water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

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

STAKEHOLDER MEETINGS

Date: 16 and 17 MAY 2017

PURPOSE OF THE MEETING:

Present the proposed Resource Quality Objectives –

goals defining the quality of the water resource according to the classification,

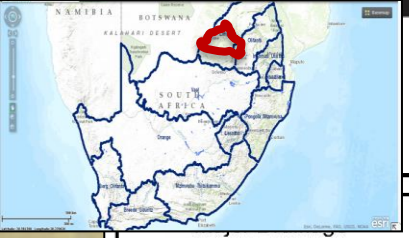
for the water resources in the Crocodile (West), Marico, Mokolo and Matlabas catchments

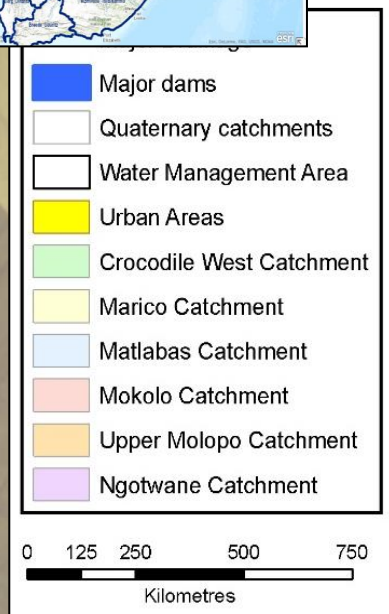
Request comments and input.

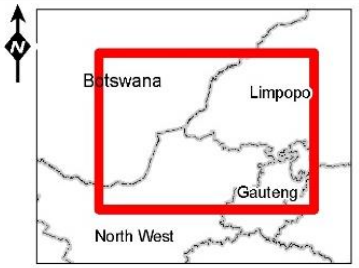
PRESENTATION CONTENT

- Introduction to Resource Quality Objectives
- Process of Resource Quality Objectives Determination
- Draft Resource Quality Objectives

STUDY AREA: MOKOLO, MATLABAS, CROCODILE (WEST), MARICO AND MOLOPO CATCHMENTS







Limpopo WMA

Olifants WMA

Vaal WMA

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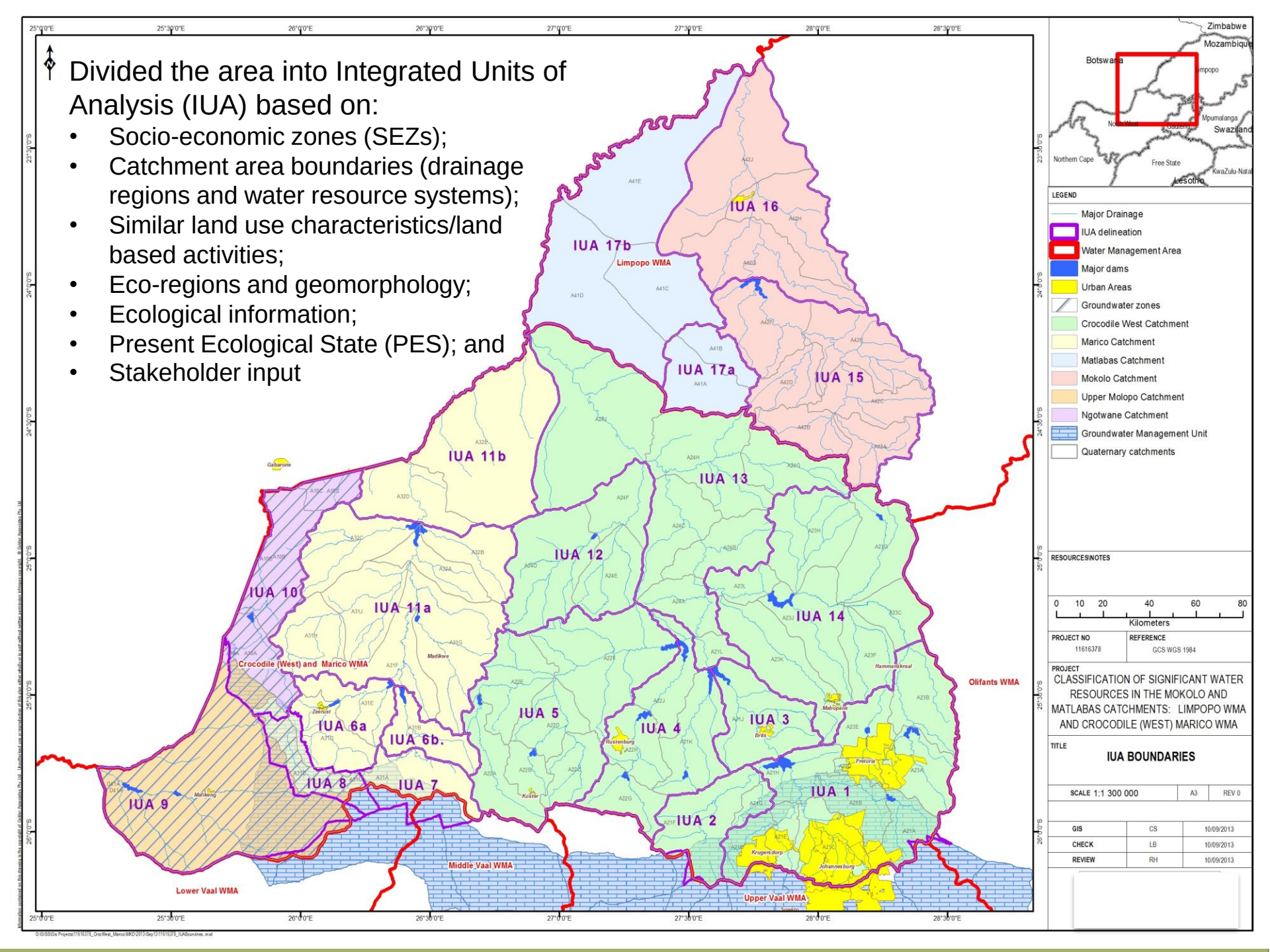
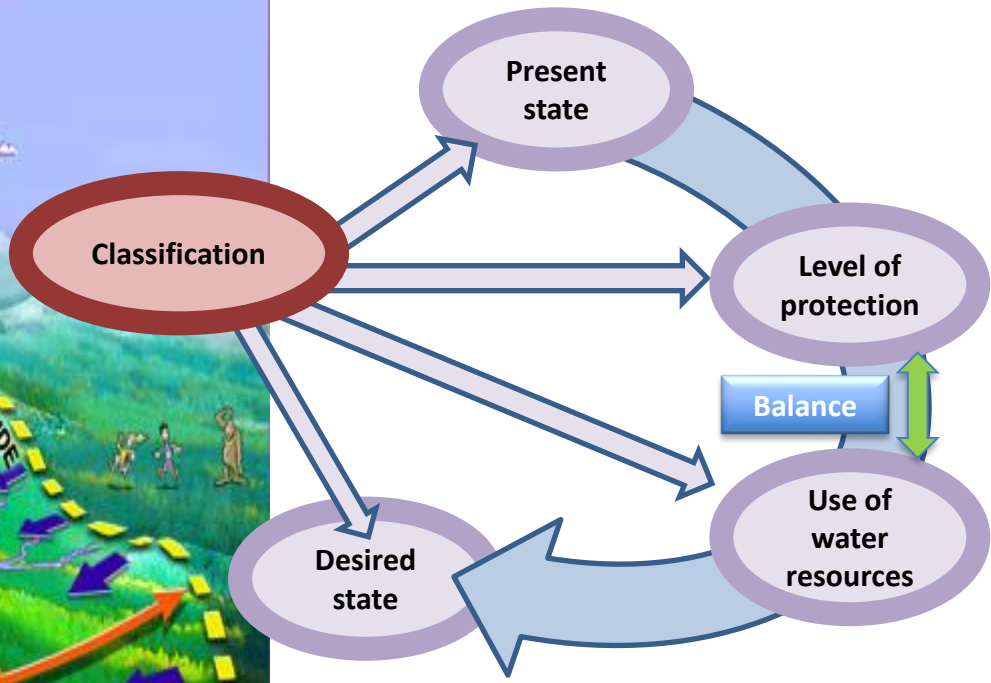

Divided the area into Integrated Units of Analysis (IUA) based on:
• Socio-economic zones (SEZs);
• Catchment area boundaries (drainage regions and water resource systems);
• Similar land use characteristics/land based activities;
• Eco-regions and geomorphology;
• Ecological information;
• Present Ecological State (PES); and
• Stakeholder input
IUA 16
IUA 17b
Limpopo WMA
IUA 17a
IUA 15
IUA 11b
IUA 13
IUA 12
IUA 10
IUA 11a
IUA 14
Crocodile (West) and Marico WMA
Olifants WMA
IUA 5
IUA 4
IUA 3
IUA 6a
IUA 6b.
IUA 8
IUA 7
IUA 9
IUA 1
IUA 2
Middle Vaal WMA
Lower Vaal WMA
Upper Vaal WMA
Zimbabwe
Mozambique
Botswana
Limpopo
Mpumalanga
Swaziland
Northern Cape
Free State
KwaZulu-Natal
Lesotho
LEGEND
Major Drainage
IUA delineation
Water Management Area
Major dams
Urban Areas
Groundwater zones
Crocodile West Catchment
Marico Catchment
Matlabas Catchment
Mokolo Catchment
Upper Molopo Catchment
Ngotwane Catchment
Groundwater Management Unit
Quaternary catchments
RESOURCES\NOTES
0 10 20 40 60 80
Kilometers
PROJECT NO
11616378
REFERENCE
GCS WGS 1984
PROJECT
CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE MOKOLO AND MATLABAS CATCHMENTS: LIMPOPO WMA AND CROCODILE (WEST) MARICO WMA
TITLE
IUA BOUNDARIES
SCALE 1:1 300 000
A3
REV 0
GIS CS 10/09/2013
CHECK LB 10/09/2013
REVIEW RH 10/09/2013

CLASSIFICATION OF WATER RESOURCES



WE ALL LIVE DOWNSTREAM

How DWS is protecting water resources?

RESOURCE MANAGEMENT

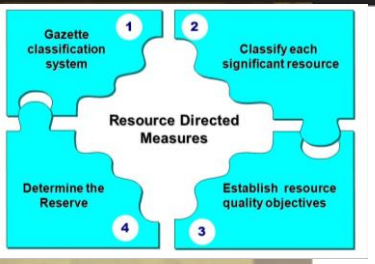
RESOURCE PROTECTION

- Setting requirements in water resources – Water Resource Class
- Resource Requirements:
  - Human Needs
  - Aquatic System Health (Ecospecs)
  - Resource Quality Objectives

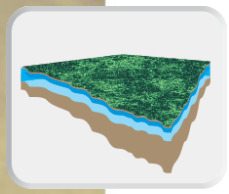
SOURCE CONTROL

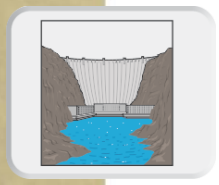
Managing and controlling activities Impacting on water resources

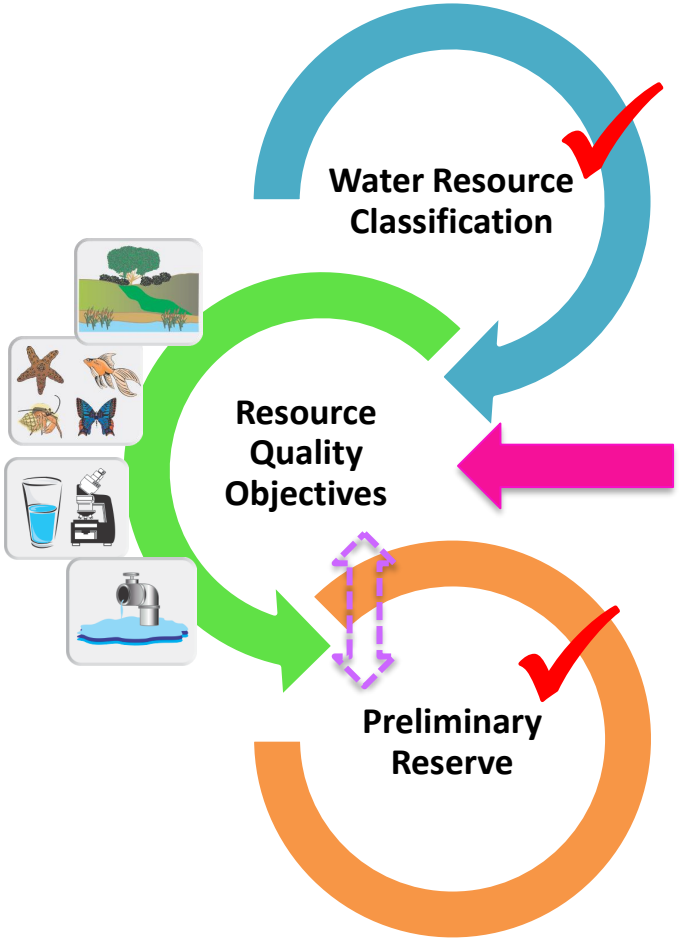
- Pollution sources
- Discharges
- Run-off (Agricultural Settlements, urban areas
- Illegal water use – Water abstraction



WATER RESOURCE PROTECTION IN THE MOKOLO, MATLABAS, CROCODILE (WEST) AND MARICO CATCHMENTS



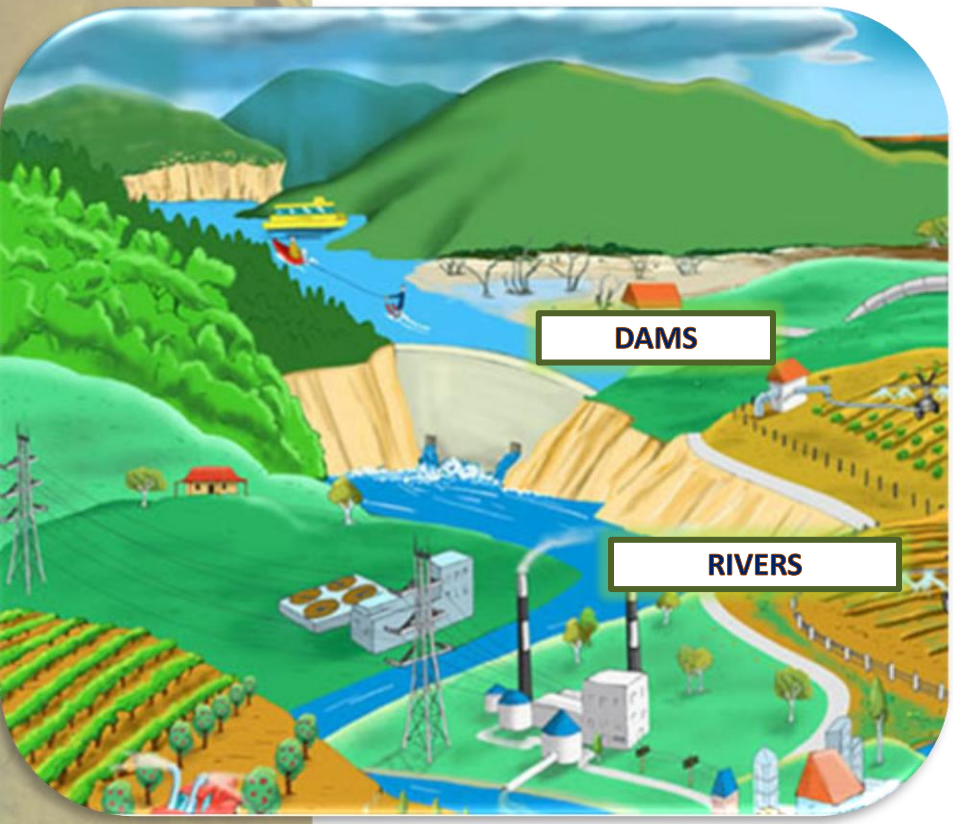




Focus of this study

RESOURCE QUALITY OBJECTIVES (RQOs):

- **RQOs can be numerical and/or descriptive statements and may relate to the:**
  - **Water Quality**
  - **Quantity (pattern and timing of flow)**
  - **Character and condition of riparian habitat**
  - **Characteristics and condition of the aquatic biota.**

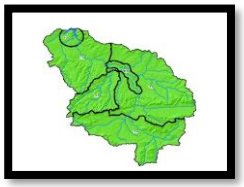


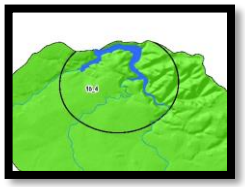
- **Resource quality objectives** are determined and gazetted for **resource units**

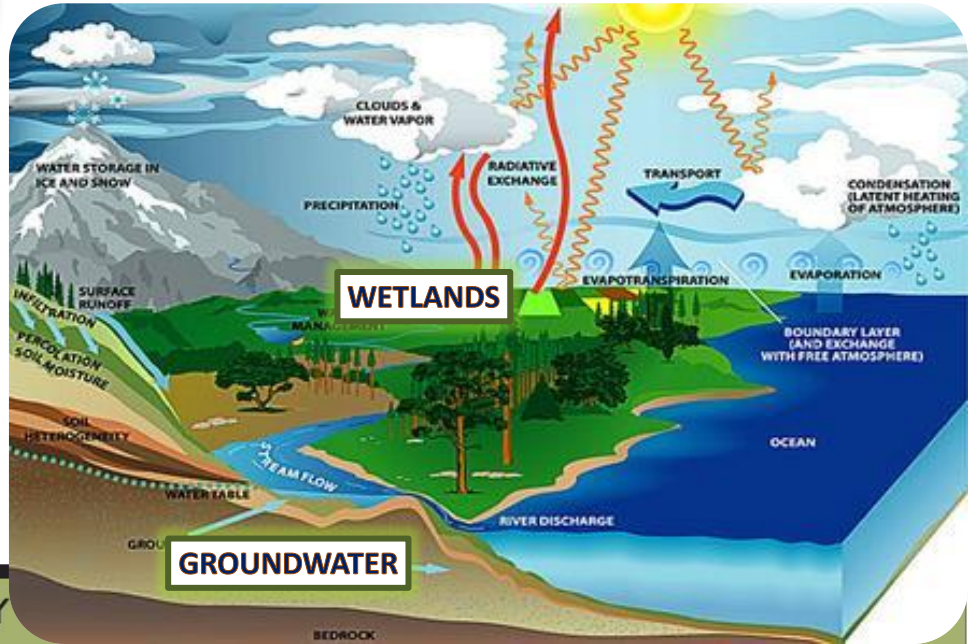
- **Resource quality objectives are determined for**

→ Rivers, Wetlands, Groundwater and Dams

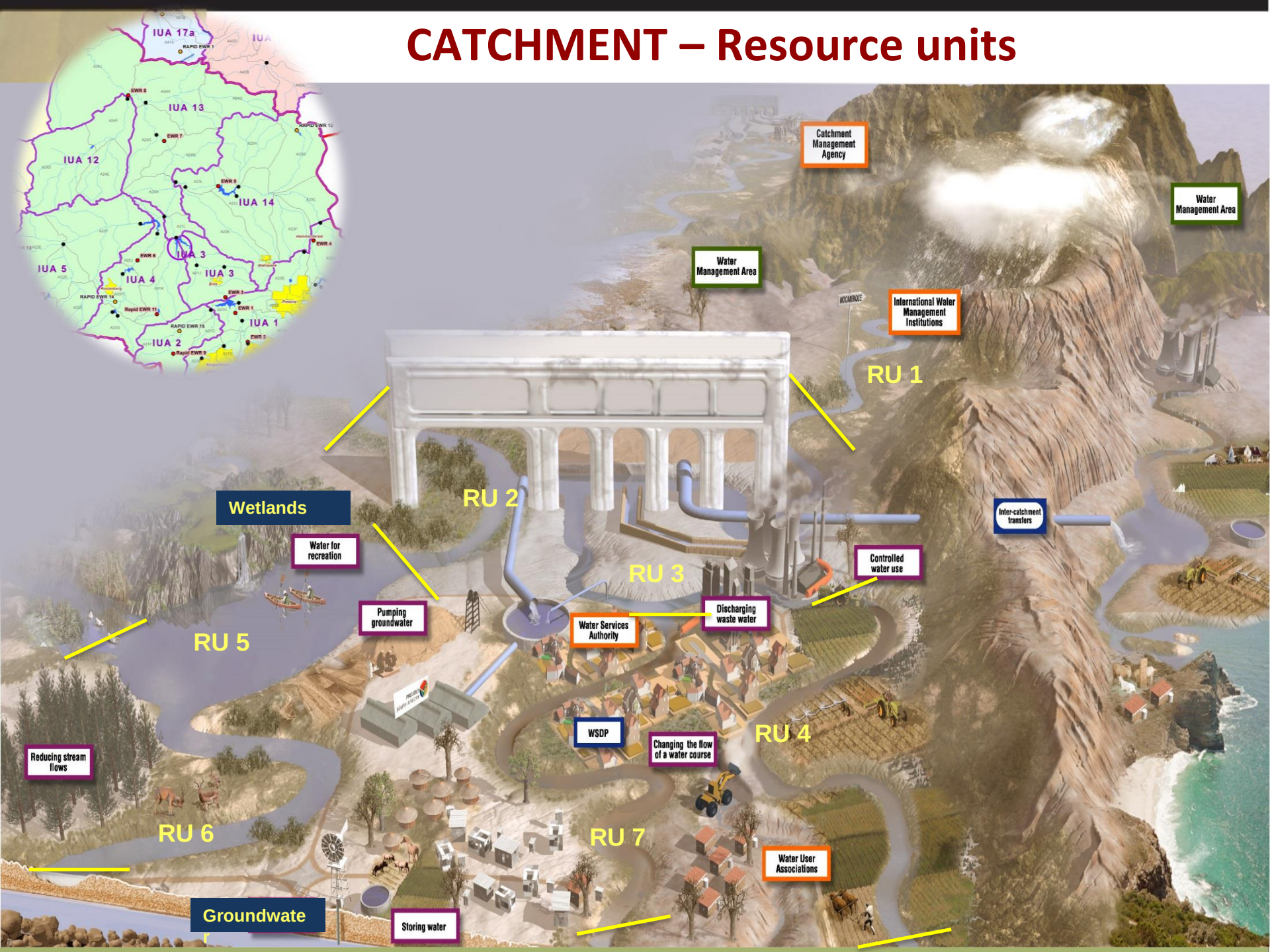
→ These are divided into management sections – called **resource units**







CATCHMENT – Resource units

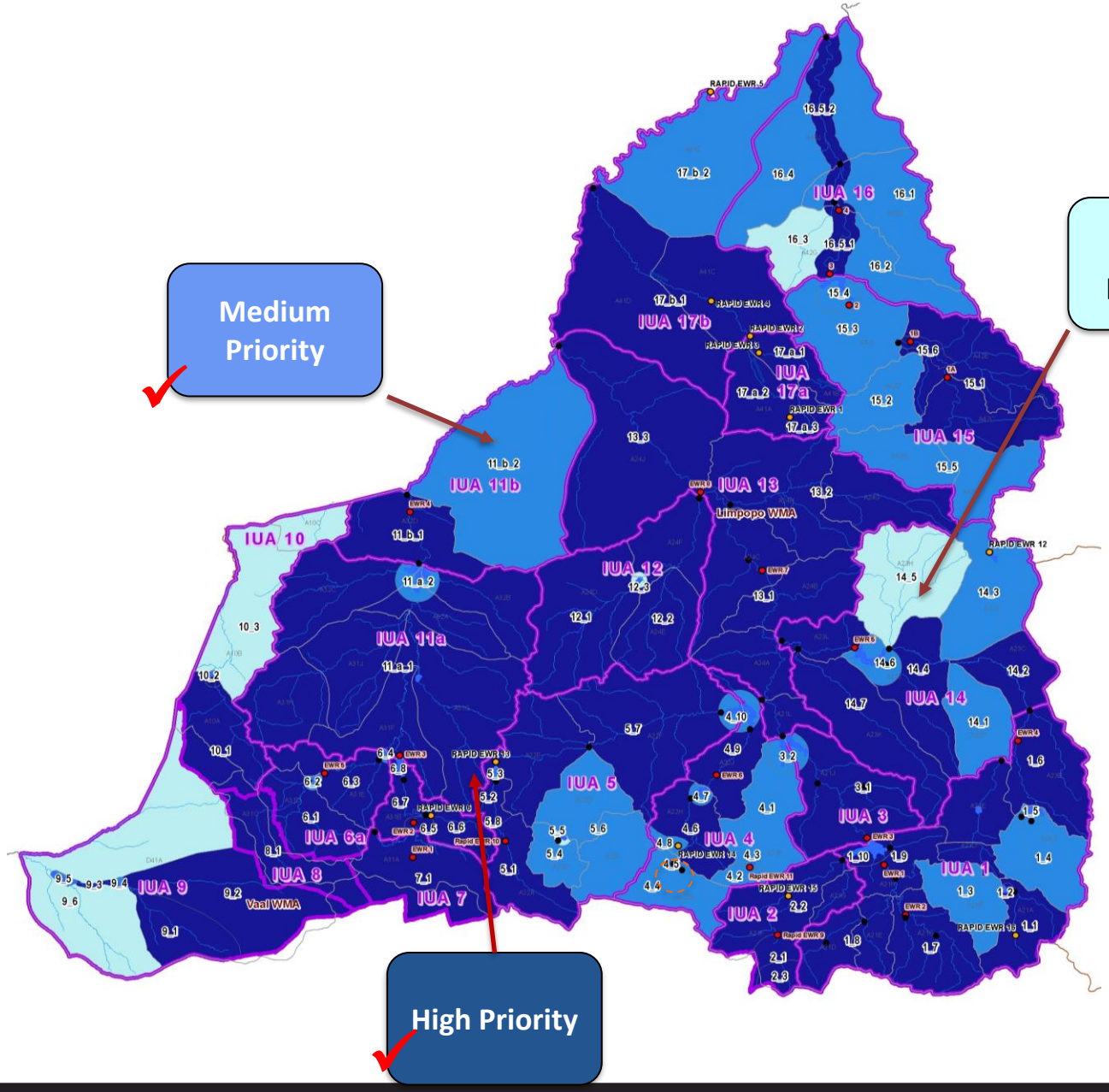


DELINEATION OF RESOURCE UNITS

Where should RQOs be set?

- RQOs can be set for each Resource Unit (a reach of river, groundwater system).
- Resource Units must be prioritised.
- **RQOs** are then developed **per RU** within the context of the IUA catchment perspective
- Three Resource Unit priority level of RQOs have been determined.
- RQOs have been set for the medium and high priority level RUs

RESOURCE UNIT PRIORITISATION



COMPONENTS AND SUB COMPONENTS
(RIVERS, DAMS, WETLANDS)

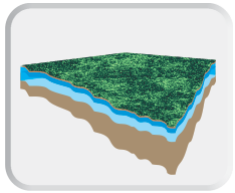
WATER QUANTITY
- High Flows
- Low Flows

WATER QUALITY
- Nutrients
- Salts
- System Variables
- Toxics
- Pathogens

HABITAT
- Instream Habitat
- Riparian Habitat

BIOTA
- Fish
- Aquatic and Riparian plant species
- Mammals
- Birds
- Periphyton
- Aquatic Invertebrates
- Diatoms

COMPONENTS AND SUB COMPONENTS (GROUNDWATER)



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**).

PRIORITY INDICATORS FOR COMPONENTS AND SUB COMPONENTS

Examples of indicators used to specify limits for sub-components

IUA	Catchment	Component indicator
IUA 1	A21D	1. Quality 2. Riparian Habitat 3. Fish
IUA 13	A24	1. Quantity
IUA 16	A42	1. Riparian vegetation 2. Water quality 3. Instream biota

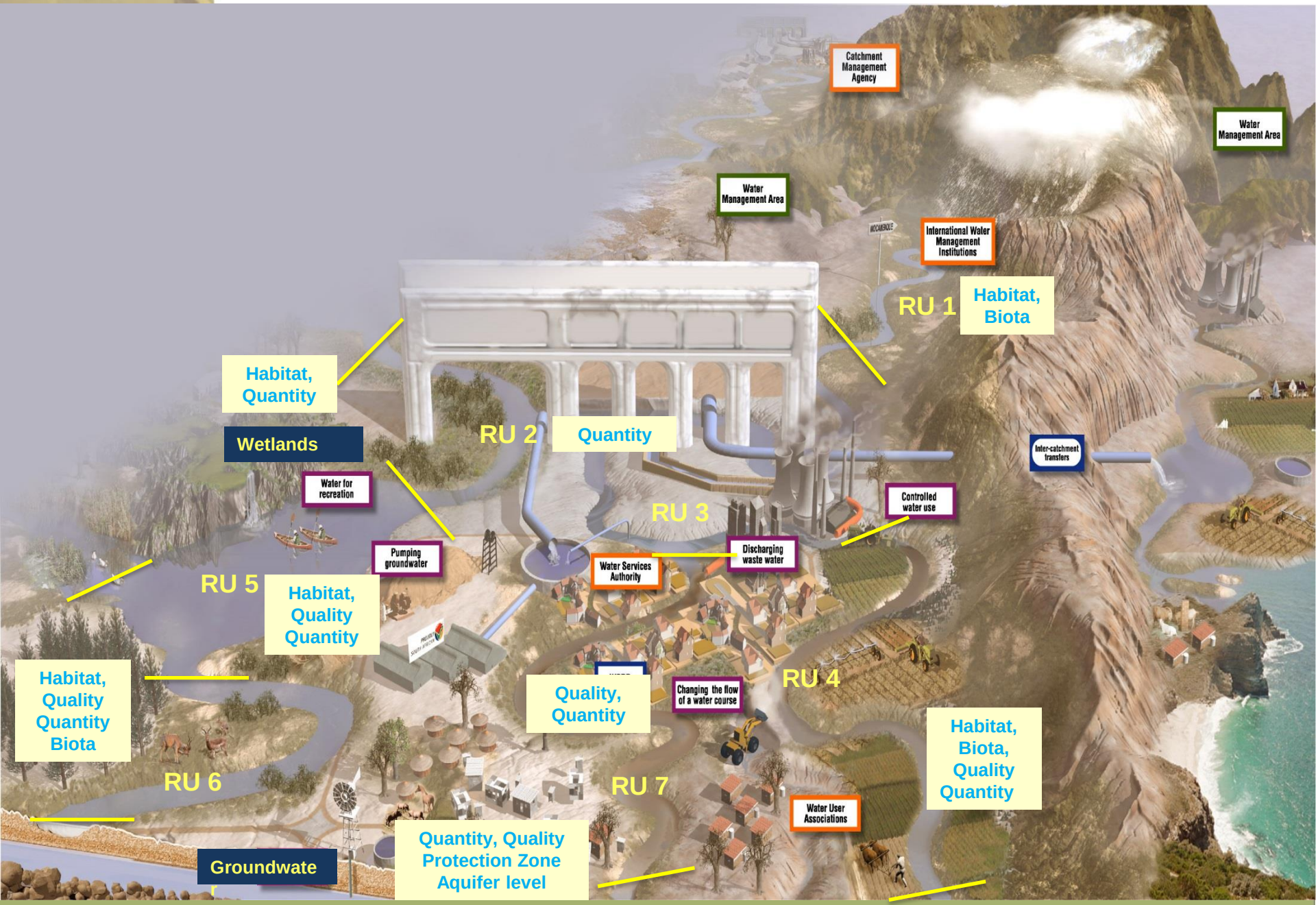
Riparian Ecological Category (EC)
Aerial cover

Fish Ecology category;
Species,
Species richness
FRAI score

Base Flows;
Floods
(EWRs - Reserve)

Nutrient levels
Conductivity
Toxics

CATCHMENT – Resource units and Components

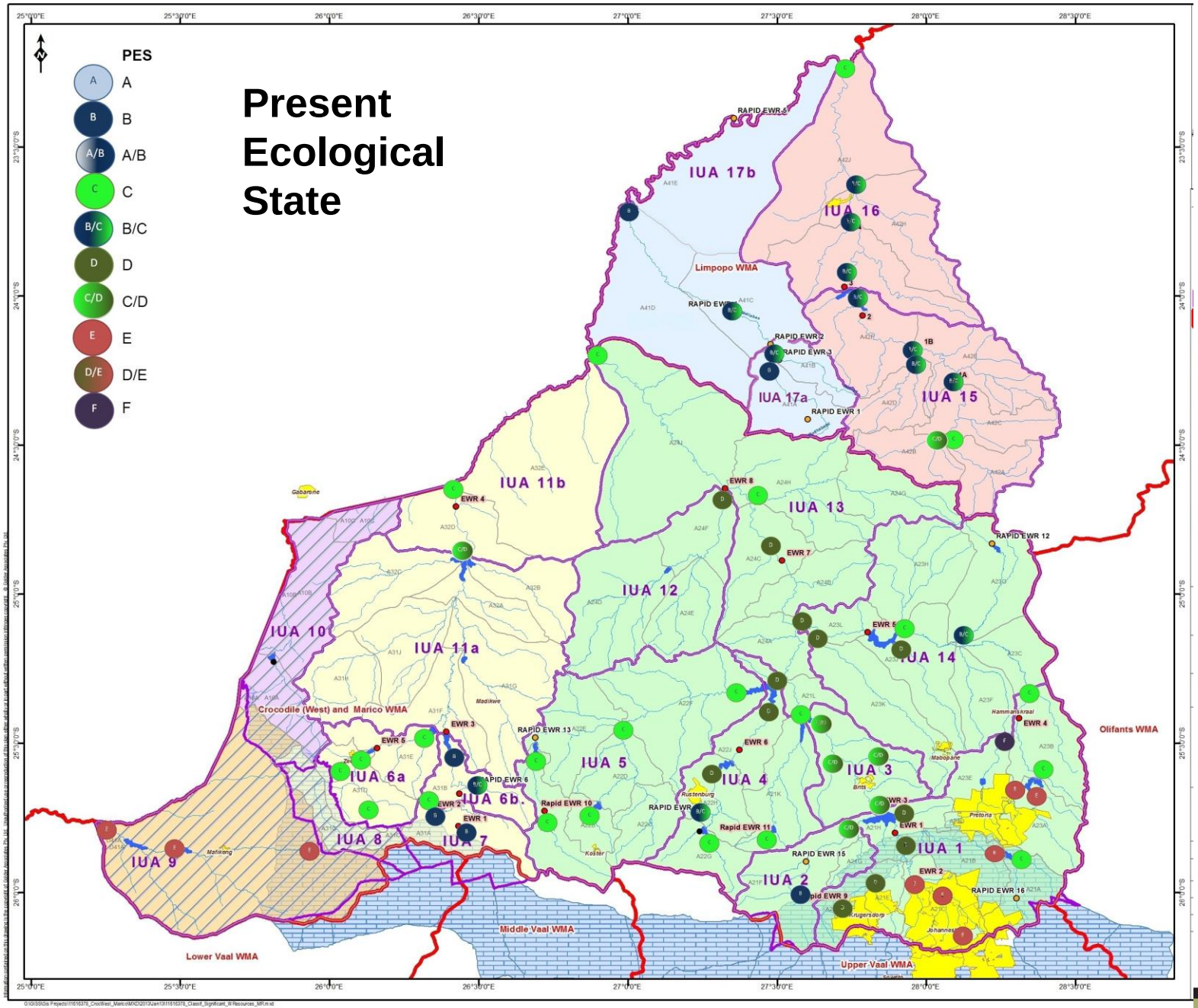


DEVELOP DRAFT RQOs

Determine present state for selected sub-components and indicators	Based on ecological classification of water resources

- Eco-classification describes ecological status of water resources in terms of ecological categories:

Ecological Category	Description
A	Near natural.
B	Largely natural
C	Moderately modified
D	Largely modified.
E	Seriously modified
F	Critically / Extremely modified


Present Ecological State
PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 11b
IUA 13
IUA 12
IUA 10
IUA 11a
IUA 14
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Limpopo WMA
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Lower Vaal WMA
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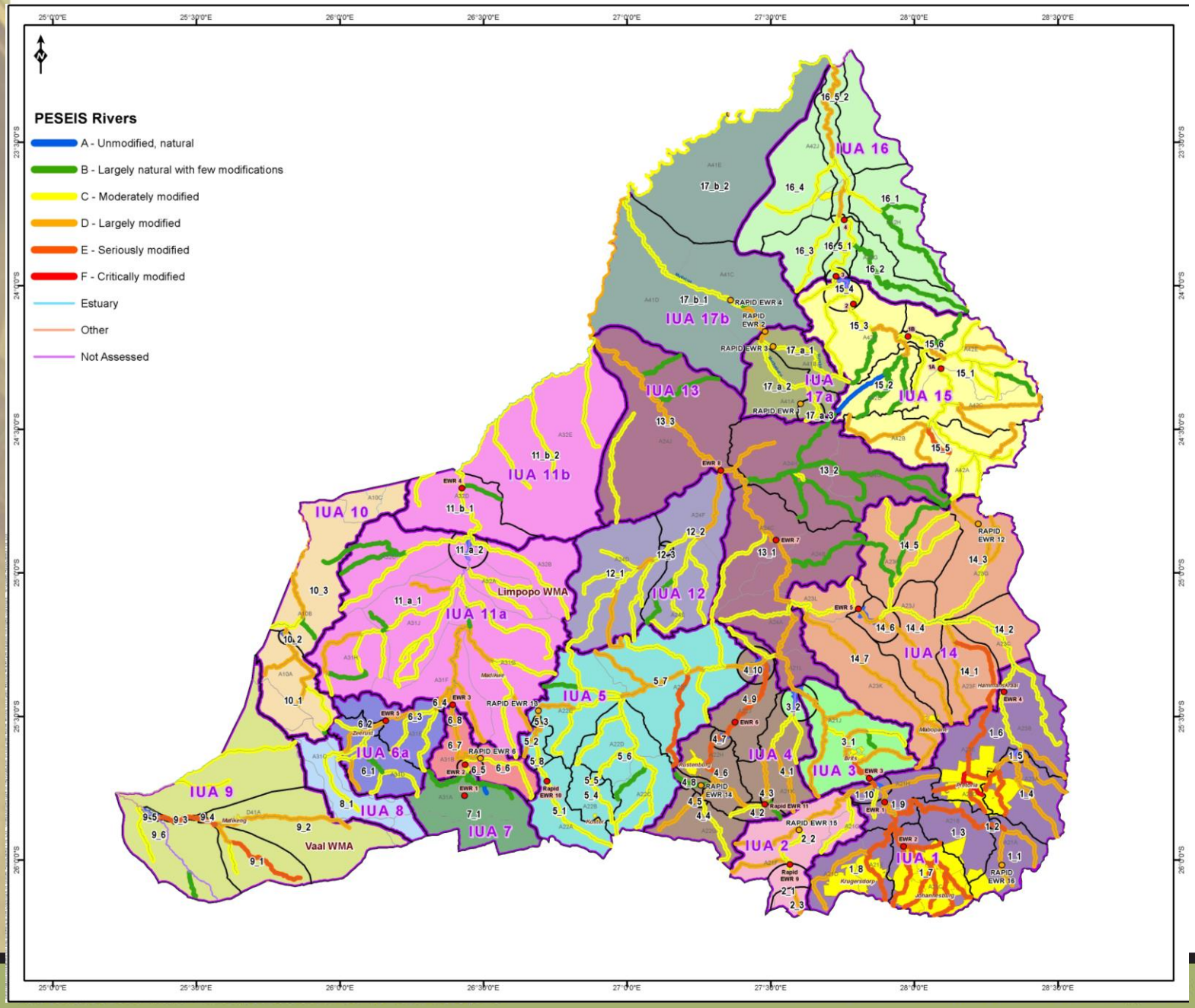
RAPID EWR 6
RAPID EWR 2
RAPID EWR 3
RAPID EWR 1
EWR 8
EWR 4
EWR 7
RAPID EWR 12
EWR 5
EWR 3
RAPID EWR 13
EWR 6
EWR 4
RAPID EWR 6
EWR 2
RAPID EWR 10
RAPID EWR 11
EWR 1
RAPID EWR 15
RAPID EWR 9
RAPID EWR 16
Gaborone
Madikwe
Mafikeng
Rustenburg
Brits
Mabopane
Hammanskraal
Pretoria
Krugersdorp
Johannesburg
Koster

Present Ecological State - Rivers



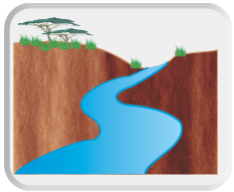
WATER QUANTITY RQOS

- **Flow regime associated with the Water Resource Class (Ecological Water Requirements to attain ecological categories)**
  - Defines the flow needed at different times of the year.
  - In low rainfall periods the flow needed is also low.
  - When rainfall is high the flow required in high.

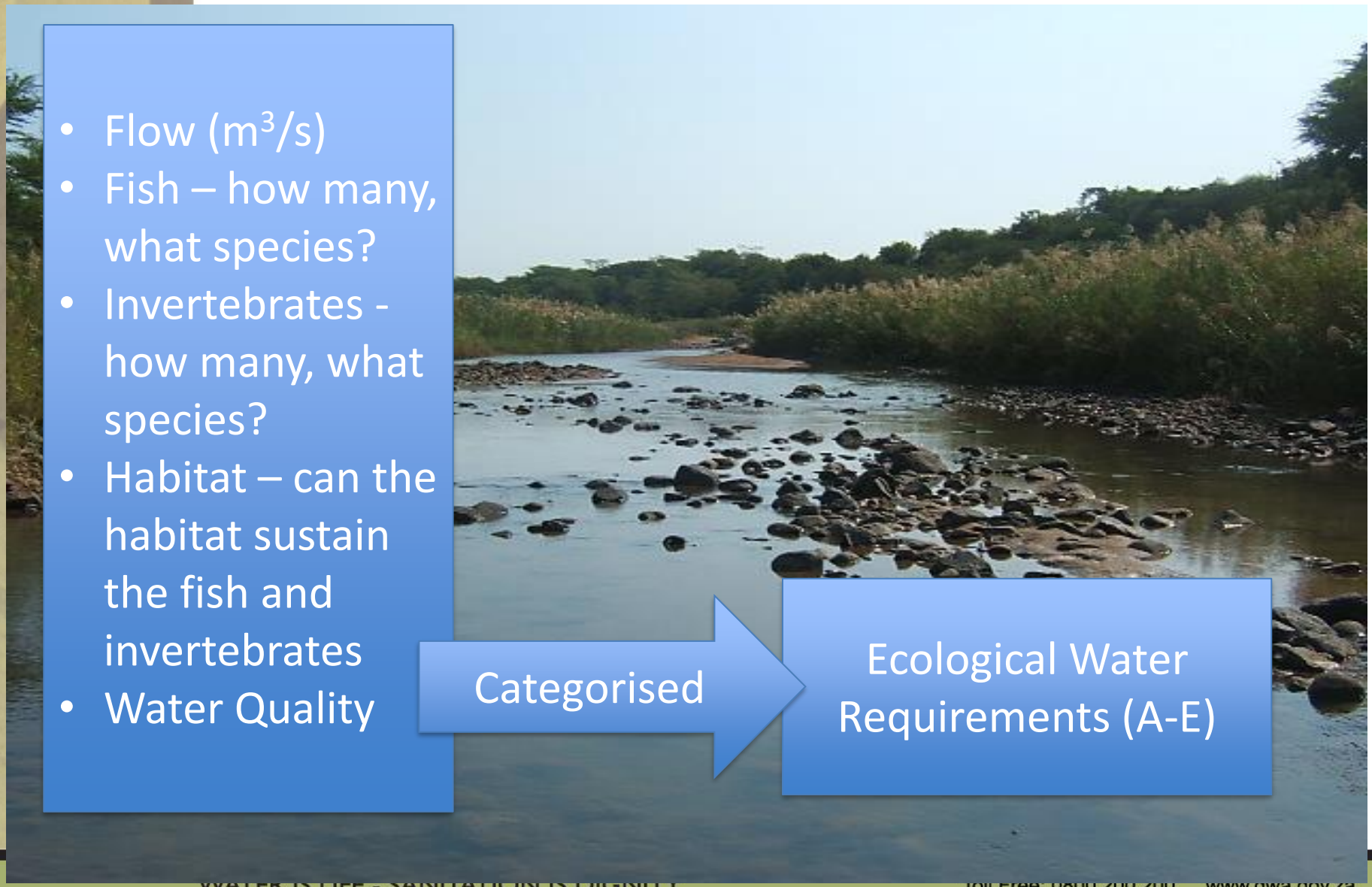
Flow RQOs are defined by quantity and frequency for each month of the year

WATER QUANTITY RQOs

- Flows specifications are outputs of classification process.
- EWR sites and nodes in catchments have flows determined
- RQOs are specified in terms of flow requirements at nodes and EWR sites (meeting ecological requirements and user specifications)



What is an Ecological Water Requirement site?

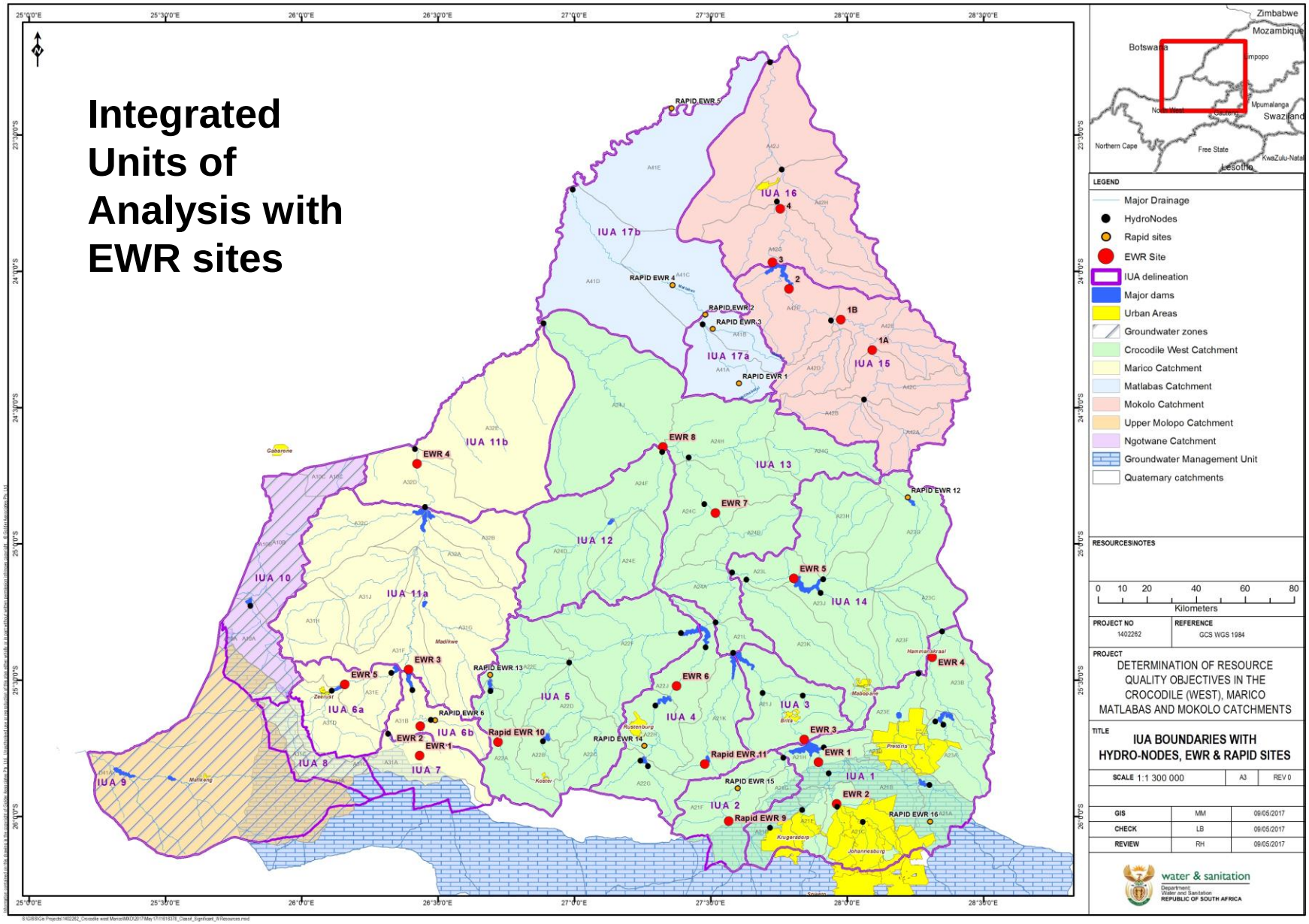


- Flow (m^3/s)
- Fish – how many, what species?
- Invertebrates - how many, what species?
- Habitat – can the habitat sustain the fish and invertebrates
- Water Quality

Categorised

Ecological Water Requirements (A-E)

WATER QUANTITY RQOs (FLOW)

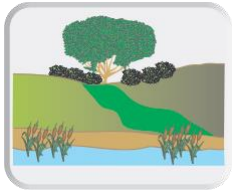


WATER QUALITY RQOs

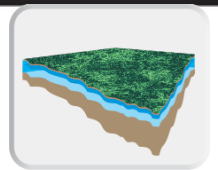
- **These describe objectives for water quality for the following (description and/or numbers):**
  - Ecological requirements: Maintenance or improvement
  - User Requirements: Strictest User in terms of South African Water Quality Guidelines
  - International Guidelines: WHO
  - Present water quality state of resource
- **Present the numbers as**
  - 95th percentile for toxics + salts
  - 50th percentile for nutrients due to greater variability with flow
- **Class and ecological category met and user requirements complied with. Downstream/upstream alignment**

HABITAT AND BIOTA RQOs

- **These describe objectives for water quality for the following (description and/or numbers):**
  - These describe the habitat and biota which must be found in the water resource if the Water Resource Class is implemented.
  - For the RUs where Habitat and Biota has been selected: A **target Ecological Category** is provided for each component and a **description and linked numbers**.
  - **Maintenance or improvement** of habitat/biota recommended based on **present state and ecological category specified**. Any important species also considered, as well as potential threats.

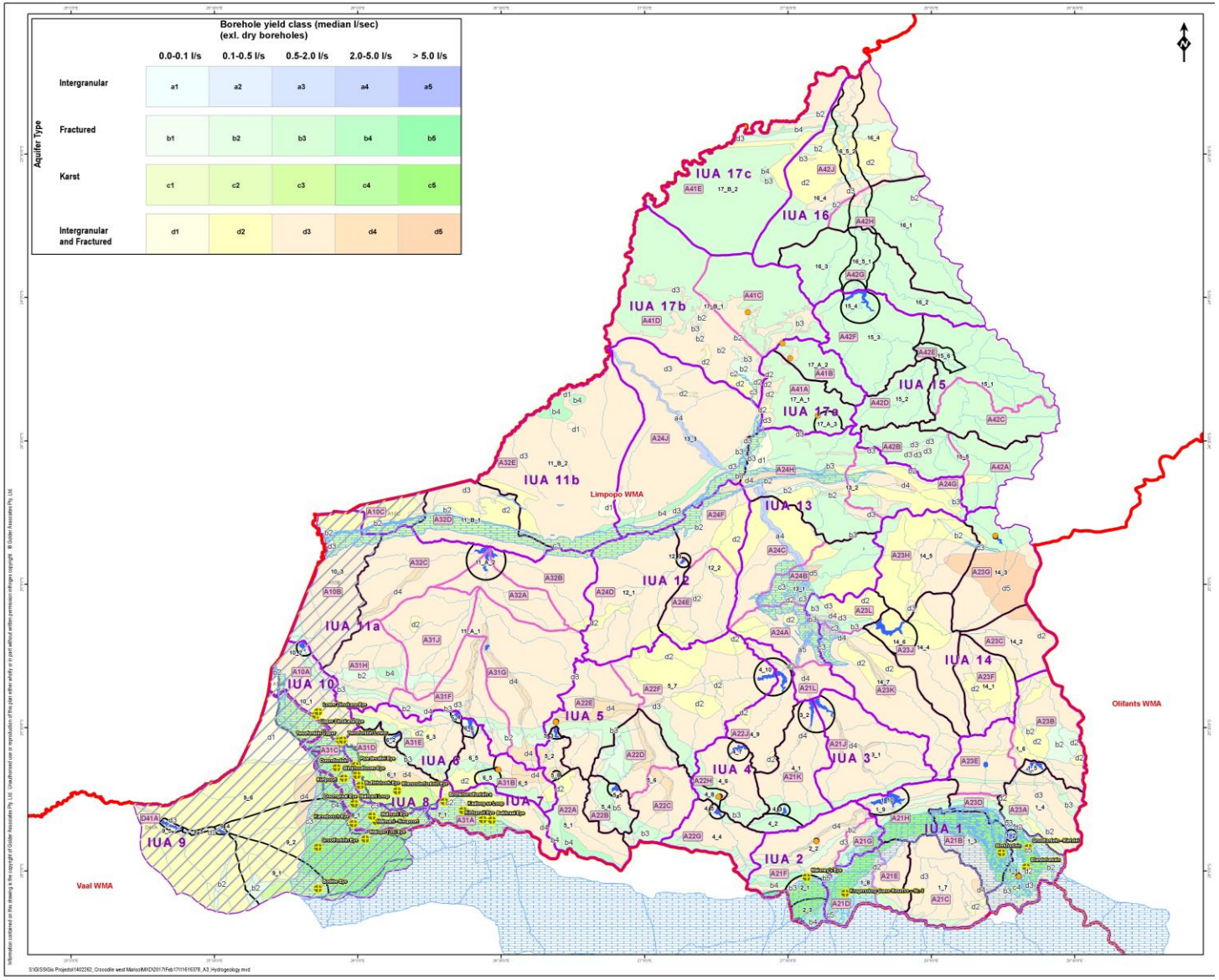


GROUNDWATER RQOs

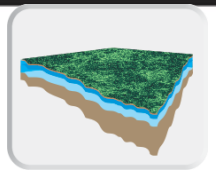


- Two important aquifer systems**: Alluvial and Dolomite (karst) aquifer systems**
- Established on a resource unit scale (regional and local):
  - Dolomite RU demarcations were adapted to portray the actual groundwater flow boundaries as per the mapped dolomite compartment boundaries.
- The approach to specify RQO for groundwater was as follows:
  - Collation of catchment wide hydrogeological information;
  - Groundwater use, aquifer, recharge information, assessment, baseflow information
  - Sustainability in terms of supply assurance, the environmental impact of abstraction (quantities), and use (qualities).

HYDROGEOLOGY OF STUDY AREA

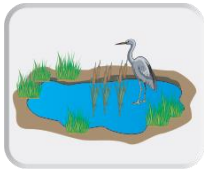


GROUNDWATER RQOs



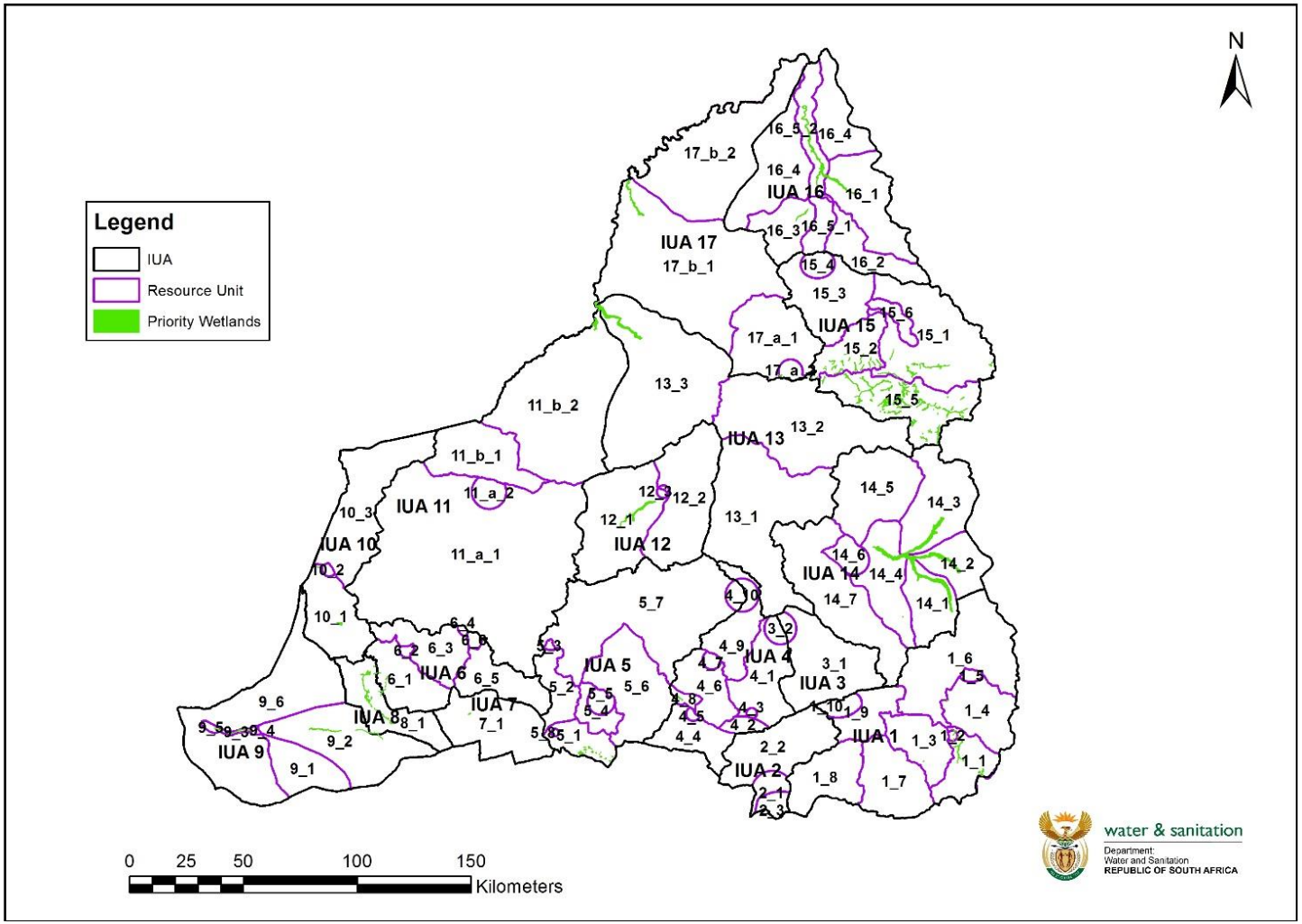
- Qualitative and quantitative RQOs and numerical limits for groundwater resource protection, as follows:
  - A stress index (SI) of 0.65 (or 65%) was used as a limit for the RQO (quantity);
  - A limit on lowering the water table elevation (i.e. drawing down aquifer saturation levels) in dolomite RUs;
  - A range of Protection Zoning (specifically for dolomite RUs discharging as eyes (radius of influence, a stream deflection factor, distance from eye and distance from wetland at eye);
  - In the case of river flood plain alluvial aquifer, a stream depletion factor should be specified
  - Consideration of microbial zoning for activities related to river flood plain alluvial aquifers, and
  - Water quality RQOs for nitrate, sulphate, and electrical conductivity are proposed as natural indicators of water quality deterioration.

WETLANDS RQOs



- Resource Unit scale wetland RQOs
  - Review of the categorisation of the priority systems (condition and ecological importance and sensitivity) – for those where this information is available.
  - Consideration and recommendation of targeted Ecological Categories for the priority wetlands where possible.
  - Recommendation of ecological specifications (protection, management, mitigation and monitoring measures) for the priority systems.
  - RQOs determined: based mostly on generic measures with reference to specific measures where appropriate or where suitable information existed for this purpose.
  - RQOs: Mostly narrative, and include general RQOs aimed mostly at the largest impacts to wetland integrity and continuity, as well as to the sub-components identified.

Priority Wetlands



SETTING RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS

Resource Unit – River

Quantity RQO – Flow requirements

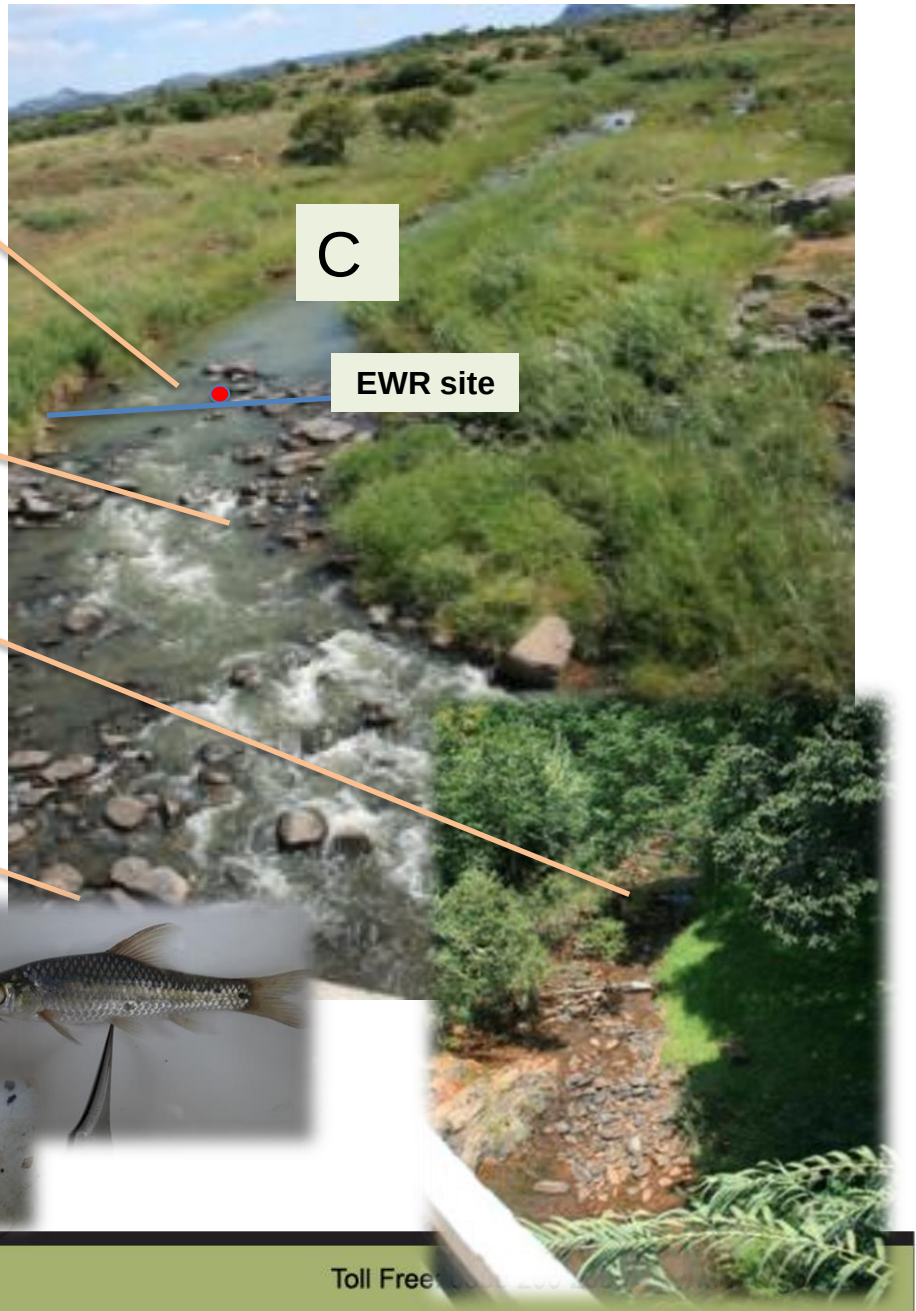
- high and low flows
- Ecological category

Habitat RQO – Instream and riparian –

- meet ecological category
- Habitat diversity
- Maintain habitat

Biota RQO – Fish and Macroinvertebrates –

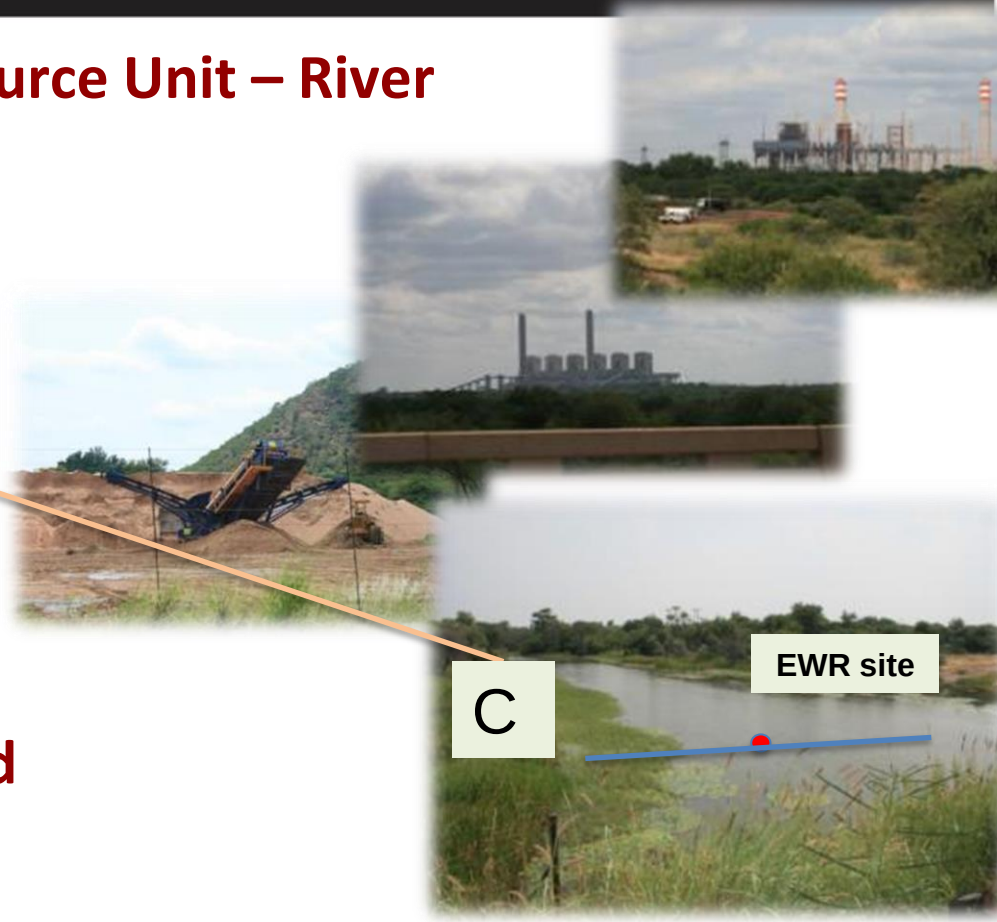
- meet ecological category
- Maintain presence of species



Resource Unit – River

Quality RQO – present state and impacts

- Ecological category
- Upstream impacts
- Downstream activities
- Nutrients, salts, pathogens, toxins



Wetland

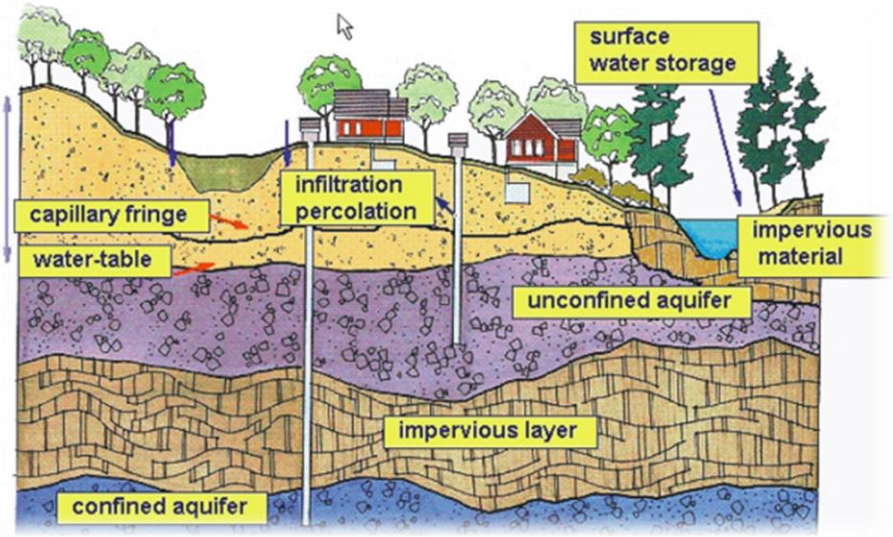
Wetland RQO – Priority wetlands/systems

- Ecological category
- Ecological integrity
- Value of systems
- **Habitat, quantity, quality**

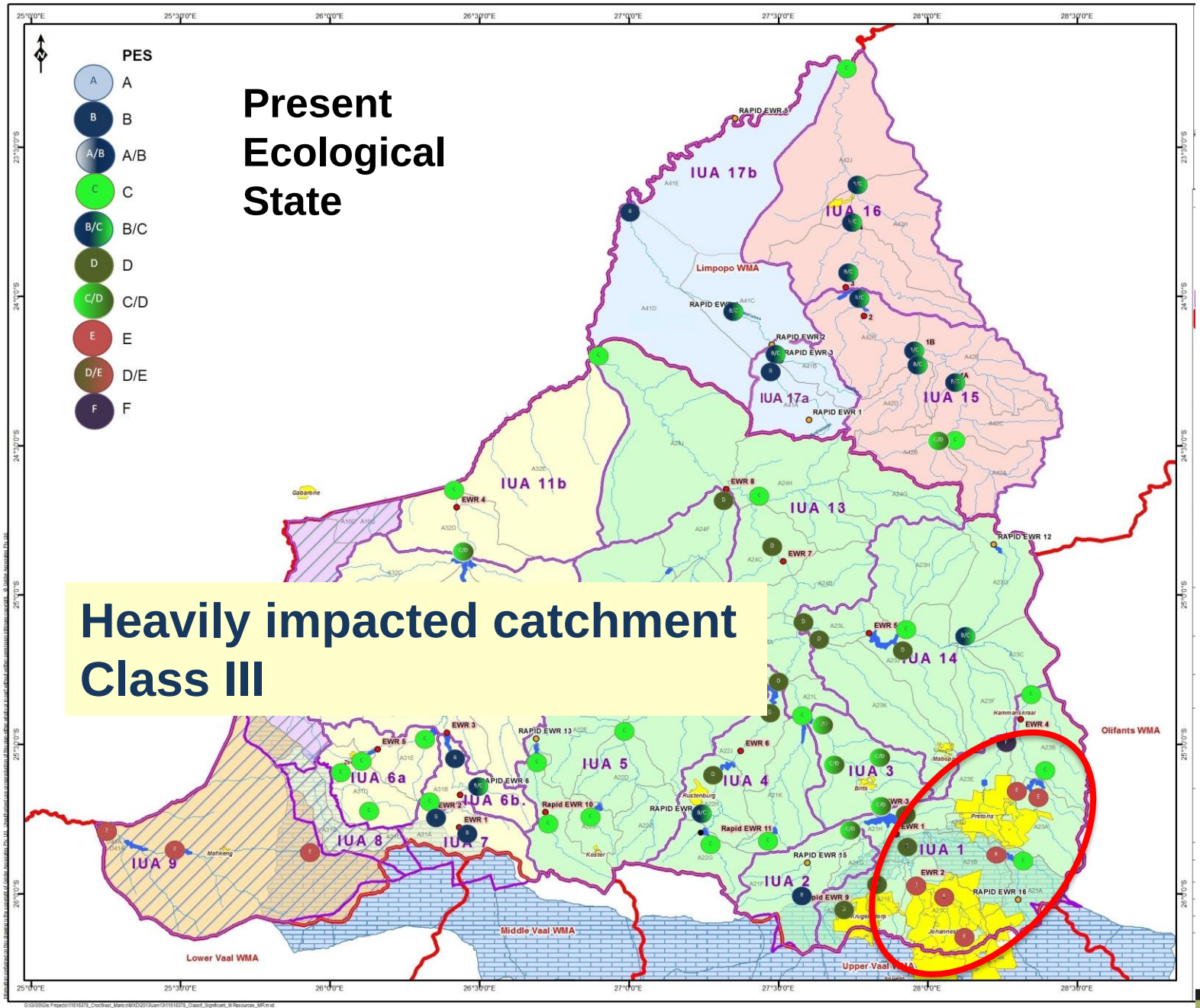
Groundwater

Groundwater RQO – Priority aquifer systems

- Protection balance with use
- Aquifer Water level
- Quality
- Protection Zoning
- Stress Index



DRAFT RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS (REPRESENTATIVE EXAMPLES OF CATCHMENTS)

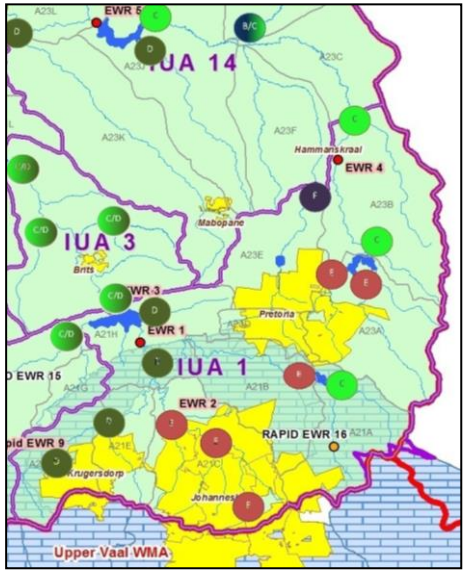

PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
Heavily impacted catchment Class III
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 11b
IUA 13
IUA 14
IUA 5
IUA 6a
IUA 6b
IUA 4
IUA 3
IUA 8
IUA 7
IUA 9
IUA 1
IUA 2
Limpopo WMA
Olifants WMA
Middle Vaal WMA
Lower Vaal WMA
Upper Vaal WMA
RAPID EWR 6
RAPID EWR 2
RAPID EWR 3
RAPID EWR 1
EWR 4
EWR 8
EWR 7
RAPID EWR 12
EWR 5
EWR 3
RAPID EWR 13
EWR 6
RAPID EWR 10
RAPID EWR 11
RAPID EWR 15
RAPID EWR 16
RAPID EWR 9
EWR 2
EWR 1

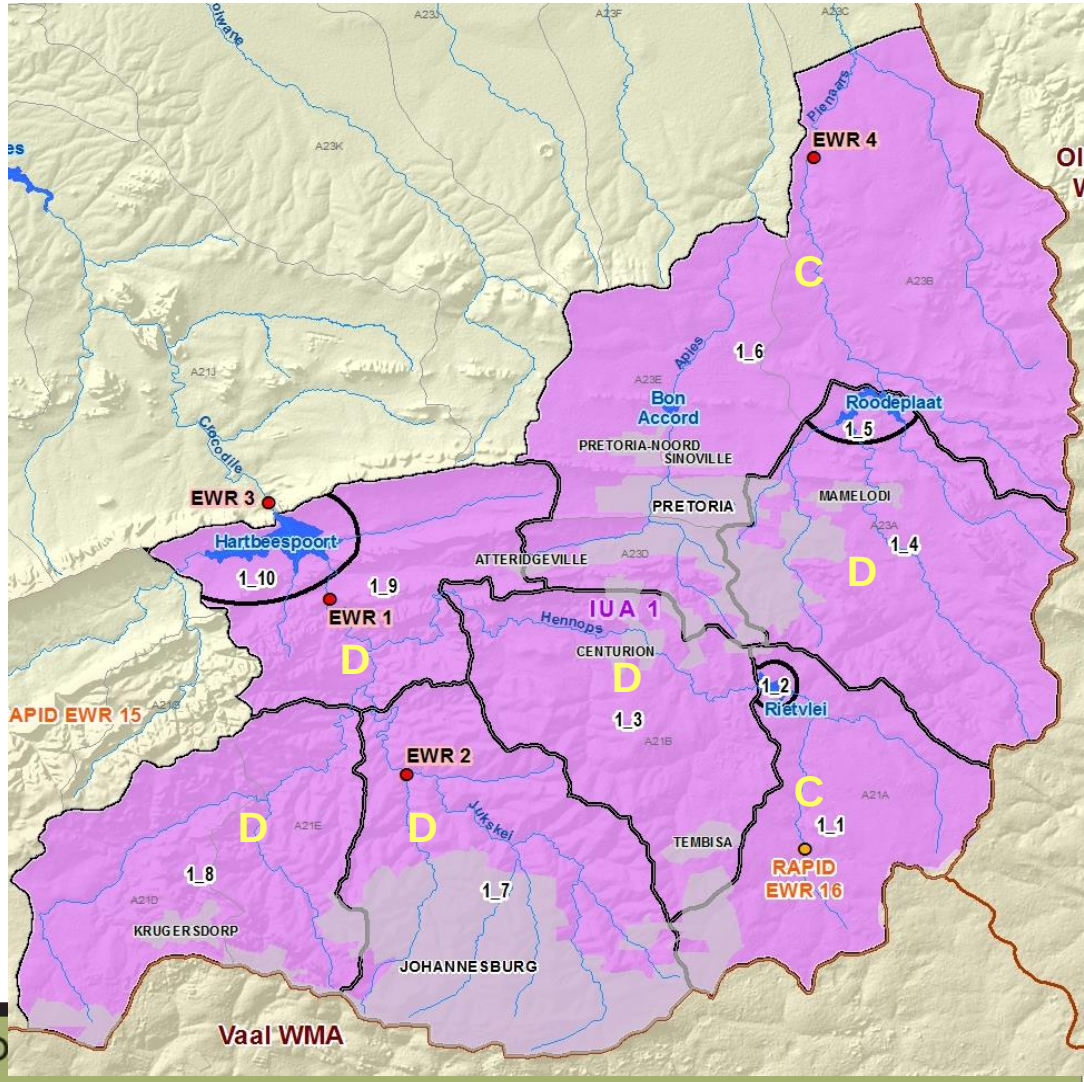
Heavily impacted catchment

IUA1: Upper Crocodile/Hennops/Hartbeespoort

Management Class: III

Ecological Category: D





IUA1: Upper Crocodile/Hennops/Hartbeespoort Class III

1_5: Roodeplaat Dam

- Eutrophic with algal blooms impacting on the taste of the water.
- Supply of raw water
- conservation area/supports a wide range of recreational activities
- Severely impacted by WWTWs discharges, urbanisation and industrial effluent
- Nutrient management and a remediation programme is required.

1_6: Upper and middle reaches of Apies River, Skinnerspruit, Pienaars

- Users: agriculture and domestic water use (direct reliance). Magalies Water abstract water at Klipdrift (option of canal or weir).
- Upper parts impacted by urbanisation, irrigation runoff and WWTWs.

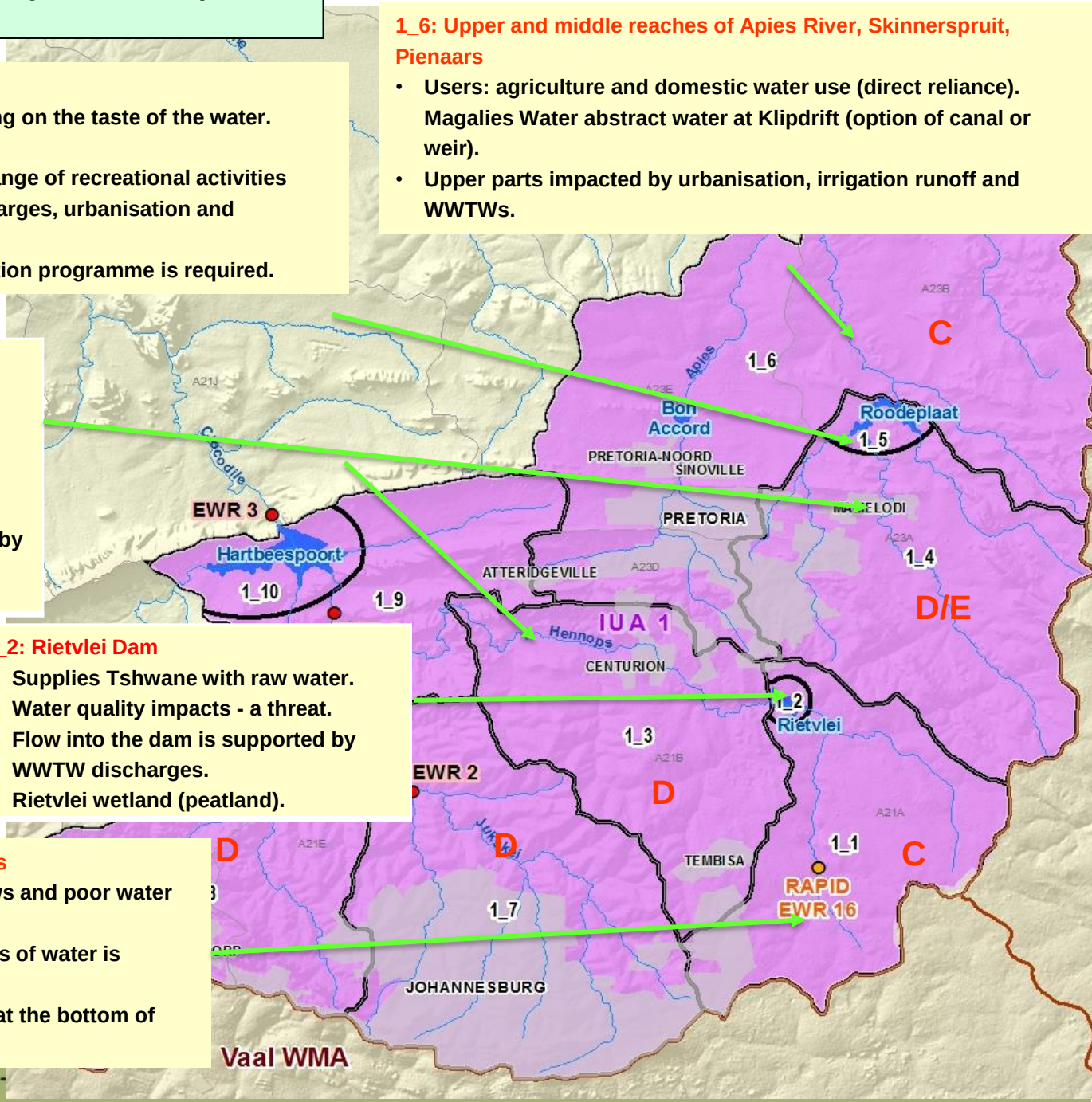
1_3 and 1_4

- Degraded due to u/s WWTWs, urbanisation, return flows and poor water quality
- Seepage wetlands - high botanical diversity.
- Irene-Pretoria dolomites : impacted by irrigation and pollution.
- Need to protect fish species

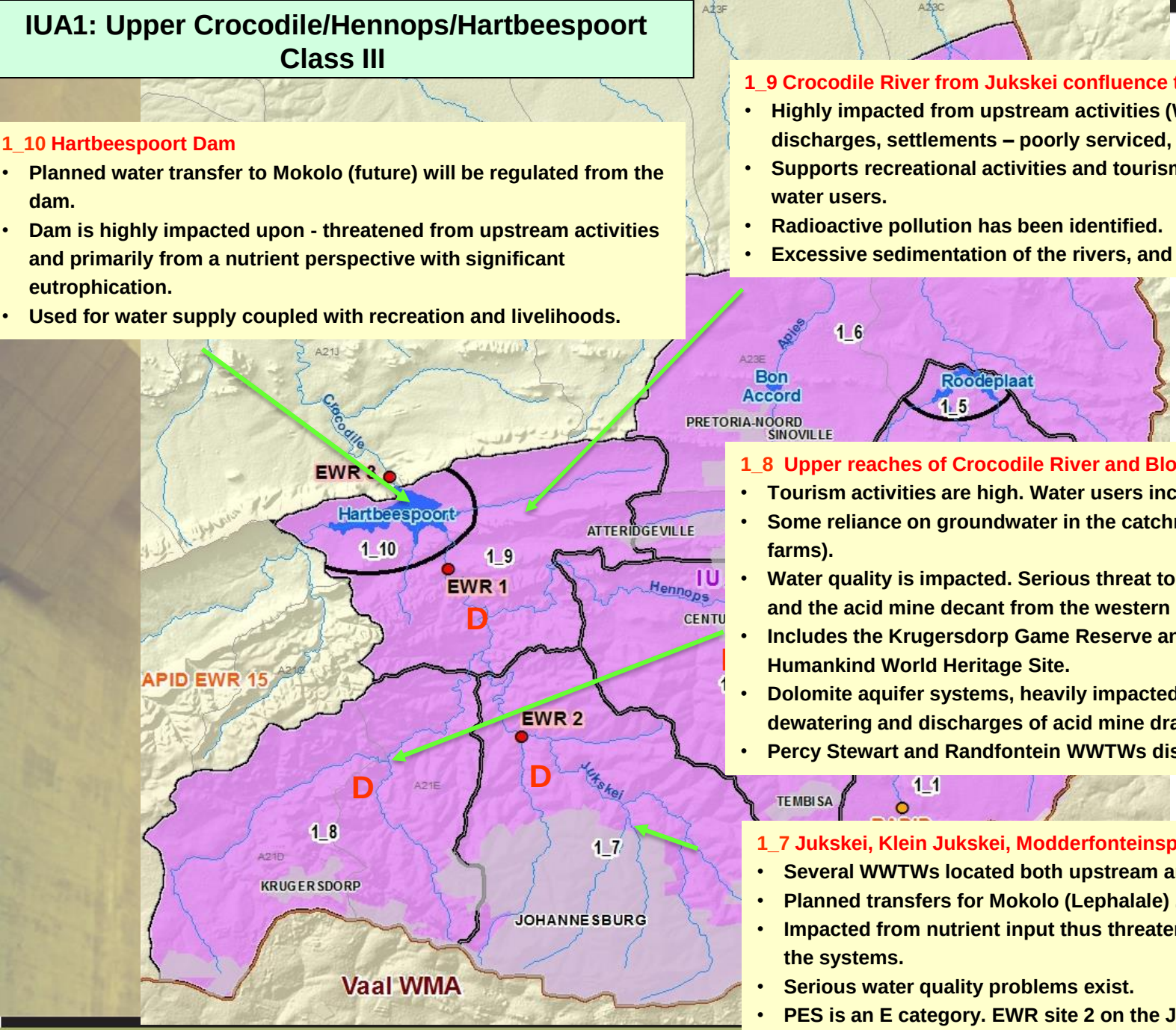
1_2: Rietvlei Dam

- Supplies Tshwane with raw water.
- Water quality impacts - a threat.
- Flow into the dam is supported by WWTW discharges.
- Rietvlei wetland (peatland).

- **1_1: Upper Hennops and Rietvlei Rivers**
- Impacted due urbanisation, return flows and poor water quality
- Irene-Pretoria dolomites. Large volumes of water is abstracted from aquifer system.
- The Rietvlei Nature Reserve is located at the bottom of this unit.



IUA1: Upper Crocodile/Hennops/Hartbeespoort Class III



1_10 Hartbeespoort Dam

- Planned water transfer to Mokolo (future) will be regulated from the dam.
- Dam is highly impacted upon - threatened from upstream activities and primarily from a nutrient perspective with significant eutrophication.
- Used for water supply coupled with recreation and livelihoods.

1_9 Crocodile River from Jukskei confluence to Hartbeespoort Dam

- Highly impacted from upstream activities (WWTW, urban activities, discharges, settlements – poorly serviced, solid wastes etc.).
- Supports recreational activities and tourism, irrigation and industrial water users.
- Radioactive pollution has been identified.
- Excessive sedimentation of the rivers, and aquatic weed infestation.

1_8 Upper reaches of Crocodile River and Bloubank Spruit

- Tourism activities are high. Water users include agriculture.
- Some reliance on groundwater in the catchment (supports flower farms).
- Water quality is impacted. Serious threat to the system is mining and the acid mine decant from the western basin.
- Includes the Krugersdorp Game Reserve and the Cradle of Humankind World Heritage Site.
- Dolomite aquifer systems, heavily impacted by historic mine dewatering and discharges of acid mine drainage (AMD)
- Percy Stewart and Randfontein WWTWs discharges

1_7 Jukskei, Klein Jukskei, Modderfonteinspruit

- Several WWTWs located both upstream and downstream
- Planned transfers for Mokolo (Lephalale) .
- Impacted from nutrient input thus threatening the biotic integrity of the systems.
- Serious water quality problems exist.
- PES is an E category. EWR site 2 on the Jukskei River

IUA 1: Upper Crocodile/Hennops/Hartbeespoort - RQOs QUALITY

Narrative RQOs: Representative for IUA

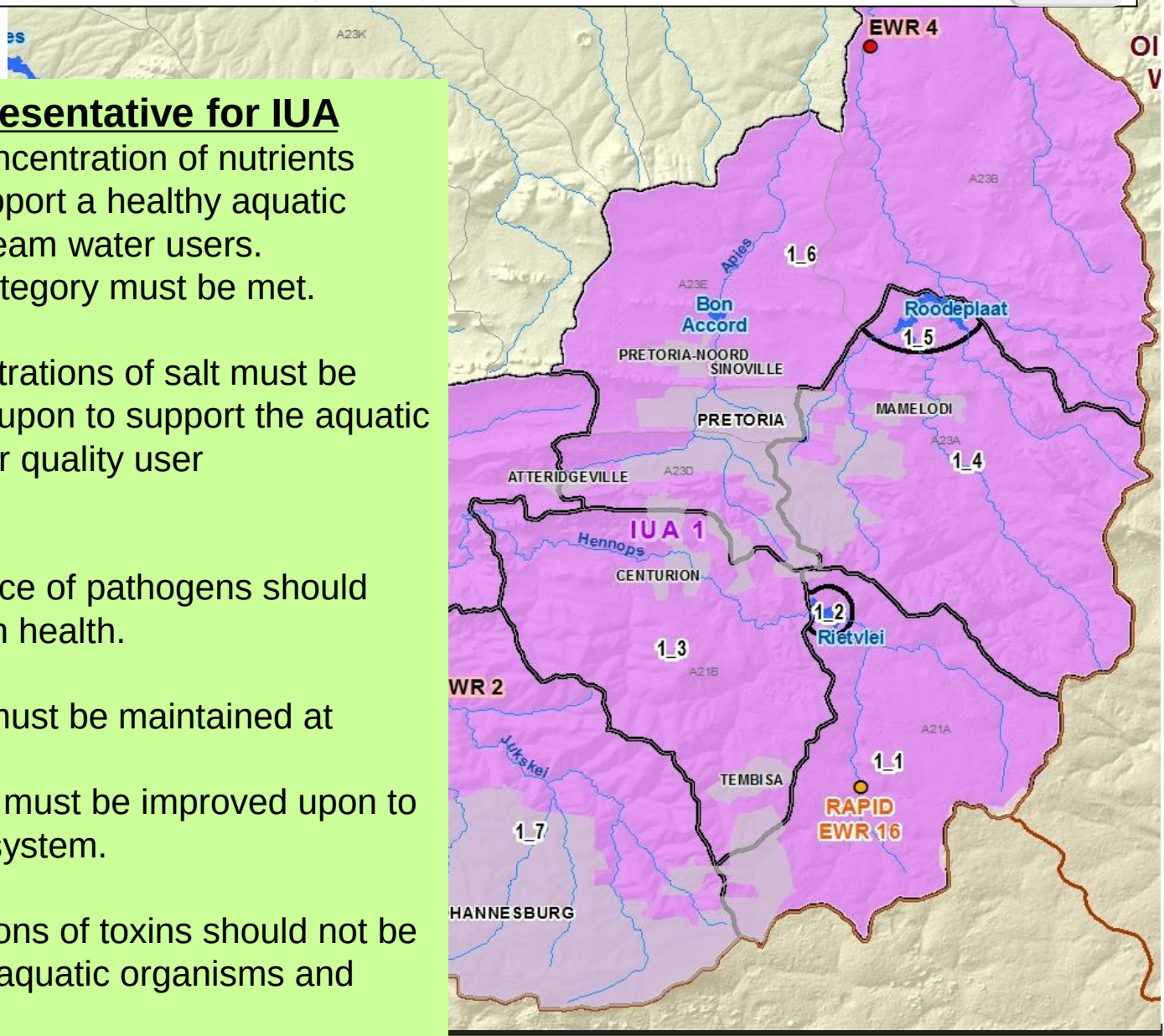
- **Nutrients:** In-stream concentration of nutrients must be improved to support a healthy aquatic ecosystem and downstream water users. Prescribed ecological category must be met.

- **Salts:** In-stream concentrations of salt must be maintained or improved upon to support the aquatic ecosystem and the water quality user requirements.

- **Pathogens:** The presence of pathogens should pose a low risk to human health.

- **System variables**: pH must be maintained at present state.
- Dissolved oxygen levels must be improved upon to support the aquatic ecosystem.

- **Toxics:** The concentrations of toxins should not be at a level that is toxic to aquatic organisms and human health.

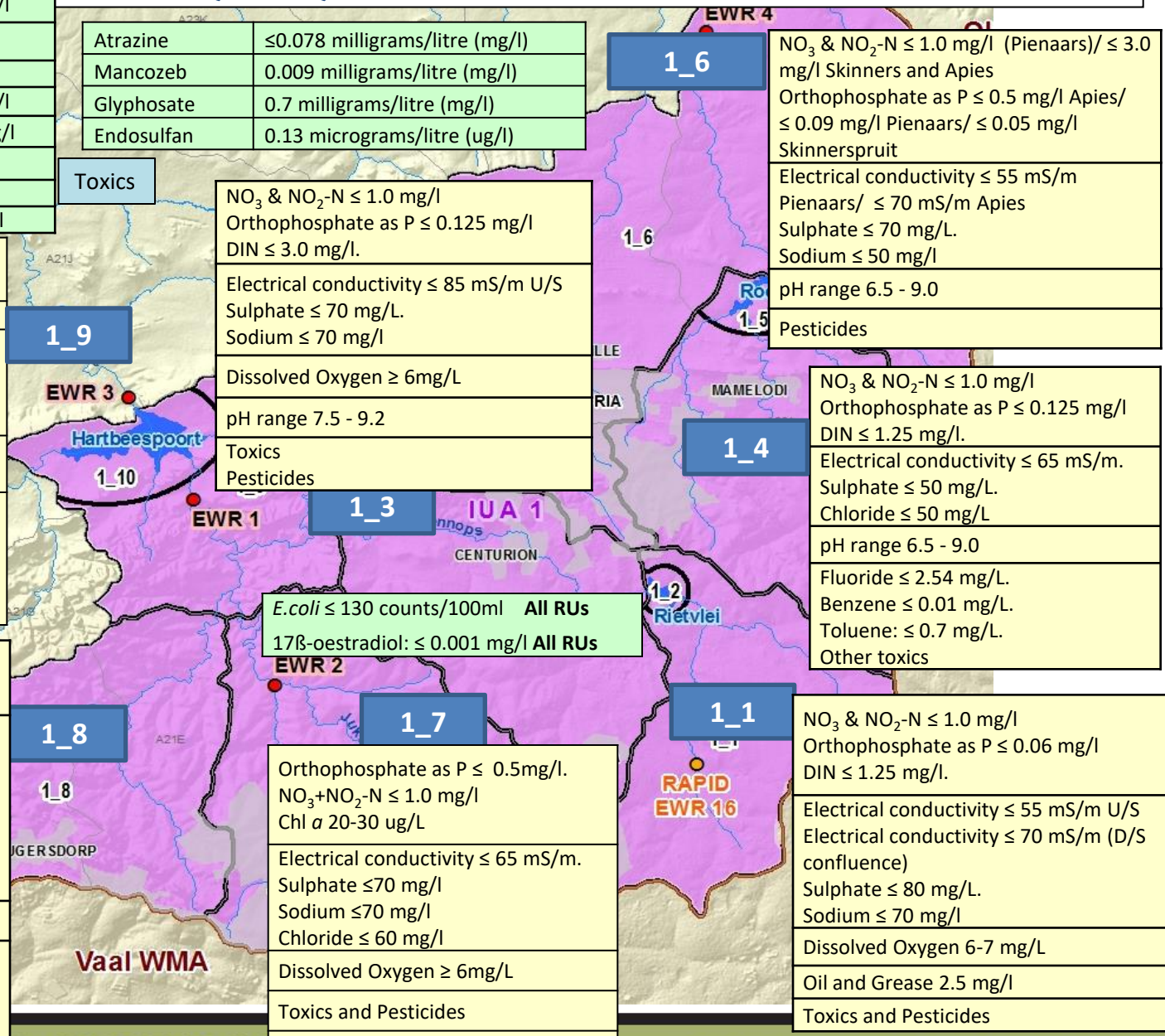


IUA 1: Upper Crocodile/Hennops/Hartbeespoort
RQOs QUALITY - RIVERS

Ammonia as N	≤ 0.0725mg/l	≤ 0.100 mg/l
Aluminium	≤ 0.105 mg/l	≤ 0.150 mg/l
Manganese	≤ 0.15mg/l.	
Iron	≤ 0.1 mg/l.	≤ 0.1 mg/l.
Lead	≤ 0.0095mg/l	≤ 0.013 mg/l
Copper	≤ 0.0073mg/l	≤ 0.0075mg/l
Nickel	≤ 0.07mg/l	≤ 0.07mg/l
Cobalt	≤ 0.05mg/l	≤ 0.05mg/l
Zinc	≤ 0.002mg/l	≤ 0.002mg/l

Atrazine	≤0.078 milligrams/litre (mg/l)
Mancozeb	0.009 milligrams/litre (mg/l)
Glyphosate	0.7 milligrams/litre (mg/l)
Endosulfan	0.13 micrograms/litre (ug/l)

Toxics



NO_3+NO_2-N ≤ 2.0 mg/l
Orthophosphate as P ≤ 0.20 mg/l

pH range 6.5 – 8.5

Electrical conductivity ≤ 75 mS/m.
Sulphate ≤ 75 mg/L.
Sodium ≤ 60 mg/l
Chloride ≤ 60 mg/l

Turbidity - A 10% variation from background concentration should be allowed.

Uranium ≤ 0.03 mg/L.
Cyanide ≤ 0.110 mg/L.
Arsenic: ≤ 0.130 mg/L.
Gross α and Gross β 0.42 Bq/litres
Other Toxics

NO_3 & NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.125 mg/l
DIN ≤ 3.0 mg/l.

Electrical conductivity ≤ 85 mS/m U/S
Sulphate ≤ 70 mg/L.
Sodium ≤ 70 mg/l

Dissolved Oxygen ≥ 6mg/L

pH range 7.5 - 9.2

Toxics
Pesticides

E.coli ≤ 130 counts/100ml **All RUs**

17ß-oestradiol: ≤ 0.001 mg/l **All RUs**

NO_3 & NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.125 mg/l

Electrical conductivity ≤ 45 mS/m (Crocodile (u/s Bloubankspruit)
Bloubankspruit: ≤ 85 mS/m
Sulphate :
Crocodile (u/s Bloubankspruit):≤ 40 mg/L
Bloubankspruit: ≤ 200 mg/L

pH range 6.5 – 8.5

Uranium ≤ 0.03 mg/L.
Cyanide ≤ 0.110 mg/L.
Arsenic: ≤ 0.130 mg/L.
Gross α and Gross β 0.42 Bq/litres
Other Toxics

Orthophosphate as P ≤ 0.5mg/l.
NO_3+NO_2-N ≤ 1.0 mg/l
Chl *a* 20-30 ug/L

Electrical conductivity ≤ 65 mS/m.
Sulphate ≤70 mg/l
Sodium ≤70 mg/l
Chloride ≤ 60 mg/l

Dissolved Oxygen ≥ 6mg/L

Toxics and Pesticides

pH range 6.5 - 9.0

NO_3 & NO_2-N ≤ 1.0 mg/l (Pienaars)/ ≤ 3.0 mg/l Skinners and Apies
Orthophosphate as P ≤ 0.5 mg/l Apies/ ≤ 0.09 mg/l Pienaars/ ≤ 0.05 mg/l Skinnerspruit

Electrical conductivity ≤ 55 mS/m Pienaars/ ≤ 70 mS/m Apies
Sulphate ≤ 70 mg/L.
Sodium ≤ 50 mg/l

pH range 6.5 - 9.0

Pesticides

NO_3 & NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.125 mg/l
DIN ≤ 1.25 mg/l.

Electrical conductivity ≤ 65 mS/m.
Sulphate ≤ 50 mg/L.
Chloride ≤ 50 mg/L

pH range 6.5 - 9.0

Fluoride ≤ 2.54 mg/L.
Benzene ≤ 0.01 mg/L.
Toluene: ≤ 0.7 mg/L.
Other toxics

NO_3 & NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.06 mg/l
DIN ≤ 1.25 mg/l.

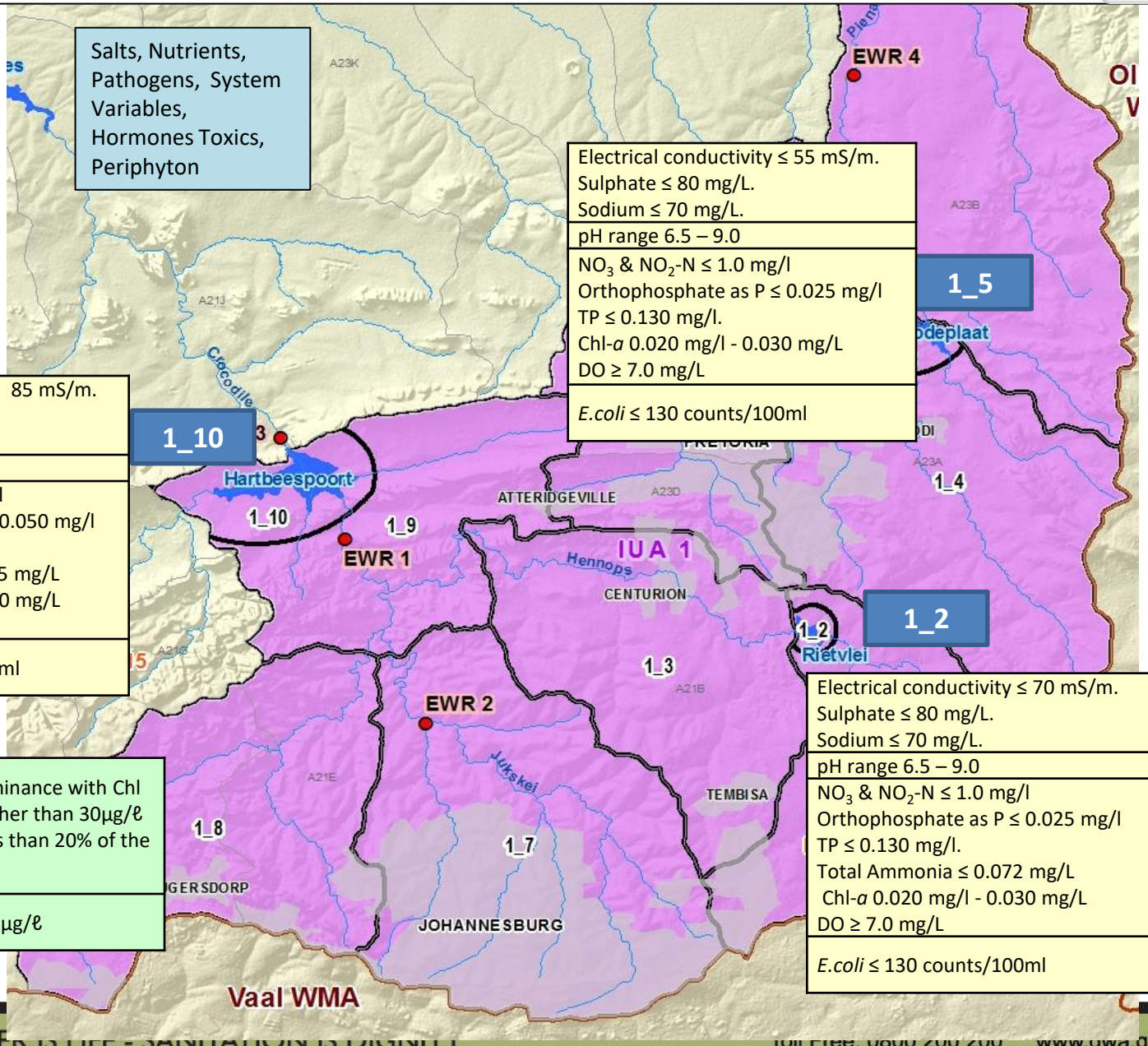
Electrical conductivity ≤ 55 mS/m U/S
Electrical conductivity ≤ 70 mS/m (D/S confluence)
Sulphate ≤ 80 mg/L.
Sodium ≤ 70 mg/l

Dissolved Oxygen 6-7 mg/L

Oil and Grease 2.5 mg/l

Toxics and Pesticides

IUA 1: Upper Crocodile/Hennops/Hartbeespoort
RQOs QUALITY - DAMS

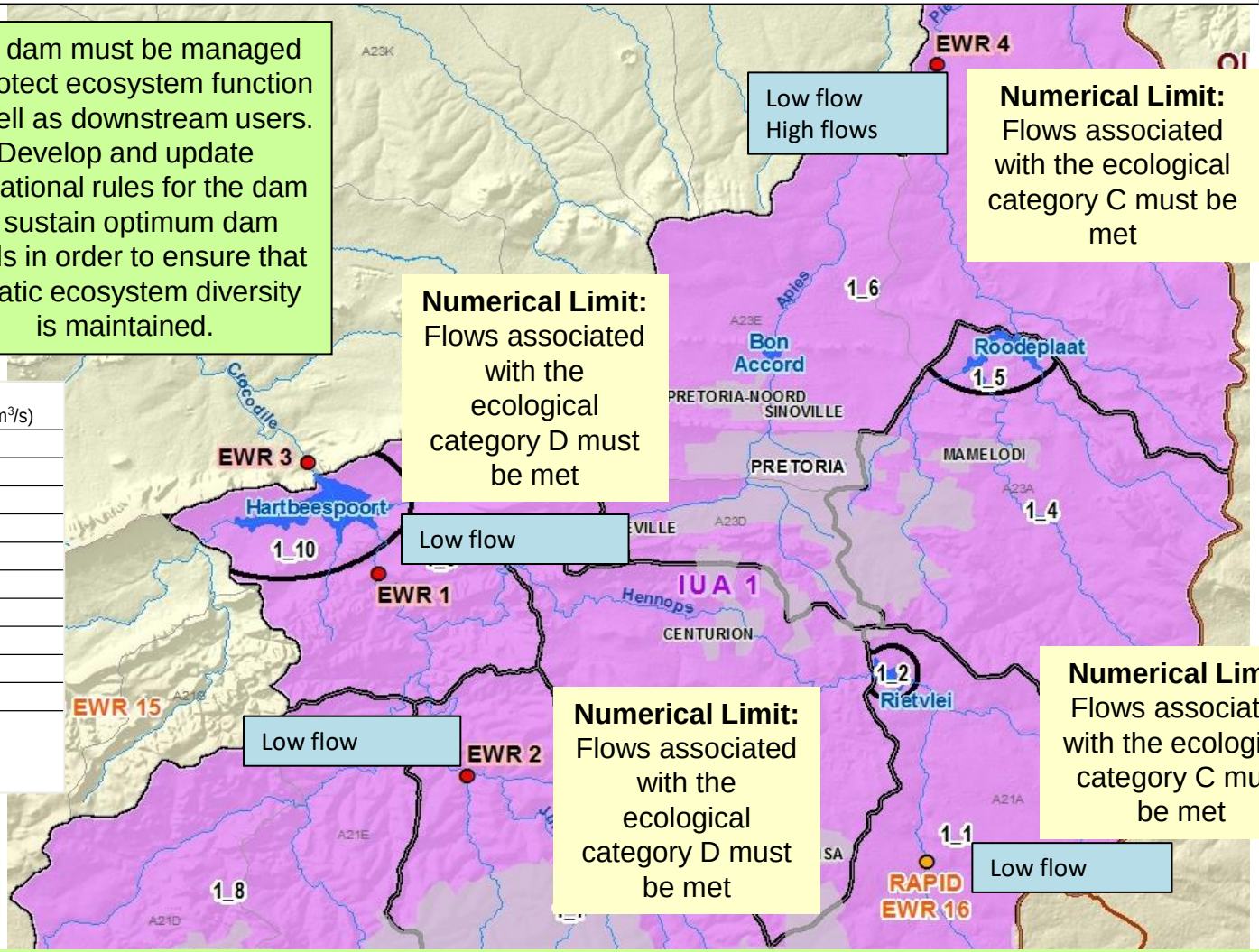


IUA 1: Upper Crocodile/Hennops/Hartbeespoort RQOs QUANTITY

Dam Levels

The dam must be managed to protect ecosystem function as well as downstream users. Develop and update operational rules for the dam to sustain optimum dam levels in order to ensure that aquatic ecosystem diversity is maintained.

Maintenance	Drought
Low flows (m^3/s)	flows (m^3/s)
Oct 1.179	1.179
Nov 1.259	1.259
Dec 1.246	1.246
Jan 1.321	1.321
Feb 1.538	1.538
Mar 1.400	1.400
Apr 1.402	1.402
May 1.334	1.334
Jun 1.368	1.368
Jul 1.313	1.313
Aug 1.279	1.279
Sep 1.244	1.244

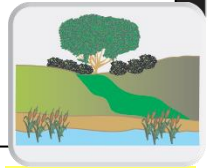


RQOs:FLOWS

Low: The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.

High: The high flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem

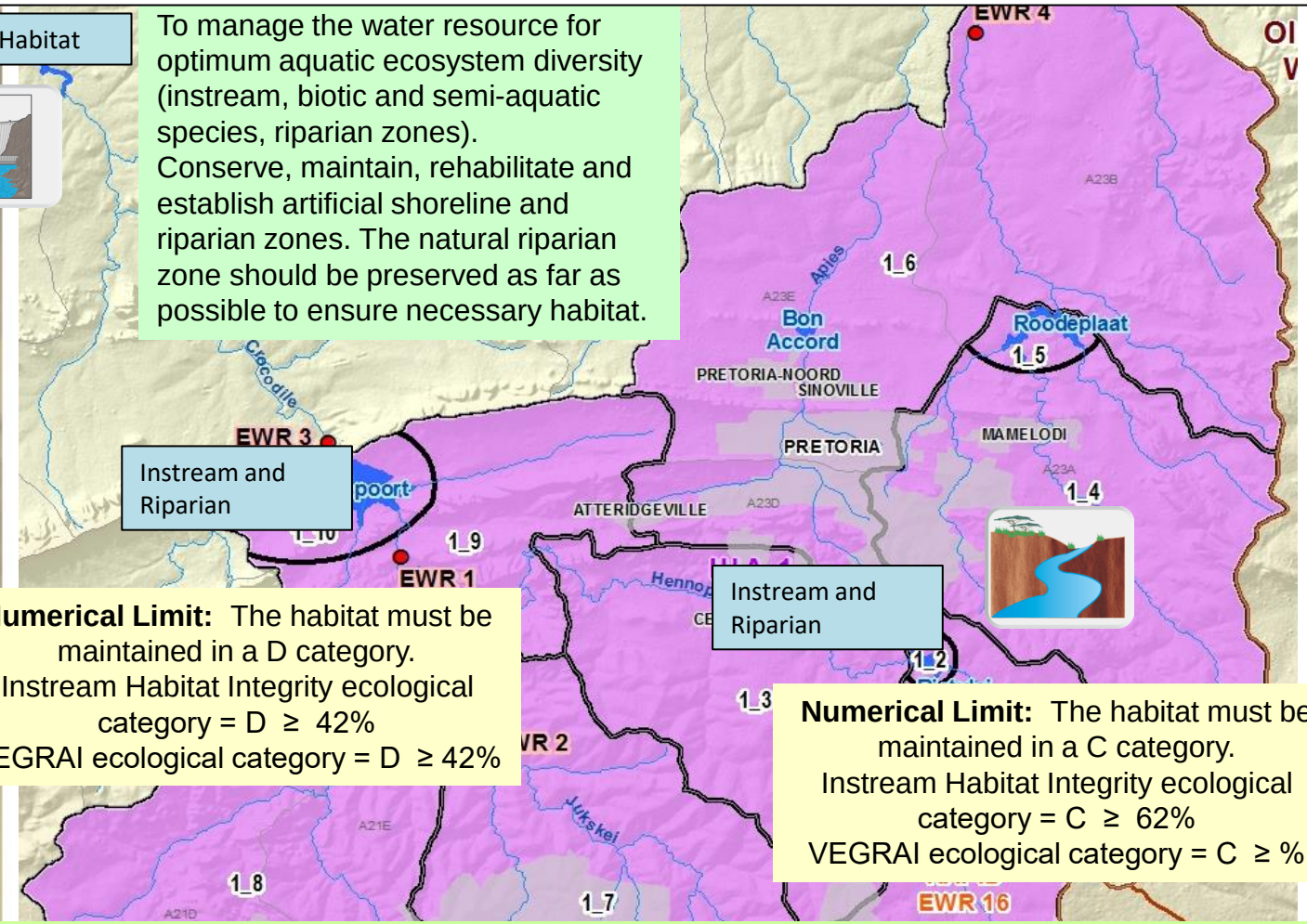
IUA 1: Upper Crocodile/Hennops/Hartbeespoort
RQOs HABITAT – INSTREAM AND RIPARIAN



Habitat

Dam Habitat

To manage the water resource for optimum aquatic ecosystem diversity (instream, biotic and semi-aquatic species, riparian zones).
Conserve, maintain, rehabilitate and establish artificial shoreline and riparian zones. The natural riparian zone should be preserved as far as possible to ensure necessary habitat.



Instream and Riparian

Numerical Limit: The habitat must be maintained in a D category.
Instream Habitat Integrity ecological category = D ≥ 42%
VEGRAI ecological category = D ≥ 42%

Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = C ≥ 62%
VEGRAI ecological category = C ≥ %

RQOs:

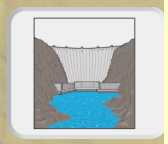
Instream: Habitat diversity should be improved from an E ecological category to a D category. Ecological integrity of system must improve. No further degradation of the instream habitat should occur. General fish habitat availability must be maintained, to sustain biotope diversity

Riparian: Habitat diversity, specifically marginal vegetation must be improved to maintain a D ecological category.

Riparian: Conserve, maintain, rehabilitate and add artificial functional systems in shoreline and riparian zone. Alien invasive control required. Vegetation cover should be maintained at an ecological category D or improved upon.

IUA 1: Upper Crocodile/Hennops/Hartbeespoort
RQOs BIOTA – FISH AND MACROINVERTEBRATES

Dams



Ensure that the diversity and quantities are maintained.
Numerical Limit: The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Target fish stocks should be determined.

Fish

Numerical Limit:
Fish FRAI should be conducted annually to monitor against the prescribed **D** ecological category.

Fish ecology category = D
FRAI ≥ 42%.

Aquatic Invertebrates

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **D** category.

MIRAI D ecological category ≥ 42%
SASS ≥ 55
ASPT ≥ 4.2

Aquatic Invertebrates

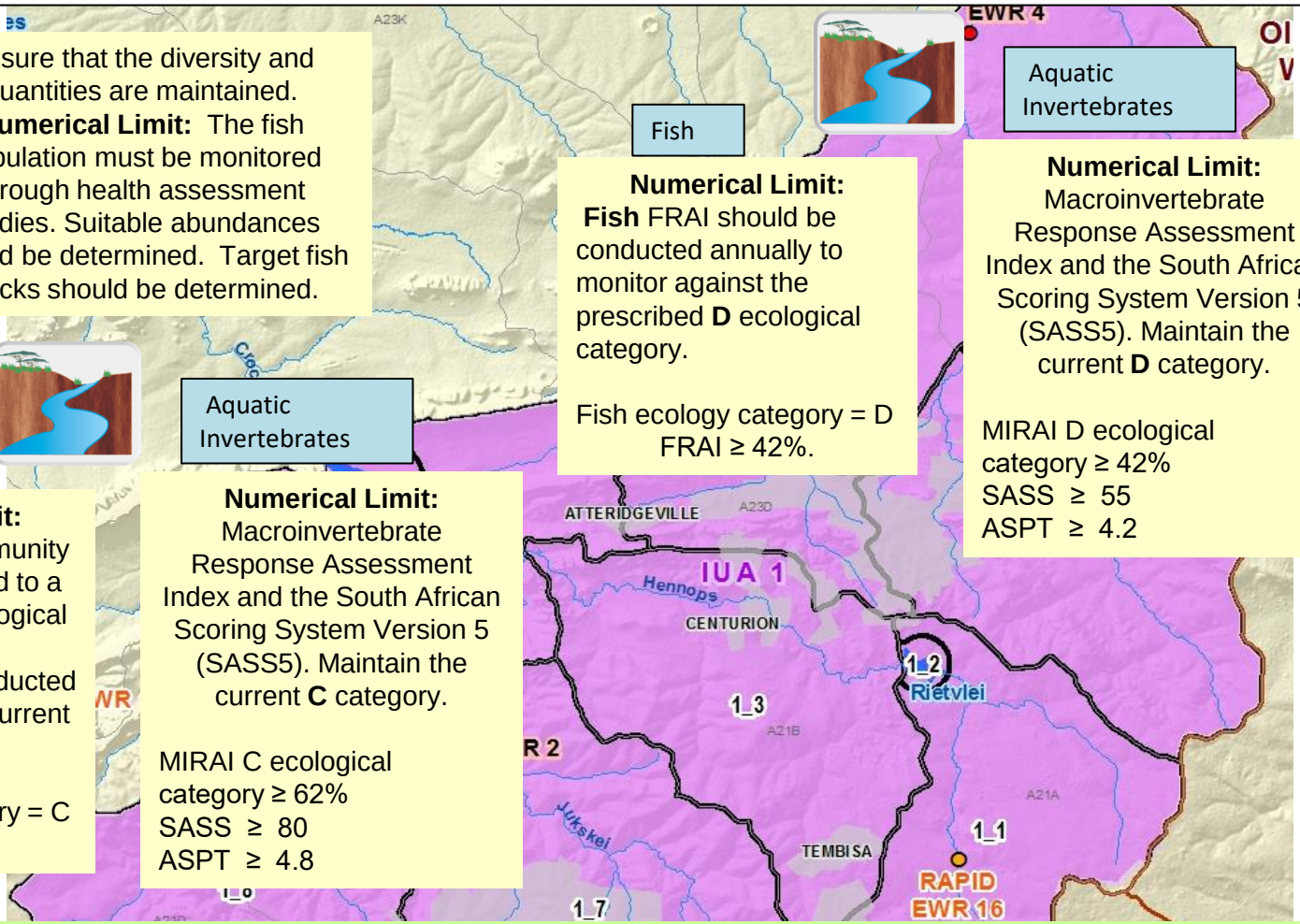
Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **C** category.

MIRAI C ecological category ≥ 62%
SASS ≥ 80
ASPT ≥ 4.8

Fish

Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of **C.**
FRAI should be conducted to monitor against current category.

Fish ecology category = C
FRAI ≥ 62%.



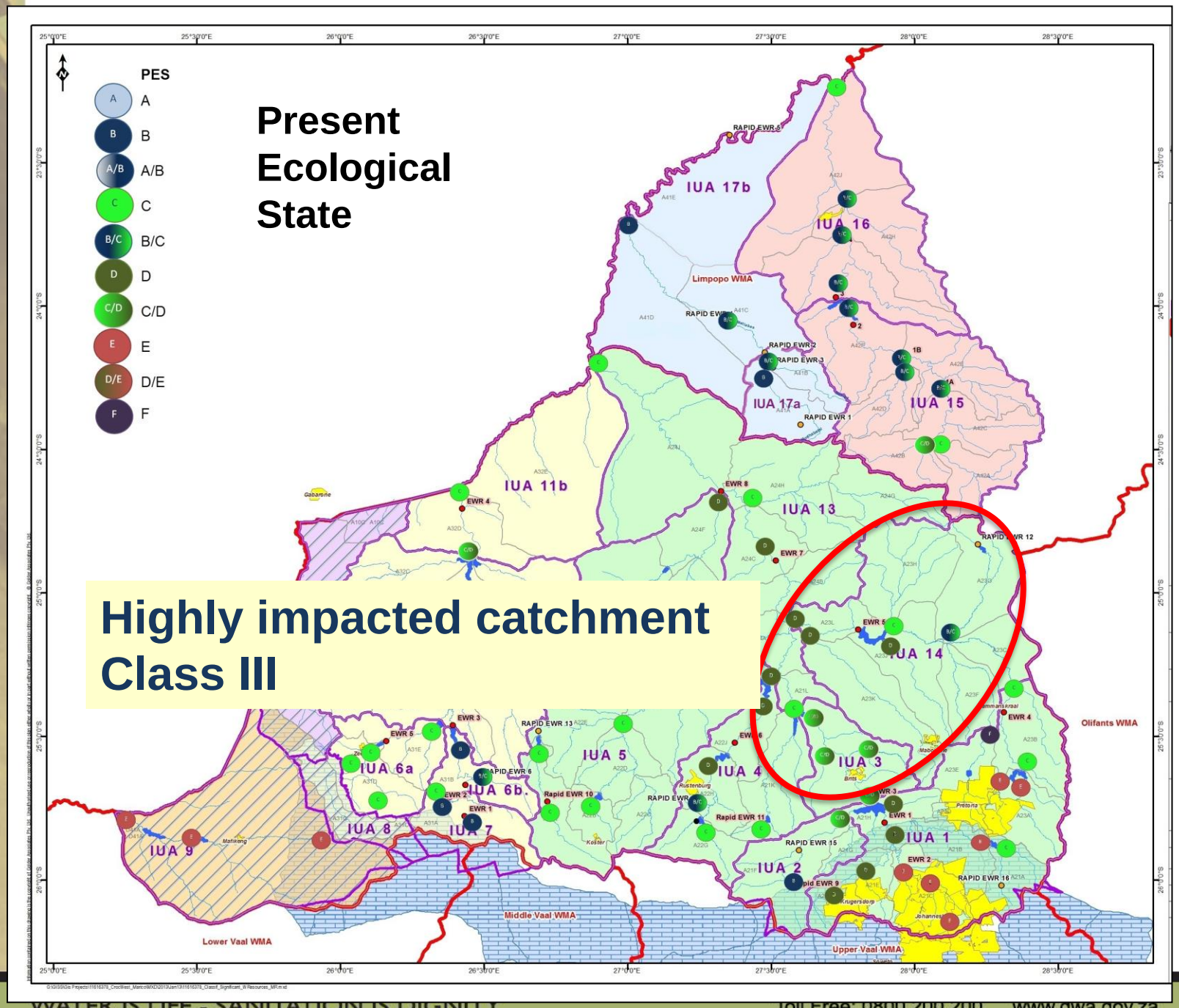
RQOs: (representative)

Fish (1_9) : Fish community should be maintained at a D ecological category or improved upon. Habitat and water quality improvement required for *CFLA* and flow should be adequate for flow dependant spp. BMAR, BPOL, CPRE

Fish (1_8): The fish community should be managed to the prescribed ecological category D ecological category or improved upon. Habitat requirements for *BMOT* (vegetation) and substrate and flow for *CPRE* must be met

Macro-invertebrates: Macroinvertebrate assemblage must be maintained within a D ecological category or improved upon.

Semi-aquatic biota: The suitability of this stretch of river to serve as a habitat and migration corridor for aquatic bird and mammal populations must be maintained through proper habitat management.

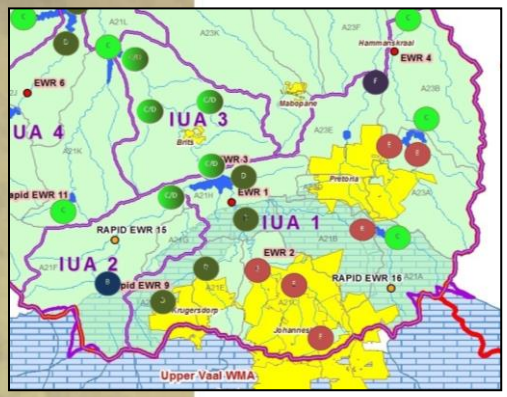

PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
Highly impacted catchment Class III
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 11b
IUA 13
IUA 14
IUA 5
IUA 6a
IUA 6b
IUA 4
IUA 3
IUA 8
IUA 7
IUA 9
IUA 1
IUA 2
Limpopo WMA
Olifants WMA
Lower Vaal WMA
Middle Vaal WMA
Upper Vaal WMA

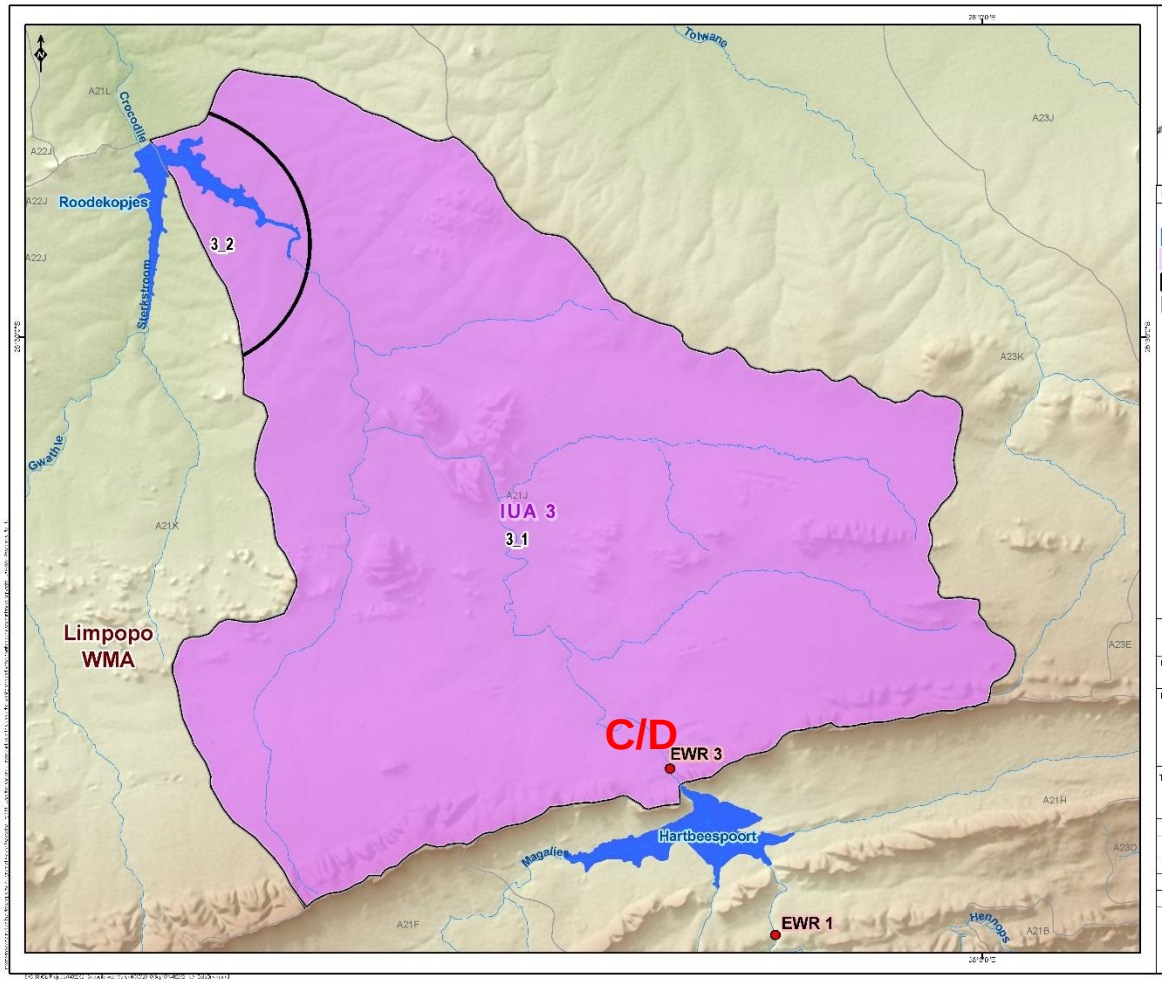
Highly impacted catchment

IUA 3: CROCODILE/ROODEKOPJES CATCHMENT

Management Class: III

Ecological Category: C/D



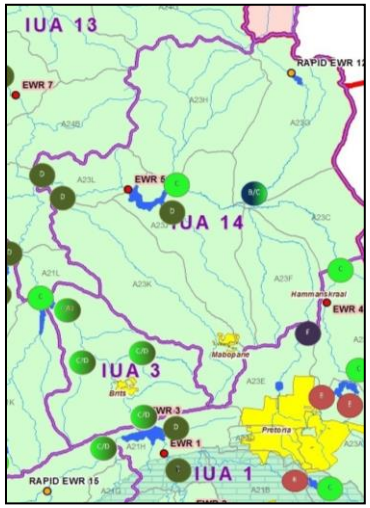


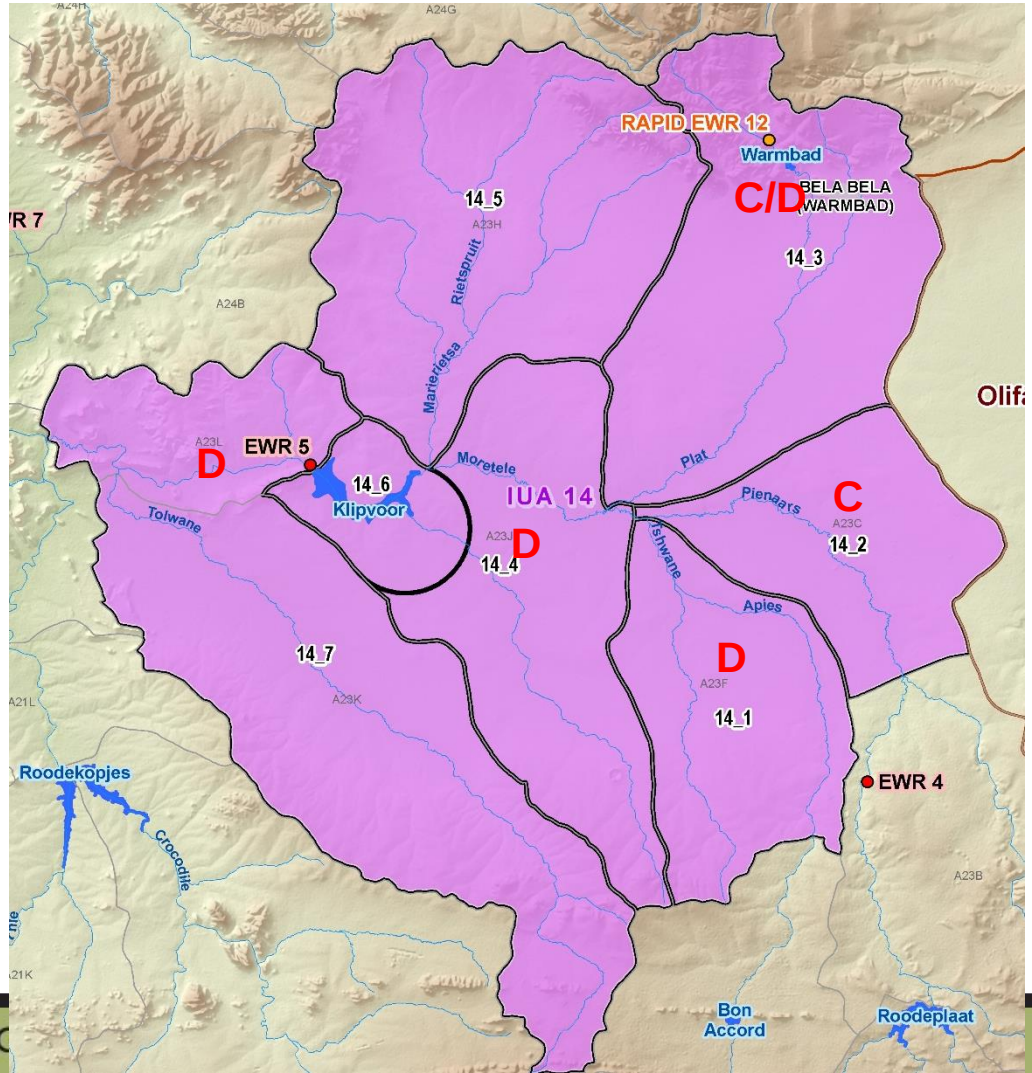
IUA 14: TOLWANE/KULWANE/MORETELE/KLIPVOOR

Quaternary Catchments: A23F – A23L

Management Class: III

Ecological Category: D

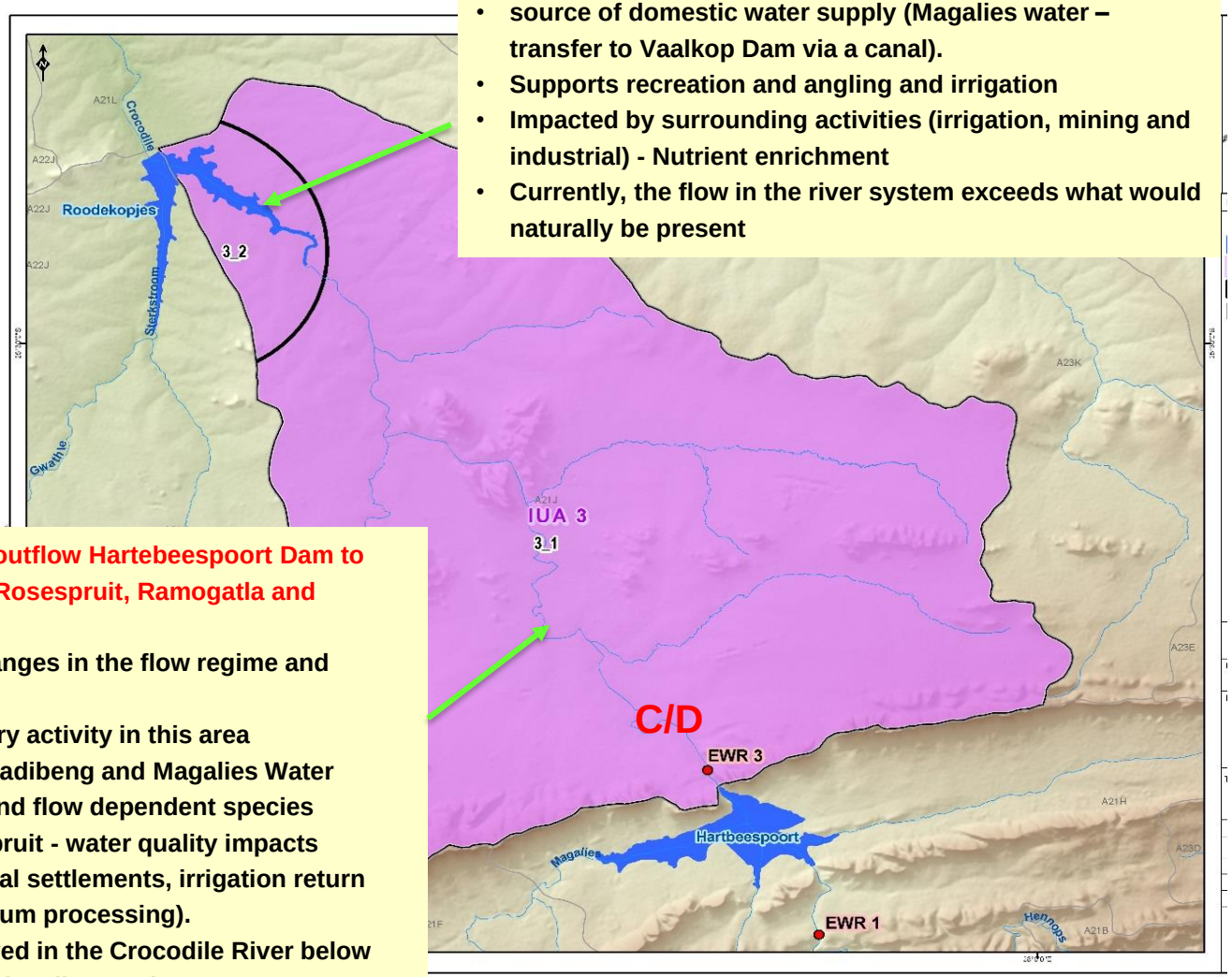




IUA 3: CROCODILE/ROODEKOPJES CATCHMENT

3_2: Roodekopjes Dam

- source of domestic water supply (Magalies water – transfer to Vaalkop Dam via a canal).
- Supports recreation and angling and irrigation
- Impacted by surrounding activities (irrigation, mining and industrial) - Nutrient enrichment
- Currently, the flow in the river system exceeds what would naturally be present



3_1: Crocodile River from outflow Hartebeespoort Dam to inflow Roodekopjes Dam, Rosespruit, Ramogatla and Kareespruit

- Impacted due to the changes in the flow regime and discharges/runoff
- Agriculture is the primary activity in this area
- Direct abstraction by Madibeng and Magalies Water
- Sensitive fish species and flow dependent species
- Rosespruit and Kareespruit - water quality impacts (mining impacts, informal settlements, irrigation return flows, industrial, vanadium processing).
- Hyacinth growth observed in the Crocodile River below Brits. Encroachment and sedimentation.

IUA 14: TOLWANE/KULWANE/MORETELE/KLIPVOOR

14_6: Klipvoor Dam

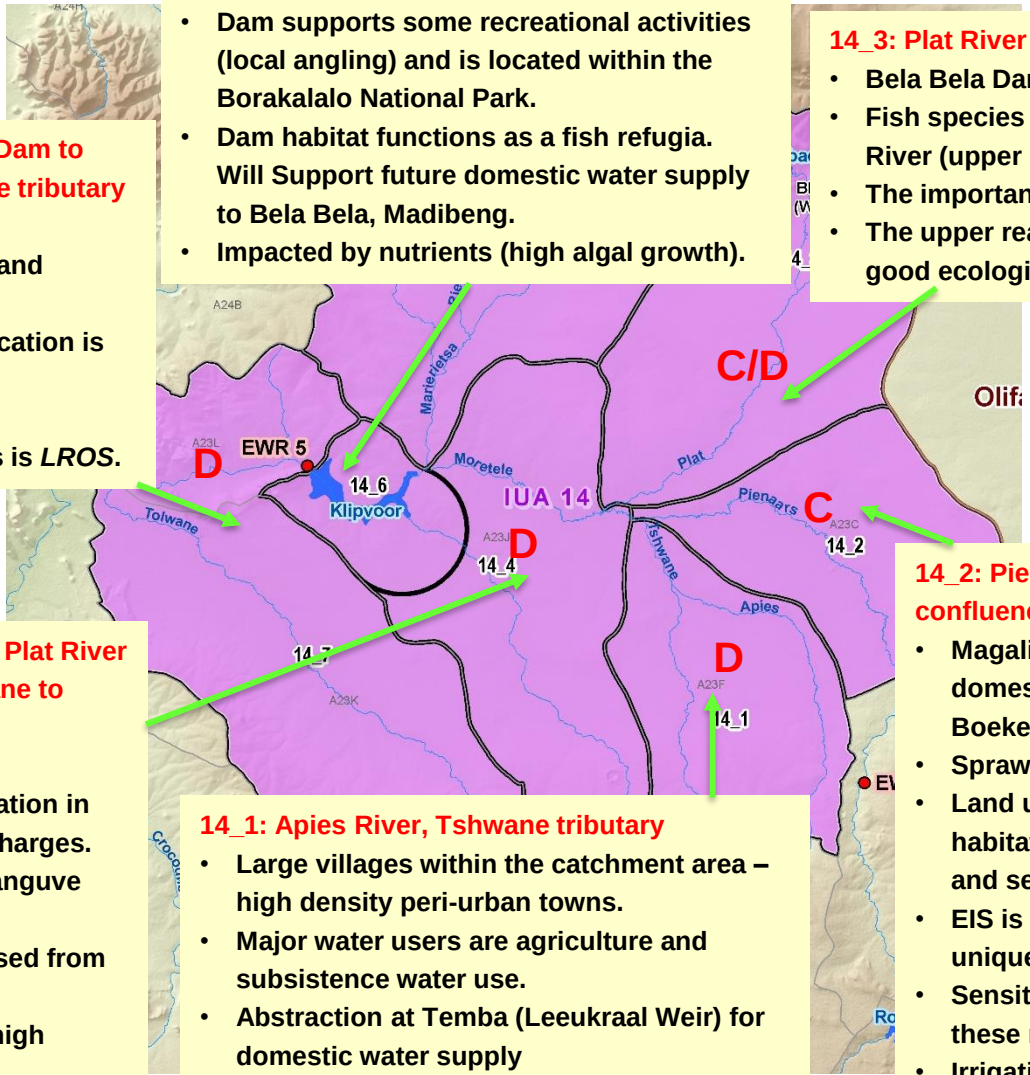
- Dam supports some recreational activities (local angling) and is located within the Borakalalo National Park.
- Dam habitat functions as a fish refugia. Will Support future domestic water supply to Bela Bela, Madibeng.
- Impacted by nutrients (high algal growth).

14_3: Plat River

- Bela Bela Dam supplies water to the town.
- Fish species (*CTHE*) occurs within the Plat River (upper reaches).
- The important Plat river floodplain occurs.
- The upper reaches of the Plat river are in good ecological condition.

14_7: Pienaars River from Klipvoor Dam to Crocodile River confluence, Tolwane tributary

- EWR site 5 on the Pienaars River
- Impacted by urban development and irrigated agriculture.
- High nutrient levels and eutrophication is evident. Extensive sand mining
- Aquatic weeds also present.
- An additional unique fish species is *LROS*.



14_4: Moretele (Pienaars) River from Plat River confluence to Klipvoor Dam, Kutswane to Klipvoor Dam

- Water quality impacts - result of urbanization, specifically deterioration in water quality due to WWTWs discharges.
- Increased development in Shoshanguve and Winterland.
- Currently too much water is released from the Rietgat WWTW.
- Moretele floodplain present with high biodiversity.
- Tswaing crater (unique endorhic wetland system).
- Top minnow fish species present which also occur within wetland systems.

14_1: Apies River, Tshwane tributary

- Large villages within the catchment area – high density peri-urban towns.
- Major water users are agriculture and subsistence water use.
- Abstraction at Temba (Leeukraal Weir) for domestic water supply
- Water quality issues are prevalent, due to localised and upstream urban impacts.
- Wetland systems are important (Apies River floodplain is present)..

14_2: Pienaars River from Boekenshout confluence to Apies River confluence

- Magalies Water abstracts water for domestic supply on Boekenshoutspruit (Klipdrift).
- Sprawling peri-urban villages.
- Land use impacts- cattle in river habitat, and impacts from solid waste and sewage effluent.
- EIS is high due to the presence of the unique fish species
- Sensitive invertebrates also reside in these reaches.
- Irrigation activities occur downstream. Wetland priority area.
- Moretele floodplain present with high biodiversity and important bird habitat.

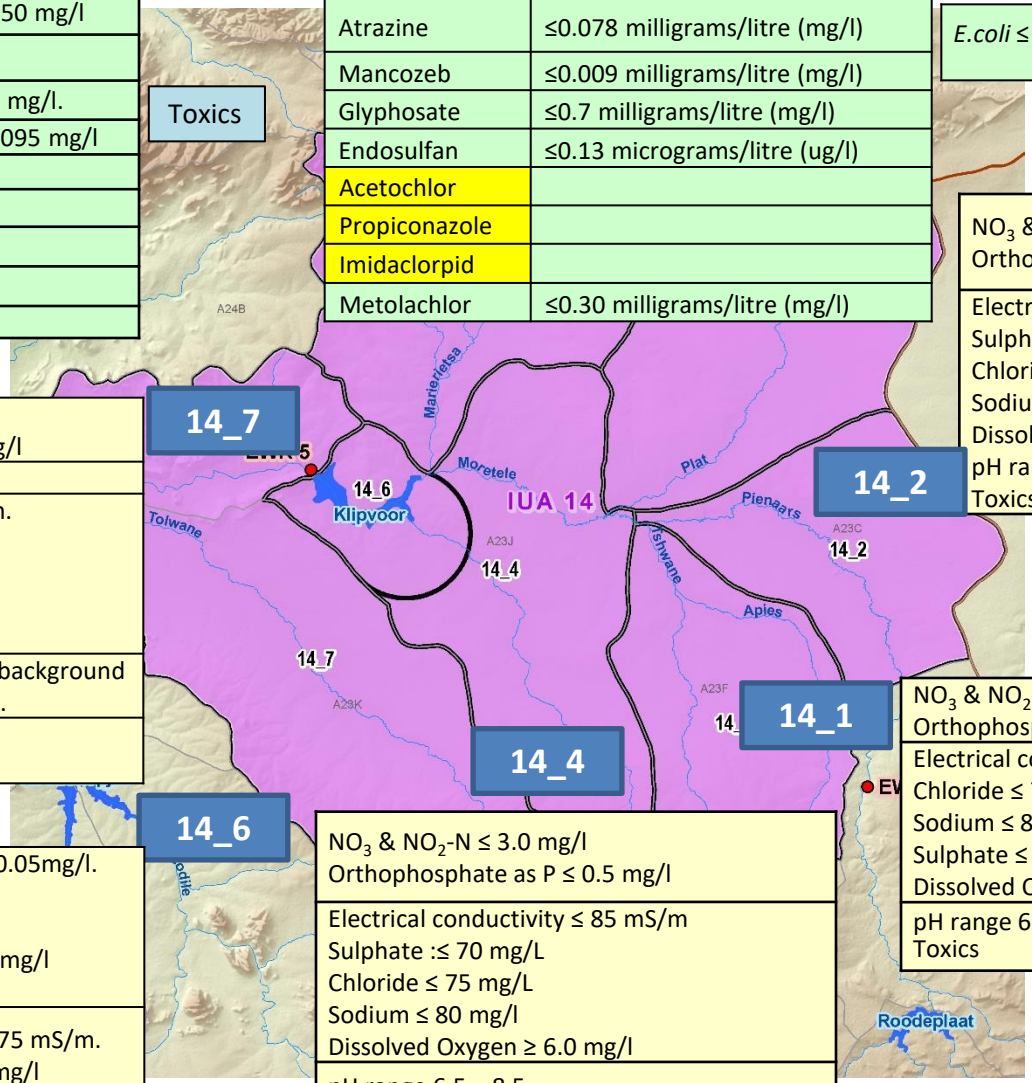
IUA 14: Tolwane/Kulwane/Moretele/Klipvoor
RQOs QUALITY

Ammonia as N	≤ 0.0725mg/l	≤ 0.100 mg/l
Aluminium	≤ 0.062 mg/l	≤ 0.150 mg/l
Manganese	≤ 0.15mg/l.	
Iron	≤ 0.1 mg/l.	≤ 0.3 mg/l.
Lead	≤ 0.0013mg/l	≤ 0.0095 mg/l
Cobalt	≤ 0.05 mg/l	
Copper	≤ 0.0073mg/l	
Nickel	≤ 0.07mg/l	
Zinc	≤ 0.002mg/l	
Chromium (IV)	≤ 0.2mg/l	

Toxics

Atrazine	≤0.078 milligrams/litre (mg/l)
Mancozeb	≤0.009 milligrams/litre (mg/l)
Glyphosate	≤0.7 milligrams/litre (mg/l)
Endosulfan	≤0.13 micrograms/litre (ug/l)
Acetochlor	
Propiconazole	
Imidaclorpid	
Metolachlor	≤0.30 milligrams/litre (mg/l)

E.coli ≤ 130 counts/100ml **All RUs**



14_7

NO_3+NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.060 mg/l

pH range 6.5 – 8.5

Electrical conductivity ≤ 75 mS/m.
Sulphate ≤ 60 mg/l
Chloride ≤ 70 mg/l
Sodium ≤ 100 mg/l
Dissolved Oxygen ≥ 6.0 mg/l

Turbidity - A 10% variation from background concentration should be allowed.

Pesticides

14_2

NO_3 & NO_2-N ≤ 0.7 mg/l
Orthophosphate as P ≤ 0.090 mg/l

Electrical conductivity ≤ 55 mS/m.
Sulphate ≤ 50 mg/L.
Chloride ≤ 50 mg/L.
Sodium ≤ 70 mg/l
Dissolved Oxygen ≥ 6.0 mg/l
pH range 6.5 – 8.5
Toxics

14_1

NO_3 & NO_2-N ≤ 3.0 mg/l
Orthophosphate as P ≤ 0.05 mg/l

Electrical conductivity ≤ 80 mS/m U/S
Chloride ≤ 75 mg/L.
Sodium ≤ 80 mg/l
Sulphate ≤ 70 mg/L
Dissolved Oxygen ≥ 6.0 mg/l

pH range 6.5 – 8.5
Toxics

14_4

NO_3 & NO_2-N ≤ 3.0 mg/l
Orthophosphate as P ≤ 0.5 mg/l

Electrical conductivity ≤ 85 mS/m
Sulphate :≤ 70 mg/L
Chloride ≤ 75 mg/L
Sodium ≤ 80 mg/l
Dissolved Oxygen ≥ 6.0 mg/l

pH range 6.5 – 8.5

14_6

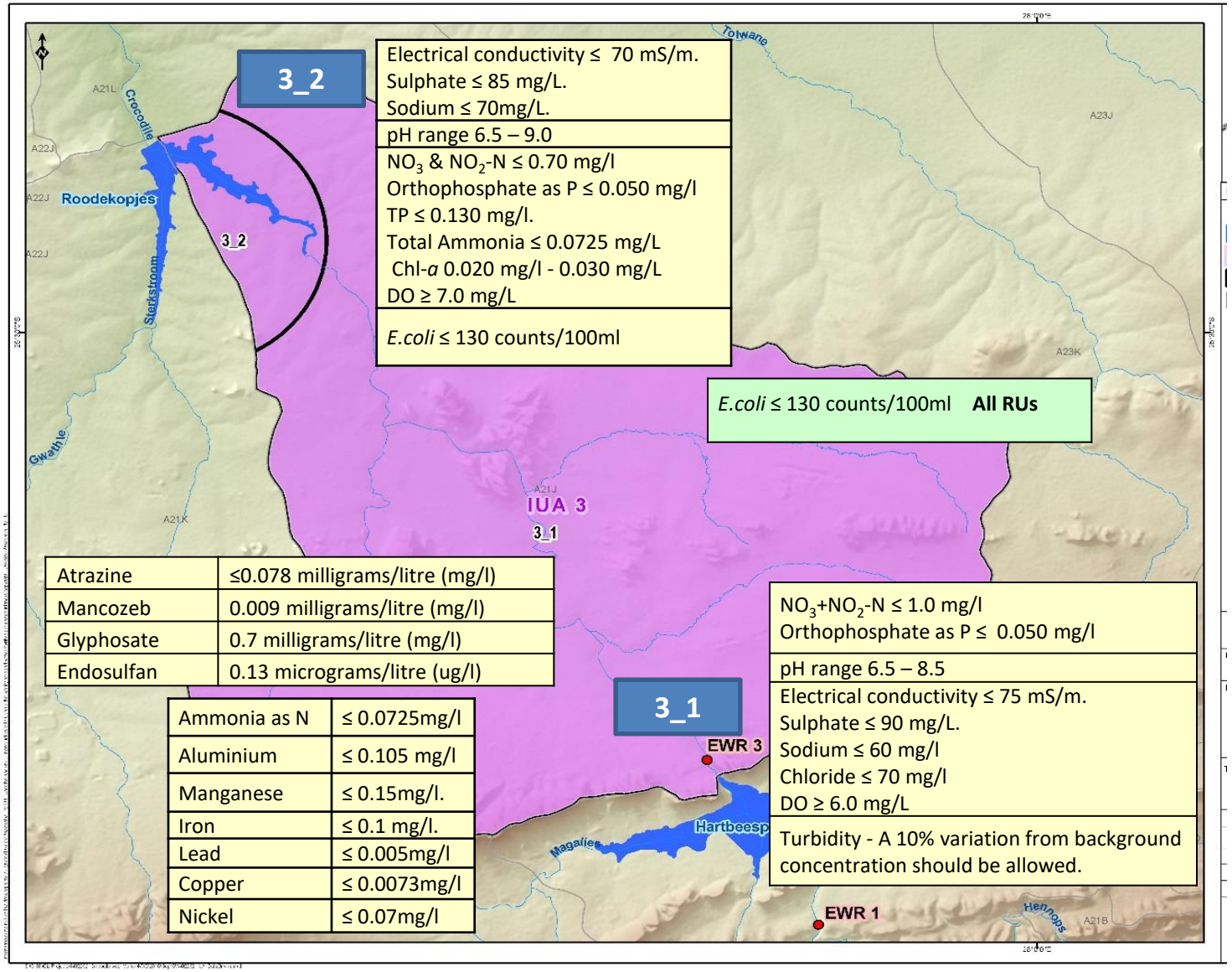
Orthophosphate as P ≤ 0.05mg/l.
NO_3+NO_2-N ≤ 1.0 mg/l
TP: ≤ 0.130 mg/l
Total Ammonia: ≤ 0.072 mg/l
Chl *a* 20-30 ug/L

Electrical conductivity ≤ 75 mS/m.
Dissolved Oxygen ≥ 7.0 mg/l
Turbidity ≥ 0.4 m

Toxics and Pesticides

pH range 6.5 – 9.0

IUA 3: Crocodile/Roodekopjes
RQOs QUALITY – Rivers and Dam

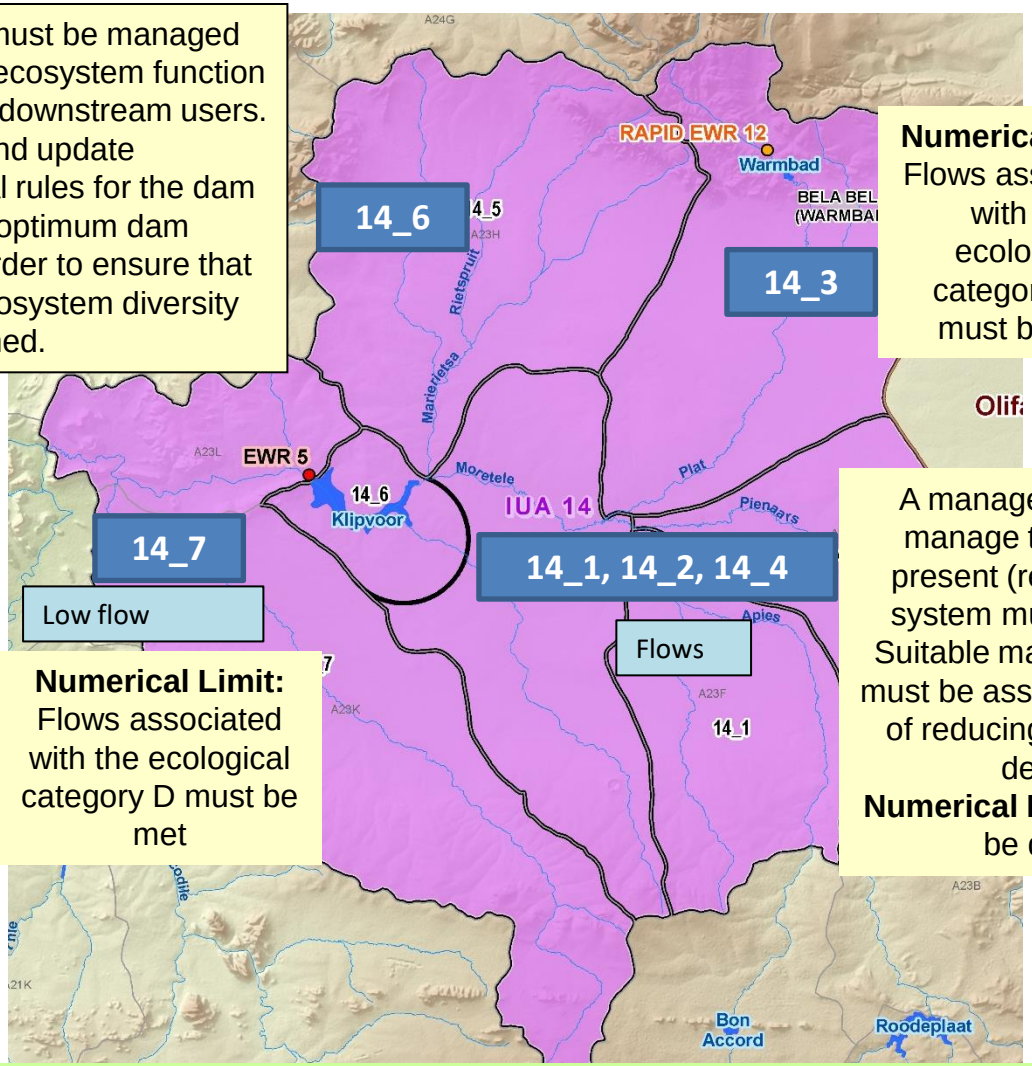


IUA 14: Tolwane/Kulwane/Moretele/Klipvoor RQOs QUANTITY

Dam Level

The dam must be managed to protect ecosystem function as well as downstream users. Develop and update operational rules for the dam to sustain optimum dam levels in order to ensure that aquatic ecosystem diversity is maintained.

	Maintenance Low flows (m^3/s)	Drought flows (m^3/s)
Oct	1.179	1.179
Nov	1.259	1.259
Dec	1.246	1.246
Jan	1.321	1.321
Feb	1.538	1.538
Mar	1.400	1.400
Apr	1.402	1.402
May	1.334	1.334
Jun	1.368	1.368
Jul	1.313	1.313
Aug	1.279	1.279
Sep	1.244	1.244



Numerical Limit: Flows associated with the ecological category C/D must be met

Numerical Limit: Flows associated with the ecological category D must be met

A management strategy to manage the excess water present (return flows) in the system must be developed. Suitable management options must be assessed. The benefits of reducing the flow must be determined.
Numerical Limit: Low flows to be determined

RQOs: FLOWS

Low: The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.

IUA 14: Tolwane/Kulwane/Moretele/Klipvoor
RQOs BIOTA – FISH AND MACROINVERTEBRATES

Fish

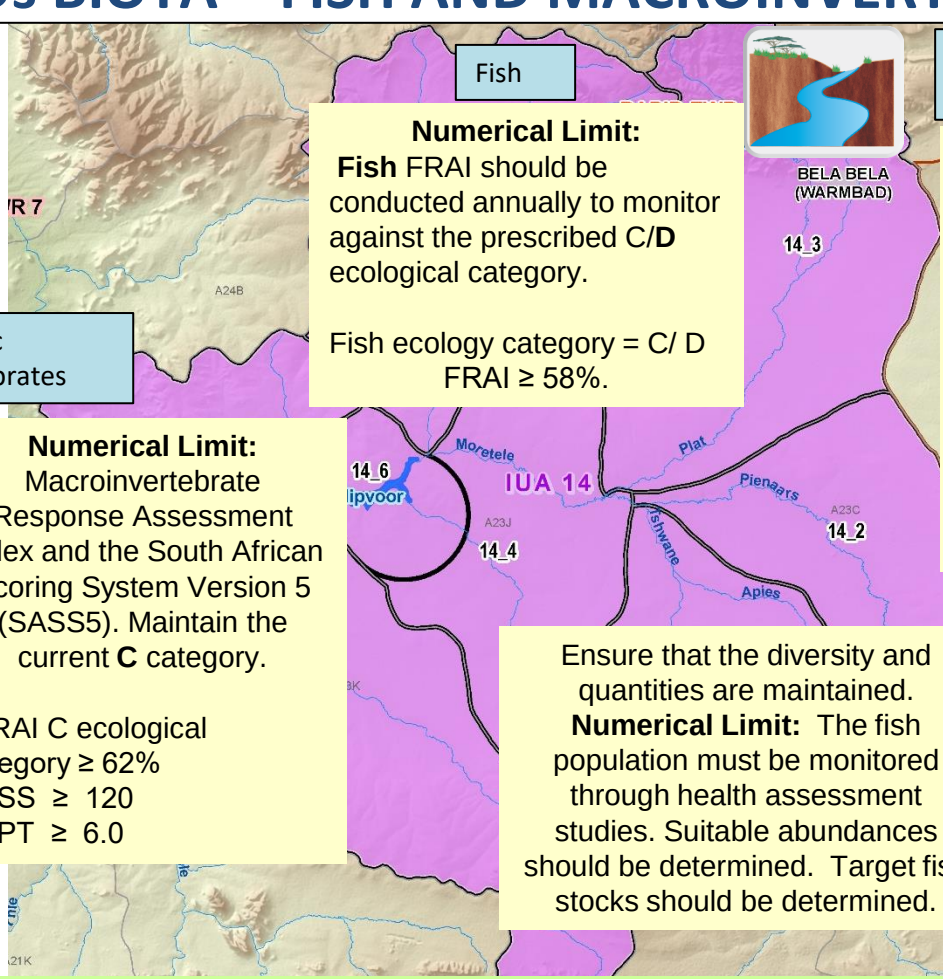
Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of **C.**
FRAI should be conducted to monitor against current category.

Fish ecology category = C
FRAI ≥ 62%.
B/C FRAI ≥ 78%.

Aquatic Invertebrates

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **C** category.

MIRAI C ecological category ≥ 62%
SASS ≥ 120
ASPT ≥ 6.0



Fish

Numerical Limit:
Fish FRAI should be conducted annually to monitor against the prescribed C/**D** ecological category.

Fish ecology category = C/ D
FRAI ≥ 58%.

Aquatic Invertebrates

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **D** category.

MIRAI D ecological category ≥ 42%
SASS ≥ 70
ASPT ≥ 4.2

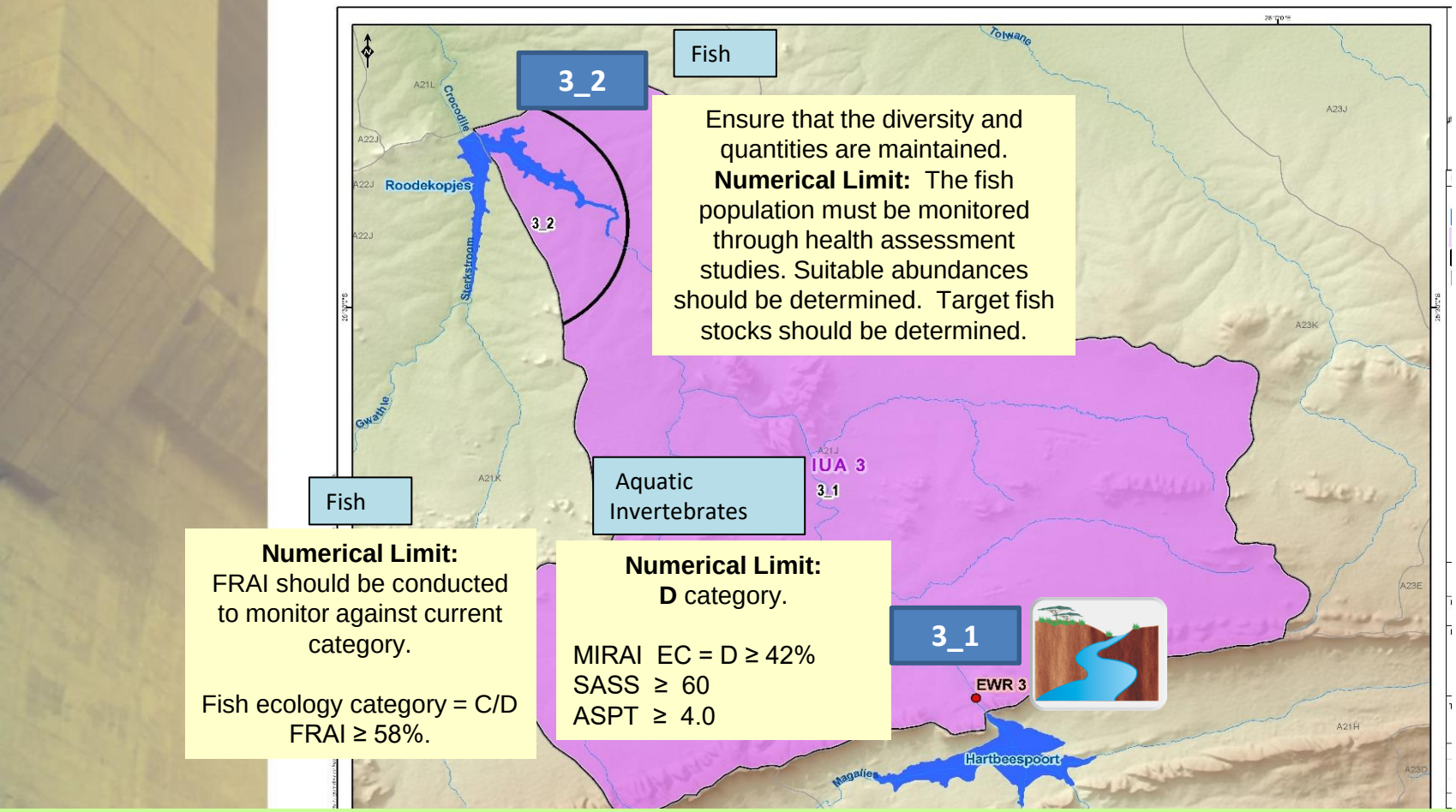
Ensure that the diversity and quantities are maintained.
Numerical Limit: The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Target fish stocks should be determined.

Dams

RQOs: (representative)

Fish (14_3): Fish community should be improved from a D ecological category to a C/D category. Maintain flow velocity/depth for fish species *LCYL* and *LMOL* and habitat sensitive species, *MBRE* and *BBR.* Isolated populations of *CTHE* in upper reaches of river must also be maintained.
Macro-invertebrates: Macroinvertebrate assemblage must be maintained within a D ecological category or improved upon.
Semi-aquatic biota (14_2): Habitat in Moretele Floodplain must be maintained. The stretch of river to serve as a habitat for aquatic bird and mammal populations must be maintained through proper habitat management. Maintain good riparian cover for otters. Maintain riparian zone as important bird habitat..

IUA 3: Crocodile/Roodekopjes
RQOs BIOTA – FISH AND MACROINVERTEBRATES

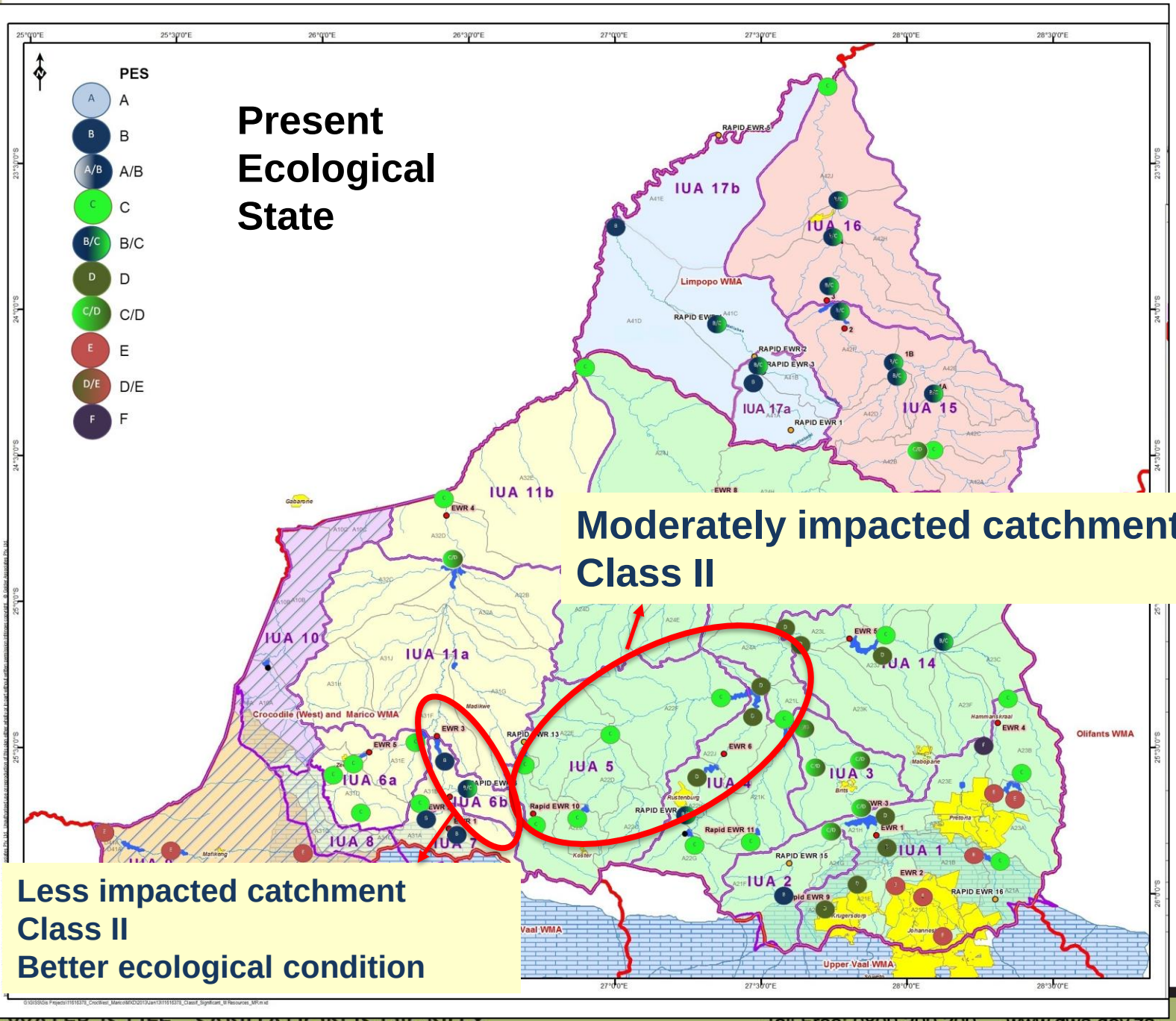


RQOs: (narrative)

Fish (3_1) Fish community should be improved from a D ecological category to a C/D category. Regulated seasonality required to accommodate flow sensitive fish species.

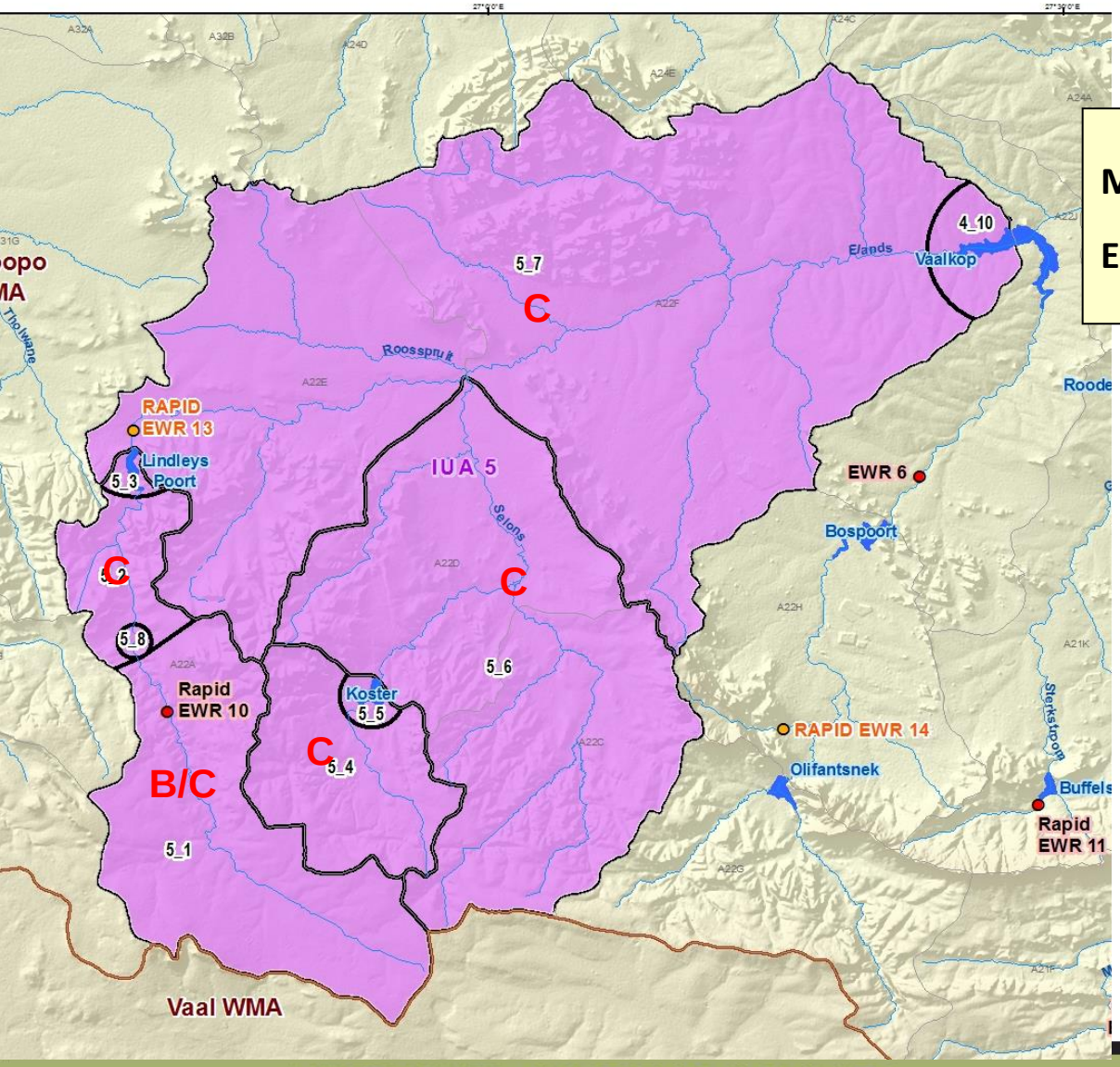
Macro-invertebrates: Macroinvertebrate assemblage must be maintained within a D ecological category or improved upon.

Semi-aquatic biota: The suitability of this stretch of river to serve as a habitat and migration corridor for aquatic bird and mammal populations must be maintained through proper habitat management.


PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 11b
IUA 10
IUA 11a
IUA 6a
IUA 6b
IUA 8
IUA 7
IUA 5
IUA 4
IUA 3
IUA 14
IUA 1
IUA 2
Limpopo WMA
Crocodile (West) and Marico WMA
Olifants WMA
Vaal WMA
Upper Vaal WMA
Moderately impacted catchment
Class II
Less impacted catchment
Class II
Better ecological condition

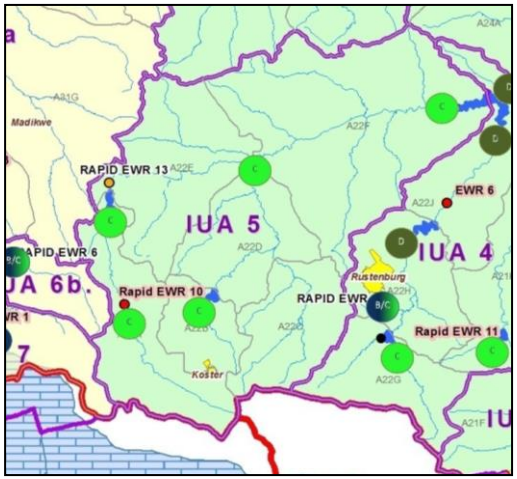
Moderately impacted catchment

IUA 5: ELANDS/VAALKOP



Management Class: II

Ecological Category: C

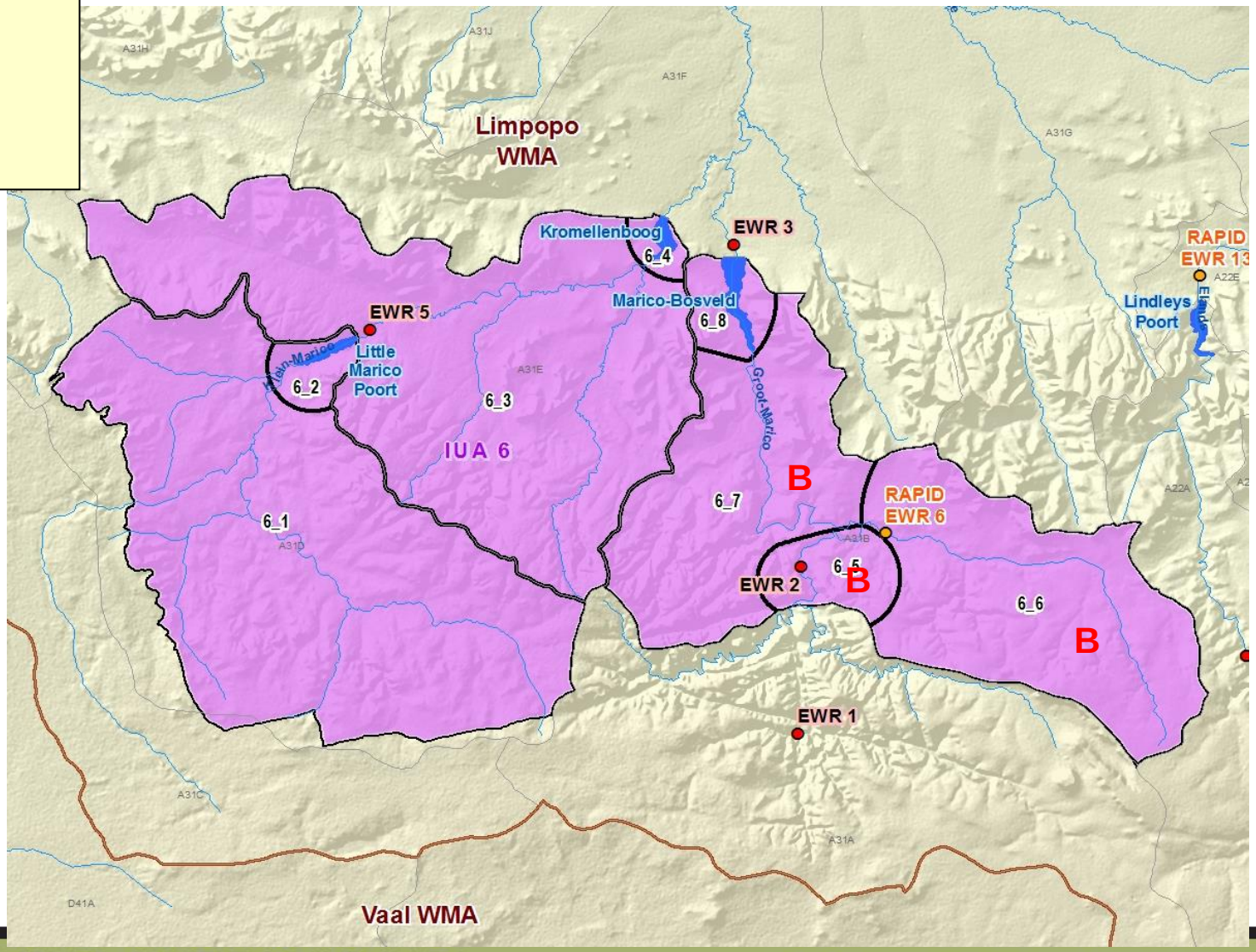


IUA 6b: GROOT MARICO

Less impacted catchment, Good ecological State

Management Class: II

Ecological Category: B



IUA 5: ELANDS/VAALKOP

5_3: Lindleyspoort Dam

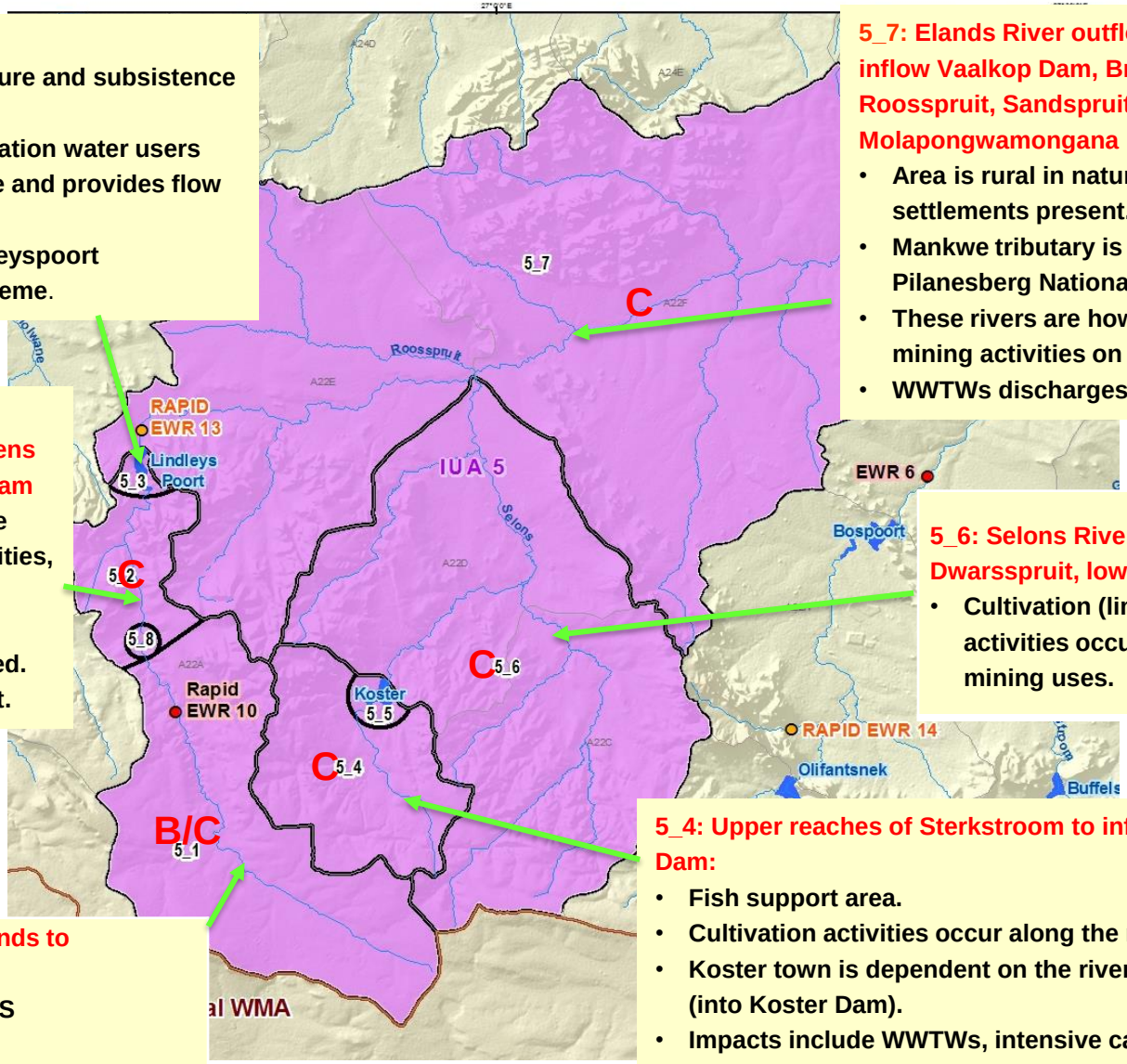
- Surrounded by agriculture and subsistence farming
- Primarily supports irrigation water users and some domestic use and provides flow regulating capacity.
- Forms part of the Lindleyspoort Government Water Scheme.

5_2: Elands river downstream Swartruggens Dam to Lindleyspoort Dam

- Impacted upon by the WWTWs, urban activities, and slate mining.
- Water quality deterioration observed.
- Flow impacts present.

5_1: Upper reaches of Elands to Swartruggens Dam

- EWR rapid site, high EIS
- Refugia for fish
- Wetlands are important
- Some dry land farming
- Slate mining - sedimentation



5_7: Elands River outflow Lindleyspoort Dam to inflow Vaalkop Dam, Brakkloofspruit, Roosspruit, Sandspruit Mankwe. Leragane, Molapongwamongana

- Area is rural in nature, some irrigation, settlements present.
- Mankwe tributary is protected in the Pilanesberg National Park.
- These rivers are however surrounded by mining activities on Leragane (impacted).
- WWTWs discharges impact on water quality

5_6: Selons River, Koedoespruit, Dwarsspruit, lower Koster River

- Cultivation (limited irrigation) activities occur. now being used for mining uses.

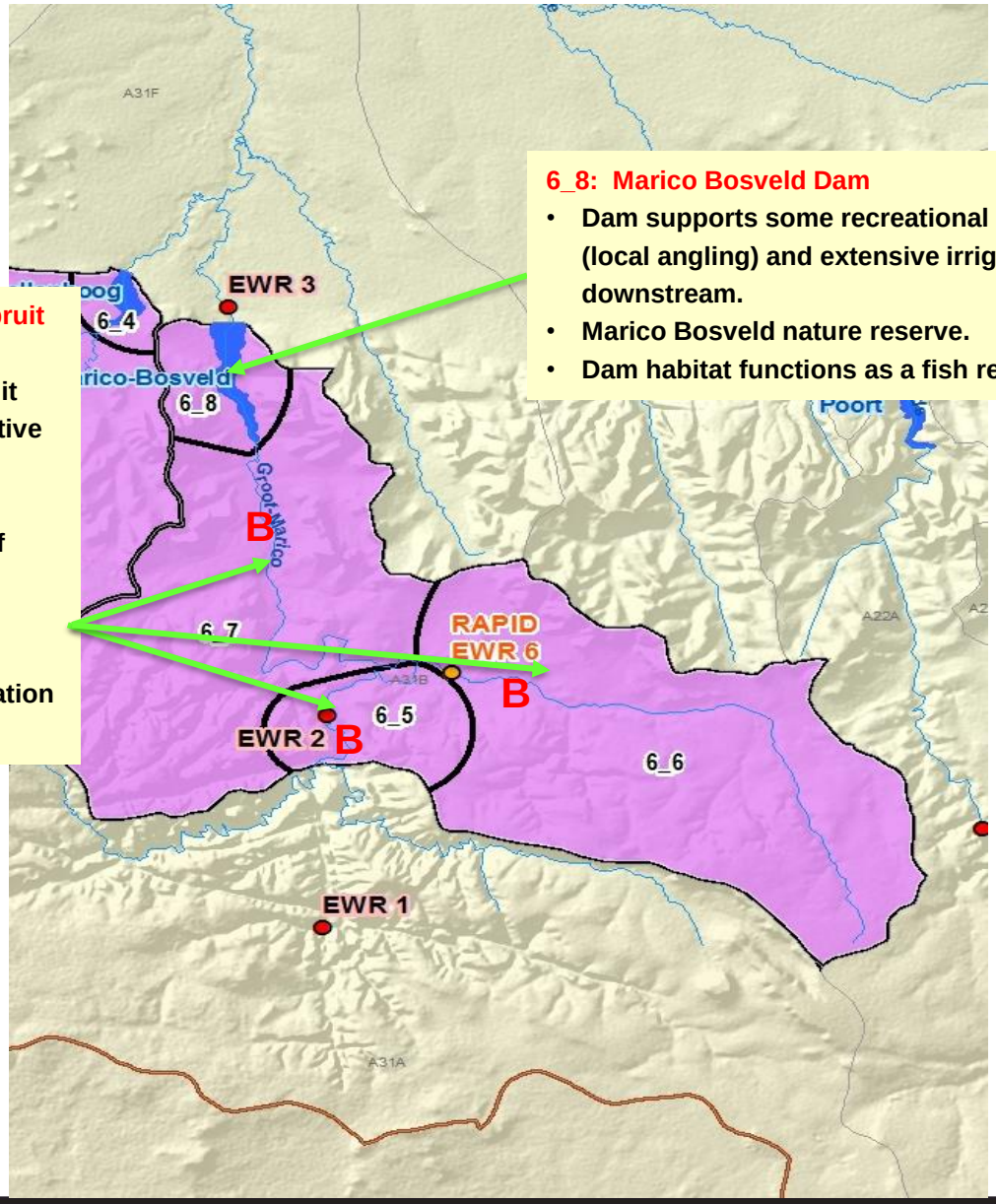
5_4: Upper reaches of Sterkstroom to inflow Buffelspoort Dam:

- Fish support area.
- Cultivation activities occur along the reach.
- Koster town is dependent on the river for water supply (into Koster Dam).
- Impacts include WWTWs, intensive cattle and poultry farming and unauthorised abstraction.

IUA 6b: GROOT MARICO

6_5, 6_6, 6_7: Groot Marico, Polkadraaispruit

- Isolated occurrences to *BMOT, AURA, CPRE* and *AMOS* in the Polkadraaispruit
- Large number of inverts and fish sensitive to water quality changes.
- Wetlands and it is a fish support area.
- Settlements forming part of the town of Marico
- Agricultural activities present.
- Water quality is impacted in the lower reaches of the Marico river due to irrigation and WWTW return flows.

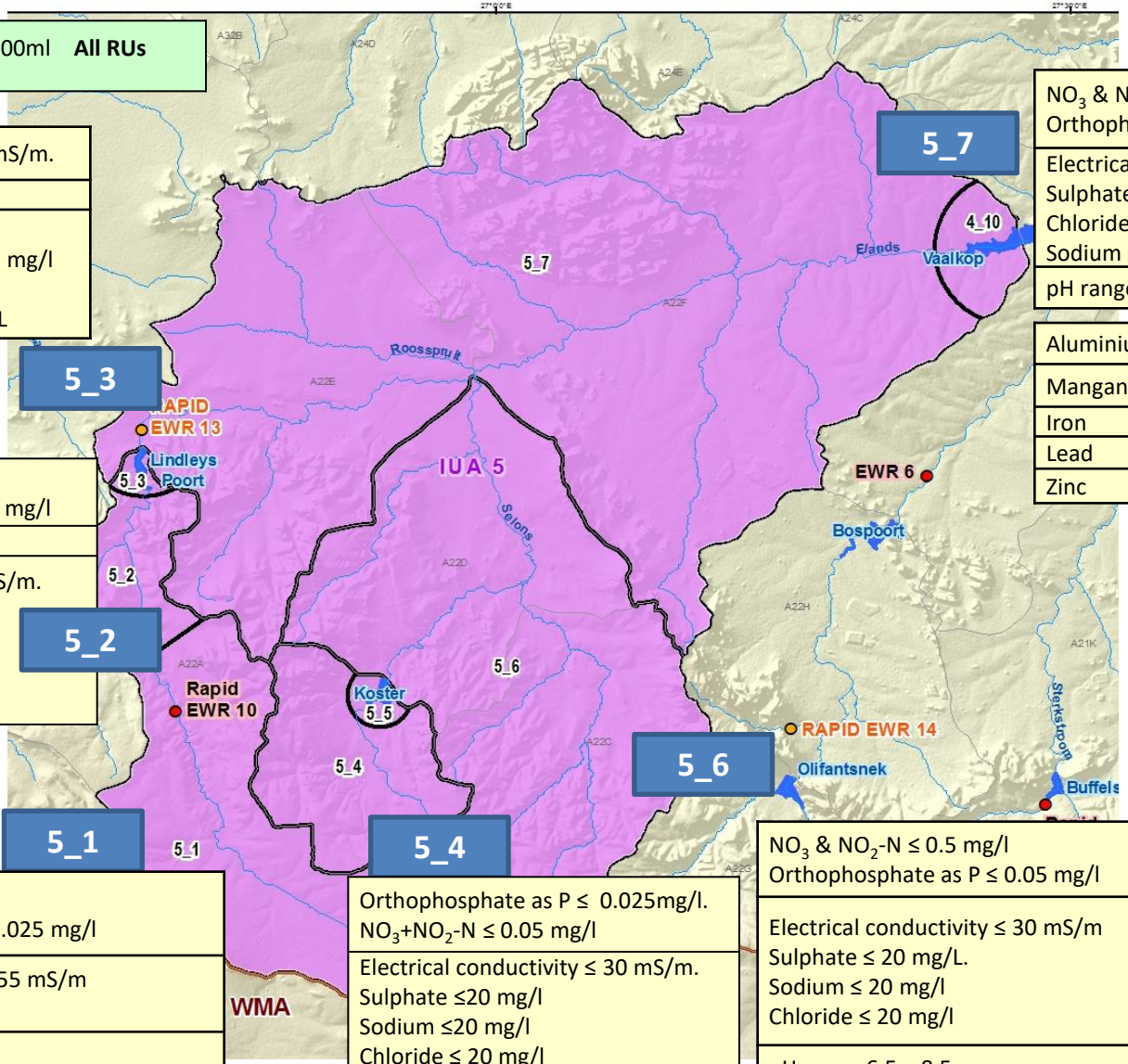


6_8: Marico Bosveld Dam

- Dam supports some recreational activities (local angling) and extensive irrigation downstream.
- Marico Bosveld nature reserve.
- Dam habitat functions as a fish refugia.

IUA 5: Elands/Vaalkop
RQOs QUALITY

E.coli ≤ 130 counts/100ml **All RUs**



Electrical conductivity ≤ 55 mS/m.
pH range 6.5 – 9.0
NO_3 & NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.015 mg/l TP ≤ 0.055 mg/l. Chl-*a* 0.011 mg/l - 0.020 mg/L

NO_3 & NO_2-N ≤ 2.0 mg/l Orthophosphate as P ≤ 0.01 mg/l
Electrical conductivity ≤ 85 mS/m. Sulphate ≤ 120 mg/L. Chloride ≤ 120 mg/L Sodium ≤ 100 mg/L
pH range 6.0 - 9.0

Aluminium	≤ 0.10 mg/l
Manganese	≤ 0.15mg/l.
Iron	≤ 0.3 mg/l.
Lead	≤ 0.0095mg/l
Zinc	≤ 0.002mg/l

NO_3+NO_2-N ≤ 0.50 mg/l Orthophosphate as P ≤ 0.050 mg/l
pH range 6.5 – 9.0
Electrical conductivity ≤ 55 mS/m. Sulphate ≤ 80 mg/L. Sodium ≤ 40 mg/l Chloride ≤ 70 mg/l Dissolved Oxygen 6-7 mg/L

NO_3 & NO_2-N ≤ 0.5 mg/l Orthophosphate as P ≤ 0.025 mg/l
Electrical conductivity ≤ 55 mS/m Sulphate : ≤30 mg/l
pH range 6.5 – 9.0

Orthophosphate as P ≤ 0.025mg/l. NO_3+NO_2-N ≤ 0.05 mg/l
Electrical conductivity ≤ 30 mS/m. Sulphate ≤20 mg/l Sodium ≤20 mg/l Chloride ≤ 20 mg/l
Dissolved Oxygen 6-7mg/L
pH range 6.5 – 8.5
17β oestradiol: ≤ 0.001 mg/L

NO_3 & NO_2-N ≤ 0.5 mg/l Orthophosphate as P ≤ 0.05 mg/l
Electrical conductivity ≤ 30 mS/m Sulphate ≤ 20 mg/L. Sodium ≤ 20 mg/l Chloride ≤ 20 mg/l
pH range 6.5 – 8.5

IUA 6b: Groot Marico
RQOs QUALITY

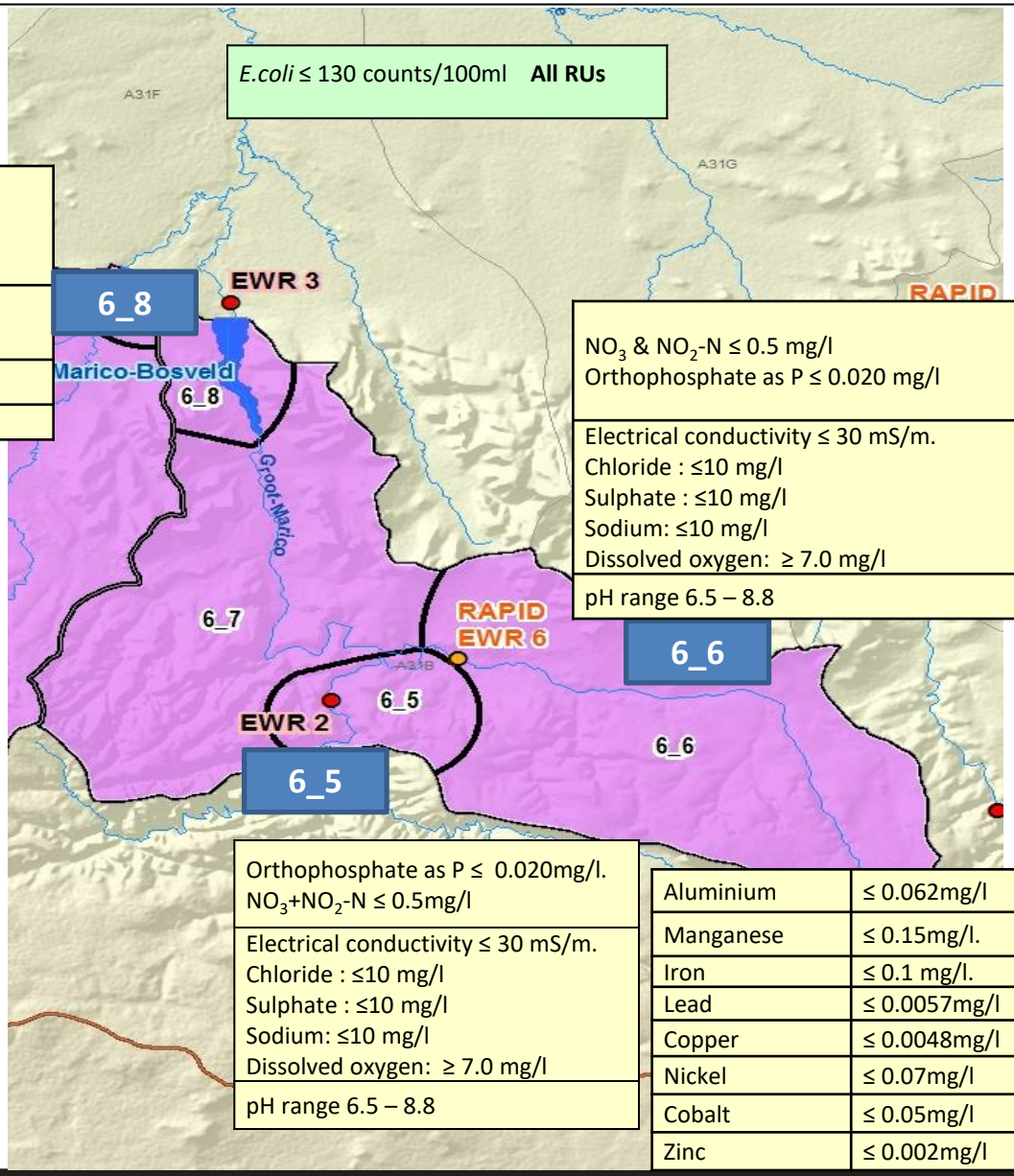
E.coli ≤ 130 counts/100ml **All RUs**

NO_3 & NO_2-N ≤ 0.7 mg/l
Orthophosphate as P ≤ 0.015 mg/l
TP; ≤ 0.025 mg/l

Electrical conductivity ≤ 35 mS/m

pH range 6.5 – 9.0

Chl *a:* 0.011 – 0.020 mg/l



NO_3 & NO_2-N ≤ 0.5 mg/l
Orthophosphate as P ≤ 0.020 mg/l

Electrical conductivity ≤ 30 mS/m.
Chloride : ≤10 mg/l
Sulphate : ≤10 mg/l
Sodium: ≤10 mg/l
Dissolved oxygen: ≥ 7.0 mg/l

pH range 6.5 – 8.8

Orthophosphate as P ≤ 0.020mg/l.
NO_3+NO_2-N ≤ 0.5mg/l

Electrical conductivity ≤ 30 mS/m.
Chloride : ≤10 mg/l
Sulphate : ≤10 mg/l
Sodium: ≤10 mg/l
Dissolved oxygen: ≥ 7.0 mg/l

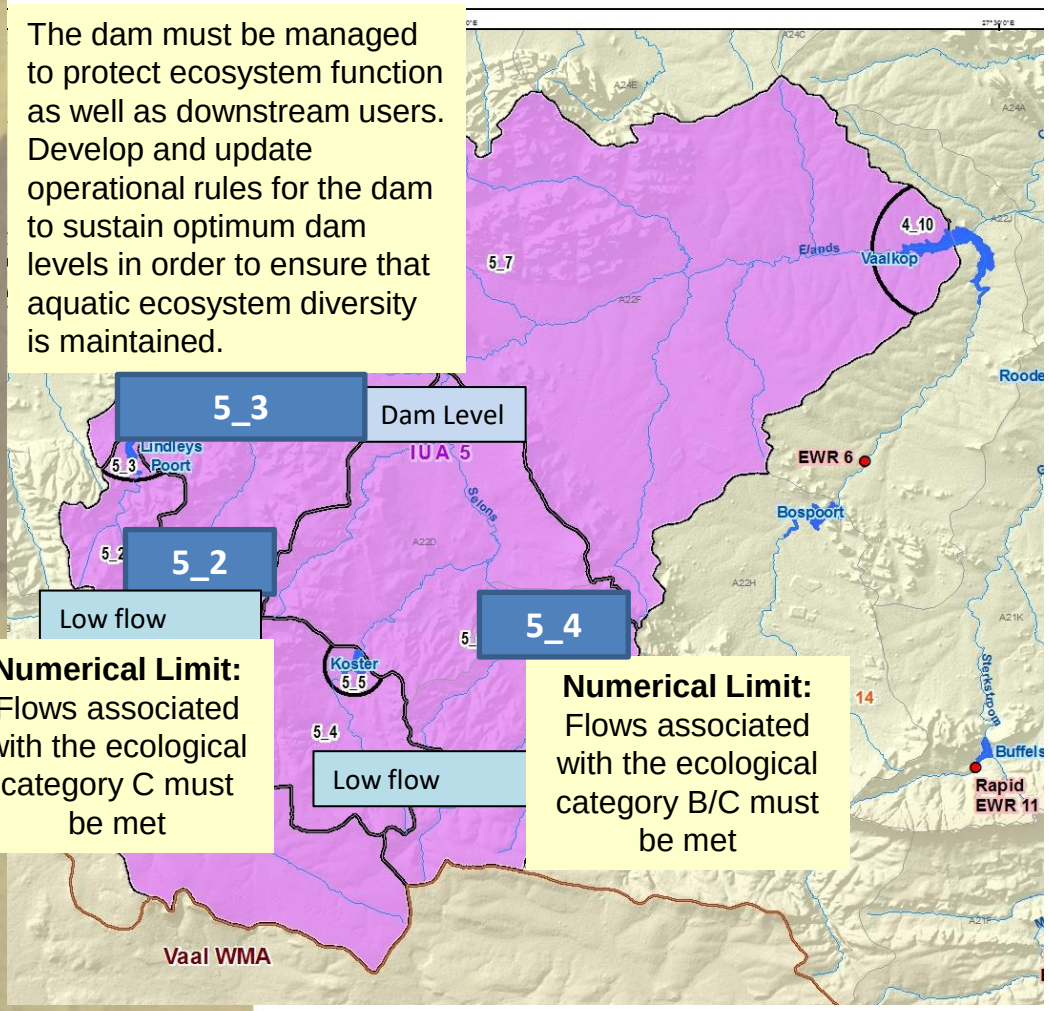
pH range 6.5 – 8.8

Aluminium	≤ 0.062mg/l
Manganese	≤ 0.15mg/l.
Iron	≤ 0.1 mg/l.
Lead	≤ 0.0057mg/l
Copper	≤ 0.0048mg/l
Nickel	≤ 0.07mg/l
Cobalt	≤ 0.05mg/l
Zinc	≤ 0.002mg/l

RQOs QUANTITY

IUA 5: Elands/Vaalkop

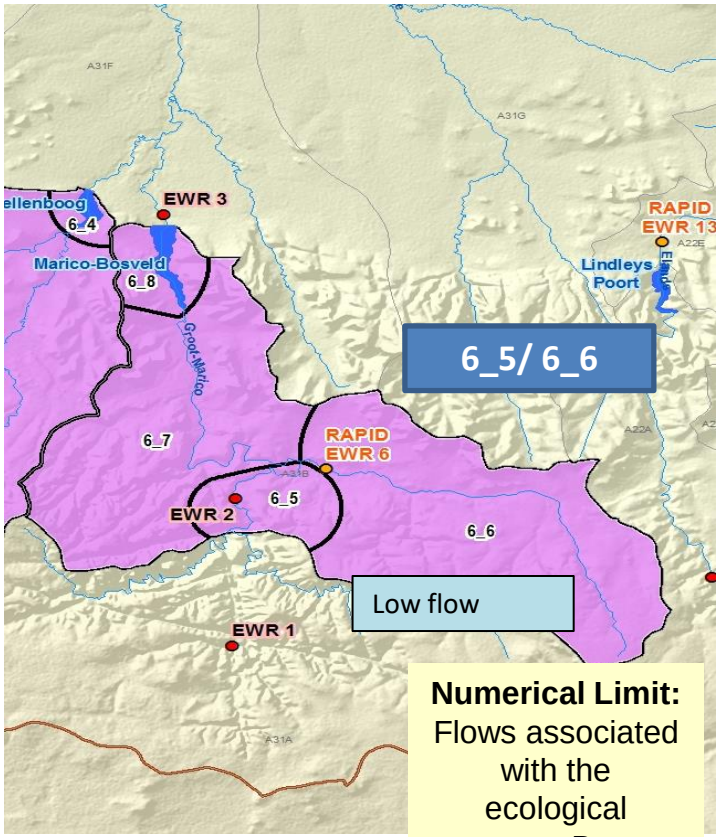
The dam must be managed to protect ecosystem function as well as downstream users. Develop and update operational rules for the dam to sustain optimum dam levels in order to ensure that aquatic ecosystem diversity is maintained.



Numerical Limit: Flows associated with the ecological category C must be met

Numerical Limit: Flows associated with the ecological category B/C must be met

IUA 6b: Groot Marico

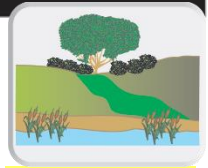


Numerical Limit: Flows associated with the ecological category B must be met

RQOs: FLOWS

Low: The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.

RQOs HABITAT



Habitat

IUA 6b: Groot Marico

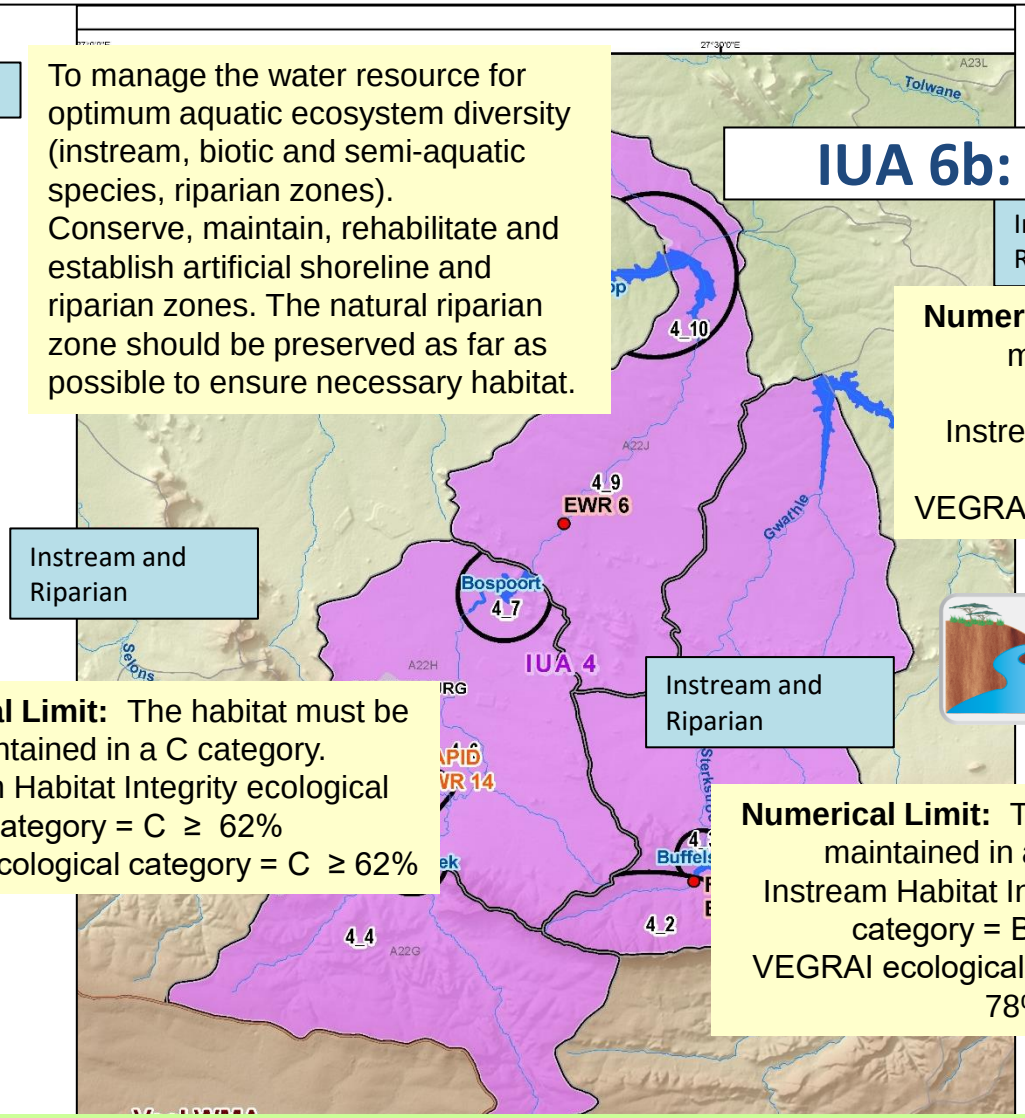
Dam Habitat

To manage the water resource for optimum aquatic ecosystem diversity (instream, biotic and semi-aquatic species, riparian zones).
Conserve, maintain, rehabilitate and establish artificial shoreline and riparian zones. The natural riparian zone should be preserved as far as possible to ensure necessary habitat.

Instream and Riparian

Numerical Limit: The habitat must be maintained in a B category.

Instream Habitat Integrity ecological category = B ≥ 82%
VEGRAI ecological category = B ≥ 82%



Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = C ≥ 62%
VEGRAI ecological category = C ≥ 62%

Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = B/C ≥ 78%
VEGRAI ecological category = B/C ≥ 78%

RQOs (Narrative)

Instream: Habitat diversity should be maintained in an ecological category C. The integrity of the habitat, water quality and flow conditions must be maintained
Riparian: Vegetation control must be maintained in a C ecological category. Protection of riparian habitat required.
Riparian: Vegetation cover should be maintained at a B/C ecological category..

IUA 5: Elands/Vaalkop
RQOs BIOTA – FISH AND MACROINVERTEBRATES

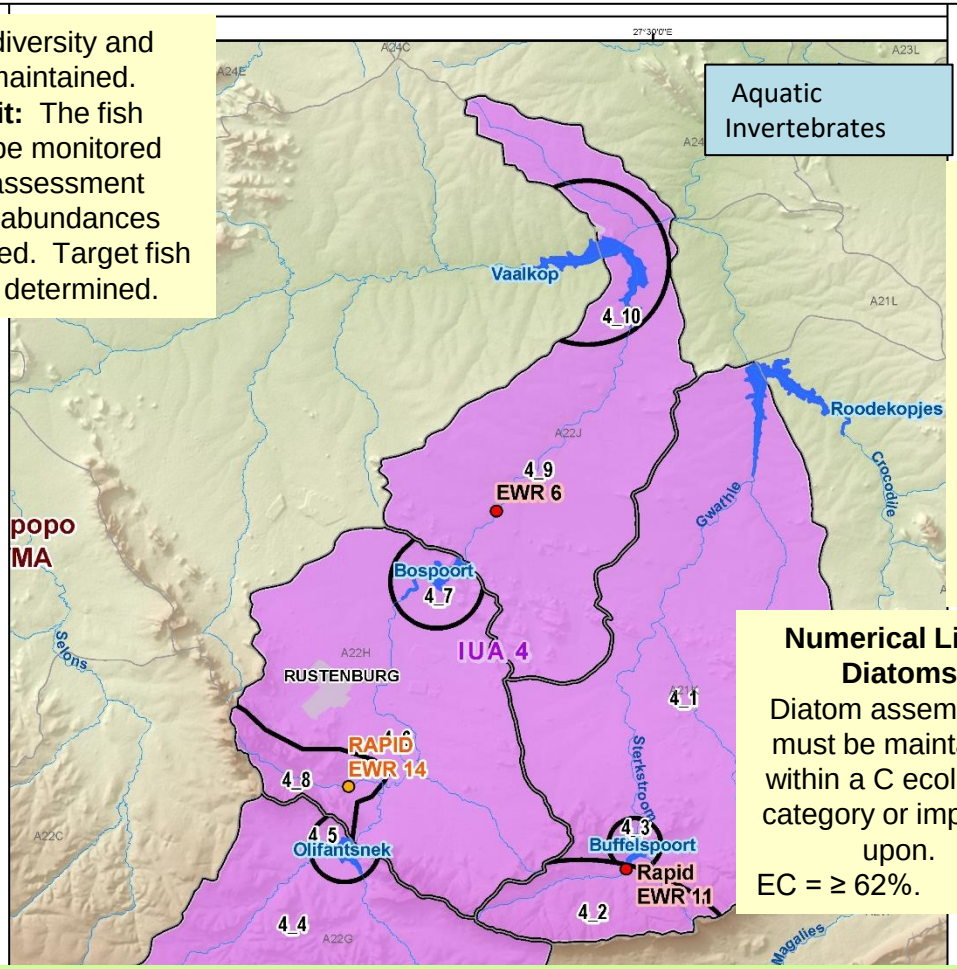
Dams

Ensure that the diversity and quantities are maintained.
Numerical Limit: The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Target fish stocks should be determined.

Fish

Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of **C.**
FRAI should be conducted to monitor against current category.

Fish ecology category = C
FRAI ≥ 62%.



Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **C** category.

MIRAI C ecological category ≥ 62%
SASS ≥ 155
ASPT ≥ 5.5

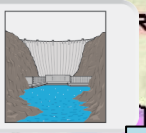
Numerical Limit:
Diatoms
Diatom assemblage must be maintained within a C ecological category or improved upon.
EC = ≥ 62%.

RQOs: (representative)

Fish : Fish community should be maintained at a D ecological category or improved upon. Flow should be adequate for flow dependant species.
Fish: Fish community should be maintained at a B/C ecological category.
Macro-invertebrates: Macroinvertebrate assemblage must be maintained within a D ecological category or improved upon.
Semi-aquatic biota: The suitability of this stretch of river to serve as a habitat and migration corridor for aquatic bird and mammal populations must be maintained through proper habitat management.

IUA 6b: Groot Marico
RQOs BIOTA – FISH AND MACROINVERTEBRATES

Ensure that the fish diversity and quantities are maintained.
Numerical Limit: The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Target fish stocks should be determined.



Dam

Numerical Limit:
Diatoms
Diatom assemblage must be maintained within a A/B ecological category or improved upon.
EC = ≥ 88%.

Aquatic Invertebrates

Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of **C/D,** or improved upon.

Fish EC = C/D
FRAI ≥ 58%.

Fish

Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of B.

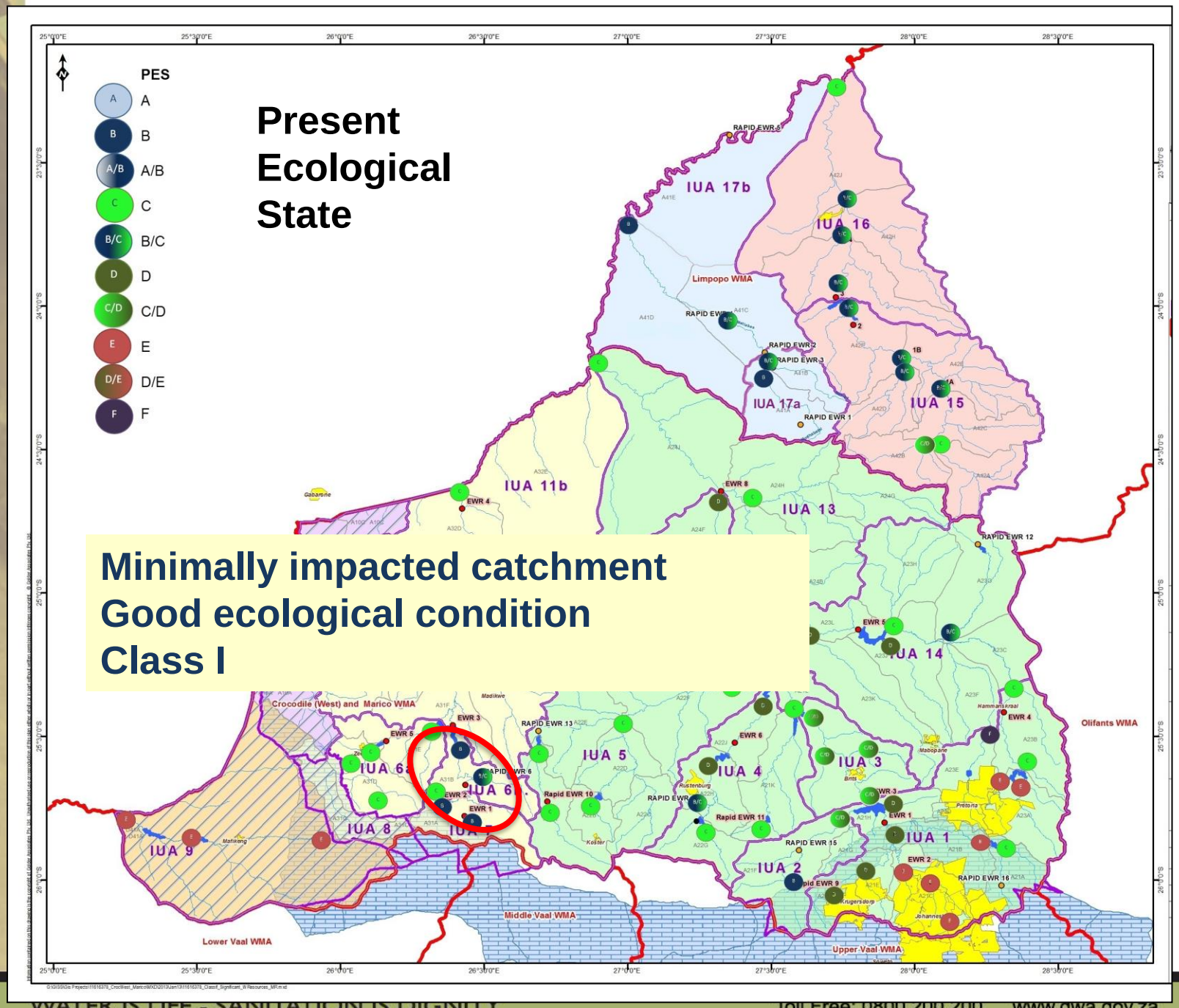
Fish ecology category = B
FRAI ≥ 82%.

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current A/**B** category.

MIRAI A/B ecological category ≥ 88%
SASS ≥ 220
ASPT ≥ 6.5

RQOs: (representative)

Fish : The fish community must be maintained in a B ecological category.
Fish: The fish community must be maintained in a C/D ecological category or better condition..
Macro-invertebrates: Macroinvertebrate assemblage must be maintained within current state at the B ecological category.


PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
Minimally impacted catchment
Good ecological condition
Class I
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 11b
IUA 13
IUA 14
IUA 5
IUA 4
IUA 3
IUA 6a
IUA 6
IUA 8
IUA 9
IUA 1
IUA 2
Limpopo WMA
Crocodile (West) and Marico WMA
Olifants WMA
Lower Vaal WMA
Middle Vaal WMA
Upper Vaal WMA
RAPID EWR 6
RAPID EWR 2
RAPID EWR 3
RAPID EWR 1
EWR 4
EWR 8
RAPID EWR 12
EWR 5
EWR 3
RAPID EWR 13
EWR 6
RAPID EWR 10
RAPID EWR 11
RAPID EWR 15
RAPID EWR 16
RAPID EWR 9
EWR 2
EWR 1

IUA 7: KAALOOG-SE- LOOP

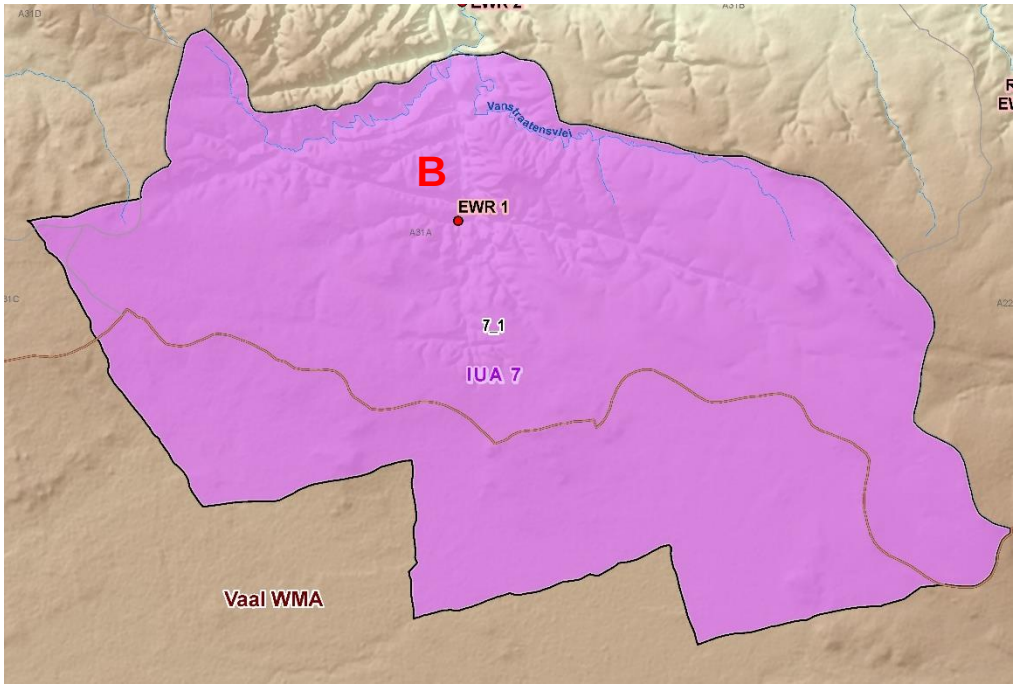
RU Number	Delineation	Quaternary Catchment
7_1	Marico Eye, Kaaloog-se-Loop, Bokkraal-se-Loop, Ribbokfontein-se-Loop	A31A

Management Class: I

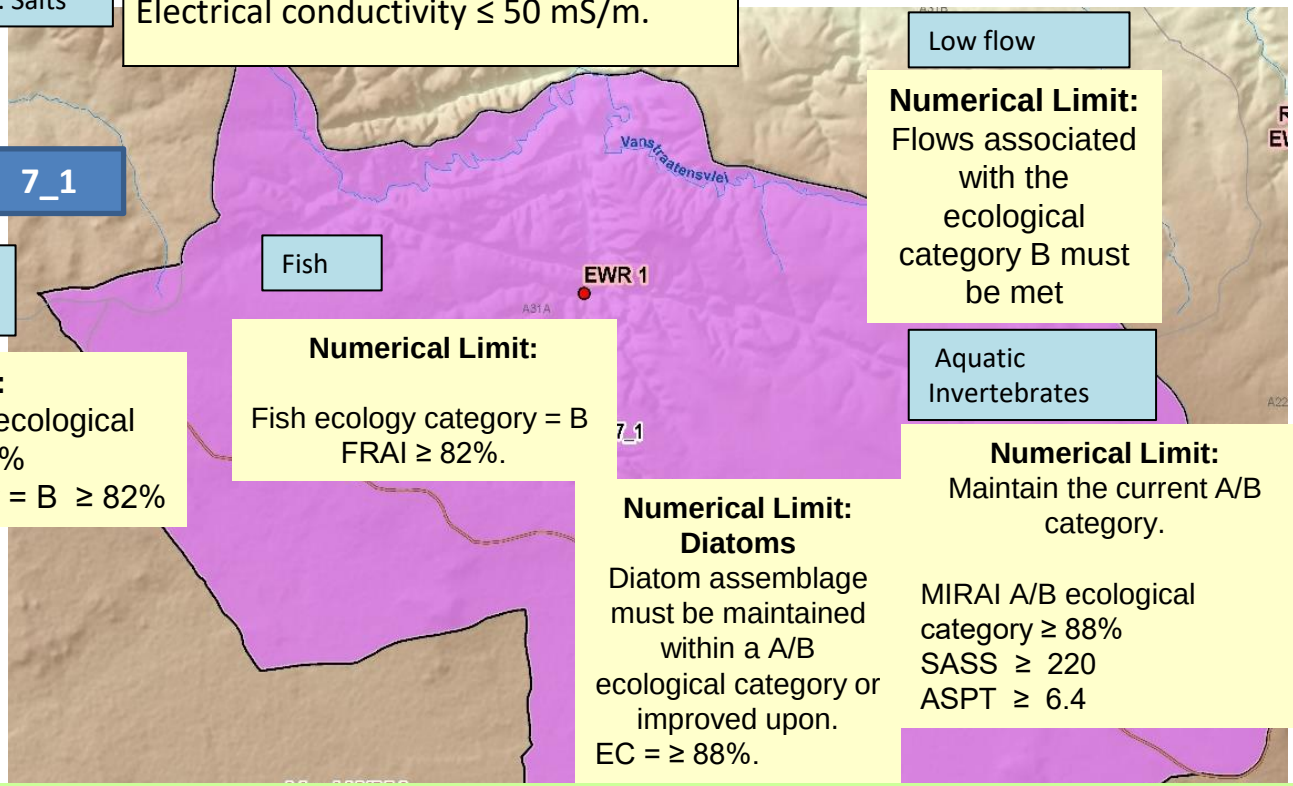
Ecological Category: B

7_1– Marico Eye, Kaaloog-se-Loop, Bokkraal-se-Loop, Ribbokfontein-se-Loop, Rietspruit (southern eye), Kuilsfontein, Syferfontein and Bronkhorstfontein

- **Isolated occurrences important fish species**
- **EWR site 1, EIS is very high due to good quality.**
- **High protection/conservation due to the dolomitic eyes and associated fauna and flora.**
- **Threat from over abstraction.**
- **FEPA rivers, important groundwater resource, wetlands**
- **Tufa waterfall (unique feature) is present.**
- **Groundwater: Large abstractions for mining, agriculture and municipal supplies**
- **Current problems with high groundwater level recession rates in the Lichtenburg Area.**
- **Some sedimentation impacts .**



IUA 7: Kaaloog-se - Loop
RQOs



Quality: Salts

Electrical conductivity ≤ 50 mS/m.

Low flow

Numerical Limit:
Flows associated with the ecological category B must be met

Instream and Riparian

Numerical Limit:
Instream Habitat Integrity ecological category = B ≥ 82%
VEGRAI ecological category = B ≥ 82%

Fish

Numerical Limit:

Fish ecology category = B
FRAI ≥ 82%.

Aquatic Invertebrates

Numerical Limit:
Maintain the current A/B category.

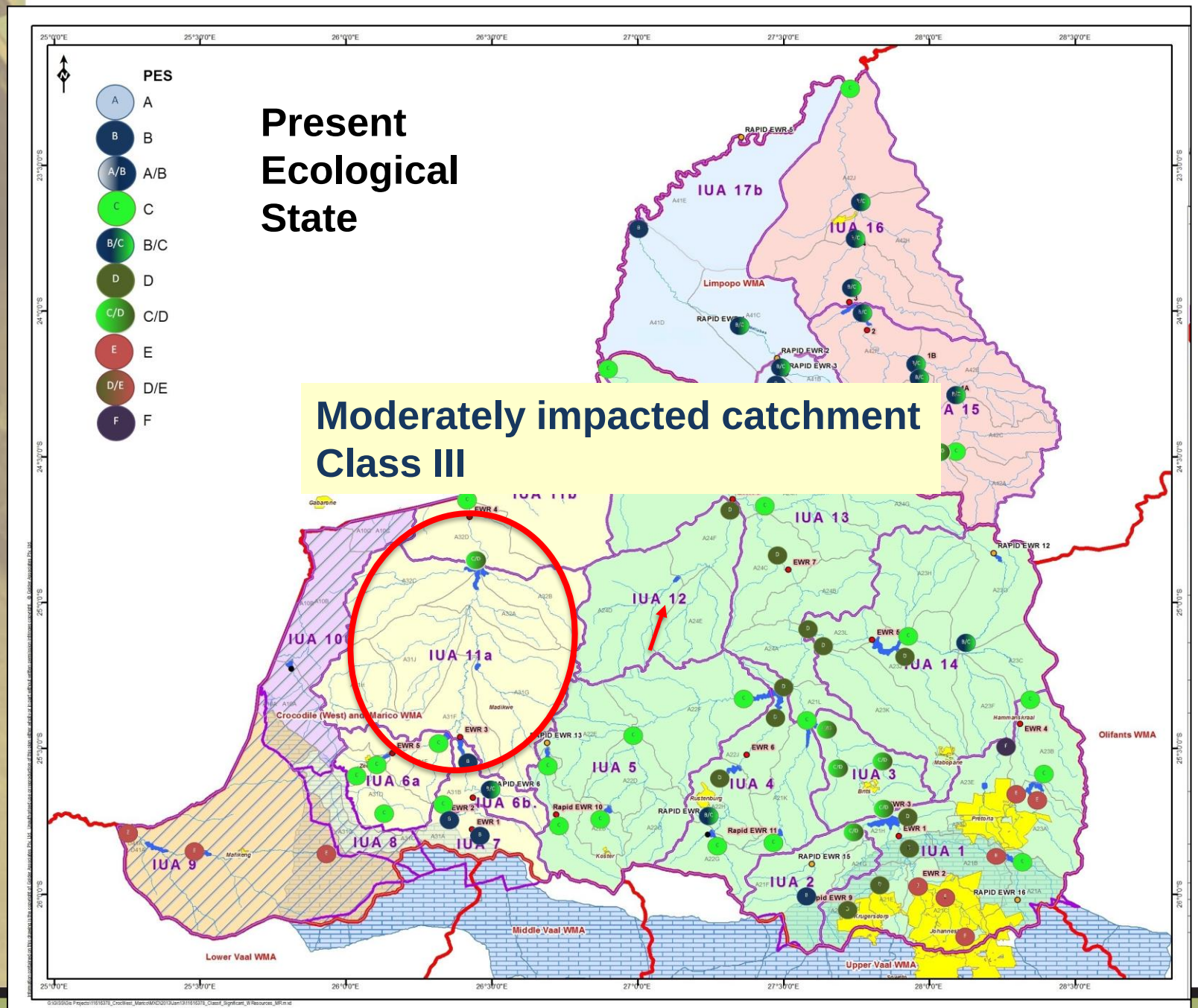
MIRAI A/B ecological category ≥ 88%
SASS ≥ 220
ASPT ≥ 6.4

Numerical Limit:
Diatoms
Diatom assemblage must be maintained within a A/B ecological category or improved upon.
EC = ≥ 88%.

RQOs (Narrative)

Salts: Pristine water quality status must be maintained. No deterioration in water quality should be permitted. Instream salinity must be maintained to ensure the ecological integrity of the resource unit remains intact.
Low Flow: The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.
Habitat Instream: The habitat must be maintained in a B category or better condition
Habitat Riparian: Vegetation cover should be maintained within a B ecological category or better condition.
Fish: The fish community must be maintained in a B ecological category
Macro-invertebrates:Macroinvertebrate assemblage must be maintained within current state at the A/B ecological category.
Diatoms: Diatom assemblage must be maintained within a largely natural to natural condition.

Present Ecological State



IUA 11a: GROOT MARICO/MOLATEDI DAM

Management Class: III

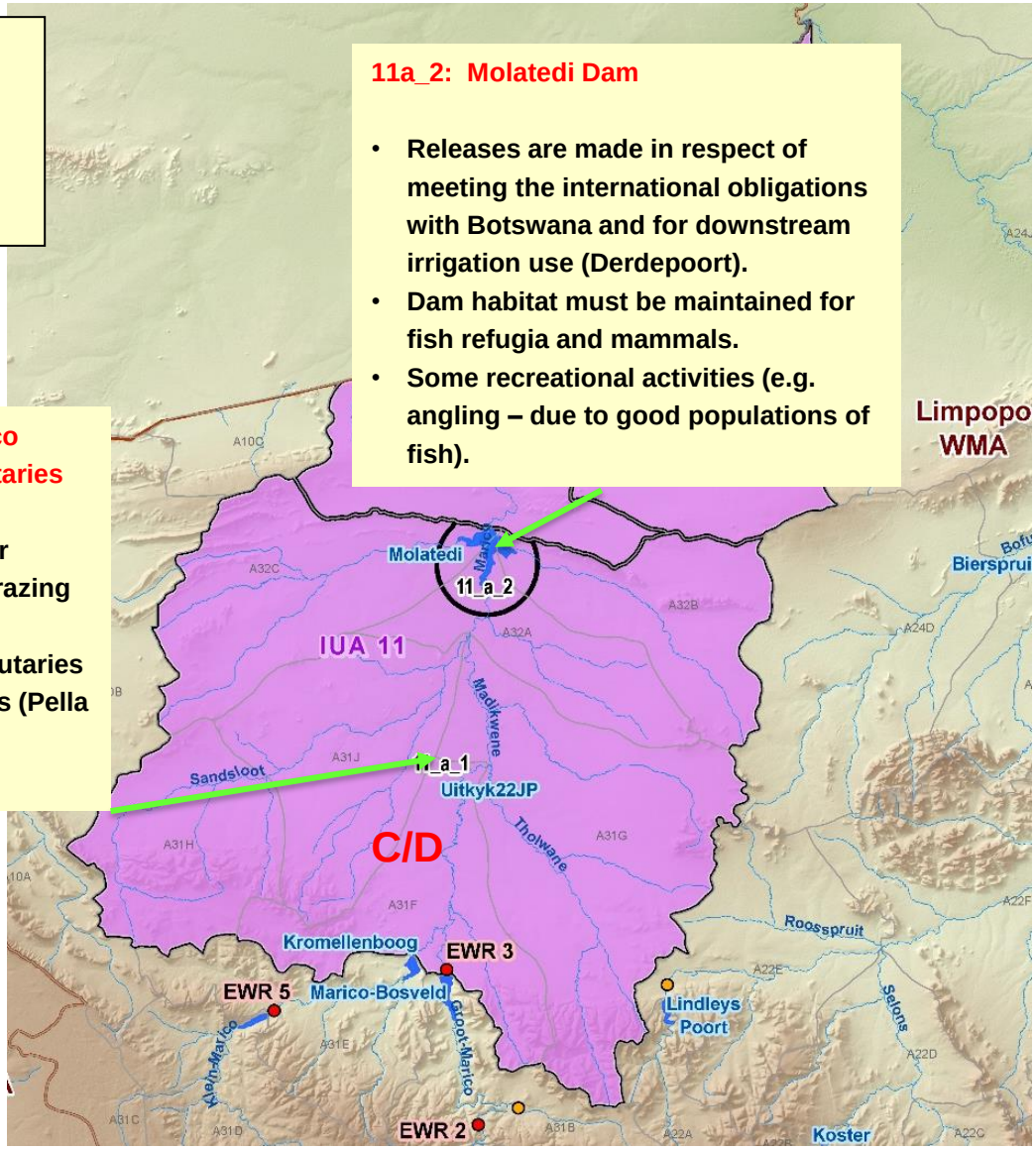
Ecological Category: C

11a_1: Groot Marico from outflow Marico Bosveld Dam to Molatedi Dam, all tributaries

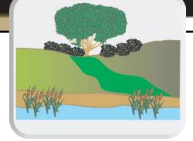
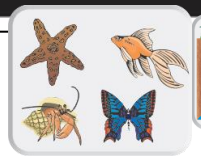
- EWR site 3 on the Groot Marico River
- Land area is degraded due to over grazing and development.
- Smaller dams are present on the tributaries supplying water to local communities (Pella Dam, Madikwe, Sehujane Dam).
- Water quality must be protected.

11a_2: Molatedi Dam

- Releases are made in respect of meeting the international obligations with Botswana and for downstream irrigation use (Derdepoort).
- Dam habitat must be maintained for fish refugia and mammals.
- Some recreational activities (e.g. angling – due to good populations of fish).



IUA 11a: Groot Marico/Molatedi Dam RQOs


Fish: The fish diversity and quantities must be maintained

Dam Level: The dam must be managed to protect ecosystem function as well as downstream users. Develop and update operational rules for the dam to sustain optimum dam levels in order to ensure that aquatic ecosystem diversity is maintained. Dam releases are required to meet downstream flows for ecological flow requirements.

Dam Habitat: To manage the water resource for optimum aquatic ecosystem diversity (instream, biotic and semi-aquatic species, riparian zones). Conserve, maintain, rehabilitate and establish artificial shoreline and riparian zones. The natural riparian zone should be preserved as far as possible to ensure necessary habitat.
50% riparian vegetation cover

Quality

NO_3+NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.090 mg/l
pH range 6.5 – 8.8
Electrical conductivity ≤ 55 mS/m Sodium ≤ 50 mg/l Chloride ≤ 40 mg/l Sulphate ≤ 50 mg/l

Instream and Riparian

Numerical Limit:
Instream Habitat Integrity ecological category = C/D ≥ 58%
VEGRAI ecological category = C/D ≥ 58%

Quality

NO_3+NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.015 mg/l TP: 0.055 mg/l
pH range 6.5 – 9.0
Electrical conductivity ≤ 55 mS/m Dissolved oxygen: ≥ 7.0 mg/l
Chl *a*: 0.011 – 0.020mg/l
E.coli ≤ 130 counts/100ml

Fish

Numerical Limit:
Fish ecology category = D
FRAI ≥ 42%.

Aquatic Invertebrates

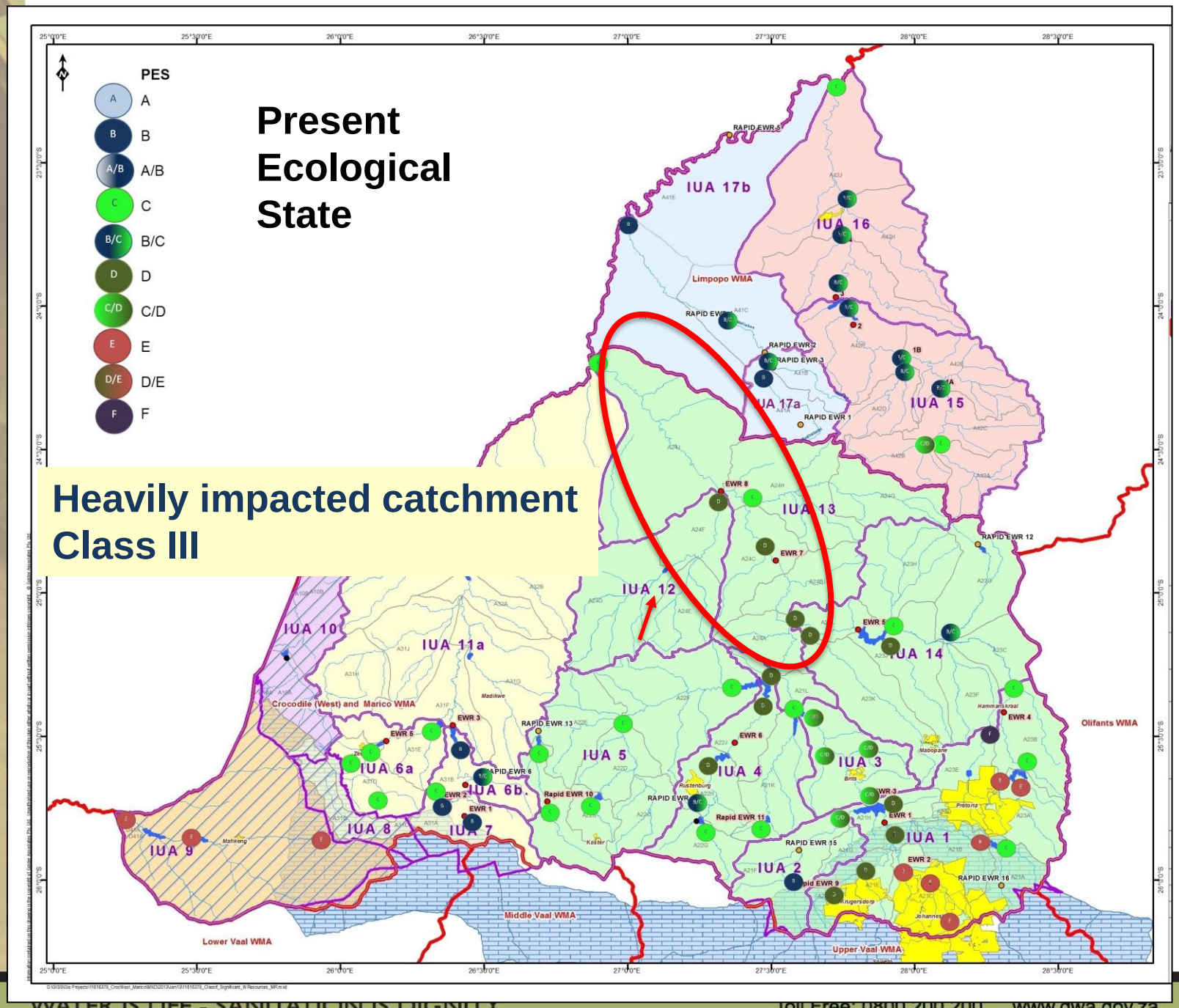
Numerical Limit:
Maintain the current C category.

MIRAI C ecological category ≥ 62%
SASS ≥ 120
ASPT ≥ 5.5

Numerical Limit:
Diatoms
Diatom assemblage must be maintained within a A/B ecological category or improved upon.
EC = ≥ 88%.

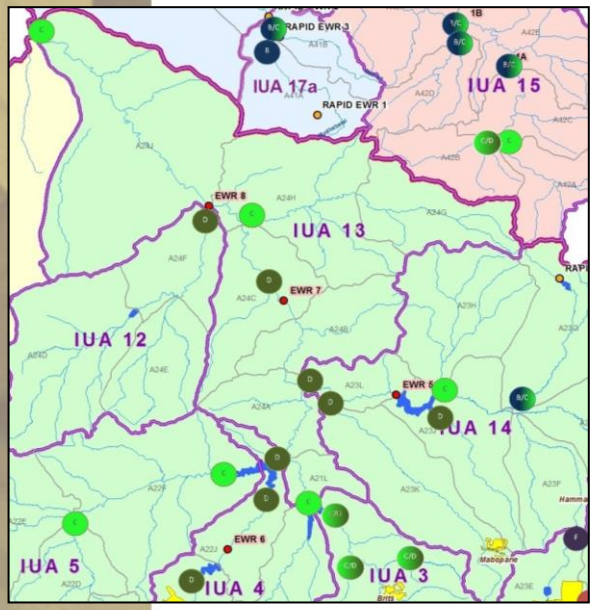
Low flow

RQO: The maintenance low flows and drought flows must be attained to support the ecological requirement and downstream users. Flows associated with the ecological category C/D must be met.


PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
Heavily impacted catchment Class III
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 13
IUA 12
IUA 14
IUA 10
IUA 11a
IUA 6a
IUA 6b
IUA 5
IUA 4
IUA 3
IUA 8
IUA 7
IUA 9
IUA 2
IUA 1
Limpopo WMA
Crocodile (West) and Marico WMA
Olifants WMA
Lower Vaal WMA
Middle Vaal WMA
Upper Vaal WMA
RAPID EWR 6
RAPID EWR 2
RAPID EWR 3
RAPID EWR 1
EWR 8
EWR 7
RAPID EWR 12
EWR 5
EWR 4
EWR 3
RAPID EWR 13
EWR 6
RAPID EWR 6
EWR 2
EWR 1
Rapid EWR 10
Rapid EWR 11
RAPID EWR 15
RAPID EWR 16
Rapid EWR 9

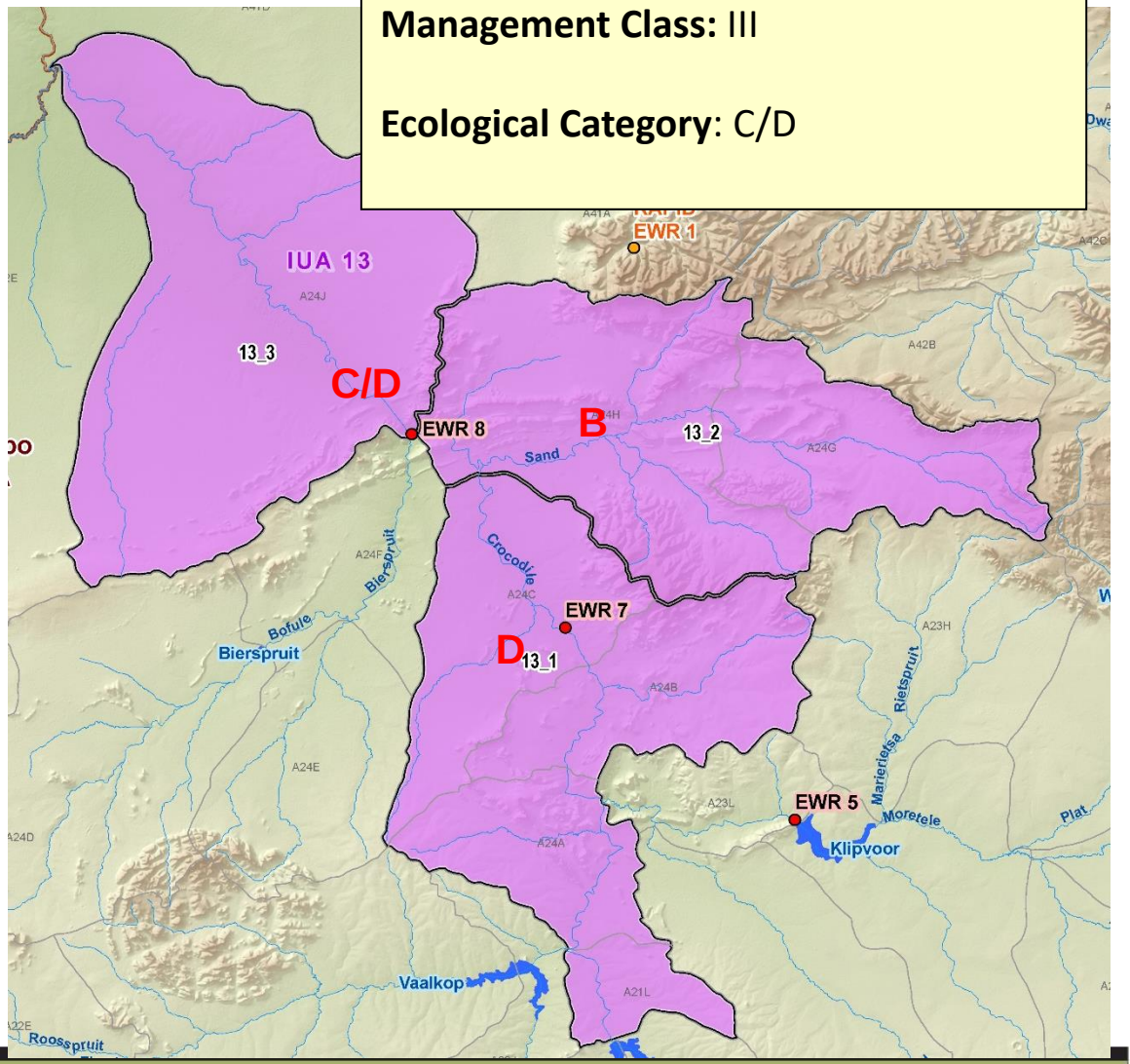
IUA 13: LOWER CROCODILE

Highly impacted catchment

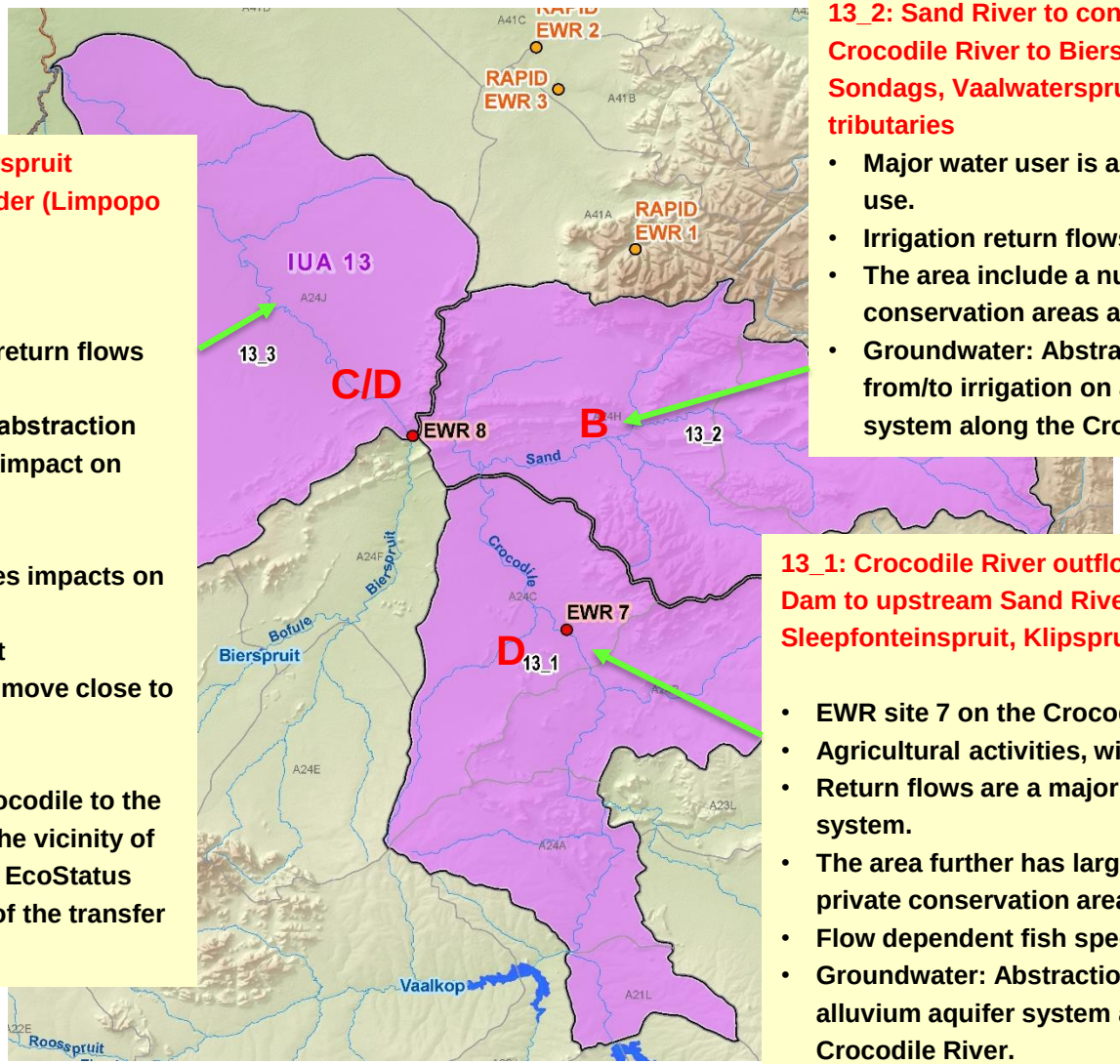


Management Class: III

Ecological Category: C/D



IUA 13: LOWER CROCODILE



13_3: Lower Crocodile from Bierspruit confluence to the Botswana border (Limpopo River

- EWR site 8
- irrigation water use and with return flows as a major impact.
- "Opportunistic irrigation" by abstraction from the sand aquifers could impact on aquifer system.
- Number of game
- Thabazimbi WWTW discharges impacts on the water quality .
- Sensitive fish species present
- During good flow, crocodiles move close to EWR site 8.
- Mining activities in the area.
- Transfer pipeline from the Crocodile to the Mokolo catchment will be in the vicinity of EWR site 8. An alternate river EcoStatus monitoring site downstream of the transfer site would then be required.

13_2: Sand River to confluence with the Crocodile River to Bierspruit confluence, Sondags, Vaalwaterspruit and Monyagole tributaries

- Major water user is agriculture - irrigation use.
- Irrigation return flows are a major impact.
- The area include a number private conservation areas and game farms.
- Groundwater: Abstraction/discharges from/to irrigation on alluvium aquifer system along the Crocodile River.

13_1: Crocodile River outflow Roodekopjes Dam to upstream Sand River confluence, Sleepfonteinspruit, Klipspruit tributaries

- EWR site 7 on the Crocodile River
- Agricultural activities, with major irrigation.
- Return flows are a major impact on the system.
- The area further has large hunting and private conservation areas.
- Flow dependent fish species
- Groundwater: Abstraction/discharges on alluvium aquifer system along the Crocodile River.
- Sand aquifer systems present.
- Proximity of mines to the aquifers could lead to dewatering of the aquifer.

IUA 13: Lower Crocodile

C/D category

RQOs

Quality

NO_3+NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.060 mg/l
pH range 6.0 – 8.5
Electrical conductivity ≤ 85 mS/m.
Sulphate ≤ 100 mg/L.
Sodium ≤ 80mg/l
Chloride ≤ 100 mg/l
Dissolved oxygen: ≥ 6mg/l
E.coli ≤ 130 counts/100ml

High flows

RQO: High flows must be attained as specified to support aquatic ecosystem requirements. Flood requirements

Low flow

RQO: Flows associated with the ecological category C/D must be met.

Fish

Fish community should be maintained within a D ecological category or improved upon
.**Numerical Limit:**
Fish = D
FRAI ≥ 42%.

Aquatic Invertebrates

Numerical Limit:
Diatoms
EC = ≥ 42%.

Pesticides

Atrazine	≤0.078 mg/l
Acetochlor	
Propiconazole	≤
Metolachlor	≤0.30 mg/l
Mancozeb	≤ 0.009 mg/l

Instream and Riparian

Numerical Limit:
Instream Habitat Integrity ecological category = C/D ≥ 58%
VEGRAI ecological category = C/D ≥ 58%

Fish

Numerical Limit:

MIRAI = C/D ecological category ≥ 58%
SASS ≥ 120
ASPT ≥ 5.0

Aquatic Invertebrates

Numerical Limit:

MIRAI = D ecological category ≥ 42%
SASS ≥ 60
ASPT ≥ 4.5

High flows

RQO: High flows must be attained as specified to support aquatic ecosystem requirements. Flood requirements

Low flow

RQO: The maintenance low flows and drought flows must be attained to support the ecological requirement and downstream users. Flows associated with the ecological category D must be met.

Fish

Fish community should be maintained within a D ecological category or improved upon

Numerical Limit:
Fish ecology category = D
FRAI ≥ 42%.

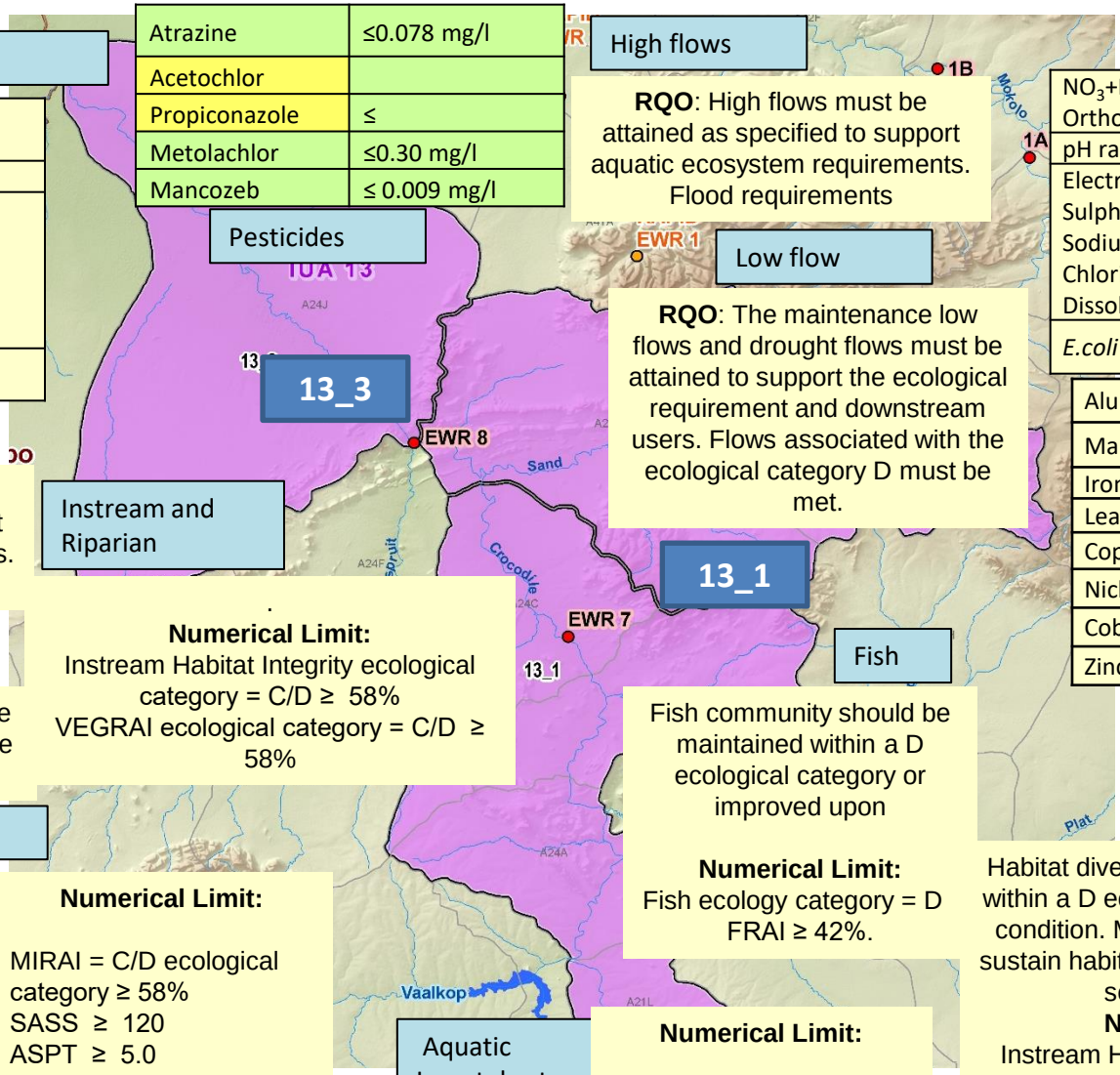
Instream and Riparian

Habitat diversity should be maintained within a D ecological category or better condition. Maintain good low flows to sustain habitat for substrate and habitat sensitive species.
Numerical Limit:
Instream Habitat Integrity ecological category = D ≥ 42%
VEGRAI ecological category = D ≥ 42%

Quality

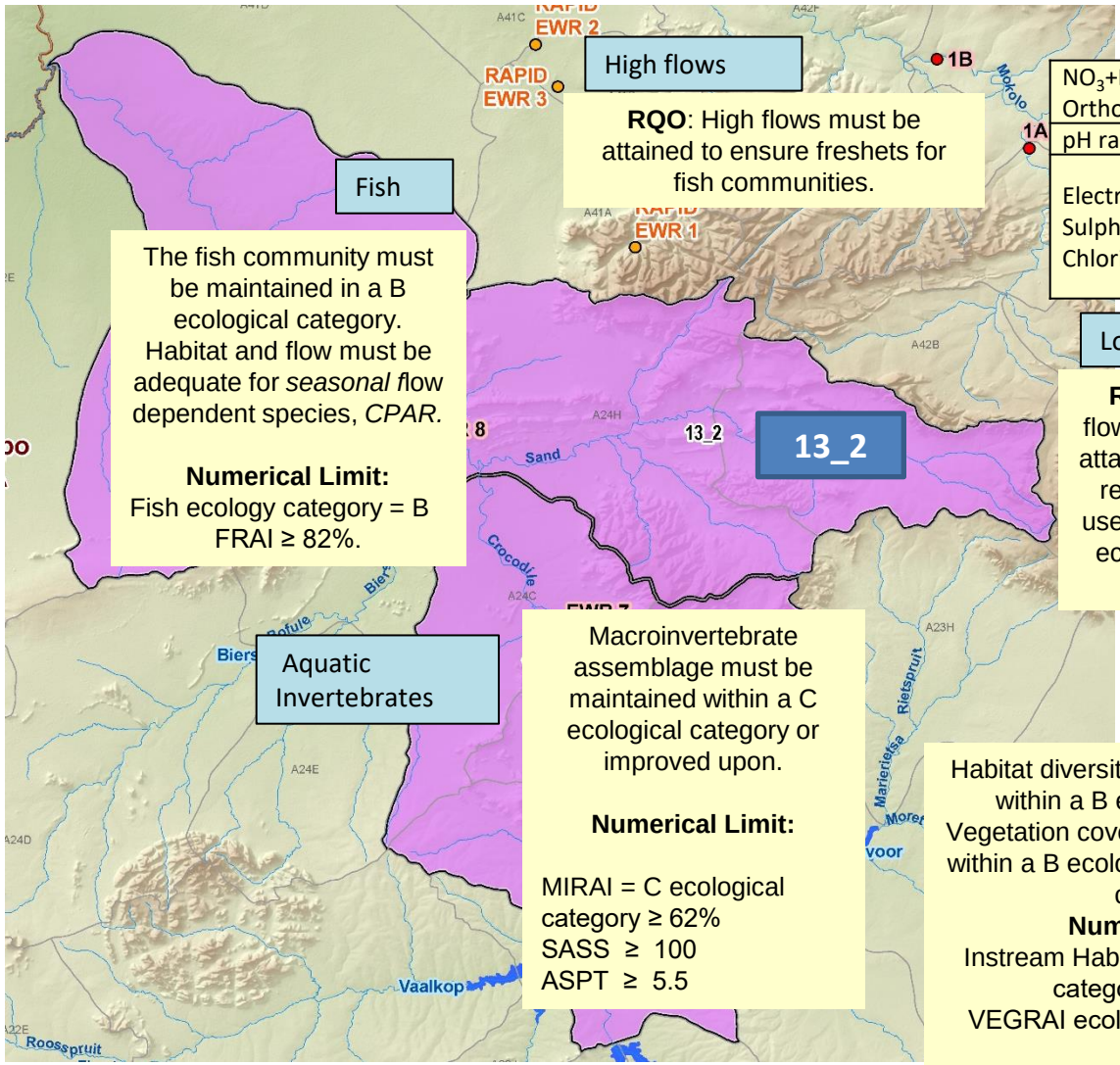
NO_3+NO_2-N ≤ 1.0 mg/l
Orthophosphate as P ≤ 0.06 mg/l
pH range 6.5 – 8.5
Electrical conductivity ≤ 85 mS/m.
Sulphate ≤ 100 mg/L.
Sodium ≤ 80 mg/l
Chloride ≤ 80 mg/l
Dissolved oxygen: ≥ 6mg/l
E.coli ≤ 130 counts/100ml

Aluminium	≤ 0.1mg/l
Manganese	≤ 0.15mg/l.
Iron	≤ 0.3 mg/l.
Lead	≤ 0.0095mg/l
Copper	≤ 0.0073mg/l
Nickel	≤ 0.07mg/l
Cobalt	≤ 0.05mg/l
Zinc	≤ 0.002mg/l



IUA 13: Lower Crocodile

B category RQOs: 13_2



Quality

NO_3+NO_2-N ≤ 0.02 mg/l
Orthophosphate as P ≤ 0.50 mg/l
pH range 6.5 – 8.5

Electrical conductivity ≤ 30 mS/m.
Sulphate ≤ 20 mg/L.
Chloride ≤ 20 mg/l

High flows

RQO: High flows must be attained to ensure freshets for fish communities.

Fish

The fish community must be maintained in a B ecological category. Habitat and flow must be adequate for *seasonal* flow dependent species, *CPAR.*

Numerical Limit:
Fish ecology category = B
FRAI ≥ 82%.

Low flow

RQO: The maintenance low flows and drought flows must be attained to support the ecological requirement and downstream users. Flows associated with the ecological category B must be met.

Aquatic Invertebrates

Macroinvertebrate assemblage must be maintained within a C ecological category or improved upon.

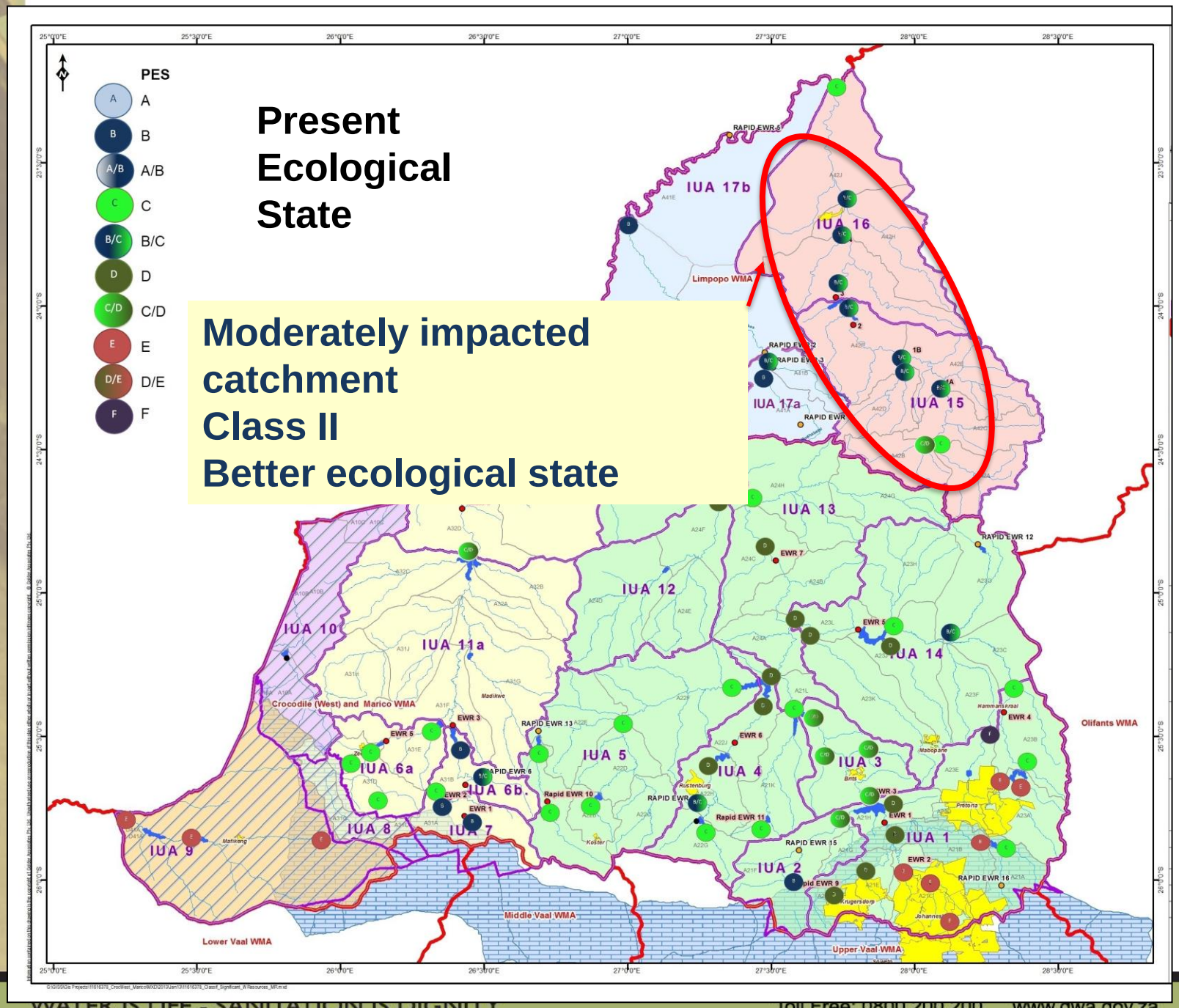
Numerical Limit:

MIRAI = C ecological category ≥ 62%
SASS ≥ 100
ASPT ≥ 5.5

Instream and Riparian

Habitat diversity should be maintained within a B ecological category. Vegetation cover should be maintained within a B ecological category or better condition.

Numerical Limit:
Instream Habitat Integrity ecological category = B ≥ 85%
VEGRAI ecological category = B ≥ 85%


PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
Moderately impacted catchment
Class II
Better ecological state
IUA 17b
IUA 16
IUA 15
IUA 17a
IUA 13
IUA 12
IUA 10
IUA 11a
IUA 14
IUA 5
IUA 4
IUA 3
IUA 6a
IUA 6b
IUA 8
IUA 7
IUA 9
IUA 1
IUA 2
Limpopo WMA
Crocodile (West) and Marico WMA
Olifants WMA
Lower Vaal WMA
Middle Vaal WMA
Upper Vaal WMA
RAPID EWR 6
RAPID EWR 12
EWR 7
EWR 5
EWR 3
EWR 4
EWR 6
EWR 2
EWR 1
RAPID EWR 13
RAPID EWR 10
RAPID EWR 11
RAPID EWR 15
RAPID EWR 16
RAPID EWR 9

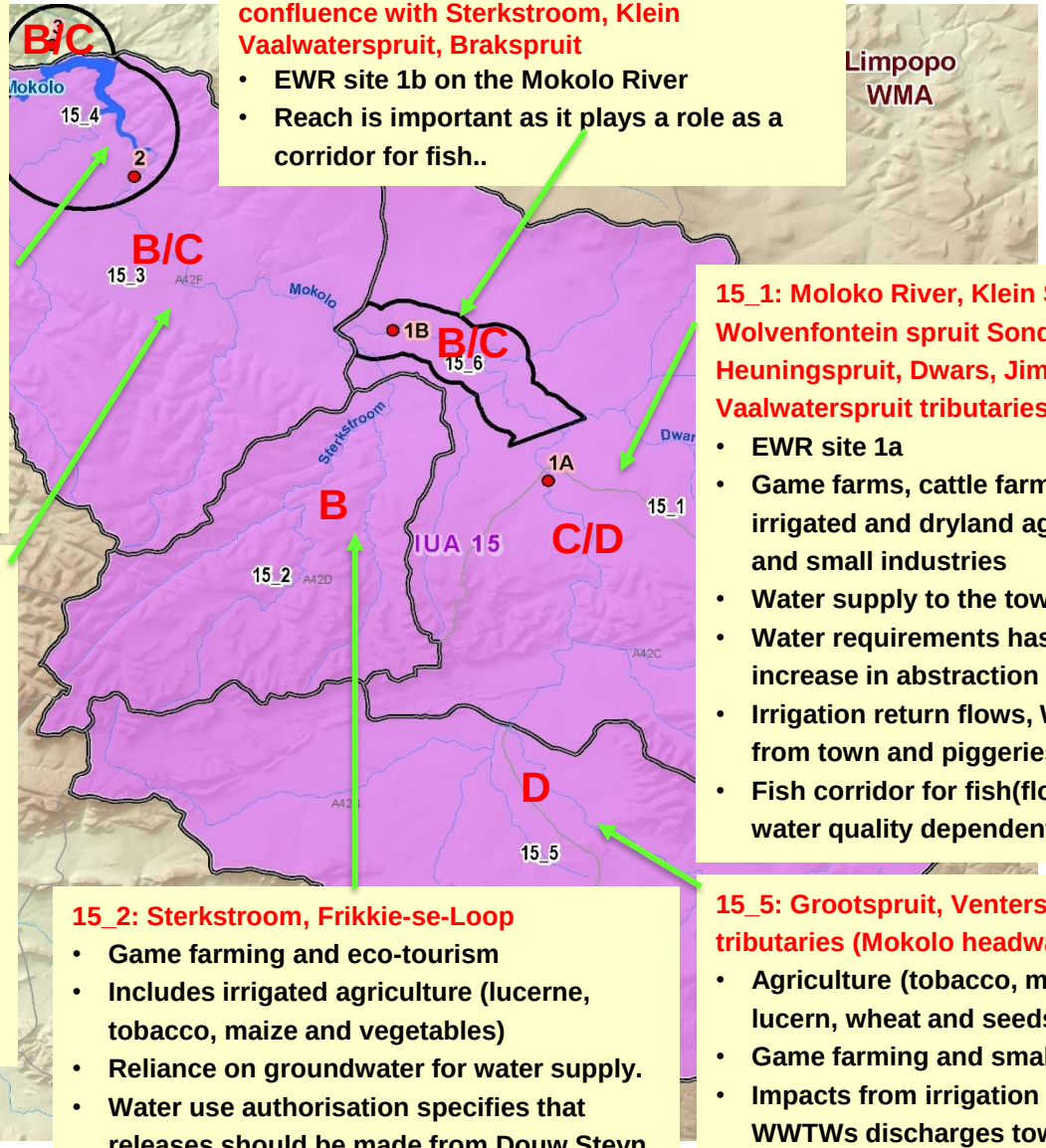
IUA 15: UPPER MOKOLO

15_4: Mokolo Dam to upper portion of A42G (10km downstream of dam)

- EWR site 3
- Dam is located within a nature reserve - protected area.
- Supplies Matimba Power Station, Exxaro Coal Mine and Lephalale (town) with domestic water.
- Also supports recreational activities (e.g. angling).
- Dam releases must be made to support downstream EWRs
- Reach below the dam has unique habitat characteristics..

15_6: – Mokolo River from Dwars river to confluence with Sterkstroom, Klein Vaalwaterspruit, Brakspruit

- EWR site 1b on the Mokolo River
- Reach is important as it plays a role as a corridor for fish..



15_1: Moloko River, Klein Sand, Dopperspruit, Wolvenfontein spruit Sondagsloop, Heuningspruit, Dwars, Jim se loop and Klein Vaalwaterspruit tributaries

- EWR site 1a
- Game farms, cattle farms, as well as irrigated and dryland agriculture, piggeries and small industries
- Water supply to the town
- Water requirements has increased – increase in abstraction
- Irrigation return flows, WWTWs discharge from town and piggeries.
- Fish corridor for fish(flow dependent and water quality dependent fish species).

15_3: Mokolo River in A42F to inflow Mokolo Dam, Taaibosspruit, Malmanies, Platbosspruit and Bulspruit tributaries

- EWR site 2
- Major water user is irrigated agriculture.
- Irrigation return flows and abstraction weirs.
- Water quality issues - septic tanks used by the game lodges.
- Rare and endangered mammals occur within the nature reserve as well as unique fish and invertebrate species.

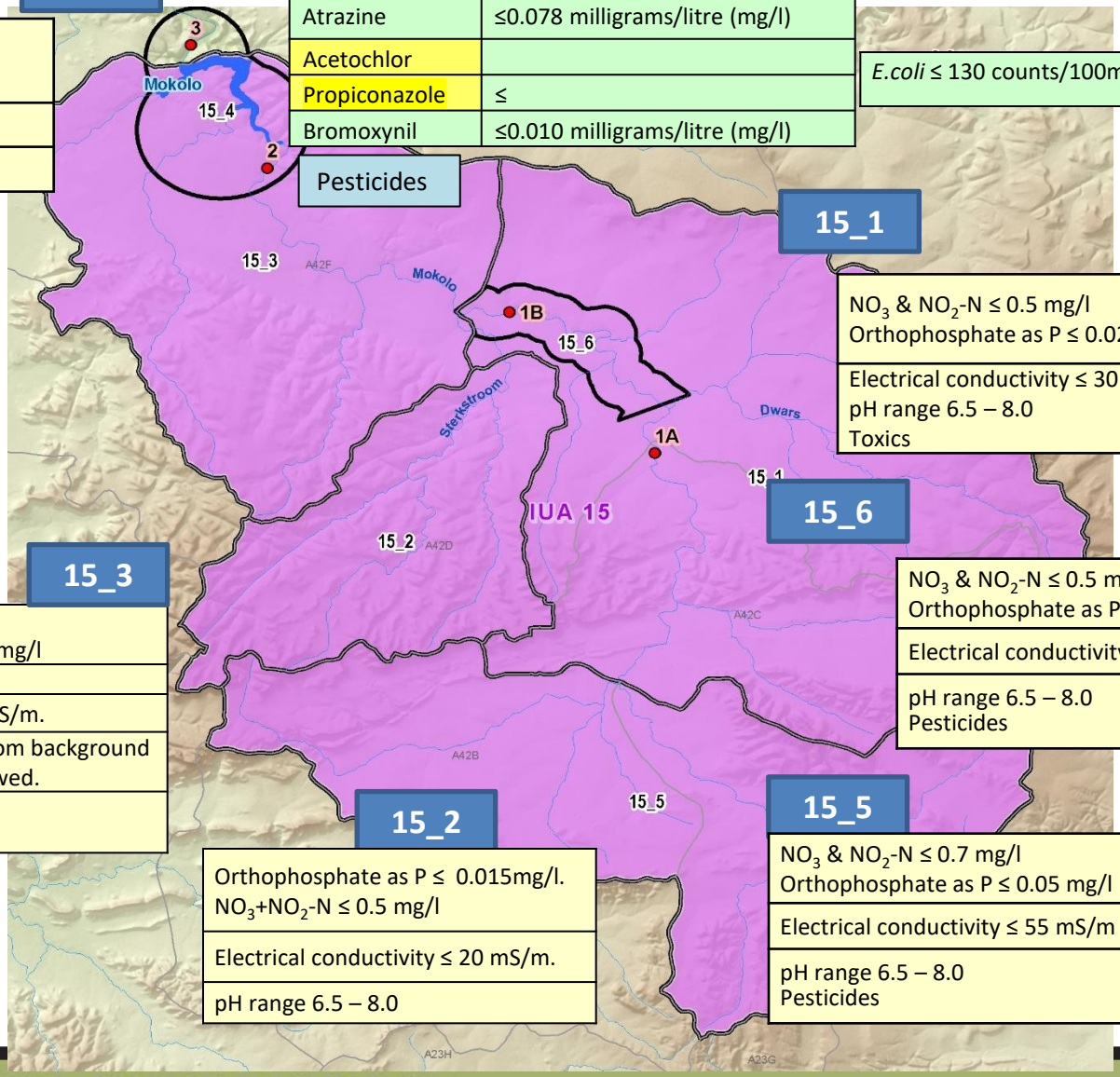
15_2: Sterkstroom, Frikkie-se-Loop

- Game farming and eco-tourism
- Includes irrigated agriculture (lucerne, tobacco, maize and vegetables)
- Reliance on groundwater for water supply.
- Water use authorisation specifies that releases should be made from Douw Steyn dam.

15_5: Grootspruit, Venterspruit and Sandspruit tributaries (Mokolo headwater catchment)

- Agriculture (tobacco, maize, vegertables, lucern, wheat and seeds for export)
- Game farming and small industries. \
- Impacts from irrigation return flows and WWTWs discharges town of Alma.
- Migration corridor for birds.
- Wetland systems are important (Waterberg system unique flora and fauna)

IUA 15: Upper Mokolo
RQOs QUALITY



15_4

NO_3 & NO_2-N ≤ 0.5 mg/l
Orthophosphate as P ≤ 0.010 mg/l

Electrical conductivity ≤ 30 mS/m

pH range 6.5 – 8.0

Atrazine	≤0.078 milligrams/litre (mg/l)
Acetochlor	
Propiconazole	≤
Bromoxynil	≤0.010 milligrams/litre (mg/l)

Pesticides

E.coli ≤ 130 counts/100ml **All RUs**

15_1

NO_3 & NO_2-N ≤ 0.5 mg/l
Orthophosphate as P ≤ 0.025 mg/l

Electrical conductivity ≤ 30 mS/m.
pH range 6.5 – 8.0
Toxics

15_6

NO_3 & NO_2-N ≤ 0.5 mg/l
Orthophosphate as P ≤ 0.020 mg/l

Electrical conductivity ≤ 30 mS/m

pH range 6.5 – 8.0
Pesticides

15_3

Orthophosphate as P ≤ 0.010 mg/l.
NO_3+NO_2-N ≤ 0.5 mg/l
TP: ≤ 0.025 mg/l
Chl *a* ≤10 ug/L

Electrical conductivity ≤ 20 mS/m.
Turbidity ≥ 0.4 m

pH range 6.5 – 9.0

NO_3+NO_2-N ≤ 0.025 mg/l
Orthophosphate as P ≤ 0.50 mg/l

pH range 6.5 – 8.0

Electrical conductivity ≤ 30 mS/m.

Turbidity - A 10% variation from background concentration should be allowed.

Pesticides

15_2

Orthophosphate as P ≤ 0.015mg/l.
NO_3+NO_2-N ≤ 0.5 mg/l

Electrical conductivity ≤ 20 mS/m.

pH range 6.5 – 8.0

15_5

NO_3 & NO_2-N ≤ 0.7 mg/l
Orthophosphate as P ≤ 0.05 mg/l

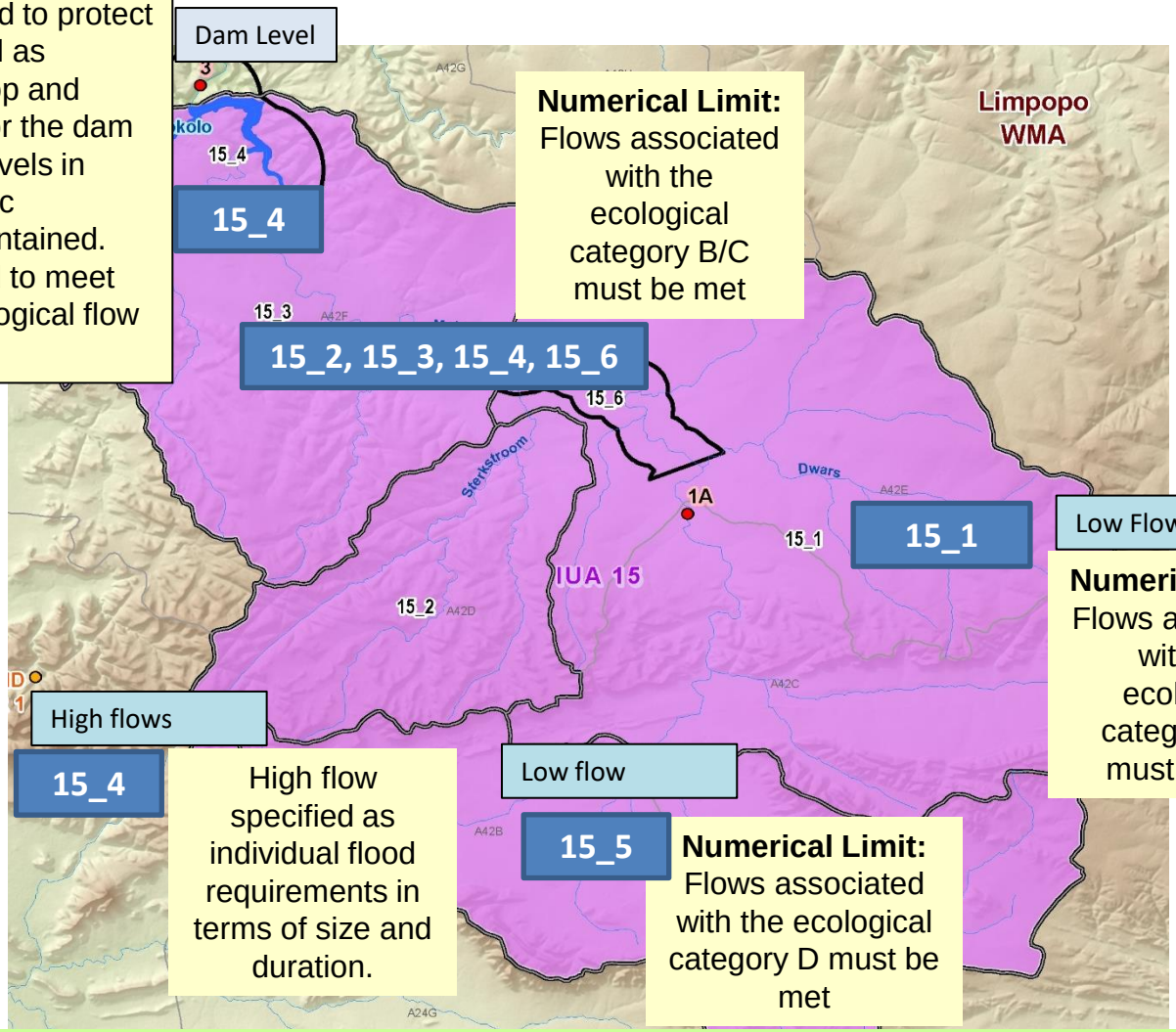
Electrical conductivity ≤ 55 mS/m

pH range 6.5 – 8.0
Pesticides

IUA 15: Upper Mokolo
RQOs QUANTITY

The dam must be managed to protect ecosystem function as well as downstream users. Develop and update operational rules for the dam to sustain optimum dam levels in order to ensure that aquatic ecosystem diversity is maintained. Dam releases are required to meet downstream flows for ecological flow requirements.

Maintenance	Drought
Low flows (m^3/s)	flows (m^3/s)
Oct 1.179	1.179
Nov 1.259	1.259
Dec 1.246	1.246
Jan 1.321	1.321
Feb 1.538	1.538
Mar 1.400	1.400
Apr 1.402	1.402
May 1.334	1.334
Jun 1.368	1.368
Jul 1.313	1.313
Aug 1.279	1.279
Sep 1.244	1.244



RQOs: FLOWS

Low: The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.

High: High flows must be attained as specified to support aquatic ecosystem requirements

IUA 15: Upper Mokolo
RQOs BIOTA – FISH AND MACROINVERTEBRATES

Ensure that the diversity and quantities are maintained.
Numerical Limit: The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Target fish stocks should be determined.

Dams

Fish

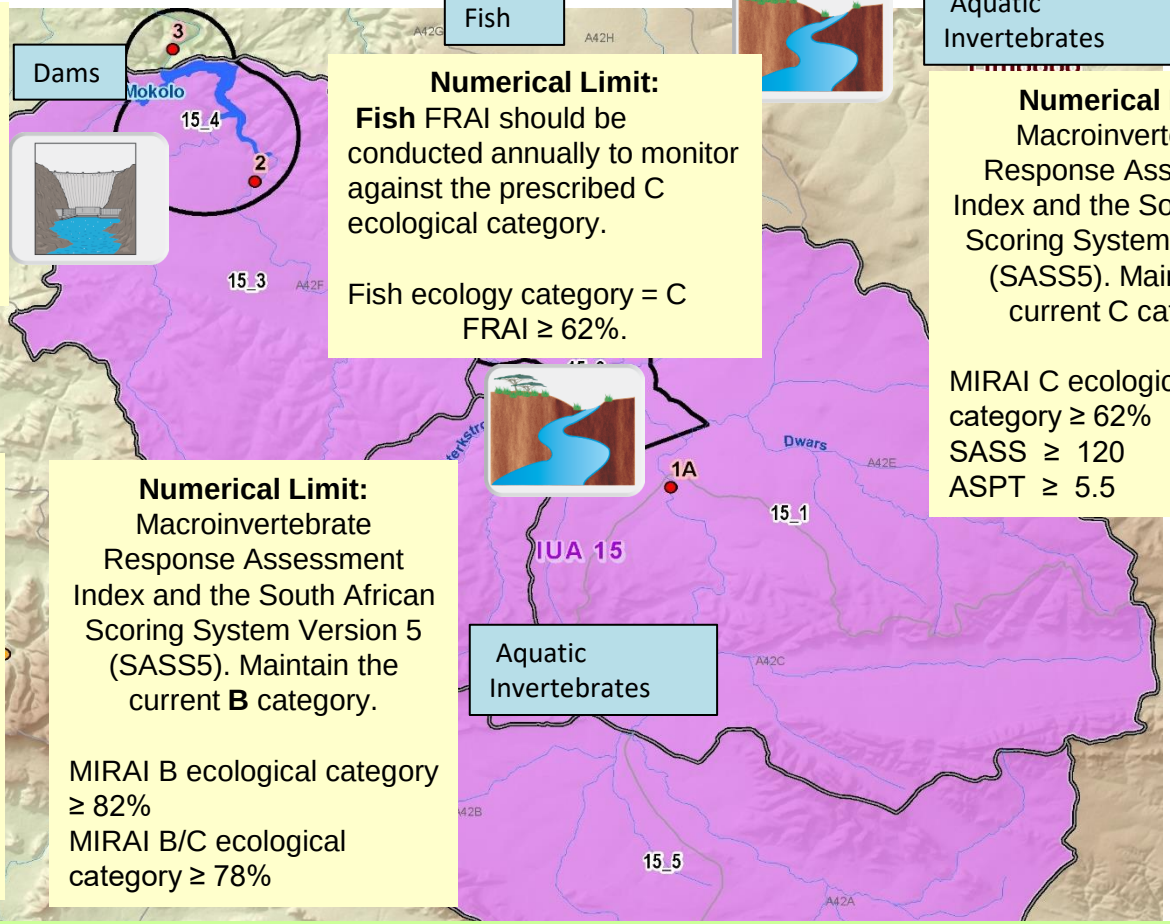
Numerical Limit:
Fish FRAI should be conducted annually to monitor against the prescribed C ecological category.

Fish ecology category = C
FRAI ≥ 62%.

Aquatic Invertebrates

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current C category.

MIRAI C ecological category ≥ 62%
SASS ≥ 120
ASPT ≥ 5.5



Fish

Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of B/**C.**
FRAI should be conducted to monitor against current category.

Fish ecology category = B/C
FRAI ≥ 78%.

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **B** category.

MIRAI B ecological category ≥ 82%
MIRAI B/C ecological category ≥ 78%

Aquatic Invertebrates

RQOs: (representative)

Fish (15_1): Fish community should be improved from a C/D ecological category to a C category. Flow velocity/depth must be maintained for species.
Macro-invertebrates (15_5): Macroinvertebrate assemblage must be maintained within a D ecological category or improved upon.
Semi-aquatic biota: This river reach must be maintained to serve as a habitat for aquatic bird and mammal populations through proper habitat management

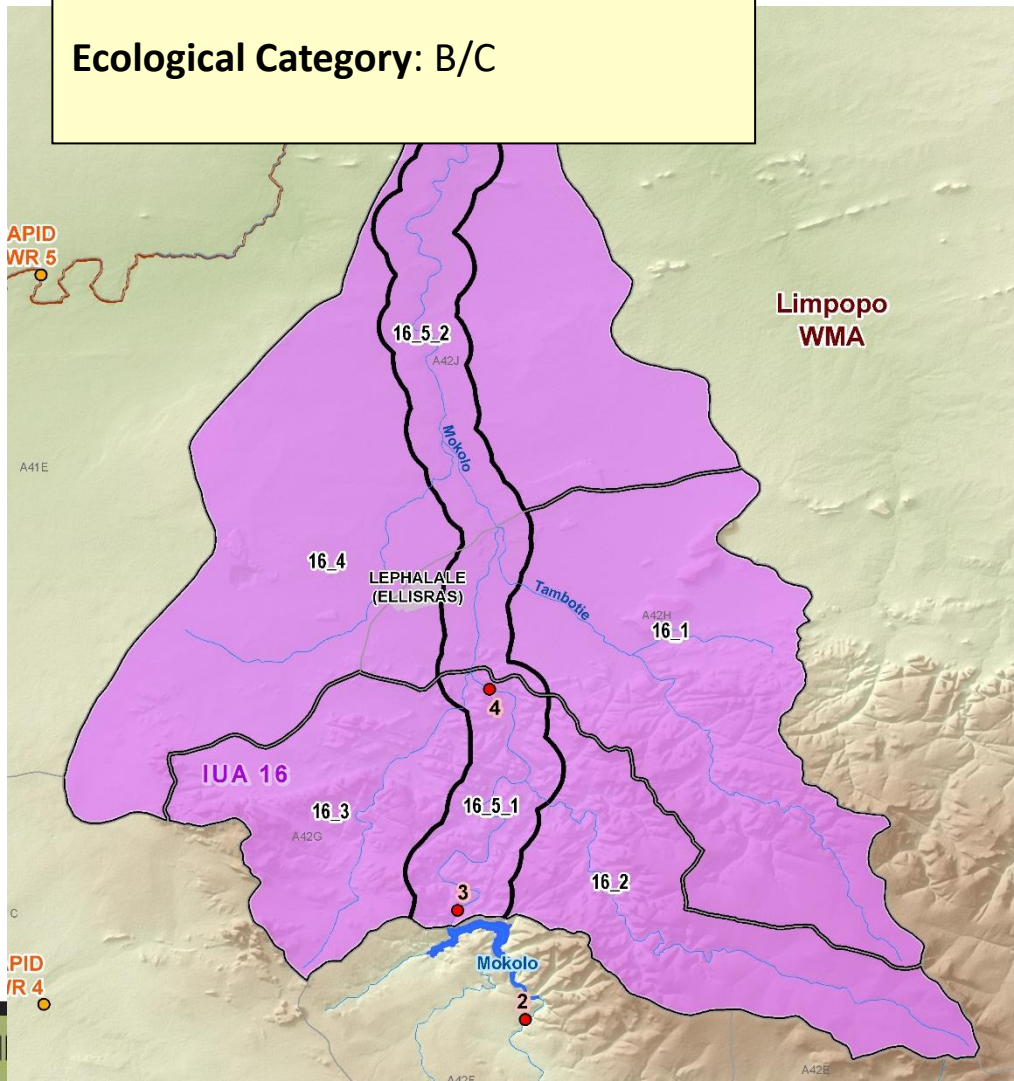
IUA 16: LOWER MOKOLO

RU Number	Delineation Description	Quaternary 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_1	Mokolo main stem - Mokolo from below EWR3 to the Tambotie confluence	A42 G, A42H, A42J (along main stem river)
16_5_2	Mokolo main stem - from Tambotie confluence to Limpopo.	A42J along main stem

Quaternary Catchments: A42G – A42J

Management Class: II

Ecological Category: B/C



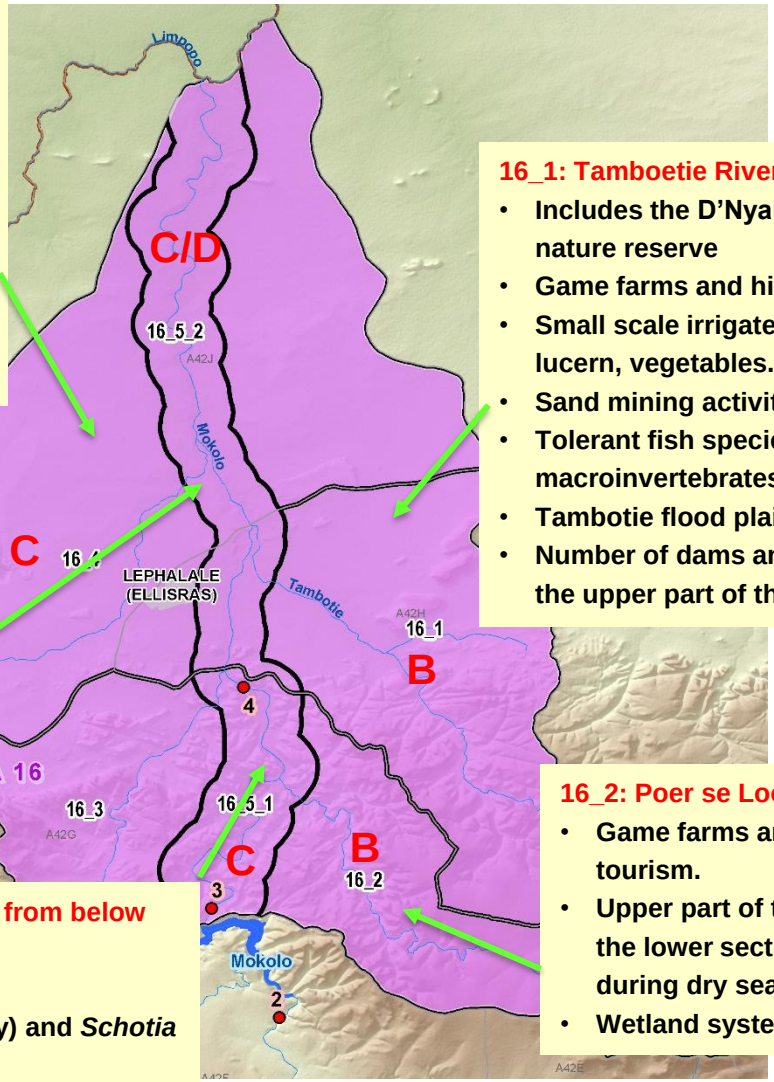
IUA 16: LOWER MOKOLO

16_4: Sandloop

- Medupi and Matimba power stations, Grootegeluk coal mine, Maropong and Lephalale towns.
- Impacts - coal mining, the power stations, - coal bed methane extraction, impacts from the towns as well as irrigated agriculture.
- Water quality impacts are a concern – some deterioration observed.
- Impacts on local groundwater resources due to dewatering and future acid mine drainage discharges.

16_5_2: Mokolo main stem - from Tambotie confluence to Limpopo

- Abstraction activities are high
- Sand mining being a concern in the Lepahlale area.
- Irrigated agriculture, game farms and eco-tourism.
- Flow dependent fish occur (*BMAR, LMOL*).
- Impact of land use on groundwater resources - ensure resource sustainability.



16_1: Tamboetie River catchment

- Includes the D'Nyala protected area and nature reserve
- Game farms and high in tourism.
- Small scale irrigated agriculture - maize, lucern, vegetables.
- Sand mining activities and farm industries
- Tolerant fish species and aquatic macroinvertebrates occur.
- Tambotie flood plain.
- Number of dams and weirs are present in the upper part of the catchment.

16_2: Poer se Loop

- Game farms and related activities, high in tourism.
- Upper part of the river gets flow opposed to the lower section which becomes dry during dry seasons
- Wetland systems in upper reaches.

16_5_1: Mokolo main stem - Mokolo from below EWR3 to the Tambotie confluence

- EWR site MOK_4
- Important vegetation (Water Berry) and *Schotia brachypetala* (huilboerboon)
- Major sand mining occurring - resulted in siltation and loosening of substrate.
- Reed encroachment also present.
- Unique wetland pans - provide habitat for water birds (Mokolo River floodplain present.

IUA 16: Lower Mokolo
RQOs QUALITY

NO_3 & NO_2-N ≤ 0.1 mg/l Orthophosphate as P ≤ 0.050 mg/l
Electrical conductivity ≤ 55 mS/m
pH range 6.5 – 8.5

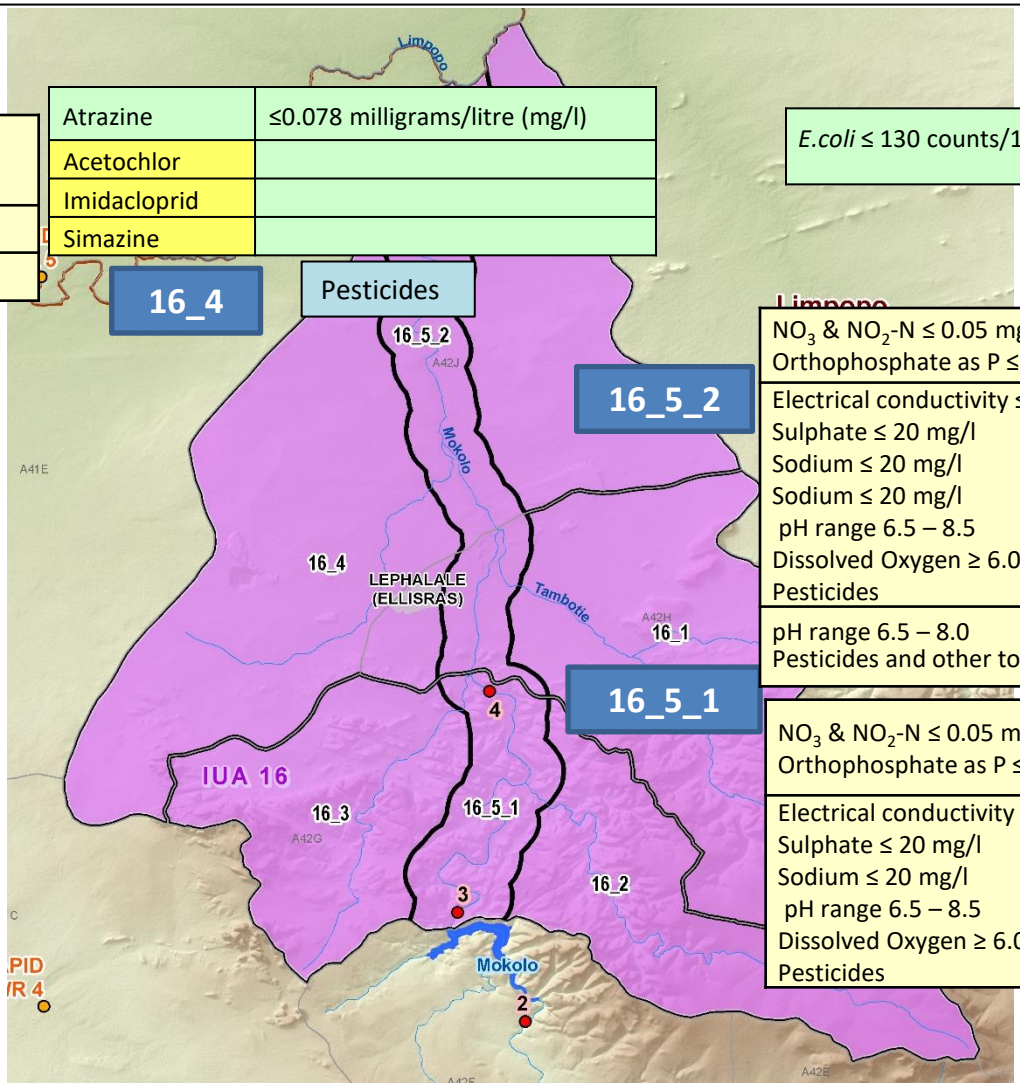
Aluminium	≤ 0.062 mg/l
Manganese	≤ 0.15mg/l.
Iron	≤ 0.1 mg/l.
Lead	≤ 0.0057mg/l
Cobalt	≤ 0.05 mg/l
Copper	≤ 0.0048mg/l
Nickel	≤ 0.07mg/l
Zinc	≤ 0.002mg/l

Other toxics

Atrazine	≤0.078 milligrams/litre (mg/l)
Acetochlor	
Imidacloprid	
Simazine	

Pesticides

E.coli ≤ 130 counts/100ml **All RUs**

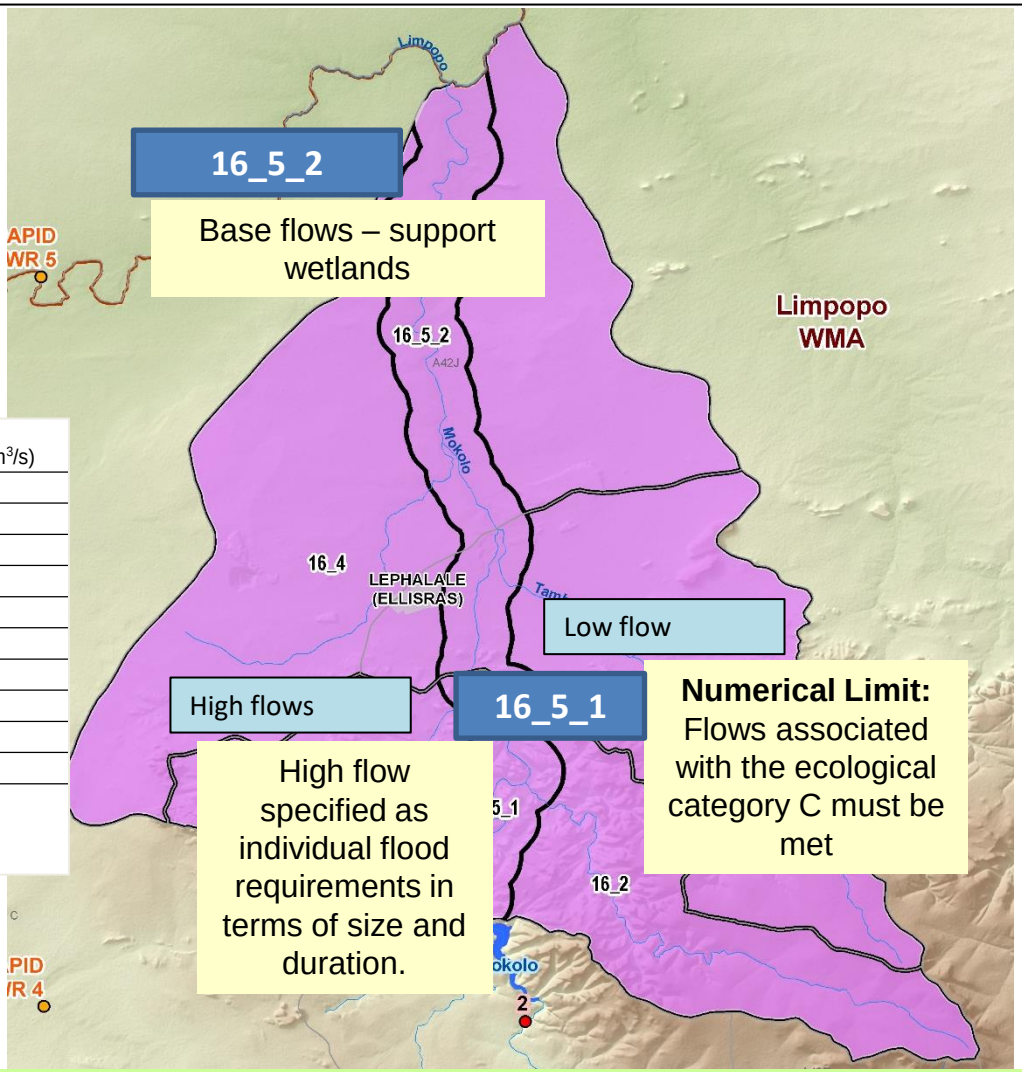


NO_3 & NO_2-N ≤ 0.05 mg/l Orthophosphate as P ≤ 0.01 mg/l
Electrical conductivity ≤ 30 mS/m Sulphate ≤ 20 mg/l Sodium ≤ 20 mg/l Sodium ≤ 20 mg/l pH range 6.5 – 8.5 Dissolved Oxygen ≥ 6.0 mg/l Pesticides
pH range 6.5 – 8.0 Pesticides and other toxics

NO_3 & NO_2-N ≤ 0.05 mg/l Orthophosphate as P ≤ 0.02 mg/l
Electrical conductivity ≤ 30 mS/m Sulphate ≤ 20 mg/l Sodium ≤ 20 mg/l pH range 6.5 – 8.5 Dissolved Oxygen ≥ 6.0 mg/l Pesticides

IUA 16: Lower Mokolo
RQOs QUANTITY

Maintenance Low flows (m^3/s)	Drought flows (m^3/s)
Oct 1.179	1.179
Nov 1.259	1.259
Dec 1.246	1.246
Jan 1.321	1.321
Feb 1.538	1.538
Mar 1.400	1.400
Apr 1.402	1.402
May 1.334	1.334
Jun 1.368	1.368
Jul 1.313	1.313
Aug 1.279	1.279
Sep 1.244	1.244



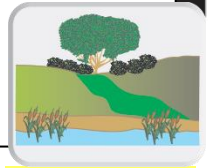
RQOs: FLOWS

Low (16_5_1): The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.

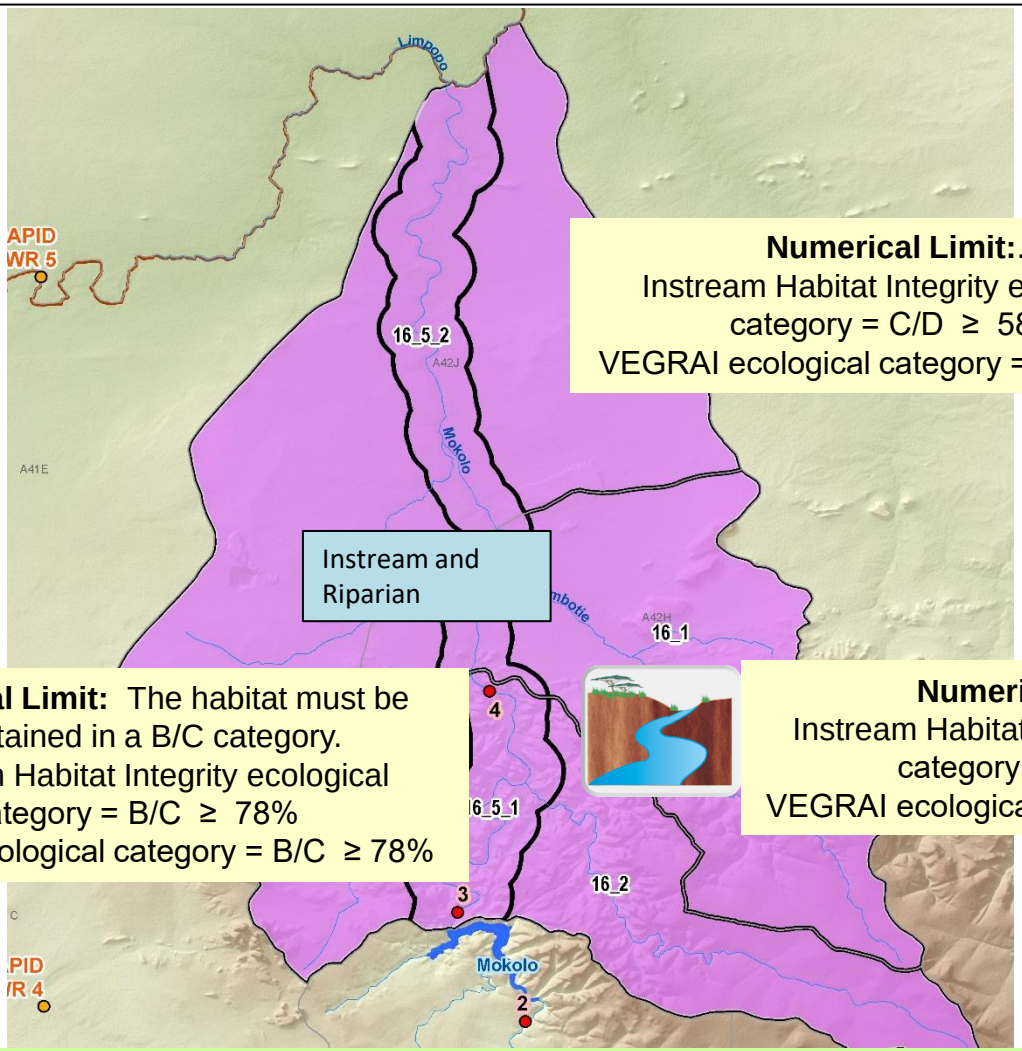
Low (16_5_2): Maintain flows in river to support wetland requirements at in A42J

High (16_5_1): High flows must be met as specified to support aquatic ecosystem requirements.

IUA 16: Lower Mokolo
RQOs HABITAT – INSTREAM AND RIPARIAN



Habitat



Numerical Limit:.
Instream Habitat Integrity ecological category = C/D ≥ 58%
VEGRAI ecological category = C/D ≥ 58%

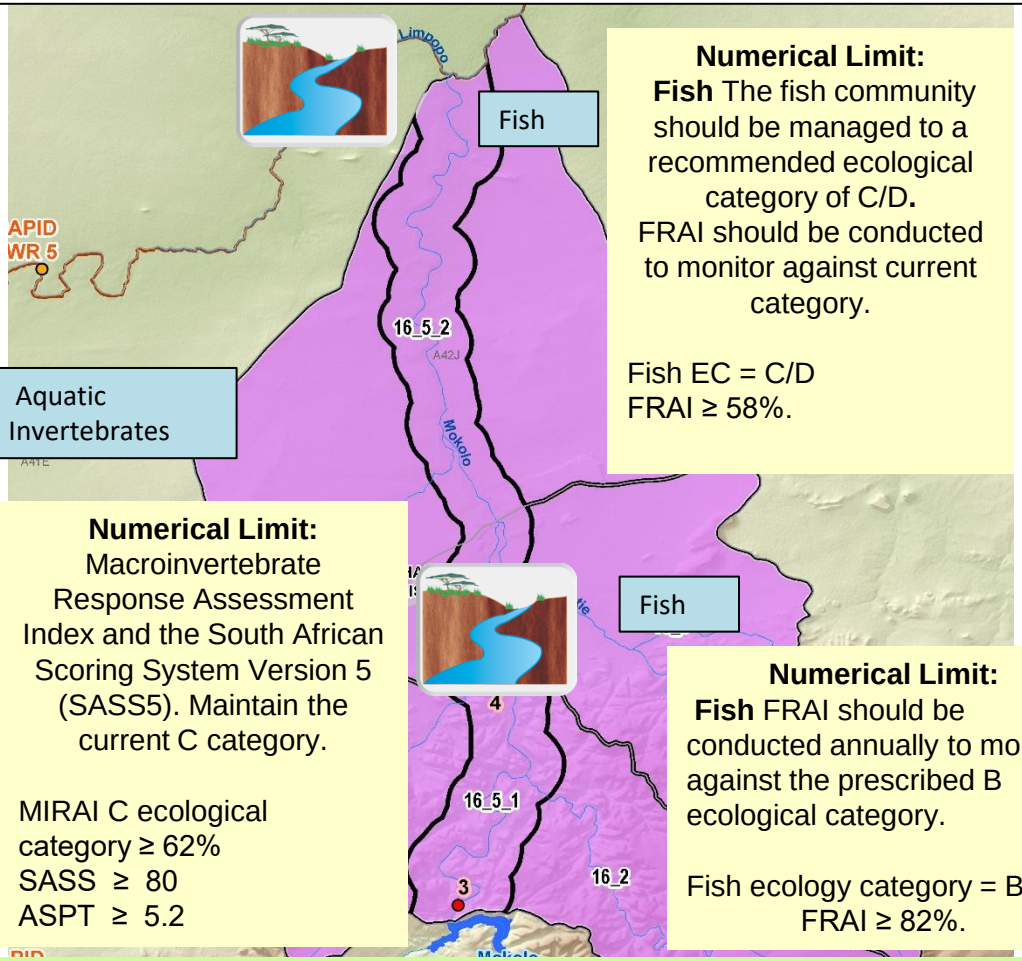
Numerical Limit: The habitat must be maintained in a B/C category.
Instream Habitat Integrity ecological category = B/C ≥ 78%
VEGRAI ecological category = B/C ≥ 78%

Numerical Limit:.
Instream Habitat Integrity ecological category = B ≥ 82%
VEGRAI ecological category = B ≥ 82%

RQOs (Narrative)

Instream: Habitat diversity should be maintained in a B ecological category.
Instream: Habitat diversity must be improved from a D ecological category to a C/D category. Monitor abstraction and flow regime Maintain good connectivity to upstream areas (16_5_1).
Riparian: Vegetation cover should be maintained within B ecological category. Maintain state of riparian zone.
Riparian: Vegetation cover must be improved from a C ecological category to a B/C category.

IUA 16: Lower Mokolo
RQOs BIOTA – FISH AND MACROINVERTEBRATES



Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of C/D**.**
FRAI should be conducted to monitor against current category.

Fish EC = C/D
FRAI ≥ 58%.

Fish

Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of B/**C.**
FRAI should be conducted to monitor against current category.

Fish ecology category = B/C
FRAI ≥ 78%.

Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current C category.

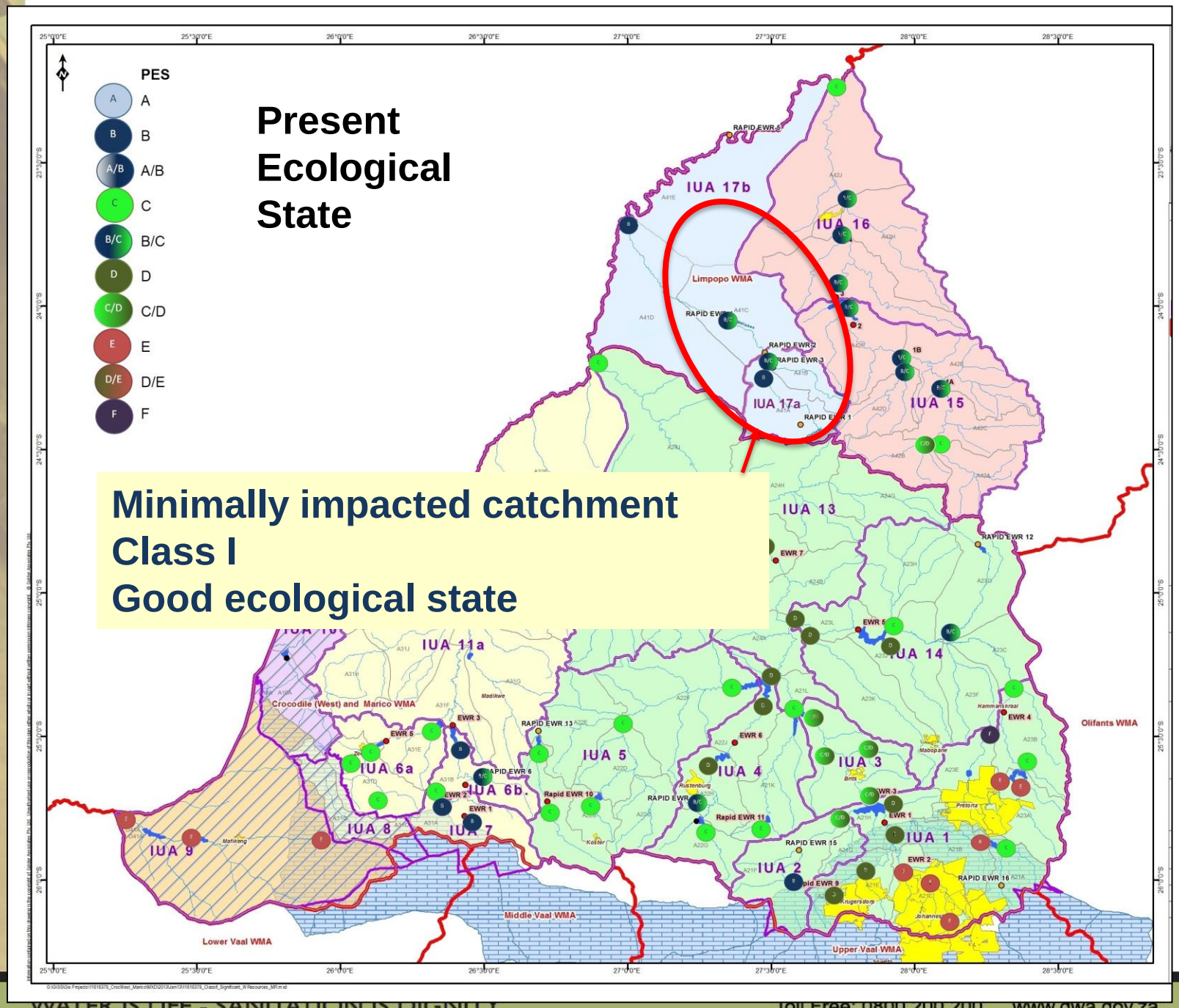
MIRAI C ecological category ≥ 62%
SASS ≥ 80
ASPT ≥ 5.2

Numerical Limit:
Fish FRAI should be conducted annually to monitor against the prescribed B ecological category.

Fish ecology category = B
FRAI ≥ 82%.

RQOs: (representative)

Fish (16_5_2): Fish community must be improved from a D ecological category to a C/D category.
Fish (16_2): Fish community should be maintained within a B ecological category. Maintain flow velocity/depth for flow dependent and habitat sensitive species. (upper catchment)
Macro-invertebrates (16_5_1): Macroinvertebrate assemblage must be maintained within a C ecological category or improved upon..
Semi-aquatic biota: This river reach must be maintained to serve as a habitat for aquatic bird and mammal populations through proper habitat management. Maintain riparian zone.


PES
A
B
A/B
C
B/C
D
C/D
E
D/E
F
Present Ecological State
Minimally impacted catchment
Class I
Good ecological state
IUA 17b
IUA 16
IUA 17a
IUA 15
IUA 13
IUA 14
IUA 11a
IUA 6a
IUA 6b
IUA 5
IUA 4
IUA 3
IUA 8
IUA 7
IUA 9
IUA 1
IUA 2
Limpopo WMA
Crocodile (West) and Marico WMA
Olifants WMA
Lower Vaal WMA
Middle Vaal WMA
Upper Vaal WMA
RAPID EWR 6
RAPID EWR 2
RAPID EWR 3
RAPID EWR 1
RAPID EWR 12
EWR 7
EWR 5
EWR 4
EWR 3
EWR 6
EWR 2
EWR 1
RAPID EWR 13
RAPID EWR 10
RAPID EWR 11
RAPID EWR 15
RAPID EWR 16
RAPID EWR 9

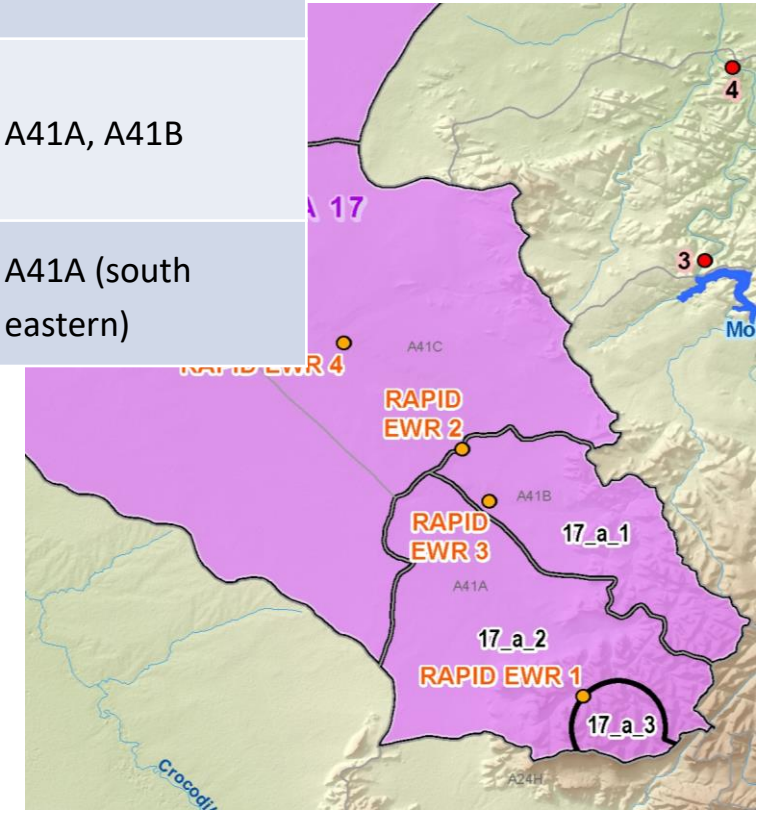
IUA 17a: MOTHLABATSI/MAMBA

RU	Delineation	Catchment
17a_1	Mamba River	A41B
17a_2	Mothlabatsi River, Matlabas	A41A, A41B
17a_3	Headwaters Mothlabatsi (Matlabas-Zyn-Kloof, peatlands)	A41A (south eastern)

Quaternary Catchments: A42G – A42J

Management Class: I

Ecological Category: B/C



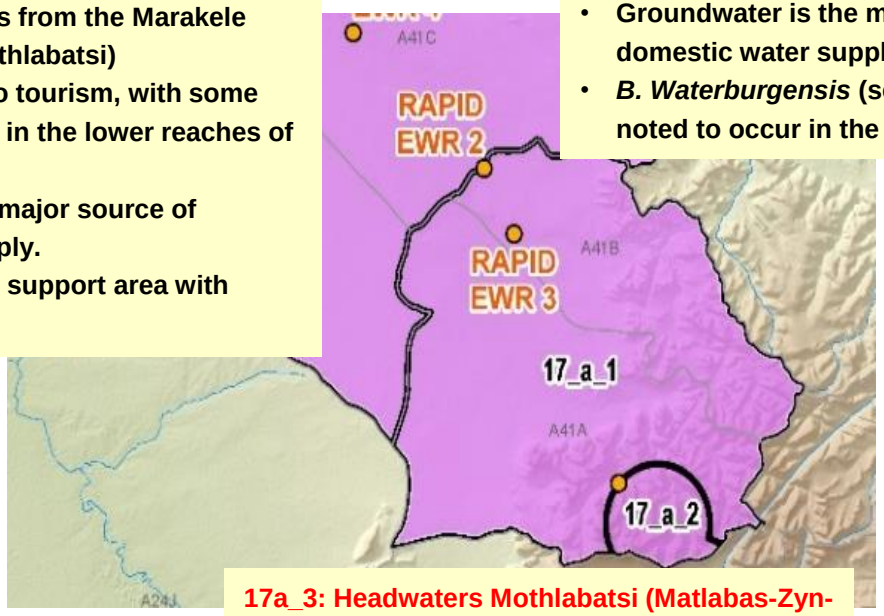
IUA 17a: MOTHLABATSI/MAMBA

17a_2: Mothlabatsi/Matlabas

- EWR site 2 on the Matlabas River
- Matlabas River flows from the Marakele Nature Reserve (Mothlabatsi)
- Area is primarily eco tourism, with some irrigated agriculture in the lower reaches of the catchment.
- Groundwater is the major source of domestic water supply.
- The system is a fish support area with limited impacts.

17a_1: Mamba River

- EWR site 3 on the Mamba River
- Area is primarily eco-tourism.
- Groundwater is the major source of domestic water supply.
- *B. Waterburgensis* (secret fish) has been noted to occur in the Mamba.



17a_3: Headwaters Mothlabatsi (Matlabas-Zyn-Kloof, peatlands)

- EWR site 1 on the Matlabas-Zyn-Kloof
- Mothlabatsi River flows through the Marakele Nature Reserve
- Headwaters of the Mothlabatsi.
- Protected area with limited impacts.
- Large wetlands occur within this IUA.
- Flow dependent fish species

IUA 17a: Mothlabatsi/Matlabas
RQOs

Low flow

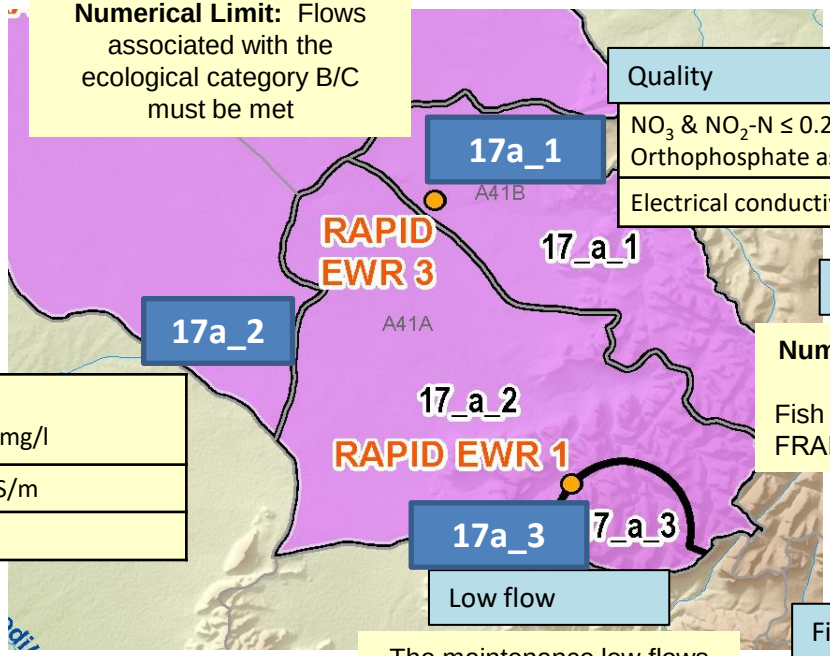
The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.
Numerical Limit: Flows associated with the ecological category B/C must be met

Instream and Riparian

.Numerical Limit:
Instream Habitat Integrity ecological category = B/C ≥ 78%
VEGRAI ecological category = B/C ≥ 78%

Instream and Riparian

.Numerical Limit:
Instream Habitat Integrity ecological category = B/C ≥ 78%
VEGRAI ecological category = C ≥ 62%



Quality

NO_3 & NO_2-N ≤ 0.25 mg/l
Orthophosphate as P ≤ 0.015 mg/l

Electrical conductivity ≤ 20 mS/m

Aquatic Invertebrates

Numerical Limit:

MIRAI = C ecological category ≥ 62%
SASS ≥ 130
ASPT ≥ 5.5

Quality

NO_3 & NO_2-N ≤ 0.25 mg/l
Orthophosphate as P ≤ 0.015 mg/l

Electrical conductivity ≤ 20 mS/m

pH range 6.5 – 8.5

Fish

Numerical Limit:

Fish EC = C
FRAI ≥ 62%.

Instream and Riparian

.Numerical Limit:
Instream Habitat Integrity ecological category = A ≥ 90%
VEGRAI ecological category = B ≥ 82%

Low flow

The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.
Numerical Limit: Flows associated with the ecological category A must be met

Fish

Numerical Limit:

Fish EC = B
FRAI ≥ 82%.

IUA 17b: /Matlabas
RQOs

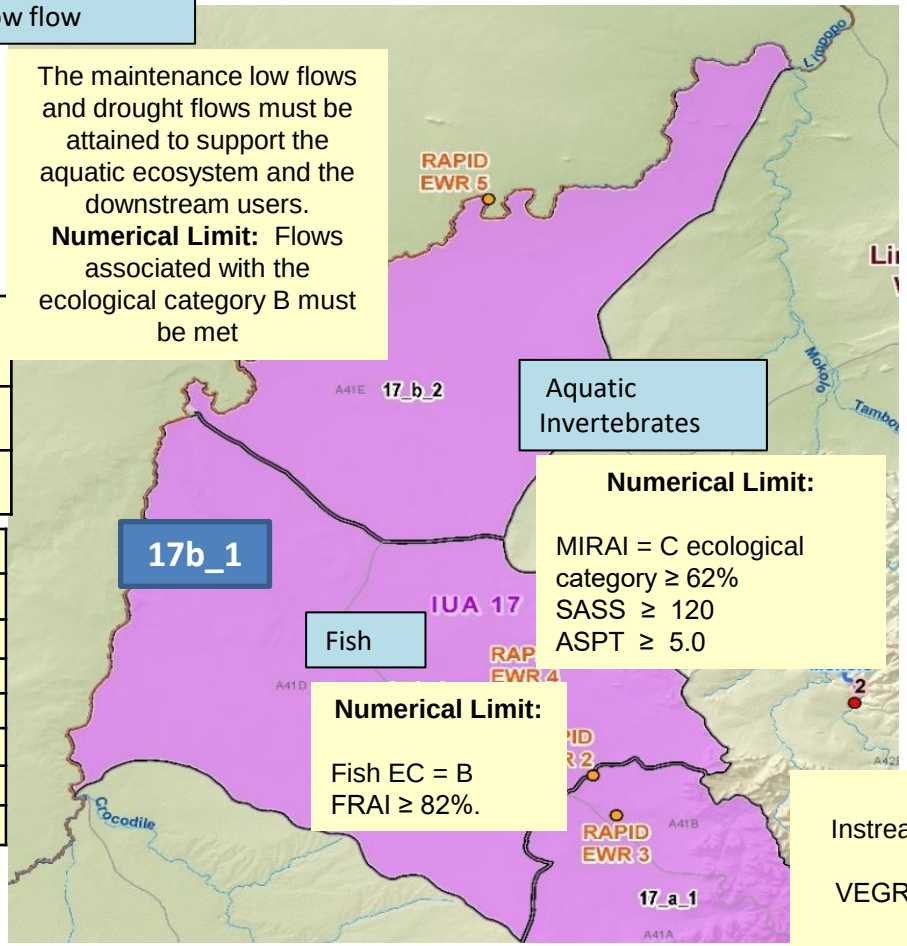
Low flow

The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.
Numerical Limit: Flows associated with the ecological category B must be met

Quality

NO_3 & NO_2-N ≤ 0.07 mg/l Orthophosphate as P ≤ 0.050 mg/l
Electrical conductivity ≤ 40 mS/m Sulphate ≤20 mg/l
pH range 6.5 – 8.5 Dissolved oxygen: ≥ 6mg/l

Aluminium	≤ 0.062 mg/l
Manganese	≤ 0.15mg/l.
Iron	≤ 0.1 mg/l.
Lead	≤ 0.0057mg/l
Cobalt	≤ 0.05 mg/l
Copper	≤ 0.0048mg/l
Nickel	≤ 0.07mg/l
Zinc	≤ 0.002mg/l



Aquatic Invertebrates

Numerical Limit:

MIRAI = C ecological category ≥ 62%
SASS ≥ 120
ASPT ≥ 5.0

Fish

Numerical Limit:

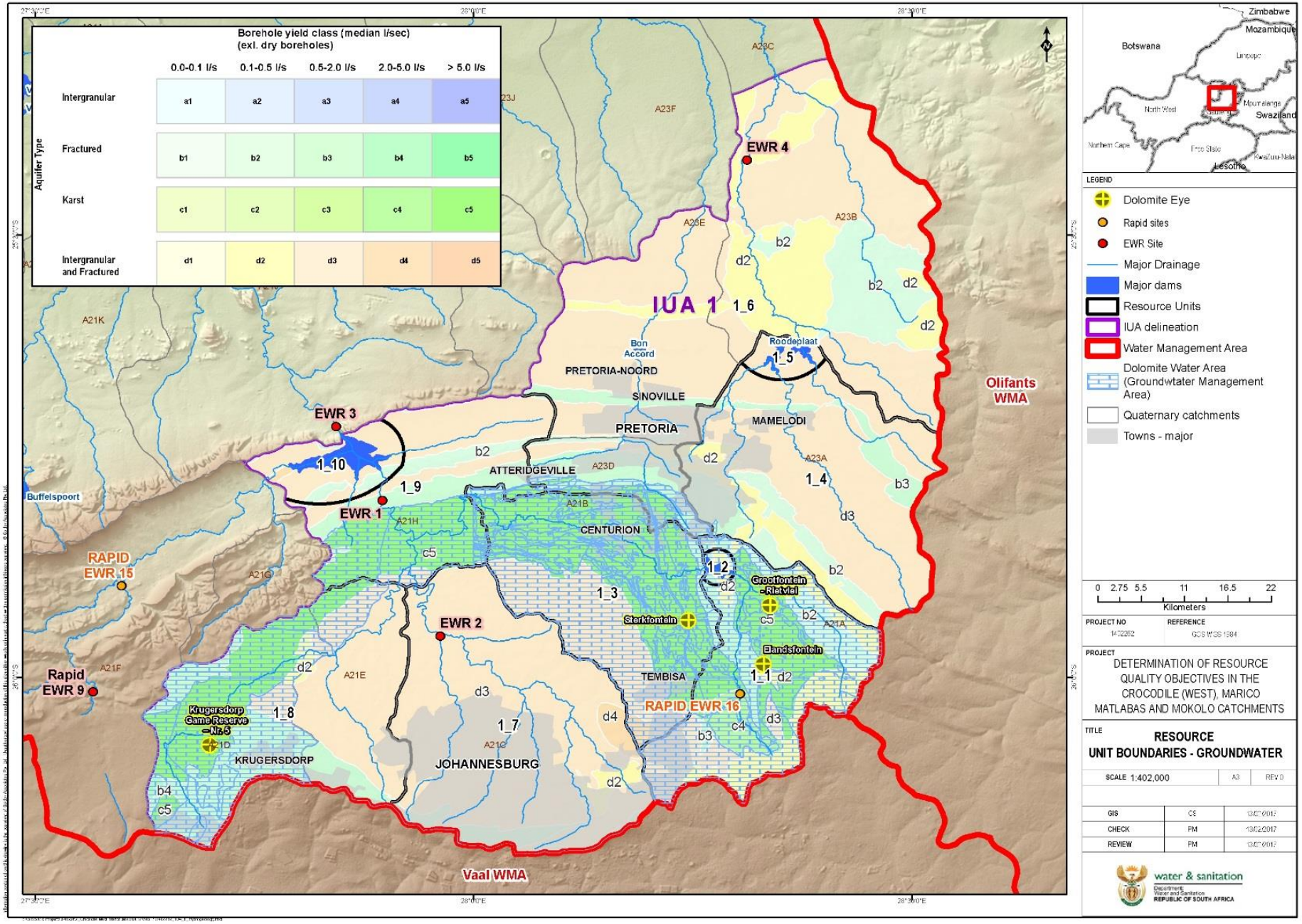
Fish EC = B
FRAI ≥ 82%.

Instream and Riparian

Numerical Limit:
Instream Habitat Integrity ecological category = B ≥ 82%
VEGRAI ecological category = B ≥ 82%

DRAFT GROUNDWATER RESOURCE QUALITY OBJECTIVES

Upper Crocodile/Hennops/Hartbeespoort: RU 1_1, 1_2, 1_3, 1_8 and 1_9



Upper Crocodile/Hennops/Hartbeespoort: RU 1_1, 1_2, 1_3, 1_8 and 1_9 QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Groundwater flow patterns based on piezometric elevations in aquifer units should not be reversed from its natural flow directions toward the local drainages (Hennops, Rietvlei and Bloubankspruit systems).	Groundwater level depths (piezometric levels to show flow regime wrt surface water sources). Time series water level monitoring (Monthly) vs abstractions and rainfall input Abstraction of groundwater within prescribed zones from the river course/wetland/eye)	Dolomite aquifer systems: Saturation levels should not be lowered >6 m below an average water level depth of ~**22** m (1_1 – 1_2), ~20 m (1_3), ~15 m (1_9), and ~**34** m (1_8) in the dolomite aquifer area. Water level recession rate must be less than 0.75 m/a. Abstraction zoning: should be regulated within a 1000 m radius from flowing eye's.
Sustainable abstractions at Grootfontein-Rietvlei and Pretoria Eyes. Groundwater balance (aquifer recharge and abstraction) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods).	Calculation of Stress Indexes (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%);

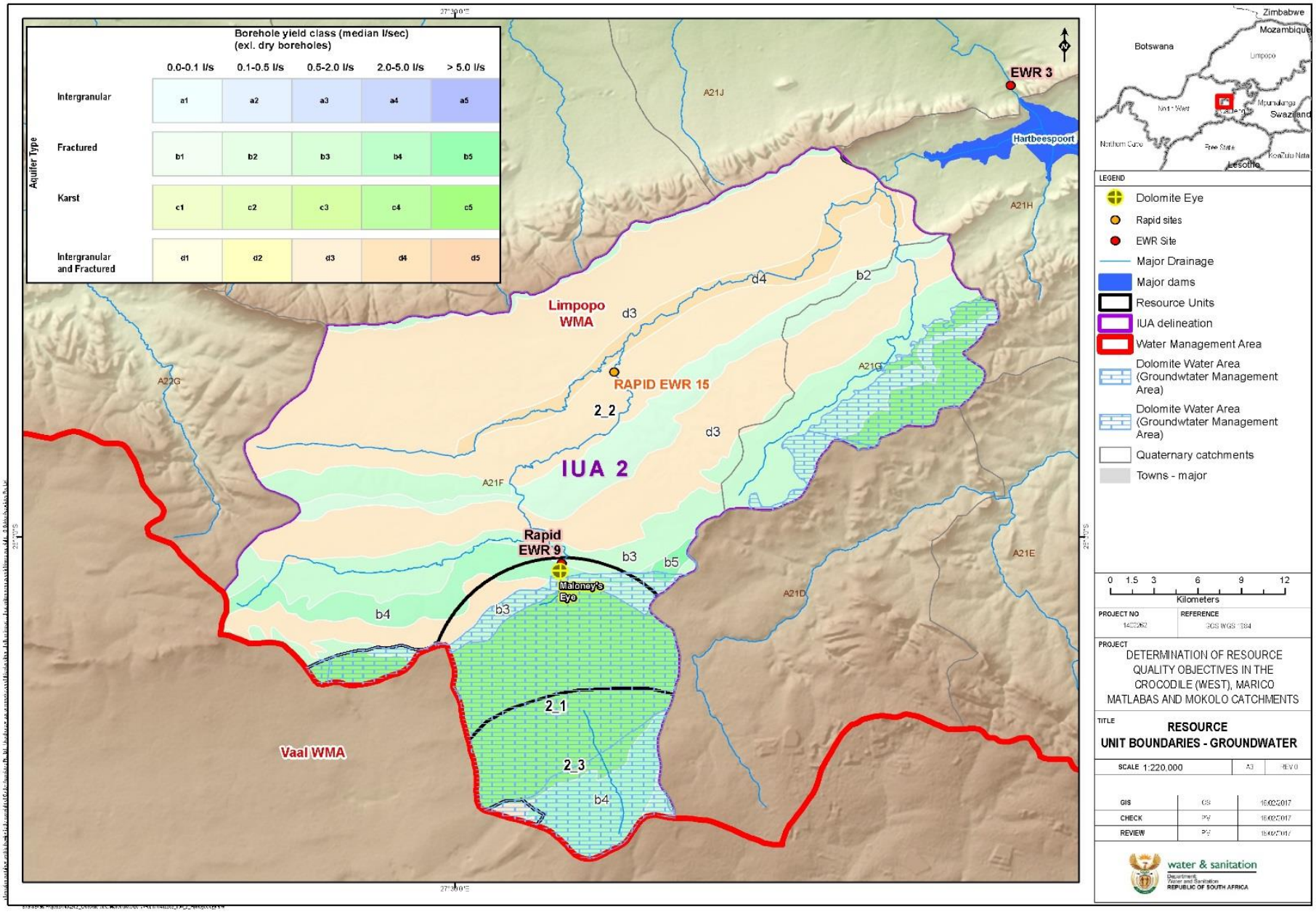
Upper Crocodile/Hennops/Hartbeespoort: RU 1_1, 1_2, 1_3, 1_8 and 1_9 QUALITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Aquifer water quality maintained to support ideal/good quality domestic water supply.	Nutrients - Nitrate (NO^3–N, mg/l). Bi-annual monitoring of major constituents (macro elements).	Nitrate: Less than 1.0 mg/l. Annual long-term trend should not approach the 50th percentile (*i.e.* 0.9 NO_3–N mg/l).
	Salts - Electrical Conductivity (TDS), mg/l). Bi-annual monitoring of major constituents (macro elements).	Electrical Conductivity ≤30 mS/m; Annual long-term trend should not approach the 95th percentile (*i.e.* ~60 mS/m).
Background water quality status in dolomite aquifer system downstream from Tweelopies Spruit and Bloubank Spruit must be maintained. (Currently impacted EC=220 mS/m, SO_4=965 mg/l, and NO_3–N=3.3 mg/l, median values).	EC, Sulphates and nitrates (origin AMD) in head water area (Tweelopies Spruit) Monthly water quality monitoring at source (TCTA WTW discharges).	Tweelopiespruit (RU 1_8): Limit long-term water quality indicators: EC level = 220 mS/m; SO_4 concentration = 200 mg/l; and NO_3–N concentration = 3.3 mg/l.
Maintain good water quality status at Grootfontein-Rietvlei and Pretoria Dolomite Eyes.	EC, pH, SO_4 and NO_3–N to be used was quality indicators.	**Limit long-term–Annual long-term:** **EC: 25 mS/m–27 mS/m (95th percentile);** **SO_4: <4.5 mg/l–6.4 mg/l SO4 (95th)** **NO_3–N: 0.9 mg/l–1.0 mg/l (95th percentile).**

Upper Crocodile/Hennops/Hartbeespoort: RU 1_1, 1_2, 1_3, 1_8 and 1_9 PROTECTION ZONE

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Specifically dolomite aquifer systems (Hennops and Bloubankspruit, Rietvlei wetlands, Grootfontein-Rietvlei and Pretoria Eyes): Specific water resource protection requirements should become audit conditions in water use licences.	Limit radius of influence (r) due to abstractions	Water level drawdown limited to dolomite sub-compartment unit.
	Distance from river (L)	Activity should be >500 m.
	Distance from wetland (L)	Activity should be >1000 m.
	Distance from Dolomite Eye (L)	Activity should be >1000 m.
	Ground stability (draw down limit, L, to protect buildings/roads /infrastructures)	Limited to 6 m in sub-compartment unit, unless specifically authorised.

Maloney's Eye: RU 2_1, 2_2



Maloney's Eye: RU 2_1, 2_2
QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Maloney's Eye – Continuous flow at eye discharge (head waters of the Magalies River – A21F and Skeerpoort River – A21G).	Groundwater Levels (boreholes) in the eye's catchment, i.e. depth to groundwater level from ground elevation;	Dolomite aquifer saturation levels should not be lowered more than 6 m below an average water level depth of ~**30** m in the Maloney's Eye catchment area;
	Flow volumes at Maloney's Eye (compared with rainfall input, water level trends and abstractions in catchment of the eye (i.e. Steenkoppies Compartment);	Flow volume at Maloney's Eye must not be lower than ~**4** Mm^3/a (i.e. the pre 1974 long-term yield since 1908 – 1973).
	Abstraction of groundwater within prescribed protection zones at the Maloney's Eye (pool and downstream course as per monitor programme).	Abstraction zoning: to be regulated with the flow at the eye in a radius of 1000 m from the eye pool area.
Groundwater balance (aquifer recharge and irrigation abstraction)	Calculation of Stress Indexes (Aquifer Unit Use ***divided*** by Aquifer Unit Recharge) as percentages.	Limitation of SI value to 65%.

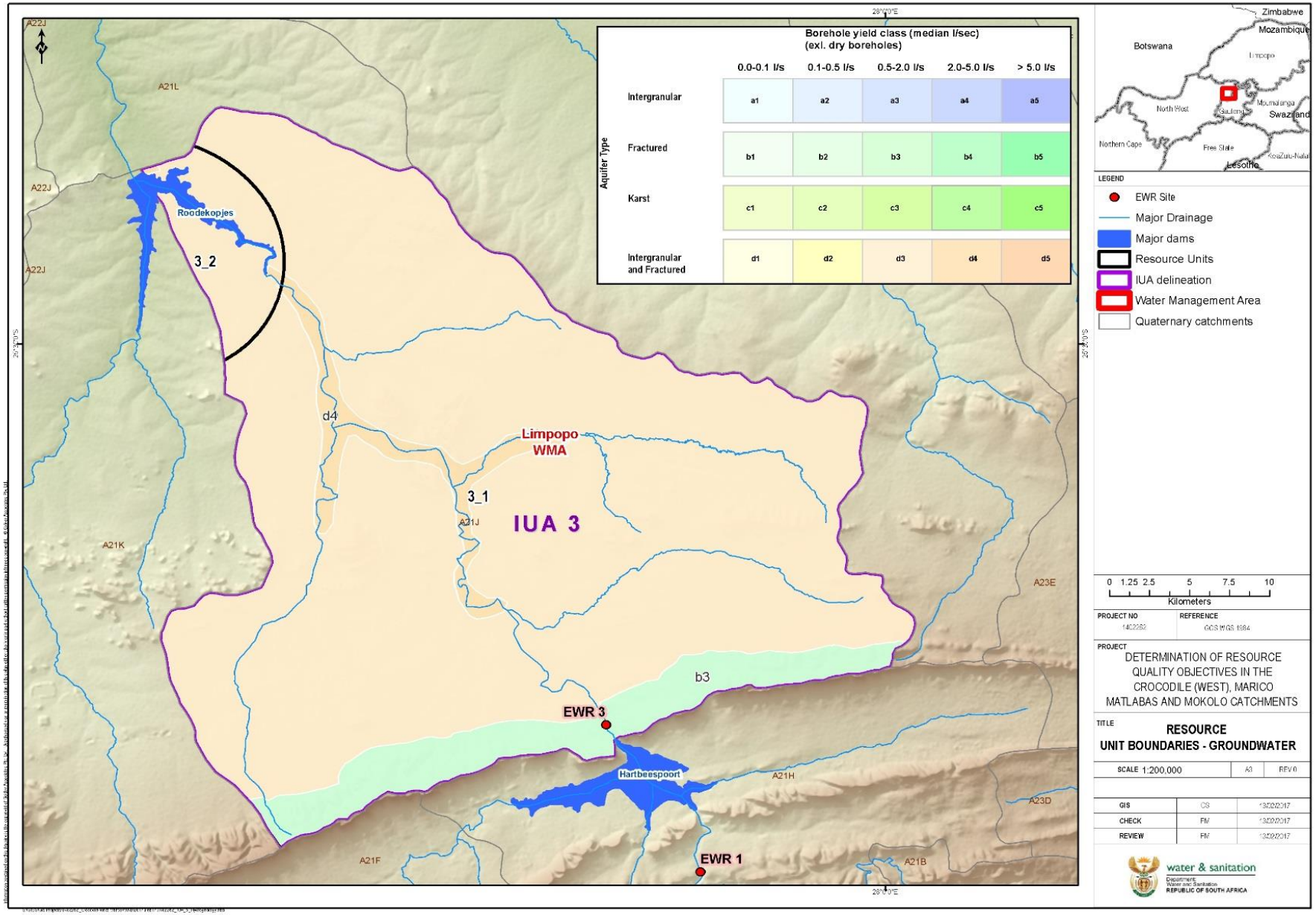
Maloney's Eye: RU 2_1, 2_2 QUALITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users.	Nutrients - Nitrate (NO_3–N, mg/l). Bi-annual Monitoring.	Nitrate: Less than 0.3 mg/l. Annual long-term trend should not approach the 95th Percentile (~0.5 mg/l)
Remain Ideal Water Quality status at Malony's Eye, Magalies and Skeerpoort Rivers.	Sulphates (origin AMD) in head water area in the Randfontein Spruit and Bloubank Spruit with possible link across A21D and A21F boundary (fractured Tarlton dyke). Bi-annual monitoring.	SO_4: Less than 5 mg/l. Annual long-term trend should not approach the 95th percentile (~10 mg/l)
Salinity levels should not increase. Concentrations must be maintained at levels to secure an Ideal/Good water quality status.	Salinity - Electrical Conductivity (TDS), mg/l). Bi-annual monitoring of major constituents (macro elements).	Electrical Conductivity: Less than 25 mS/m; Annual long-term trend should not approach the 95th percentile (~30 mS/m).

Maloney's Eye: RU 2_1, 2_2
Protection Zone

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Demarcated protection zones to be introduced, *i.e*. distances between activity and eye/pool. Specifically for dolomite aquifer systems (Maloney's Eye, Magalies River downstream and Skeerpoort River).	Stream Depletion Factor	Limit to <5% of wetland/surface water resource
	Distance from river (L).	Activity regulated if <500 m from downstream drainage
	Distance from Dolomite Eye (L).	Activity regulated if <1000 m from downstream drainage.
	Distance from wetland (L).	Activity regulated if <1000 m from downstream drainage.
	Ground stability (DCU drawdown limit, L) (Buildings/roads/infrastructures).	Limited to 6 m sub-compartment unit, unless specifically authorised.

IUA3: (Upper) Crocodile River (Alluvial Aquifers): 3_1 and 3_2



IUA3: (Upper) Crocodile River (Alluvial Aquifers): 3_1 and 3_2 QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Time series water level monitoring (L) across local intergranular and fractured aquifer to establish aquifer-river water interaction; Water level observations (local piezometric status).	Water Level - Depth to groundwater level on alluvial aquifer system. Groundwater level trends; and Gwater level gradient in drainage valley.	Reverse groundwater gradient in a 500 m zone along main stem not allowed. Water level recession rate must be less than 1.0 m/a.
Water balance (interception of surface water).	Positive/Negative water balance estimations, Volume (Q); Flow depletion at downstream gauging weirs.	Surface water losses at gauging stations must equal authorised abstractions from river.
Groundwater balance status in intergranular and fractured aquifer system	Calculation of Stress Indexes (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	Limitation of Stress index value (<65%).

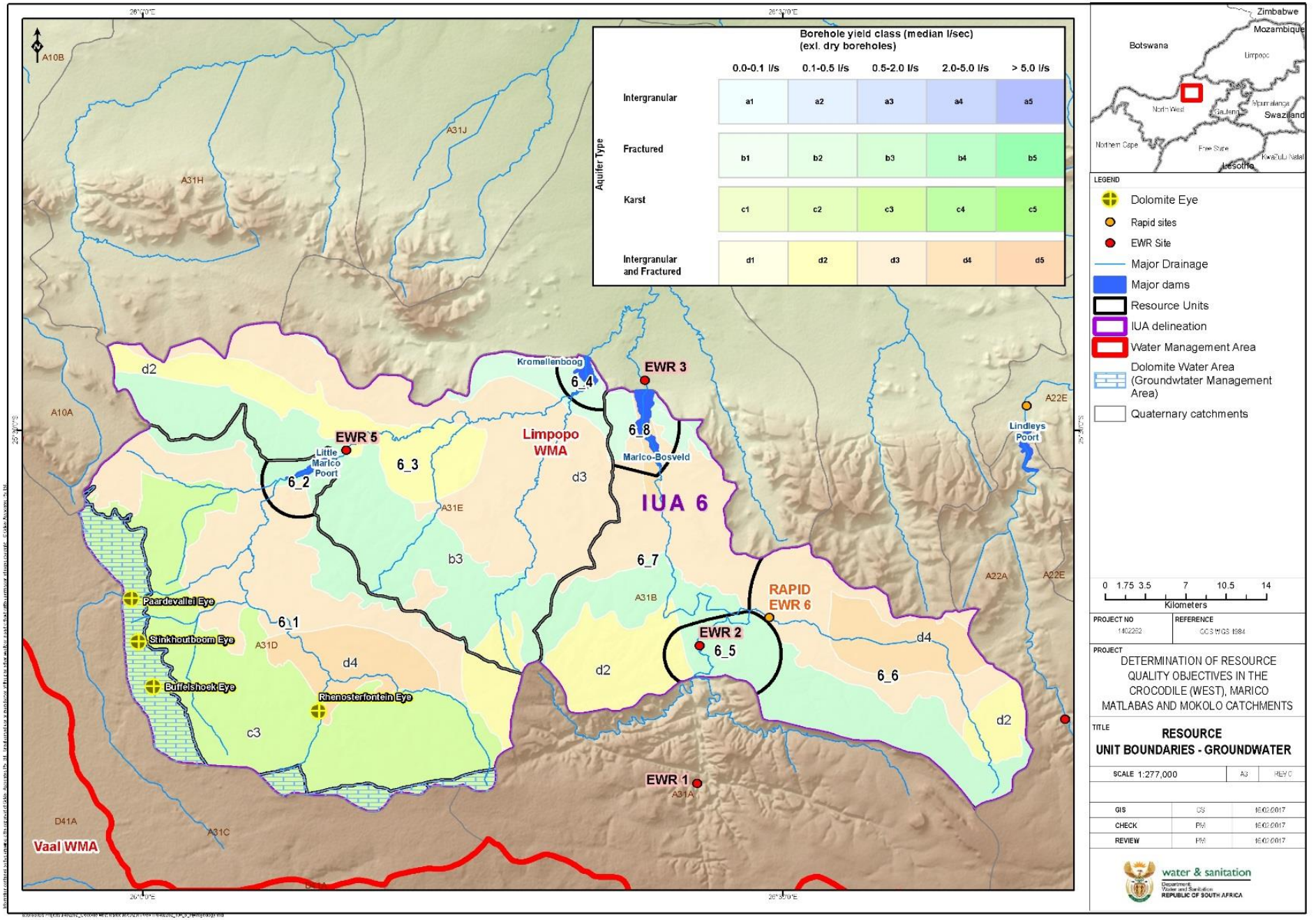
IUA3: (Upper) Crocodile River (Alluvial Aquifers): 3_1 and 3_2 QUALITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users.	Nutrients - Nitrate (NO_3–N, mg/l). Bi-annual Monitoring.	Nitrate: <6.0 mg/l;
Manage irrigation return flows from alluvial aquifer system. Salinity levels should not increase. Concentrations must be maintained at levels to secure an Ideal - Good water quality status.	Salts - Electrical Conductivity Monthly monitoring To monitor quality of return flows from alluvial area. Sodium Adsorption Ratio for alluvial aquifer water	Electrical Conductivity: <75 mS/m.

PROTECTION ZONE

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Protect Intergranular (alluvial) and fractured aquifer system along central Crocodile and Rosespruit segments in terms of surface water - groundwater Interaction	Stream Depletion Factor (manage distance between surface water source and well fields).	Limit impact to <5% of abstraction yield supported by surface water sources.
Land use activities that may impact on the intergranular (alluvial) aquifer.	Specify all land use activities on floodplain area and intergranular aquifer system	Limit activities according to 50 day (microbial) and 365 (dilution) day water quality protection zoning (L)

RU 6_1: Klein Marico Eyes



RU 6_1: Klein Marico Eyes: Groundwater Quantity

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Groundwater flow patterns based on piezometric elevations in aquifer units should not be reversed from its natural flow directions toward the local drainages (Upper Klein Marico River, Rhenosterfontein Spruit, and Lower Malmani Loop).	Water Levels - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input.	Dolomite aquifer systems: Saturation levels should not be lowered >6 metres below an average water level depth of ~**20** m in the dolomite aquifer area. Water level recession rate must be less than 0.75 m/a.
Groundwater balance (aquifer recharge and irrigation abstraction) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods).	Calculation of Stress Index (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. Stress Index of 65% and less);

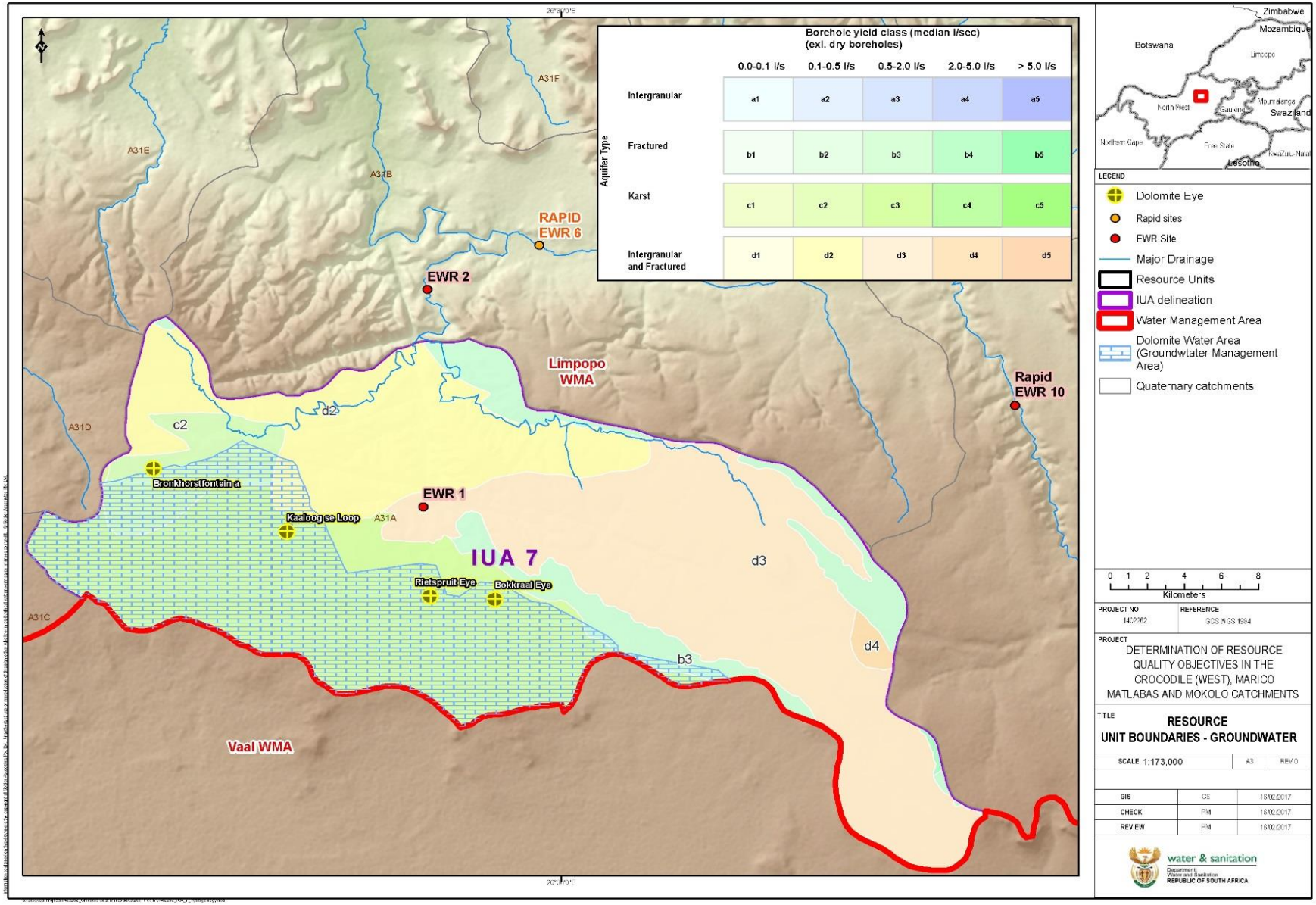
RU 6_1: Klein Marico Eyes: Groundwater Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values must be maintained to support domestic water users (Ideal – Good water quality).	Nutrients - Nitrate (NO_3–N, mg/l). Bi-annual Monitoring.	Nitrate: ~0.3 mg/l Long-term trend should not approach 95th percentile (~1.2 mg/l)
Flouride – impact on users – elevated fluoride levels	Fluoride (F, mg/l); Bi-annual monitoring.	Fluoride: ~0.2 mg/l. Annual long-term trend should not approach the 95th percentile (~1.42 mg/l).
Salinity levels should not increase. Concentrations must be maintained at levels to secure an Ideal-Good water quality status.	Salts - Electrical Conductivity (TDS), mg/l). Bi-annual monitoring of major constituents (macro elements). NaCl concentrations from mining activities in Dolomitic Eye catchments (*i.e*. Rhenosterfontein Eye case)	Electrical Conductivity: ≤ 50 mS/m Annual long-term trend should not approach the 95th percentile (~60 mS/m)

RU 6_1: Klein Marico Eyes: Protection Zoning

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Specifically dolomite aquifer systems (Irrigation area); Specific water resource protection requirements should become audit conditions in Water Use Licences	Restriction of abstraction based on application of the Stress Index approach. Abstraction zoning should be regulated according to downstream flow requirement	Abstraction restriction (SI<65%) within a radius of 1000 m from dolomite eye pool area.
	Water level drawdown limit in dolomite compartment unit.	Maximum 6 m (unless specifically authorised)
	Limitation of irrigation area on property size (ha's).	Limit to 9% of deed area (ha's)
	Distance from local river system	Activity should be >500 m.
	Distance from Dolomite Eye (L)	Activity should be >1000 m, unless specifically authorised.
	Ground stability (Dolomitic Compartment Unit drawdown limit, L) (buildings/roads/infrastructures).	Limited to 6 m sub-compartment unit.

Marico Eye (ref. Kaaloog Se Loop, Rietspruit and Bokkraal Eyes): 7_1



Marico Eye (ref. Kaaloog Se Loop, Rietspruit and Bokkraal Eyes): 7_1 Quantity

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Continuous Flow measurement at selected dolomite eyes, i.e. Bokkraal Nr. 1 via the Vanstratensvlei River (only flow data from 1907 to 1943!). (Other important eye discharging into the upper Groot Marico River is Rietspruit (via the Vanstratensvlei River)); (Note: there are several other dolomite eyes in the area, but no information are available).	Demarcation of eye catchment area (southern boundary not clear); Water Levels - Depth to groundwater level from ground elevation; Time series water level monitoring (Monthly) vs abstractions and rainfall input; and Abstraction of groundwater within prescribed zones from the river course/wetland/eye-spring)	Dolomite aquifer systems: Saturation levels should not be lowered >**6** metres below an average water level depth of ~**21** m in the eye catchment area. Water level recession rate must be less than 0.75 m/a. Abstraction zoning: should be regulated with flow of the eye in a radius of 1000 m from the Kaaloog Se Loop, Bokkraal and Rietspruit Eye pool areas.
Groundwater balance (aquifer recharge and irrigation abstraction) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods).	Calculation of Stress Indexes (Aquifer Unit Use ***divided*** by Aquifer Unit Recharge) as percentages	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%);

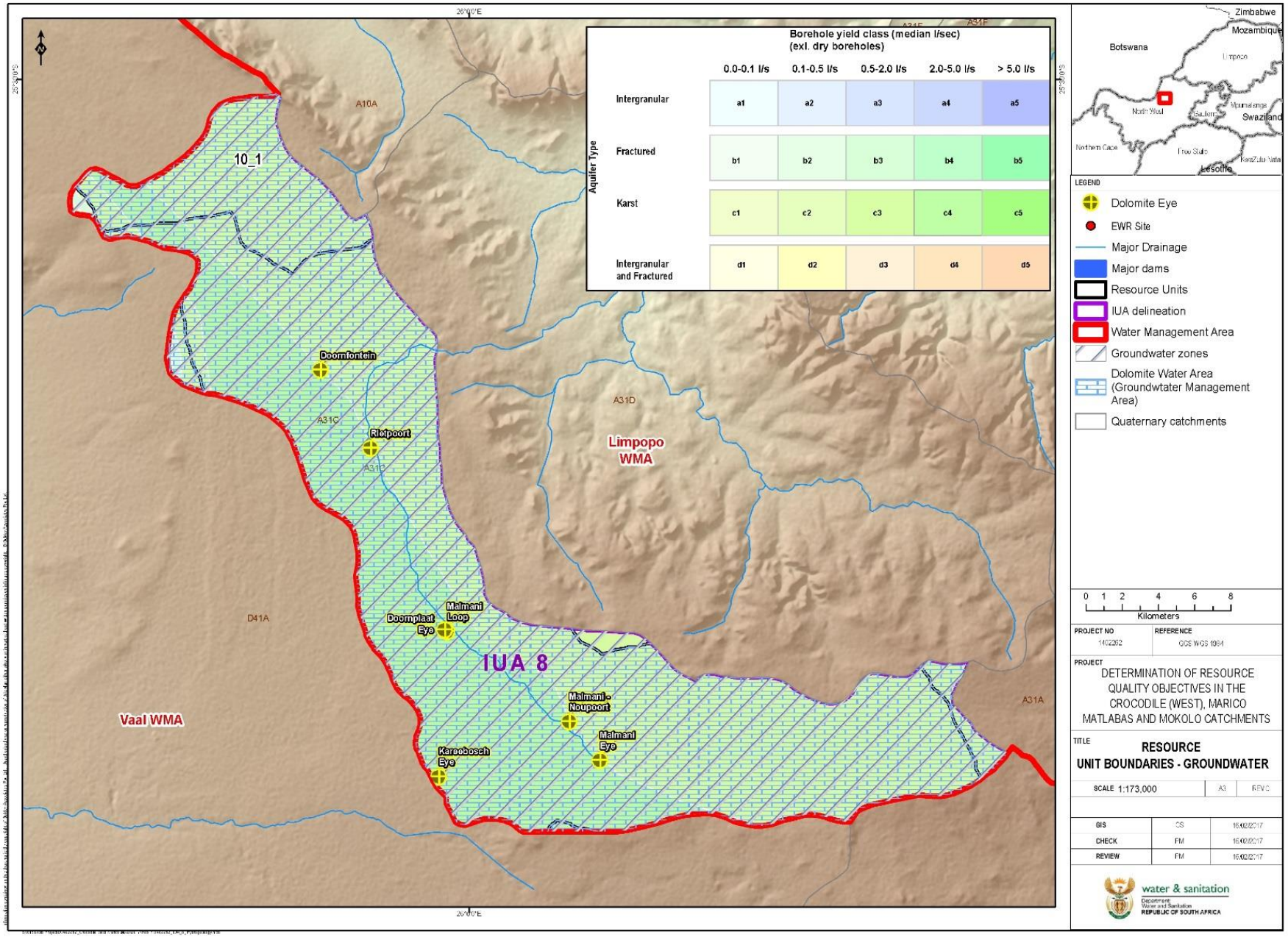
Marico Eye (ref. Kaaloog Se Loop, Rietspruit and Bokkraal Eyes): 7_1 Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users.	Nutrients - Nitrate (NO^3–N, mg/l). Bi-annual monitoring.	Nitrate: ≤ 0.2 mg/l; Annual long-term trend should not approach the 95th percentile (~1.10 mg/l)
Flouride levels must not impact negatively on the health of waeter users – elevated fluoride levels	Fluoride (F, mg/l) Bi-annual monitoring.	Fluoride: ~0.1 mg/l Annual long-term trend should not approach the 95th percentile (~1.3 mg/l).
Salinity levels should not increase. Concentrations must be maintained at levels to secure an Ideal/Good water quality status.	Salts - Electrical Conductivity (TDS), mg/l). Bi-annual monitoring of major constituents (macro elements).	Electrical Conductivity: ≤ 35 mS/m Annual long-term trend should not approach the 95th percentile (~60 mS/m)

Marico Eye (ref. Kaaloog Se Loop, Rietspruit and Bokkraal Eyes): 7_1 Protection Zone

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Demarcated protection zones to be introduced, i.e. distances between activity and eye/pool. Specifically for dolomite aquifer systems (Marico Eyes and Groot Marico, Rietspruit River downstream).	Map catchment (hectares) of the Eye and include a bulk water supply abstraction limitation.	Restriction of abstraction based on application of the Stress Index approach.
	Limitation of irrigation area on property size (ha's).	Limit to 9% of deed area (ha's)
	Distance from local river system	Activity regulated if <500 m from downstream drainage
	Distance from Dolomite Eye (L)	Activity regulated if <1000 m from downstream drainage.
	Distance from wetland (L).	Activity regulated if <1000 m from downstream drainage.
	Waterlevel drawdown limit in dolomite compartment unit.	Limited to 6 m sub-compartment unit.

Malmanie se loop: 8_1



Malmanie se loop: 8_1 QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Groundwater flow patterns based on piezometric elevations in aquifer units should not be reversed from its natural flow directions toward the local drainages (Malmani Eye Se Loop). Discharge areas (i.e. Malmani Eye, Malmani-Noupoort, Doornplaat Eye, Rietpoort Eye, Doornfontein, Buffelshoek, Stinkhoutboom, and Paardevallei dolomitic Eyes) should be protected against depletion of water table below eye outflow gauge).	Water Levels - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input Abstraction of groundwater within prescribed zones from the river course/wetland/eye-spring);	Dolomite aquifer systems: Saturation levels should not be lowered >6 metres below an average water level depth of ~21 m in the dolomite aquifer area. Water level recession rate must be less than 0.75 m/a. Abstraction zoning: should be regulated (1000 m for eye pools).
Groundwater balance (aquifer recharge and irrigation abstraction) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods). Proper irrigation schedules need to be developed and applied at all times (100% compliance).	Abstraction - Volume (Q).Time series of abstraction-rainfall-water level of aquifer system. Annual groundwater balance (aquifer recharge and irrigation abstraction) needs to be for wet and dry cycles.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%);
Water balance Status	Calculation of Stress Indexes (Aquifer Unit Use ***divided*** by Aquifer Unit Recharge) as percentages.	

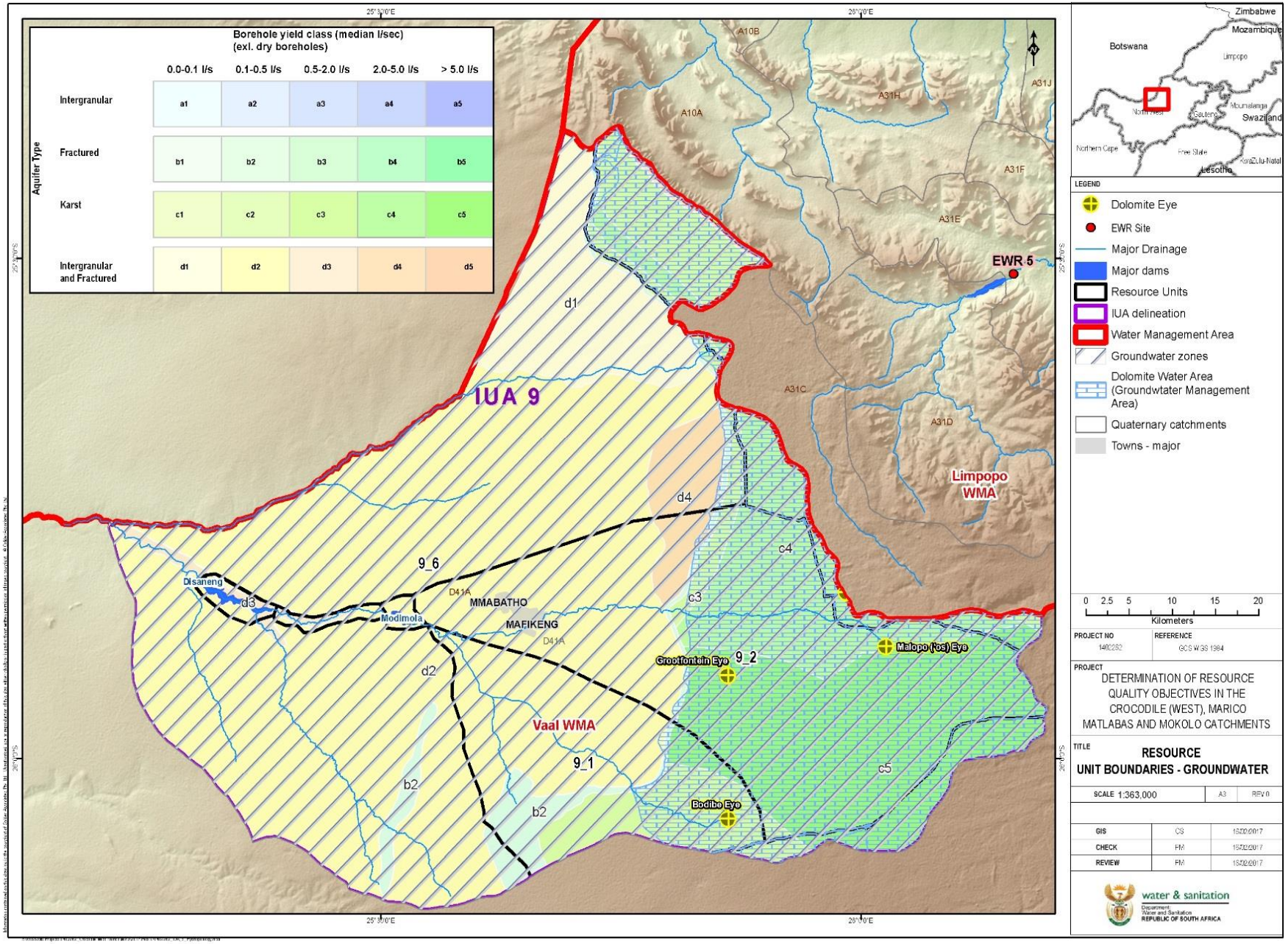
Malmanie se loop: 8_1
QUALITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users (95th percentile = 18 mg/l).	Nutrients - Nitrate (NO_3–N, mg/l). Bi-annual Monitoring.	Nitrate: Less than 1.0 mg/l; Annual long-term trend should not approach the 75th percentile (i.e. 3.5 mg/l)
Salinity levels should not increase. Concentrations must be maintained at levels to secure a healthy water quality status.	Salts - Electrical Conductivity Monthly monitoring at discharge	Electrical Conductivity: ≤ 50 mS/m; Annual long-term trend should not approach the 95th percentile (i.e. 85 mS/m)
Flouride should not impact negatively on the health of users. (elevated fluoride levels must be prevented)	Fluoride (F, mg/l) Bi-annual monitoring.	Fluoride: Less than 0.15 mg/l; Annual long-term trend should not approach the 95th percentile (~1.0 mg/l).

Malmanie se loop: 8_1
PROTECTION ZONING

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Specifically dolomite aquifer systems (*viz*. the larger dolomitic Eyes);	Water level drawdown limit in dolomite compartment unit.	Maximum 6 m (unless specifically authorised)
Specific water resource protection requirements should become audit conditions in water use licences.	Stream Depletion Factor	Limit to </=5% of wetland/surface water resource
	Limitation of irrigation area on property size (ha's).	Limit to 9% of deed area (ha's)
	Distance from Dolomite Eye and wetland zone (L)	Should be >1000 m, unless specifically authorised for bulk water supplies.

IUA 9: Upper Molop River: RU 9_1 and 9_2



IUA 9: Upper Molop River: RU 9_1 and 9_2
QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Groundwater flow patterns based on piezometric elevations in aquifer units should not be reversed from its natural flow directions toward the local drainages Discharge areas (i.e. Malapo Eye) should be protected against total depletion of water table (i.e. as the case is for Grootfontein Eye and Bodibe Eye.	Water Levels - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input Abstraction of groundwater within prescribed zones from the river course/wetland/eye-spring)	Dolomite aquifer systems: Saturation levels should not be lowered >6 metres below an average water level depth of ~**19** m in the dolomite water area. Water level recession rate must be less than 0.75 m/a. Abstraction zoning: should be regulated (1000 m for karst aquifer systems.
Groundwater balance (aquifer recharge and irrigation abstraction) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods). Proper irrigation schedules need to be developed and applied at all times (100% compliance).	Abstraction - Volume (Q).Time series of abstraction-rainfall-water level of aquifer system. Annual groundwater balance (aquifer recharge and irrigation abstraction) needs to be for wet and dry cycles.	Annual abstraction should not be larger than 65% of average annual recharge
Water balance Status	Calculation of Stress Indexes (Aquifer Unit Use ***divided*** by Aquifer Unit Recharge) as percentages.	

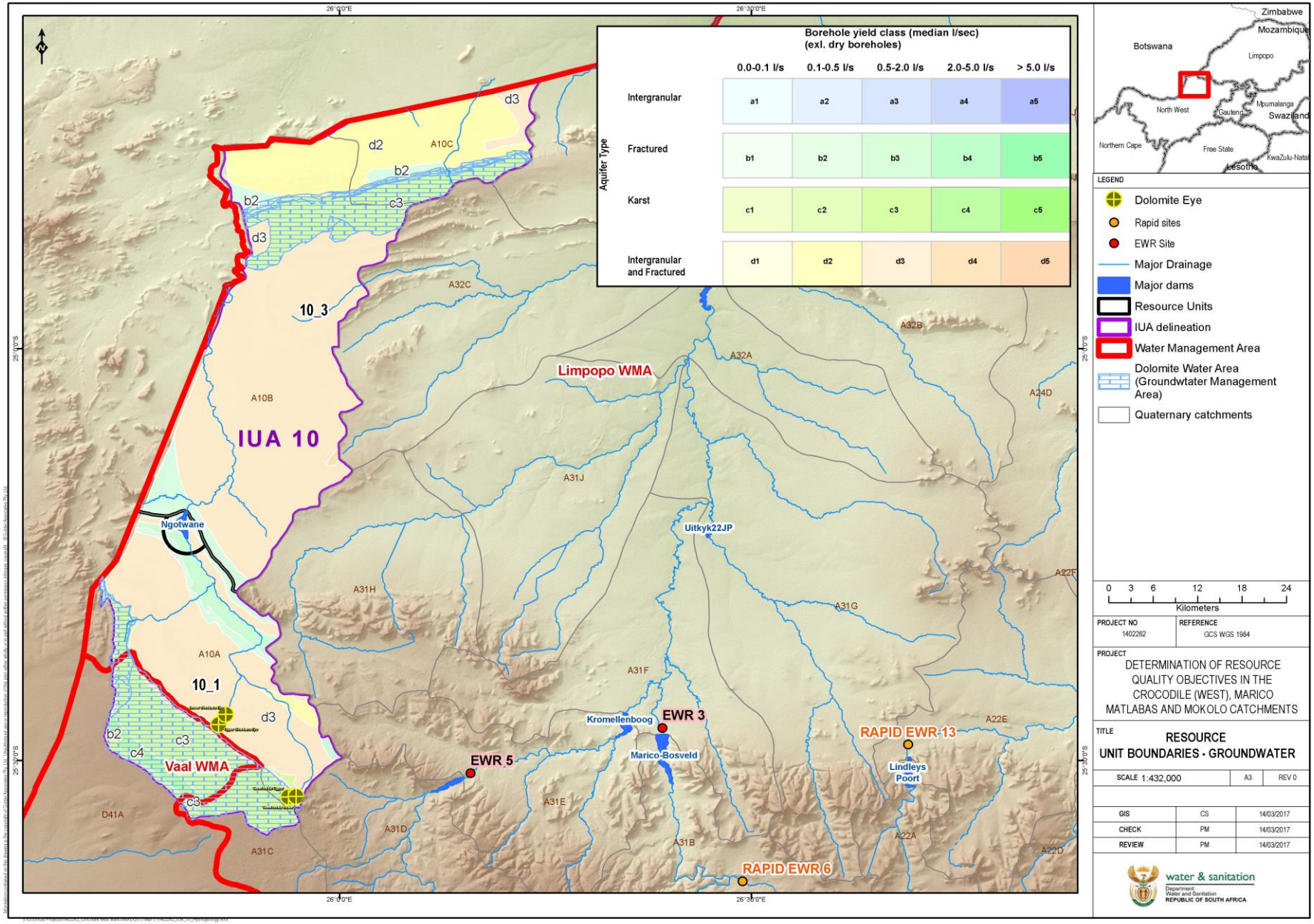
IUA 9: Upper Molop River: RU 9_1 and 9_2 QUALITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users. (Agricultural sources for nitrate)	Nutrients - Nitrate (NO_3–N, mg/l). Bi-annual Monitoring Monthly monitoring at DWS gauging stations.	Nitrate: Less than 1.0 mg/l; Annual long-term trend should not approach the 95th percentile (3.0 mg/l).
Salinity levels should not increase. Concentrations must be maintained at levels to secure a healthy water quality status.	Salts - Electrical Conductivity. Monthly monitoring at DWS gauging stations.	Electrical Conductivity: ≤ 50 mS/m; Annual long-term trend should not approach the 95th percentile (80 mS/m).
Industrial/agricultural pollutants for Molopo, Grootfontein, Itsoseng (Bodibe) Eyes.	Sulphates SO_4 concentrations) Monthly water quality monitoring at source areas (eye's and well fields)	$SO_{4:}$ Less than 5.0 mg/l; Annual long-term trend should not approach the 95th percentile (30 mg/l).

IUA 9: Upper Molop River: RU 9_1 and 9_2
PROTECTION ZONING

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Protection of Intergranular and Fractured Aquifers: Protect lower sections of Madibe, Polfontein Spruit and Molopo River against industrial/agricultural/microbial pollution.	Distance from drainage valley: based on 50 Day travel time (microbial) and 365 day dilution period (inorganic constituents)	<1000 m Protection zoning (DLMT aquifers) <500 m Protection zoning (hard rock aquifers).
	Distance from discharge area of dolomite eyes: based on 50 Day travel time (microbial) and 365 day dilution period (inorganic constituents)	<1000 m Protection zoning (hard rock aquifers)

IUA 10: Ngotwane: 10_1 (Dinokana & Tweefontein Eyes)



IUA 10: Ngotwane: 10_1
QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Discharge areas (i.e. Dinokana Upper & Lower and Tweefontein Upper and Lower dolomitic Eyes) should be protected against total depletion of flow)	Water levels: Time series water level monitoring (Monthly) vs abstractions and rainfall input.	Dolomite aquifer systems: Saturation levels should not be lowered >**6** metres below an average water level depth of ~**24** m in the dolomite aquifer area. Water level recession rate must be less than 0.75 m/a. Abstraction zoning: should be regulated (1000 m radius from eye pool).
Water balance Status (Water use regulation in recharge area)	Flow gauging at Eye discharge. Calculation of Stress Indexes (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%).

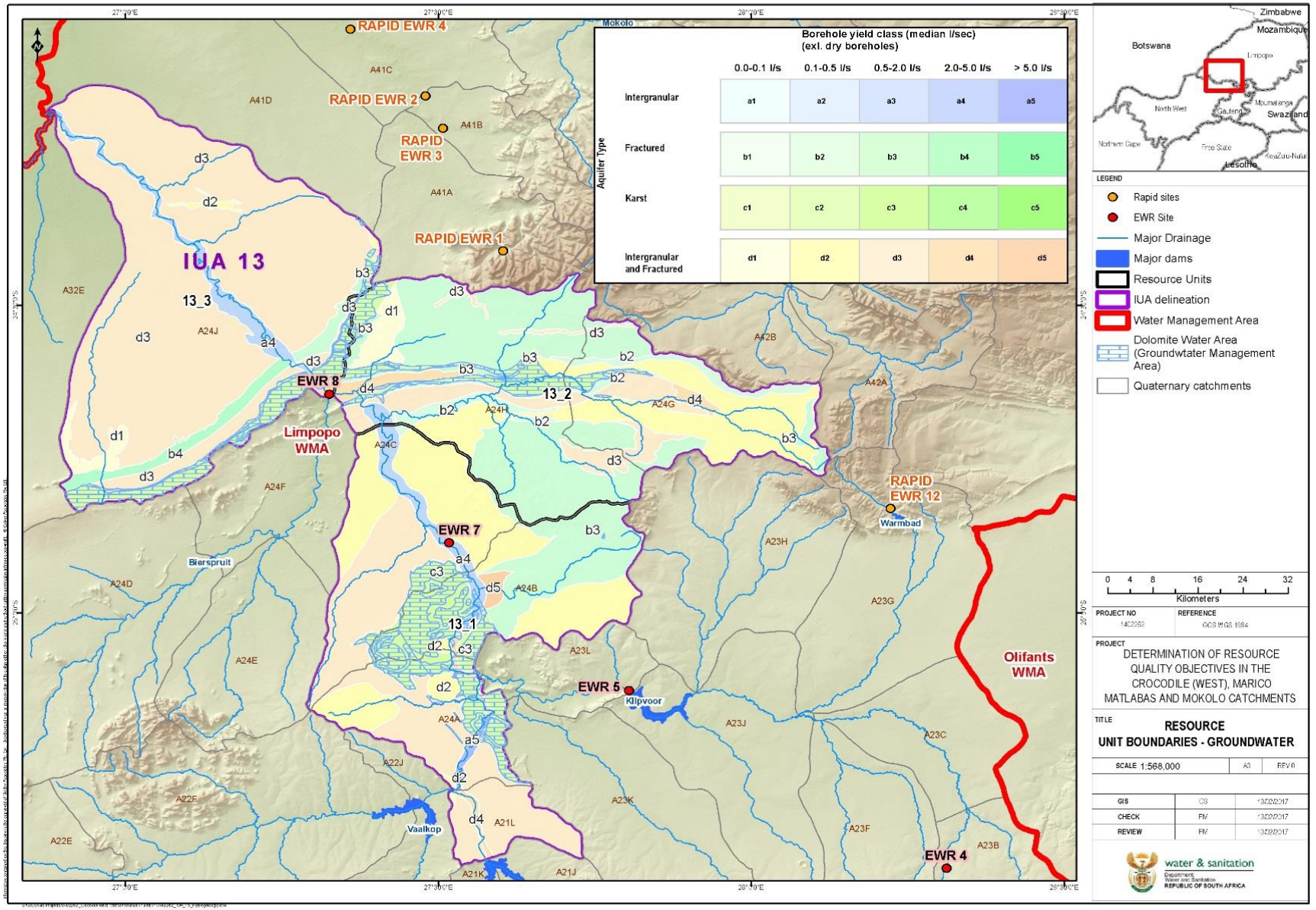
IUA 10: Ngotwane: 10_1
QUALITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users.	Nutrients - Nitrate (NO^3–N, mg/l). Bi-annual Monitoring.	Nitrate: ~1.0 mg/l; Annual long-term trend should not approach the 95th percentile (~1.1 mg/l).
Flouride shuld not have a negative impact on health of users. Elevated fluoride levels must be prevented.	Fluoride (F, mg/l) Bi-annual monitoring.	Fluoride ~0.15 mg/l; Annual long-term trend should not approach the 95th percentile (~0.5 mg/l).
Salts: Concentrations must be maintained at levels to secure a healthy water quality status.	Salinity - Electrical Conductivity Monthly monitoring at discharge area.	Electrical Conductivity: ≤ 45 mS/m; Annual long-term trend should not approach the 95th percentile (~55 mS/m).

IUA 10: Ngotwane: 10_1
PROTECTION ZONING

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Specifically dolomite aquifer systems Specific water resource protection requirements should become audit conditions in WUL.	Map catchment (hectares) of the eye and include a bulk water supply abstraction limitation.	Restriction of abstraction based on application of the Stress Index approach.
	Water level drawdown limit in dolomite compartment unit.	Maximum 6 m (unless specifically authorised).
Additional wellfields in the catchment area of the Dolomitic Eyes.	Limitation of irrigation area on property size (ha's).	Limit to 9% of deed area (ha's).
	Distance from Dolomite Eye (L).	Should be >1000 m, unless specifically authorised for bulk water supplies.

IUA 13: Lower Crocodile: 13_1 and 13_3



IUA 13: Lower Crocodile: 13_1 and 13_3
Quantity

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Limit capturing of surface water when abstracting water via boreholes in the flood plain alluvial aquifer systems (there should be a distance limit).	Groundwater level gradient across intergranular aquifer system; and Groundwater level trends on intergranular aquifer systems.	Reverse groundwater gradient (river towards borehole/well field in a 500 m zone along main stem not allowed. Water level recession rate must be less than 1.0 m/a.
	Stream/river flow gauging: Positive/Negative water balance estimations: Volume (Q); Flow depletion at downstream gauging weirs.	Surface water losses must be equal to authorised abstractions from river (incl. evapotranspiration losses).
Groundwater balance status in intergranular and fractured aquifer system	Calculation of Stress Indexes (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%).

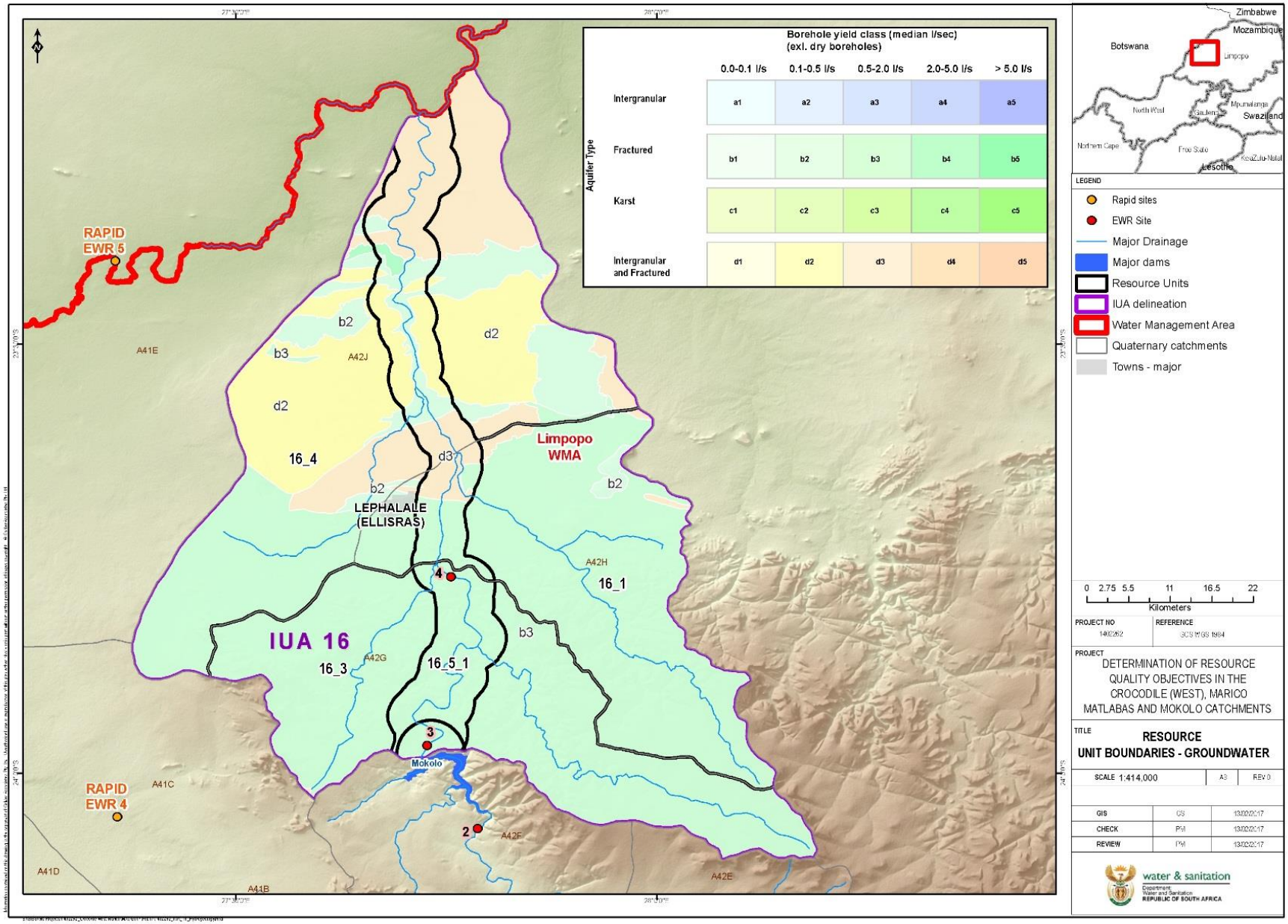
IUA 13: Lower Crocodile: 13_1 and 13_3
Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users.	Nutrients - Nitrate (NO^3–N, mg/l). Bi-annual Monitoring.	Nitrate: ≤ 1.0 mg/l
Dissolved salts in groundwater resource: Manage irrigation return flow quality from intergranular (alluvial) aquifer system. Concentrations must be maintained at levels to secure an Ideal - Good water quality status.	Salinity - Electrical Conductivity Weekly/Monthly monitoring. Quality of intergranular (alluvial) aquifer system. Sodium Adsorption Ratio for alluvial aquifer water	Electrical Conductivity: ≤ 85 mS/m SAR: Within appropriate limit for irrigation water.

IUA 13: Lower Crocodile: 13_1 and 13_3
Protection Zoning

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Minimum distance from surface water resource where groundwater may be abstracted (based on the hydraulic characteristics of the intergranular (alluvial) aquifer system.	Stream Depletion Factor.	Limit borehole/well field abstraction yield to less than 5% of flow in surface water resources (at specific abstraction point).
Land use activities that may impact on the alluvial aquifer. Specify protection zoning (i.e. distance from surface water resources) on intergranular (alluvial) aquifer system in terms of microbial and industrial/agricultural pollution migration.	Water quality measure (microbial migration towards surface water source); Water quantity measure (impact on surface water whilst abstracting from intergranular (alluvial) aquifer system.	Water quality limit (1): A 50 day (microbial) zoning, distance between activity and surface water source. Water quantity limit (2): A 365 (dilution) day water quality protection zoning (L).

IUA 16: Sandloop and Mokolo: 16_4



IUA 16: Sandloop and Mokolo: 16_4 Quantity

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Limit depletion (lowering) of aquifer saturations levels (water levels).	Time series aquifer water level in a surrounding Reference Area which represent a background zone around a particular development, i.e. mining area, industrial area and agricultural development).	Water level recession rate must be less than 0.5 m/a in reference area of specific activity.
Groundwater balance status in intergranular and fractured aquifer system.	Calculation of Stress Index (Aquifer Unit Use ***divided*** by Aquifer Unit Recharge) as percentages.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%).

IUA 16: Sandloop and Mokolo: 16_4 Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Acidity of groundwater with regard to acid rock drainage potential (high in areas of coal mining and UCG's)	pH-value of groundwater in specified Reference Area.	pH value between 6.1 and 8.2 in Reference Area.
Nutrients in groundwater must be maintained to support domestic water users. Nutrients should not impact on health of water users.	Nitrate (NO_3-N) concentration in groundwater in specified Reference Area (T3)	Nitrate: Less than 35 mg/l in Reference Area Annual long-term trend should not approach the 50th percentile + 10% (~40 mS/m) – Based on local studies.
Dissolved salts in groundwater resources - Monitoring Medupi/ Grootegeluk and other impact related monitoring networks.	Salinity: Electrical Conductivity (EC) of groundwater in specified Reference Area (T3).	Electrical Conductivity Less than 200 mS/m in Reference Area. Annual long-term trend should not approach the 50th percentile + 10% (~220 mS/m) – Based on local studies.
Macro chemical element of concern dissolved in groundwater.	Chloride (Cl) concentration in groundwater in specified reference area.	Chloride: ≤Less than 300 mg/l in Reference Area. Annual long-term trend should not approach the 50th percentile + 10% (~330mS/m) – Based on local studies.

IUA 16: Sandloop and Mokolo: 16_4
Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Acid Mine Water (or ARD) and decanting into surface water resources.	Sulphates (SO4) concentration in groundwater in specified Reference Area. (T3)	SO4: Less than 200mg/l in Reference Area. Annual long-term trend should not approach the 50th percentile + 10% (~220 mg/l) – Based on local studies.
Fluoride concentrations in groundwater supplied to domestic users must be not impact on health of users.	Fluoride (F) concentration in groundwater in specified Reference Area. (T3)	Fluoride: Less than 2.5 mg/l in Reference Area. Annual long-term trend should not approach the 50th percentile + 10% (~2.7 mg/l) – Based on local studies.

IUA 16: Sandloop and Mokolo: 16_4
Protection Zoning

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Aquifer saturation levels	Water level set for a three (3) tier zoning area.	**T1–Area of activity: Water level depletion required for activity.** **T2–Buffer Area: Water level recession rate must be less than 1.0 m/a.** **T3–Background or Reference Area: Water level recession rate must be less than 0.5 m/a.**
As per water quality specifications.	Water quality parameters set for a three (3) tier zoning area.	**T1–Area of activity, concentration levels due to impact (95th Percentile of water quality in QC):** pH: 5.0 to 9.5; NO_3–N: 60 mg/l; Salinity EC: 600 mS/m; Chloride: 1500 mg/l; Sulphates: 800 mg/l; and Fluoride: 6.4 mg/l. **T2–Buffer Area: Allow up to 75th Percentile supported by a buffer area background study – actual values in observed in QC A42J:** pH: 6.7 to 8.1; NO_3–N: 35 mg/l; Salinity EC: 340 mg/l; Chloride: 650 mg/l; Sulphates: 250 mg/l; and Fluoride: 2.5 mg/l. **T3–Background or Reference Area: Allow up to 50th Percentile + 10% in key constituents as indicated above (Quality).**

IUA 16: Mokolo: 16_5_2
Quantity

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Limit capturing of surface water when abstracting water via boreholes in the flood plain alluvial aquifer systems (there should be a distance limit).	Water levels in aquifer: Groundwater level gradient across intergranular aquifer system; and Groundwater level trends on intergranular aquifer systems.	Reverse groundwater gradient in a 500 m zone along main stem not allowed. Water level trends not <-1.0 m/a
Interaction status between surface water and groundwater resources.	Positive/Negative water balance estimations: Volume (Q); Flow depletion at downstream gauging weirs.	Surface water losses must be equal to authorised abstractions from river (incl. evapotranspiration losses).
Groundwater balance status in intergranular and fractured aquifer system	Calculation of Stress Index (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%).

IUA 16: Mokolo: 16_5_2
Quality

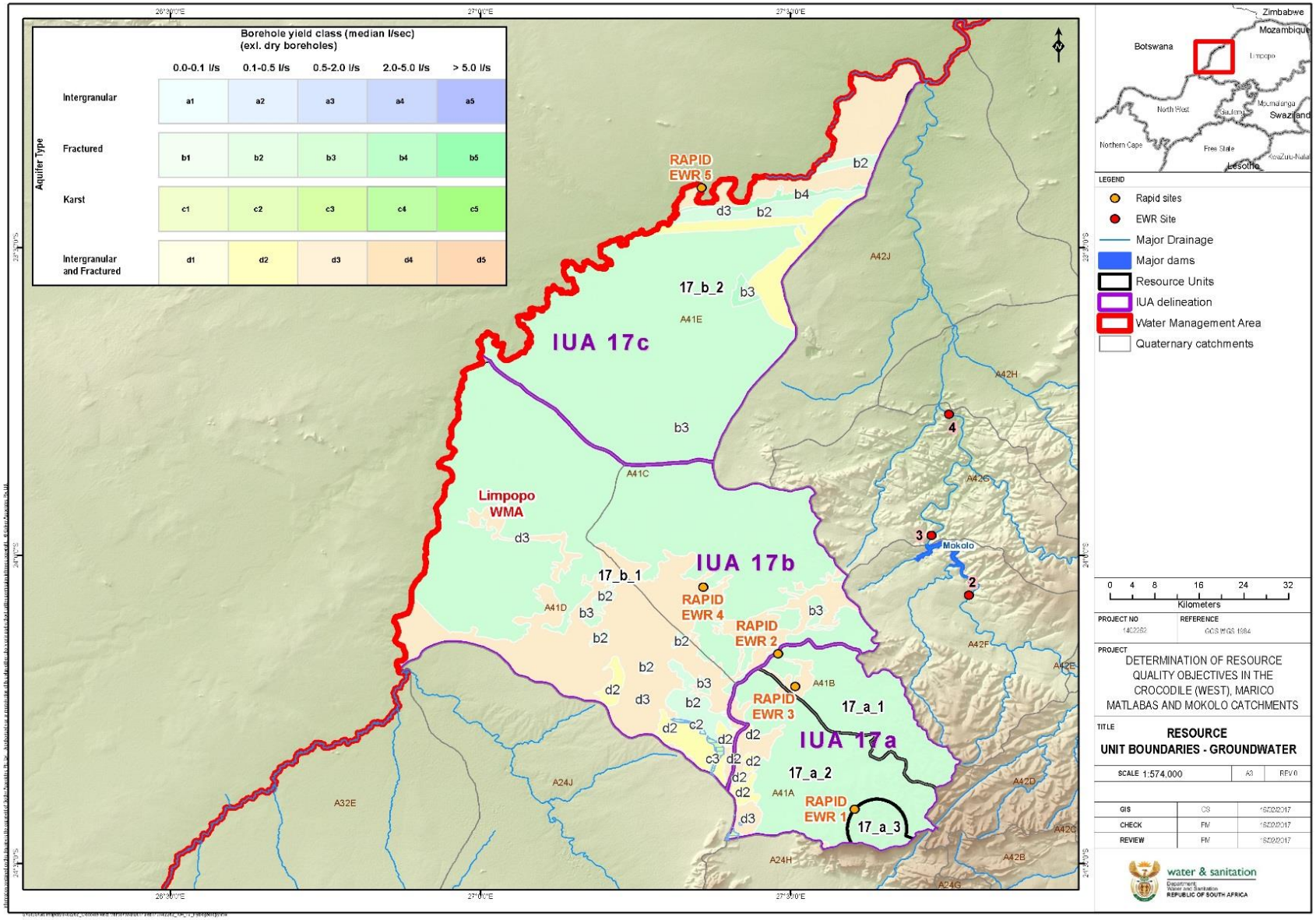
Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nitrate values in the recharge area must be maintained to support domestic water users. Monthly monitoring at DWS gauging stations. Establish background "natural" nitrate concentration in water resource.	Nitrate (NO3-N) concentration in groundwater Establish background "natural" nitrate concentration in water resource.	Nitrate: Less than 0.5 mg/l (95th percentile)
Dissolved salts in groundwater resources must not be allowed to deteriorate. Monitoring Medupi/ Grootegeluk and other impact related monitoring networks.	Salinity - Electrical Conductivity Establish background "natural" salinity concentration in water resource.	Electrical Conductivity: Less than 55 mS/m (95th percentile)
Acid Mine Water (or AMD). Monitoring at Medupi/ Grootegeluk and other industrial areas/activities.	Sulphates ($SO_{4)}$ concentration levels in groundwater. Establish background "natural" sulphate concentration in water resource.	SO_4: Less than 80 mg/l. (95th percentile)

Elevated background values for critical hydro-chemical elements may be a natural phenomenon and should be acknowledged.

IUA 16: Mokolo: 16_5_2
Protection zone

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Limit capturing of surface water when abstracting water via boreholes in the flood plain alluvial aquifer systems (there should be a distance limit).	Stream Depletion Factor for Mokolo alluvial aquifer system, (L).	Limit borehole/well field abstraction yield to less than 5% of flow in surface water resources (at specific abstraction point).
Land use activities that may impact on the intergranular (alluvial) aquifer system.	Water quality measure (microbial migration towards surface water source); Water quantity measure (impact on surface water whilst abstracting from intergranular (alluvial) aquifer system.	Water quality limit (1): A 50 day (microbial) zoning, distance between activity and surface water source. Water quantity limit (2): A 365 (dilution) day water quality protection zoning (L).

IUA 17: Matlabas: 17_b_2



IUA 17: Matlabas: 17_b_2
Quantity

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Limit depletion (lowering) of aquifer saturations levels (water levels).	Water levels in aquifer system; Groundwater level trends.	Water level recession rate must be less than 0.5 m/a.
Groundwater balance status in aquifer system; Calculation of Stress Index (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	A Positive/Negative water balance.	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%).

IUA 17: Matlabas: 17_b_2
Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nutrients in groundwater must be maintained to support domestic water users. Nutrients should not impact on health of water users.	Nitrate (NO_3-N) in groundwater in specified Reference (background) Area	Nitrate: Less than 3.0 mg/l; Annual long-term trend should not approach the 75th percentile (~3.3 mg/l).
Dissolved salts in groundwater resources -	Salinity: Electrical Conductivity (EC) of groundwater specified in Reference (background) Area.	Electrical Conductivity Less than 140 mS/m Annual long-term trend should not approach the 75th percentile +10% (~155 mS/m).
Macro chemical element of concern dissolved in groundwater.	Chloride (Cl) concentration in groundwater in specified Reference (background) Area.	Chloride: Less than 145 mg/l in Reference Area. Annual long-term trend should not approach the 75th percentile +10% (~160 mg/l).

IUA 17: Matlabas: 17_b_2
Quality

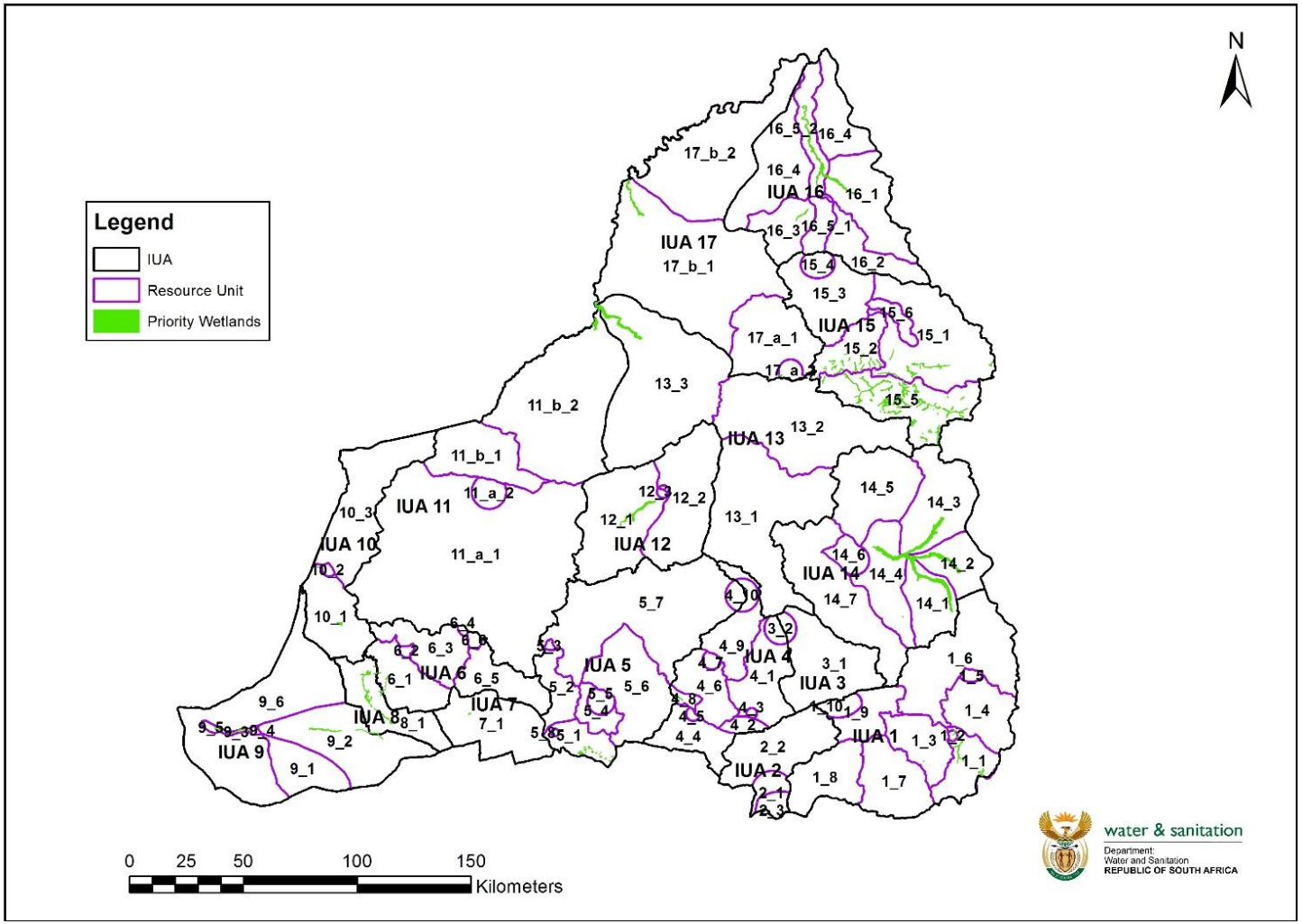
Resource Quality Objective	Indicator/ Measure	Numerical Limit
Generation of acid mine water from underlying potential acidic rocks; and Prevent future decanting of underground mine water into surface water resources.	Sulphates (SO_4) concentration in groundwater in specified Reference (background) Area.	SO4: Less than 85 mg/l. Annual long-term trend should not approach the 75h percentile +10% (~94 mg/l).
Fluoride concentrations in groundwater supplied to domestic users.	Fluoride (F) concentration in groundwater in specified reference area.	Fluoride: Less than 1.3 mg/l; Annual long-term trend should not approach the 75th percentile +10% (~1.4 mg/l).

IUA 17: Matlabas: 17_b_2
Protection Zoning

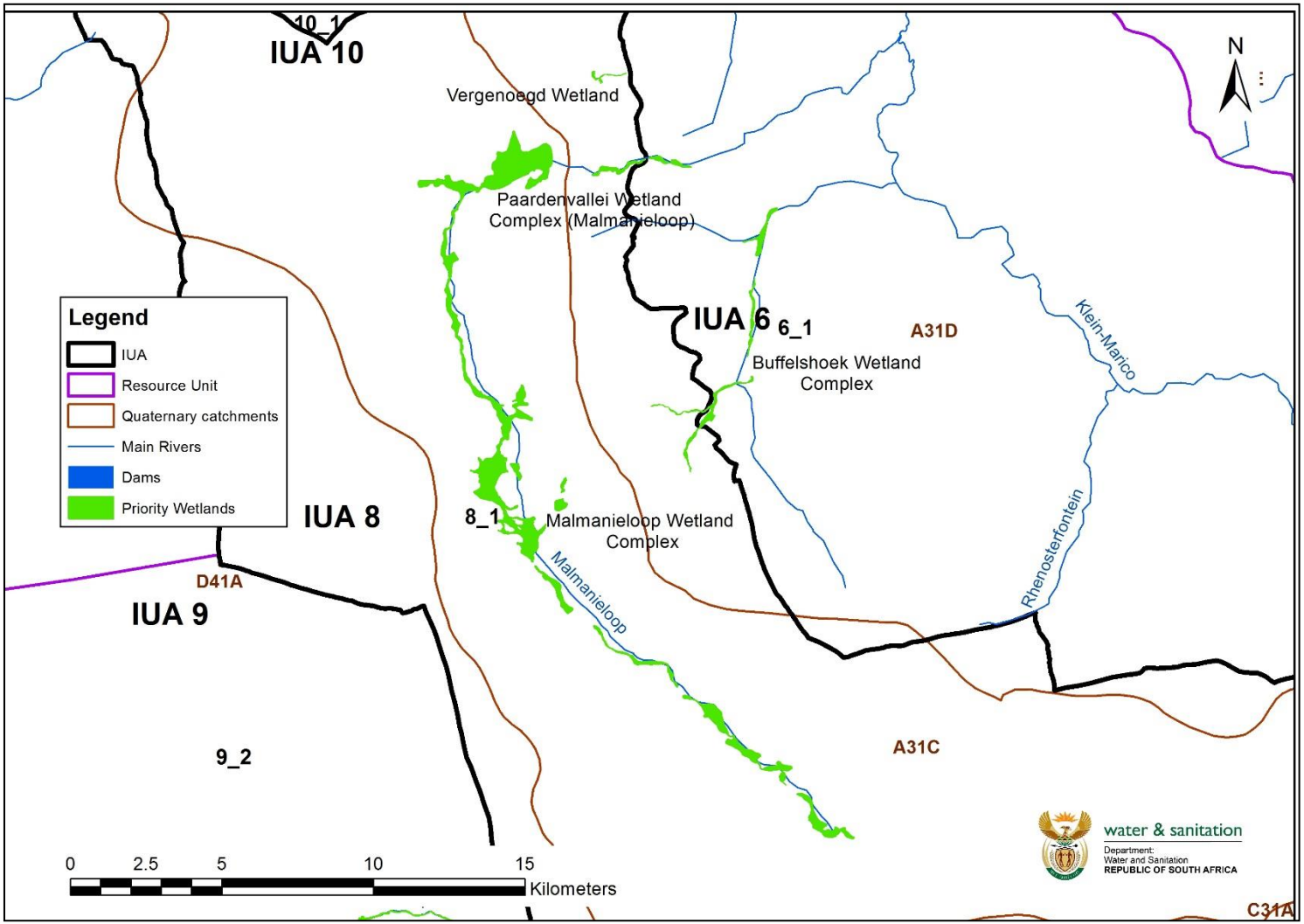
Resource Quality Objective	Indicator/ Measure	Numerical Limit
Aquifer saturation levels	Water level set for a three (3) tier zoning area.	T1–Area of activity: Water level depletion required for activity. T2–Buffer Area: Water level recession rate must be less than 1.0 m/a. T3–Background or Reference Area: Water level recession rate must be less than 0.5 m/a.
As per water quality specifications.	Water quality parameters set for a three (3) tier zoning area.	**T1–Area of activity, maximum concentration levels due to impact (based on dataset in impacted area):** **pH:;** **pH: 5.0 to 9.5;** **NO_3–N: 60 mg/l;** **Salinity EC: 600 mS/m;** **Chloride: 1500 mg/l;** **Sulphates: 800 mg/l; and** **Fluoride: 6.4 mg/l.** **T2–Buffer Area: Allow up to 75th Percentile of actual background values in QC A41E:** **pH: 7.2 – 7.8;** **NO_3–N: 8.0 mg/l;** **Salinity EC: 200 mg/l;** **Chloride: 300 mg/l;** **Sulphates: 170 mg/l; and** **Fluoride: 1.8 mg/l.** **T3–Background or Reference Area: Allow up to 50th Percentile + 10% in key constituents as indicated above (see Quality above).**

DRAFT WETLAND RESOURCE QUALITY OBJECTIVES

Priority Wetlands



Example: Malmanieloop Wetland Complex

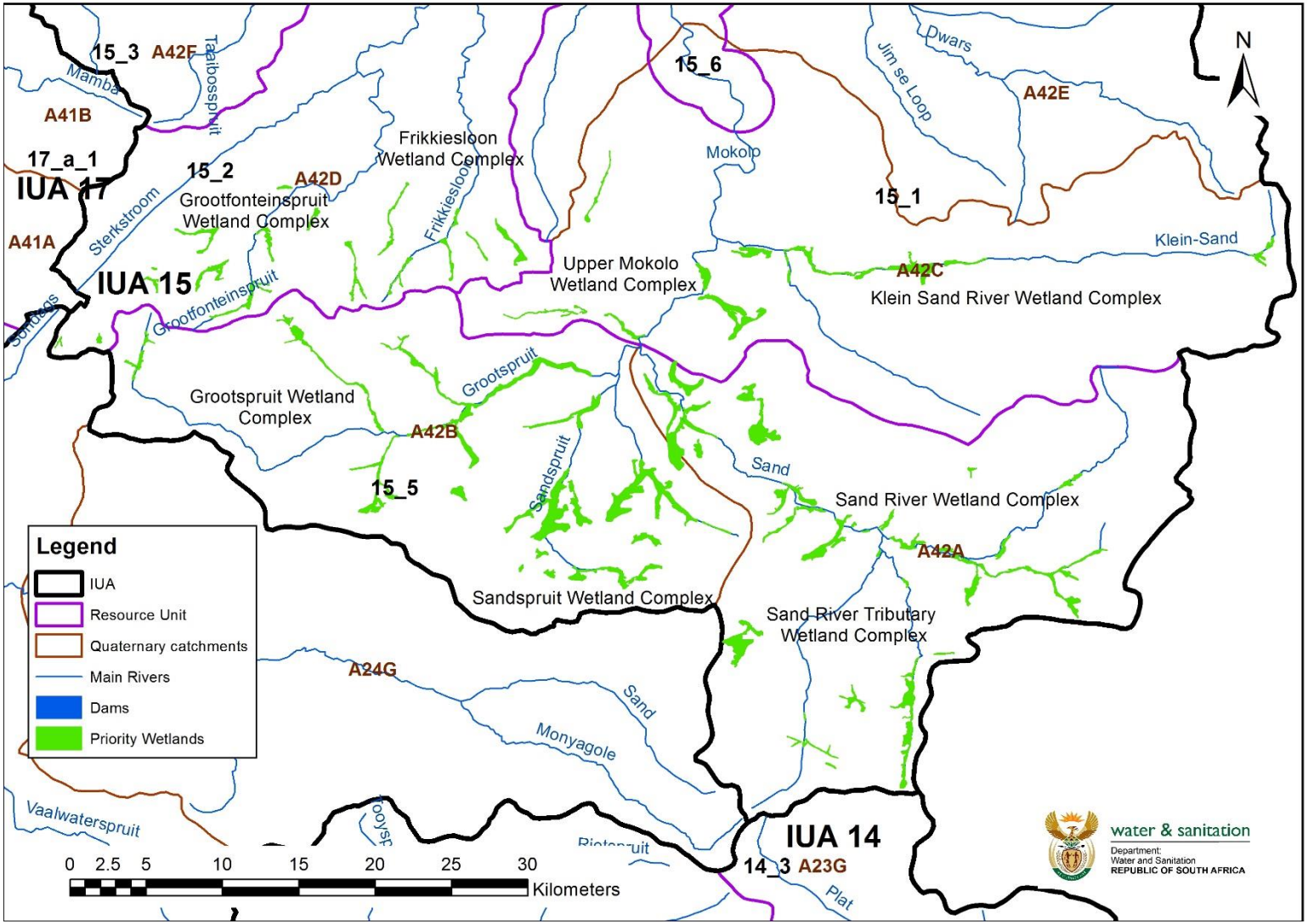


RQO Examples

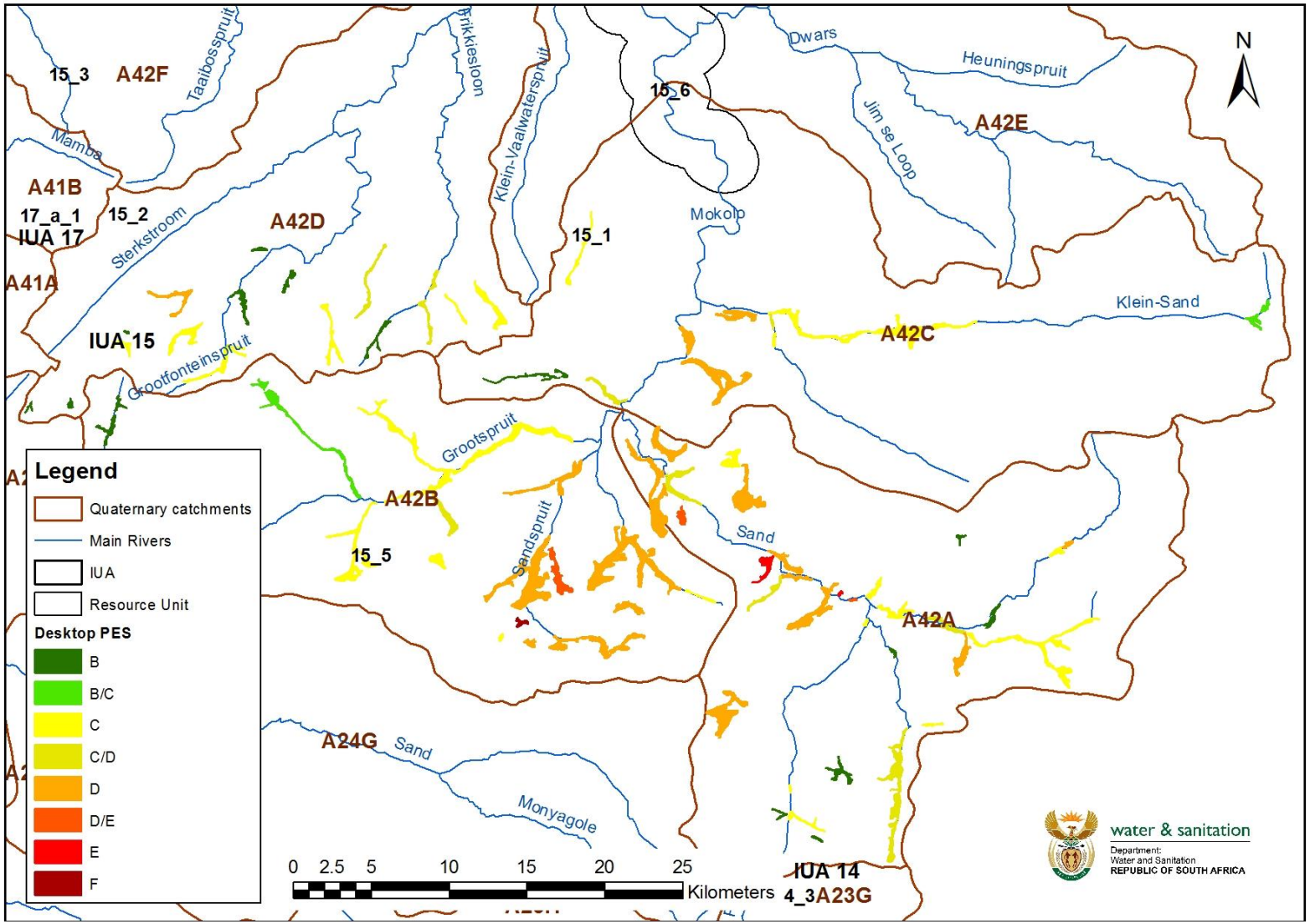
RU 8_1, **Malmanieloop Wetland Complex**, PES=B/C, EIS=Very High, REC=B

Component prioritised	Indicator	RQO	Numerical Criteria
Quantity	Groundwater indicators apply (see groundwater indicators).	A constant baseflow must be maintained to ensure that the system remains perennial and that most of the marginal and instream vegetation remains inundated throughout the summer growing season and that the rooting zone is saturated throughout the year. This is a requirement for enabling perennial obligate hydrophytes to complete their life cycle and reproduce and in order to maintain the peat in the system. Groundwater RQO's apply (see groundwater RQO's).	Groundwater numerical limits apply (see groundwater numerical limits) Undertake a preliminary wetland Reserve for the system and determine the ecological flow requirements of the wetland. Use these to set the numerical criteria for the water quantity component of the RQO's.
Quality	River and groundwater indicators apply (see river and groundwater indicators).	River and groundwater RQO's apply (see river and groundwater RQO's).	River and groundwater numerical limits apply (see river and groundwater numerical limits). Update these based on the findings of the water quality component of the preliminary wetland Reserve.
Habitat	Desktop PES Category (based on a semi-quantitative area based weighted average score for all wetland units in the wetland complex_. The extent and distribution of peat and populations of peat forming plants species in the wetland.	Wetland vegetation and geomorphology must be maintained to protect the unchannelled character of the system and overall biodiversity must be maintained including viable populations of peat forming plant species. Area based weighted Average PES category of B although the likely BAS Category is C. Peat distribution and extent should remain at least unchanged/stable or be increasing.	Compile desktop basemap for the system prior to the start of monitoring and determine/estimate and map the extent of peat and peat forming plant species in the system. Undertake a desktop PES assessment and determine the area based weighted average score for the wetland. Verify by undertaking a rapid field-based PES assessment of the wetland and take fixed point photographs of key features. During the habitat assessment determine/estimate whether the extent of peat in the system has changed. Estimate the extent of peat forming plant species
Protection zone	Groundwater indicators apply (see groundwater indicators).	Groundwater RQO's apply (see groundwater RQO's).	Groundwater numerical limits apply (see groundwater numerical limits).

Example: Grootspruit Wetland Complex



Example: Grootspruit Wetland Complex

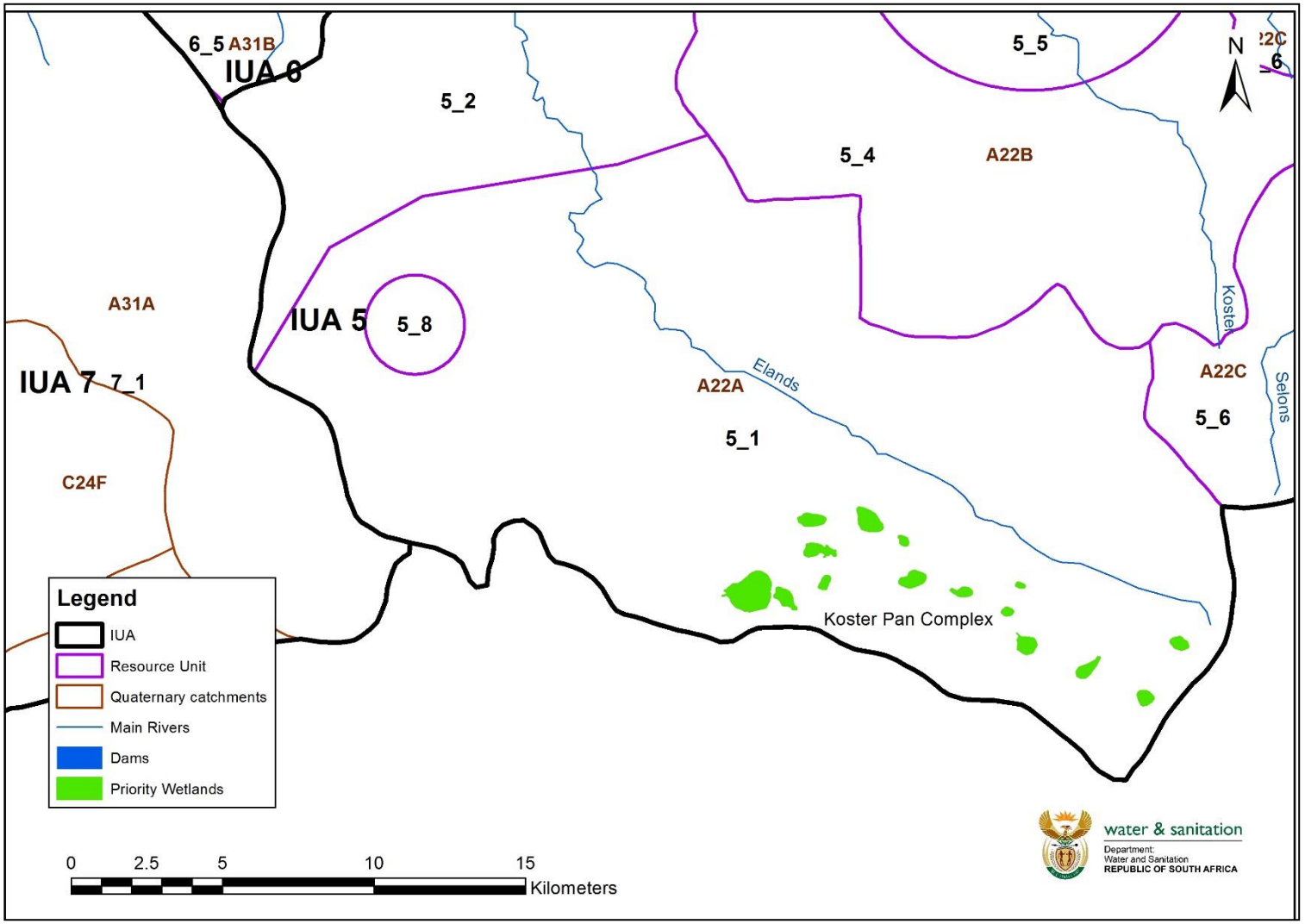


RQO Examples

RU 15_5, **Grootspruit Wetland Complex**, PES=C, EIS=Moderate to High, REC=C

Component prioritised	Indicator	RQO	Numerical Criteria
Habitat	Desktop PES Category (based on a semi-quantitative area based weighted average score for all wetland units in the wetland complex).	Area based weighted Average PES category of B/C although the likely BAS Category is C.	Undertake a desktop PES assessment and determine the area based weighted average score for the wetland complex. Repeat every 3 to 5 years and assess and report on this with a view to assess if there have been any changes in the state of the system. Verify by undertaking a rapid field-based PES assessment of the wetland and take fixed point photographs of key features.
Biota	The continued presence of Blue Cranes within the pentad (5x5 minute squares - the mapping unit used in BABAP2) covering the wetlands.	The continued presence of Blue Cranes must be maintained.	Using the data generated by the South African Bird Atlas Project 2, the continued presence of Blue Cranes within the pentad must be confirmed by ensuring that a reporting rate higher than 5 % is maintained for the affected pentad (2425_2800).

Example: Koster Pan Complex

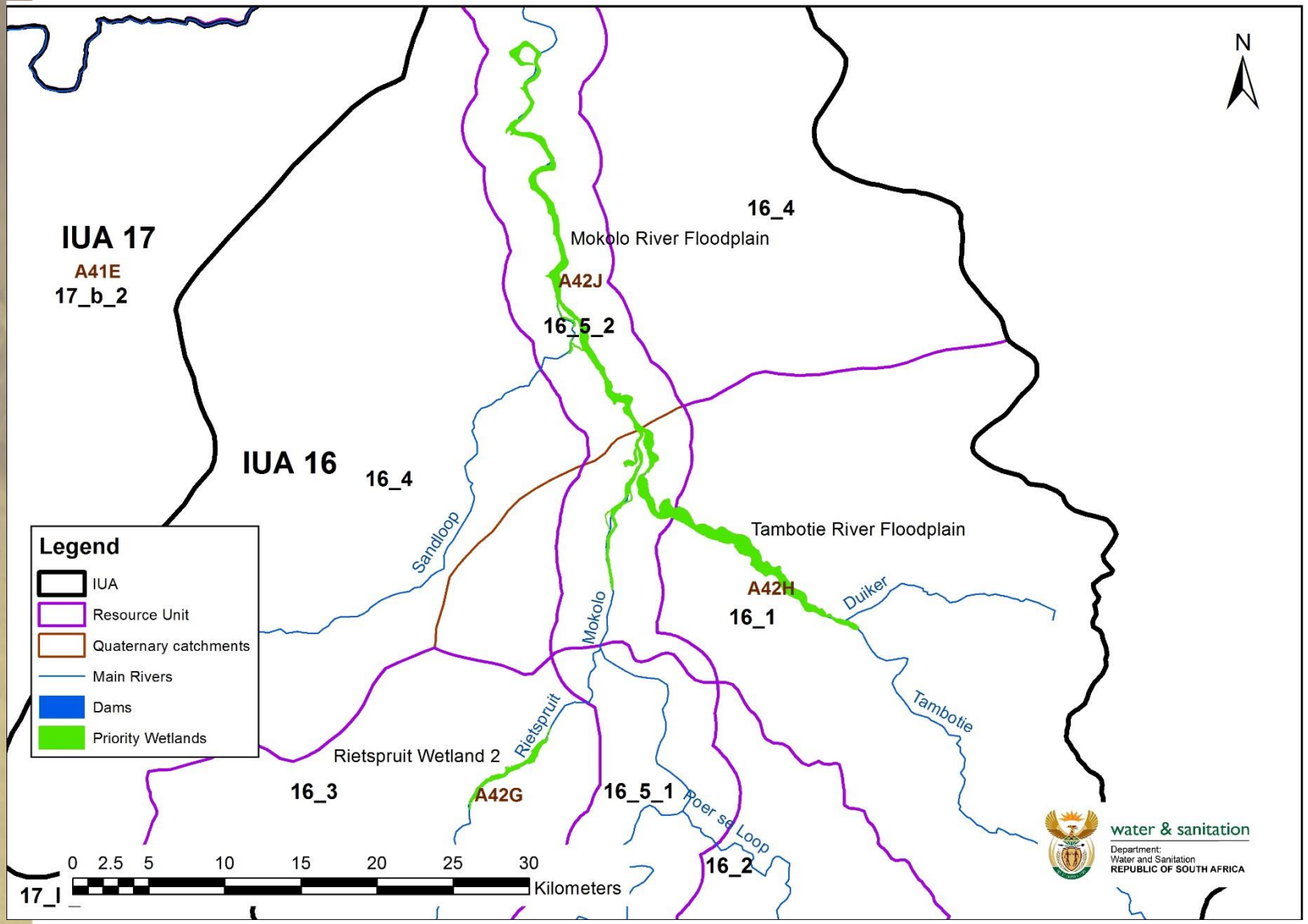


RQO Examples

RU 5_1, **Koster Pan Complex**, PES=C, EIS=High, REC=C

Component prioritised	Indicator	RQO	Numerical Criteria
Quantity	Pan wetted perimeter as measured from desktop mapping in relation to antecedent rainfall.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems. In particular, abstraction or artificial water inputs should be limited in the pans so that the depth and duration of inundation is maintained within the normal range for high, average and low rainfall years.	Compile an accurate desktop basemap for the systems prior to the start of monitoring using the most recent available remote imagery and determine the wetted perimeter in relation to antecedent rainfall for selected pans. Repeat the above every 3 to 5 years and assess and report on this with a view to assess if there have been any measurable changes in the relationship between wetted perimeter and antecedent rainfall in the pans selected.
Quality	pH, Electrical Conductivity, TDS, Total Alkalinity as $CaCO_3$, Sodium, Calcium, Magnesium, Sulphate, Iron, Chloride, Potassium, Magnesium, Manganese, Aluminium, Phosphorous, Silica, Fluoride Ammonia, Nitrate and Fluoride.	Water quality impacts to the pan systems must be restricted to ensure that the water and sediment chemistry remain within an acceptable normal range (anion and cation concentration to pan volume relationship) for this particular water chemistry pan type.	For selected pans, sample every 3 to 5 years.
Habitat	Desktop PES Category (based on a semi-quantitative area based weighted average score for all the pans units in the wetland complex).	Area based weighted Average PES category of B/C although the likely BAS Category is C.	Undertake a desktop PES assessment and determine the area based weighted average score for the wetland complex. Repeat every 3 to 5 years and assess and report on this with a view to assess if there have been any changes in the state of the system. Verify by undertaking a rapid field-based PES assessment of selected pans and take fixed point photographs of key features.

Example: Tambotie River Floodplain



RQO Examples

RU 16_1 and 16_5_2, **Tambotie River Floodplain**, PES=B/C, EIS=Very High, REC=B

Component prioritised	Indicator	RQO	Numerical Criteria
Quantity	Extent and frequency of flooding in relation to rainfall in the catchment.	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.	Using available remote imagery, estimate the extent and frequency of flooding in relation to rainfall for the wetland. Repeat the above every 3 to 5 years and assess and report on this with a view to assess if there are any measurable changes in the relationship between flooding extent and rainfall events.
	River indicators for RU 16_5_2 and groundwater indicators as per the floodplain alluvial aquifer for RU 16_4 also apply (see river and groundwater indicators).	River RQO's for RU 16_5_2 and groundwater RQO's as per the floodplain alluvial aquifer for RU 16_4 also apply (see river and groundwater RQO's).	River numerical limits for RU 16_5_2 and groundwater numerical limits as per the floodplain alluvial aquifer for RU 16_4 also apply (see river and groundwater numerical limits).
Quality	River indicators for RU 16_5_2 and groundwater indicators as per the floodplain alluvial aquifer for RU 16_4 apply (see river and groundwater indicators).	River RQO's for RU 16_5_2 and groundwater RQO's as per the floodplain alluvial aquifer for RU 16_4 apply (see river and groundwater RQO's).	River numerical limits for RU 16_5_2 and groundwater numerical limits as per the floodplain alluvial aquifer for RU 16_4 apply (see river and groundwater numerical limits).
Habitat	Desktop PES Category (based on a semi-quantitative area based weighted average score for the wetland).	Area based weighted Average PES category of A/B although the likely BAS Category is B/C.	Undertake a desktop PES assessment and determine the area based weighted average score for the floodplain . Repeat every 3 to 5 years and assess and report on this with a view to assess if there have been any changes in the state of the system. Verify by undertaking a rapid field-based PES assessment of the system and take fixed point photographs of key features.
Biota	Reporting rates (RR) for aquatic/wetland dependent Red Data bird species. Maintenance of a structurally and species diverse riparian zone.	Overall biodiversity and populations of floodplain dependent Red Data bird species must be maintained. The overall structural and species diversity of the riparian zone must be maintained.	Verify from monitoring records and recorded sightings from available avifaunal reporting rate data. Using a rapid field-based assessment monitor the structure and species diversity of the riparian zone at selected sites along the floodplain. Take fixed point photographs of key features. Report on the above every 3 to 5 years.

5.4 NEXT STEPS

- **Finalise RQOs and numerical limits based on feedback (June 2017)**
- **Gazetting Process to be initiated from July 2017**
- **Comment period – Deadline 9 June 2017**
- **Still be opportunity during gazetting process (60 days for public comment)**