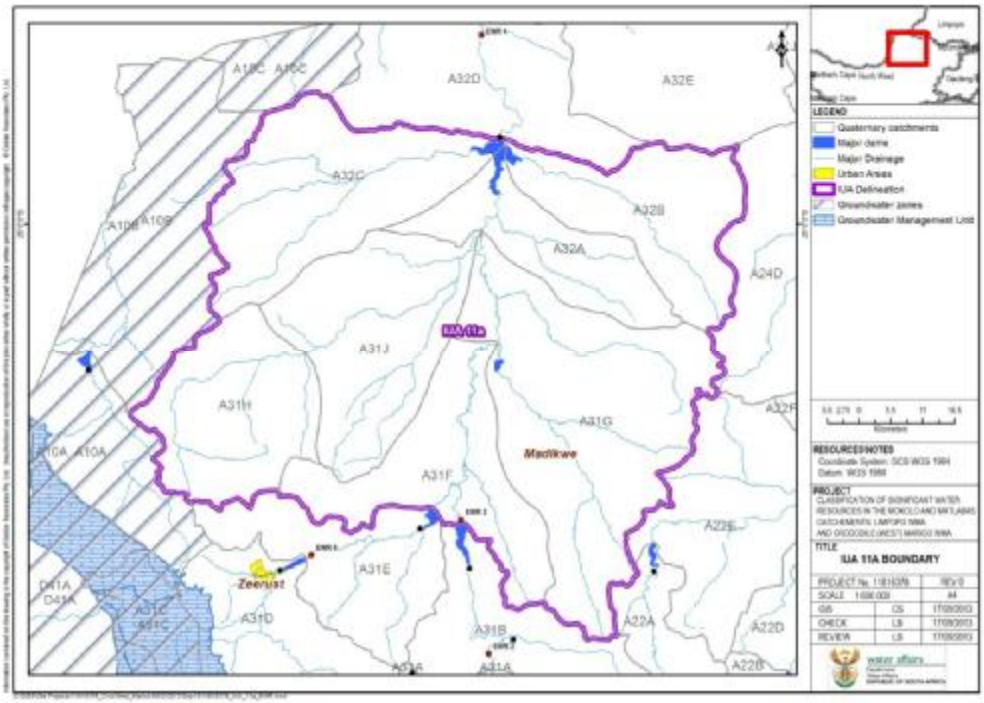

Figure 18: IUA 11a Groot Marico/Molatedi Dam

Ecological condition and the Ecological Reserve

The present state is a C category mainly due to the impact of the Molatedi Dam upstream and the release pattern from the Tswasa Weir for irrigation purposes just upstream of the EWR site.

The presence of Kromellemboog Dam (Klein Marico) and specifically the Marico Bosveld Dam just upstream of this IUA has severely impacted on the flow of the Marico River. Only small volumes of seepage from the dams are available instream. This resulted in a degraded system with a PES of a C/D. The EIS is high due to the species/taxon richness of the system and the presence of a number of inverts sensitive to water quality changes

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 60. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

There is one EWR site on the Groot Marico downstream Marico Bosveld Dam.

Table 60: IUA 11a Groot Marico/Molatedi Dam: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN40	A31F, G, A32A	Marico from Marico Bosveld and	High	High	C/D	C/D	B	65.08	23.62	**III**

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
		Kromelmboog Dam to Molatedi Dam (MAR_EWR3), outlet of IUA11a								

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2010 PES update (DWA, 2010).

[2)] Based on EWR for maintenance and drought flows only

Wetlands

Given the available information and due to the topography and soil type, and apart from pans, there do not appear to be many wetlands in this IUA. Where wetlands occur, they appear to be mostly associated with drainage lines and streams and low lying depressions and are widely dispersed. Based on examination of the aerial imagery, it appears that the SANBI probability map and NFEPA wetland coverage exaggerates the wetland extent and distribution around the dam in the north of the IUA. As such this representation is probably not accurate in this area.

Economy

This large IUA is largely rural in nature and contains a portion of the former Bophuthatswana Homeland. Major socio-economic activities in the IUA include: commercial agriculture, dry-land agriculture and subsistence farming. Local communities in the area are highly dependent on the ecosystem services delivered by the Groot Marico River.

Conclusions and Proposed MC

The hydrological modelling conducted showed that it is not possible to implement either a PES ecological category or a REC ecological category at EWR site 3 without a significant trade-off with existing water users, principally irrigation agriculture. It is recommended that the ecological classification be maintained at a C/D and be managed to a MC III (Table 61).

Table 61: IUA Class for the Groot Marico/Molatedi Dam catchment based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C/D	Management Class
% representation	100	III

Additional considerations to be noted and recommendations to be taken forward

Table 62: Proposed Management Actions and Implications for IUA 11a

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater;	DWA is responsible for ensuring irrigation flows are maintained in the upstream Marico Bosveld Dam and downstream and must work with irrigation farmers (existing and emerging to see how best to

Management Actions to improve the EC	Implications
• Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Work closely with irrigation farmers (existing and emerging) to assess water availability; • Map the wetland in more detail	utilise the irrigation water); • DWA must allow water leaking from dam to continue to maintain the ecology that has developed; • The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • Further work would be required at a more detailed scale to more accurately map the extent of wetlands in the IUA.

4.13 MANAGEMENT CLASS IUA 11b: GROOT MARICO/SEASONAL TRIBUTARIES

IUA Description

This IUA contains the Groot Marico and a number of seasonal tributaries. As with IUA 11a, IUA 11b is characterised by a large rural population with high unemployment rates. Numerous nature reserves and conservation areas, including the Madikwe Game Reserve that is one of the largest game reserves in South Africa is situated in the Marico catchment.

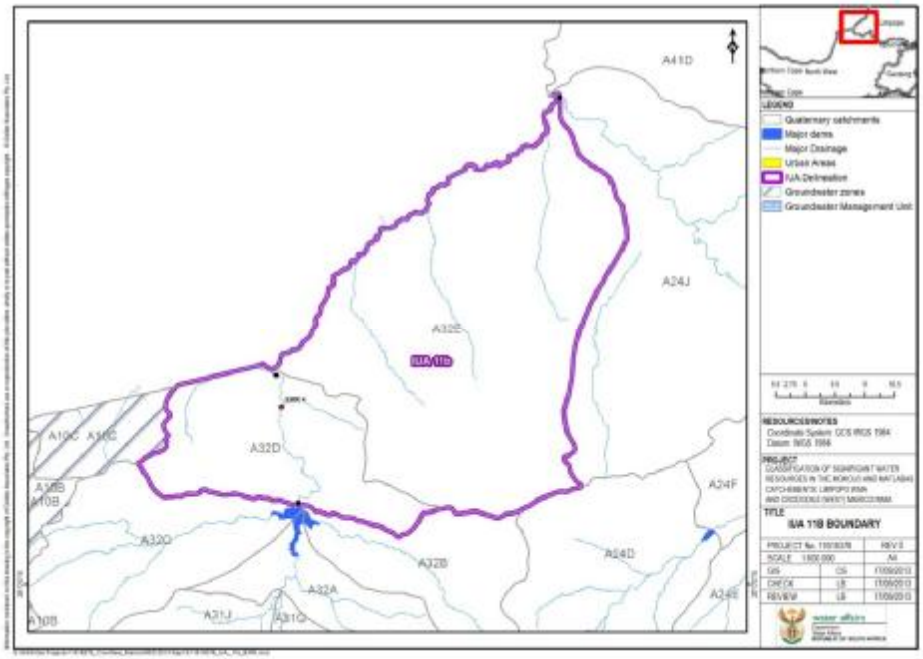

Figure 19: Groot Marico seasonal tributaries

Groundwater use

Groundwater use in IUA 11b is estimated at 0.576 Mm^3/a. The categorisation of groundwater in IUA 11b is set out in Table 63.

Table 63: IUA 11b Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 11b	4626	52.768	0.576	1%	**I**	**I**	**II**

Ecological condition and the Ecological Reserve

The present state is a C category mainly due to the impact of the Molatedi Dam upstream and the release pattern from the Tswasa Weir for irrigation purposes just upstream of the EWR site.

The EIS is high as this reach forms a natural refugia with a number of perennial pools and is adjacent to the Madikwe Provincial Nature Reserve. Water is currently transferred from Molatedi Dam to Botswana.

There is one EWR site on the Groot Marico downstream Tswasa Weir.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 64. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 64: IUA 13 Groot Marico and seasonal tributaries: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN41	A32D, E	Marico from Molatedi Dam to confluence with Crocodile (MAR_EWR4), outlet of IUA11b	High	High	C	C	B	153.25	7.96	**II**

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Wetlands

Given the available information and due to the topography and soil type, and apart from a few pans and the system along the lower Marico River, not many wetlands are indicated on the available databases for this IUA. Two fairly large wetland systems were however identified from the aerial imagery of the area. These include the lower section of the Lengope la Kgamanyane River just before the confluence with the Marico River and what appears to be an extensive floodplain-type system associated the Lenkwane River at and upstream of the confluence of the Marico River. Additional work would be required at a more detailed scale to accurately map the extent of these systems.

From consideration of the NFEPA maps as well as available aerial imagery, there is also an extensive riparian zone associated with the Marico River.

Floodplain wetland features also occur along the Marico River. Sections of the Marico River and its associated riparian zone as well as well as these wetland features are indicated as a WETFEPA. Pans also occur in this IUA. Some are indicated on the WETFEPA coverage.

Priority wetlands are set out in Table 65.

Table 65: Priority wetlands in IUA 11b

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Lower Marico River	Riparian zone and floodplains	B to D	Very High	Central Bushveld Group 2 - **VU**	No	Yes	Old growth riparian forest assemblages, floodplain features, paleo-channels as well as backwater features
Lengope la Kgamanyane River	Floodplain	C	High	Central Bushveld Group 2 – **VU**	No	No	-
Lenkwane River	Floodplain	C	High	Central Bushveld Group 2 - **VU**	No	No	-
-	Pans	B to D	High to Very High	Central Bushveld Group 2 - **Vu**	No	Some	

Economy

This IUA is largely rural in nature and contains a portion of the former Bophuthatswana Homeland. Major socio-economic activities in the IUA include: commercial agriculture, dry-land agriculture and subsistence farming. Local communities in the area are highly dependent on the ecosystem services delivered by the Groot Marico River.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC III is recommended for IUA 11b (Table 66) even though the ecological category should be maintained as a C.

Table 66: IUA 11b Class for the Groot Marico seasonal tributaries based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C	Management Class
% representation	100	III

Additional considerations to be noted and recommendations to be taken forward

Table 67: Proposed Management Actions and Implications for IUA 11b

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Map the wetlands in more detail	• DWA is responsible for ensuring flows from the Molatedi Dam and for monitoring release pattern from the Tswasa Weir for irrigation and transfer to Botswana; • The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system and contributions to base flow; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • Further work would be required at a more detailed scale to more accurately map the extent of wetlands in the IUA.

4.14 MANAGEMENT CLASS IUA 12: BIERSPRUIT

IUA Description

The main rivers of the IUA are Wilgespruit, Bierspruit and some seasonal tributaries. The population of IUA 12 is 111 987 (Census, 2011).

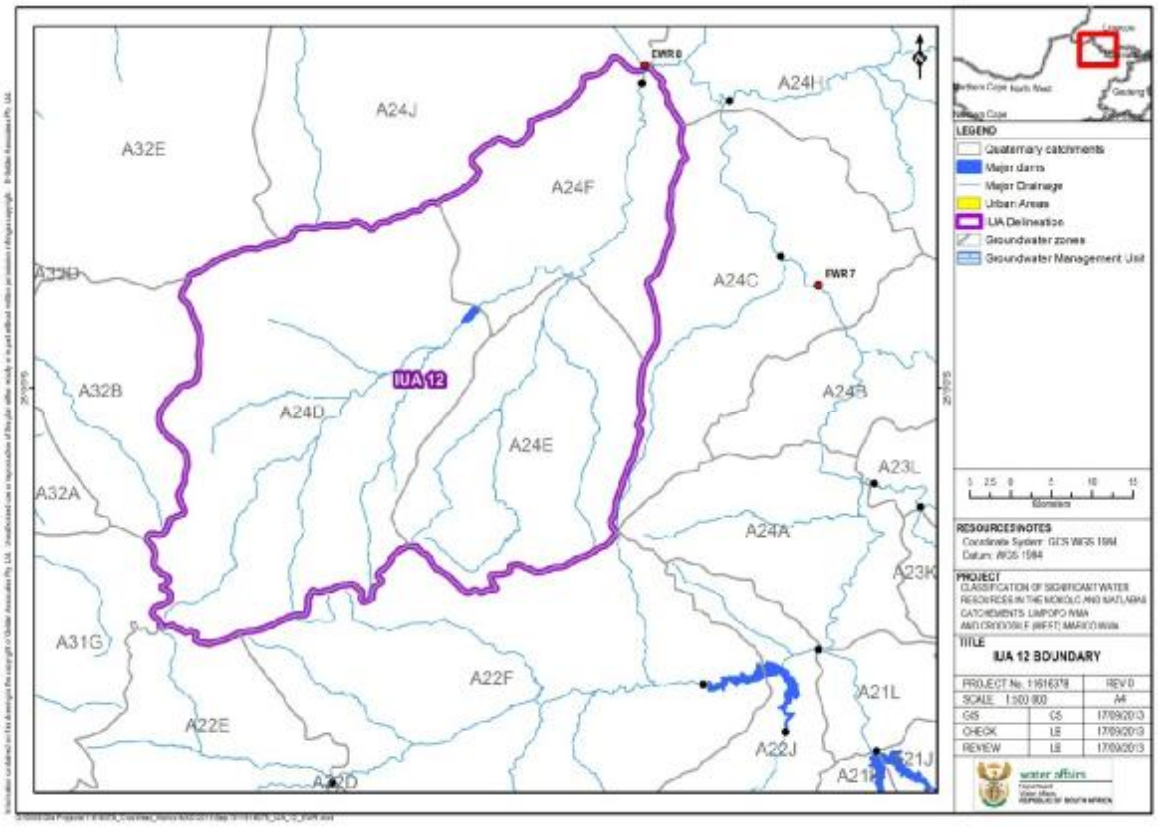

Figure 20: Bierspruit and seasonal tributaries

Groundwater use

Estimated groundwater use in IUA 12 is 6.077 Mm^3/a. The groundwater categorisation in this IUA is set out in Table 68.

Table 68: IUA 12 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	Ground water use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 12	2606	43.222	6.077	14%	**I**	**I**	**II**

Ecological condition and the Ecological Reserve

The water resources are degraded due to mining activities, town development and irrigation in the catchment. The Bierspruit Dam is situated in the upper reaches of the Bierspruit.

There are no EWR sites in this IUA.

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN42	A24D, E, F	Bierspruit to confluence with Crocodile River, outlet of IUA12	Mod	Mod	D		C	-	-	**III**

Wetlands

Given the available information and due to the topography and soil type, there do not appear to be many wetlands in this IUA. It is likely that hillslope seepages would occur on the granites as this would be expected due to the sandy nature of these soils. Shallow groundwater movement would be a key driver of these systems. As these systems are sometimes difficult to detect, even in the field, identifying signatures remotely is even more difficult.

Economy

The IUA contains the town of Thabazimbi. Mining is an important sector in this IUA, with iron ore and andalusite, significant examples. The IUA is also important as a hunting area and the Pilansberg National Park is found here.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC II is recommended for IUA 12 (Table 69).

Table 69: IUA Class for the Bierspruit and seasonal tributaries based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	D	Management Class
% representation	100	III

Additional considerations to be noted and recommendations to be taken forward

Table 70: Proposed Management Actions and Implications for IUA 12

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Map the wetlands in more detail	• The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads once it is in place; • Further work would be required at a more detailed scale to more accurately map the extent of wetlands in the IUA.

4.15 MANAGEMENT CLASS IUA 13: LOWER CROCODILE

IUA Description

The main rivers in this IUA are the Crocodile West and smaller tributaries (Sand). The population of IUA 13 is 88 962 (Census, 2011).

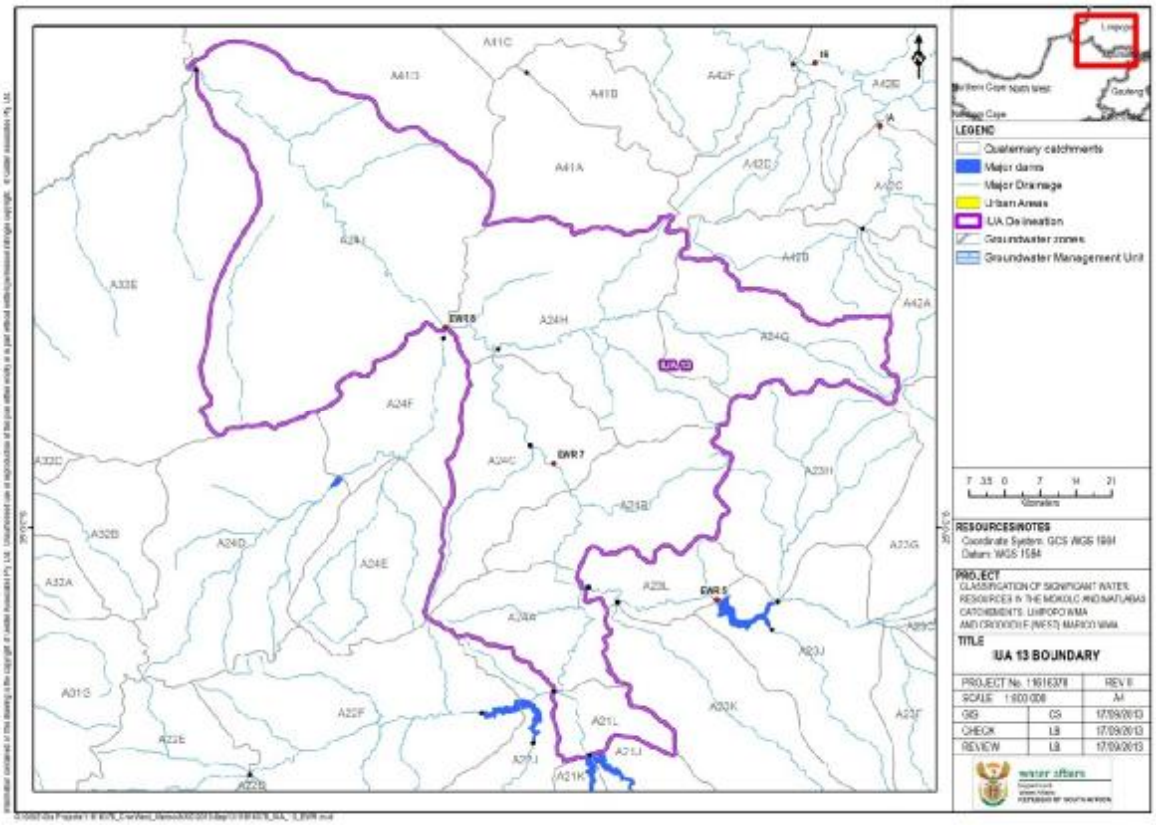

Figure 21: IUA 13: Lower Crocodile

Groundwater use

Groundwater use in IUA 13 is 59.866 Mm^3/a. The categorisation of the groundwater in IUA 13 is set out in Table 71.

Table 71: IUA 13 Groundwater categorisation

IUA	Area (Km^2)	Recharge Mm^3	[1]Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 13	6805	146.281	59.866	41%	**II**	**II**	**II**

Ecological condition and the Ecological Reserve

The water resources are in a C to D category mainly due to irrigation use and return flows. The proposed transfer of water to Lephalale is situated in the middle reaches of the river, downstream of Thabazimbi

The EWR sites in the IUA are on the Crocodile upstream of the confluence with the Bierspruit and on the Crocodile in the Ben Alberts Nature Reserve.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 72. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 72: IUA 13 Lower Crocodile: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Defau lt REC[1)]	Natural MAR (mcm/ a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN43	A24G, A24H	Sand to confluence with Crocodile	Mod	Mod	C		C	-	-	III
HN44	A21L, A24A-C, A24H	Crocodile from Roodekopjes Dam (CROC_EWR7) to proposed Mokolo transfer (CROC_EWR8)	Mod	Mod	D	D	C	463.8	9.14	
HN45	A24J	Crocodile from CROC_EWR8 to confluence with Limpopo, outlet of IUA13	Mod	Mod	C	C	C	559.9	14.22	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update
[2)] Based on EWR for maintenance and drought flows only

Wetlands

The dominant land use in IUA 13 (which comprises of the lower reaches of the Crocodile River) is largely natural, but irrigation along the Crocodile River main stem is an important contributor to local GDP. Some granite mining is found in IUA 13. Again, given the available information and due to the topography and soil type, and apart from a few pans, there do not appear to be many wetlands in this IUA apart from pans. Where wetlands occur, they appear to be mostly associated with drainage lines and streams and low lying depressions and are widely dispersed. As with IUA 12, it is likely that hillslope seepages would occur on the granites as this would be expected due to the sandy nature of these soils. Shallow groundwater movement would be a key driver of these systems. As these systems are sometimes difficult to detect, even in the field, identifying signatures remotely is even more difficult. Sections of the Crocodile River and its associated off-channel wetlands and floodplain are indicated as a WETFEPA. Further work would be required at a more detailed scale to more accurately map the extent of wetlands in the IUA.

Table 73: Priority wetlands in IUA 13

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Sections of the Crocodile River	Riparian zone, off-channel wetlands, backwaters	B to D	High	Central Bushveld Grou**p 2 and 3 – VU to EN**	No	Yes	Riparian zone, floodplain and off-channel features

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
	and floodplains						

Economy

This large IUA is primarily agricultural in nature and contains commercial agriculture, dry-land and subsistence agriculture. In addition, the area has large hunting and private conservation areas.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC III is recommended for IUA 13 (Table 74).

Table 74: IUA Class for the Lower Crocodile based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	C	D	Management Class
% representation	66.7	33.3	III

Additional considerations to be noted and recommendations to be taken forward

Table 75: Proposed Management Actions and Implications for IUA 13

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Monitor the transfer of water to Lepahale when it comes into play; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs;	• The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess water quality and to assess impacts on the aquifer system; and to assess the transfer of water to Lephalale; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads once it is in place;

4.16 MANAGEMENT CLASS IUA 14: TOLWANE/KULWANE/MORETELE/KLIPVOOR

IUA Description

The main rivers in this IUA are the Pienaar/Moretele, Plat, Riet, Tolwane, Kutswane and Tshwane. The population in IUA 14 is 1 304 137.

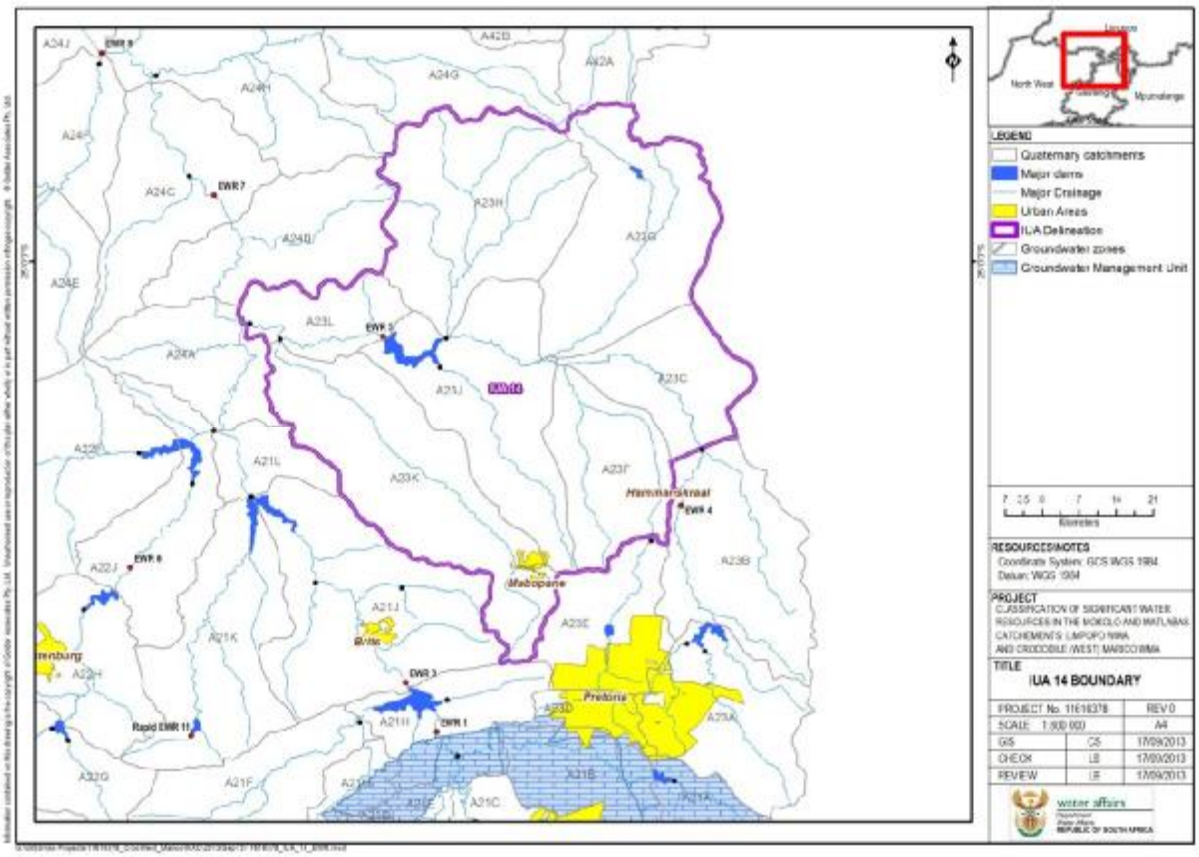

Figure 22: IUA 14: Tolwane/Kulwane/Moretele/Klipvoor

Ecological condition and the Ecological Reserve

The lower reach of the Pienaars/Moretele River flows through the extensive Moretele Floodplain and the Borakalalo National Park. Klipvoor Dam is situated in this reach. The present state is in a D category mainly due to the changes in flow as a result of the releases from the dams and water quality impacts from upstream urbanization, specifically decrease in water quality related to WWTWs.

The EIS is high due to the presence of the unique *Barbus rappax* and a number of fish species (*Chiloglanis pretoriae, Labeobarbus marequensis, Labeo cylindricus, Labeo molybdinus*) and inverts intolerant to water quality and flow changes.

The downstream reach is important for fish movement, especially with Roodeplaat and Klipvoor Dams upstream and downstream of the site.

The EWR sites are on the Pienaars/Moretele, downstream of Klipvoor Dam in Borakalalo National Park and a Rapid III site on Buffelspruit before the confluence with the Plat River.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 76. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 76: IUA 14: Tolwane/Kulwane/Moretele/Klipvoor: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Defau lt REC[1)]	Natural MAR (mcm/ a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN46	A23G	Platspruit (source, CROC_EWR12) to confluence with Pienaars	Mod	Mod	B/C	B/C	C	3.144	35.85	
-	A23C, A23F	Wetland at Pienaars & Apies confluence and inflow to Klipvoor Dam	Mod	Mod	C		C	-	-	
HN47	A23H	Karee/Rietspruit to confluence with Pienaars	Mod	Mod	C		C	-	-	**III**
HN48	A23J A23J, A23L	Moretele (Pienaars) to confluence with Crocodile (CROC_EWR5), outlet of IUA14	High	High	D	C	B	113.0	11.82	
HN49	A23K	Tolwane to confluence with Moretele	High	High	D		B	-	-	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Wetlands

Based on the current conditions, an understanding of the geomorphology, drainage patterns, and soils in this IUA, four wetland types have been identified. These are pans or depressions, hillslope seepage wetlands, unchannelled valley bottom wetlands, channelled valley bottom wetlands and floodplains.

The largest and probably one of the most important systems in this IUA is the Moretele or Pienaars River floodplain. Together with the Apies River floodplain which is also in this IUA and which flows into the Moretele, this combined system forms the second largest floodplain in the Bushveld Ecoregion. It also represents the southern-most natural distribution of Wild Rice (*Oryza longistaminata*) in Africa. The floodplain is used extensively by the surrounding communities for fishing and grazing and is also regarded as an important birding area, with the floodplain and surrounding area supporting 362 of the 461 species recorded in the North West Province. The wetland also includes traditionally sacred sites which have high cultural significance.

Based on Noble and Hemens (1978) and Rogers (1995) definition, the floodplain can be classified as a "storage floodplain". This category of riparian wetlands is characterised by the occurrence of a riverine area and a grassy floodplain of varying width on either side and is able to retain standing water in oxbow lakes and backwaters for long periods between floods. The riverine area may be permanently or seasonally inundated while the grassy floodplain is more

seasonally to intermittently inundated following flooding events. The PES is indicated as C/D to D/E, mainly due to the changes in the systems as a result of the modification of flow due to urban development upstream and sewage as well as agricultural return flows. The EIS is considered to be Very High.

The wetlands within the Borakalalo National Park are also considered of high conservation value, despite being heavily degraded. They have also been the focus of WfWetlands work over the past few years. Borakalalo forms the western end of the Moretele floodplain. The Tswaing Crator and its associated pan or depression wetland also fall within this IUA.

Priority wetlands in the IUA are set out in Table 77.

Table 77: IUA 14 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Moretele River floodplain	Floodplain	D to E	Very High	Central Bushveld Group 2 - **VU**	Springbokvlakte Thornveld - **VU**	Yes	High biodiversity wetland and important bird habitat. Important grazing resource for local community
Apies River floodplain	Floodplain	E to F	Very High	Central Bushveld Group 2 - **VU**	Springbokvlakte Thornveld - **VU**	No	Important grazing resource for local community
Tswaing Crator	Depression	-	Very High	Central Bushveld Group 2 - **VU**	No	Yes	Unique endorheic system

Economy

This IUA contains the peri-urban areas of Mabopane and a portion of Hammanskraal, which have large populations. The IUA contains commercial agriculture, dry-land and subsistence agriculture. The Moretele flood plain is important from an ecosystems services point of view as it supports grazing in the dry season. The floodplain is also an important birding area. The IUA also contains the Borakalalo Game Reserve.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC III is recommended for IUA 14 (Table 78).

Table 78: IUA Class for the Tolwane/Kulwane/Moretele/Klipvoor based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B/C	C	D	Management Class
% representation	20	40	40	II

Additional considerations to be noted and recommendations to be taken forward

Table 79: Proposed Management Actions and Implications for IUA 14

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Assess nutrient loads and overall water quality from WWTWs and upgrade if needed;	• DWA is responsible for ensuring flows are maintained from Roodeplaat Dam and Klipvoor Dam; • The DWA must set RQOs to ensure the conservation areas are protected, especially considering how the Moretele floodplain can be maintained both in terms of water quality and quantity to prevent further degradation of the floodplain; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law; • The DWA R/O or CMA will be responsible for implementing the Waste Discharge Charge System to reduce nutrient and salt loads once it is in place; • Municipalities must assess the WWTWs in terms of nutrients being discharged and overall effluent quality and do upgrades as needed;

4.17 MANAGEMENT CLASS IUA 15: UPPER MOKOLO

IUA Description

The main rivers in this IUA are the Mokolo, Sand, Klein Sand, Grootspruit and a number of smaller tributaries. The population of IUA 15 is 27 238 (Census, 2011).

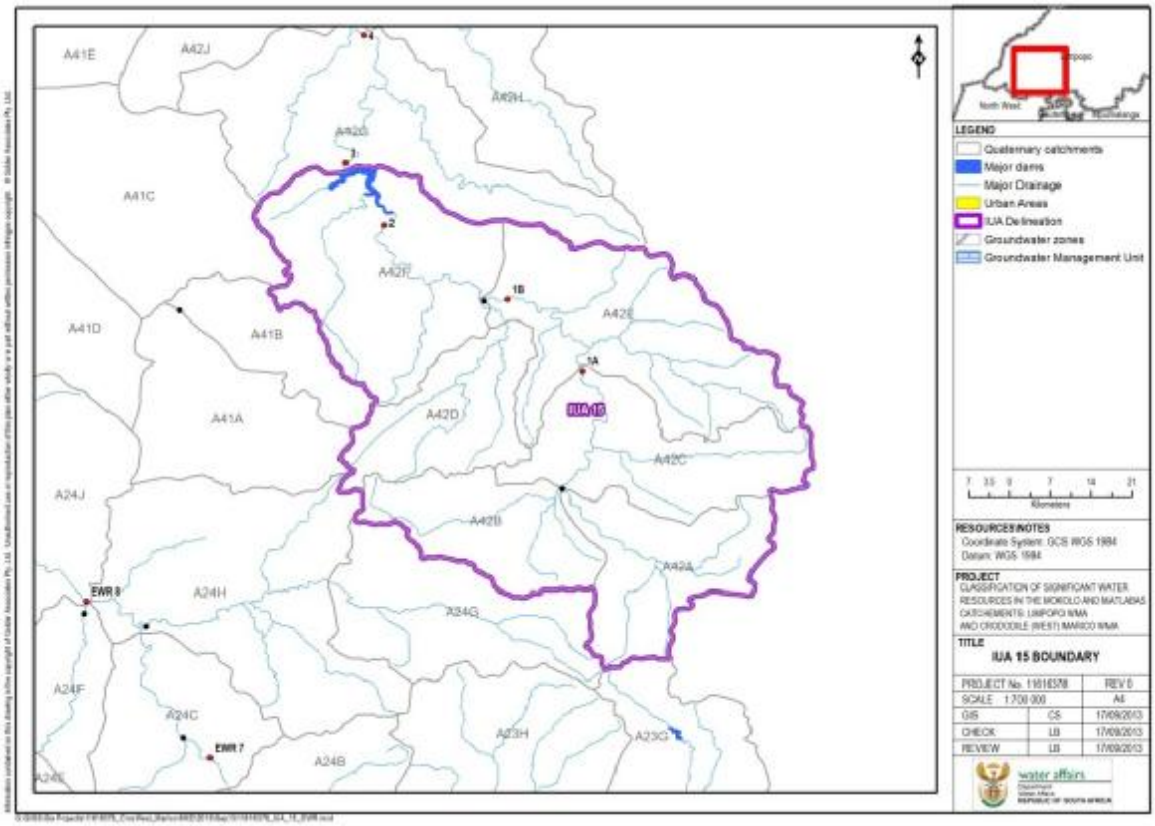

Figure 23: IUA 15: Upper Mokolo catchment

Groundwater use

Groundwater use in IUA 15 is estimated at 28.22 Mm^3/a. Groundwater categorisation in IUA 15 is set out in Table 80.

Table 80: IUA 15 Groundwater use

IUA Catchment	QC	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA15 **Upper Mokolo**	A42A	1095	33.96	9.02	27%	**II**	**I**	**II**
	A42B-F	3224	99.33	19.20	19%	**I**	**I**	**II**
	A42H-J	2869	30.95	2.21	7%	**I**	**II**	**III**

Ecological condition and the Ecological Reserve

Rivers: Mokolo, Sand, Klein Sand, Grootspruit and a number of smaller tributaries

The PES is a C/D category mainly due to the abstractions for irrigation purposes and general farming activities. The EIS is high due to the presence of rare and endangered mammals, reptiles and unique fish species.

Rivers: Frikkie-se-Loop, Sterkstroom, Dwars, Mokolo

The present state is in a B/C category with farming activities the main impact on the water resources. The EIS is high due to the presence of rare and endangered mammals, reptiles and unique fish species and the taxon and species richness of the system.

Rivers: Taaibosspruit, Mokolo

The present state is in a B/C category with farming activities and abstraction weirs the main impacts on the water resources. The EIS is very high due to the presence of rare and endangered mammals, reptiles and unique fish and invert species and the taxon and species richness of the system.

There are three EWR Sites in thus IUA: Mokolo: Vaalwater, Mokolo: Tobacco and Mokolo: Ka'ingo.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 81. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 81: IUA 15 Upper Mokolo: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Defau lt REC[1)]	Natural MAR (mcm/ a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN50	A42A	Sand (source) to confluence with Grootspruit	Mod	Mod	C		C	-	-	
HN51	A42B	Grootspruit (source) to confluence with Sand	Mod	Mod	C		C	-	-	
HN52	A42C	Mokolo to confluence with Dwars (MOK_EWR1a)	High	High	C/D	B/C	B	84.84	22.6	
HN53	A42D, A42E	Mokolo to confluence with Sterkstroom (MOK_EWR1b)	High	High	B/C	B	B	135.03	17.6	II
HN54	A42D	Sterkstroom (source) to confluence with Mokolo, including Dwars	High	High	B/C		B	-	-	
HN55	A42F	Mokolo from Sterkstroom to Mokolo Dam (MOK_EWR2), outlet of IUA15	Very high	Very high	B/C	B	A	196.2	19.8	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Wetlands

This IUA comprises the watershed and upper catchment of the Mokolo River. This area is characterized by steep mountain slopes of the Waterberg with sandy nutrient poor soils, rocky plateaus and mixed broad leaved savanna bushveld. The wetland systems typically found include hillslope seepage wetlands, sheetrock wetlands and channeled and unchanneled valley-bottom systems. Water quality is typically good, and the streams are flanked by narrow riparian zones with the larger dominant tree typically being the Waterberry (*Syzygium cordatum*) and water pear (*Syzygium guineense)*. Valley-bottom wetlands typically comprise a mixture of tall emergent plants such as the common reed *Phragmites australis* and the grass *Miscanthus junceus* and shorter grass-sedge meadows dominated by *Leersia hexandra* and Red vlei grass (*Ischaemum fasciculatum*). The main ecosystem services supplied by these systems include flood attenuation, water quality enhancement, streamflow augmentation and biodiversity maintenance.

Extensive wetland systems occur in the Sand River catchment (southern-most watershed of the Mokolo River). They form important habitat for Blue cranes and are thus of high importance from a conservation and biodiversity perspective. Land use in the area is mostly agricultural and as a result many of the wetland systems have been degraded. WfWetlands targeted the area for wetland rehabilitation and to date a number of projects have been implemented. The Thaba Metsi wetland was also targeted as part of this work. In addition to these wetlands, the riparian and instream habitats of the Sterkstroom, Taaibosspruit and Rietspruit are also considered important ecologically. These are also some of the remaining rivers in the catchment that still support flow dependent fish species (River Health Programme, 2006). At the catchment scale the wetlands in IUA 15 are expected to provide valuable ecosystem services, most notably streamflow augmentation, but also biodiversity support, and, due to their largely unchannelled, diffuse-flow nature, flood attenuation, sediment trapping and water quality improvement functions (DWA, 2010).

The land use in the catchment is game farming, and it can be considered to be largely pristine in parts, consisting of mixed broad-leafed woodland. Other parts of the IUA are however heavily impacted by agricultural practices, particularly in the areas where the topography is not so steep. In the agricultural areas, the PES of the wetlands is usually in a category C/D while in the nature reserves and game farms this improves to A/B. Extensive desktop mapping was undertaken in this IUA and the wetland map derived is considered to be reasonable accurate at that level.

Priority wetlands are set out in Table 82.

Table 82: IUA 15 Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Valley bottom wetlands	A/B to C/D	High	Central Bushveld Group 3 - **EN**	No	Yes	Part of the Waterberg system with a unique combination of flora and faunal

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
							associations
-	Valley bottom wetlands	A/B to C/D	High	Central Bushveld Group 1 - **EN**	No	No	Part of the Waterberg system with a unique combination of flora and faunal associations. I
-	Hillslope seepage wetlands	A/B to C/D	High	Central Bushveld Group 3 - **EN**	No	No	Part of the Waterberg system with a unique combination of flora and faunal associations
-	Hillslope seepage wetlands	A/B to C/D	High	Central Bushveld Group 1 - **EN**	No	No	Part of the Waterberg system with a unique combination of flora and faunal associations

Economy

The IUA is largely comprised of a mix between conservation and game farming. The IUA contains some commercial agriculture. Tourism, in the form of hunting and game viewing, is an important sector in this IUA. At present, a pipeline is being built from the Mokolo Dam to supply the Grootgeluk Coal Mine in IUA 16.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC II is recommended for IUA 11b (Table 83).

Table 83: IUA 15 Class for the Upper Mokolo based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B/C	C	C/D	Management Class
% representation	50	33.3	16.7	II

Additional considerations to be noted and recommendations to be taken forward

Table 84: Proposed Management Actions and Implications

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs;	• DWA is responsible for ensuring irrigation flows are maintained in the upstream Marico Bosveld Dam and downstream and must work with irrigation farmers (existing and emerging to see how best to utilise the irrigation water); • The DWA must set RQOs to ensure the conservation areas are protected especially in relation to wetlands in the Sand River catchment (southern-most watershed of the Mokolo River) which form an important habitat

Management Actions to improve the EC	Implications
• Work closely with irrigation farmers (existing and emerging) to assess water availability;	for Blue cranes and are thus of high importance from a conservation and biodiversity perspective; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law;

4.18 MANAGEMENT CLASS IUA 16: LOWER MOKOLO

IUA Description

IUA 16 is found within the lower Mokolo Catchment and is largely rural in nature with large tracts of land set aside for game farming and hunting. This IUA also contains the Matimba coal fired power station and the Medupi power station (under construction). The population of IUA 16 is 46 276 (Census, 2011).

Groundwater use

The estimated groundwater use in IUA 16 is 2.34 Mm^3/a. The groundwater categorisation for the IUA is set out in Table 85.

Table 85: IUA 16 Groundwater categorisation

IUA Catchment	QC	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA16 **Lower Mokolo**	A42G	1207	26.40	0.13	1%	**I**	**I**	**III**
	A42H-J	2869	30.95	2.21	7%	**I**	**II**	**III**

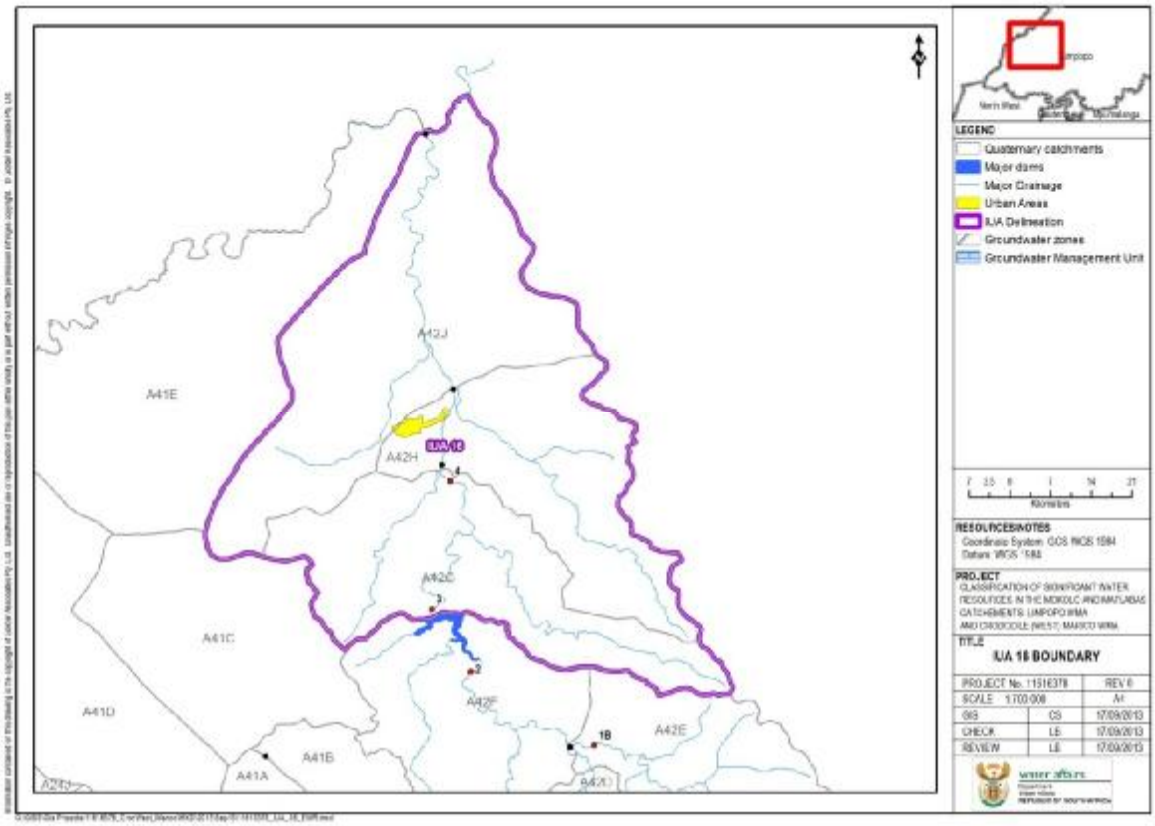

Figure 24: IUA 16: Lower Mokolo

Ecological condition and the Ecological Reserve

Rivers: Mokolo, Malmanies, Bulspruit

The present state is in a B/C category with farming activities and the Mokolo Dam the main impacts on the water resources. The EIS is very high due to the presence of rare and endangered biota and fish species intolerant to water quality changes.

Rivers: Mokolo, Rietpruit

The present state is in a C category with farming activities and the Mokolo Dam the main impacts on the water resources. The EIS is very high due to the presence of rare and endangered biota and fish species intolerant to water quality changes.

Rivers: Mokolo, Tambotie, Sandloop

This reach of the river was assessed as a floodplain. The IHI for the floodplain was determined as a D category due to decreased flows, farming activities and sand mining that changed the groundwater characteristics of the system.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 86. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 86: IUA 16: Lower Mokolo: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Defau lt REC[1)]	Natural MAR (mcm/ a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN56 HN57	A42G	Rietspruit (source) to Mokolo confluence Mokolo below dam (MOK_EWR3) to Rietspruit confluence (MOK_EWR4)	Mod Very High	Mod Very High	B/C B/C	B	C A	214.5	12.5	II
HN58	A42H, A42J	Mokolo from MOK_EWR4 to confluence with Limpopo, outlet of IUA16.	Very High	Very High	C	B	A	253.3	16.5	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Wetlands

Downstream of the Mokolo Dam the Mokolo River enters the Limpopo plain. Here colluvial processes dominate and the river and associated riparian and wetland habitats are controlled by the deposition, transport and erosion of sediment (Figure 31). Here the alluvial (river process driven) aquifer supports an extensive riparian forest fringe and instream biota. The riparian zone in particular, which includes large specimens of the Nyala berry (*Xanthocercis zambesiaca*), Waterberry (*Syzygium cordatum*) and the Tamboti (*Spirostachys africana*), is dependent on this shallow alluvial aquifer system. The lower reaches also support Leadwood trees (*Combretum imberbe*). The pools and backwater floodplains associated with the lower Mokolo River provide valuable refugia for river and wetland biota during dry periods and thus play a valuable biodiversity support role. The floodplains also provide high quality grazing for the farms located along these areas and sediment trapping and flood attenuation during high flow periods (DWA, 2010)

In the vicinity of Lephalale, the river is extensively used for sand mining. This together with the regulated flows from the Mokolo Dam upstream has affected the structure of the river along this reach with resulting alterations to the flow regime and pattern. There is also evidence suggesting that the resulting changes have not only affected the distribution and abundance of reedbeds in the system, but also the alluvial aquifer which in turn is impacting on the instream and riparian ecosystem. The reduction in flows and large floods due to upstream dams and abstraction is expected to have reduced the recharge of the river-associated wetlands (ox-bows and backwater pools) along the lower section of the Mokolo River (DWA, 2010).

The Tambotie River which flows through D'Nyala Nature Reserve and joins the Mokolo River near to Lephalale, is also regarded as an important system. The floodplain of the Tambotie River supports an extensive population of Tamboti (*Spirostachys Africana*) and Leadwood trees (*Combretum imberbe*). Water abstraction and the droughts experienced in the 1980's and early 1990's impacted on the system and with the drying out of the alluvial aquifer during this time,

many of the Leadwood trees died. This floodplain system is nevertheless considered to have high ecological importance and sensitivity and is a key wetland in the region.

The priority wetlands in IUA 16 are listed in Table 87.

Table 87: Preliminary list of priority wetlands in IUA 16

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
-	Valley bottom wetlands	-	High	Central Bushveld Group 4 – **VU** to **EN**	No	No	-
-	Hillslope seepage wetlands	-	High	Central Bushveld Group 4 - **VU**	No	No	-
Mokolo River and floodplain	Floodplain	C/D to D/E	High	Central Bushveld Group 4 - **VU**	No	Yes	Old growth riparian forest assemblages, alluvial aquifer and floodplain as well as backwater features
Tambotie River floodplain	Floodplain	C/D to D/E	High to Very High	Central Bushveld Group 4 - **VU**	No	No	Old growth riparian forest assemblages, alluvial aquifer and floodplain features

Economy

The IUA contains the town of Lephalale. The area is an important future energy hub and contains the Matimba power station as well as the Medupi power station, which is under construction. The Grootgeluk Coal Mine is in the IUA and several new coalmines have been earmarked for the future. The IUA is also important from a game farming and conservation perspective and contains the D'Nyala Nature Reserve.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC II is recommended for IUA 16 (Table 88).

Table 88: IUA Class for the Lower Mokolo based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B/C	C	Management Class
% representation	66.7	33.3	II

Additional considerations to be noted and recommendations to be taken forward

Table 89: Proposed Management Actions and Implications in IUA 16

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and	• DWA is responsible for maintaining flows from the Mokolo Dam; • The DWA must set RQOs to ensure the

Management Actions to improve the EC	Implications
groundwater; • Maintain flows; • Improve water quality (reduce nutrient and salt loads); • Set RQOs; • Implement water use authorisations; • Stop unlawful water use; • Implement the EWRs; • Sustainability of resources in close proximity of rivers with base flow requirements needs to be assessed;	conservation areas are protected (especially the Tambotie floodplain area); • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether EWRs are being met, to assess the water quality and to assess impacts on the aquifer system; • The DWA should set up a study with a research organisation (such as WRC) to assess the sustainability of resources in close proximity of rivers with base flow requirements; • The Regional Office or CMA must ensure that water users are registered and authorised correctly, audited as required and that water use licences issued, are in line with RQOs; • The DWA Monitoring and Enforcement Directorate must ensure that all water users are acting within the law;

4.19 MANAGEMENT CLASS IUA 17a: MOTHLABATSI/MAMBA

IUA Description

The main rivers in this IUA are the Mamba and Motlhabatsi. The population in IUA 17a is 4 983 (Census, 2011).

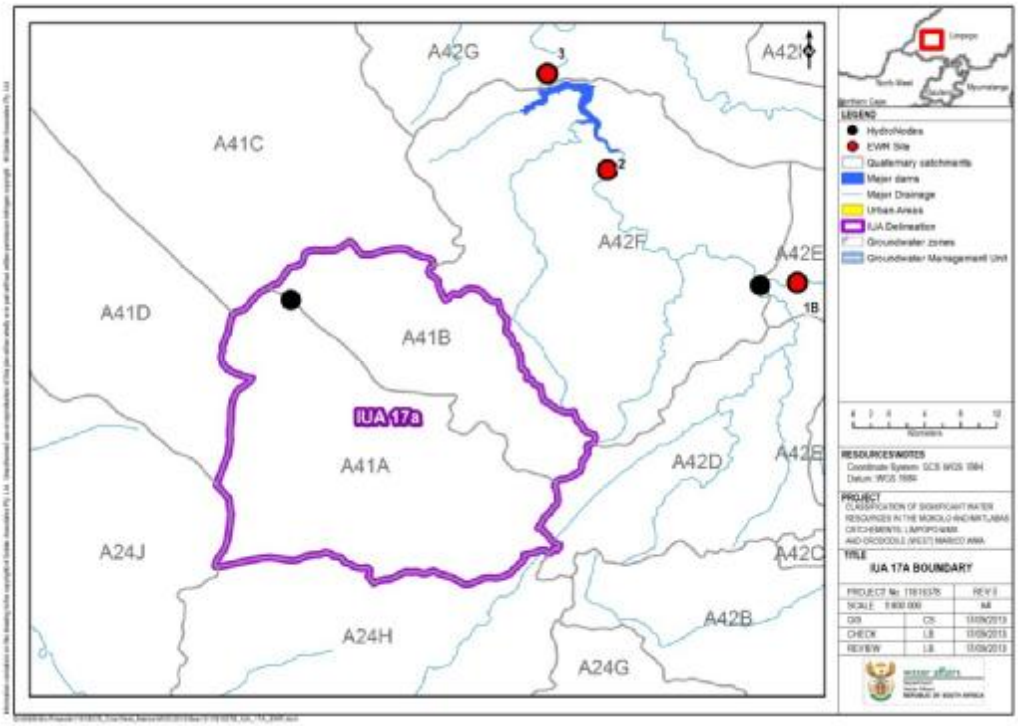

Figure 25: IUA 17a: Mothlabatsi/Mamba

Groundwater use

The estimated groundwater use in IUA 17a is 1.95 Mm^3/a. The groundwater categorisation is set out in Table 90.

Table 90: IUA 17a Groundwater categorisation

IUA	QC's	Area (Km^2)	Recharge Mm^3	Groundwater Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
IUA 17a **Upper Matlabas**	A41A A41B	1050	25.53	0.465	2%	**I**	**I**	**-**

Ecological condition and the Ecological Reserve

The present state is in a C category with a high EIS. The Matlabas River flows through the Marakele Nature Reserve with a present state on a B.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 90. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 91: IUA 17a Mothlabatsi/Mamba: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN59	A41A	Mothlabatsi to confluence with Mamba	Very High	Very High	B	A	A	5.23	57.07	**I**
HN60	A41B	Mamba to confluence with Mothlabatsi, outlet of IUA17a	Mod	Mod	B/C	B/C	C	9.54	35.49	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Wetlands

The Matlabas River flows through the Marakele Nature Reserve. The park is characterized by the Waterberg Moist Bushveld vegetation type (veld type 12), mixed Bushveld (veld type 18) and the Sweet Bushveld (veld type 17). The Sweet Bushveld is mostly found along the banks of the Matlabas River and forms an important winter refuge area for game particularly during limiting periods at the end of the dry season.

Given the available information not many wetlands have been mapped in this IUA. While there are expected to be many smaller wetlands associated with the drainage lines in the Waterberg in particular, these cannot easily be identified using remote mapping techniques. There however do not appear to be many large wetlands in this IUA. Where wetlands occur, they appear to be mostly associated with drainage lines and streams and are widely dispersed.

Some riparian wetlands can be seen on the aerial imagery in sections of the Motlhabatsi and Mamba Rivers.

Economy

The IUA is largely comprised of conservation and contains the Marakele Nature Reserve.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC I is recommended for IUA 17a (Table 92).

Table 92: IUA Class for the Mothlabatsi/Mamba based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B	B/C	Management Class
% representation	50	50	I

Additional considerations to be noted and recommendations to be taken forward

Table 93: Proposed Management Actions and Implications in IUA 17a

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Set RQOs; • Do a more detailed and higher confidence Reserve determination; • Do a more detailed wetland assessment	• The DWA must set RQOs to ensure the conservation areas are protected; • DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether to assess the water quality and to assess impacts on the aquifer system; • The RDM Office should do a higher confidence Reserve determination ; • Further wetland assessments need to be undertaken to more accurately map the wetlands..

4.20 MANAGEMENT CLASS IUA 17b: MATLABAS

IUA Description

IUA 17b is found within the Matlabas catchment, and the dominant land use is conservation and game farming. This IUA has been earmarked for future coal mining developments, more specifically in quaternary catchmengt A41E. The main river in IUA 17b is the Matlabas flowing to Limpopo River. The population of IUA 17b is 5 723 (Census, 2011).

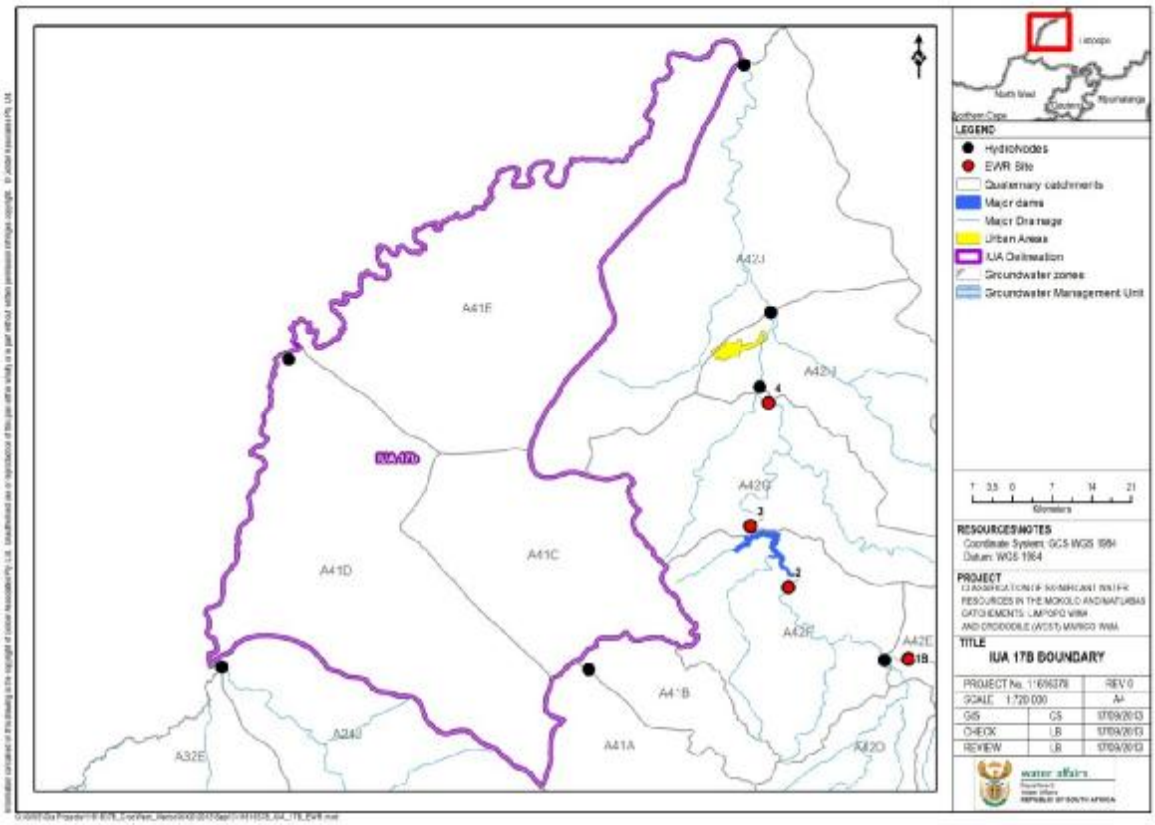

Figure 26: IUA 17b Matlabas catchment

Groundwater use

Groundwater use in IUA 17b is 2.923 Mm^3/a. Categorisation of groundwater in IUA 17b is set out in Table 94.

Table 94: IUA 17b Groundwater categorisation

IUA	QC's	Area (Km^2)	Recharge Mm^3	[1]Ground water Use Mm^3/a	Stress Index (SI)	Present Category (SI)	Present Category (Impact)	Present Category (Quality)
Lower Matlabas	A41C A41D	3024	29.95	1.64	6%	**I**	**I**	**III**
Steenbok -pan	A41E	1940	12.41	2.923	23%	**I**	**I**	**II**

Ecological condition and the Ecological Reserve

The present state is in a C category with a high EIS. Grazing and abstraction from small farm dams are the main activities impacting on the water resources.

The two EWR sites in this IUA are on the Matlabas at Haarlem Oos after the Mamba confluence and on the Matlabas upstream of the confluence with the Limpopo.

A summary of eco-classification and ecological water requirement (as a percentage of natural MAR) is indicated in Table 93. The EWRs listed are based on maintenance low and drought flows only for the PES as indicated in the table.

Table 95: IUA 17b Matlabas: Summary of Eco-classification and EWR

Node	Quarte-nary	Nodes	EI	ES	PES	REC	Default REC[1)]	Natural MAR (mcm/a)	EWR as % of natural MAR [2)]	Recom-mended Class
HN61	A41C	Matlabas from Mamba confluence to MAT_EWR2	High	High	C	B/C	B	32.8	33.23	II
HN62	A41C, D	Matlabas from MAT_EWR2 to confluence with Limpopo, outlet of IUA17b	Mod	Mod	B	B	B	35.58	33.42	

[1)] Based on the argument that the higher the EI-ES, the closer to the reference the REC should be. Default REC: Very high = A; High = B; Moderate = C and Low to Very Low = D. This does not consider attainability. DWA 2011 PES update

[2)] Based on EWR for maintenance and drought flows only

Wetlands

Given the available information and due to the topography and soil type, and apart from a fairly large number of pans, there do not appear to be many other wetlands in this IUA. Where wetlands occur, they appear to be mostly associated with drainage lines and streams and low lying depressions and are widely dispersed.

A fairly large wetland system is indicated on the 1:50 000 topographic maps associated with the lower Matlabas River. There is also an extensive wetland system associated with a section of the Aslaagte River which is a tributary of the Matlabas River. From consideration of the NFEPA maps as well as available aerial imagery, there is also an extensive riparian zone associated with the Limpopo River. Floodplain wetland features such as cut-off meanders associated with the paleo-channel of the Limpopo River also occur. The Limpopo River and its associated Riparian zone as well as well as these wetland features are regarded as important systems (WETFEPA) and further work is recommended to more accurately map and assess these systems and features, particularly considering the proposed future coal mining activities in this IUA and the potential impact thereof on this system and these wetland features which lie at the lower-end of the catchment. Similarly, and in addition to considering the wetlands and riparian features along the Limpopo River, additional work would be required at a more detailed scale to accurately map the extent of the wetlands in this IUA.

There is also very little information available on the pans in this IUA and further work on these systems is also recommended, particularly given that many are indicated as WETFEPAS. Pans in general are recognised as being important for biodiversity support. Understanding how they may be linked to other drainage features will also be important, particularly considering the proposed future coal mining activities in this IUA and the potential impact thereof on these systems as well.

Priority wetlands are set out in Table 96.

Table 96: IUA 17b Priority wetlands

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features

Lower Matlabas River	Valley bottom wetland	B/C	High	Central Bushveld Group 4 – **EN**	No	Parts of the system	-
Aslaagte	Valley bottom wetland	B	High	Central Bushveld Group 4 – **EN**	No	No	-
Limpopo River and associated riparian zone and floodplain features	Riparian zone and floodplains	B to D	Very High	Central Bushveld Group 4 - **VU**	No	Yes	Old growth riparian forest assemblages, floodplain features, paleo-channels as well as backwater features
-	Pans	B to D	High to Very High	Central Bushveld Group 4 - **EN**	No	No	Old growth riparian forest assemblages, alluvial aquifer and floodplain features

Economy

The major economic activities in this IUA are stock or game farming and tourism in the form of hunting. The Steenbokpan area has been earmarked for future coal mining in this IUA.

Conclusions and Proposed MC

The recommended scenario maintains the PES ecological category at all nodes within the IUA. A MC II is recommended for IUA 17b (Table 97).

Table 97: IUA Class for the Matlabas based on percentage representation of indicated EC groups as per WRCS guidelines (2007)

Ecological category	B	B/C	Management Class
% representation	50	50	II

Additional considerations to be noted and recommendations to be taken forward

Table 98: Proposed Management Actions and Implications in IUA 17a

Management Actions to improve the EC	Implications
• Develop and maintain an adequate monitoring programme (quantity and quality) for both surface water and groundwater; • Set RQOs; • Do a more detailed and higher confidence Reserve determination; • Do a more detailed wetland assessment;	• DWA Regional Office or the CMA must ensure that a monitoring programme is in place to assess whether to assess the water quality especially where the MCWAP pipeline will cross the river and scouring will take place, and to assess impacts on the aquifer system; • The DWA must set RQOs to ensure the conservation areas are protected and especially relating to development of any coal mining activities; • The RDM Office should do a higher confidence Reserve determination; • Further wetland assessments need to be undertaken to more accurately map the wetlands..

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the above, the proposed IUA MCs for the Crocodile (West), Marico, Mokolo and Matlabas catchments are presented in

Table 99 and Figure 27.

In terms of the integrated water resource MCs proposed for the 20 IUAs in the Crocodile (West), Marico, Mokolo and Matlabas catchments:

- 2 IUAs falls within a MC I (IUA 7 and 13),
- 1 IUA falls with a MC II related to groundwater (IUA 9);
- 8 IUAs fall within a MC II (IUAs 2, 4, 5, 6a, 6b, 15, 16 and 17b);
- 2 IUAs fall with a MC III related to groundwater (IUAs 8 and 10); and
- 7 IUAs fall within a MC III (IUAs 1, 3, 11a, 11b, 12, 13 and 14).

The level of confidence of the data used in the study was high in the Crocodile (West) catchment, medium to high in the Marico and Mokolo catchments and low in the Matlabas catchment.

Table 99: Proposed Management Classes for the Recommended Scenarios

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
CROCODILE (WEST)	**1**	Upper Crocodile/Hennops/ Hartebeespoort	III	75	15	10	80	**Preferred Scenario: Ecological category = REC + future water use as per the Crocodile-West Reconciliation Strategy** Future Water Requirements driven by: • Future urban expansion in Gauteng, leading to significantly increased return flows; • Additional future mining activities in the Rustenburg area, primarily related to platinum mining; and • Future water use requirements around Lephalale, which would necessitate a water transfer from the Crocodile directly to Lephalale • Water supply, does not constrain the future growth and development of the economy, with the exception of agriculture. • The Recommended (REC) ecological category for the Crocodile West catchment is achievable. • From 2018 onwards, the augmentation of the water supply system through using the surplus water stored in dams would start reducing dam water levels in especially the Hartbeespoort Dam, Roodeplaat Dam and Rietvlei Dam during the dry winter seasons. • There are potential future costs associated with the treatment of AMD and nutrient loads in the Crocodile West River. • With this scenario the economy grows and there is no net loss of river and wetland ecosystem
	2	Magalies	II	60	33	7	8	
	3	Crocodile/ Roodekopjes	III	95	5	0	-	
	4	Hex/Waterkloofspruit/ Vaalkop	II	77	9	14	90	
	5	Elands/Vaalkop	II	75	5	20	90	
	12	Bierspruit	III	80	20	0	20	
	13	Lower Crocodile	III	68	25	7	20	
	14	Tolwane/Kulwane/ Moretele/Klipvoor	III	65	15	20	75	

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
								services.
MARICO	6a	Klein Marico/ Kromellemboog	II	75	25	0	90	**Preferred Scenario: Ecological category = REC + present water use** Future water use and river flows are driven by: • Possible future urban expansion in towns, leading to marginal increased demands for domestic water • No large scale additional future use is envisaged and additional future water uses are to be achieved through water demand management and well planned and managed groundwater supply schemes. • In this scenario the water economy stays stable and there is no net loss of river and wetland ecosystem services.
	6b	Groot Marico/Marico Bosveld Dam	II	90	10	0	90	**Preferred Scenario: PES, AIP clearing, present water use (incl emerging farmers)** • No additional significant future water supply is possible in the Groot Marico; • The key water source here is the dolomitic outflow, and this supply is current used at a
	7	Kaaloog-se-Loop	I	35	35	30	90	
	8	Malmaniesloop	III	0	70	30	0	

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
	9	Molopo	II	5	70	25	0	maximum rate, both in the Groot Marico and towards the south towards Lichtenburg; and • In this scenario the water economy stays stable and there is no net loss of river and wetland ecosystem services.
	10	Dinokana Eye/Ngotwane Dam	III	15	70	15	0	
	11a	Groot Marico/Molatedi Dam	III	80	20	0	60	**Preferred Scenario: ESBC: Ecological = PES, present water use** • Groundwater supply adequate; and • In this scenario the water economy stays stable and there is no net loss of river and wetland ecosystem services.
	11b	Groot Marico/seasonal tributaries	III	75	20	5	80	
MOKOLO	**15**	Upper Mokolo	II	74	10	16	75	**Preferred Scenario: PES with future water use (2030)** • The Lephalale area is forecast to experience a very significant growth in coal mining, power generation and industrial economic activity; • This will not directly affect the Mokolo River; • The water required for this expansion is significant;

	IUA	Catchment area	Recommended Management Class	% contribution to achieve the MC			% NFEPA coverage	Implications of implementation
				Surface water	Ground water	Wetlands		
	16	Lower Mokolo	II	60	20	20	75	• These water requirements are to be met through a water transfer from the Crocodile West River, directly to the Lephalale; • Extensive coal mining IUA 16 could affect aquifers and could lead to AMD in future; • The aesthetic appeal of IUA 16 may be negatively affected; and • In this scenario the water economy grows significantly however there may be some negative impact on ecosystem services.
MATLABAS	17a	Mothlabatsi/Mamba	I	95	5	0	100	**Preferred Scenario: ESBC is to be maintained** • No change in economic results and ecosystem services
	17b	Matlabas/Limpopo	II	75	20	5	100	

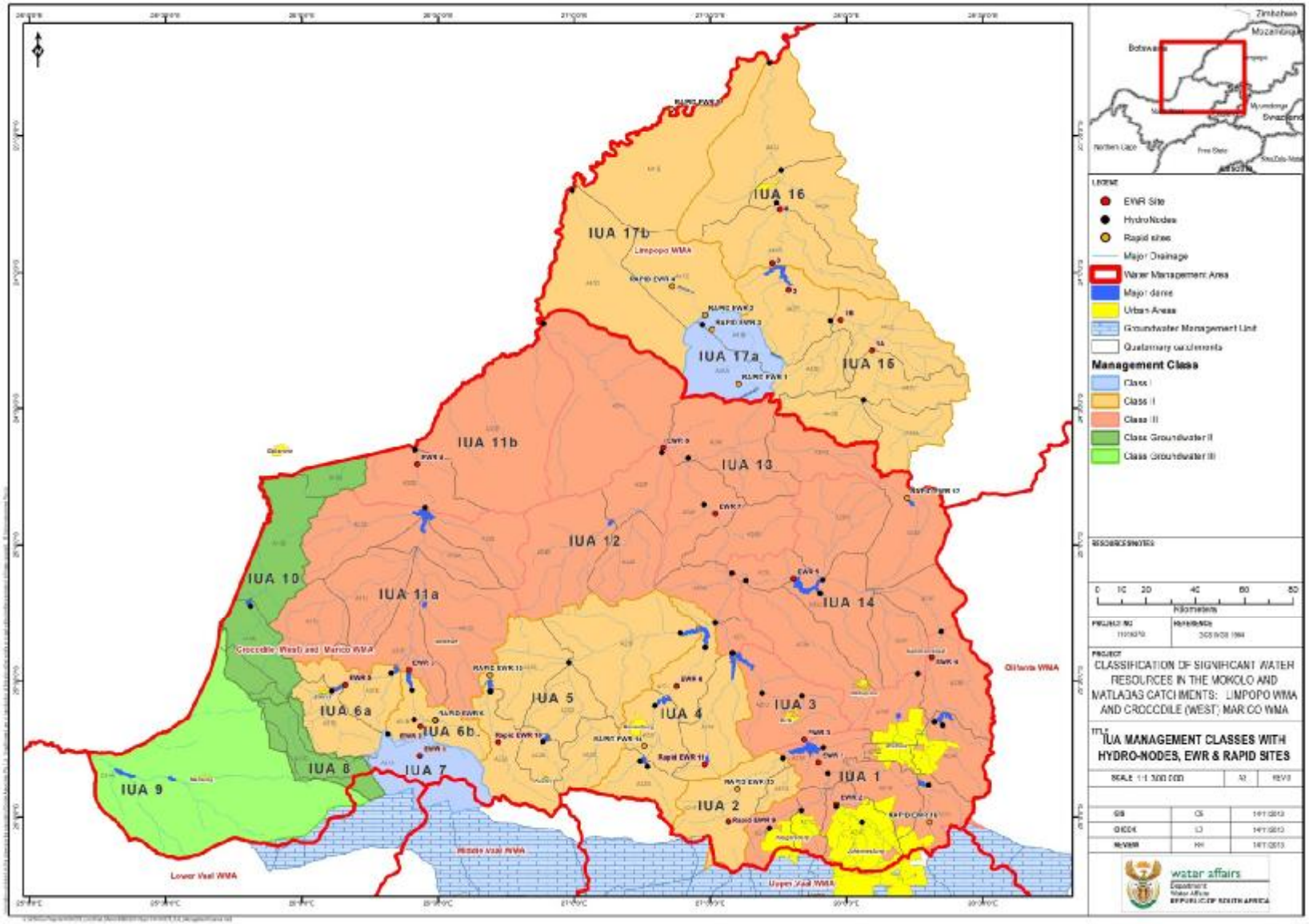

Figure 27: The Crocodile (West), Marico, Mokolo and Matlabas catchments indicating proposed IUA MCs

Recommendation for MC Implementation

Based on the results of the study, the following general recommendations are proposed:

- Crocodile West catchment: scenarios which supply the PES ecological category, which in the context of the Crocodile West catchment is equal to the REC ecological category, and meet the future growth in water requirements (2030) in the WMA;
- Marico catchment: the scenario in the Klein Marico is the REC with present water use (2030); the scenario in the Groot Marico is the REC with present water use (2015);
- Mokolo catchment: PES with future water use (2030);
- Matlabas, Molopo and Ngotwane: the ESBC is to be maintained;
- The implementation of the MCs will require management of water quality which includes source directed measures, regulatory and institutional structures;
- Concerted and regular monitoring and compliance management will be required to ensure the successful implementation of the MCs;
- The implementation and updating of the reconciliation strategies for the Crocodile (West), Marico, Mokolo and Matlabas catchments are central to the implementation of the proposed MCs;
- Integrated Water Quality Management Plans are required for the catchments;
- A monitoring programme will need to be implemented to ensure that the MCWAP transfers reach their desired destination and limits pollution to the Matlabas River during pipe scouring; and
- Recommendations specific to the sensitive areas of wetlands and pans are set out in Table 100 and general recommendations for the wetlands are:
    - If a wetland is located at a proposed development site, or where the development footprint is within 500m of the wetland (see GN 1199), or the nature of the impact or proposed use of the resource is such that a Water User Licence is required (in terms of the National Water Act, Act 36 of 1998), then the developer should be advised to proceed with a WULA application in conjunction with the standard EIA study where appropriate;
    - Due to the current state of loss of wetlands across the country, and in line with the proposed SANBI wetland offset guideline principles (as contained in Macfarlane, von Hase and Brownlie, 2012), the principle of ‘no net loss’ of wetlands should be applied as far as is reasonably possible within the study area. The draft Guideline document and principles contained therein are in the process of being reviewed by DWA and it is expected to be endorsed by the

Department following a public review and comment process. Any developments, including of the water resource, that may impact on wetlands should thus follow the mitigation hierarchy and in cases where a residual loss of wetland function cannot be avoided, the principle of 'no net loss' should be applied via a wetland offset strategy developed in line with the guidelines contained in Macfarlane *et al*. (2012);

- In addition, where information relating to flow and potential flow related impacts is not available for a particular priority wetland where there is a development application that could potentially affect the wetland, then it is recommended that the Environmental Water Requirements (EWRs) should be assessed and quantified as part of as part of a Wetland Reserve Study;
- In relation to applications where there may also be non-flow related impacts on wetlands, suitable buffer zones should also be provided for (a draft buffer zone guideline document is currently being developed by DWA in conjunction with the Water Research Commission) to limit impacts on the wetlands; and
- Resource Quality Objectives (RQOs) should be developed and set for the priority wetlands.

Table 100: Recommendations specific to sensitive area

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
IUA 1					
-	Pans	C/D to E	Very High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as development within and adjacent to these systems poses a risk to the remaining systems. Flow related impacts will occur as a result of changes in hydrology mostly as a result of urban development, and in some cases agricultural, impacts in the catchments of these systems. Water quality impacts as a result of urban runoff and even intentional decant of industrial and sewage effluent into pans potentially pose a high risk to these systems in the long term. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. Strict compliance monitoring will be required to ensure that the REC is achieved in the case of individual development assessments and applications.
-	Valley bottom wetlands	A/B to D/E	Moderate	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	Increased return flows are likely to result in more water entering the systems. Higher baseflows can thus be expected which together with regular high flows due to an increase in runoff as a result of hardened catchment surfaces will promote erosion and scour of most of the systems. It will be very difficult to achieve the REC for most systems as a general deterioration in wetland condition throughout the urban areas is expected in the long-term.
-	Hillslope seepage wetlands	C/D to E/F	High	Specific to individual systems	Not related to changes in flow in the rivers. Non-flow related impacts such as development within and adjacent to these systems poses a risk to the remaining systems. Flow related impacts will occur as a result of changes in hydrology mostly as a result of urban development, and in some cases agricultural, impacts in the catchments of these systems. Interruption of interflow and increased surface runoff as a result of the development of the local catchment that feed these systems therefore poses the main flow related threat to the remaining systems in the long-term. It will be very difficult to achieve the REC for most systems as a general deterioration in wetland condition throughout the urban areas is expected in the long-term.
Rietvlei wetland complex	Peatland	C/D to D/E	High to Very High	Improvement from current PES of individual systems	Main risk to this system is groundwater abstraction. Rehabilitation has been implemented in parts of the system to try to improve the current condition. Waste water return flows from sewage treatment and increased peak flows as the upper catchment is developed could potentially pose a risk to the system in the long-term.
Colbyn Valley wetland	Peatland	D	High to Very High	C/D	System is stable at present and no deterioration is expected as long as the rehabilitation structures at the keypoint of the system remain intact.
IUA 2					
-	Pans	-	High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as agricultural practices and development within and adjacent to these systems poses a risk to the remaining systems. Water quality impacts as a result of agricultural practices also potentially poses a high risk to these systems in the long term, although these effects are likely to have already occurred as the area is already farmed in most areas where pans occur. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. Strict compliance monitoring will be required to ensure that the REC is achieved in the case of individual development assessments and applications.

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
-	Valley bottom wetlands	-	Moderate	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	Increased return flows and the resulting higher baseflows expected are likely to promote erosion and scour of most of the systems on the main rivers. Water quality changes may also occur depending on the risk of AMD entering the systems. It will be very difficult to achieve the REC for most systems along the main rivers as a general deterioration in wetland condition is expected in the long-term.
-	Hillslope seepage wetlands	-	High	Specific to individual systems	Not related to changes in flow in the rivers. Non-flow related impacts such as development within and adjacent to these systems poses a risk to the remaining systems. Flow related impacts will occur as a result of changes in hydrology mostly as a result of urban development, and in some cases agricultural and mining related impacts in the catchments of these systems. Interruption of interflow and increased surface runoff as a result of the development of the local catchment that feed these systems therefore poses the main flow related threat to the remaining systems in the long-term.
Maloney's eye	Dolomitic eye and peatland	B	Very High	Maintain (B)	Main risk to this system is groundwater abstraction and pollution.
IUA 4					
Waterval Valley Bottom Mire (peatland)	Unchannelled valley bottom	-	Very High	Maintain	No risks expected as the system is at the head of the catchment within a nature reserve.
IUA 5					
-	Pans	-	Very High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as agricultural practices within and adjacent to these systems poses a risk to the remaining systems. Water quality impacts as a result of agricultural practices also potentially poses a high risk to these systems in the long term, although these effects are likely to have already occurred as the area is already farmed in most areas where pans occur. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.
-	Valley bottom wetlands	-	Moderate	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.
-	Hillslope seepage wetlands	-	High	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	Not related to changes in flow in the rivers. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.
IUA 7					

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
-	Valley bottom wetlands	C/D	Moderate to High	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.
-	Pans	D	High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as agricultural practices within and adjacent to these systems poses a risk to the remaining systems. Water quality impacts as a result of agricultural practices also potentially poses a high risk to these systems in the long term, although these effects are likely to have already occurred as the area is already farmed in most areas where pans occur. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.
-	Tufa waterfall	B	Very High and very sensitive to water quality changes	Maintain	Main risk to this system is groundwater abstraction and pollution or changes in water quality which could potentially affect the process of tufa formation/deposition. Site specific management measures would also help to ensure the continued protection of this system.
Marico eye	Valley bottom Peatland	B/C	Very High	Maintain	Main risk to this system is groundwater abstraction and pollution . Site specific management measures would also help to ensure the continued protection of this system.
IUA 8					
Malmanie Loop	Valley bottom mire or peatland	B to C/D	Very High	Maintain	Main risk to this system is groundwater abstraction and pollution . Future groundwater use will potentially pose a high risk to this system. Any applications for further groundwater use in the area will need to consider the impacts on this system, both from an EIA and WUL perspective, and strict licensing conditions including monitoring of the system should apply. It is recommended that a Wetland Reserve is undertaken for this system. Site specific management measures would also help to ensure the continued protection of this system.
IUA 9					
-	Pans	-	High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as agricultural practices within and adjacent to these systems poses a risk to the remaining systems. Water quality impacts as a result of agricultural practices also potentially poses a high risk to these systems in the long term, although these effects are likely to have already occurred as the area is already farmed in most areas where pans occur. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.
-	Pans	-	High		
-	Valley bottom wetlands	-	Moderate	Specific to individual systems but should aim for at least the same as the	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
-	Valley bottom wetlands	-	Moderate	PES or at least one category higher if possible	
Molopo	Unchannelled valley bottom wetlands and peatlands	B to D	Very High	Maintain	Main risk to this system is groundwater abstraction and pollution . Future groundwater use will potentially pose a high risk to this system. Any applications for further groundwater use in the area will need to consider the impacts on this system, both from an EIA and WUL perspective, and strict licensing conditions including monitoring of the system should apply. It is recommended that a Wetland Reserve is undertaken for this system. Site specific management measures would also help to ensure the continued protection of this system.
Bodibe peatland	Unchannelled valley bottom wetlands	E/F	Very High	System is lost	System is essentially lost and without reinstating the groundwater that drives the system it will not recover and will continue to burn until all the peat is lost.
IUA 10					
Ngotwana Wetland	Unchannelled valley bottom wetland and spring	B to D/E	High to Very High	Specific to individual systems within the complex but should aim for at least the same as the PES or at least one category higher if possible	No flow related impacts are expected at this stage based on the Scenario Report. At least maintain the *status quo.* As a non-flow related intervention, it is recommended that a rehabilitation plan is developed and implemented for this system in consultation with the local community. The plan should address the erosion at the head of the system and make a provision, not only for structural interventions, but also the development of a grazing management plan for the system and its catchment.
Dinokana eye and Wetland	Unchannelled valley bottom, spring and hillslope seepage wetlands	C to D/E	High to Very High	Maintain C and improve D/E	Main risk to this system is groundwater abstraction and pollution . Future groundwater use will potentially pose a high risk to the eye. Any applications for further groundwater use in the area will need to consider the impacts on this system, both from an EIA and WUL perspective, and strict licensing conditions including monitoring of the system should apply. It is recommended that a Wetland Reserve is undertaken for this system. Site specific management measures would also help to ensure the continued protection of this system.
IUA 11b					
Lower Marico River	Riparian zone and floodplains	B to D	Very High	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	Not clear what the effect of the recommended scenario will be on this system. It is assumed that no flow related impacts will be expected at this stage based on the Scenario Report which would mean at least maintaining the *status quo.* It is however recommended that further studies are undertaken on this system to get a better understanding of the flow related changes that have occurred in the system and what the current trajectory of change is in order to better evaluate the impact of implementing the recommended scenario on the system.
Lengope la Kgamanyane River	Floodplain	C	High	Maintain (C)	It is assumed that no flow related impacts will be expected at this stage based on the Scenario Report which would mean at least maintaining the *status quo.* It is however recommended that further studies are undertaken on this system to get a better understanding of the system, its extent and key hydrological drivers and what the current trajectory of change is in order to better evaluate the impact of implementing the recommended scenario on the system.
Lenkwane River	Floodplain	C	High	Maintain (C)	It is assumed that no flow related impacts will be expected at this stage based on the Scenario Report which would mean at least maintaining the *status quo.* It is however recommended that further studies are undertaken on this system to get a better understanding of the system, its extent and key hydrological drivers and what the current trajectory of change is in order to better evaluate the impact

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
					of implementing the recommended scenario on the system.
-	Pans	B to D	High to Very High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as agricultural practices within and adjacent to these systems poses a risk to the remaining systems. Water quality impacts as a result of agricultural practices also potentially poses a high risk to these systems in the long term, although these effects are likely to have already occurred as the area is already farmed in most areas where pans occur. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems,
IUA 13					
Sections of the Crocodile River	Riparian zone, off-channel wetlands, backwaters and floodplains	B to D	High	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	Increased baseflows are expected which could potentially promote erosion and scour of the channel. This could affect the frequency of overtopping and hence wetting of the off-channel wetlands and floodplain features during high flows. The scenario with respect to high flows required for overtopping are unclear. It may thus be difficult to achieve the REC for most systems as a general deterioration in associated wetland condition could be expected in the long-term.
IUA 14					
Moretele River floodplain	Floodplain	D to E	Very High	C/D	Increased return flows will result in more water entering the system. Higher baseflows can thus be expected which together with regular high flows due to an increase in runoff as a result of hardened catchment surfaces will promote erosion and scour in the system. Increased channel incision could affect the frequency of overtopping onto the floodplain during high flows. Management of Roodeplaat Dam under the future water use scenario could further impact on middle-order flood events which are required for maintaining the floodplain system. There are likely to be less of these getting through to the floodplain. This together with increased baseflows is likely to have a significant negative effect on the floodplain system . It will thus be very difficult to achieve the REC or even maintain the current PES for the system as a general deterioration in wetland condition is expected in the long-term.
Apies River floodplain	Floodplain	E to F	Very High	D	Increased return flows will result in more water entering the system. Higher baseflows can thus be expected which together with regular high flows due to an increase in runoff as a result of hardened catchment surfaces will promote erosion and scour in the system. Increased channel incision could affect the frequency of overtopping onto the floodplain during high flows. It will thus be very difficult to achieve the REC for the system as a general deterioration in wetland condition is expected in the long-term.
Tswaing Crator	Depression	-	Very High	-	Not related to changes in flow in the rivers.
IUA 15					
-	Valley bottom wetlands	A/B to C/D	High	Specific to individual systems but should aim for at least the same as the	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems.

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
-	Valley bottom wetlands	A/B to C/D	High	PES or at least one category higher if possible	
-	Hillslope seepage wetlands	A/B to C/D	High	Specific to individual systems	Not related to changes in flow in the rivers. Non-flow related impacts such as development within and adjacent to these systems poses a risk to the remaining systems. Flow related impacts will occur as a result of changes in hydrology mostly as a result of urban development, and in some cases agricultural, impacts in the catchments of these systems. Interruption of interflow and increased surface runoff as a result of the development of the local catchment that feed these systems therefore poses the main flow related threat to the remaining systems in the long-term. It will be very difficult to achieve the REC for most systems as a general deterioration in wetland condition throughout the urban areas is expected in the long-term.
-	Hillslope seepage wetlands	A/B to C/D	High		
IUA 16					
-	Valley bottom wetlands	-	High	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems,
-	Hillslope seepage wetlands	-	High	Specific to individual systems	Not related to changes in flow in the rivers. Non-flow related impacts such as development within and adjacent to these systems poses a risk to the remaining systems. Flow related impacts will occur as a result of changes in hydrology mostly as a result of urban development, and in some cases agricultural, impacts in the catchments of these systems. Interruption of interflow and increased surface runoff as a result of the development of the local catchment that feed these systems therefore poses the main flow related threat to the remaining systems in the long-term. It will be very difficult to achieve the REC for most systems as a general deterioration in wetland condition throughout the urban areas is expected in the long-term.
Mokolo River and floodplain	Floodplain	C/D to D/E	High	C	No further flow related impacts are expected at this stage based on the Scenarios Report. The floodplain features and associated wetland habitats have already been affected by changes to flow as a result of the upstream dam (DWA, 2010). It is unlikely that flows to the system will improve in the future, which together with non-flow related impacts such as sand mining and other flow related impacts such as abstraction, means it is unlikely that there will be any improvement in the system. A REC of C will thus likely be unachievable. While the aim is to try to maintaining the *status quo* for the associated wetlands, this may even be difficult to achieve under the future water use scenario.
Tambotie River floodplain	Floodplain	C/D to D/E	High to Very High	C/D	No further flow related impacts are expected at this stage based on the Scenarios Report. The floodplain has already been affected by a reduction in flow which affected the alluvial aquifer in the past resulting in a die-off of large sections of the riparian forest. It is unlikely that flows to the system will improve in the future and as such it is unlikely that there will be any improvement in the system. A REC of C/D will thus likely be unachievable. Maintaining the *status quo*, while not ideal, is all that is likely achievable under the future water use scenario.
IUA 17b					

Wetland	Type	PES	EIS	REC (Recommended Ecological Category)	Changes that may be expected based on the recommended scenarios from the Scenarios Report and general recommendations relating to trying to deal with these
Lower Matlabas River	Valley bottom wetland	C	High	B/C	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems. Further studies on this system are recommended.
Aslaagte	Valley bottom wetland	C	High	B/C	No flow related impacts are expected at this stage based on the Scenarios Report. At least maintain the *status quo.* The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems. Further studies on this system are recommended.
Limpopo River and associated riparian zone and floodplain features	Riparian zone and floodplains	B to D	Very High	Specific to individual systems but should aim for at least the same as the PES or at least one category higher if possible	Not clear what the effect of the recommended scenario will be on this system. It is assumed that no flow related impacts will be expected at this stage based on the Scenario Report which would mean at least maintaining the *status quo.* It is however recommended that further studies are undertaken on this system to get a better understanding of the flow related changes that have occurred in the system and what the current trajectory of change is in order to better evaluate the impact of implementing the recommended scenario on the system.
-	Pans	B to D	High to Very High	Specific to individual pans	Not related to changes in flow in the rivers. Non-flow related impacts such as agricultural practices within and adjacent to these systems poses a risk to the remaining systems. Water quality impacts as a result of agricultural practices also potentially poses a high risk to these systems in the long term, although these effects are likely to have already occurred as the area is already farmed in most areas where pans occur. Maintaining water quality is a critical aspect in pans as this determines pan geochemistry which in turn drives the biodiversity aspects. The application of buffer zones around the wetlands could be considered if the objective is to improve the current state of the systems,

6 IMPLICATIONS FOR IMPLEMENTATION

In order for the recommended management classes to be implemented and to provide further detail for the setting of the RQOs, it is important that the recommendations are taken forward within the next 2 to 15 years. An implementation plan must be developed for each of the catchments within the next 5-20 years and should include aspects set out in Table 101.

Table 101: Aspects to be considered as part of the implementation plan

Implementation Plan aspect	Task	Timeframe
Resource Quality Objectives	• The RQOs must be developed; • Update water quality and quantity monitoring programmes to allow higher level of confidence for the RQOs project, especially in the Marico and Matlabas catchments; • Assess discharge standards to align with RQOs; • Assess approved Reserve to see whether it needs to be updated	2 years 2-5 years 2-5 years 5-10 years
Ecological aspects	• Implement the EWRs; • Eradication of Alien vegetation especially in IUAs 6a and 6b; • Eradication of unlawful water use in all catchments; • Assess the impacts on habitats due to increased return flows from WWTW	5-15 years 5-10 years 5-20 years
Monitoring programmes	• Water Quality Management Plans for all the catchments in the study area to be developed starting with the Crocodile (West), Marico and Lower Mokolo focussing specifically on: o TDS reduction and WWTW discharges in IUAs 1, 2, 6a, 9 and 14. • Monitoring programmes for dolomite aquifer systems (specifically IUAs 1 and 2) must be reviewed and upgraded if necessary within the next 2 years; • Localised pollution impacts (especially from mine discharge and industries) on the aquifer systems in IUAs 1 and 2 to be investigated; • Status of contribution to base flow needs to be evaluated in IUAs 8 and 10; • Sustainability of resources in close proximity of rivers with base flow requirements needs to be assessed in IUA 16 (Lower Mokolo); and • Monitoring of the RQO compliance once implemented.	5-10 years
Source Directed Control	• Review trends of current standards for WWTW and industries against WDCS implementation in the Crocodile (West) catchment;	5-10 years
Reconciliation Strategies	• Implement and maintain the Reconciliation Strategy for the Crocodile (West) catchment;	2-5 years

Implementation Plan aspect	Task	Timeframe
	• Update/develop the Reconciliation Strategies for the Marico and Mokolo catchments;	5-10 years
Conservation Areas	• As part of the RQO process ensure that RQOs are set to protect conservation areas; • Take cognisance of those areas that have high conservation status and where specific statements have been made relating to limiting mining activities, for example in IUA2; and • Review the NFEPAS in areas where there is no or little correlation, this is especially relevant in IUAs IUAs 1 and 2 where some wetland areas are not covered and 6a and 6b which has wetland areas indicated where there are none.	5 -10 years
Cooperative governance	• Assess areas where DWA can work closely with DMR or other relevant Government Departments that may have a part in implementing the MC or RQOs. This is particularly relevant where integrated water use licences would be issued	5-10 years
Monitoring and enforcement	• Improve on the monitoring and enforcement of water use authorisation conditions.	2-5 years
Economic aspects	• Assess the economic aspects associated with implementing the above; and • Prioritise those aspects that will give quick wins at least cost.	2-5 years

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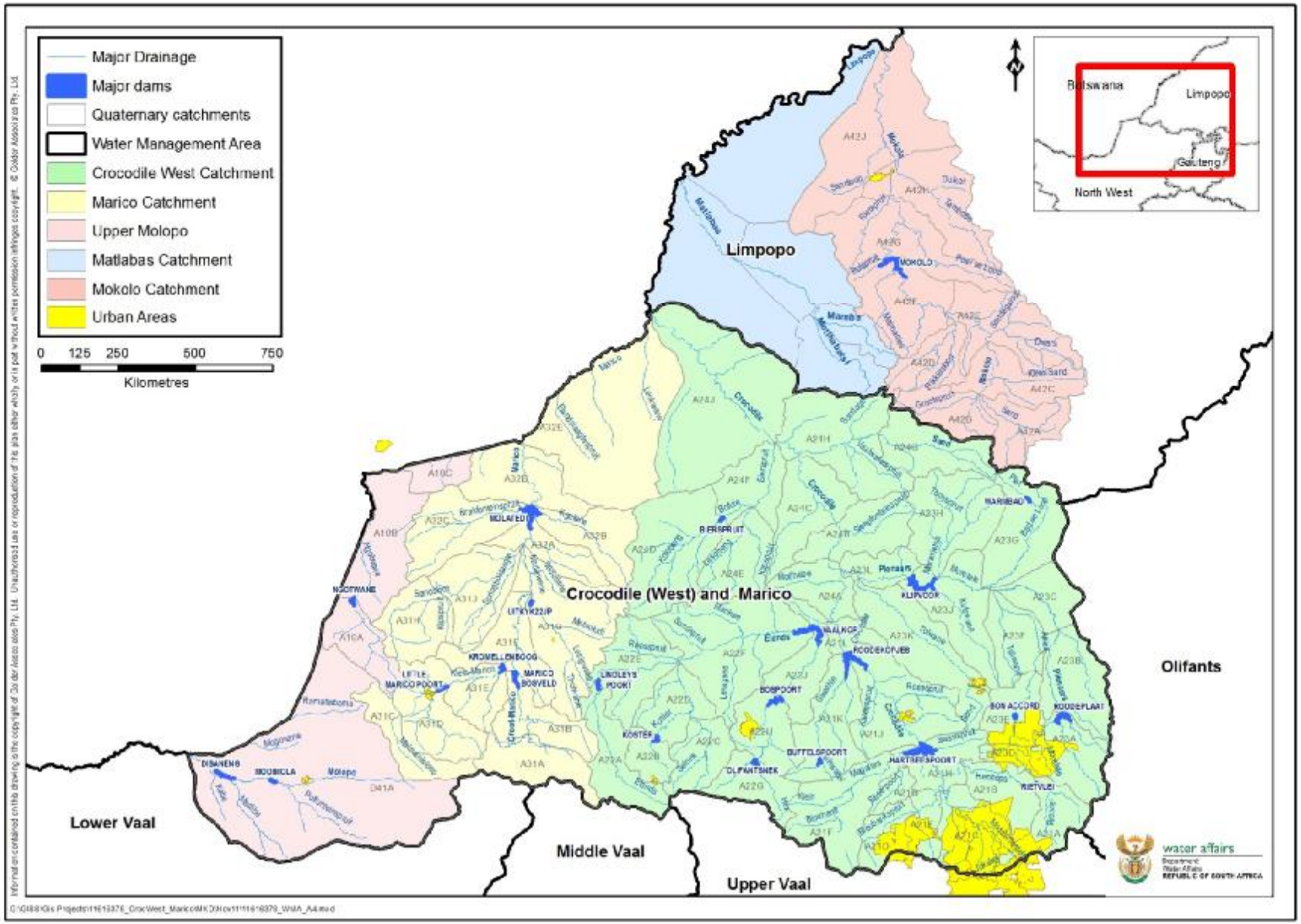
APPENDIX A

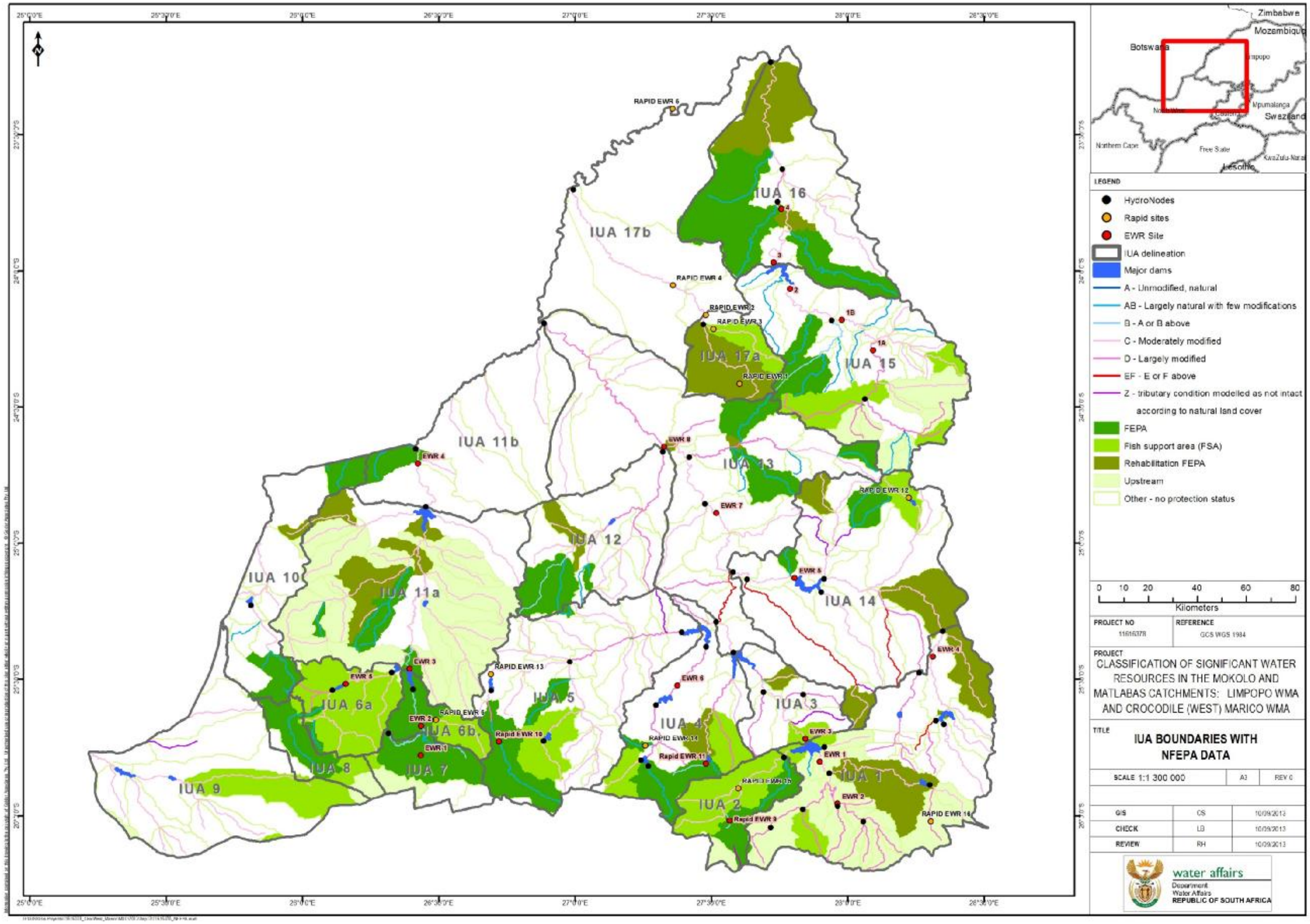
STUDY AREA



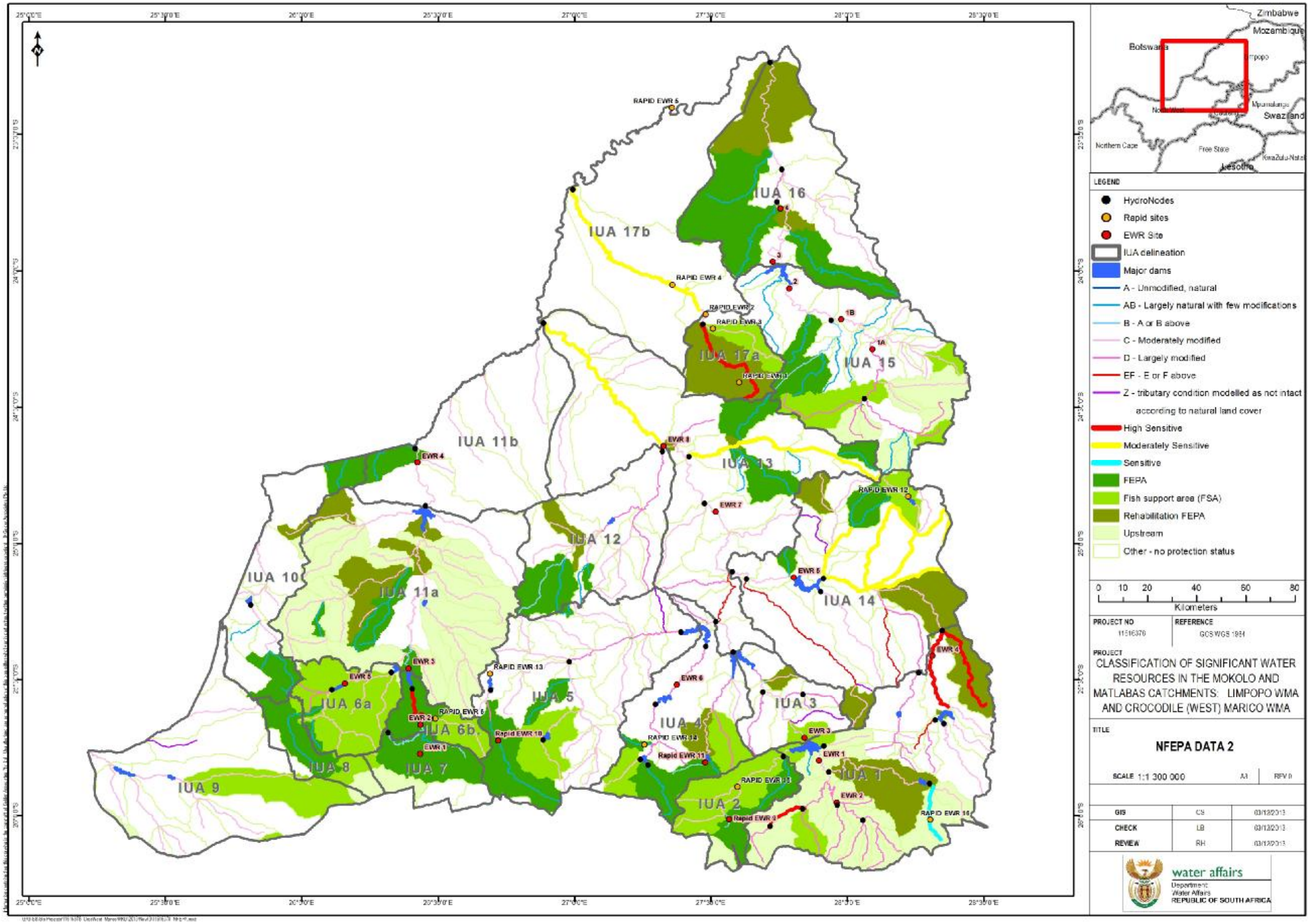
Study area – the Crocodile (West), Marico, Mokolo and Matlabas catchments

APPENDIX B

FRESHWATER ECOSYSTEM PRIORITY AREAS (FEPAS) IN THE CROCODILE (WEST), MARICO, MOKOLO AND MATLABAS CATCHMENTS



FEPAs identified for the Crocodile (West), Marico, Mokolo and Matlabas catchments and an indication of whether they are addressed through the Classification Process (MCs and Nodes)



FEPAs identified for the Crocodile (West), Marico, Mokolo and Matlabas catchments and areas where higher level of protection will be needed

IUA	Catchment area	Quaternaries with NFEPAs		% NFEPA supported	Proposed IUA MC	Does the MC give effect to the NFEPAs?
CROCODILE WEST						
1	Upper Crocodile/ Hennops/ Hartbeespoort	A23B; A23A; A21A; A21C; A21B; A23D; A23E; A21H; A21E; A21D	Upstream management area; Phase 2 FEPA and associated sub-quaternary catchment; Fish support area; Fish sanctuary; wetland FEPA	80%	III	Yes, however the current PES is such that it will not meet the NFEPAs
2	Magalies	A21F; A21G	River FEPA and associated sub-quaternary catchment; Fish support area and associated sub-quaternary catchment	80%	II	Yes
3	Crocodile/ Roodekopjes	A21J	Fish sanctuary; Phase 2 FEPA and associated sub-quaternary catchment;	0%	III	No NFEPAS where nodes located
4	Hex/ Waterkloofspruit/Vaalkop	A22G; A22H; A21K; A22J	River FEPA and associated sub-quaternary catchment; Fish sanctuary	90%	II	Yes
5	Elands/Vaalkop	A22A; A22B; A22C; A22D; A22E; A22F;	River FEPA and associated sub-quaternary catchment; Fish sanctuary;	90%	II	Yes
12	Bierspruit	A24D; A24E; A24F;	River FEPA and associated sub-quaternary catchment; Phase 2 FEPA and associated sub-quaternary catchment;	20%	III	Nor adequately; NFEPA areas have been highlighted as areas requiring a higher level of protection than the MC
13	Lower Crocodile	A24A; A24B; A24C; A24G; A24H; A24J	River FEPA and associated sub-quaternary catchment; Phase 2 FEPA and associated sub-quaternary catchment;	20%	III	No, but NFEPA areas have been highlighted as areas requiring a higher level of protection than the MC
14	Tolwane/Kulwane/Moretele/ Klipvoor	A23K; A23J; A23F; A23C; A23G; A23H; A23L;	River FEPA and associated sub-quaternary catchment; Phase 2 FEPA and associated sub-quaternary catchment; Wetland FEPA;	75%	III	Yes

IUA	Catchment area	Quaternaries with NFEPAs		% of IUA based on hydronodes location	Proposed IUA MC	Does the MC give effect to the NFEPAs?
MARICO						
6a	Klein Marico/ Kromellemboog	A31D; A31E	River FEPA and associated sub-quaternary catchment; Fish sanctuary: other threatened; River FEPA and associated sub-quaternary catchment;	90%	II	Yes
6b	Groot Marico/Marico Bosveld Dam	A31A; A31B;	River FEPA and associated sub-quaternary catchment; Fish sanctuary; Fish support area and associated sub-quaternary catchment	90%	II	Yes
7	Kaaloog-se-Loop	A31A	River FEPA and associated sub-quaternary catchment; Fish sanctuary; wetland FEPA	90%	I	Yes
8	Malmaniesloop	A31C	Wetland FEPA; River FEPA and associated sub-quaternary catchment	0% as groundwater zone	III*	No
9	Molopo	D41A	Wetland FEPA; River FEPA and associated sub-quaternary catchment	0% as groundwater zone	II*	No
10	Dinokana Eye/Ngotwane Dam	A10A; A10B; A10C	River FEPA and associated sub-quaternary catchment; Phase 2 FEPA and associated sub-quaternary catchment;	0% as groundwater zone	III*	No
11a	Groot Marico/Molatedi Dam	A31H; A31F; A31J; A31G; A32C; A32A; A32B	Upstream management area; Phase 2 FEPA and associated sub-quaternary catchment; River FEPA and associated sub-quaternary catchment;	60%	II	Yes
11b	Groot Marico/seasonal tributaries	A32D; A32B	River FEPA and associated sub-quaternary catchment;	80%	II	Yes

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

APPENDIX C

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APPENDIX E: Comments received on the Scenarios Report and manner in which they were addressed

Comment received from	Comment	Addressed (Y/N)	How addressed
H Roux	Pages 14 and 31: conflict with table 2, please note the comments regarding table 2 and the explanations provided. This table (Table 2) does not make sense....when you read the interpretations below as Class I mostly B or higher but table indicates 99% higher than D.....I understand what you would like to say but it is not clear.	Y	Table 2 was updated to be more easily interpreted
	please explain *	Y	Table updated therefore * no longer relevant
	Page 27: reference please not just Kleynhans	Y	Referenced in full
	Page 34: please provide me with GPS co-ordinates of this hydro node, something looks misplaced (relates to HN map)	Y	Hydronode coordinates checked and corrected on map
	Page 36: Please correct, it is Dinokana eye	Y	Corrected in all relevant reports
	Page 37: grammatical errors ..such as a cement factory at Slurry. …lower Marico in the vicinity of Madikwe game reserve	Y	Corrections made
	Page 45: mattozi and has changed to rappax- check with Dr. Neels Kleynhans DWA RQS; Need to include maps of the most important ones?	Y	Corrected in report; wetland maps included
	Page 48: I think that the existing development in this catchment precludes it from being a Class I. However, this needs to be considered in the RQO project where these areas must be prioritised.	Y	Recommended that this IUA not have further development and have included statement from Mogale City
	Page 49: MC of II although EIS/PES and important conservation area? Understand that II is probably what can be attained if water quantity is evaluated but does not "feel" correct. Also if all of the NB wetlands are considered.....I?	Y	
	Page 55: Upper reaches to Olifantsnek still in better condition and important to keep it that way to attain the MC.	Y	Recommendations made in action plan tables included in MC Report
	Page 56: Need to include special RQO's for upstream areas and the Waterkloofspruit that should attain a A/B category MC of I, they are important for NFEPA and conservation.		
	Page 58: due to slate and diamond mining.... This reach also serves as a refugia	Y	Added sentences to report
	Page 59: Slate and diamond mining? Note that Zeerust town is dependent on groundwater abstraction from compartments in Malmaniesloop. Kareespruit	Y	Added and made correction

Comment received from	Comment	Addressed (Y/N)	How addressed
	Page 61: Zeerust WWTW	Y	Correction made
	Page 63: Polkadraaispruit is the listed DWA name Remove this part, inlude that EWR 3 is situated at the outlet of the Unit. Include the new node at the N4 bridge. Please redo map to show all the nodes (HN33, HN34, HN63), this will make the explanation of the MC easier. IUA 6b? We agreed to add in that the MC at the N4 bridge node (HN34) must be I (default REC of A). This is very important both for conservation aspirations (including NFEPA) as well as for good quality water for irrigators from the Marico Bosveld Dam as well as the recreational water based activities on the Dam. RQO to include irrigators using earth channels to change to cement to prevent water loss.	Y	Corrections made and changes made to reflect the recommendations
	Page 65: there are two tufa waterfalls one on Bokkraal and the other on Kuilfontein.	Y	Updated in report
	Page 66: Also important to set RQO's to minimise further dam or weir constructions to link up with the NFEPA recommendations Also RQO for water abstraction out of the dolomitic compartments that feed the river system Water quality and quantity RQO's to protect the two tufa systems. Also Provincial Nature Reserve around the eye.	Y	Included in recommendations in report
	Page 69: Do not agree, should be class I also drinking water for Zeerust and villages in Lehurutse and Dinokana area Water abstraction for drinking water must be monitored- lots of disputes and court cases at the moment between DWA, municipality and downstream abstraction point farmers.	Y	Groundwater class II does mean that it is not fit for consumption, rather that there is adequate groundwater and that it can still be developed ; Recommendations included
	Page 71: Problem with peat burning at Bodibe....	Y	Included in report
	Page 72: Is groundwater class III safe for human consumption??????	Y	Groundwater class II does mean that it is not fit for consumption,

Comment received from	Comment	Addressed (Y/N)	How addressed
	RQO's also need to consider vulnerability of fires when peat dries out due to abstraction..... irrigation downstream of Ngotwane Dam		rather that there is adequate groundwater and that it can still be developed ; Recommendations included
	Page 73: this does not seem correct, the abstraction has increased and the river has very little (5cm) flow left after the main abstraction point. …and historical lands ((Dinokana)). These wetlands are also the type localities of various animals, plants and fish.	Y	Noted and included recommendation of assessment needed;
	Page 75: yes, they made a mistake since their GIS Dam maps did not have Molatedi Dam on it- subsequently mapped the Dam as natural wetland.	-	-
	Page 77: Wetlands in Madikwe Nature reserve and old tufa formations. Bush encroachment in the reserve has also deteriorated the wetlands.	Y	Wetland component of report updated
	Page 79: more clay than sand in this area- extensive clay wetland systems activated after rain but yes fieldwork is required.	Y	Updated report and recommendations made
	Page 79: Marakele is not in this unit, Pilanesberg is	Y	Updated report
	Table 55: incorrect table inserted	Y	corrected
	Page 83: specifically decrease in water quality related to WWTW's	Y	Included in report
	Page 85: need to include water quality and quantity regulations in RQO's to prevent further degradation of the floodplain	Y	Recommendation made
	Page 92: include specifics for RQO's	Y	Recommendation made
T Nyamande	No spacing between the words (a lot of those) Table 1 and Figure not referred on the text Alignment of font in page 28.	Y	Spacing corrected; References made Alignment corrected
	Include NFEPA coverage	Y	Included in updated report
	Included NFEPA coverage map	Y	Included in updated report
	In MC table, remove groundwater class and add % contribution for SW/GW and wetlands and included implications	Y	Table updated
	Included implications per IUA	Y	An additional table relating to an action plan and associated mitigation has been included for each IUA