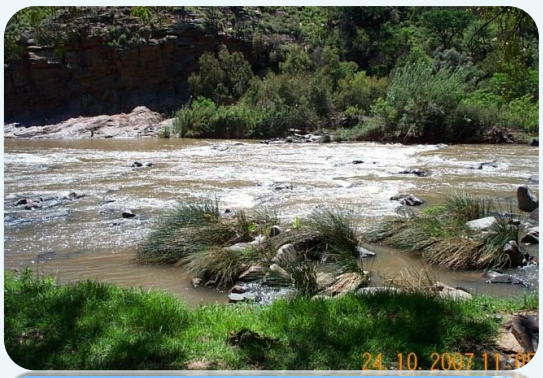

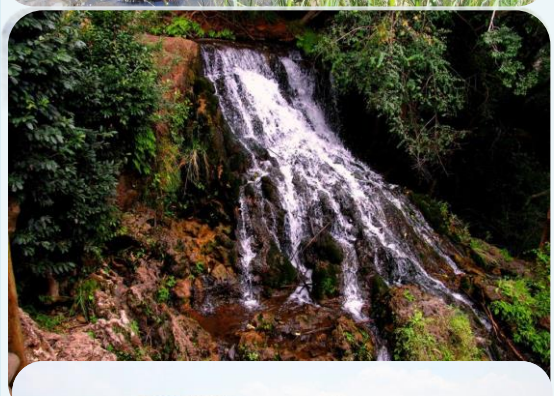

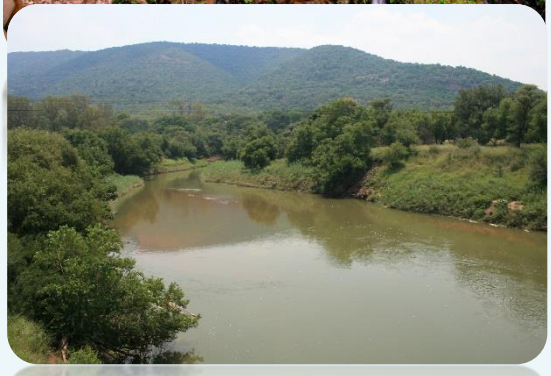

DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE MOKOLO, MATLABAS, CROCODILE (WEST) AND MARICO CATCHMENTS IN THE LIMPOPO NORTH WEST WATER MANAGEMENT AREA (WMA 01)

WP10992

RESOURCE UNITS PRIORITISATION, SUB-COMPONENT PRIORITISATION AND INDICATOR SELECTION REPORT

REPORT NO.: RDM/WMA01/00/CON/RQO/0316

FINAL

Chief Directorate: Water Ecosystems

NOVEMBER 2016

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Published by

Department of Water and Sanitation
Private Bag X313
Pretoria, 0001
Republic of South Africa

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Fax: (012) 336 6731/ +27 12 336 6731

This report is to be cited as:

Department of Water and Sanitation, South Africa. November 2016. Determination of Resource Quality Objectives in the Mokolo, Matlabas, Crocodile West and Marico Catchments in the Limpopo North West Water Management Area (WMA01): Resource Units Prioritisation, Sub-component Prioritisation and Indicator Selection Report. Report No: RDM/WMA01/00/CON/RQO/0416

Prepared by:

Golder Associates Africa in association with Wetland Consulting Services, Hydrosol and JMM Stassen

Title:	*Resource Units Prioritisation, Sub-component Prioritisation and Indicator Selection Report*
Authors:	*P Moodley, L Boyd, E van Wyk, JMM Stassen, G Marneweck, T Coleman*
Project Name:	*Determination of Resource Quality Objectives in the Mokolo, Matlabas, Crocodile (West) and Marico Catchments in the Limpopo North West Water Management Area: WP 10992*
DWS Report No:	*RDM/WMA01/00/CON/RQO/0416*
Status of Report:	*Final*
First Issue:	*30 September 2016*
Final Issue:	*30 November 2016*

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

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3.0	RDM/WMA01/00/CON/RQO/0316	Preliminary Resource Units Report
4.0	**RDM/WMA01/00/CON/RQO/0416**	**Reource Units Prioritisation, Sub-component Prioritisation and Indicator Selection Report**

LIST OF ABBREVIATIONS

CD: WE	Chief Directorate: Water Ecosystems
DLMT	Dolomite
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
EIS	Ecological importance and sensitivity
EWR	Ecological Water Requirements
FEPAs	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assesment Index
GMU	Groundwater Management Unit
GWS	Government Water Schemes
HGM	Hydrogeopmorphic
IHI	Index of habitat integrity
IUA	Integrated Unit of Analysis
IUAs	Integrated Units of Analysis
IWRM	Integrated Water Resource Management
IWRMP	Integrated Water Resources Management Plan
NWA	National Water Act
PES	Present Ecological State
RHAM	Rapid Habitat Assessment Method
RQOs	Resource Quality Objectives
RDM	Resource Directed Measures
RHP	River Health Programme

RUs	Resource Units
Userspec	User specification
VEGRAI	Vegetation Response Assessment Index
WMA	Water Management Area
WMS	Water Management System
WRCS	Water Resource Classification System
WfWetlands	Working for Wetlands
WWTW	Wastewater Treatment Works

EXECUTIVE SUMMARY

The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) in March 2016, has commissioned the study "Determination of Resource Quality Objectives (RQOs) in Mokolo, Matlabas, Crocodile (West) and Marico catchments in the Limpopo North West Water Management Area (WMA)". Proposed water resource classes have been completed in these catchment areas and the determination of the RQOs follows on from this process. Establishment of RQOs is a mechanism through which the balance between sustainable and optimal water use and protection of the water resource can be achieved. RQOs are defined by the National Water Act as "clear goals relating to the quality of the relevant water resources" (DWAF, 2006).

RQOs are descriptive or quantitative and are the goals defined to protect the water resource and the alignment to the catchment vision and class of the water resource. In determining the RQOs, it is important to recognise that different water resources will require different levels of protection.

As part of the RQO process the first step is to delineate the units of analysis and define Resource Units (RUs). Each integrated unit of analysis (IUA) represents a homogenous catchment area of similar impacts which must be considered in the determination of RQOs. A RU on the other hand is a stretch of river within an IUA that is sufficiently ecologically distinct to warrant its own specification. Groundwater RUs are defined separately and are based on a number of factors.

The IUA delineation of Mokolo, Matlabas, Crocodile (West) and Marico catchments was done as part of the water resource classification process, through which 20 IUAs were delineated. This study builds on that process, and RUs have been defined for each IUA. Delineation of RUs is required in order to facilitate the effective management of a river set, by breaking down the river into discrete, manageable and ecological homogenous units. The RUs are aligned to the IUA boundaries to prevent overlap between two IUAs. Based on a range of characteristics and considerations a total of 82 RUs were delineated (incorporating dams and priority groundwater and wetlands components) in the Mokolo, Matlabas, Crocodile (West) and Marico catchments. (Figure E1)

The RQO determination procedure proposes RQOs for each resource unit, however this may not always be possible due the potentially large number of RUs that could be delineated for a catchment. In order to prioritise and select the most useful RUs for RQO determination, the rationalisation process developed as part of the RQO Determination Procedure (DWA, 2011) was applied, in terms of Step 3 of the process. Based on the priority ratings obtained through application of the RU prioritisation tool, priority RUs were selected for RQO determination.

Following on from RU prioritisation, as part of Step 4 of the RQO development process, selection of components and the identification of proposed sub-components and indicators for which RQOs should be formulated is required for the water resources within the prioritised resource units of the Mokolo, Matlabas, Crocodile (West) and Marico catchments.

This report therefore presents the final prioritised resource units following stakeholder consultation and details the list of sub-components and indicators prioritised per resource unit which form the basis for development of RQOs and associated numerical limits.

Resource Units Prioritisation

The rationalisation process for RU prioritisation is based on a decision support tool that has been

developed to guide and support the process. The 'Resource Unit Prioritisation Tool' incorporates a multi criteria decision analysis approach to assess the importance of monitoring each RU as part of management operations to identify high priority RUs. The scores for all criteria are combined into a priority rating which scores the RUs relative to each other. This provides an integrated measure to inform the selection of priority RUs.

Based on the priority ratings obtained through application of the RU prioritisation tool, priority RUs for RQO determination were selected by the study team. These preliminary results were presented and discussed with specialists and catchment water resource managers to obtain their input on the rating of the resource units. Based on their local knowledge and understanding of the study area the desktop prioritisation scores were revised, and relevant RUs selected and prioritised. These updated RU unit prioritisation results have subsequently been presented to stakeholders at two project steering committee meetings held over 27 and 28 September 2016 in the catchment area, in order to obtain agreement of the final list of prioritised resource units.

Based on the feedback and input from the meetings, agreement was obtained on the 75 RUs that have been prioritised. The RUs selected for RQOs development include:

- 57 RUs were prioritised (which incorporates the groundwater priority areas and priority wetlands/wetland clusters).
- 18 dam RUs were prioritised.

The prioritised resource units (ratings 0.5 to 0 1.0) are indicated in Figure E2.

Sub-component Prioritisation and Indicator Selection

The step of the RQO procees, has two key objectives, firstly to identify and prioritise sub-components (*viz*. habitat, quantity, quality, biota) that maybe important to users or the environment; and secondly to select those sub-components and associated indicators (e.g. flow, salinity, fish, invertebrates etc) for which RQOs and numerical limits should be developed.

There are wide range of sub-components and indicators for which RQOs can be set. However it is not practical or necessary to set RQOs for all sub-components in a resource unit. A rationalisation process is required to evaluate and prioritise the sub-components for RQO determination. The process is supported by a decision support tool – the 'Resource Unit Evaluation Tool'. The evaluation undertaken in this step of the RQO development process bears particular relevance to consideration of impacts and land based activities on the water resources of the Mokolo, Matlabas, Crocodile (West) and Marico catchments and to identify which sub-components should be protected to support activities, maintain integrity and ecological functioning.

The Resource Unit Evaluation was undertaken for the water resources in the Mokolo, Matlabas, Crocodile (West) and Marico catchments using desktop information, local expert knowledge, previous studies and specialist studies and detailed understanding of the catchment. The assessment was undertaken in a workshop environment with technical specialists, catchment managers and key stakeholders. The overall priorities identified through the evaluation process was used to guide the selection of sub-components for RQO determination. Once the sub-components were selected, suitable indicators for monitoring were then identified. Sub-components for wetlands and groundwater were also selected through independent approaches based on assessment and evaluation of relevant aspects.

The list of sub-components, indicators selected for monitoring and the rationale for consideration

(where applicable) for the rivers, dams, wetlands and groundwater in the Mokolo, Matlabas, Crocodile (West) and Marico catchments are documented in this report. This prioritisation will form the basis for development of RQOs and numerical limits.

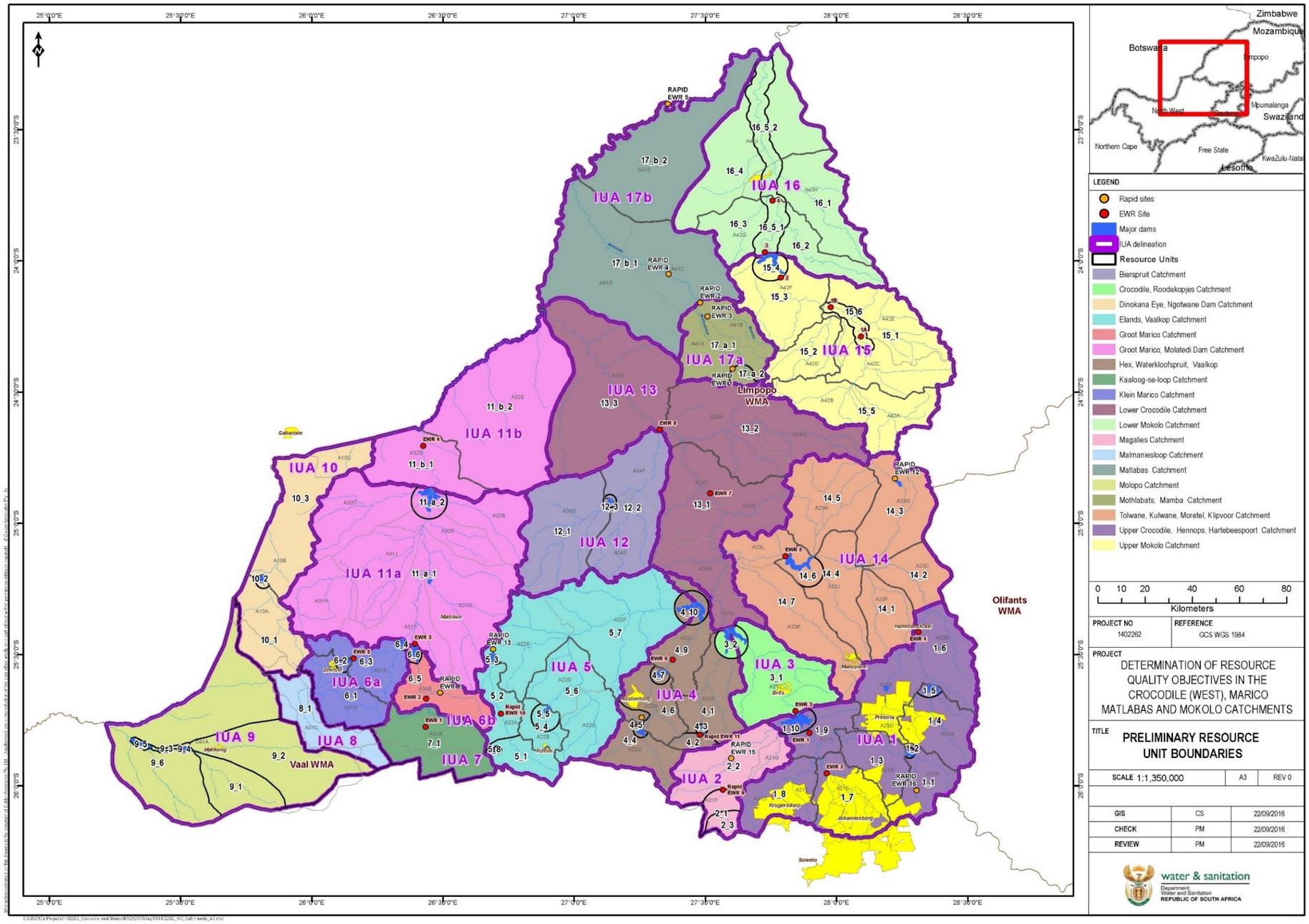

Figure E-1: Delineated Resource Units

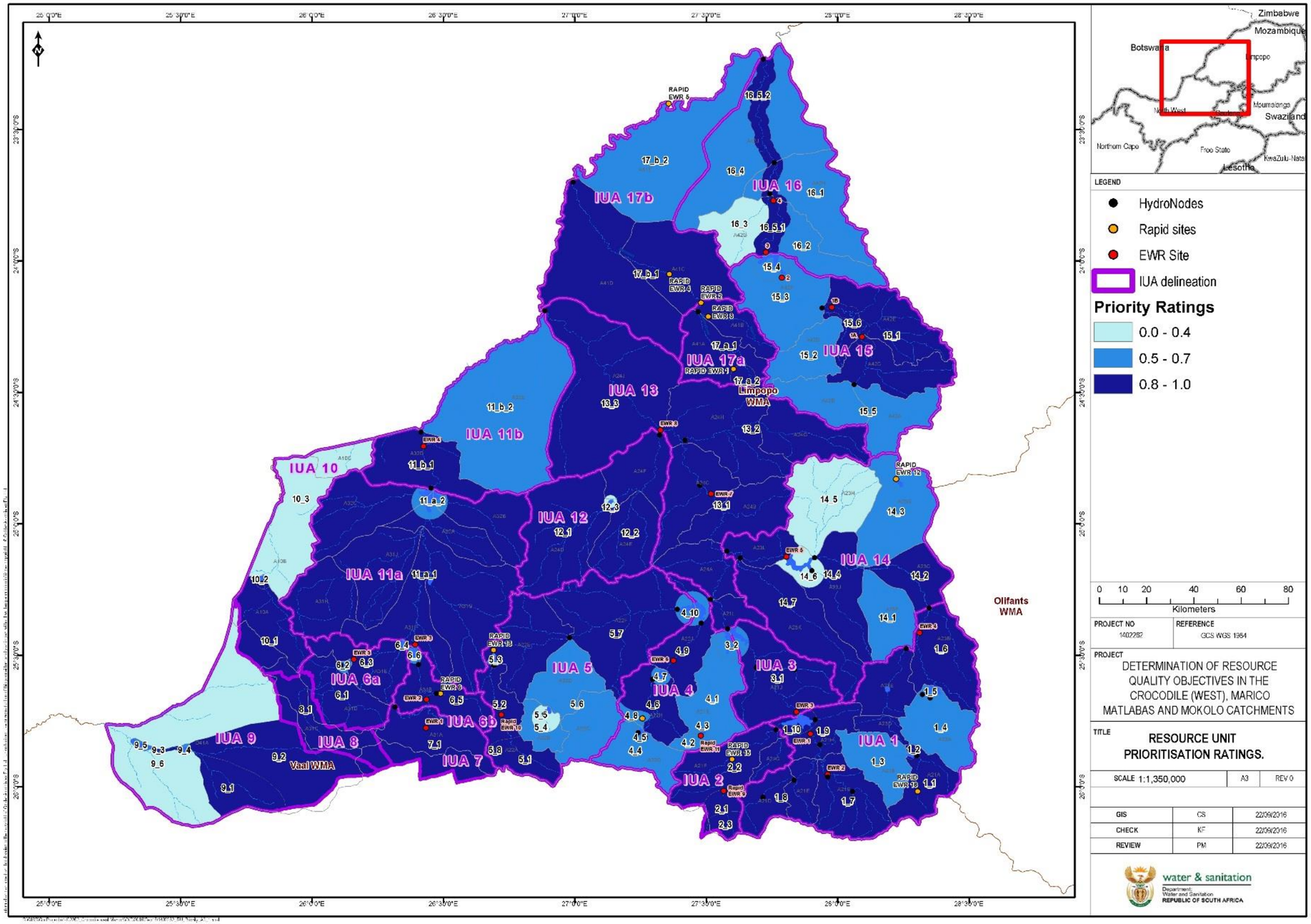

Figure E-2: Priotisation of Resource Units (RUs rated 0.5 to 1.0 have been prioritised for RQO development)

Determination of Resource Quality Objectives in the Mokolo, Matlabas, Crocodile (West) and Marico catchments

Reource Units Prioritisation, Sub-component Prioritisation and Indicator Selection Report

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1 INTRODUCTION

1.1 BACKGROUND

Resource Directed Measures (RDM) is enabled through Chapter 3 of the National Water Act (Act No.36 of 1998) (NWA) which provides for the protection of water resources through the Classification of water resources, determination of Resource Quality Objectives (RQOs) and determination of the Reserve. These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources on one hand and the need to develop and use them on the other.

Resource quality objectives have to be determined for a significant water resource as the means to ensure a desired level of protection. The purpose of the RQOs is to provide limits or boundaries (biological, physical and chemical attributes, etc.) which should be met in the receiving water resource in order to ensure protection.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource class, the RQOs determined will ensure that the needs of all users and competing interests who rely on the water resources are considered.

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS) has initiated the development of Resource Quality Objectives (RQOs) for the Mokolo, Matlabas, Crocodile (West) and Marico catchments. With the water resources in these catchment areas having been classified, RQOs are to be determined as the next step of the protection framework.

In terms of the National Water Act, the RQOs are based on the water resource class and may relate to the following:

- the Reserve;
- the in-stream flow;
- the water level;
- presence and concentration of particular substances in the water;
- the characteristics and quality of the water resource;
- the in-stream and riparian habitat quality;
- characteristics and distribution of aquatic biota; and
- the regulation or prohibition of in-stream or land-based which may affect the quantity of water in or quality of the water resource, and
- any other characteristic of the water resource in question.

RQOs encompass four components of the resource:

- Water quantity;
- Water quality;
- Habitat integrity; and
- Biotic characteristics.

RQOs are important management objectives against which resource monitoring will be assessed. Compliance monitoring will provide an indication as to whether the water resource class is being maintained. RQOs will form important sustainability indicators for water resource management.

1.2 PURPOSE OF THE STUDY

The objective of the study is to determine Resource Quality Objectives (RQOs) for all significant water resources in the Mokolo, Matlabas, Crocodile (West) and Marico Catchments that must give effect to the Water Resources Classes that have been determined.

RQOs are developed following the seven step process for determining RQOs (DWA, 2011) which is depicted in Figure 1. Once gazetting has been finalised, implementation, monitoring and review would then follow. The process also requires engagement and communication with stakeholders at key steps in the process.

The study approach is defined by 5 tasks depicted in Figure 2.

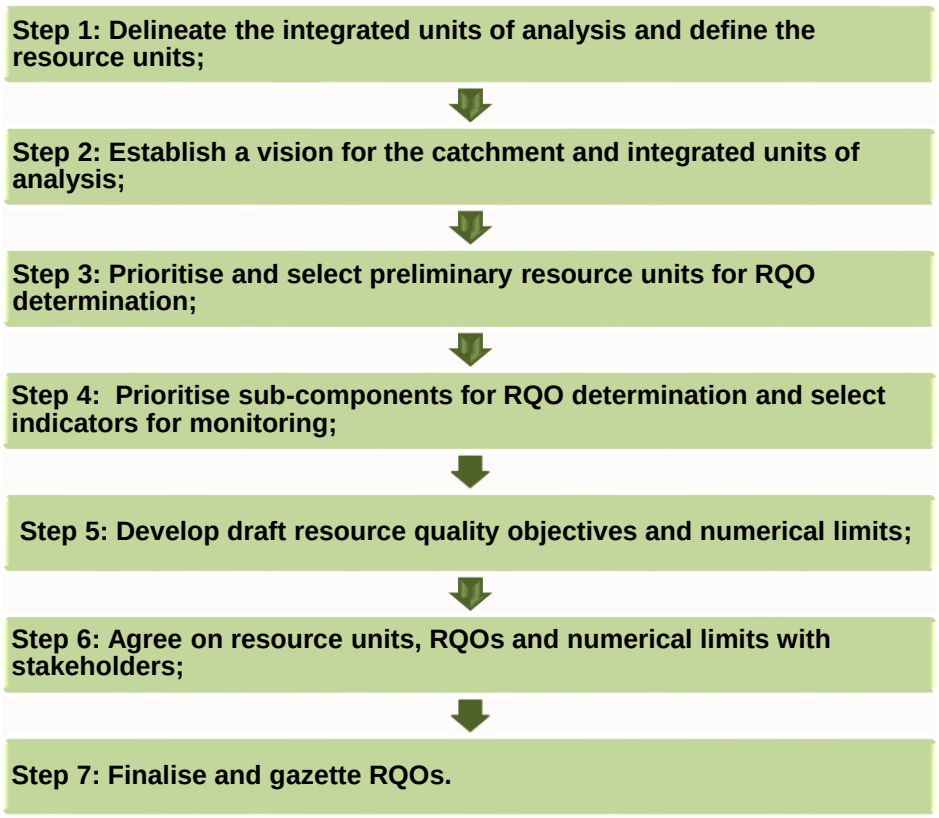

Figure 1: Seven step process for RQO determination

In terms of the RQO determination process outlined above, IUA delineation (Step 1) and the vision (Step 2) have been completed as part of the water resource classification study. Resource units have however been defined through this study.

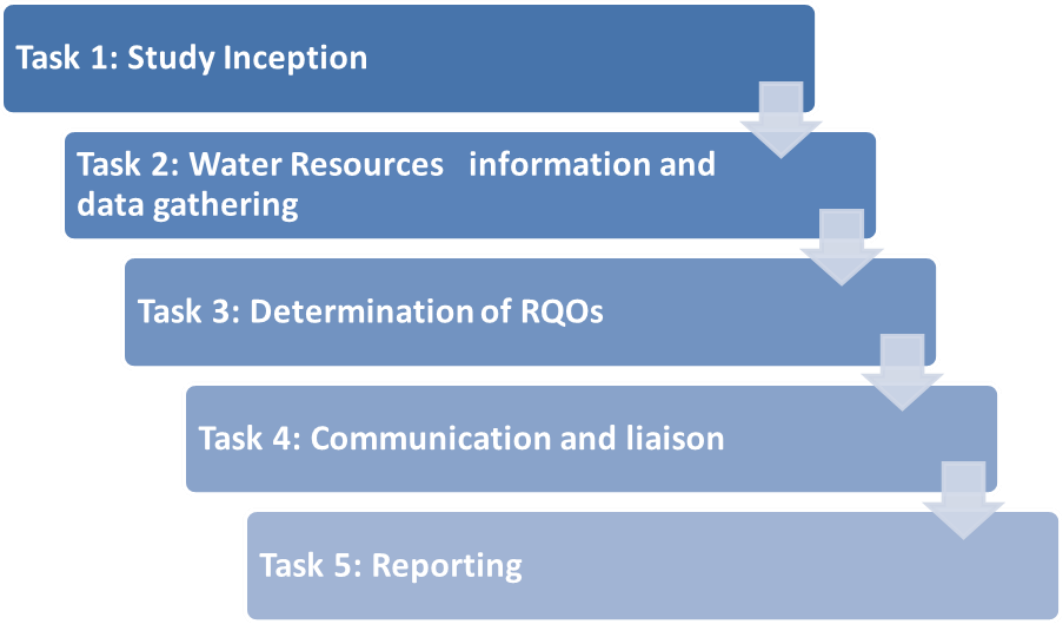

Figure 2: Study tasks

1.3 STUDY AREA

The study area for the RQO Determination study is the Mokolo, Matlabas, Crocodile (West) and Marico Catchments (Figure 3) in the Limpopo Water Management Area (WMA). The spatial extent of the area includes tertiary drainage regions A10, A21 to A24, A31, A32, A41, A42 and quaternary drainage region D41A (Table 1).

Table 1:Sub-catchments and related quaternary drainage regions comprising the Mokolo, Matlabas and Crocodile (West) and Marico Catchment areas

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

Much of the area has low rainfall with significant inter-dependencies for water resources between catchments and with neighbouring WMAs.

The catchment areas lie predominately within the North West Province and include the northern part of Gauteng as well as the south-western portion of the Limpopo Province. Towards the north west

the area borders on Botswana. The main river systems within the catchment (Crocodile, Marico, Mokolo and Matlabas rivers) flow northwards to join the Limpopo River. Major tributary systems include the Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies, Elands, Klein Marico, Molopo, and Ngotwane rivers.

The Pilanesburg Nature Reserve, the Cradle of Humankind Heritage Site, the Marakele Nature Reserve, the Bafokeng Tribal area, the dolomitic wetland or eye systems and large dams such as the Hartbeespoort, Vaalkop, Roodekopjes, Klipvoor, Roodeplaat, Molatedi and Mokolo Dams are all very important features in the catchment area. The Pilanesburg Nature Reserve, the Cradle of Humankind Heritage Site and Hartbeespoort Dam are key tourist attractions in South Africa.

The area is altered by catchment development, with economic activity dominated by urban areas and industrial complexes of northern Johannesburg and Tshwane, with platinum mining north-east of Rustenburg, and power generation and mining. In the Lephalale area, economic activity is mainly centred around commercial agriculture, together with increasing mining operations, game and livestock farming and eco-tourism. The major land-use is irrigation farming, with private and provincial nature reserves as well as extensive coal mining and platinum mining. Parts of the catchment area are also largely rural in nature.

The water resources of the catchment area support major economic activities and a population of approximately 5.0 million people. The surface water potential of the area has largely been developed. Large dolomitic groundwater aquifers occur along the southern part of the area. The aquifers are utilised extensively for urban and irrigation purposes. Groundwater is therefore used extensively. However, over exploitation occurs in certain areas. Several inter-water management area transfers exist, all of which bring water into the catchment. A transfer from the Crocodile (West) catchment into the Mokolo catchment is being planned to support the power generation and expected growth in mining in the Lephalale area.

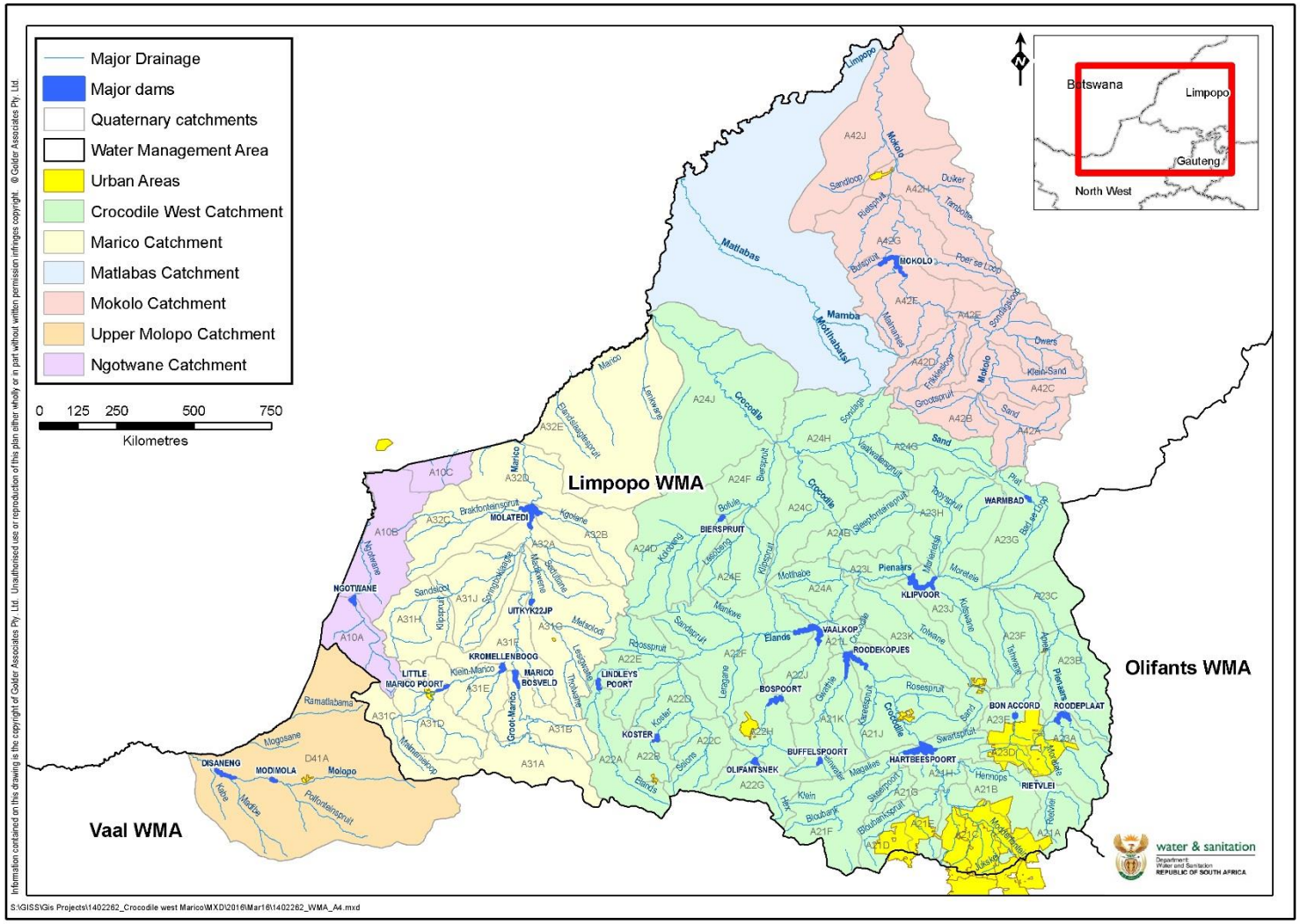

Figure 3: The Study Area - Mokolo, Matlabas, Crocodile (West) and Marico catchments

1.4 RESOURCE UNIT PRIORITISATION AND PRIORITISATION OF SUB-COMPONENTS AND SELECTION OF INDICATORS TASK

As part of the RQO process the first step was to delineate the units of analysis and define Resource Units (RUs). The IUA delineation of Mokolo, Matlabas, Crocodile (West) and Marico catchments was done as part of the water resource classification process, through which 20 IUAs were delineated. The IUAs delineated form the basis for the RQO determination process. Through this study the resource units for the water resources in Mokolo, Matlabas, Crocodile (West) and Marico catchments were delineated and preliminary prioritised (Step 3 of the process).

The priorisation of RUs has now been finalised following stakeholder consultation and agreement and the next step of the RQO determination process is to prioritise sub-components for RQO determination and select indicators for monitoring.

The selection of components and the identification of proposed sub-components and indicators for which RQOs are set, forms part of Step 4 (Figure 1) of the RQO determination process. The step has two key objectives, firstly to identify and prioritise sub-components (*viz.* habitat, quantity, quality, biota) that maybe important to users or the environment; and secondly to select those sub-components and associated indicators (e.g. flow, salinity, fish, invertebrates etc) for which RQOs and numerical limits should be developed.

In this study RQOs for rivers, groundwater, dams and wetland resources will be determined. To generate RQOs for these resources the existing seven step procedure methodology available from DWA (2011) has been expanded on to include dam and wetland methodologies.

There are wide range of sub-components and indicators for which RQOs can be set however it is not practical or necessary to set RQOs for all sub-components in a resource unit. A rationalisation process is required to evaluate and prioritise the sub-components for RQO determination.

1.5 PURPOSE OF THE REPORT

This report presents the final prioritised resource units for the water resources in Mokolo, Matlabas, Crocodile (West) and Marico catchments. It also details the list of sub-components prioritised and indicators selected for water resource components in the Mokolo, Matlabas, Crocodile (West) and Marico catchments. This prioritisation will form the basis for development of RQOs and numerical limits.

2 INTEGRATED UNITS OF ANALYSIS (IUAS)

The Water Resource Classification and the Reserve Determination studies for the Mokolo, Matlabas, Crocodile (West) and Marico catchments have been completed in 2014 and 2009 respectively. Through the classification study the IUAs for the catchment were delineated and the EWR sites and river nodes were specified. These outputs from the classification study form the basis for the RQO determination process, and primarily for the RU definition.

In terms of the classification study, 20 IUAs were delineated (DWA, 2012a). These are listed in Table 2 and shown in Figure 4. The IUAs form the boundaries for RU delineation.

Table 2: IUAs delineated for the Crocodile (West), Marico, Mokolo and Matlabas catchments

IUA No.	Main river system/ 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

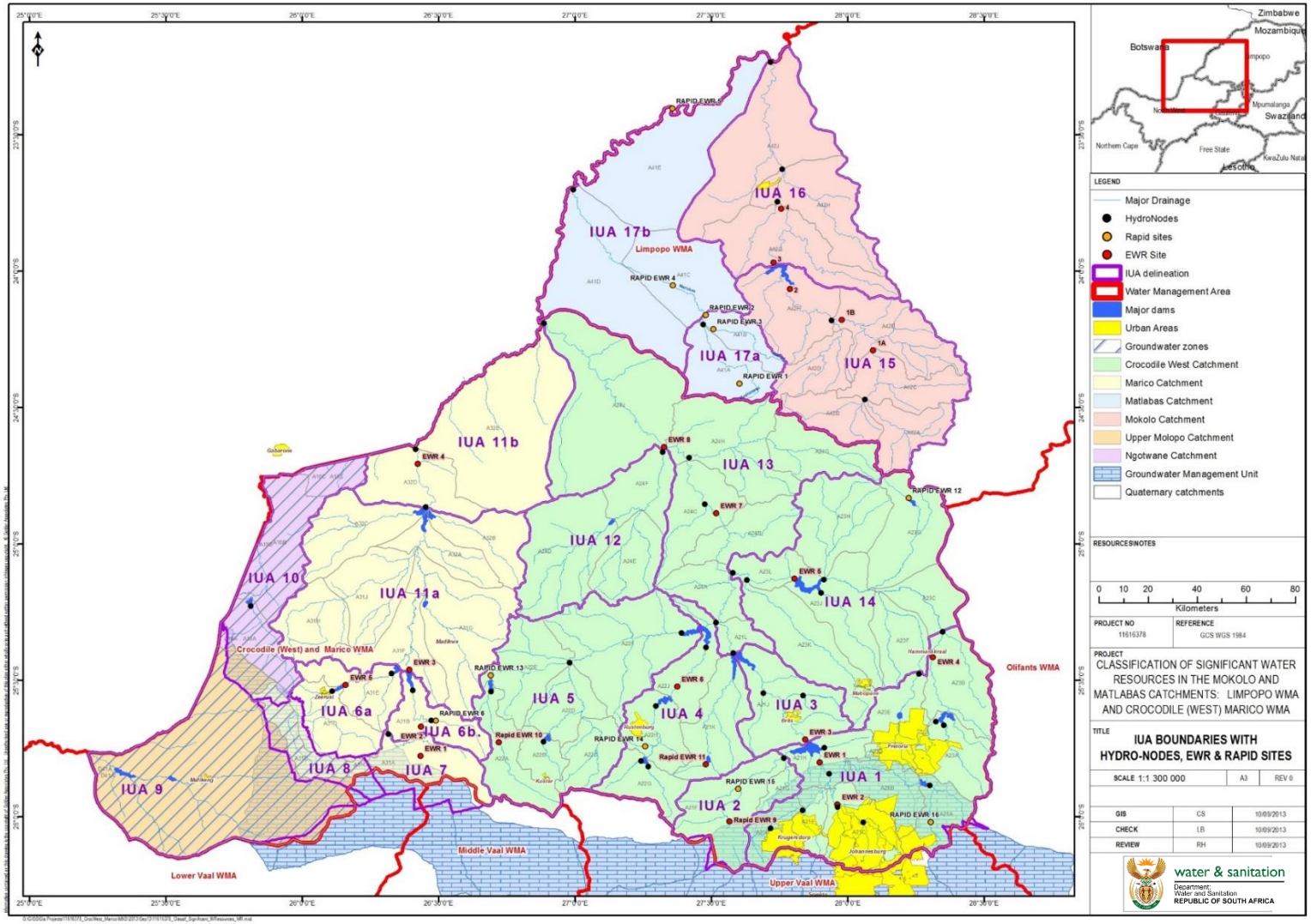

Figure 4: IUAs delineated within Crocodile (West), Marico, Mokolo and Matlabas catchments

3 RESOURCE UNITS PRIORTISATION

Delineation and prioritisation of RUs is required as it would not be appropriate to set the same RQOs for all water resources in a catchment. The RUs are aligned to the IUA boundaries to prevent overlap between two IUAs. Based on a range of characteristics and considerations a total of 82 RUs were delineated (incorporating dams and priority groundwater and wetlands components) in the Mokolo, Matlabas, Crocodile (West) and Marico catchments. The RUs delineated are shown in Figure 6.

The RQO determination procedure proposes RQOs for each resource unit, however this may not always be possible due the potentially large number of RUs that could be delineated for a catchment. In order to prioritise and select the most useful RUs for RQO determination, the rationalisation process developed as part of the RQO Determination Procedure (DWA, 2011) was applied, in terms of Step 3 of the process (Figure 5). Based on the priority ratings obtained through application of the RU prioritisation tool, priority RUs were selected for RQO determination, which were then taken through stakeholder consultation process to confirm priority.

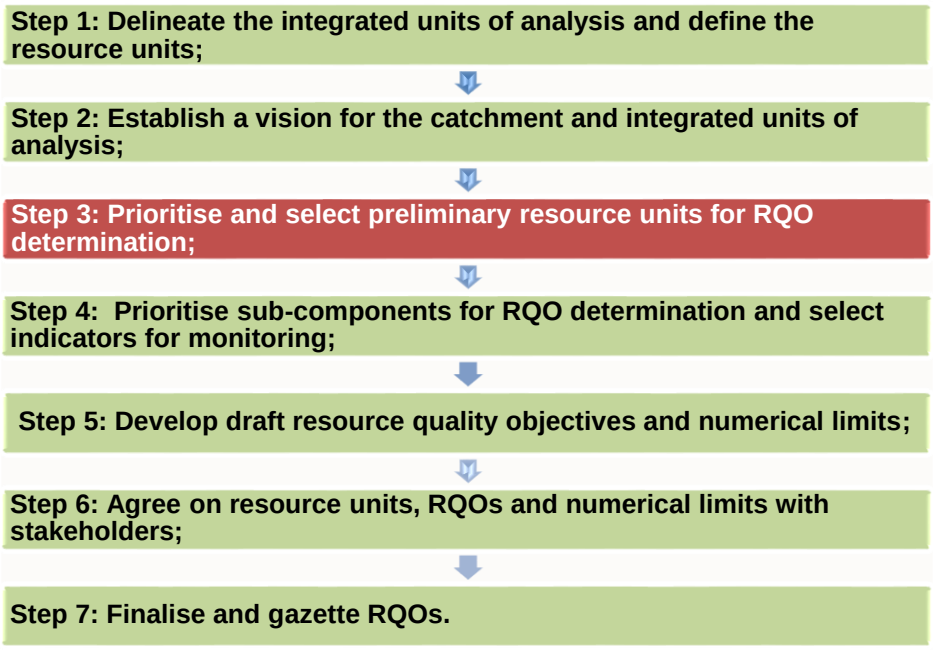

Figure 5: RQO Determination Process

The rationalisation process for RU selection and prioritisation is based on a decision support tool that has been developed to guide and support the process. The 'Resource Unit Prioritisation Tool' incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU as part of management operations to identify important RUs.

The criteria assessed per RU include:

- Position of RUs within an IUA;
- Importance of the RU to users;
- Threat posed to water resource quality for users;

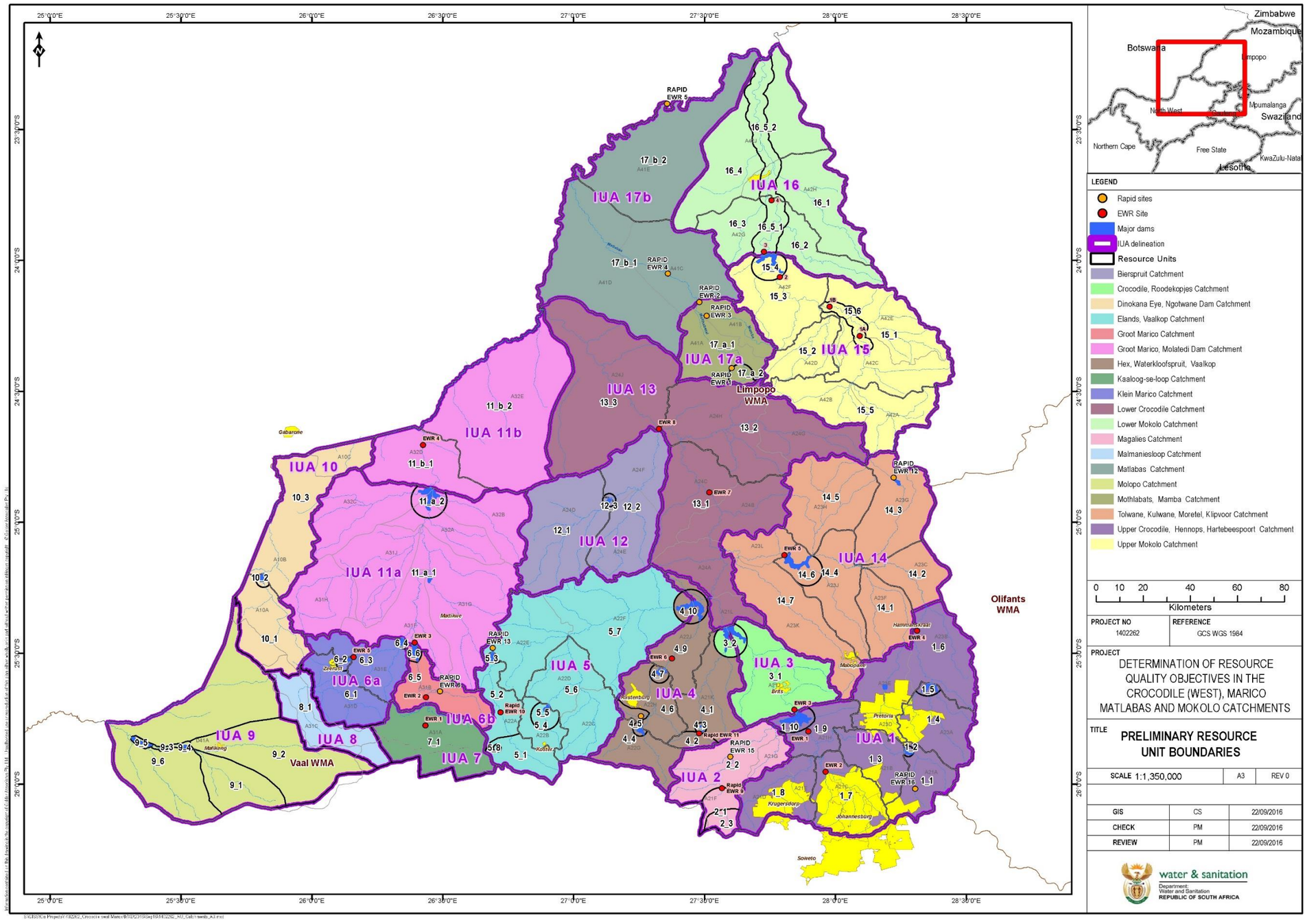

Figure 6: Delineated Resource Units

- Threat posed to water resource quality for the environment;
- Ecological considerations;
- Practical Constraints, and
- Management Considerations.

Standardised rankings and weightings are proposed for each of the seven criteria above used in the prioritisation process by application of the tool. The RU Prioritisation Tool consists of a simple scoring system where a score of 0, 0.5 or 1 is assigned to the criteria to assess conformance to the guidelines supporting criterion. The rating scores then through ranking, relative weighting and multiplication allows for the relative prioritisation of RUs to be determined, by producing a prioritisation score – the priority rating of the RU (DWA, 2011). The priority rating scores the RUs relative to each other and considers the summary scores for the criteria. This provides an integrated measure to inform the selection of RUs. However these values maybe altered if strong motivation exists and may be adjusted to suite the current context. The process also requires that a rationale is provided for the selection of priority RUs as in some cases low and moderate rated RUs may be selected over higher rated ones (DWA, 2011).

Based on the priority ratings obtained through application of the RU prioritisation tool, priority RUs for RQO determination were selected. These preliminary results were presented and discussed with specialists and catchment water resource managers to obtain their input on the rating of the resource units. Based on their local knowledge and understanding of the study area the desktop prioritisation scores were revised, and relevant RUs selected and prioritised. These updated RU unit prioritisation results have subsequently been presented to stakeholders in the catchment area at two project steering committee meetings held over 27 and 28 September 2016, in order to obtain agreement of the final list of prioritised resource units.

In terms of the 82 RUs that were delineated, 75 have been prioritised for RQO determination. The prioritised units are listed in Table 3 and shown in Figure 7. Of the final prioritised RUs:

- 57 are surface water RUs (including approximately fifty wetlands/wetland priority areas)
- 18 are dam RUs;
- Groundwater priority areas were identified (dolomite aquifer systems, alluvial aquifer systems, and deep fractured systems).

The detailed results of the above are detailed in the Preliminary Resource Units Report (DWS, 2016).

Table 3: Prioritised Resource Units for the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments

IUA1	Upper Crocodile/Hennops/Hartebeespoort	
RU	**Delineation**	**Catchment**
1_1	Upper Hennops and Rietvlei Rivers to inflow to Rietvlei Dam	A21A
1_2	Rietvlei Dam	A21A
1_3	Hennops River from outflow Rietvlei Dam to the A21B catchment (including Kaalspruit and Olifantspruit tributaries)	A21B
1_4	Upper Pienaars River, Edendalespruit and Moretlele Rivers to Roodeplaat Dam	A23A
1_5	Roodeplaat Dam	A23A

1_6	Upper and middle reaches of Apies River, Skinnerspruit, Pienaars River from outflow Roodeplaat Dam to Boekenhoutpruit confluence, Roodeplaatspruit, Boekenhoutspruit	A23B, A23D, A23E
1_7	Jukskei, Klein Jukskei, Modderfonteinspruit	A21C
1_8	Upper reaches of Crocodile River and Bloubank Spruit	A21D, A21E
1_9	Crocodile River from Jukskei confluence to inflow Hartebeespoort Dam, Swartspruit	A21H
1_10	Hartebeespoort Dam	A21H
IUA2	**Magalies**	
RU	**Delineation**	**Catchment**
2_1	Maloneys Eye	South eastern portion of A21F
2_2	Magalies River, Klein Magalies, Bloubank, Skeerpoort Rivers	A21F, A21G
2_3	Surface water area linked to Maloney's Eye (catchment area)	A21F
IUA3	**Crocodile/Roodekopjes**	
RU	**Delineation**	**Catchment**
3_1	Crocodile River from outflow Hartebeespoort Dam to inflow Roodekopjes Dam, Rosespruit, Ramogatla and Kareespruit	A21J
3_2	Roodekopjes Dam	A21J
IUA4	**Hex/Waterkloofspruit/Vaalkop**	
RU	**Delineation**	**Catchment**
4_1	Sterkstroom from outflow Buffelspoort Dam to inflow Roodekopjes Dam, Maretwane, Tshukutswe	A21K middle and lower catchment below dam
4_3	Buffelspoort Dam	A21K
4_2	Upper reaches of Sterkstroom to inflow Bueffelspoort Dam , Kleinwater	A21K upper catchment to dam
4_4	Upper Hex River to Olifantsnek Dam, Rooikloofspruit	A22G
4_5	Olifantsnek Dam	A22G
4_6	Hex River outflow Olifantsnek Dam to inflow Bospoort Dam, Sandspruit	A22H
4_7	Bospoort Dam	A22H
4_8	Water Kloofspruit tributary catchment	A22H
4_9	Hex River outflow Bospoort Dam to inflow Vaalkop Dam	A22J
4_10	Vaalkop Dam	A22J
IUA5	**Elands/Vaalkop**	
RU	**Delineation**	**Catchment**
5_1	Upper reaches of Elands to Swartruggens Dam	A22A south eastern portion
5_2	Elands river downstream Swartruggens Dam to Lindleyspoort Dam	A22A
5_3	Lindleyspoort Dam	A22A
5_4	Upper Koster River to Koster Dam	A22B
5_6	Selons River, Kodoespruit, Dwarsspruit, lower Koster River	A22C, A22D
5_7	Elands River outflow Lindleyspoort Dam to inflow Vaalkop Dam, Brakkloofspruit, Roosspruit, Sandspruit Mankwe. Leragane, Molapongwamongana	A22E, A22F
5_8	Swartruggens Dam	A22A
IUA6a	**Klein Marico**	
RU	**Delineation**	**Catchment**

6_1	Upper Klein Marico to inflow Klein Maricopoort dam, Rhenosterfonteinspruit, Malmanieloop, Kareespruit	A31D
6_2	Klein Maricopoort dam	A31D
6_3	Klein Marico downstream Klein Maricopoort Dam to Kromellenboog Dam, Wilgeboomspruit	A31E
6_4	Kromellenboog Dam	A31E
IUA6b	**Groot Marico**	
RU	**Delineation**	**Catchment**
6_5	Groot Marico, Polkadraaispruit	A31B
6_6	Marico Bosveld Dam	A31B
IUA7	**Kaloog-se-Loop**	
RU	**Delineation**	**Catchment**
7_1	Marico Eye, Kaaloog-se-Loop, Bokkraal-se-Loop, Ribbokfontein-se-Loop, Rietspruit (southern eye), Kuilsfontein, Syferfontein and Bronkhorstfontein	A31A
IUA8	**Malmaniesloop**	
RU	**Delineation**	**Catchment**
8_1	Malmanie Eye, Dolomites	A31C
IUA9	**Molopo**	
RU	**Delineation**	**Catchment**
9_1	Bodibe Eye	D41A (Polfonteinspruit and Lotlhakane tributary catchment area)
9_2	Molopo Eye, Grootfontein Eye, Molopo headwaters to inflow Modimola dam	D41A
9_3	Molopo River mainstem only from Modimola Dam to Disaneng Dam	D41A (mainstem)
9_4	Modimola Dam (Setumo Dam)	D41A
9_5	Disaneng Dam	D41A
IUA10	**Dinokana Eye/Ngotwane Dam**	
RU	**Delineation**	**Catchment**
10_1	Upper Ngotwane, Dinokane Eye	A10A
10_2	Ngotwane Dam	A10A
IUA11a	**Groot Marico/Molatedi Dam**	
RU	**Delineation**	**Catchment**
11a_1	Rasweu, Maselaje rivers	A32D
11a_2	Molatedi dam	A32E
IUA11b	**Groot Marico/Seasonal tributaries**	
RU	**Delineation**	**Catchment**
11b_1	Groot Marico from outflow Marico Bosveld Dam to Molatedi Dam, all tributaries	A31G, A31H, A31F, A31J, A32A, A32B, A32C
11b_2	Elandslaagtespruit, Lengope la Kgamanyane, Lenkwane	A32A, A32B, A32C
IUA12	**Bierspruit**	
RU	**Delineation**	**Catchment**
12_1	Wilgespruit, Bofule, Kolobeng, Magoditshane, Motlhabe	A24D
12_2	Bierspruit outflow Bierspruit Dam to confluence with the Crocodile River, Brakspruit, Phufane, Sefatlhane, Lesobeng, lower reach Bofule	A24E, A24F

IUA13	Lower Crocodile	
RU	**Delineation**	**Catchment**
13_1	Crocodile River outflow Roodekopjes Dam to upstream Sand River confuence, Sleepfonteinspruit, Klipspruit tributaries	A21L, A24A, A24B, A24C
13_2	Sand River to confluence with the Crocodile River to Bierspruit confluence, Sondags, Vaalwaterspruit and Monyagole tributaries	A24G, A24H
13_3	Lower Crocodile from Bierspruit confluence to the Botswana border (Limpopo River)	A24J
IUA14	**Tolwane/Kulwane/Moretele/Klipvoor**	
RU	**Delineation**	**Catchment**
14_1	Apies River, Tshwane tributary	A23F
14_2	Pienaars River from Boekenshout confluence to Apies River confluence	A23C
14_3	Plat River	A23G
14_4	Moretele (Pienaars) River from Plat River confluence to Klipvoor Dam, Kutswane to Klipvoor Dam	A23J
14_7	Pienaars River from Klipvoor Dam to Crocodile Riverconfluence, Tolwane tributary	A23K, A23L
IUA15	**Upper Mokolo**	
RU	**Delineation**	**Catchment**
15_1	Moloko River in A42C, Sand River and Klein Sand, Brakspruit, Sondagsloop, Heuningspruit, Dwars, Jim se loop tributaries	A42C, A42E
15_2	Sterkstroom, Frikkie-se-Loop	A42D, A42E
15_3	Mokolo River in A42F to inflow Mokolo Dam, Taaibosspruit, Malmanies and Bulspruit tributaries	A42F
15_4	Mokolo Dam	A42F
15_5	Grootspruit and Sandspruit tributaries (Mokolo headwater catchment)	A42B
15_6	Mokolo River from Dwars river to confluence with Sterkstroom, Klein Vaalwaterspruit, Brakspruit	A42E
IUA16	**Lower Mokolo**	
RU	**Delineation**	**Catchment**
16_1	Tambotie river catchment	A42H (major portion - eastern)
16_2	Poer se Loop catchment	A42G
16_4	Sandloop	A42J and remaining portion of A42H
16_5	Mokolo mainstem	A42 G, A42H, A42J (along mainnstem river)
IUA17a	**Mothlabatsi/Mamba**	
RU	**Delineation**	**Catchment**
17a_1	Mothlabatsi, Mamba Rivers	A41A, A41B
17a_2	Headwaters Mothlabatsi (peatlands)	A41A (south eastern)
IUA17b	**Matlabas**	
RU	**Delineation**	**Catchment**
17b_1	Matlabas	A41D, A41C
17b_2	Catchment area including Steenbokpan	A41E

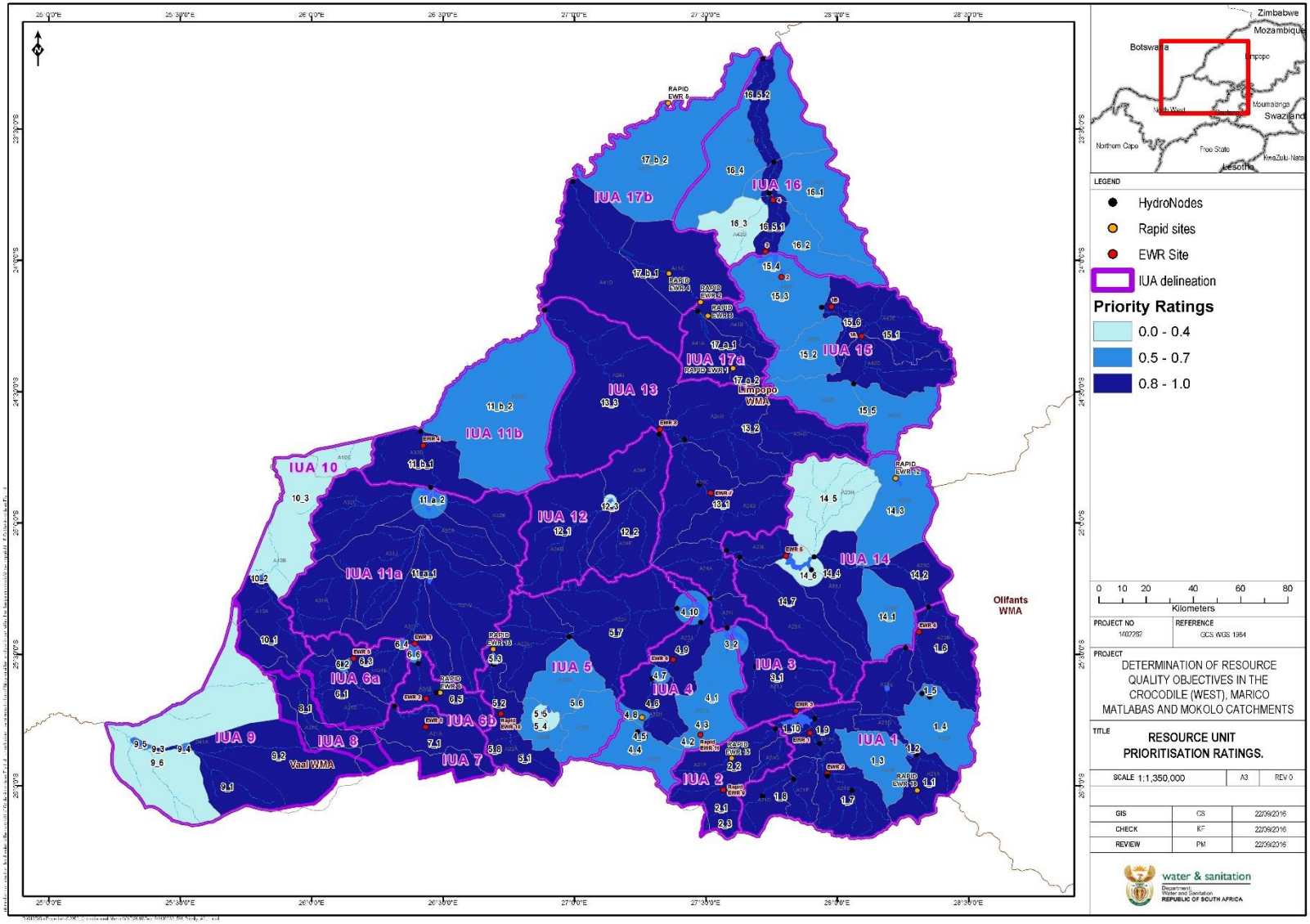

Figure 7: Prioritised Resource Units for the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchment

3.1 PRIORITY GROUNDWATER AREAS

Two important aquifer systems have been identified in terms of specifying groundwater priority areas, *i.e*.:

- Alluvial aquifer systems; and
- Dolomite (karst) aquifer systems.

Alluvial Aquifer Systems

The presence of significant alluvial deposits (referenced as intergranular aquifers) in the river valleys opts for demarcation (*viz*. specific RUs) of these systems as well, as they are in fact acting as an interface between the surrounding intergranular and fractured and fractured aquifers and the surface water body in the drainage channel. Where applicable (*i.e*. where these systems represents a noticeable component of the water resource), it has been specifically mapped as a groundwater priority area, *i.e*. the Lower Crocodile River (

Figure **8**), Thabazimbi to Limpopo River confluence, IUA17b, and the Lower Mokolo (A42J).

Major Dolomite (Karst) Aquifer Resources

The detailed demarcations for the karst aquifers have been aligned to specifically include the mapped dolomite resource units. The three major dolomite (karst) aquifer resource systems are delineated *viz*. (1) Centurion, Pretoria and Rietvlei-Kempton Park dolomites; (2) Maloney's Eye (Steenkoppies Catchment and Tarlton dolomites) and (3) Upper-Molopo Catchment, Marico/Holpan and Dinokana-Zeerust dolomites (Figure 9, Figure 10 and Figure 11). These units form the priority groundwater management areas (GMAs) for RQO development. The reason is that the groundwater flow paths through these karst systems are high and flow paths are demarcated by the presence of secondary boundary systems (*i.e*. intrusive dykes acting as flow boundary systems). For the remainder of the study area, *i.e.* the non-karst aquifer units, the groundwater resource units are the same as the surface ones.

The delineation of dolomite resources requires the identification and mapping of small and larger dolomite compartments, at sub quaternary catchment scale, by considering aspects such as geological lithology, aquifer recharge, hydraulic gradients, water level (piezometric) information, water quality data, location of springs, discharge areas and quaternary catchment boundaries.

The priority groundwater areas selected for RQO determination are listed in Table 4.

Table 4: Priority Groundwater Areas selected for RQO Determination

SELECTED GROUNDWATER PRIORITY UNITS		
Dolimitic GMA1 (RU1_1; 1_2; 1_3; 1_6)	Centurion, Pretoria and Rietvlei-Kempton Park dolomite resources.	A21A, A21B, A23D
Dolimitic GMA 2 (RU 2_1; 2_2; 2_3)	Maloney's Eye (Steenkoppies Catchment and Tarlton dolomite resources	A21D, A21F, A21G
Dolimitic GMA3 (RU 7_1, 8_1, 9_1)	Upper-Molopo Catchment, Marico/Holpan and Dinokana-Zeerust dolomite resources	A31A, A31C, D41A
General: Alluvial aquifer systems	Systems along major drainage channels *viz*.the Lower Crocodile River, Thabazimbi to Limpopo River confluence and the Lower Mokolo	A24B, A24C, A24H, A24J;

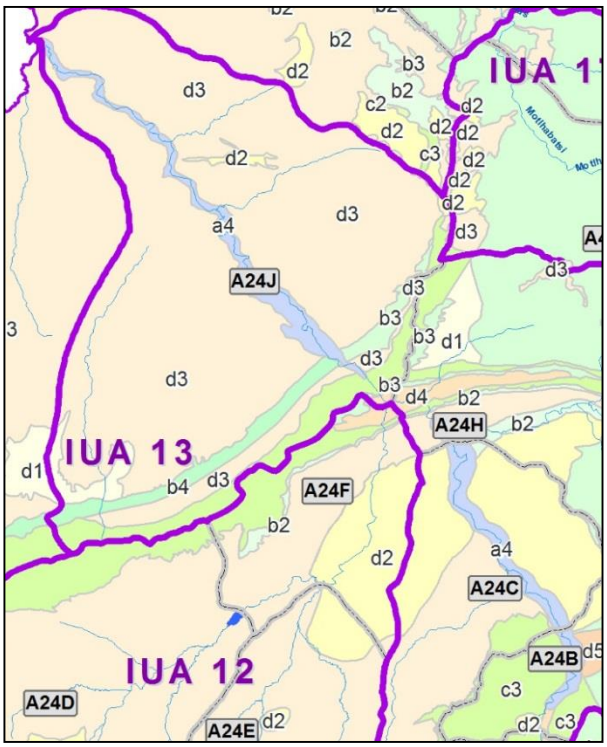

Figure 8: Alluvial aquifer systems along major drainage channels (shown the lower Crocodile (West) river between Thabazimbi and Limpopo Confluence

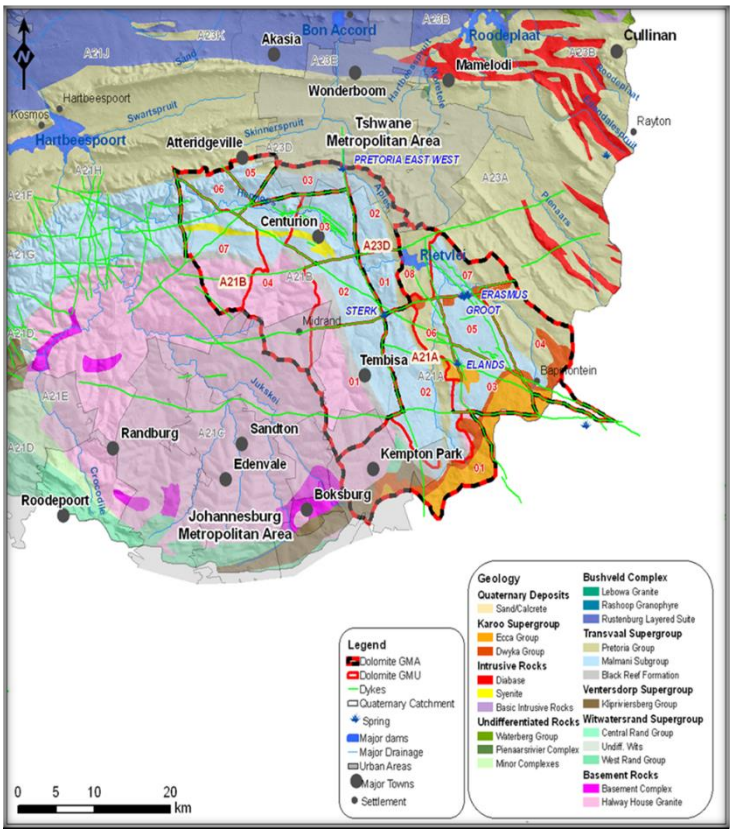

Figure 9: Centurion, Pretoria and Rietvlei-Kempton Park dolomite resources

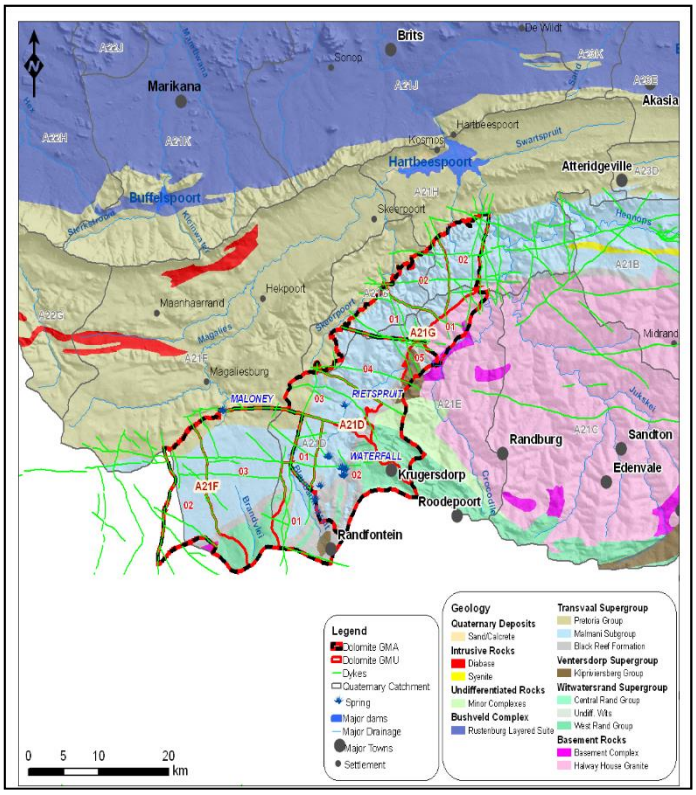

Figure 10: Maloney's Eye (Steenkoppies Catchment and Tarlton dolomite resources)

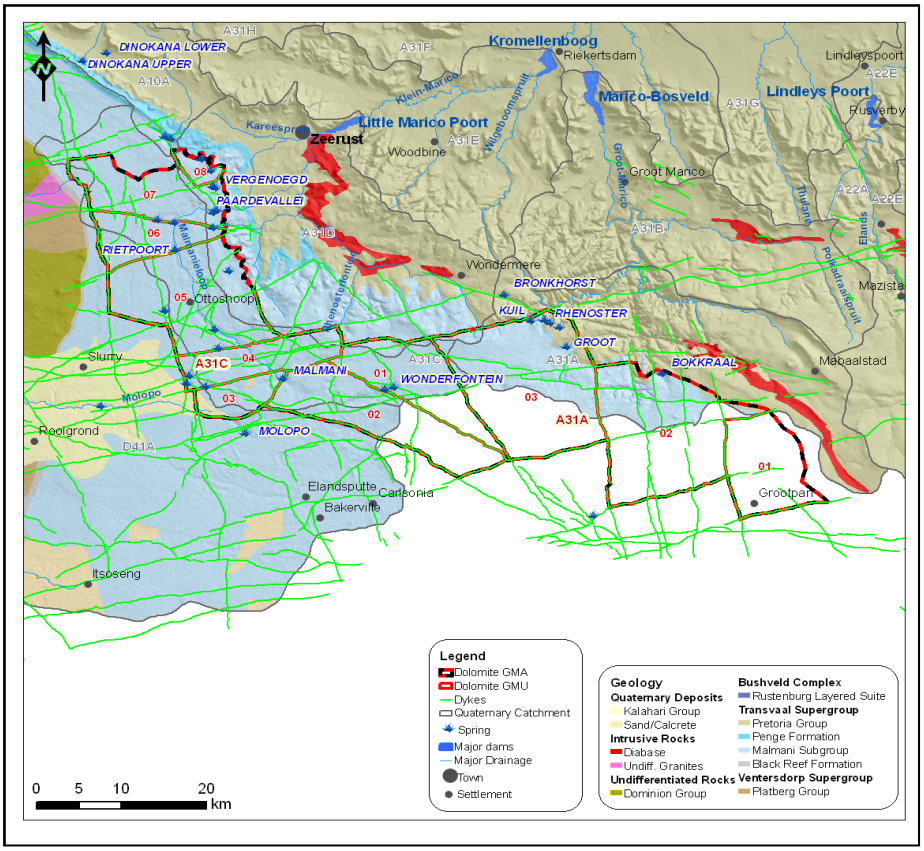

Figure 11: Upper-Molopo Catchment, Marico/Holpan and Dinokana-Zeerust dolomite resources

3.2 PRIORITY WETLANDS

The list of priority wetlands per IUA and Resource Unit (RU) is provided in Table 5. A map showing the distribution of wetlands per IUA and RU is shown in Figure 12.

Table 5: Priority wetlands per IUA and RU indicating the type of system and a brief description of any unique features associated with the wetland systems

IUA	RU	Wetland	Type	Unique features
IUA 1	1_1	-	Pans	Endorheic seasonal grass-sedge depressions
	1_1	-	Valley bottom wetlands	-
	1_3, 1_7, 1_8	-	Hillslope seepage wetlands	High botanical diversity
	1_1	Rietvlei wetland complex	Peatland	Peatlands
	1_4	Colbyn Valley wetland	Peatland	Peatlands
IUA 2	2_1	-	Pans	Endorheic seasonal grass-sedge depressions
	2_1, 2_2	-	Valley bottom wetlands	-
	2_1, 2_2	-	Hillslope seepage wetlands	High botanical diversity
	2_1	Maloney's eye	Dolomitic eye and peatland	Dolomitic eye
IUA 4	4_8	Waterval Valley Bottom Mire (peatland)	Unchannelled valley bottom	Peatland at the headwaters of the Waterkloofspruit
IUA 5	5_1, 5_2	-	Pans	Endorheic seasonal grass-sedge depressions
	5_1	-	Valley bottom wetlands	-
	5_1	-	Hillslope seepage wetlands	High botanical diversity
IUA 7	7_1	-	Valley bottom wetlands	-
	7_1	-	Pans	-
	7_1	-	Tufa waterfall	Waterfall composed of limestone or calcium carbonate formed by the precipitation of carbonate minerals. Very rare type of waterfall in SA
	7_1	Marico eye (Kaaloog se Loop)	Valley bottom Peatland	Dolomitic eye
IUA 8	8.1	Malmanie Loop	Valley bottom mire or peatland	Dolomitic eye with a valley bottom peatland downstream. Unique biota associated with the dolomitic eye.
IUA 9	9_1	-	Pans	Endorheic temporary to seasonal depressions
	9_6	-	Pans	Endorheic seasonal grass-sedge depressions
	9_2	-	Valley bottom wetlands	-
	9_4	-	Valley bottom wetlands	-
	8_1, 9_2	Molopo	Unchannelled valley bottom wetlands and peatlands	Molopo Eye and peatland. Is important for water supply and biodiversity support
	9_1	Bodibe peatland	Unchannelled valley	Potfontein eye and Bodibe

IUA	RU	Wetland	Type	Unique features
			bottom wetlands	peatland.
IUA 10	10_1	Ngotwana Wetland	Unchannelled valley bottom wetland and spring	High biodiversity wetland in semi-arid climate with its source in Botswana. Important grazing and water resource for local community
	10_1	Dinokana eye and Wetland	Unchannelled valley bottom, spring and hillslope seepage wetlands	High biodiversity wetland and important for water supply
IUA 11b	11_b_1	Lower Marico River	Riparian zone and floodplains	Old growth riparian forest assemblages, floodplain features, paleo-channels as well as backwater features
	11_b_2	Lengope la Kgamanyane River	Floodplain	-
	11_b_2	Lenkwane River	Floodplain	-
	11_b_2	-	Pans	-
IUA 13	13_3	Sections of the Crocodile River	Riparian zone, off-channel wetlands, backwaters and floodplains	Riparian zone, floodplain and off-channel features
IUA 14	14_2, 14_4	Moretele River floodplain	Floodplain	High biodiversity wetland and important bird habitat. Important grazing resource for local community
	14_1	Apies River floodplain	Floodplain	Important grazing resource for local community and important tributary of the Moretele River floodplain
	14_3	Plat River floodplain	Floodplain	Important tributary of the Moretele River floodplain system
	14_4	Tswaing Crator	Depression	Unique endorheic system
IUA 15	15_1	-	Valley bottom wetlands	Part of the Waterberg system with a unique combination of flora and faunal associations
	15_5	-	Valley bottom wetlands	Part of the Waterberg system with a unique combination of flora and faunal associations. I
	15_1	-	Hillslope seepage wetlands	Part of the Waterberg system with a unique combination of flora and faunal associations
	15_5	-	Hillslope seepage wetlands	Part of the Waterberg system with a unique combination of flora and faunal associations
IUA 16	16_3	-	Valley bottom wetlands	-
	16_3	-	Hillslope seepage wetlands	-
	16_5	Mokolo River and floodplain	Floodplain	Old growth riparian forest assemblages, alluvial aquifer and floodplain as well as backwater features

IUA	RU	Wetland	Type	Unique features
	16_1	Tambotie River floodplain	Floodplain	Old growth riparian forest assemblages, alluvial aquifer and floodplain features
IUA 17b	17_b_1	Lower Matlabas River	Valley bottom wetland	-
	17_b_1	Aslaagte	Valley bottom wetland	-
	17_b_2	Limpopo River and associated riparian zone and floodplain features	Riparian zone and floodplains	Old growth riparian forest assemblages, floodplain features, paleo-channels as well as backwater features
	17_b_2	-	Valley bottom wetland	Large oxbow-type wetland linked to the Limpopo River
	17_a_2	Matlabas Peatland/Mire	Valley bottom wetland	Peatland in the headwaters of a tributary of the Motlhabatsi River
	17_b_1, 17_b_2	-	Pans	Old growth riparian forest assemblages, alluvial aquifer and floodplain features

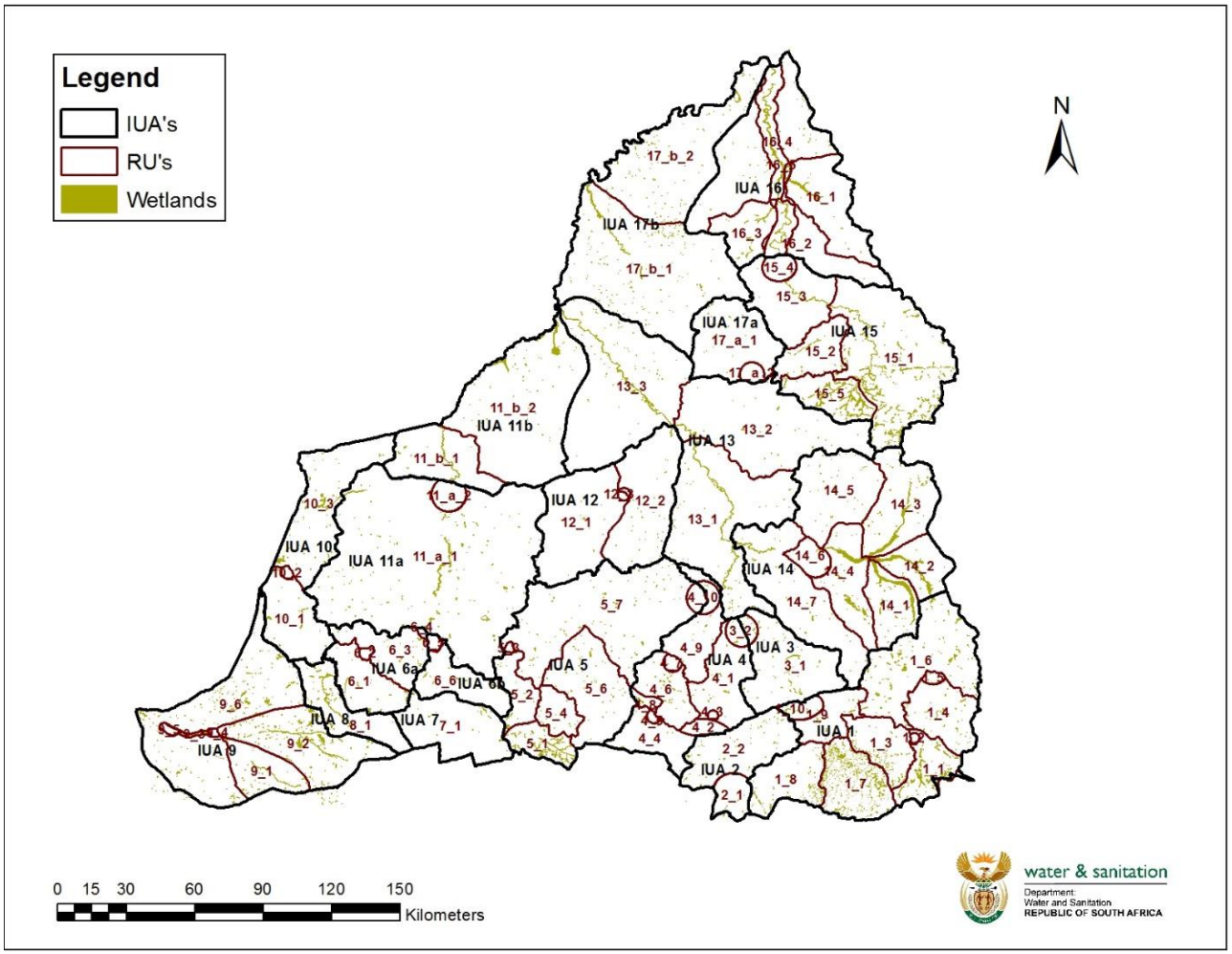

Figure 12: Map showing the distribution of wetlands per IUA and RU for the study area

4 APPROACH TO PRIORITISATION OF SUB-COMPONENTS AND SELECTION OF INDICATORS

Once the RUs were prioritised the next step of the RQO determination process was to prioritise sub-components for RQO determination and select indicators for monitoring. This step of the RQO procedure step allows for a process of rationalisation in order to determine what RQOs should be formulated for water resources within the prioritised resource units of the Mokolo, Matlabas, Crocodile (West) and Marico catchments *i.e.* sub-components that may be important to either the users or the environment are prioritised. This step also requires consideration of the impacts of land based activities on the water resource.

Sub-components include the following:

- Quantity
    - Low Flows
    - High Flows
- Quality
    - Nutrients
    - Salts
    - Systems variables
    - Toxics
    - Pathogens
- Habitat
    - Instream habitat
    - Riparian habitat
- Biota
    - Fish
    - Aquatic and riparian plant species
    - Mammals
    - Birds
    - Amphibians and reptiles
    - Periphyton
    - Aquatic invertebrates
    - Diatoms

The four water resource components addressed for the Mokolo, Matlabas, Crocodile (West) and Marico catchments included rivers, dams, groundwater and wetland components.

4.1 River and Dam Component

The evaluation process for sub-component prioritisation and indicator selection is based on a decision support tool that has been developed to guide and support the process. The 'Resource Unit Evaluation Tool' incorporates decision analyses approach to assess impacting activities, user requirements and protection of the resource.

The four aspects that were assessed/evaluated per RU include:

- Identification and assessment of the impact of current and anticipated future use on water resource components;
- Identification of requirements of important user groups;
- Selection of sub-components for RQO determination; and
- Establishment of the desired direction of change for selected sub-components.

4.1.1 Resource Evaluation Tool

As described above the Resource Evaluation Tool incorporates four aspects that are assessed, to arrive at the prioritised sub-components. The aspects are described in Table 6 below.

Table 6: Aspects and sub-steps evaluated in Resource Evaluation Tool (DWA, 2011)

Aspect	Sub-step	Consideration/Evaluation
Identify and assess the impact of current and anticipated future use on water resource components: The first aspect in prioritising sub-components for RQO determination involves building an understanding of current impacts and future pressures on the RU using available data and specialist knowledge.	**Assess the importance of activities in driving resource change**	Consideration is given to current users (existing and authorised water use) and anticipated future use (within next 5 years) within and upstream of the RU being evaluated. Those activities which were considered to have a considerable impact are rated as very important users irrespective of their contribution to the economy. The economic contribution of activities was then assessed in terms of their contribution to GDP, the number of jobs that they provide and whether they are a strategic water user.
	Determine the anticipated level of impact on each sub-component	Each of the listed activities (*e.g.* irrigated agriculture, urban areas, rehabilitation, *etc*.) has the potential to impact the components and sub-components of the water resource in a variety of different ways. The purpose of this sub-step is to identify those sub-components which are threatened as a result of high levels of impact as such sub-components should be prioritised over those sub-components which are experiencing a low level of impact. The assessment was based on the scale, location and intensity of the current and future activities in the Resource Unit and/or catchment.
	Determine the cumulative level of impact on each sub-component	The purpose of this step was to identify the cumulative effect of all of the impacting activities on each sub-component. Cumulative effects are commonly understood as the impacts which combine from different activities and which result in significant changes, which is larger than the individual impacts.
	Determine the anticipated consequences of the impacting	Once an understanding of key impacts driving current and future impacts to the RU was assessed, this was

Aspect	Sub-step	Consideration/Evaluation
	activities on each sub-component	used to help inform an assessment of the anticipated consequences of impacting activities on water resource quality. This is expressed as a projected trajectory of change for each sub-component
Identify requirements of important user groups: The second aspect in prioritising sub-components for RQO determination entails identifying which groups are using the resource, classifying the importance of these groups and determining which sub-components are important to them.	**Identify important user groups within the 'protection of the water resource' and 'water resource dependent activity' user group types**	The purpose of this sub-step is to identify water users that need to be considered when setting RQOs. The relative importance of user groups was therefore assessed.
	Rate the importance of sub-components for the 'protection of the water resource' and 'water resource dependent activities	The purpose this sub-step is to determine which sub-components are important and / or of concern to different user groups. This was determined identifying the importance of sub-components for users who were identified as important or very important. This helps to highlight sub-components of primary concern to different user groups, thus reflecting aspects of the water resource that they feel need to be closely monitored.
	Summarise the aspirations of each important user group	Opportunity is provided to summarise relevant aspirations of conservation agencies and users dependent on the water resource. In the case of conservation agencies and users dependent on the water resource, stakeholders highlighted specific components or attributes of the water resource which are of concern to them.
	Review Present State information	In this step the Present State information reviewed for each sub-component. This is used to inform the desired direction of change for users. The current trajectory of change for each component was also estimated. This is informed by the assessment of impacting activities but may be over-written based on more reliable information.
	Propose the desired direction and magnitude of change for each sub-component for important user-groups	For 'water resource dependent activities' and organisations responsible for protecting the natural environment, an assessment of the desired direction of change was undertaken to provide an indication of whether stakeholders would like a particular sub-component of the water resource to be improved or whether some level of degradation may be acceptable. Both the importance ratings for each of the sub-components and present state / fitness for use information was used to guide this assessment.
Selection of sub-components for RQO determination: The purpose of this sub-step is to	**Review the Ecosystem and User Prioritisation ratings**	Two prioritisation ratings, one for the ecosystem and the other for users, are then determined. These prioritisation ratings are based on how important a sub-component is from an ecological or user perspective and whether this sub-component is threatened by anthropogenic activities occurring in the catchment. This steps highlight those sub-components which are both important from an ecological and/or user

Aspect	Sub-step	Consideration/Evaluation
select key sub-components for RQO determination and identify appropriate indicators to monitor them. This sub-step was undertaken using the 'Indicator Selection' worksheet in the Resource Unit Evaluation Tool.		perspective and which are threatened by anthropogenic activities. Such sub-components are logical choices for RQO determination.
	Select sub-components and associated indicators for RQO determination	The priority are used to guide the selection of sub-components for RQO determination. Sub-components with high scores should be selected first. A rationale for selecting each sub-component was provided. Based on the rationale for sub-component selection, the selection of a sub-component as a 'UserSpec', 'EcoSpec' and/or 'Integrated measure' was documented. Once the sub-components were selected, suitable indicators for were identified. This was informed by the Ecosystem and User Prioritisation requirement and the rationale for selecting the indicator is also documented.

The evaluation of sub-components and selection of indicators was done applying the aspects and sub-steps of Resource Unit Evaluation Tool in the the Mokolo, Matlabas, Crocodile (West) and Marico catchments using desktop information, local knowledge and detailed understanding of the catchment. The assessment was undertaken in a workshop environment with technical specialists, catchment managers and key stakeholders (22-24 August 2016). The overall priorities obtained through this process was used to guide the selection of sub-components for RQO determination. Once the sub-components were selected, suitable indicators for monitoring were then identified. The rankings of the evaluation provided an indication of the priority sub-components. Based on this and expert judgement and knowledge the priority sub-components were selected for the 75 prioritised Resource Units (rivers and dams) in the the Mokolo, Matlabas, Crocodile (West) and Marico catchments.

The proposed priority sub-components and related indicators have subsequently been presented to stakeholders in the catchment area at two project steering committee meetings held over 27 and 28 September 2016, in order to obtain agreement of the final sub-components and indicators for which RQOs should be determined.

4.2 Wetlands

Wetlands in the study area provide a range of services including flood attenuation, stream flow regulation, sediment trapping, erosion control and water quality enhancement services. Maintenance and enhancement of wetland functioning is therefore required to ensure that these key ecosystem services necessary to meet societal and environmental requirements are not undermined or lost at a catchment scale. Prioritisation of sub-components is based on no net loss' principles, conservation plans, wetland types (inferred functionality) and species targets; as well related to ecological specfications (protection, management, mitigation and monitoring).

The Wetland Evaluation Tool was used to a limited extent to prioritise sub-components. Rather the evaluation and prioritisation of the sub-components focused primarily on the availability of data. For all prioritised wetlands the sub-components Quality, Quantity and Habitat were selected for RQO development. Biota was included as a sub-component where available species data was available to support RQO development.

Potential sub-components were discussed and presented to stakeholders in the catchment area at two project steering committee meetings held over 27 and 28 September 2016, to obtain input on the approach and the proposed sub-components.

4.3 Groundwater

Step 4 of the RQO Process, "Prioritise Sub-Components for RQO Determination and Select Indicators for Monitoring", has not yet been developed for the groundwater component of the water resource.

The following components are being assessed in identifying measurable sub-components and indicators for groundwater:

- Hydrogeological characteristics for example difference between a high yielding karst (dolomites) and moderate to low yielding sedimentary (sandstone and shale) groundwater units;
- In terms of local aquifer conditions, e.g. interaction with wetlands, surface water sources, to specify distances between these areas and potential groundwater abstraction points (*i.e*. borehole/well fields);
- Borehole yield classes (GIS information) were used to select high and low yielding aquifer systems within the demarcated groundwater units;
- Areas where high groundwater use occurs were noted using the National Groundwater Resources Assessment Phase II information. These values were incorporated to define the potential balance between groundwater recharge and use (based on the stress factor) to obtain future groundwater level trends. The idea is to define an annual groundwater level recession value which can be used as a defined parameter for an aquifer's RQO status in terms of yield sustainability;
- Groundwater quality. This attribute is being obtained from the National geo-hydrological Maps; to provide a background water quality criteria have a negative impact of the water quality criteria.

For the non-dolomite water areas, the RQOs should be based on basic hydrogeological parameters as observed through baseline groundwater information (1: 500 000 Geohydrological Map/Brochure Series) and groundwater time series monitoring information (*viz*. National Groundwater Quality Monitoring Programme and detailed water level monitoring records by DWS Regional Offices). These aquifers are generally localised and most of them will discharge into the local surface water drainage systems or support local pans/wetlands; otherwise evapotranspiration losses. The interaction between groundwater and surface run-off needs to be acknowledged as well.

The sub-components identified for groundwater RQOs include:

- Quantity (Abstraction),
- Aquifer Water Level,
- Water Quality, and
- Protection Zones

In terms of indicators, only those hydrogeological indicators that can be observed and evaluated are to be considered. These include:

- Water Level - Depth to groundwater level
- Time series water level monitoring (Monthly)
- Abstraction - Abstraction rate (Volume; Q)
- Continuous Flow measurement at Eye

In terms of aquifer water quality:

- reference groundwater quality character and status (macro, micro, trace elements);
- presence of suspended substances and other potential pollution already part of the natural/induced transport flow regime;
- hydro-chemical trends and spatial coverage; and
- natural deterioration due to geological reasons.

Protection zones:

- Radius of influence

For the dolomite water areas, the RQOs will consider results of indicators observed from special studies (long-term quantity and quality trends, ground stability status, recharge mechanisms. Setting of RQO specifications for the recharge areas of dolomite groundwater units is required and may be upgraded to a level where total protection of such areas may be considered at a resource quality objective.

5 PRIORITISATION OUTCOMES

5.1 Rivers and Dams

The list of prioritised sub-components, indicators selected for monitoring, are indicated in Table 7 below per RU for each of the IUAs. This prioritisation will be used as the basis for developing RQOs and numerical limits.

Table 7: Sub-component Prioritisation for the Resource Units in Mokolo, Matlabas, Crocodile (West) and Marico catchments

Resource Unit	Component prioritised	Sub-component	Indicator
1_1 Upper Hennops and River Rivers (inflow into Rietvlei Dam)	Quantity	Low flows	Base Flows (after confluence of Rietvlei and Hennops Rivers)
	Quality	Nutrients	Orthophosphates, Dissolved Inorganic Nitrogen; Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Metals, Pesticides, Oil, Pharmaceutical
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Yellow fish population, Fish Response Assessment Index (FRAI)
		Birds	Fish Eagles, indicator species Birdlife
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_2 Rietvlei Dam	Quantity	Dam levels	Minimum level required in dam, critical level for aquatic system
	Quality	Nutrients	Orthophosphates, Dissolved Inorganic Nitrogen; Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
		Toxics	Metals, Pesticides, Hormone driven Pharmaceuticals
	Biota	Fish	Targets for fish stocks e.g. Small scale yellow fish
		Mammals	Health assessment studies. (Hippos present?)
		Birds	Indicator species Birdlife. Health assessment studies
		Periphyton	Chlorophyll *a*
		Blue-green Algae	Cyanobacteria

Resource Unit	Component prioritised	Sub-component	Indicator
1_3 Hennops from outflow Rietvlei Dam to A21H (Kaalspruit and Olifantspruit tributaries)	Quality	Nutrients	Orthophosphates, Dissolved Inorganic Nitrogen; Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Metals, Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	*Barbus rappax*, Fish Response Assessment Index (FRAI)
		Birds	Fish Eagles, Indicator species Birdlife
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_4 Upper Pienaars River, Edendalespruit and Moretele Rivers to Roodeplaat	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Hormone driven Pharmaceuticals, metals, hydrocarbons (manganese)
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_5 Roodeplaat Dam	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Metals, Pesticides, Hormone driven Pharmaceuticals

Resource Unit	Component prioritised	Sub-component	Indicator
1_6 Upper reaches_Apies, Skinnerspruit,	Quantity	Low flows	Base Flows
		High flows	Floods
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium

Resource Unit	Component prioritised	Sub-component	Indicator
Pienaars River from Roodeplaat Dam		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_7 Juskei, Klein Jukskei, Modderfontein spruit	Quantity	Low flows	Base Flows in terms of ecological requirements (Reserve)
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate, Chlorophyll *a*
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen, Suspended solids
		Toxics	Pesticides, Metals
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI), *Yellow fish, Tilapia, Barbel (flow dependent)*
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_8 Upper reaches of the Crocodile River and Bloubankspruit	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Total Dissolved Salts, Sulphate, Magnesium, Calcium
		Pathogens	*Escherichia coli*
		System Variables	pH, suspended solids, dissolved oxygen
		Toxics	Cyanide metal complexes, radionuclides
			Metals: iron, manganese, aluminium, lead, cobalt, nickel, copper, zinc
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI), *Species present – BMOT, CPRE, BPOL (flow dependent species)*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Birds	Indicator species Birdlife
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_9 Crocodile River	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate

Resource Unit	Component prioritised	Sub-component	Indicator
from Jukskei confluence to Hartbeespoort Dam		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Radionuclides, Metals
	Habitat	Instream	Integrated Habitat Index, Geomorphic Assessment Index
		Riparian habitat	Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
1_10 Hartbeespoort Dam	Quantity	Dam levels	Minimum level required in dam, critical level for aquatic system
	Quality	Nutrients	Orthophosphates, Dissolved Inorganic Nitrogen; Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Dissolved Oxygen
		Toxics	Metals, Pesticides
	Biota	Fish	Targets for fish stocks
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
2_1 Maloneys Eye	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *Yellow fish (BPOL), AURA, CPRE present , BMOT*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
2_2 Magalies Rriver, Klein Magalies, Bloubank, Skeerpoort Rivers	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
		Toxics	Metals, Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *Yellow fish (BPOL), AURA, CPRE present , BMOT*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
2_3 Surface water area linked to Maloney's Eye	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride

Resource Unit	Component prioritised	Sub-component	Indicator
3_1_ Crocodile River outflow Hartbeespoort Dam to Roodekopjes Dam	Quantity	Low flows	Base Flows and freshettes
		Capping flows	
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
		Toxics	Pesticides, Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment, Geomorphic Assessment Index
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *Sensitive species (Crocodile River), AJOH, - flow dependant BMAR, CPRE*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
3_2 Roodekopjes Dam	Quantity	Dam levels	Minimum level required in dam, critical level for aquatic system
	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium

Resource Unit	Component prioritised	Sub-component	Indicator
		Pathogens	*Escherichia coli*
		System Variables	pH, Dissolved Oxygen
		Toxics	Metals, Pesticides
	Biota	Fish	Targets for fish stocks
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Amphibians/Reptiles	Indicator species. Health assessment studies
		Periphyton	Indicator of dam health (algal growth) – eutrophication

Resource Unit	Component prioritised	Sub-component	Indicator
4_1_ Sterkstroom from outflow Buffelspoort Dam to inlow Roodekopjes Dam, Maretwane, Tshukutswe	Quantity	Flows	Groundwater related
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment, Geomorphic Assessment Index
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *BMOT*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
4_2_ Upper reaches of Sterkstroom to inflow Buffelspoort Dam	Quantity	Low Flows	Base Flow
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment,
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *B Sensitive species, AURA, BMOT*

Resource Unit	Component prioritised	Sub-component	Indicator
4_3_ Buffelspoort Dam	Quantity	Dam levels	Minimum level required in dam, critical level for aquatic system
	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH
	Biota	Fish	Targets for fish stocks
		Birds	Indicator species Birdlife. Health assessment studies

Resource Unit	Component prioritised	Sub-component	Indicator
4_4	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate

Resource Unit	Component prioritised	Sub-component	Indicator
Upper Hex river to Olifantsnek Dam, Rooikloofspruit		Salts	Electrical Conductivity, Sodium, Chloride
		Pathogens	*Escherichia coli*
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment,
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *BMOT*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
4_5_ Olifantsnek Dam	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
	Dam Habitat	Habitat	Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
4_6 Hex river from Olifantsnek Dam, to inflow Bospoort Dam, Sandspruit	Quantity	Low Flows	Base flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Mammals	Indicator species. Health assessment studies
		Birds	Indicator species. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
4_7 Bospoort Dam	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
	Dam Habitat	Habitat	Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
4_8 Waterkloof-spruit	Quantity	Low Flows	Base flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species: *BMOT, Isolated TSPA upstream of waterfall*
		Mammals	Indicator species. Health assessment studies
		Birds	Indicator species. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
4_9 Hex River outflow Bospoort Dam to inflow Vaalkop Dam	Quantity	Low Flows	Base flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Heavy metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
4_10 Vaalkop Dam	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Metals
		Blue-green Algae	Cyanobacteria
	Dam Habitat	Habitat	Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
5_1 Upper reaches of Elands to Swartruggens Dam	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *BMOT*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
5_2 Elands downstream Swartruggens Dam to Lindleyspoort Dam	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
5_3 Lindleyspoort Dam	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity, Sulphate, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Metals
	Dam Habitat	Habitat	Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
5_4 Upper Koster River to Koster Dam	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
		Toxics	Metals
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *BMOT*

Resource Unit	Component prioritised	Sub-component	Indicator
5_6 Selons River, Kodoespruit, Dwarsspruit, lower Koster River	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Pesticides

Resource Unit	Component prioritised	Sub-component	Indicator
5_7 Elands River outflow	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*

Resource Unit	Component prioritised	Sub-component	Indicator
		System Variables	pH, Turbidity
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment, Geomorphic Assessment Index
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI).
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Mammals	Habitat Assessments: Indicator species
		Birds	Habitat Assessments: Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
6_1 Upper Klein Marico to inflow, Klein Maricopoort Dam, Rhenostersprui t, Malmaniesloop, Kareespruit	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment,
		Riparian habitat	Integrated Habitat Index

Resource Unit	Component prioritised	Sub-component	Indicator
6_2 Klein Maricopoort Dam	Quality	Nutrients	Orthophosphates, Nitrate& Nitrate
		Salts	Electrical Conductivity, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Metals
	Dam Habitat	Habitat	Indicator species

Resource Unit	Component prioritised	Sub-component	Indicator
6_3 Klein Marico downstream Klein Maricopoort Dam to Kromellenboog Dam, Wilgeboomspr uit	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI).
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
6_4 Kromellenboog Dam	Quantity	Dam levels	Minimum level required in dam, critical level for aquatic system
	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Biota	Fish	Targets for fish stocks
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
6_5 Groot Marico, Polkadraai-spruit	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved Oxygen
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *certain BMOT, AURA, CPRE, AMOS*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
6_6 Marico Bosveld Dam	Quantity	Dam levels	Minimum level required in dam, critical level for aquatic system
	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH
		Toxics	Pesticides
	Biota	Dam Habitat	Indicator species
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
7_1 Marico Eye, Kaaloog-se-Loop, Bokkraal se Loop Rietspruit (southern eye), Kuilsfontein, Syferfontein and Bronkhorstfontein	Groundwater RQOs		

Resource Unit	Component prioritised	Sub-component	Indicator
8_1 Malmanie Eye Dolomites	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI).
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
9_1 Bodibe eye	Wetland and Groundwater RQOs		

Resource Unit	Component prioritised	Sub-component	Indicator
9_2 Molopo Eye, Grootfontein Eye, Molopo headwaters to inflow Modimola	Quantity	Flows	Groundwater related (Molopo and Grootfontein Eye)
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species *PPHI, Malawian Cichlids*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
9_3 Molopo River mainstem from Modimola Dam to Disaneng Dam	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index

Resource Unit	Component prioritised	Sub-component	Indicator
9_4 Modimola Dam (Setumo Dam)	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Dissolved Oxygen
	Biota	Dam Habitat	Indicator species
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
9_5 Disaneng Dam	Quantity	Dam levels	Minimum level required in dam
	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH
	Biota	Dam Habitat	Indicator species
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
10_1 Upper Ngotwane, Dinokana Eye	Wetland and Groundwater RQOs		
	Habitat	Instream	Integrated Habitat Index

Resource Unit	Component prioritised	Sub-component	Indicator
10_2 Ngotwane Dam	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Dissolved Oxygen
	Biota	Dam Habitat	Indicator species
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
11a_1 Groot Marico from outflow Marico Bosveld Dam to Molatedi Dam, All tributaries	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment, Geomorphic Assessment Index
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI).
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index
		Birds	Indicator species Birdlife. Health assessment studies

Resource Unit	Component prioritised	Sub-component	Indicator
11a_2 Molatedi Dam	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity
		System Variables	pH, Dissolved Oxygen
	Habitat	Dam Habitat	Indicator species
	Biota	Fish	Target fish stocks
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
11b_1 Groot Marico, Rasweu, Maselaje	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI). Indicator species: *BMAR, BMOL, SZAM*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
12_1 Wilgespruit, Bofule, Kolobeng, Magoditshane, Motlhabe	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		System Variables	pH, Turbidity
		Toxics	Metals
		Pathogens	*Escherichia coli*
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment, Geomorphic Assessment Index
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI).
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
12_2 Bierspruit outflow Bierspruit Dam to confluence with the Crocodile River, Brakspruit, Phufane, Sefatlhane, Lesobeng	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		System Variables	pH, Turbidity
		Toxics	Metals
		Pathogens	*Escherichia coli*
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment, Geomorphic Assessment Index
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI).

Resource Unit	Component prioritised	Sub-component	Indicator
13_1 Crocodile outflow Roodekopjes Dam to Sand river confluence, Sleepfonteinspruit, Klipspruit tributaries	Quantity	Low flows	Base Flows
		High flows	Floods
		Groundwater RQOs (related to abstraction)	
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides, metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *Sensitive fish species. Course substrate, CPRE, LMOL*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
13_2 Sand River to confluence with Crocodile River	Quantity	High flows	Freshettes for fish
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *Moderately, Sensitive species CPAR (seasonal dependant flows)*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
13_3 Lower Crocodile from Bierspruit	Quantity	Low flows	Base Flows
		High flows	Floods
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *Semi-sensitive species CPAR, LMOL*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
14_1 Apies River, Tshwane tributary	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides, metals
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index
	Biota	Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
14_2 Pienaars River from Boekenshout confluence to Apies River confluence	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides, metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *Sensitive species CPRA, LMOL. BRAP*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
14_3 Plat River	Quantity	Low flows	Base Flows
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *CTHE – isolated populations – upper part.*
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
14_4 Moretele (Pienaars) River from Plat River confluence to Klipvoor Dam, Kutswane to Klipvoor Dam	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides, metals

Resource Unit	Component prioritised	Sub-component	Indicator
14_6 Klipvoor Dam	Quality	Nutrients	Orthophosphates; Nitrate& Nitrate
		Salts	Electrical Conductivity
		System Variables	pH, Dissolved Oxygen
		Pathogens	*Escherichia coli*
		Toxics	Pesticides
	Habitat	Dam Habitat	Indicator species
	Biota	Fish	Target fish stocks
		Periphyton	Chlorophyll *a*

Resource Unit	Component prioritised	Sub-component	Indicator
14_7 Pienaars River from Klipvoor Dam to Crocodile River	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium, Chloride
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Fish	Fish Response Assessment Index (FRAI): Indicator species *Yellow fish*
		Birds	Indicator species Birdlife. Health assessment studies
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
15_1 Mokolo, klein sand, Brakspruit, sondagsloop, Heuningspruit, Dwars, Jim se loop	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *CPRE, AURA*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
15_2 Sterkstroom, Frikkie se loop	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *CPRE, B Waterberg*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
		Diatoms	Specific Pollution Index

Resource Unit	Component prioritised	Sub-component	Indicator
15_3 **Mokolo River A42F, inflow Mokolo Dam, Taaibosspruit, Malmanies and Bulspruit**	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *CPRE*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
15_4 **Mokolo Dam_ And upper portion of A42G (10km d/s)**	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		Pathogens	*Escherichia coli*
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index. Syzygium cordatum
		Dam habitat	Indicator species
	Biota	Fish	Fish Response Assessment Index (FRAI): Indicator species *CPRE*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies

Resource Unit	Component prioritised	Sub-component	Indicator
15_2 **Sterkstroom, Frikkie se loop**	Quantity	Low flows	Base Flows
		Important Wetland habitat	
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		System Variables	pH, Turbidity
		Toxics	Pesticides
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
16_1 Tambotie river	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
16_2 Poer se loop (upper catchment)	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI) (upper catchment)
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
16_3 Rietspruit (lower reaches)	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index

Resource Unit	Component prioritised	Sub-component	Indicator
16_4 Sandloop	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
		System Variables	pH, Turbidity
		Toxics	Pesticides, metals
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index

Resource Unit	Component prioritised	Sub-component	Indicator
16_5_1 Mokolo mainstem to Tamboti confluence below (bedrock reach (sand deposit to, wider portion of river)	Quantity	Low flows	Base Flows
		High flows	Floods
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index. Syzygium cordatum (water berry and Jackle berry)
	Biota	Fish	Fish Response Assessment Index (FRAI)
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
16_5_2 **Mokolo mainstem from Tamboti confluence to Limpopo**	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate, Sodium
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index.
	Biota	Fish	Fish Response Assessment Index (FRAI). *Flow requirements, BMAR, BMOL.*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies

Resource Unit	Component prioritised	Sub-component	Indicator
17a_1 **Mothlabatsi, Mamba Rivers**	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index.
	Biota	Fish	Fish Response Assessment Index (FRAI). *Flow dependent species, AURA*
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Component prioritised	Sub-component	Indicator
17a_2 **Headwaters Mothlabatsi(peatlands)**	Quantity	Low flows	Base Flows
	Habitat	Instream	Integrated Habitat Index
		Riparian habitat	Integrated Habitat Index, Vegetation Response Assessment Index.
	Biota	Fish	Fish Response Assessment Index (FRAI). *C. AURA*

Resource Unit	Component prioritised	Sub-component	Indicator
17b_1 Matlabas	Quantity	Low flows	Base Flows
	Quality	Nutrients	Orthophosphates, Nitrate & Nitrate
		Salts	Electrical Conductivity, Sulphate
		System Variables	pH, Turbidity, Dissolved oxygen
		Toxics	Metals
	Habitat	Instream	Integrated Habitat Index, Rapid Habitat Assessment
		Riparian habitat	Integrated Habitat Index
	Biota	Fish	Fish Response Assessment Index (FRAI).
		Mammals	Health assessment studies
		Birds	Indicator species Birdlife. Health assessment studies
		Aquatic invertebrates	Macroinvertebrate Response Assessment Index, South African

Resource Unit	Component prioritised	Sub-component	Indicator
			Scoring System 5.

5.2 Wetlands

A summary of the proposed sub-components for wetland resources is presented in Table 8**.** The proposed subcomponents are based on an evaluation of no net loss' principles, conservation plans, wetland types (inferred functionality) and species targets.

Error! Reference source not found.**Table 8: Summary of subcomponents and indicators proposed for wetlands**

IUA	Wetlands	Resource Unit	Sub-component	Indicator/measure	Rationale/Consideration
IUA 14	Moretele River Floodplain and associated tributary floodplains	RU 14_1 RU 14_2 RU 14_3 RU 14_4	Quantity	Water distribution and retention patterns score from Wet-Health. Also flow requirements based on available ecological water requirement studies on the system.	Floods are necessary to inundate the floodplain thereby providing the wetting regime required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles.
			Quality	River Resource Quality Objective's indicator/measure.	It is assumed that the RQO's set for the river water quality will ensure the continued functioning of the floodplain system (maintenance of the TEC).
			Habitat	Wetland vegetation and geomorphology score from the Vegetation and Geomorphology modules of Wet-Health.	Wetland vegetation condition and the geomorphology of the floodplain are good indicators of habitat condition.
			Biota	Presence and breeding of important aquatic bird species during flood events.	Floodplain system provides an important refuge, feeding and breeding area for numerous aquatic bird species.
IUA 8 & 9	Molopo eye and associated peatland system	RU 8_1 RU 9_2	Quantity	Quantitative and qualitative flow requirements based on existing specialist studies on the system. Groundwater RQO's.	Dependent on groundwater and thus threatened by groundwater abstraction and further surface water abstraction. Wetland downstream of the eye already stressed/degraded as a result of surface water abstraction. An integrated management strategy is required for conserving this unique system.
			Quality	Groundwater quality RQO's.	System is driven by groundwater.
			Habitat	Wetland vegetation and geomorphology score from the Vegetation and	Tourism development has contributed towards the loss of natural habitat on the periphery of

IUA	Wetlands	Resource Unit	Sub-component	Indicator/measure	Rationale/Consideration
				Geomorphology modules of Wet-Health.	the eye. Agricultural activities, roads and road culverts, dams and so on have contributed to habitat fragmentation in the downstream peatland. Surface water abstraction has resulted in a loss of peat habitat in the downstream wetland.
			Biota	Continued presence of healthy populations of unique fish and ostracod species in the system.	Endemic fish species currently under risk of extinction due to loss of habitat as a result of reduced flows to the wetland area. Unique ostracod diversity that requires protection. Risk of habitat transformation and fragmentation and invasions by alien species (particularly exotic plants and exotic fish species).
IUA4	**Waterkloofspruit peatland**	**RU 4_8**	**Quantity**	Water distribution and retention patterns score from Wet-Health. Peat profile monitoring.	The system is characterised by a permanent wetting regime in places with seasonal saturation along the edges.
			Quality	Water quality monitoring of selected variables.	Water quality impacts to the system must be monitored to ensure that the water chemistry remains within an acceptable normal range for the system.
			Habitat	Wetland vegetation and geomorphology score from the Vegetation and Geomorphology modules of Wet-Health. Distribution of peat (mapped).	A low Impact Score for these two aspects is indicative of healthy habitat conditions in the system.
			Biota	Distribution and abundance of plant indicator species (indicative of the presence of peat).	Peat forms as a result of a combination of factors, one of which is plant species tolerant of permanent inundation. The wetting regime supports obligate hydrophytic grasses, sedges and forbs that support the formation of peat.
IUA5	**Pan – part of the pan complex at the headwaters of the Elands River**	**RU 5_1**	**Quantity**	Water level in the pan basin.	Water quantity impacts must be managed so as not to undermine the ecological value of the pan. In particular, abstraction should be limited so that the depth and duration of inundation is maintained within the normal range for high, average and low rainfall years.

IUA	Wetlands	Resource Unit	Sub-component	Indicator/measure	Rationale/Consideration
			Quality	Water quality monitoring of selected variables.	Water quality impacts to the pan must be restricted to ensure that the water and sediment chemistry remain within an acceptable normal range (anion and cation concentration) for this particular water chemistry pan type.
			Habitat	Area of open water versus vegetated zones.	Habitat availability to biota depends on the relative area of open water versus vegetated habitat.
			Biota	Presence and number of important bird species.	The pan provides an important feeding area for certain bird species.

5.3 Groundwater

Selection of subcomponents for groundwater resource units was based on the measurable parameters including Quantity (Abstraction), Aquifer Water Level, Water Quality and Protection Zones (related to a localised borehole as a means of protecting the basic human needs and the ecological Reserve). A summary of the sub-components selected per groundwater resource unit and IUA is presented in Table 9.

Table 9: Summary of subcomponents and indicators selected for Groundwater Resource Units

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
1: Upper Crocodile/Hennops/Hartbeespoort	**RU - G1**	**1_1, 1_2, 1_3,**	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
			Quality	Nutrients - Nitrate Bi-annual Monitoring
				Salts - Electrical Conductivity Bi-annual Monitoring
			Protection Zone	Radius of influence (r)
				Distance from river (L)
				Distance from wetland (L)
				Distance from Dolomite Eye (L)
				Ground stability (draw down limit, L) (buildings/roads/infrastructures)
	RU - G2	**1_8 and 1_9**	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Abstraction - Abstraction rate (Q) Continuous Flow measurement at Eye

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
			Quality	Nutrients - Nitrate Bi-annual monitoring
				Sulphates (origin AMD) in head water area (Tweelopies Spruit) Monthly monitoring at source (TCTA WTW discharges).
				Salts - Electrical Conductivity Monthly monitoring at source (TCTA WTW discharges).
			Protection Zone	Radius of influence (r) .
				Distance from river (L).
				Distance from Dolomite Eye (L).
				Distance from wetland (L).
				Ground stability (DCU drawdown limit, L) (buildings/roads/infrastructures).

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
2: Magalies Catchment Area	**RU G3**	**2_1 and 2_2**	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream users (Magalies River
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%)
			Quality	Nutrients - Nitrate Monthly Monitoring at Randfontein WWTW discharges.
				Salts - Electrical Conductivity Bi-annual Monitoring
			Protection Zone	Radius of influence (r)
				Distance from wetland (L)
				Distance from Dolomite Eye (L)
				Ground stability (draw down limit, L) (buildings/roads/infrastructures)

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
7: Kaaloog-se-Loop	**RU – G4**	**7_1**	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream: Dolomite water supporting local springs/eye's
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%)
			Quality	Nutrients - Nitrate Bi-annual Monitoring
				Salts - Electrical Conductivity Bi-annual Monitoring
			Protection Zone	Radius of influence (r)

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
				Distance from wetland (L)
				Distance from Dolomite Eye (L)
				Waterlevel elevation in DCU(s) (L)

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
8: Malmaniesloop	**RU – G5**	**8_1**	**Quantity**	Water Level - Depth to groundwater level from ground elevation in dolomite compartment unit(s). – DCU's Time series water level monitoring (Monthly) vs abstractions and rainfall input.
				Spring flow monitoring Time series daily interval at smaller dolomite eyes, i.e. Rhenosterfontein Eye
				Abstraction - Volume (Q) Time series of abstraction vs rainfall in DMU's.
				Specification of discharges to downstream (Q): Dolomite water supporting local springs/eye's.
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%).
			Quality	Nutrients - Nitrate Monthly monitoring at discharge area(s)
				Salts - Electrical Conductivity Monthly monitoring at discharge area(s), i.e. Rhenosterfontein Eye
			Protection Zone	Waterlevel elevation in DCU(s) (L)
				Distance from wetland (L)
				Limitation of irrigation systems (ha's) to 9% of deed area (ha's).
				Distance from Dolomite Eye (L)

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
9: Molopo	RU – G6	9_1	Quantity	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input.
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
			Quality	Nutrients - Nitrate Bi-annual Monitoring.
				Salts - Electrical Conductivity Bi-annual Monitoring.
				Microbiological status Site specific monthly monitoring programme at Itsoseng well field
			Protection Zone	Waterlevel elevation in DCU(s) limit on DCU's dewatering , say -25 m (L)
				Recreational Area limitation on land use activities (domestic discharge pollution).
				Ground stability at depleted eyes (i.e. Bodibe Eye, - peat burning) (L).
	RU – G7	9_2	Quantity	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Abstraction - Abstraction rate (Q) Continuous Flow measurement at Eye
			Quality	Nutrients - Nitrate Bi-annual monitoring
				Microbial Status Monthly monitoring at discharge area(s), i.e. Molopo Eye discharge weir.
				Salts - Electrical Conductivity Monthly monitoring at discharge area(s), i.e. Molopo Eye discharge weir.
			Protection Zone	Waterlevel elevation in DCU(s) limit on DCU's dewatering , say -25 m (L)
				Limitation of irrigation systems (ha's) to 9% of deed area (ha's)
				Distance from Dolomite Eye (L) Grootfontein Eye recovery to -30 m bgl (L)
				Waterlevel elevation in DCU(s) limit on DCU's dewatering (L) Recovery to -25 m bgl.

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
10: Malmaniesloop	RU – G8	10_1	Quantity	Water Level - Depth to groundwater level from ground elevation in dolomite compartment unit(s). – DCU's Time series water level monitoring (Monthly) vs abstractions and rainfall input in upper catchment areas (A10A).
				Spring flow monitoring Time series daily interval, i.e. Dinokana Eye.
				Abstraction - Volume (Q) Time series of abstraction vs rainfall in DMU's at Dinokana Eye
				Specification of discharges to downstream (Q): Dolomite water supporting local groundwater users
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%).
			Quality	Nutrients - Nitrate Monthly monitoring at discharge area(s)

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
				Salts - Electrical Conductivity Monthly monitoring at discharge area(s), i.e. Molopo Eye.
				Microbial status Area immediately upstream of the Dinokana Eye.
			Protection Zone	Waterlevel elevation in DCU(s) limit on DCU's dewatering , say -15 m (L)
				Limitation of irrigation systems (ha's) to 9% of deed area (ha's) in catchment area of Dinokana Eye
				Distance from Dolomite Eye (L) Upstream land use activities at Dinikana Eye limited to natural conditions.

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
13: Lower Crocodile River	**RU – G9 Alluvial Aquifer River Stretch.**	**13_1, 13_2 and 13_3.**	**Quantity**	Water Level - Depth to groundwater level on alluvial aquifer system. Time series water level monitoring (L) (Monthly) vs abstractions and river stage height
				Abstraction from alluvial aquifer system - Volume (Q) Time series of abstraction vs stream flows.
				River flow Gains/Losses between DWS gauging stations, Volume Q. Volume of return flows from alluvial aquifer system.
			Quality	Nutrients - Nitrate Monthly monitoring at DWS gauging stations. Elevated nitrate (>10 mg/l NO_3–N) along lower Crocodile West (RU 13_3).
				Salts - Electrical Conductivity. Monthly monitoring at DWS gauging stations.
				Characterising water quality of return water. To monitor quality of return flows from alluvial area. Elevated fluoride (>1.5 mg/l) concentration along lower main stem of the Crocodile West (RU 13_3).
				Microbial status. Monthly monitoring at DWS gauging stations.
			Protection Zone	Estimate a Stream Depletion Factor for Lower Crocodile River alluvial aquifer system, (L). Distance to minimise surface water flow capturing.
				Land use activities that may impact on the alluvial aquifer. Specify all land use activities on alluvial area and alluvial aquifer system.
				50 day and 365 day water quality protection zoning (L). Hydrocensus to generate database on alluvial aquifer impacts.

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
16: Lower Mokolo.	**RU – G10 Sandloop**	**16_4**	**Quantity**	Water Level - Depth to groundwater level on alluvial aquifer system. Monthly time series water level monitoring (L) across local fractured aquifer and river alluvium aquifer to establish aquifer-river interaction
				Positive/Negtative water balance estimations, Volume (Q) Considering possible local discharges at Medupi and Grootegeluk. Towards downstream aquifer systems
			Quality	Nutrients - Nitrate Monthly monitoring at Gwater monitoring networks. Local elevated nitrate (>10 mg/l NO_3–N) noted in RU 16_4.

IUA	Ground-water unit	RU	Sub-component	Indicator/ Measure
				Salts - Electrical Conductivity Monthly monitoring Medupi/ Grootegeluk and other impact related monitoring networks.
				Sulphates (indicator for ARD). Monthly monitoring Medupi/ Grootegeluk and other impact related monitoring networks.
			Protection Zone	Migration Plumes (L) Buffering zone around source of ARD and other pollution-like sources. Adopt/implement mitigation measures.
				365 day water quality protection zoning (T) Modelling of potential impacts on local aquifer systems

6 SUMMARY AND CONCLUSION

In terms of the evaluation and various considerations assessed for the selection of components and the identification of proposed sub-components and indicators based on the understanding and expert knowledge of the Mokolo, Matlabas, Crocodile West and Marico Catchments, the previous sections detail the results of the prioritisation process for rivers, dams, wetlands and groundwater.

RQOs and numerical limits for the prioritised and selected rivers, dams and groundwater RUs and wetlands/wetland clusters will be determined as the next step of the process based on the sub-components and indicators that have been prioritised (Steps 5 of the RQO process).

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