water & sanitation

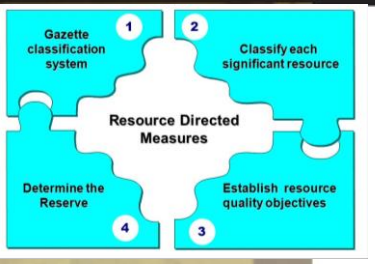
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

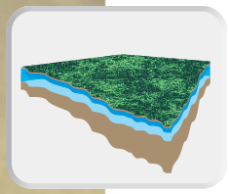
DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE MOKOLO, MATLABAS, CROCODILE (WEST) AND MARICO CATCHMENTS IN THE LIMPOPO WATER MANAGEMENT AREA (WMA 01)

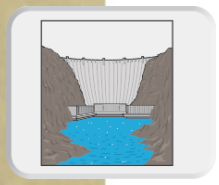
PROJECT STEERING COMMITTEE MEETING 2

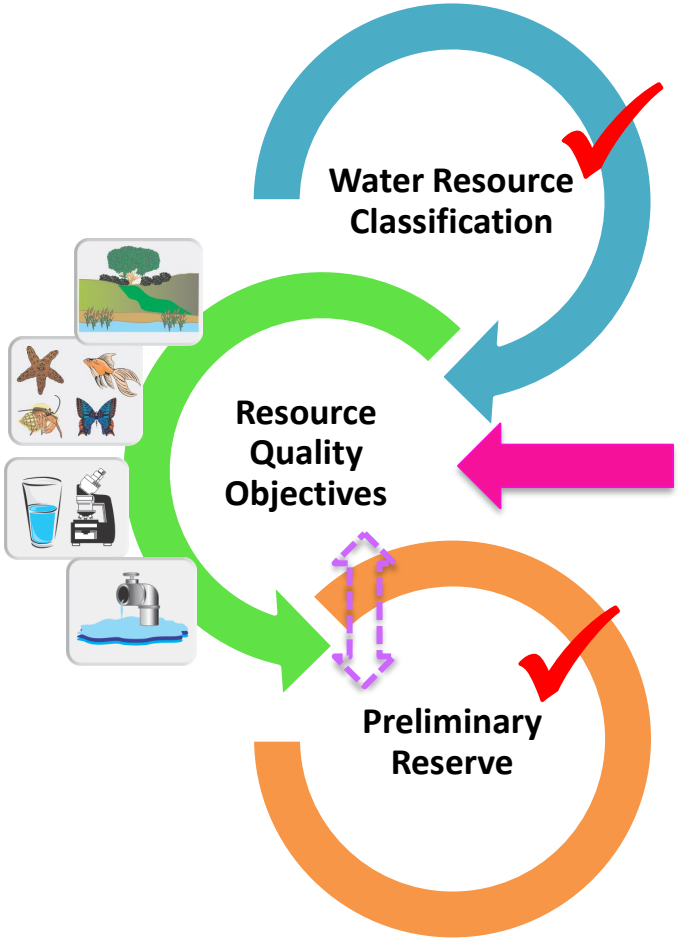
Date: 28 February and 1 March 2017



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







Focus of this study

STUDY PROCESS

This process

Step 1: Delineate the integrated units of analysis and define the resource units;

Step 2: Establish a vision for the catchment and integrated units of analysis;

Partly through WRCS

Step 3: Prioritise and select preliminary resource units for RQO determination;

Step 4: Prioritise sub-components for RQO determination and select indicators for monitoring;

PSC 1

Step 5: Develop draft resource quality objectives and numerical limits;

Work done since then

Step 6: Agree on RQOs and numerical limits with stakeholders;

We are here

Step 7: Finalise and gazette RQOs.

PURPOSE OF THE MEETING:

Introduce the 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

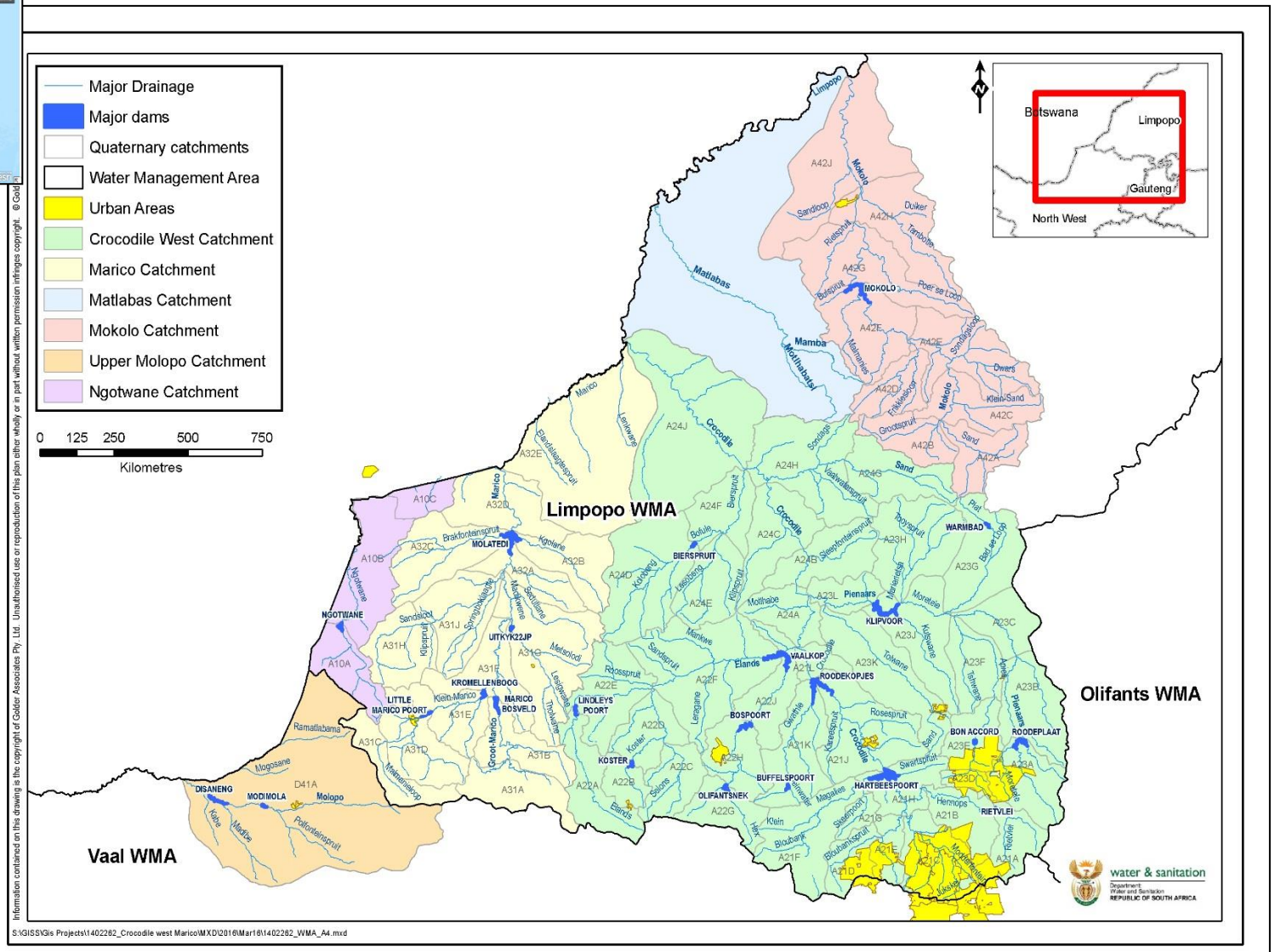
Request comments, input and solicit participation.

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

Southern Portion of the Limpopo Water Management Area



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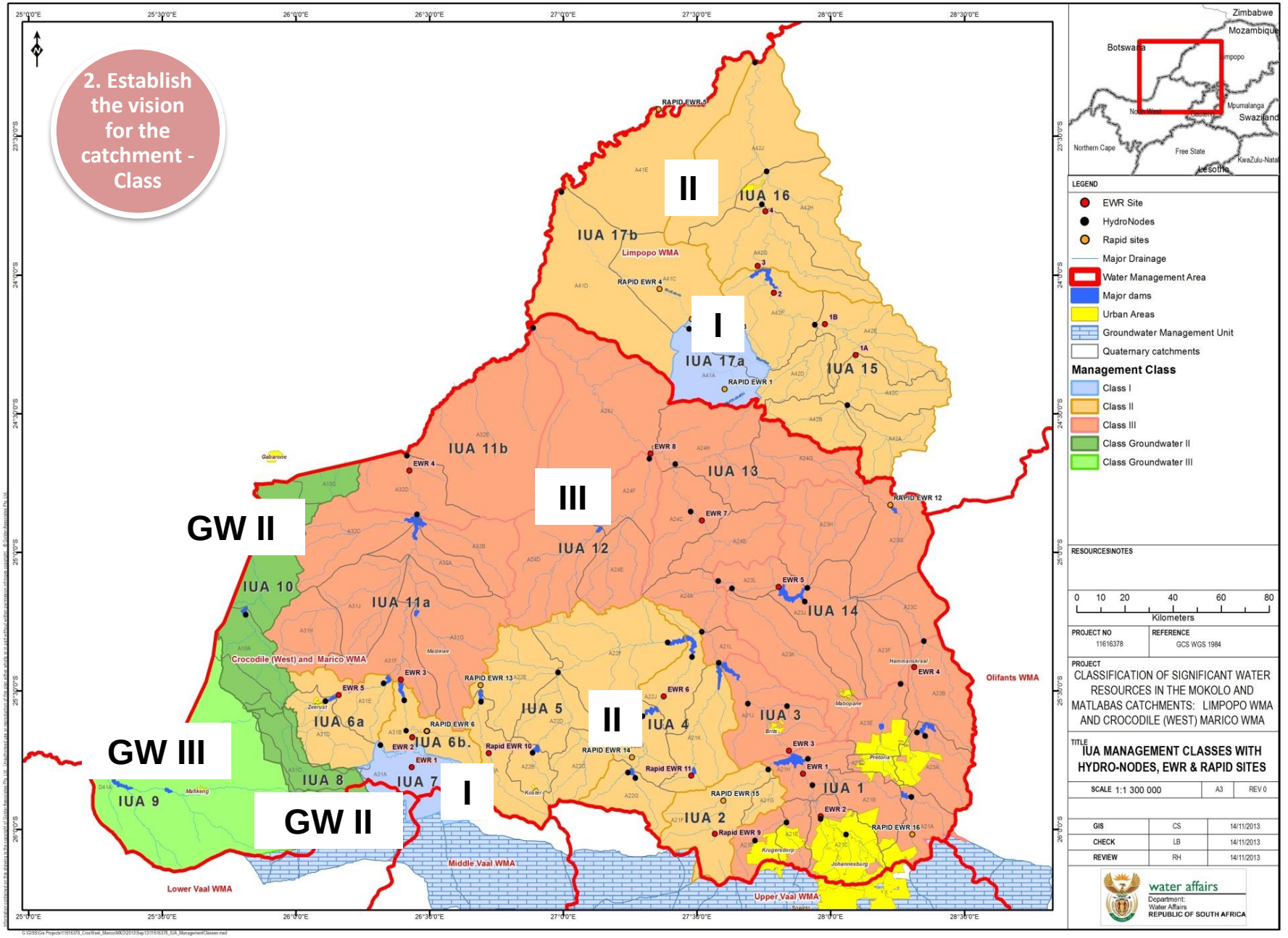
Proposed Water Resource Classes

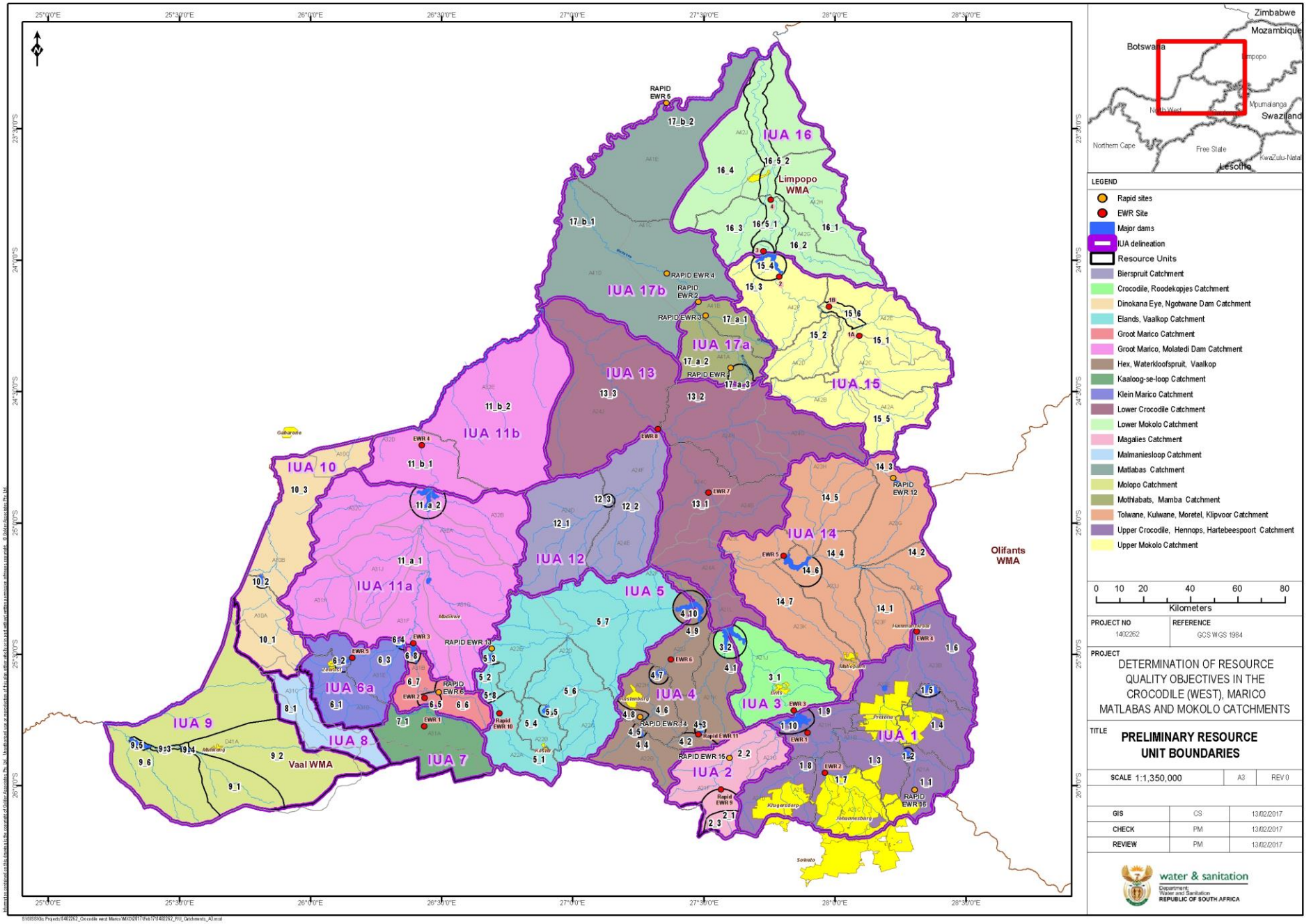


RESOURCE UNIT PRIORITISATION

WHERE SHOULD RQOs BE SET? (Priority)

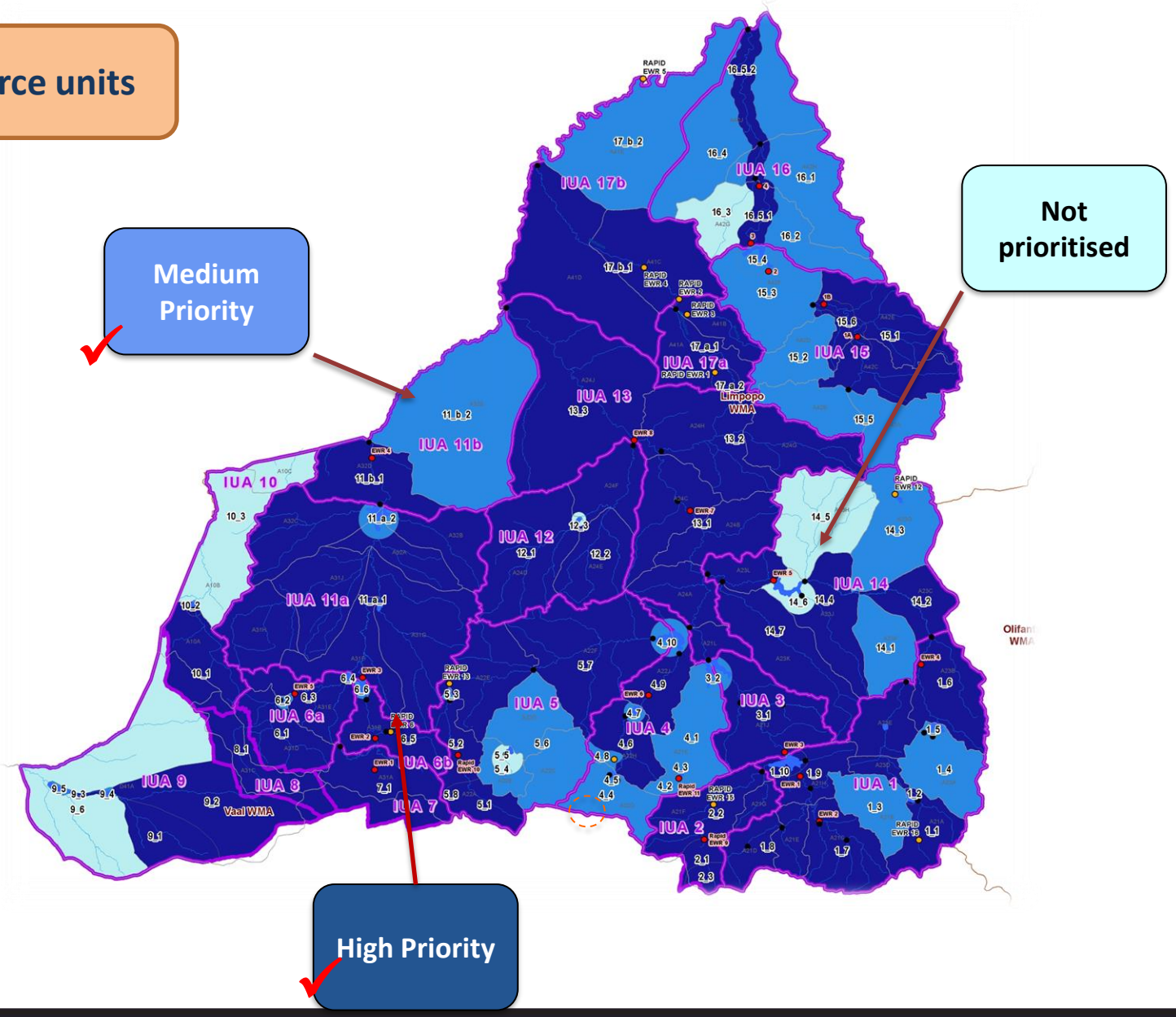
DELINEATION OF RESOURCE UNITS

- 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


IUA 16
IUA 17b
IUA 17a
IUA 15
IUA 13
IUA 11b
IUA 10
IUA 11a
IUA 12
IUA 14
IUA 5
IUA 6a
IUA 4
IUA 3
IUA 9
IUA 8
IUA 7
IUA 2
IUA 1
Limpopo WMA
Olifants WMA
Vaal WMA
Zimbabwe
Mozambique
Botswana
Swaziland
Lesotho
Northern Cape
Free State
KwaZulu-Natal
Mpumalanga
LEGEND
Rapid sites
EWR Site
Major dams
IUA delineation
Resource Units
Biespruit Catchment
Crocodile, Roodekopjes Catchment
Dinokana Eye, Ngotwane Dam Catchment
Elands, Vaalkop Catchment
Groot Marico Catchment
Groot Marico, Molatedi Dam Catchment
Hex, Waterkloofspruit, Vaalkop
Kaaloog-se-loop Catchment
Klein Marico Catchment
Lower Crocodile Catchment
Lower Mokolo Catchment
Magalies Catchment
Malmaniesloop Catchment
Matlabas Catchment
Molopo Catchment
Mothlabats, Mamba Catchment
Tolwane, Kulwane, Moretel, Klipvoor Catchment
Upper Crocodile, Hennops, Hartebeespoort Catchment
Upper Mokolo Catchment
0 10 20 40 60 80
Kilometers
PROJECT NO 1402262
REFERENCE GCS WGS 1984
PROJECT
DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE CROCODILE (WEST), MARICO MATLABAS AND MOKOLO CATCHMENTS
TITLE
PRELIMINARY RESOURCE UNIT BOUNDARIES
SCALE 1:1,350,000
A3
REV 0
GIS CS 13/02/2017
CHECK PM 13/02/2017
REVIEW PM 13/02/2017
water & sanitation
Department: Water and Sanitation
REPUBLIC OF SOUTH AFRICA

RESOURCE UNIT PRIORITISATION

Prioritised resource units



FOR WHICH COMPONENTS AND INDICATORS ARE RQOs SET?

COMPONENTS AND SUB COMPONENTS
(RIVERS, DAMS, WETLANDS)

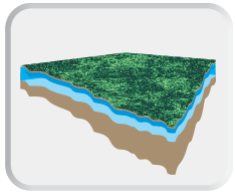
WATER QUANTITY
- High Flows
- Low Flows

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

PROCESS TO DETERMINE RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS

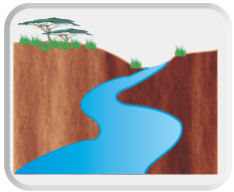
WATER QUANTITY RQOS (HYDROLOGICAL)

- **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.

(Hydrological RQOs are defined by quantity and frequency for each month of the year)

WATER QUANTITY RQOs (HYDROLOGICAL)

- 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)



WATER QUANTITY RQOS (HYDROLOGICAL)

Summary of EWR estimate for: EWR 13 Cumulative Natural Flows

Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Million. cubic. metres or index values):	
Mean Annual Runoff =	2654.289
Standard Deviation =	1877.75
CV =	0.707
Q75 =	35.51
Q75/MMF =	0.161
BFI Index =	0.34
CV(JJA+JFM) Index =	2.337

Ecological Reserve Category = C

Total IFR	= 606.747 (22.86 %MAR)
Maintenance Low flow	= 307.950 (11.60 %MAR)
Drought Low flow	= 1.234 (0.05 %MAR)
Maintenance High flow	= 298.797 (11.26 %MAR)

Monthly Distributions (cubic.m./s)

Distribution Type

Month	Natural Flows			Modified Flows (EWR)			
				Low Flows		High Flows	Total Flows
	Mean	SD	CV	Maintenance	Drought		Maintenance
Oct	64.651	105.441	0.609	7.254	0.029	0.000	7.254
Nov	130.295	156.933	0.465	10.7	0.043	14.600	25.300
Dec	146.236	140.007	0.357	11.931	0.047	0.000	11.931
Jan	160.381	144.114	0.335	13.892	0.055	14.129	28.021
Feb	214.942	312.889	0.602	18.531	0.073	92.225	110.756
Mar	126.387	157.52	0.465	15.172	0.06	0.000	15.172
Apr	58.9	59.439	0.389	11.532	0.046	0.000	11.532
May	33.719	53.771	0.595	7.732	0.031	0.000	7.732
Jun	17.821	14.18	0.307	5.863	0.024	0.000	5.863
Jul	20.814	36.099	0.648	5.278	0.022	0.000	5.278
Aug	16.175	14.261	0.329	4.78	0.02	0.000	4.780
Sep	29.095	87.843	1.165	5.177	0.022	0.000	5.170

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**

WATER QUALITY RQOS

BASIC PRINCIPLE – MAINTAIN OR IMPROVE

1

Basis is Ecological Category (Class and Present Ecological State) → No present state Water Quality Data available for river reach → Understand catchment activities → Consider user requirements → Ecological Specifications at minimum or stricter to meet user requirements or control land based activities

2

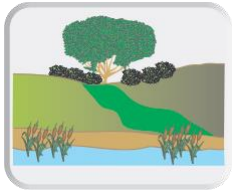
Basis is Ecological Category (Class or Present Ecological State) → Present State Water Quality Data assessed → Understand status quo compared to water quality ecological specifications → Consider user requirements/ impacting activities → Stricter limits of present state and ecological water quality specifications (also satisfy user requirements)

Where the Status Quo was better than the ecological protection required, RQO was set at status quo.

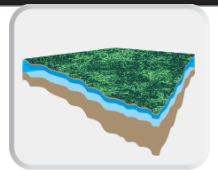
Where the status quo When worse than the recommended level of protection, the ecological water quality category limit was used which also met user requirements

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.

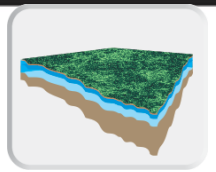


GROUNDWATER RQOs



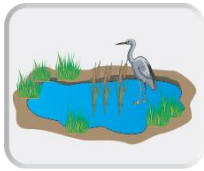
- Two important aquifer systems**: Alluvial and Dolomite (karst) aquifer systems**
- E stablished on a resource unit scale (regional and local):
  - Dolomite RU demarcations were adapted to portray the actual groundwater flow boundaries as per the mapped dolomite compartment boundaries.
- The approach 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).

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.

DRAFT RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS

TYPICAL RQOs TABLE IN DOCUMENT - PER RU

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
1_9 **Crocodile River from Jukskei confluence to Hartbeespoort Dam** **A21H**	Quantity	Low flows	EWR maintenance low and drought flows: Crocodile River at CROC_EWR1 in A21H PMAR = 231.05x10^{6} m^{3} REC=D category The maintenance and drought flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem and users.	Base Flows Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	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	Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Water resource class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
	Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category and the water quality requirements of the water users are met. Nutrient management required to improve current state and ensure sustainability of the system.	Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50th percentile)	Improvement in instream concentrations required. Meets ecological specfications
				Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.0 milligrams/litre (50th percentile)	Improvement in instream concentrations required. Meets ecological specfications
		Salts	Instream salinity must be maintained to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 75 milliSiemens/metre (mS/m) (95th percentile)	Present state quality. Within prescribed ecological category for aquatic ecosystem, Ecological Reserve manual (2008).
				Sodium	≤ 60 milligrams/litre (mg/l) (95th percentile)	Maintain within present salinity state.
				Chloride	≤ 60 milligrams/litre (mg/l) (95th percentile)	Maintain within present salinity state
				Sulphate	≤ 75 milligrams/litre (mg/l) (95th percentile)	Maintain within present salinity state
		Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		System Variables	pH range must be maintained at within limits specified to support the aquatic ecosystem. .	pH range	6.5 (5th percentile) and 8.5 (95th percentile)	Aquatic ecosystem and user as the drivers
			A baseline assessment to determine the present state instream turbidity is required.	Turbidity	A 10% variation from background concentration is allowed.	No baseline data available. Monitoring required to determine present state.

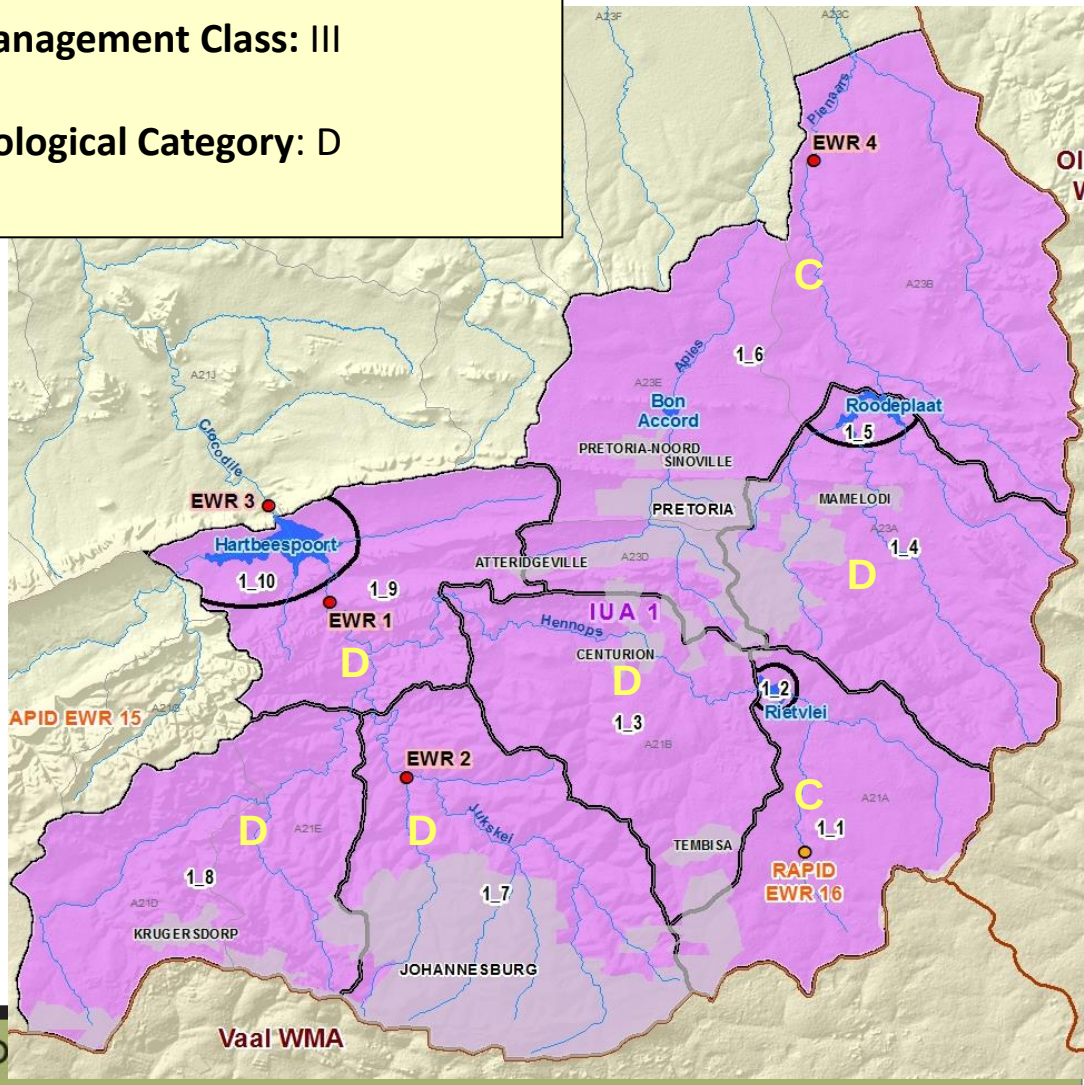
IUA1: Upper Crocodile/Hennops/Hartbeespoort

RU	Delineation Description	Quat
1_1	Upper Hennops and Rietvlei Rivers to inflow to Rietvlei Dam	A21A
1_2	Rietvlei Dam	A21A
1_3	Hennops River to the A21B catchment	A21B
1_4	Upper Pienaars River, Edendalespruit and Moretlele Rivers	A23A
1_5	Roodeplaat Dam	A23A
1_6	Upper and middle reaches of Apies River, Skinnerspruit, Middle Pienaars River, Roodeplaatspruit, Boekenhoutspruit	A23B, A23D, A23E
1_7	Jukskei, Klein Jukskei, Modderfonteinspruit	A21C
1_8	Upper reaches of Crocodile River and Bloubankspruit	A21D, A21E
1_9	Crocodile River from Jukskei confluence to inflow Hartbeespoort Dam, Swartspruit	A21H
1_10	Hartbeespoort Dam	A21H

Quaternary Catchments:
A21A – A21H ; A23A – A23E

Management Class: III

Ecological Category: D



IUA1: Upper Crocodile/Hennops/Hartbeespoort Class III

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

- EIS is high. EWR site 4 on the Pienaars River
- Important for fish movement
- and mining present
- 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.
- Parts of the River can be classified as an urban river.

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.

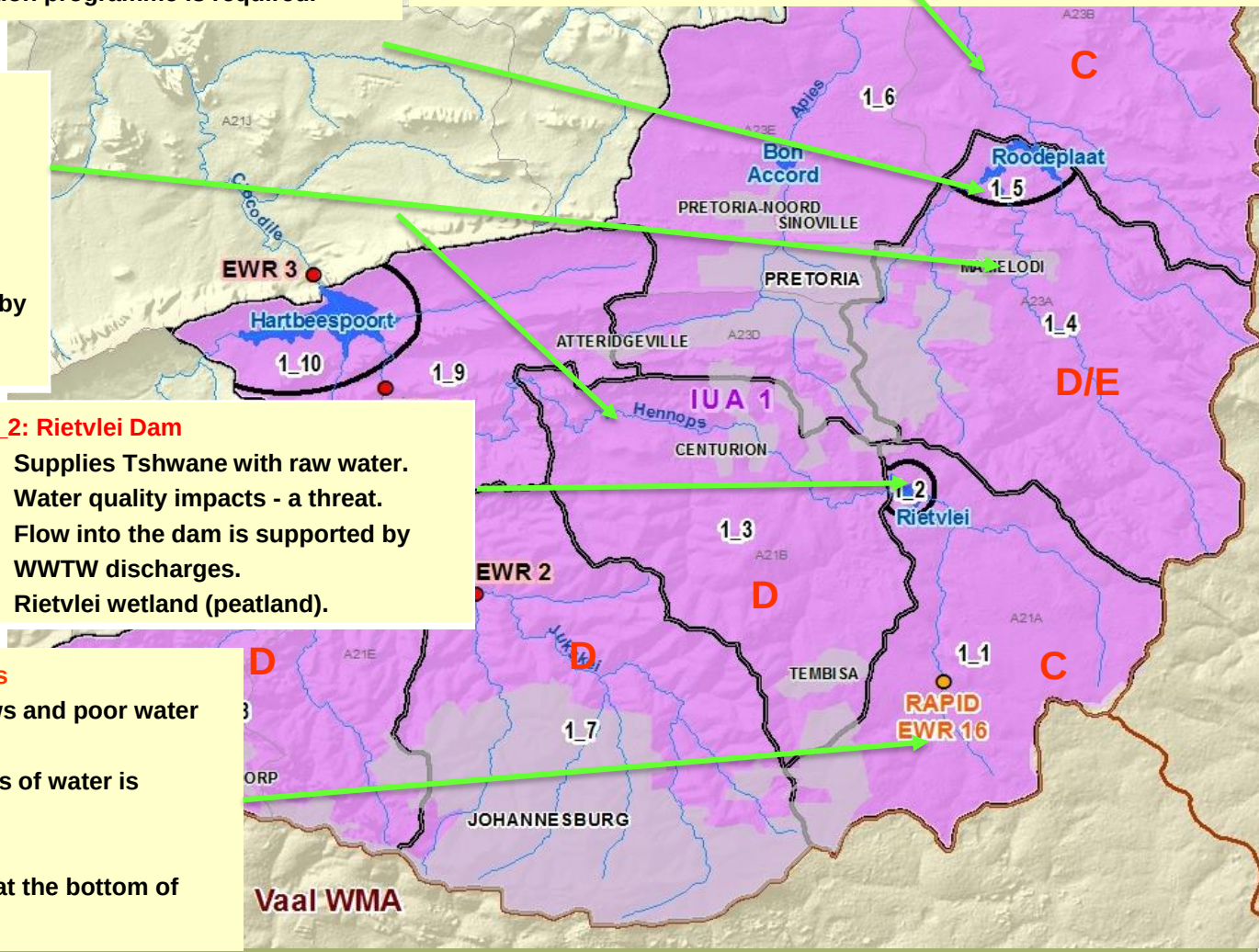
1_3 and 1_4

- 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.
- Some wetlands present.
- The Rietvlei Nature Reserve is located at the bottom of this unit.



IUA1: Upper Crocodile/Hennops/Hartbeespoort Class III

1_10 Hartbeespoort Dam

- Outlet of IUA1.
- 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

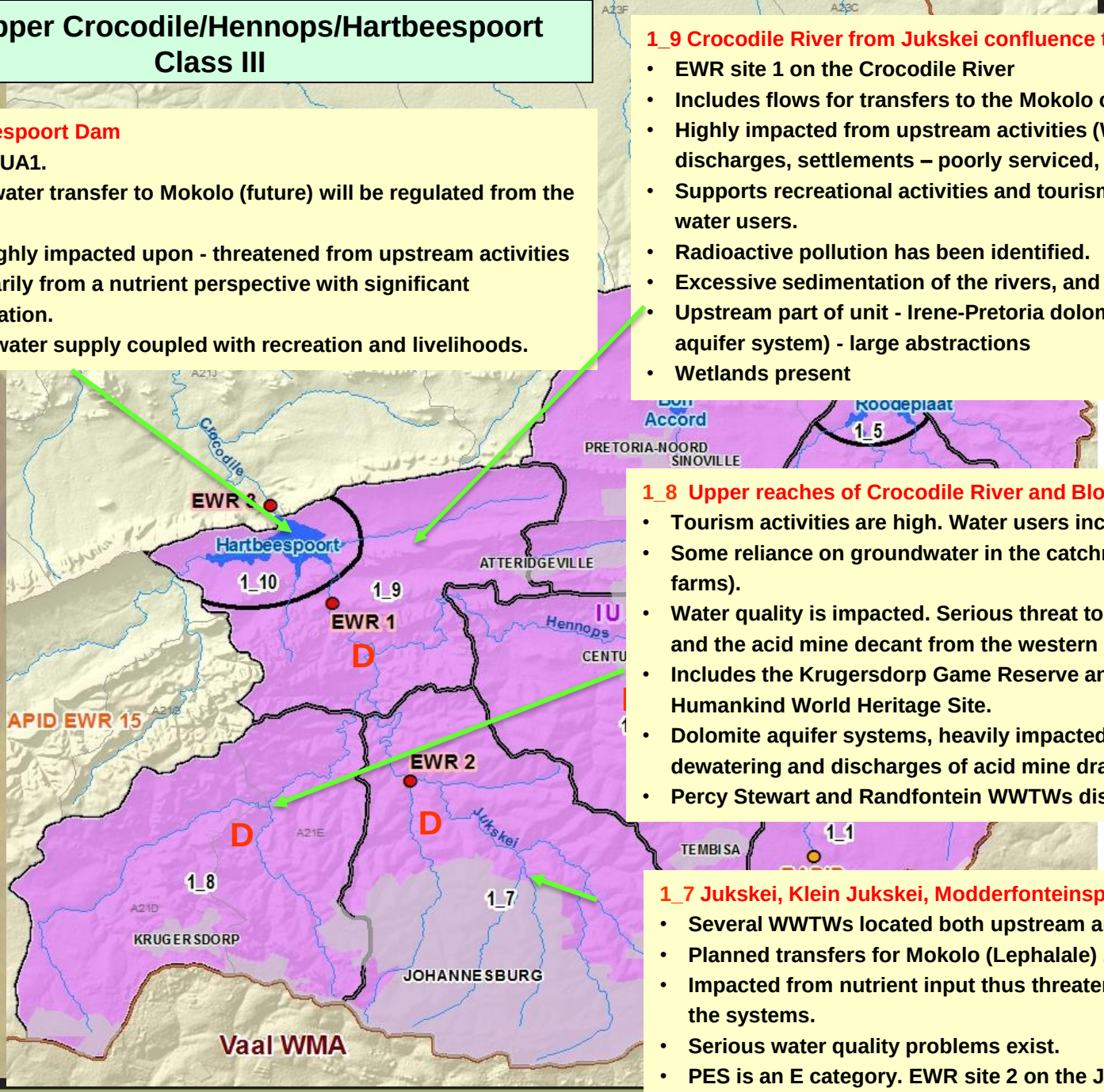
- EWR site 1 on the Crocodile River
- Includes flows for transfers to the Mokolo catchment at Thabazimbi.
- Highly impacted from upstream activities (WWTW, urban activities, discharges, settlements – poorly serviced, solid wastes etc.).
- Supports recreational activities and tourism, irrigation and industrial water users.
- Radioactive pollution has been identified.
- Excessive sedimentation of the rivers, and aquatic weed infestation.
- Upstream part of unit - Irene-Pretoria dolomites (Centurion dolomite aquifer system) - large abstractions
- Wetlands present

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

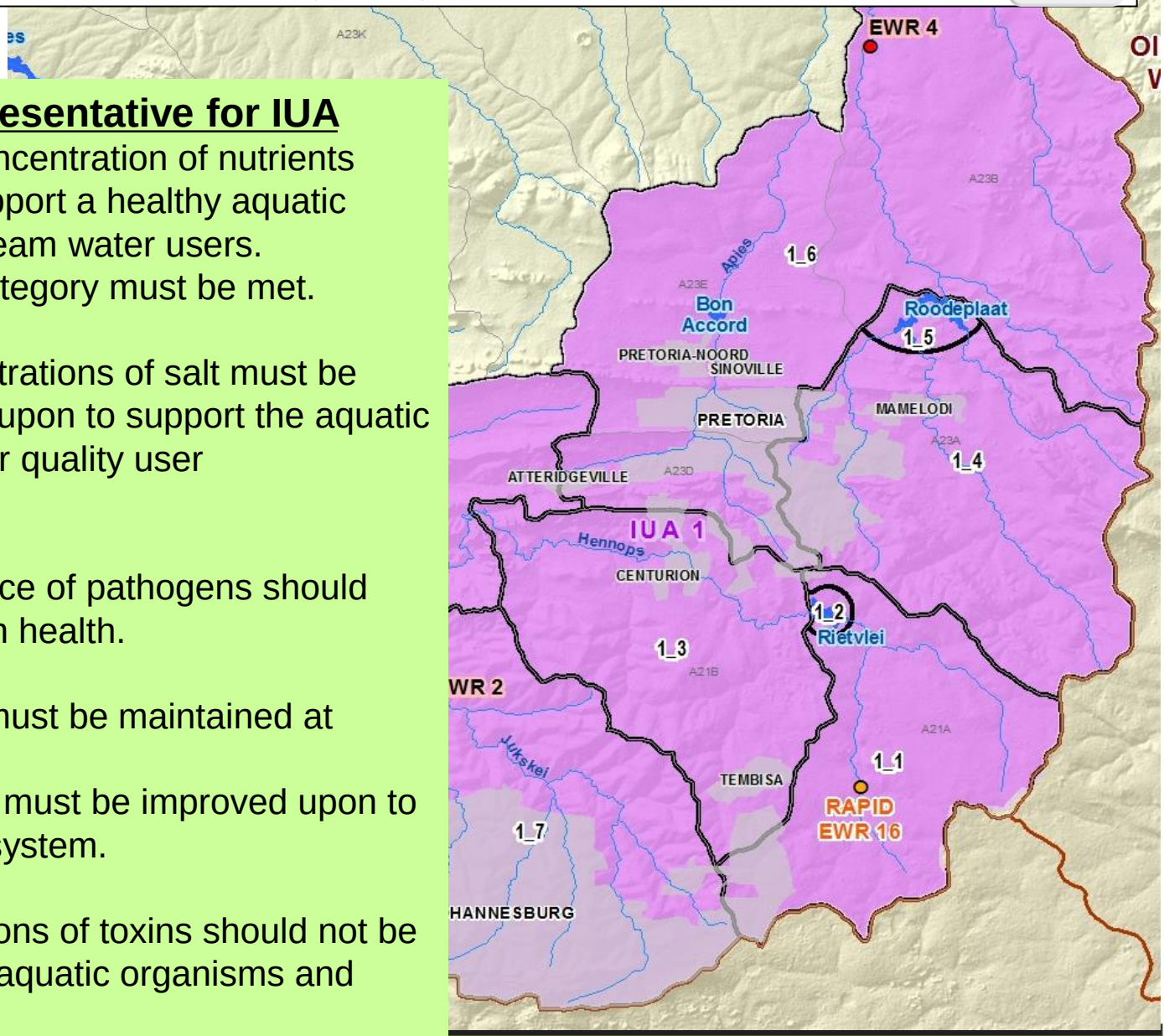
- **Nutrients:** In-stream concentration of nutrients must be improved to support a healthy aquatic ecosystem and downstream water users. Prescribed ecological category must be met.

- **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.

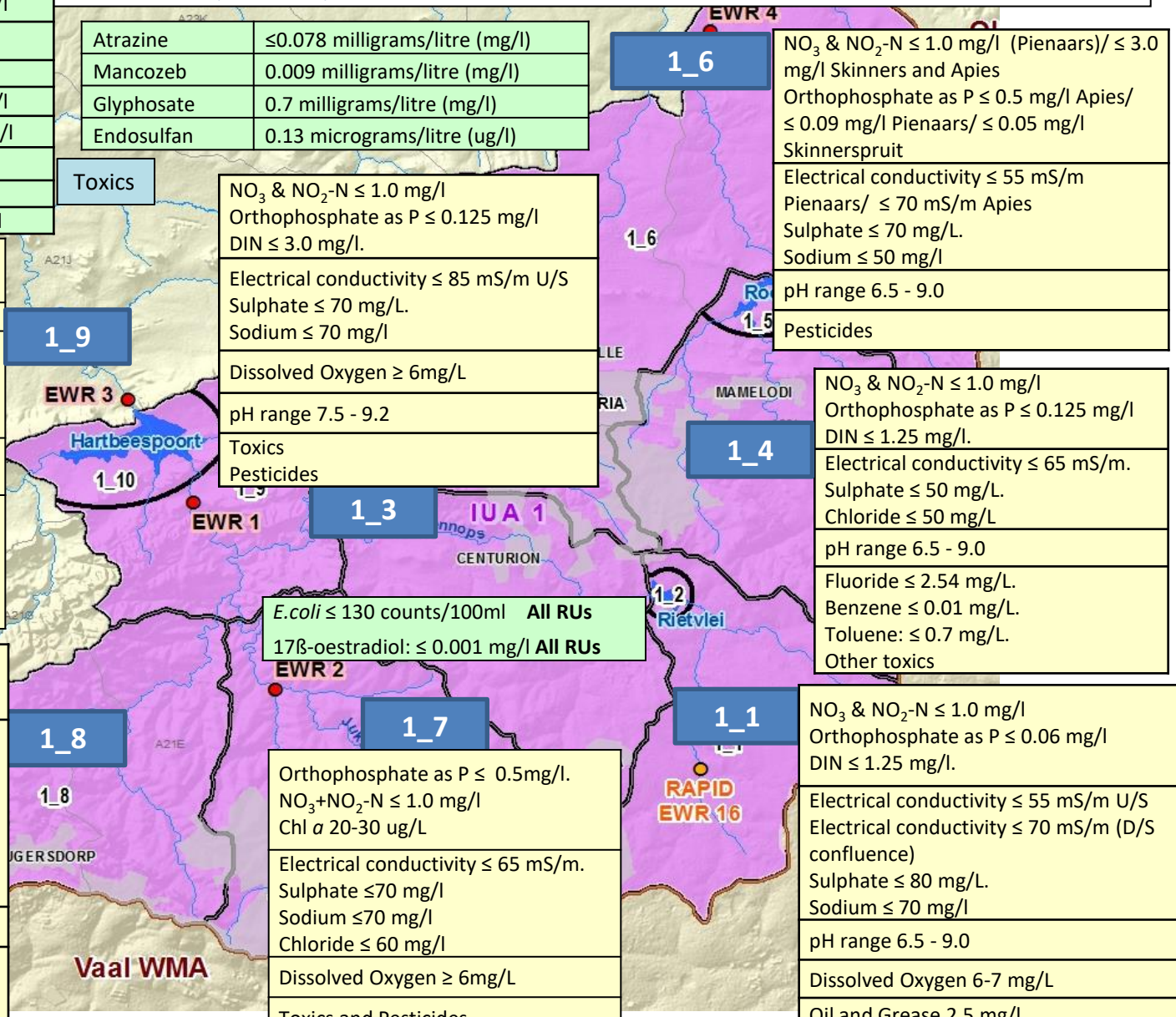


IUA 1: Upper Crocodile/Hennops/Hartbeespoort
RQOs QUALITY - RIVERS

Ammonia as N	≤ 0.0725mg/l	≤ 0.100 mg/l
Aluminium	≤ 0.105 mg/l	≤ 0.150 mg/l
Manganese	≤ 0.37mg/l.	≤ 0.37mg/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 ≤ 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 ≤ 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

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 ≤ 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

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
Tweelopiespruit: tbc

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
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

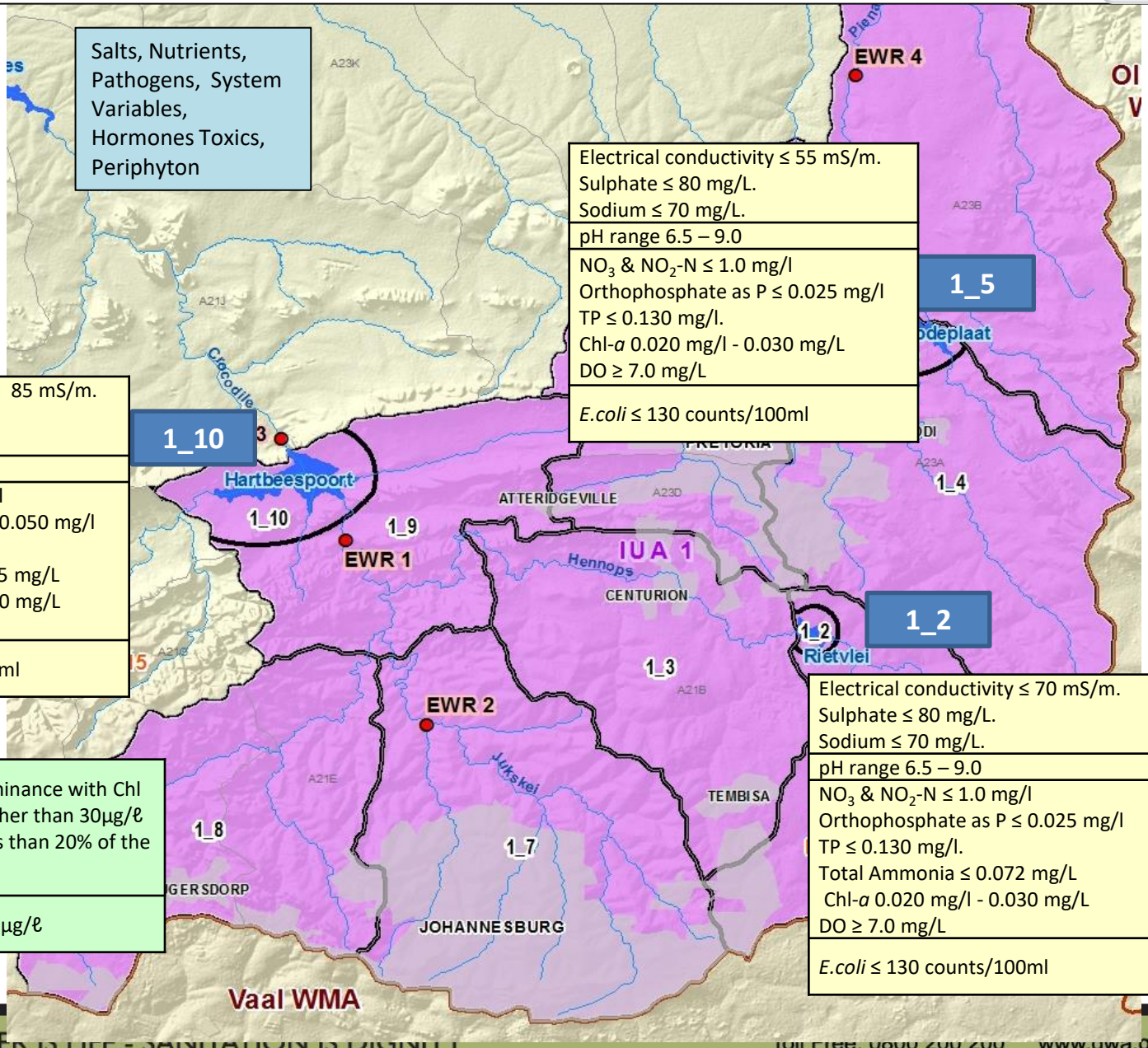
pH range 6.5 - 9.0

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

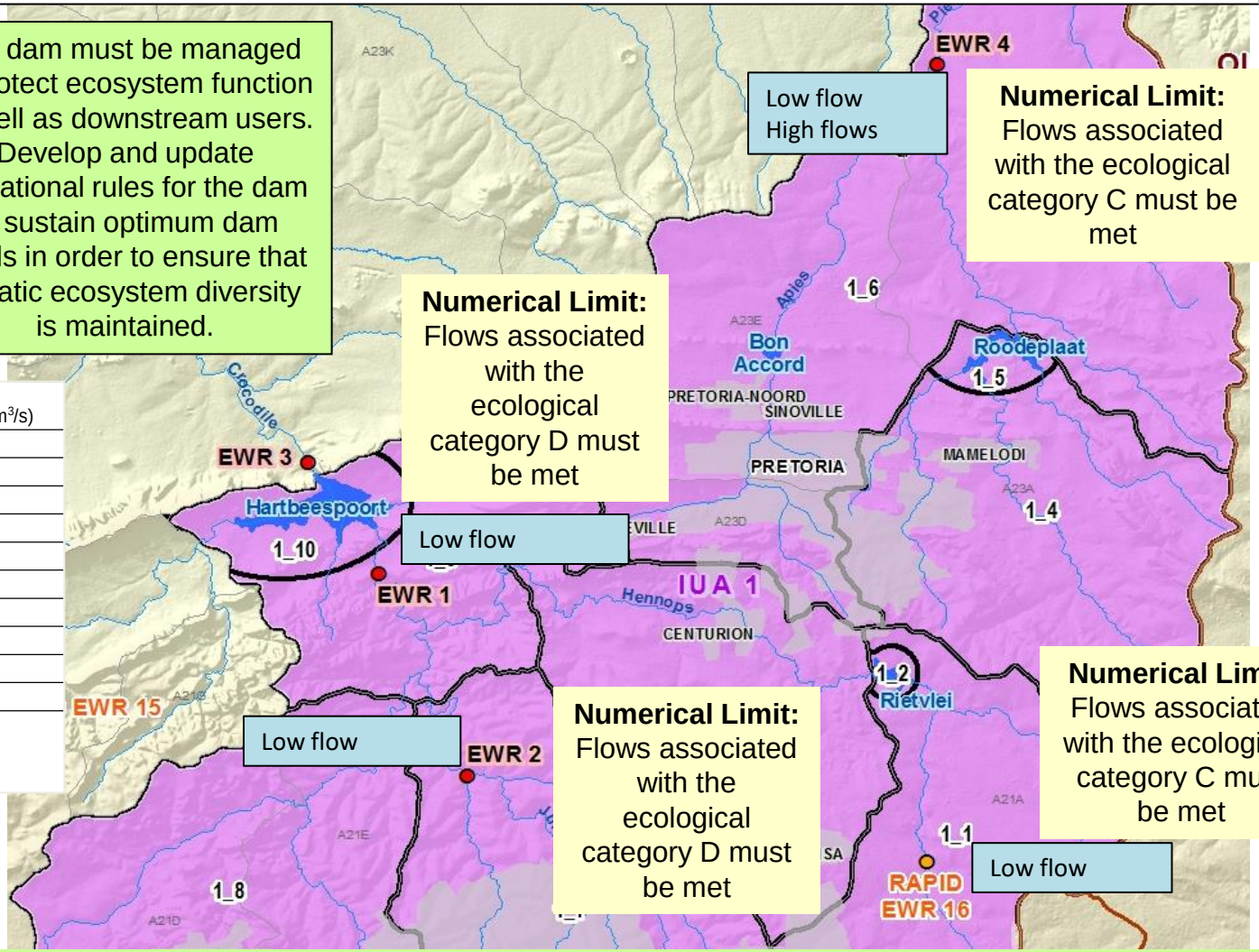


IUA 1: Upper Crocodile/Hennops/Hartbeespoort RQOs QUANTITY

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

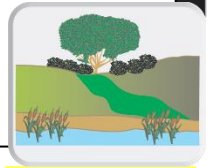


RQOs:FLOWS

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

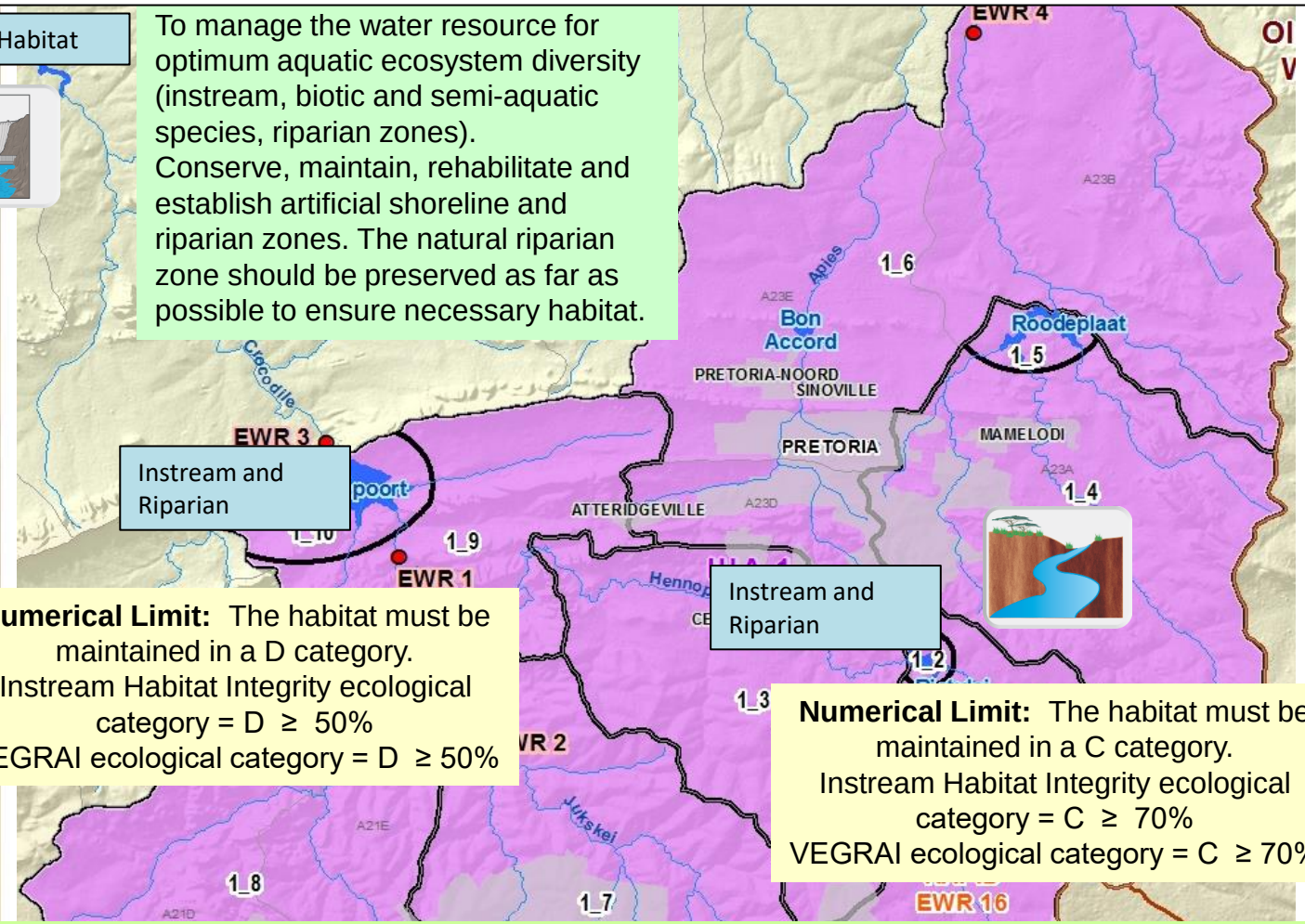
IUA 1: Upper Crocodile/Hennops/Hartbeespoort
RQOs HABITAT – INSTREAM AND RIPARIAN



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 ≥ 50%
VEGRAI ecological category = D ≥ 50%

Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

RQOs:

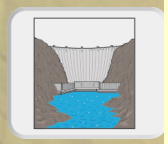
Instream: Habitat diversity should be improved from an E ecological category to a D category. Ecological integrity of system must improve. No further degradation of the instream habitat should occur. General fish habitat availability must be maintained, to sustain biotope diversity

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

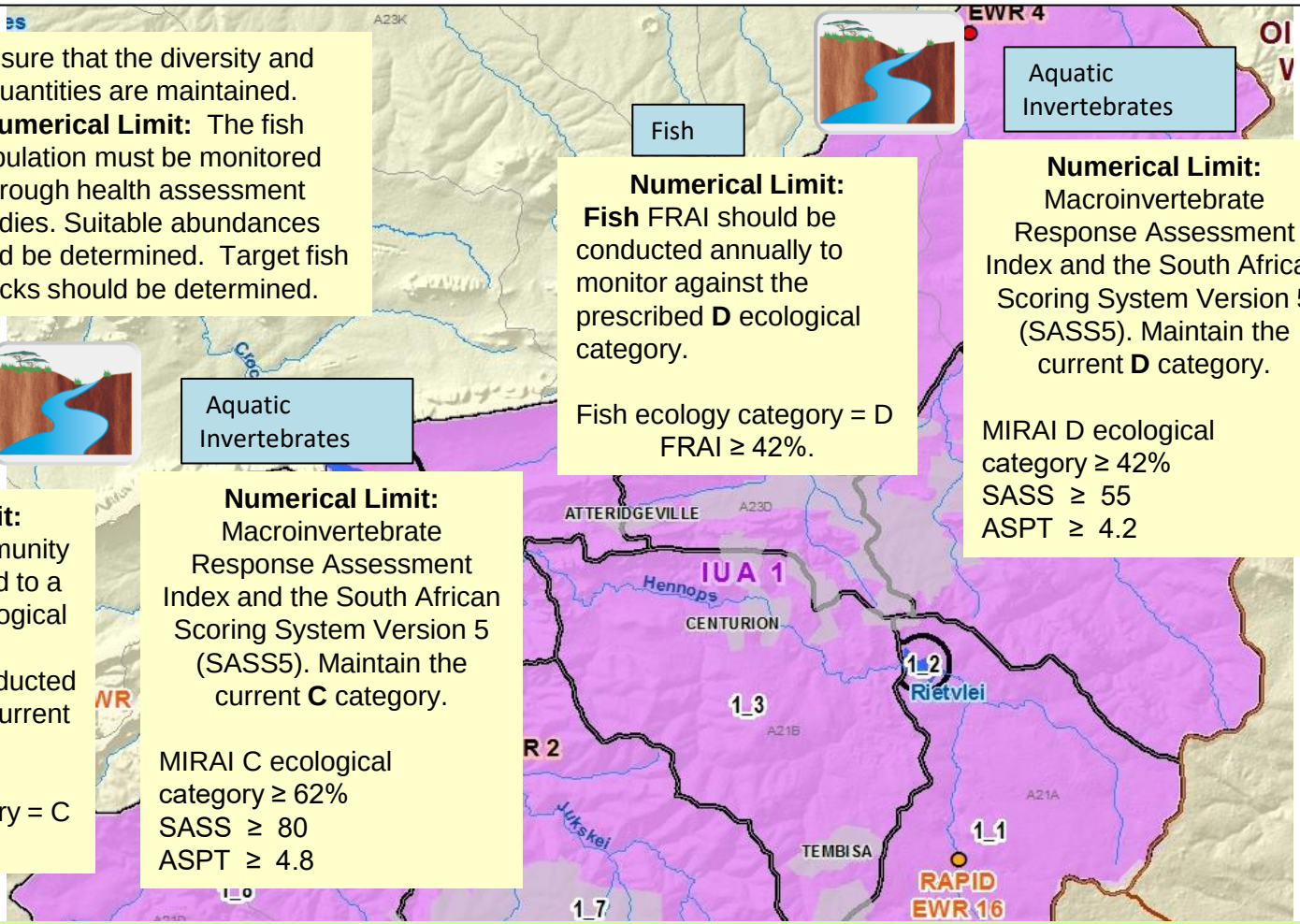
Numerical Limit:
Macroinvertebrate Response Assessment Index and the South African Scoring System Version 5 (SASS5). Maintain the current **C** category.

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.

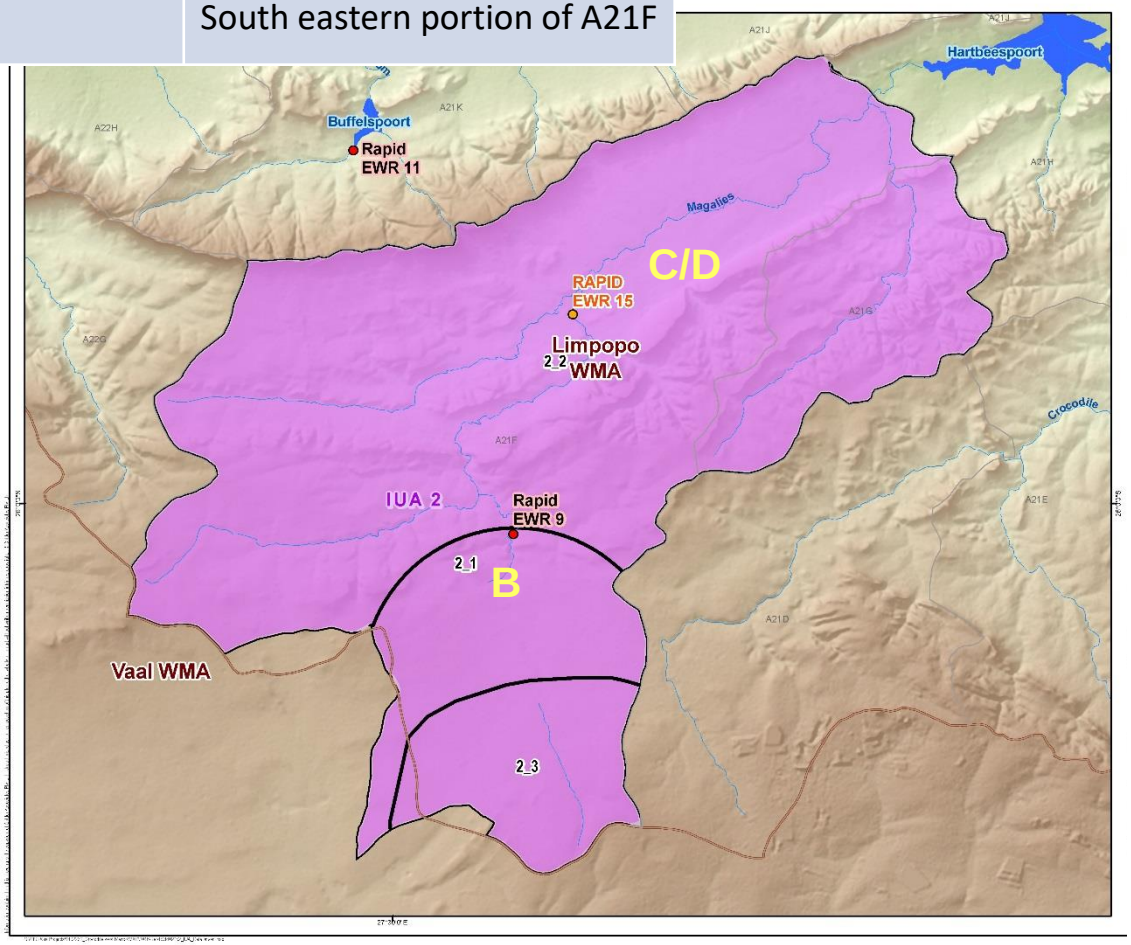
IUA 2: MAGALIES CATCHMENT AREA

RU	Delineation	Catchment
2_1	Maloneys Eye	A21F
2_2	Magalies River, Klein Magalies, Bloubank, Skeerpoort Rivers	A21F, A21G
2_3	Rietspruit catchment area	South eastern portion of A21F

Quaternary Catchments:
A21F, A21G

Management Class: II

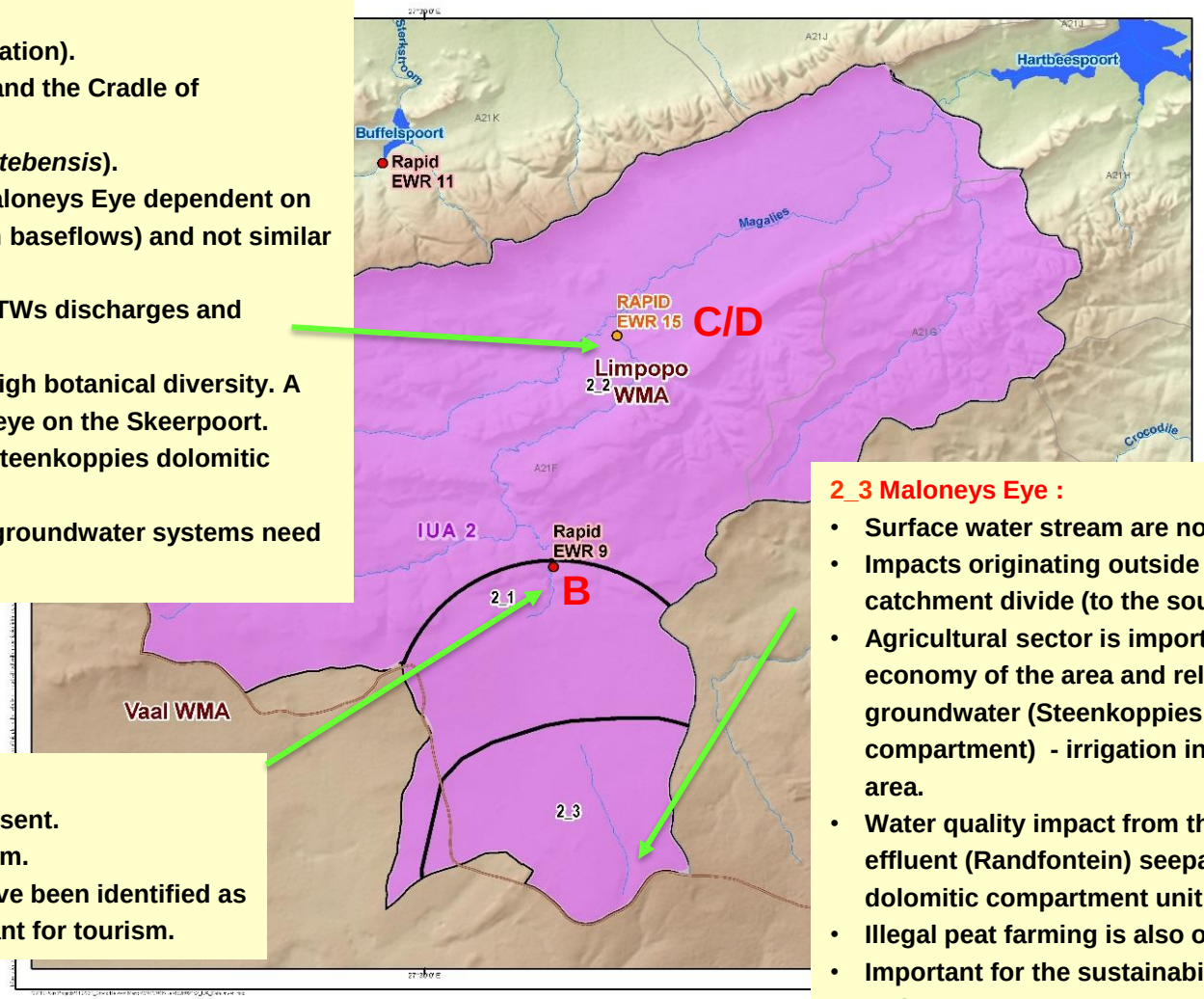
Ecological Category: C



IUA 2: Magalies Catchment Area

2_2 Magalies River, Klein Magalies, Bloubank, Skeerpoort Rivers:

- Eco-tourism and agriculture (irrigation).
- Magaliesburg conservation area and the Cradle of Humankind World Heritage Site.
- Fish support area (i.e. *Barbus motebensis*).
- Magalies River downstream of Maloneys Eye dependent on dolomitic outflows (constant high baseflows) and not similar to other tributaries.
- Water quality is impacted by WWTWs discharges and irrigation return flows.
- Hillsope seepage wetlands with high botanical diversity. A tufa waterfall is present. Nouklip eye on the Skeerpoort.
- Discharges from upper reaches Steenkoppies dolomitic compartment unit.
- Interaction between surface and groundwater systems need to be determined.



2_1 Maloneys Eye :

- High EIS. EWR Rapid site 9 is present.
- Regarded as a priority river system.
- Areas associated with the eye have been identified as irreplaceable and the eye important for tourism.

2_3 Maloneys Eye :

- Surface water stream are not well defined
- Impacts originating outside the catchment divide (to the south)
- Agricultural sector is important to the economy of the area and relies on groundwater (Steenkoppies compartment) - irrigation in the Tarlton area.
- Water quality impact from the sewage effluent (Randfontein) seepage into dolomitic compartment unit
- Illegal peat farming is also occurring.
- Important for the sustainability of Maloneys Eye.

IUA 2: Magalies Catchment - RQOs QUALITY

Narrative RQOs: Representative for IUA

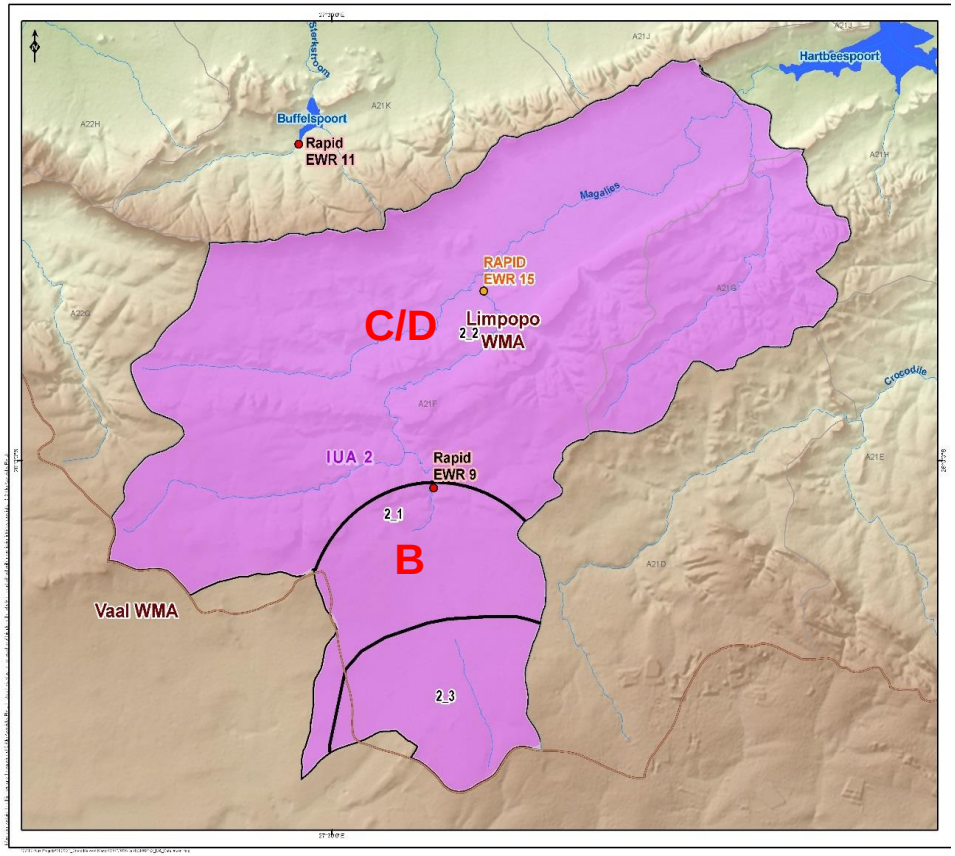
- **Nutrients:** Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.

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

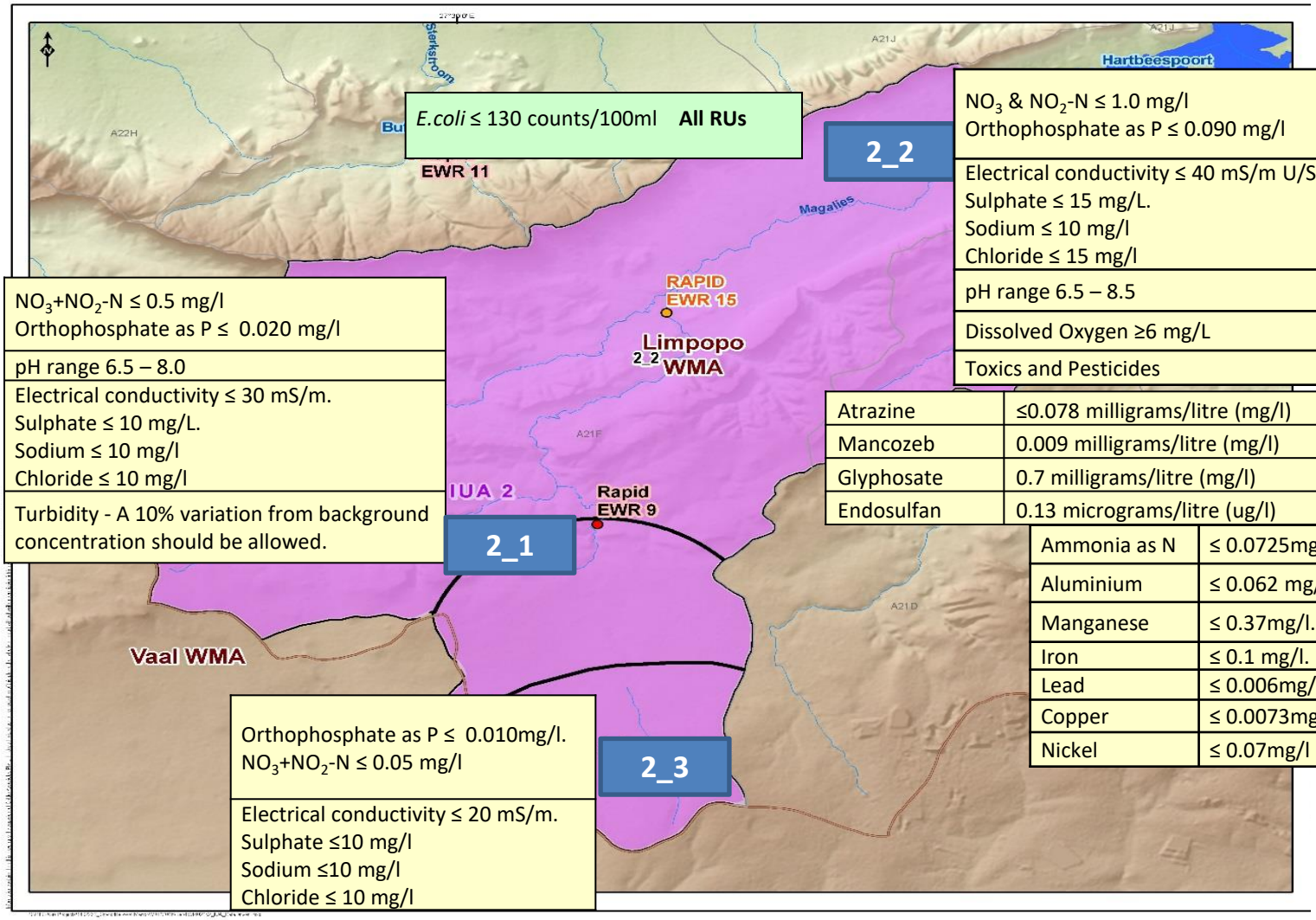
- **Pathogens:** The presence of pathogens should pose a low risk to human health.

- **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 2: Magalies Catchment
RQOs QUALITY - RIVERS



E.coli ≤ 130 counts/100ml **All RUs**

2_2

NO_3 & NO_2-N ≤ 1.0 mg/l Orthophosphate as P ≤ 0.090 mg/l
Electrical conductivity ≤ 40 mS/m U/S Sulphate ≤ 15 mg/L. Sodium ≤ 10 mg/l Chloride ≤ 15 mg/l
pH range 6.5 – 8.5
Dissolved Oxygen ≥6 mg/L
Toxics and Pesticides

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)

Ammonia as N	≤ 0.0725mg/l
Aluminium	≤ 0.062 mg/l
Manganese	≤ 0.37mg/l.
Iron	≤ 0.1 mg/l.
Lead	≤ 0.006mg/l
Copper	≤ 0.0073mg/l
Nickel	≤ 0.07mg/l

NO_3+NO_2-N ≤ 0.5 mg/l Orthophosphate as P ≤ 0.020 mg/l
pH range 6.5 – 8.0
Electrical conductivity ≤ 30 mS/m. Sulphate ≤ 10 mg/L. Sodium ≤ 10 mg/l Chloride ≤ 10 mg/l
Turbidity - A 10% variation from background concentration should be allowed.

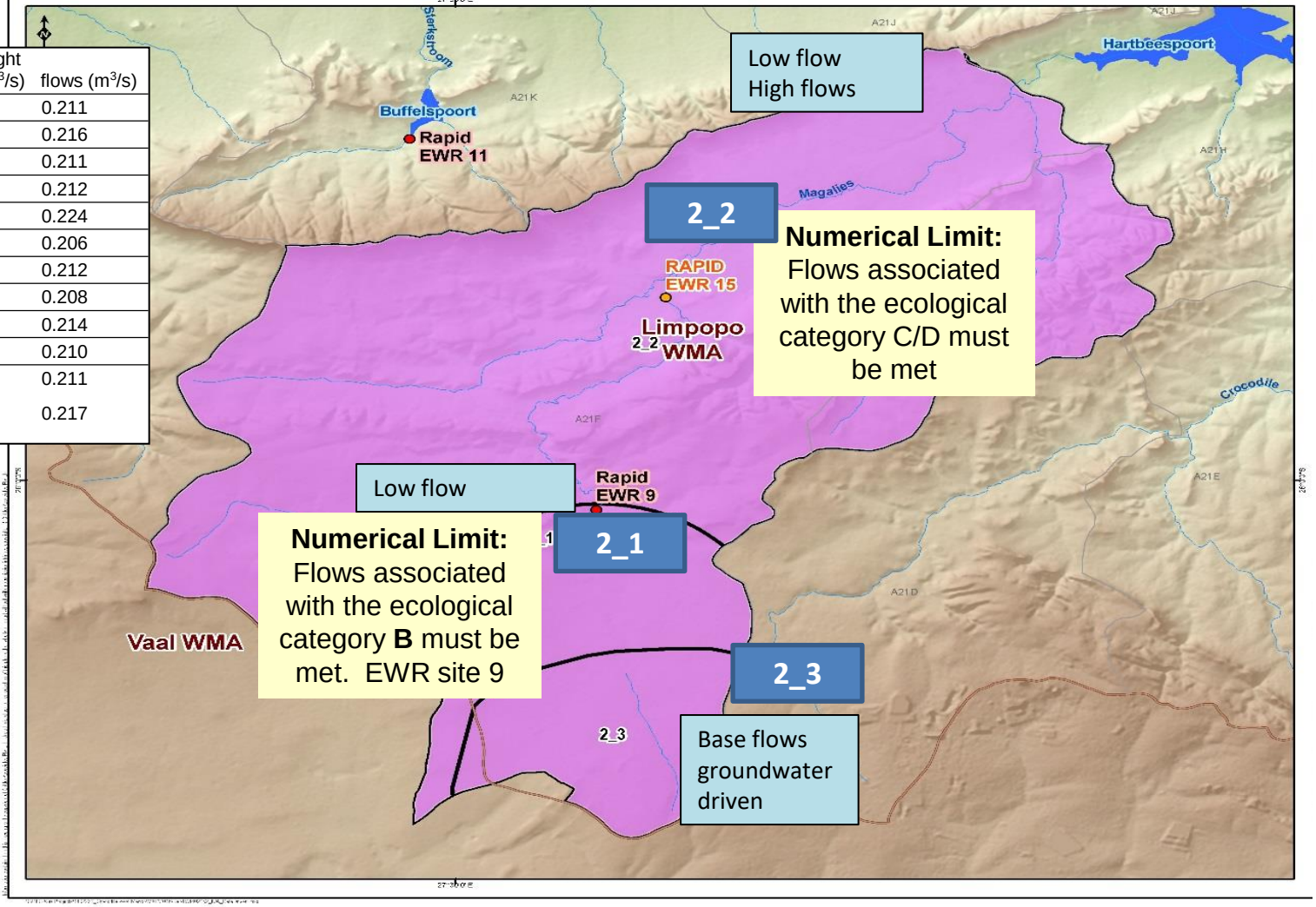
2_1

Orthophosphate as P ≤ 0.010mg/l. NO_3+NO_2-N ≤ 0.05 mg/l
Electrical conductivity ≤ 20 mS/m. Sulphate ≤10 mg/l Sodium ≤10 mg/l Chloride ≤ 10 mg/l

2_3

IUA 2: Magalies Catchment
RQOs QUANTITY – FLOW

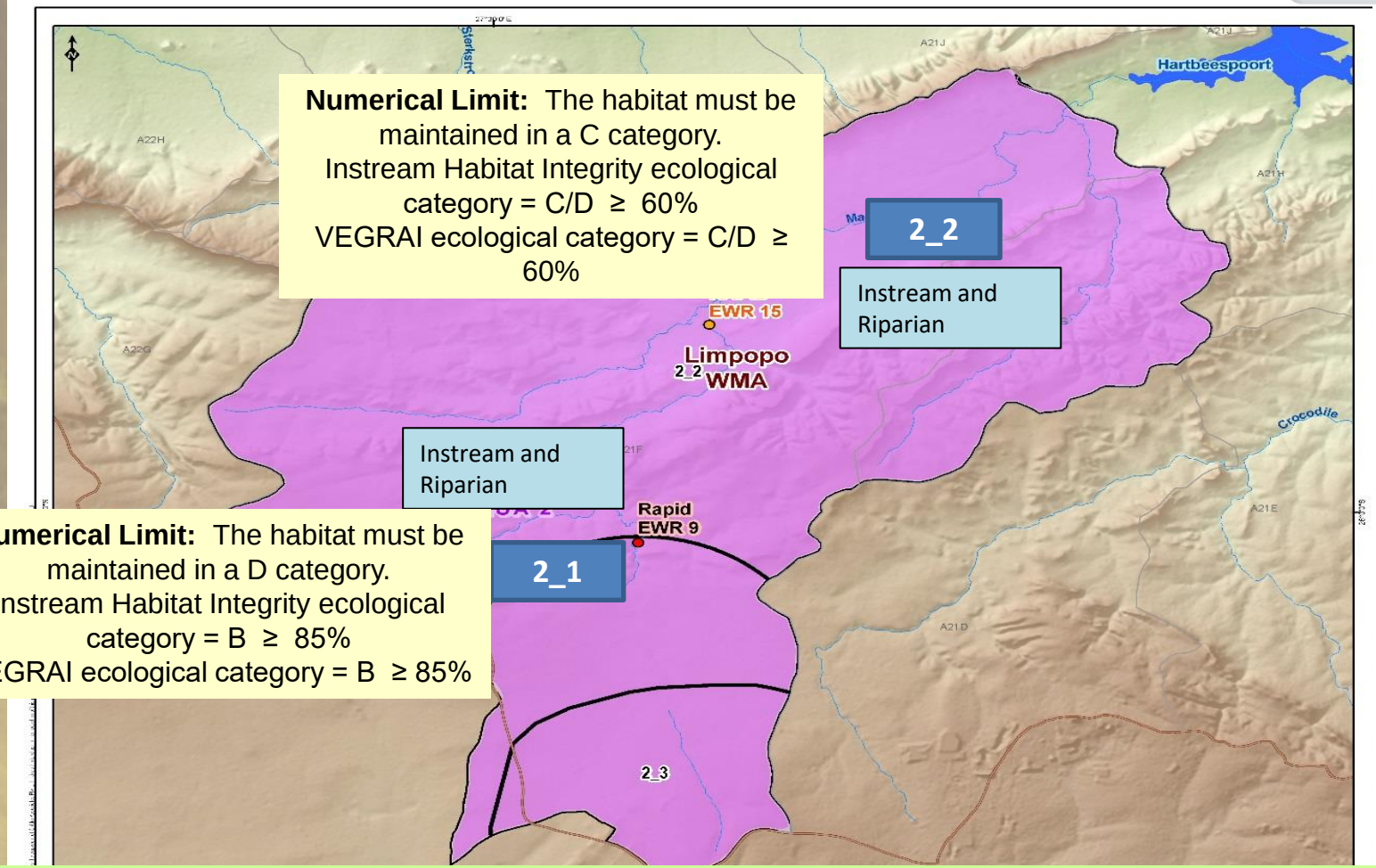
Maintenance Low flows (m^3/s)	Drought flows (m^3/s)
Oct 0.211	0.211
Nov 0.216	0.216
Dec 0.211	0.211
Jan 0.212	0.212
Feb 0.224	0.224
Mar 0.206	0.206
Apr 0.212	0.212
May 0.208	0.208
Jun 0.214	0.214
Jul 0.210	0.210
Aug 0.211	0.211
Sep 0.217	0.217



RQOs:FLOWS

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

IUA 2: Magalies Catchment
RQOs HABITAT – INSTREAM AND RIPARIAN



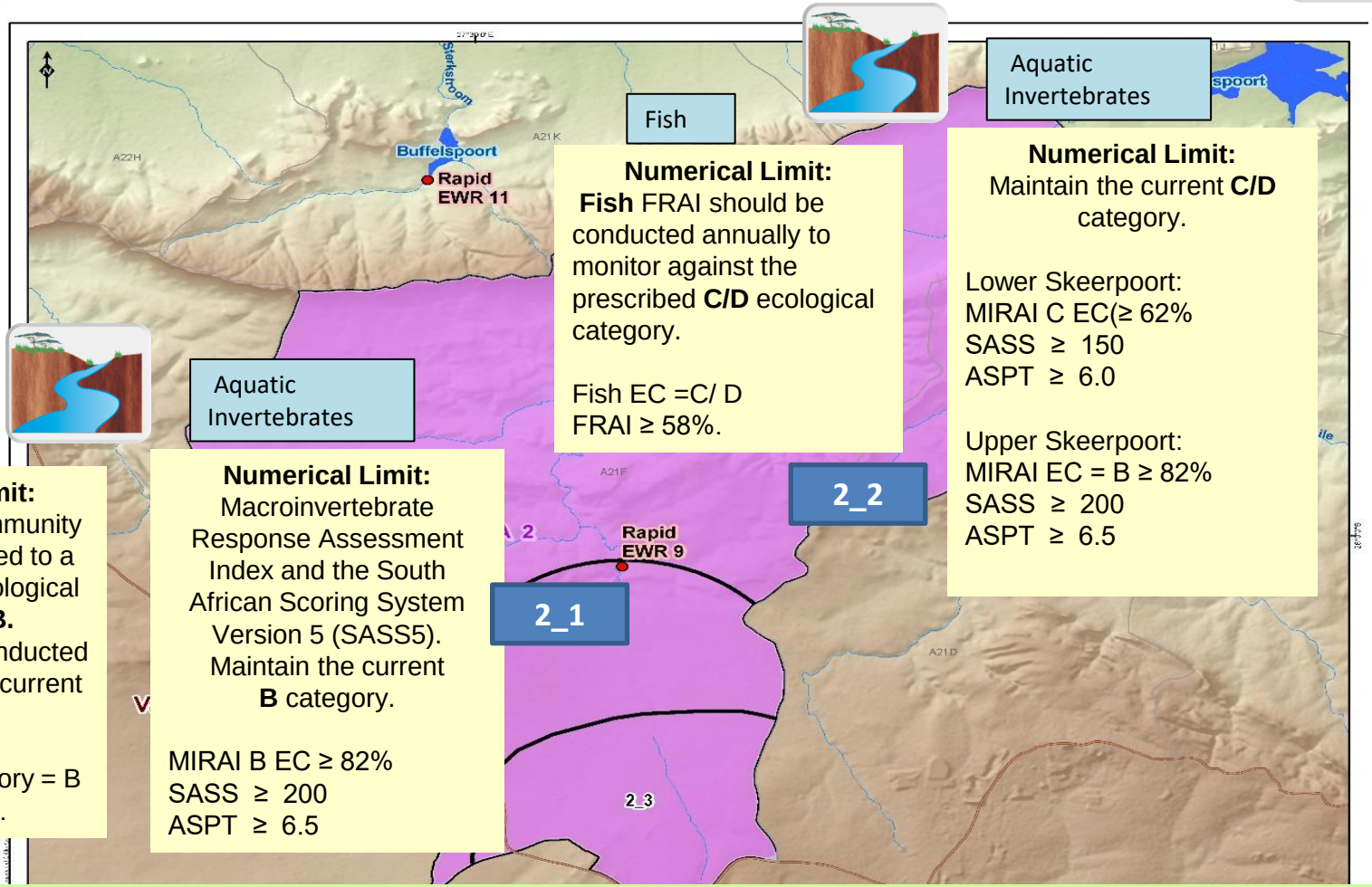
RQOs (narrative):

Instream: Habitat diversity should be maintained at prescribed B ecological category.
Habitat diversity must be maintained at the C/D ecological category. Good marginal vegetation and low silt load in riffles must be maintained.

Riparian: Vegetation cover should be maintained at prescribed B ecological category

Riparian: Vegetation cover should be maintained at the C/D ecological category. Alien invasive control must be undertaken and protection of riparian zone must improve. Encroachment must be managed.

IUA 2: Magalies Catchment
RQOs BIOTA – FISH AND MACROINVERTEBRATES



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

Fish ecology category = B
FRAI ≥ 82%.

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

MIRAI B EC ≥ 82%
SASS ≥ 200
ASPT ≥ 6.5

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

Fish EC =C/ D
FRAI ≥ 58%.

Numerical Limit:
Maintain the current **C/D** category.

Lower Skeerpoort:
MIRAI C EC(≥ 62%
SASS ≥ 150
ASPT ≥ 6.0

Upper Skeerpoort:
MIRAI EC = B ≥ 82%
SASS ≥ 200
ASPT ≥ 6.5

RQOs: (narrative)

Fish (2_1) The fish community should be managed to the prescribed B ecological category Ensure presence of species *Yellow fish (BPOL), AURA, CPRE, BMOT*

Fish (2_2): Fish community should be maintained at the prescribed C/D ecological category. Ensure presence of indicator species. Flow should be maintained to accommodate species.

Macro-invertebrates: Macroinvertebrate assemblage must be maintained within a largely natural condition or improved upon.

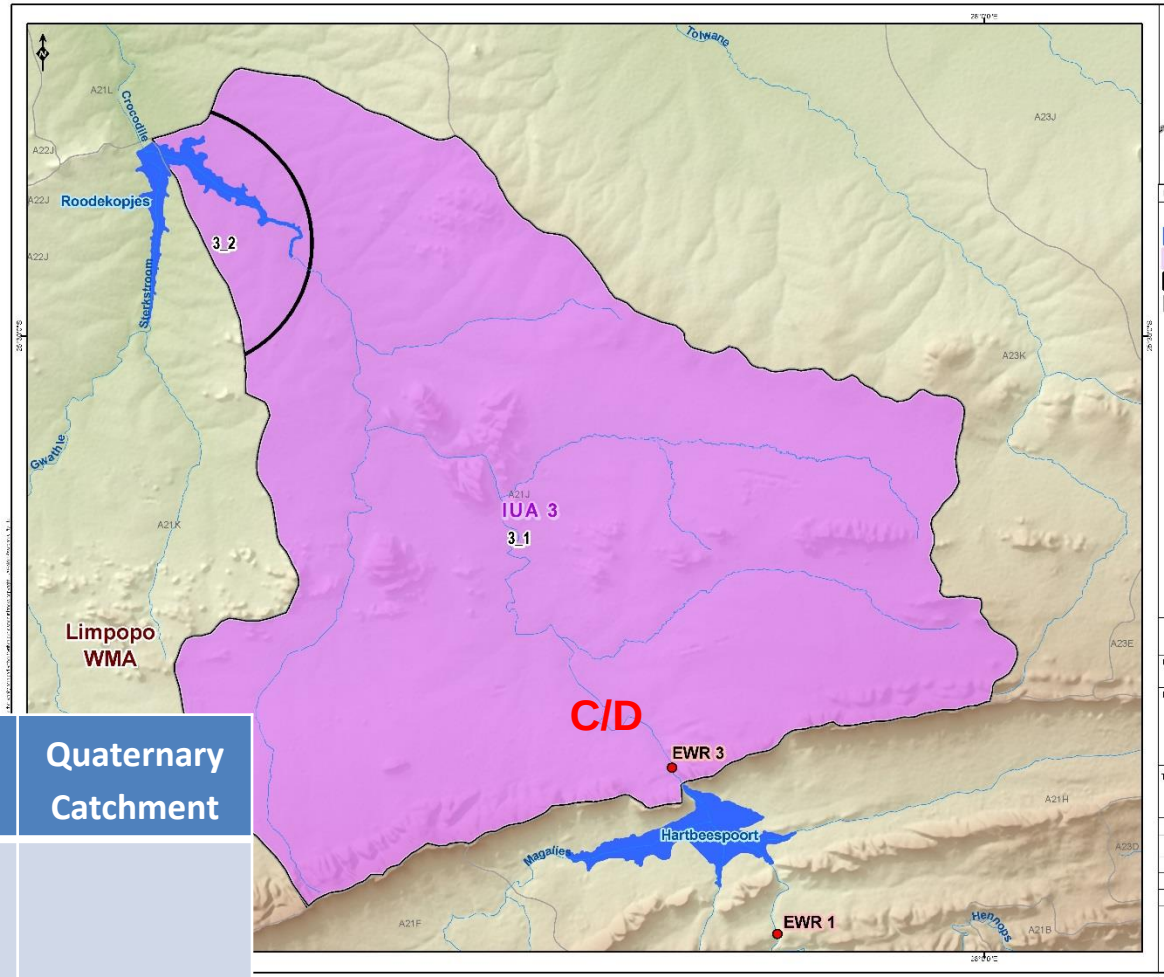
Semi-aquatic biota: The suitability of this stretch of river to serve as a habitat and migration corridor for aquatic bird and mammal populations must be maintained through proper habitat management.

IUA 3: CROCODILE/ROODEKOPJES CATCHMENT

Quaternary Catchments: A21J

Management Class: III

Ecological Category: C/D

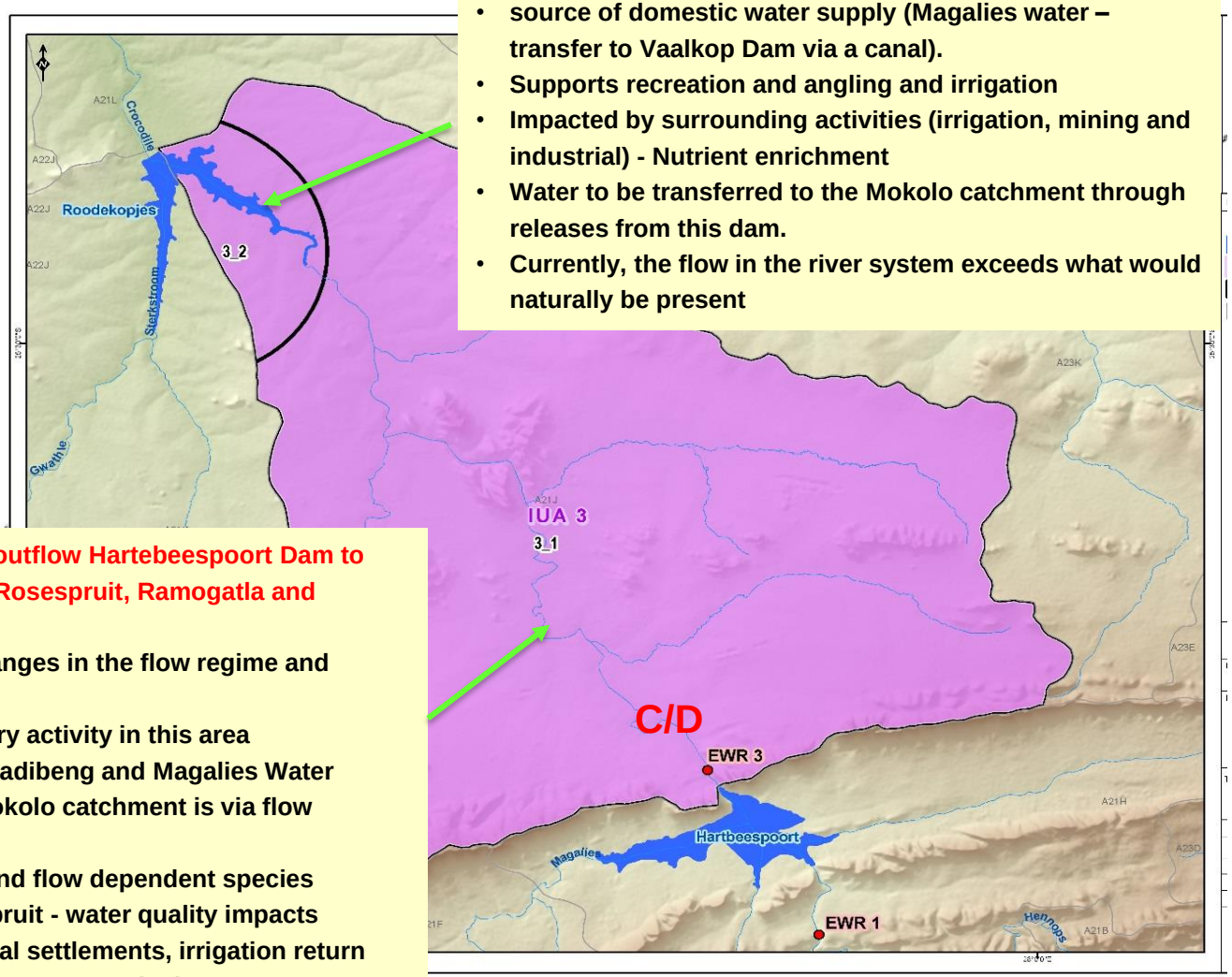


RU Number	Delineation Description	Quaternary Catchment
3_1	Crocodile River from outflow Hartebeespoort Dam to inflow Roodekopjes Dam, Rosespruit, Ramogatla and Kareespruit	A21J
3_2	Roodekopjes Dam	A21J

IUA 3: CROCODILE/ROODEKOPJES CATCHMENT

3_2: Roodekopjes Dam

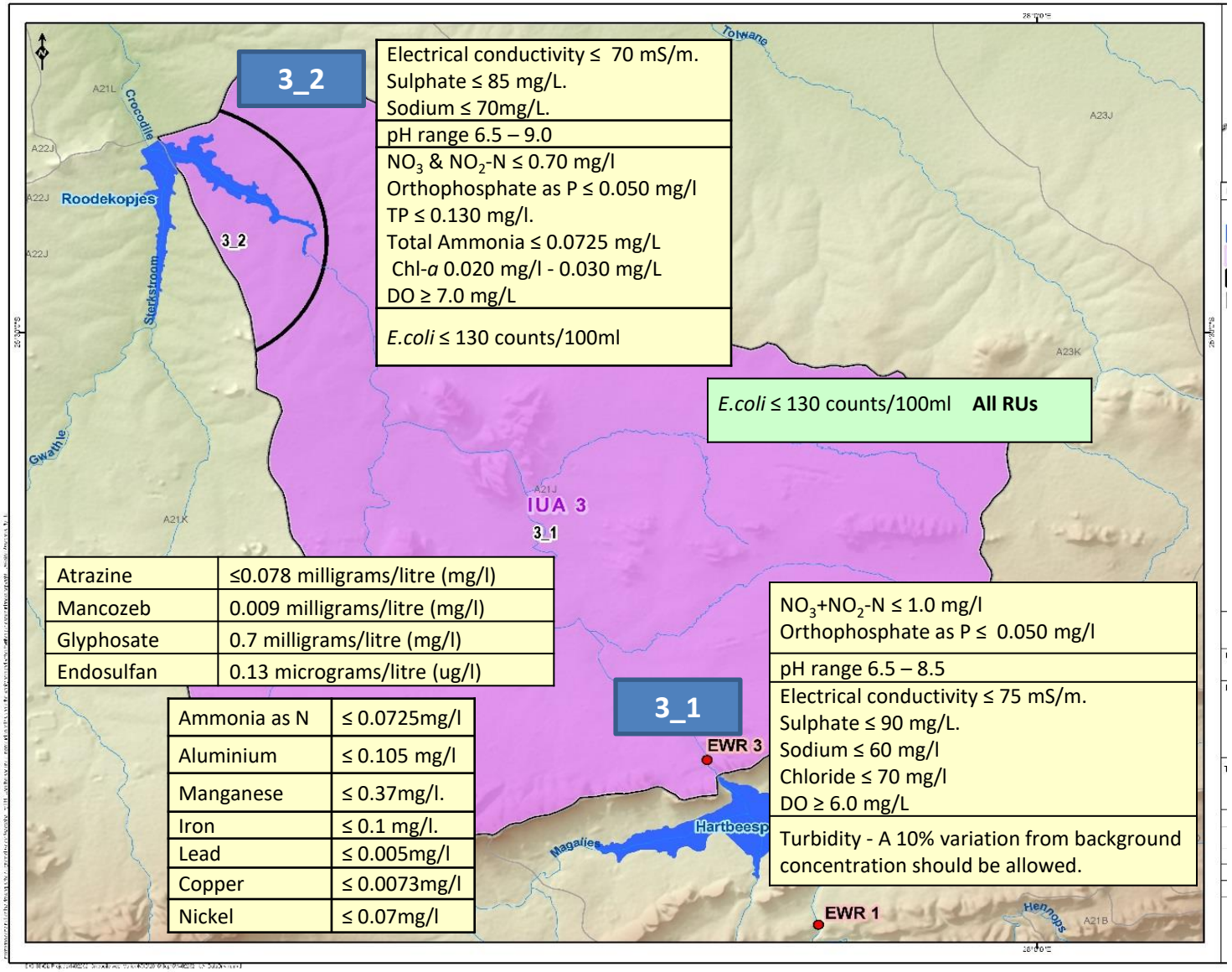
- source of domestic water supply (Magalies water – transfer to Vaalkop Dam via a canal).
- Supports recreation and angling and irrigation
- Impacted by surrounding activities (irrigation, mining and industrial) - Nutrient enrichment
- Water to be transferred to the Mokolo catchment through releases from this dam.
- 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
- Water transfer to the Mokolo catchment is via flow through the reach.
- 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.

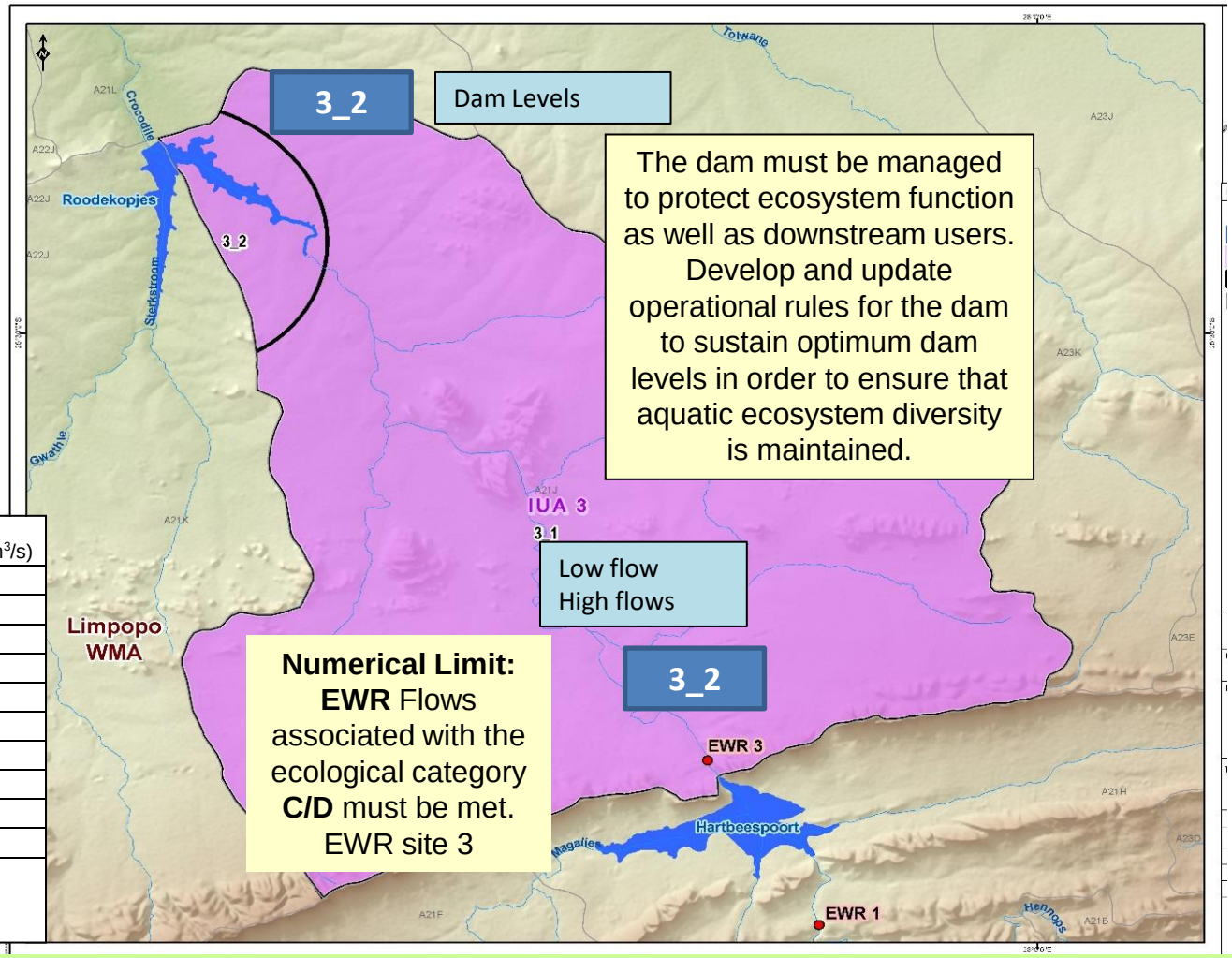
IUA 3: Crocodile/Roodekopjes
RQOs QUALITY – Rivers and Dam



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)

Ammonia as N	≤ 0.0725mg/l
Aluminium	≤ 0.105 mg/l
Manganese	≤ 0.37mg/l.
Iron	≤ 0.1 mg/l.
Lead	≤ 0.005mg/l
Copper	≤ 0.0073mg/l
Nickel	≤ 0.07mg/l

IUA 3: Crocodile/Roodekopjes
RQOs QUANTITY

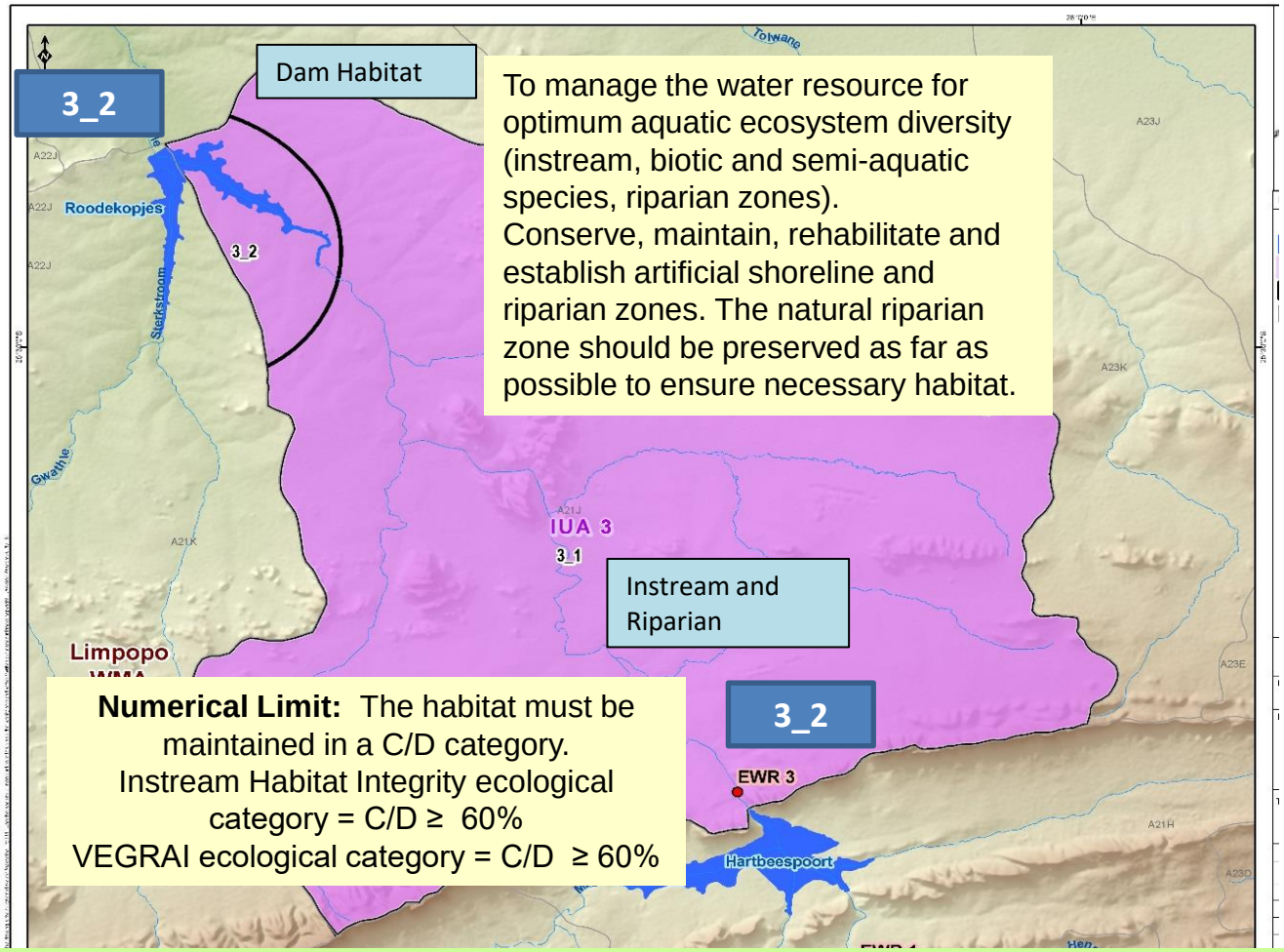


Maintenance Low flows (m^3/s)	Drought flows (m^3/s)
Oct 0.211	0.211
Nov 0.216	0.216
Dec 0.211	0.211
Jan 0.212	0.212
Feb 0.224	0.224
Mar 0.206	0.206
Apr 0.212	0.212
May 0.208	0.208
Jun 0.214	0.214
Jul 0.210	0.210
Aug 0.211	0.211
Sep 0.217	0.217

RQOs:FLOWS

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

IUA 3: Crocodile/Roodekopjes
RQOs HABITAT – INSTREAM AND RIPARIAN

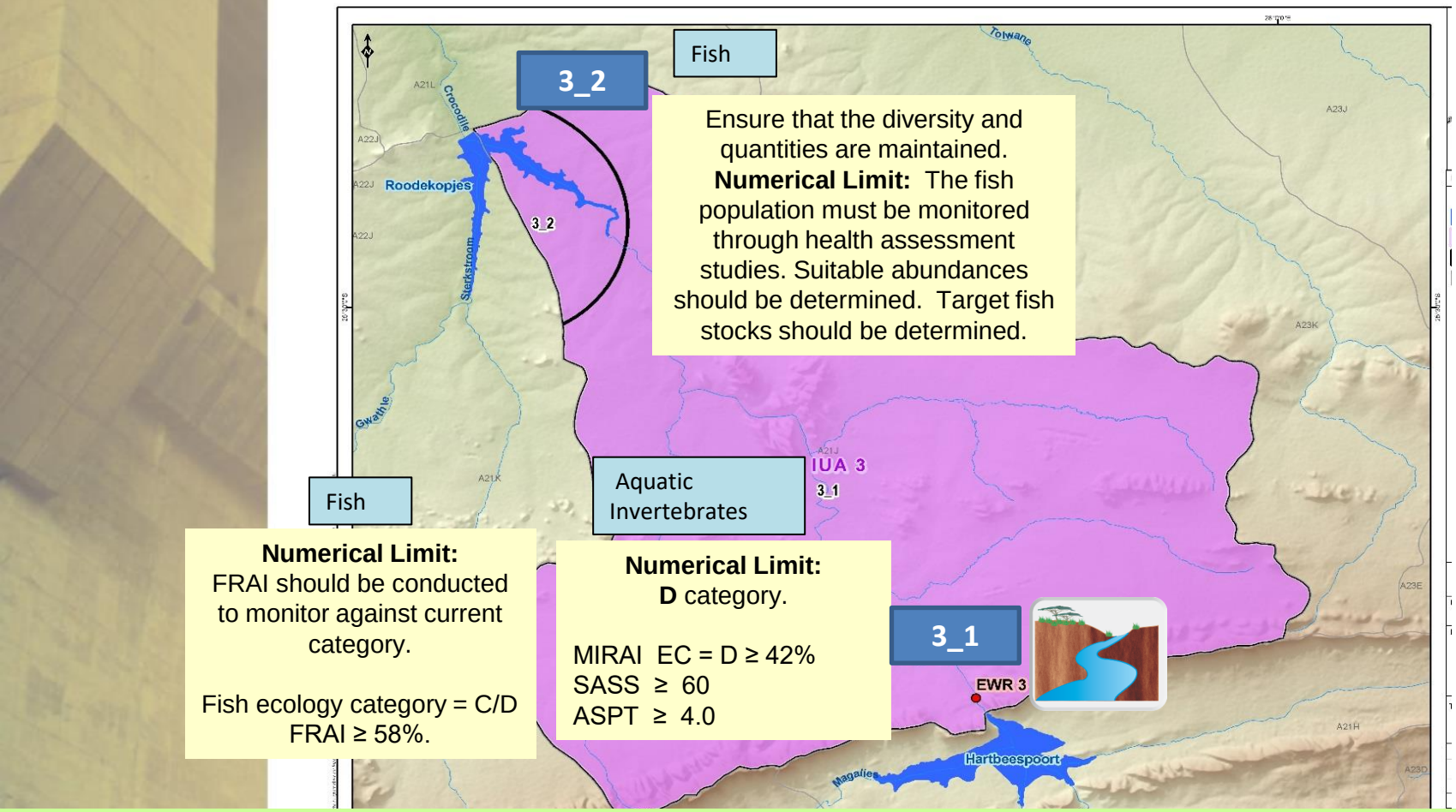


RQOs (narrative):

Instream: Habitat diversity should be improved from a D category to a C/D ecological category. Flow should be adequate flow dependent species.

Riparian: Vegetation cover should be maintained at prescribed C/D ecological category. Alien vegetation infestation must be controlled and developments into the riparian zone should be prohibited.

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.

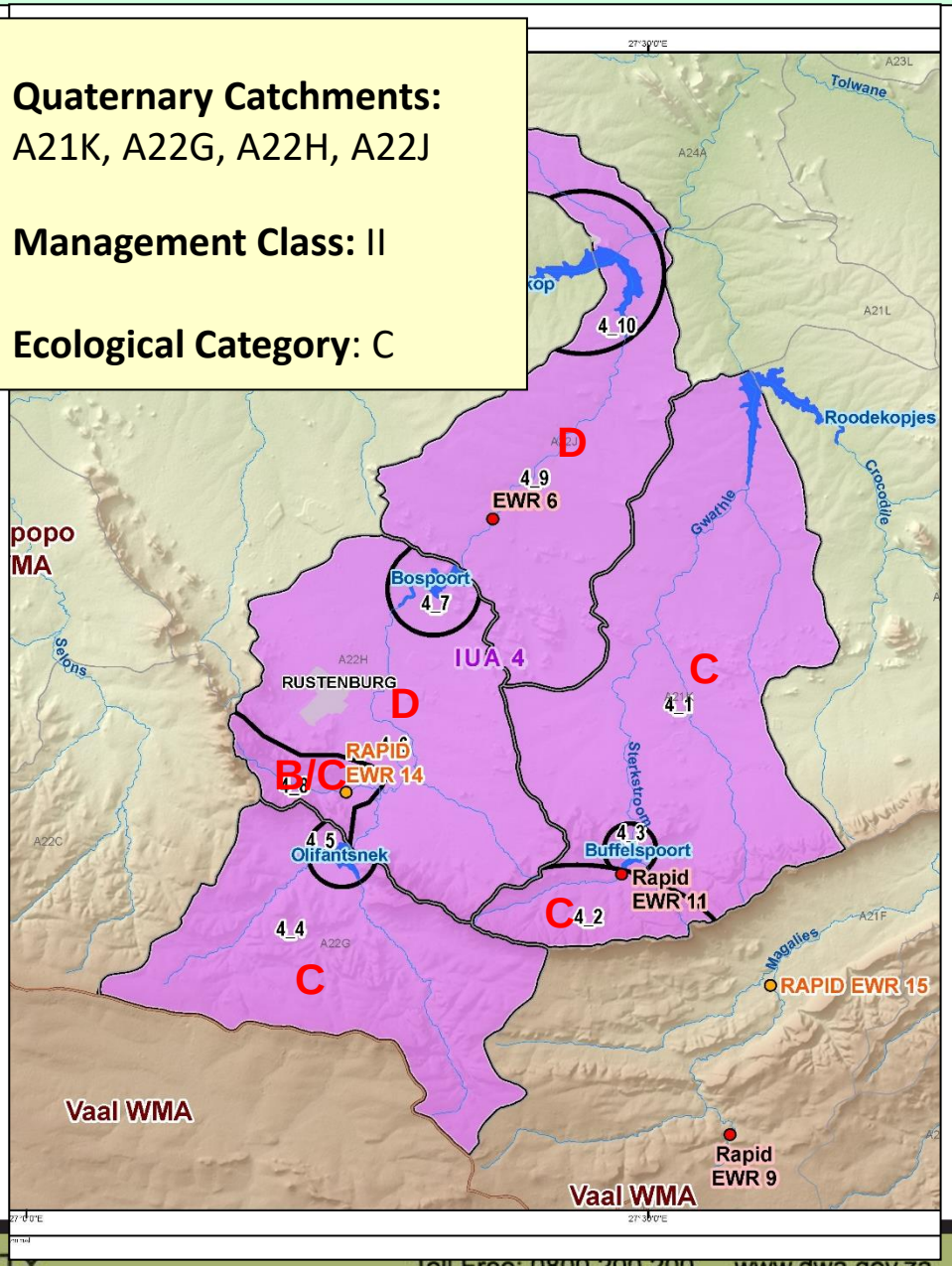
IUA 4: HEX/WATERKLOOFSPRUIT/VAALKOP

RU Number	Delineation Description	Quaternary Catchment
4_1	Sterkstroom from outflow Buffelspoort Dam to inflow Roodekopjes Dam, Maretwane, Tshukutswe	A21K middle and lower catchment below dam
4_3	Buffelspoort Dam	A21K
4_2	Upper reaches of Sterkstroom to inflow Bueffelspoort Dam , Kleinwater	A21K upper catchment to dam
4_4	Upper Hex River to Olifantsnek Dam, Rooikloofspruit	A22G
4_5	Olifantsnek Dam	A22G
4_6	Hex River outflow Olifantsnek Dam to inflow Bospoort Dam, Sandspruit	A22H
4_7	Bospoort Dam	A22H
4_8	Water Kloofspruit tributary catchment	A22H
4_9	Hex River outflow Bospoort Dam to inflow Vaalkop Dam	A22J
4_10	Vaalkop Dam	A22J

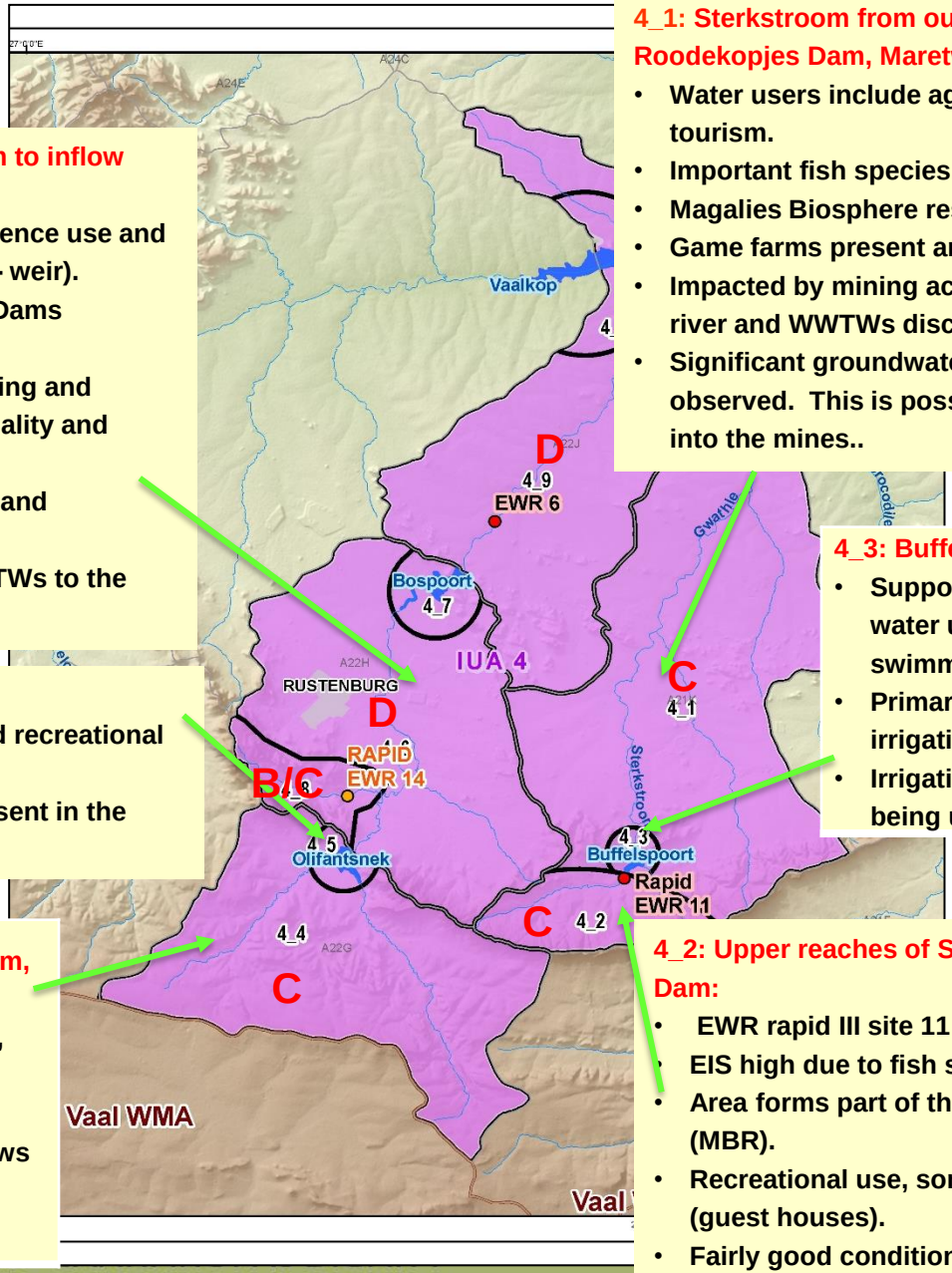
Quaternary Catchments:
A21K, A22G, A22H, A22J

Management Class: II

Ecological Category: C



IUA 4: HEX/WATERKLOOFSPRUIT/VAALKOP



4_1: Sterkstroom from outflow Buffelspoort Dam to inflow Roodekopjes Dam, Maretwane, Tshukutswe

- Water users include agriculture and mining and Eco-tourism.
- Important fish species.
- Magalies Biosphere reserve area
- Game farms present are dependent on groundwater.
- Impacted by mining activities, settlements along the river and WWTWs discharges.
- Significant groundwater levels to the north have been observed. This is possibly linked to natural flow ingress into the mines..

4_2: Upper reaches of Sterkstroom to inflow Buffelspoort Dam:

- EWR rapid III site 11 on the Sterkstroom
- EIS high due to fish species present
- Area forms part of the Magaliesberg Biosphere Reserve (MBR).
- Recreational use, some agriculture and eco-tourism (guest houses).
- Fairly good condition with limited impacts.

4_3: Buffelspoort Dam

- Supports irrigation, recreational water use –angling, boating, swimming
- Primary use is for the downstream irrigation.
- Irrigation water allocations are now being used for mining uses.

4_4: Upper Hex River to Olifantsnek Dam, Rooikloofspruit

- Nature reserve with limited land use, high tourism value.
- Cattle farming and chicken farms, minor irrigation and some return flows
- Forms part of the Magaliesberg Biosphere Reserve (MBR).

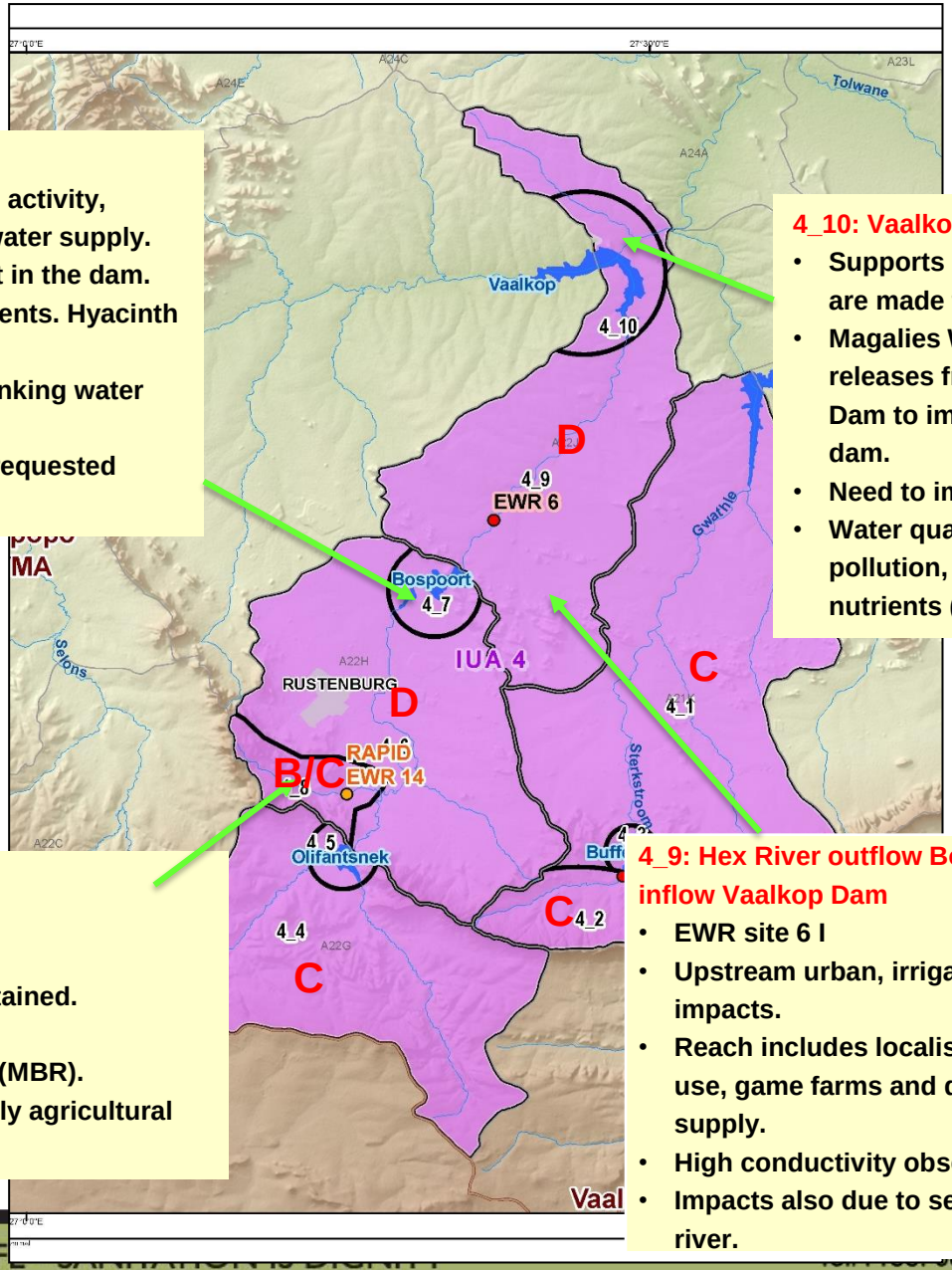
4_5: Olifantsnek Dam

- Supports downstream irrigation and recreational water use.
- Some water quality impacts are present in the dam.

4_6: Hex River outflow Olifantsnek Dam to inflow Bospoort Dam

- Abstractions for agriculture, subsistence use and domestic water supply (Dorpspruit – weir).
- Olifantsnek, Bospoort and Vaalkop Dams impacted on Hex River.
- Rustenburg town and extensive mining and agriculture further impacts - both quality and quantity.
- Urbanisation, irrigation return flows and discharges from WWTWs.
- Direct supply of water from the WWTWs to the Rustenburg mines.

IUA 4: HEX/WATERKLOOFSPRUIT/VAALKOP



4_7: Bospoort Dam

- Supports irrigation and recreational activity, subsistence fishing and domestic water supply.
- Poor water quality currently present in the dam.
- Eutrophication impacts due to nutrients. Hyacinth growth.
- Need to be improved to improve drinking water quality.
- The tribal authority in the area has requested remediation of the dam.

4_10: Vaalkop Dam

- Supports fishing, recreation and releases are made for irrigation.
- Magalies Water has requested more releases from Bospoort and Olifantsnek Dam to improve water quality in Vaalkop dam.
- Need to improve drinking water quality.
- Water quality is impacted due to industrial pollution, return flows, mining impacts, nutrients (eutrophication).

4_8: Waterkloofspruit

- EWR rapid III site 14
- Wetland priority areas are
- Protected area that must be maintained.
- Flow dependent fish species
- Magaliesberg Biosphere Reserve (MBR).
- Some impacts by furrows to supply agricultural water use.

4_9: Hex River outflow Bospoort Dam to inflow Vaalkop Dam

- EWR site 6 I
- Upstream urban, irrigation and mining impacts.
- Reach includes localised subsistence use, game farms and domestic water supply.
- High conductivity observed.
- Impacts also due to settlements along river.

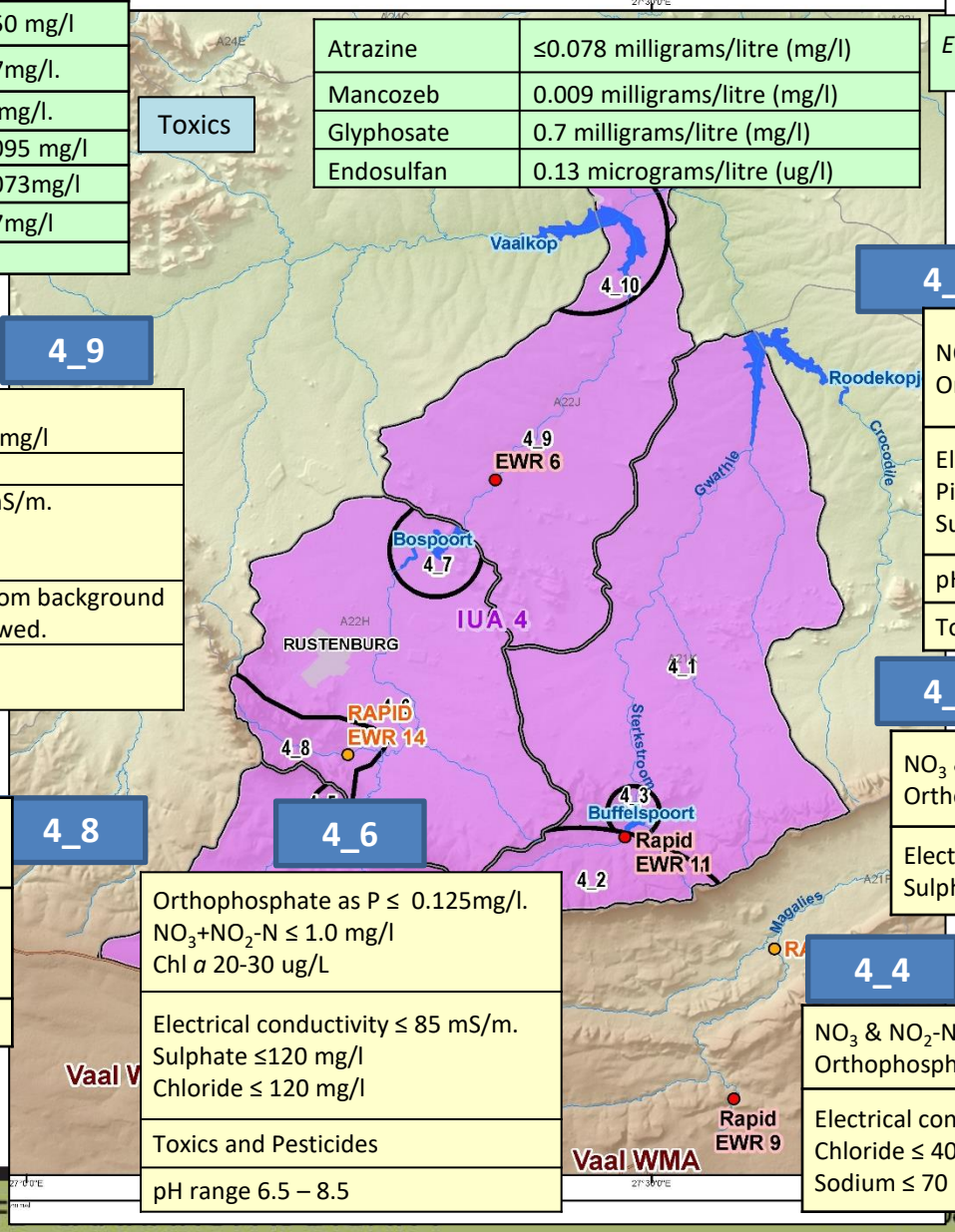
IUA 4: Hex/Waterkloofspruit/Vaalkop
RQOs QUALITY - RIVERS

Ammonia as N	≤ 0.0725mg/l	≤ 0.100 mg/l
Aluminium	≤ 0.062 mg/l	≤ 0.150 mg/l
Manganese	≤ 0.37mg/l.	≤ 0.37mg/l.
Iron	≤ 0.1 mg/l.	≤ 0.3 mg/l.
Lead	≤ 0.005mg/l	≤ 0.0095 mg/l
Copper	≤ 0.0073mg/l	≤ 0.0073mg/l
Nickel	≤ 0.07mg/l	≤ 0.07mg/l
Chromium (IV)	≤ 0.0675mg/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)

E.coli ≤ 130 counts/100ml **All RUs**



4_9

NO_3+NO_2-N ≤ 2.0 mg/l
Orthophosphate as P ≤ 0.50 mg/l

pH range 6.5 – 8.5

Electrical conductivity ≤ 85 mS/m.
Sulphate ≤ 120 mg/L.
Chloride ≤ 120 mg/l

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

Toxics

4_1

NO_3 & NO_2-N ≤ 0.5 mg/l
Orthophosphate as P ≤ 0.05 mg/l

Electrical conductivity ≤ 70 mS/m
Pienaars/ ≤ 70 mS/m Apies
Sulphate ≤ 70 mg/L.

pH range 6.5 – 8.5

Toxics

4_2

NO_3 & NO_2-N ≤ 0.5 mg/l
Orthophosphate as P ≤ 0.01 mg/l

Electrical conductivity ≤ 55 mS/m.
Sulphate ≤ 70 mg/L.

4_8

NO_3 & NO_2-N ≤ 0.25 mg/l
Orthophosphate as P ≤ 0.025 mg/l

Electrical conductivity ≤ 20 mS/m
Sulphate :≤ 10 mg/L
Chloride ≤ 10 mg/L.

pH range 6.5 – 8.5

4_6

Orthophosphate as P ≤ 0.125mg/l.
NO_3+NO_2-N ≤ 1.0 mg/l
Chl *a* 20-30 ug/L

Electrical conductivity ≤ 85 mS/m.
Sulphate ≤120 mg/l
Chloride ≤ 120 mg/l

Toxics and Pesticides

pH range 6.5 – 8.5

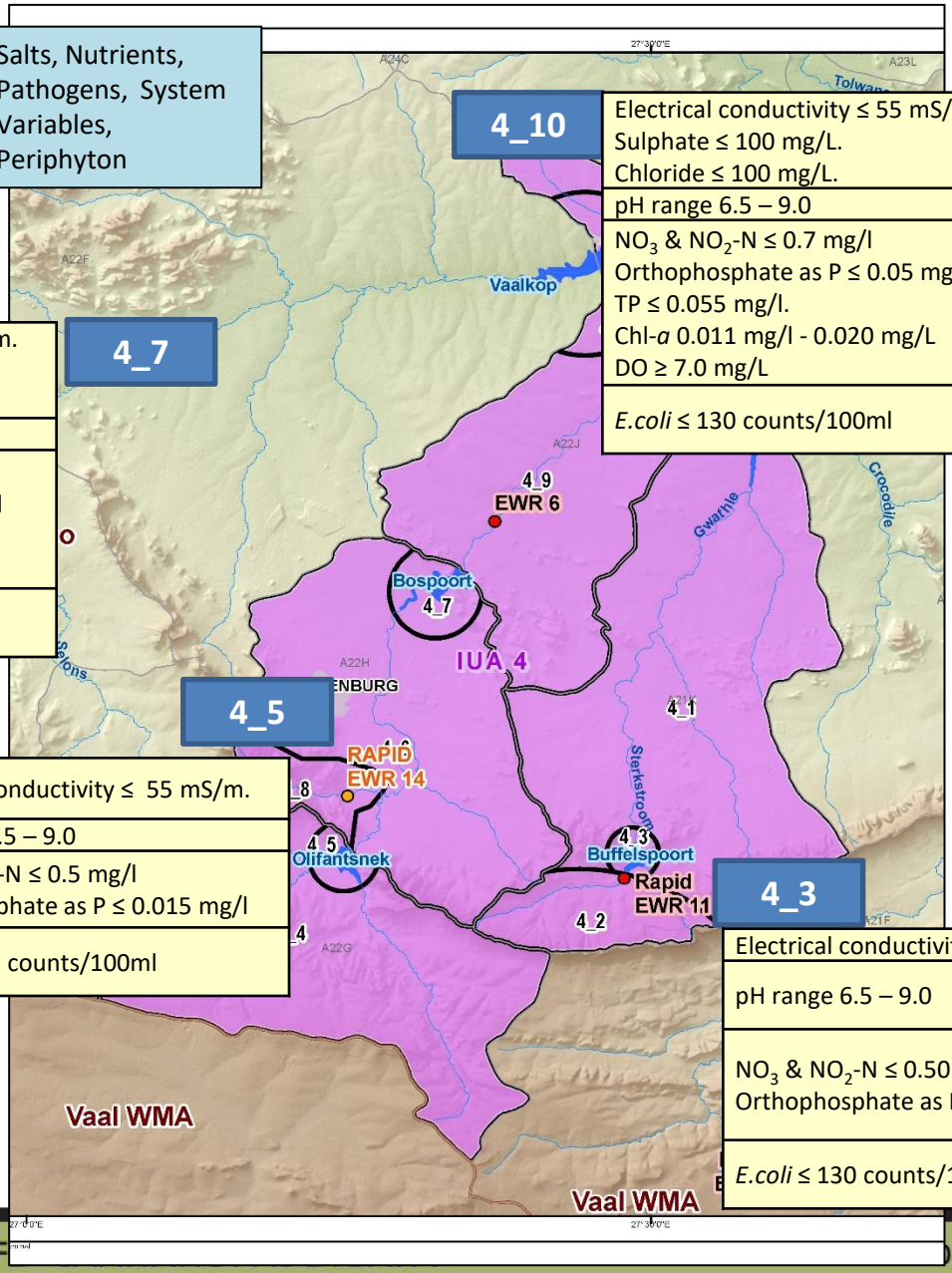
4_4

NO_3 & NO_2-N ≤ 0.50 mg/l
Orthophosphate as P ≤ 0.015 mg/l

Electrical conductivity ≤ 55 mS/m U/S
Chloride ≤ 40 mg/L.
Sodium ≤ 70 mg/l

IUA 4: Hex/Waterkloofspruit/Vaalkop
RQOs QUALITY - DAMS

Salts, Nutrients, Pathogens, System Variables, Periphyton



4_10
Electrical conductivity ≤ 55 mS/m. Sulphate ≤ 100 mg/L. Chloride ≤ 100 mg/L.
pH range 6.5 – 9.0
NO_3 & NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.05 mg/l TP ≤ 0.055 mg/l. Chl-*a* 0.011 mg/l - 0.020 mg/L DO ≥ 7.0 mg/L
E.coli ≤ 130 counts/100ml

4_7
Electrical conductivity ≤ 85 mS/m. Sulphate ≤ 100 mg/L. Sodium ≤ 100mg/L.
pH range 6.5 – 9.0
NO_3 & NO_2-N ≤ 1.0 mg/l Orthophosphate as P ≤ 0.50 mg/l TP ≤ 0.130 mg/l. Chl-*a* 0.020 mg/l - 0.030 mg/L
E.coli ≤ 130 counts/100ml

4_5
Electrical conductivity ≤ 55 mS/m.
pH range 6.5 – 9.0
NO_3 & NO_2-N ≤ 0.5 mg/l Orthophosphate as P ≤ 0.015 mg/l
E.coli ≤ 130 counts/100ml

4_3
Electrical conductivity ≤ 55 mS/m.
pH range 6.5 – 9.0
NO_3 & NO_2-N ≤ 0.50 mg/l Orthophosphate as P ≤ 0.015 mg/l
E.coli ≤ 130 counts/100ml

Cyanobacterial dominance with Chl a concentration higher than 30µg/ℓ must be kept at less than 20% of the time.

IUA 4: Hex/Waterkloofspruit/Vaalkop
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 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
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May	1.334	1.334
Jun	1.368	1.368
Jul	1.313	1.313
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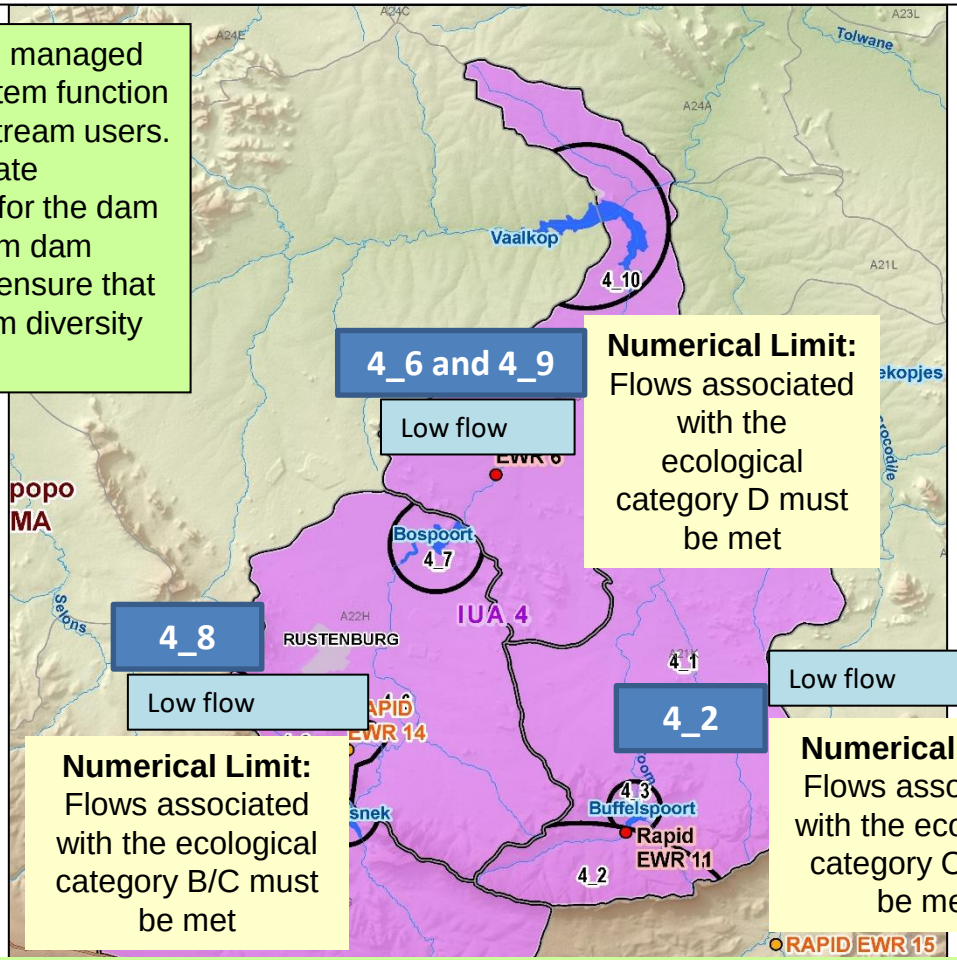


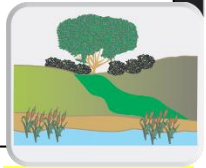
RQOs: FLOWS

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

Low Flow (4_2): Adequate protection of instream flows required (must be maintained to support biota). Management of land based activities required.

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

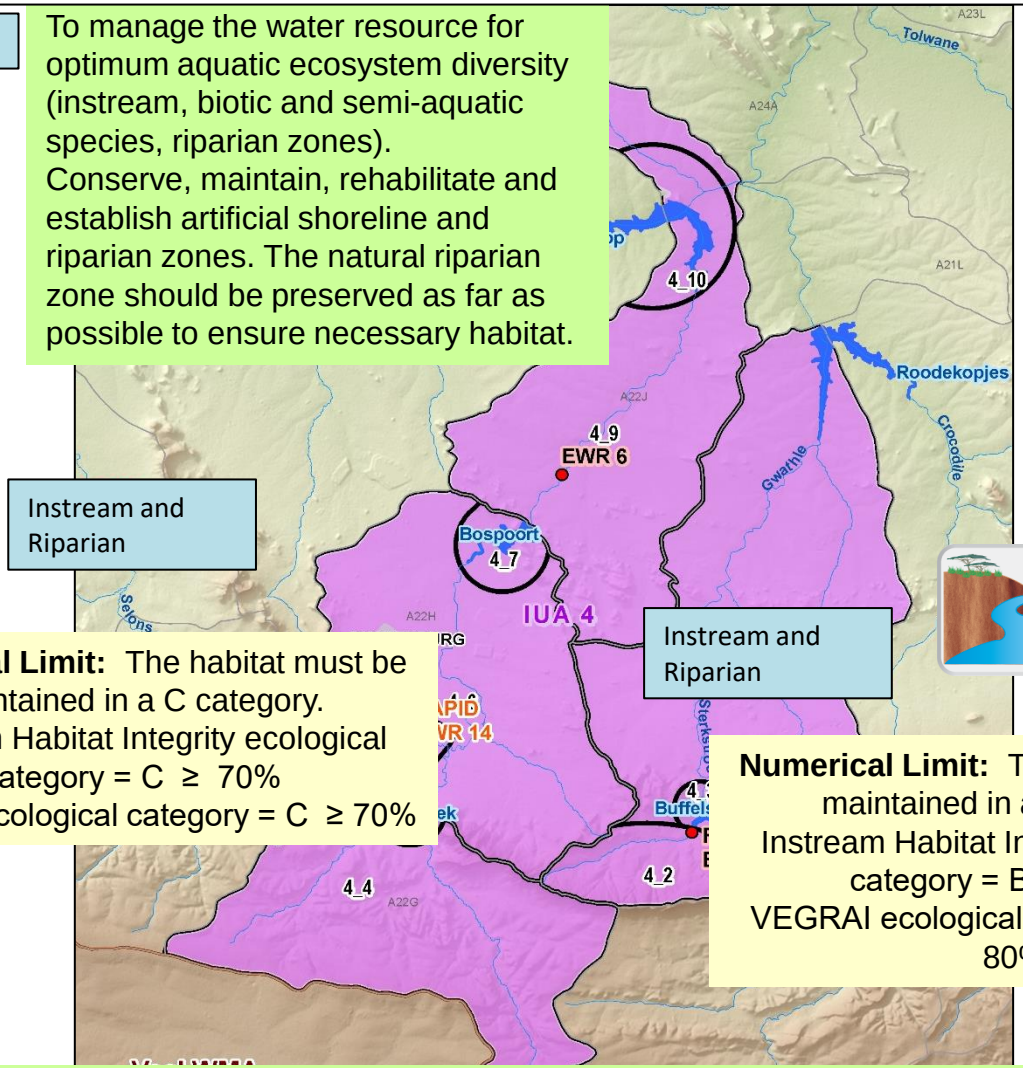
IUA 4: Hex/Waterkloofspruit/Vaalkop
RQOs HABITAT – INSTREAM AND RIPARIAN



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 C category.
Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = B/C ≥ 80%
VEGRAI ecological category = B/C ≥ 80%

RQOs (Narrative)

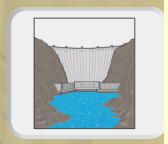
Instream: Habitat diversity should be maintained in an ecological category C. The integrity of the habitat, water quality and flow conditions must be maintained

Riparian: Vegetation control must be maintained in a C ecological category. Alien infestation control must be implemented.

Riparian: Vegetation cover should be maintained at a B/C ecological category..

IUA 4: Hex/Waterkloofspruit/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%.
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 ≥ 140
ASPT ≥ 5.8

Fish

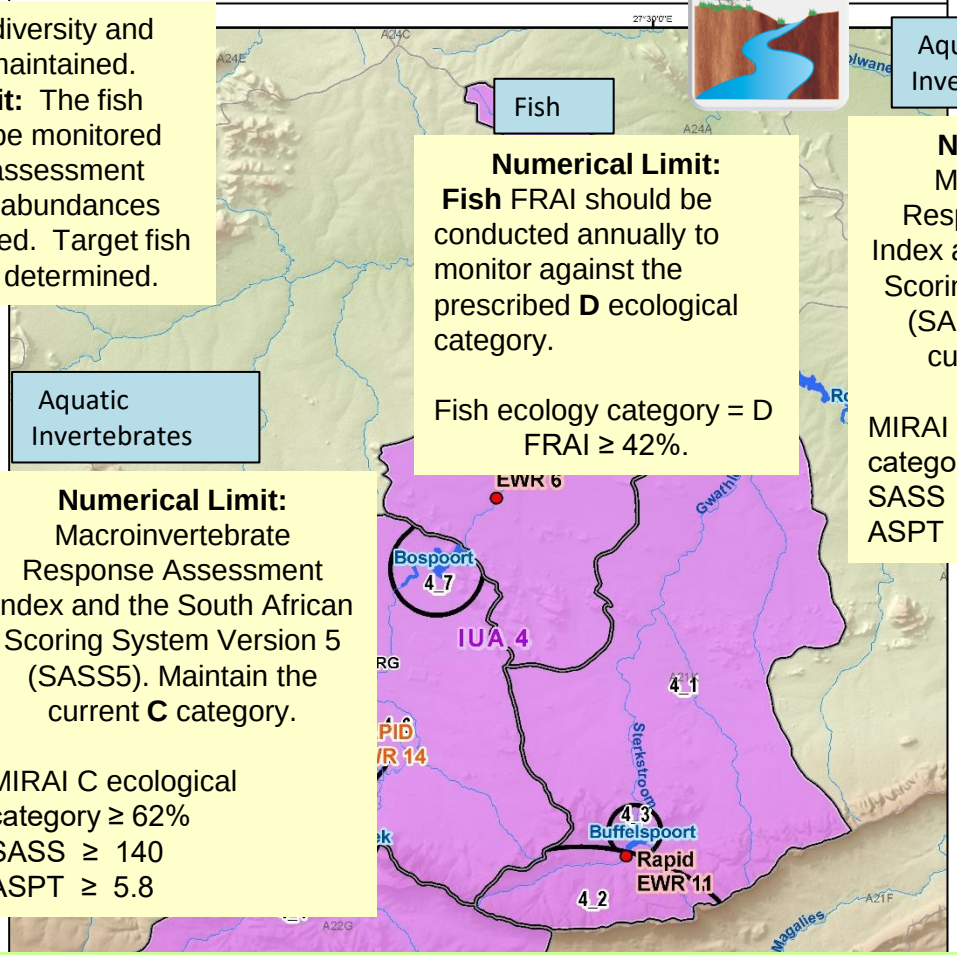
Numerical Limit:
Fish FRAI should be conducted annually to monitor against the prescribed **D** ecological category.

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 ≥ 70
ASPT ≥ 4.2



RQOs: (representative)

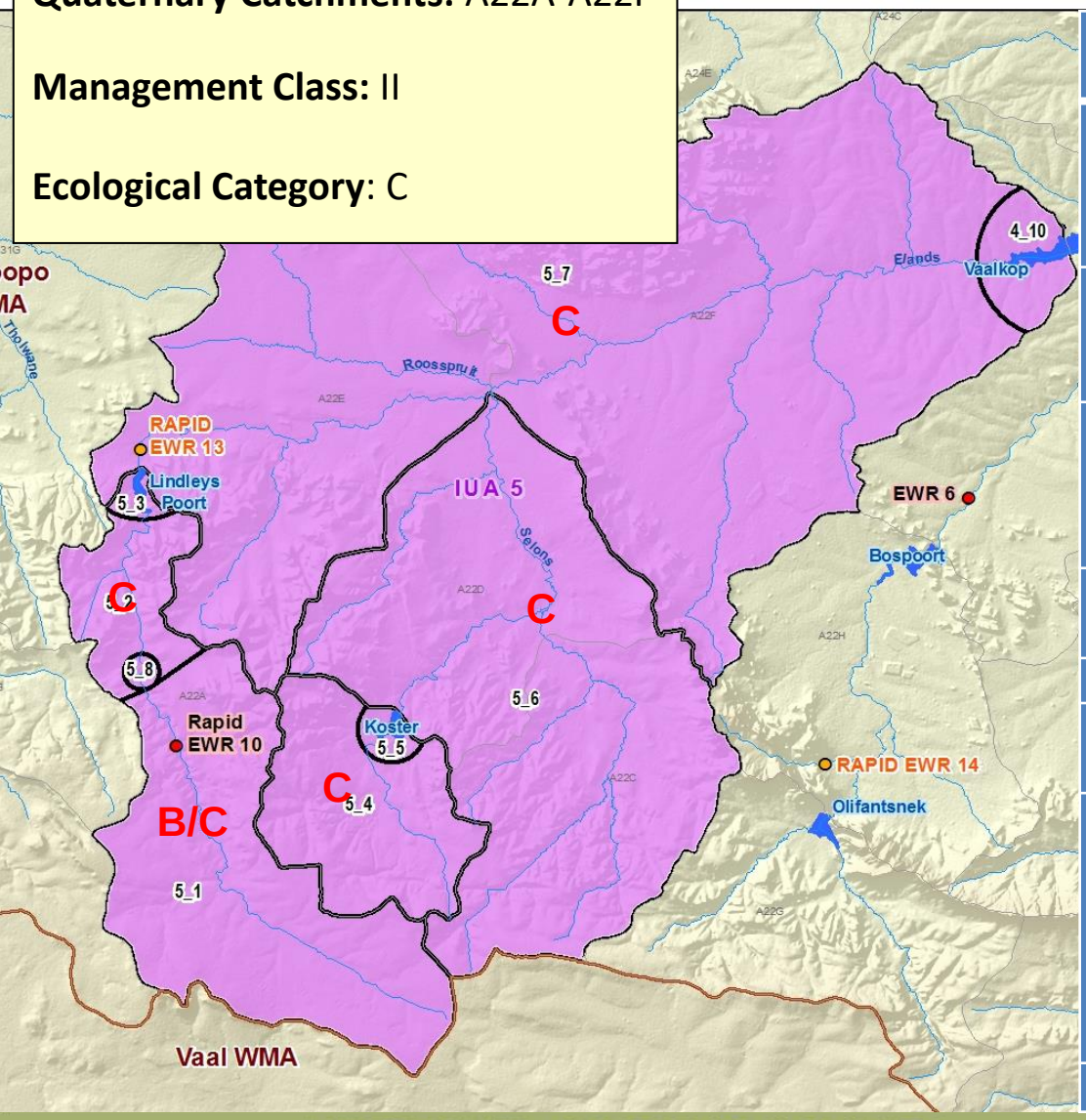
Fish (4_6) : Fish community should be maintained at a D ecological category or improved upon. Flow should be adequate for flow dependant species.
Fish (4_8): Fish community should be maintained at a B/C ecological category. Area above the waterfall must be protected due to presence of *TSPA* upstream of waterfall. FRAI should be conducted to monitor against current 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 5: ELANDS/VAALKOP

Quaternary Catchments: A22A-A22F

Management Class: II

Ecological Category: C



RU Number	Delineation Description	Quaternary Catchment
5_1	Upper reaches of Elands to Swartruggens Dam	A22A south eastern portion
5_2	Elands river downstream Swartruggens Dam to Lindleyspoort Dam	A22A
5_3	Lindleyspoort Dam	A22A
5_4	Upper Koster River to Koster Dam	A22B
5_5	Koster Dam	A22B
5_6	Selons River, Kodoespruit, Dwarsspruit, lower Koster River	A22C, A22D
5_7	Elands River outflow Lindleyspoort Dam to inflow Vaalkop Dam, Brakkloofspruit, Roosspruit, Sandspruit Mankwe. Leragane, Molapongwamongana	A22E, A22F
5_8	Swartruggens Dam	

IUA 5: ELANDS/VAALKOP

5_3: Lindleyspoort Dam

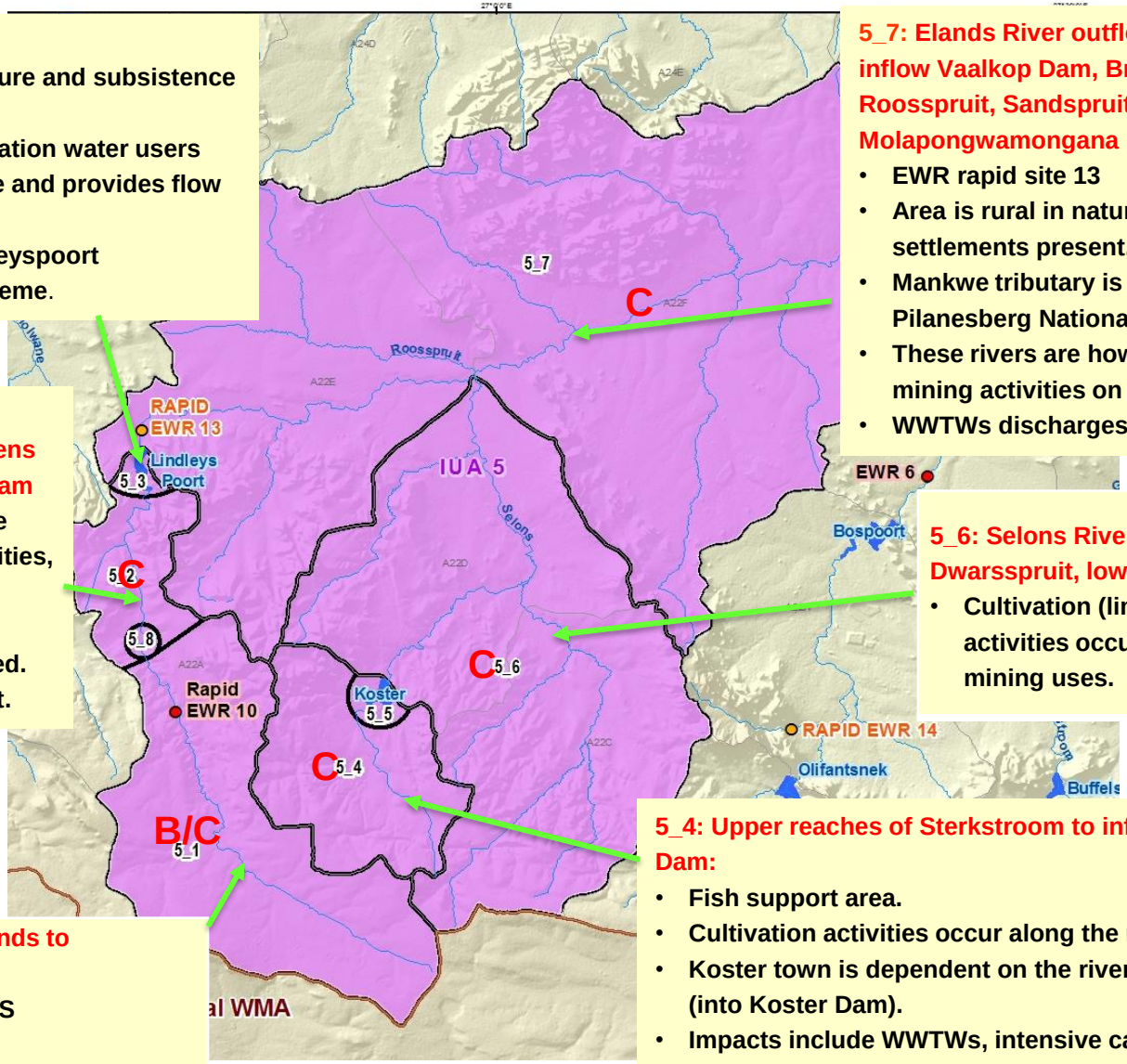
- Surrounded by agriculture and subsistence farming
- Primarily supports irrigation water users and some domestic use and provides flow regulating capacity.
- Forms part of the Lindleyspoort Government Water Scheme.

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

- EWR rapid site 13
- 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

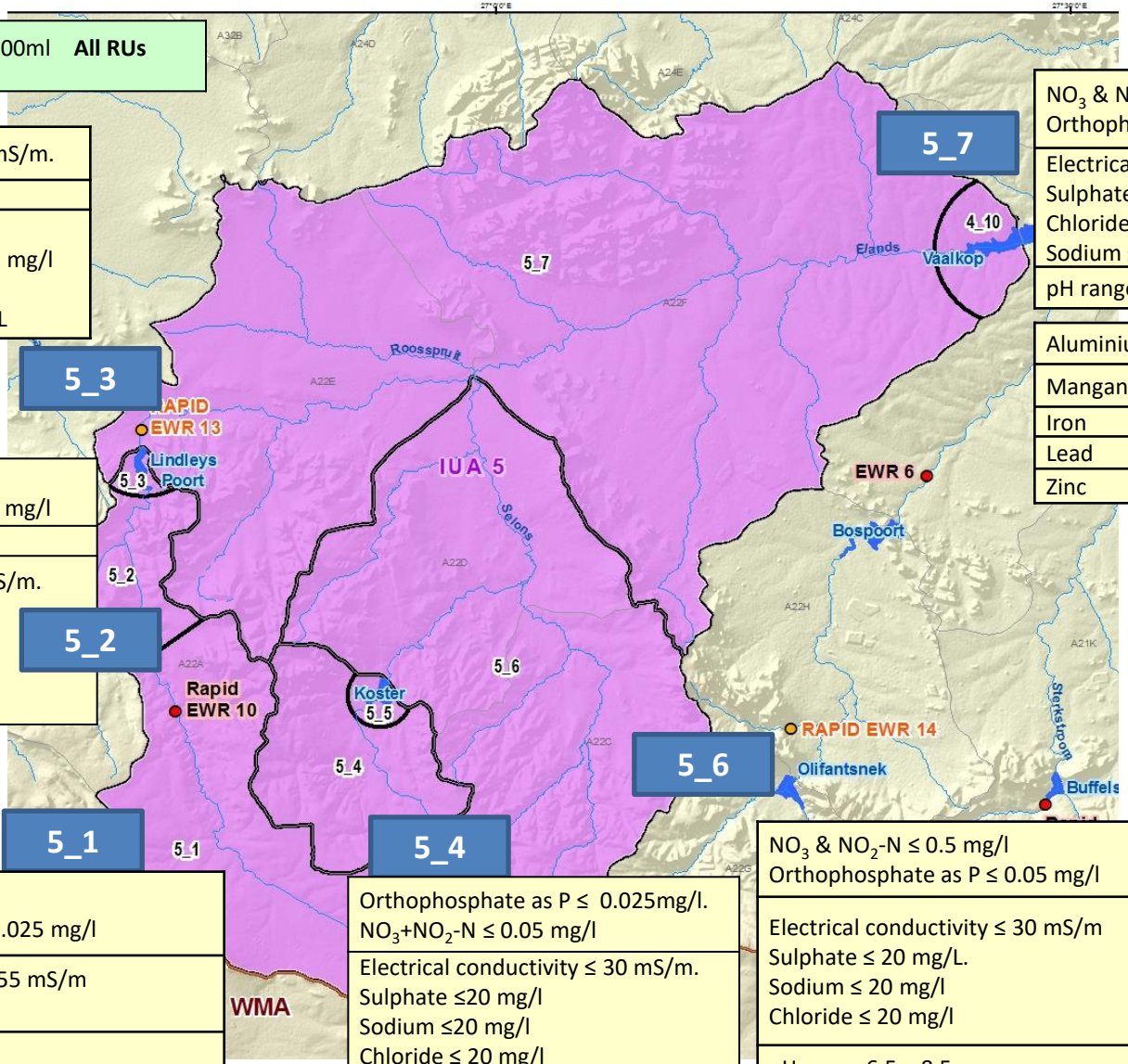
- Cultivation (limited irrigation) activities occur. now being used for mining uses.

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 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	≤ 0.37mg/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 5: Elands/Vaalkop
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.

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
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Feb 1.538	1.538
Mar 1.400	1.400
Apr 1.402	1.402
May 1.334	1.334
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Jul 1.313	1.313
Aug 1.279	1.279
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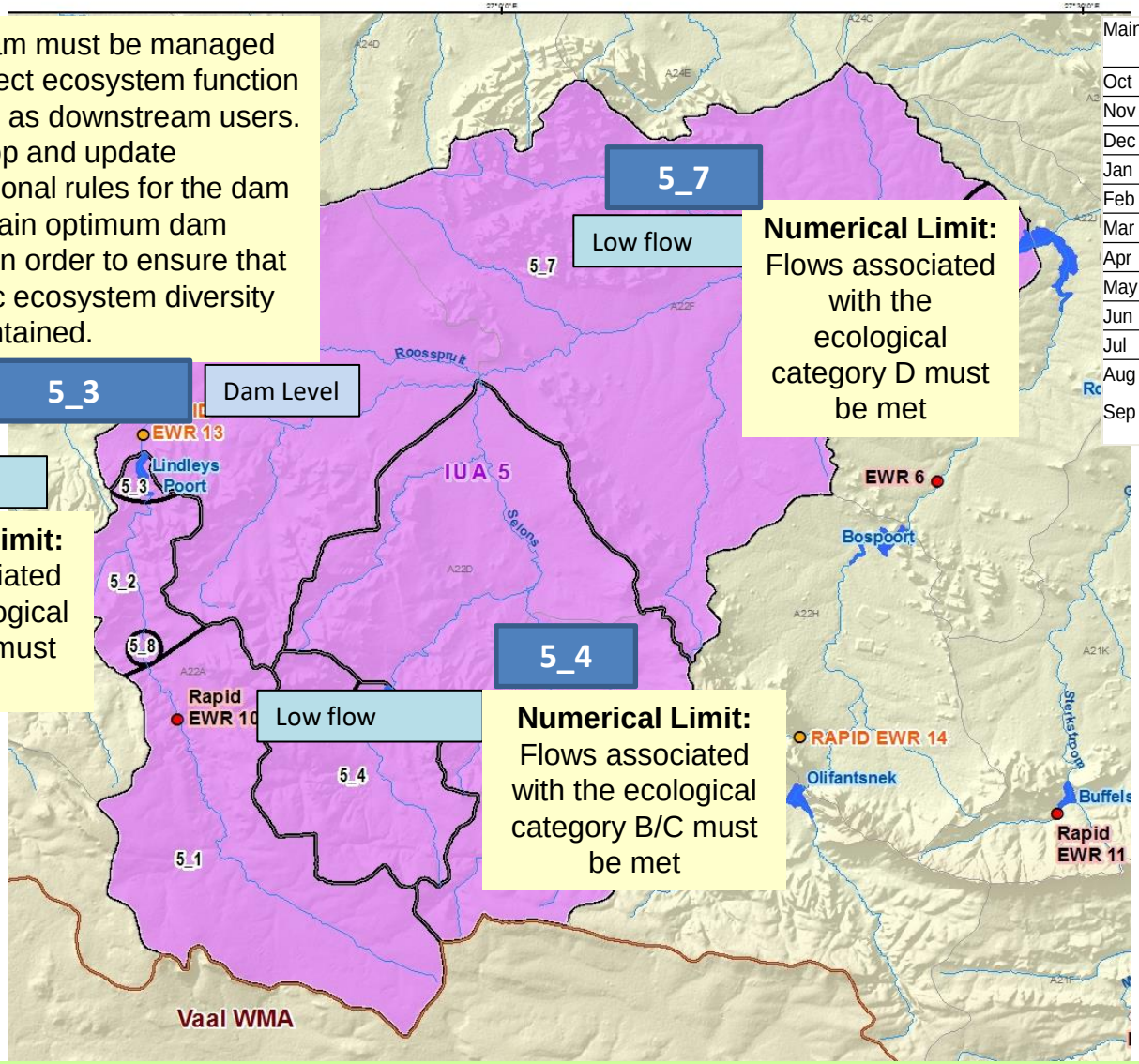
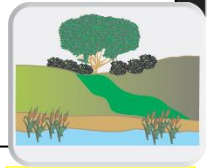


RQOs: FLOWS

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

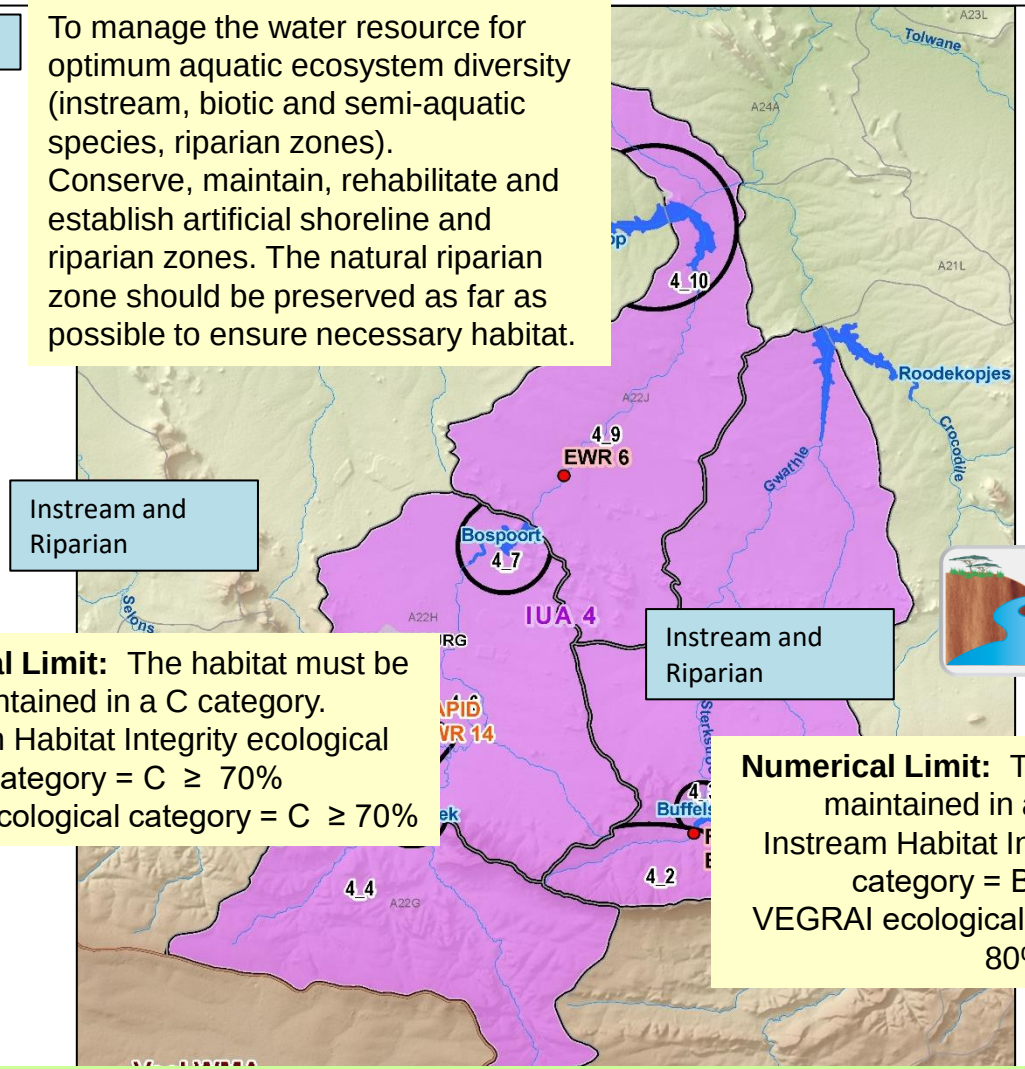
IUA 5: Elands/Vaalkop
RQOs HABITAT



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 C category.
Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = B/C ≥ 80%
VEGRAI ecological category = B/C ≥ 80%

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

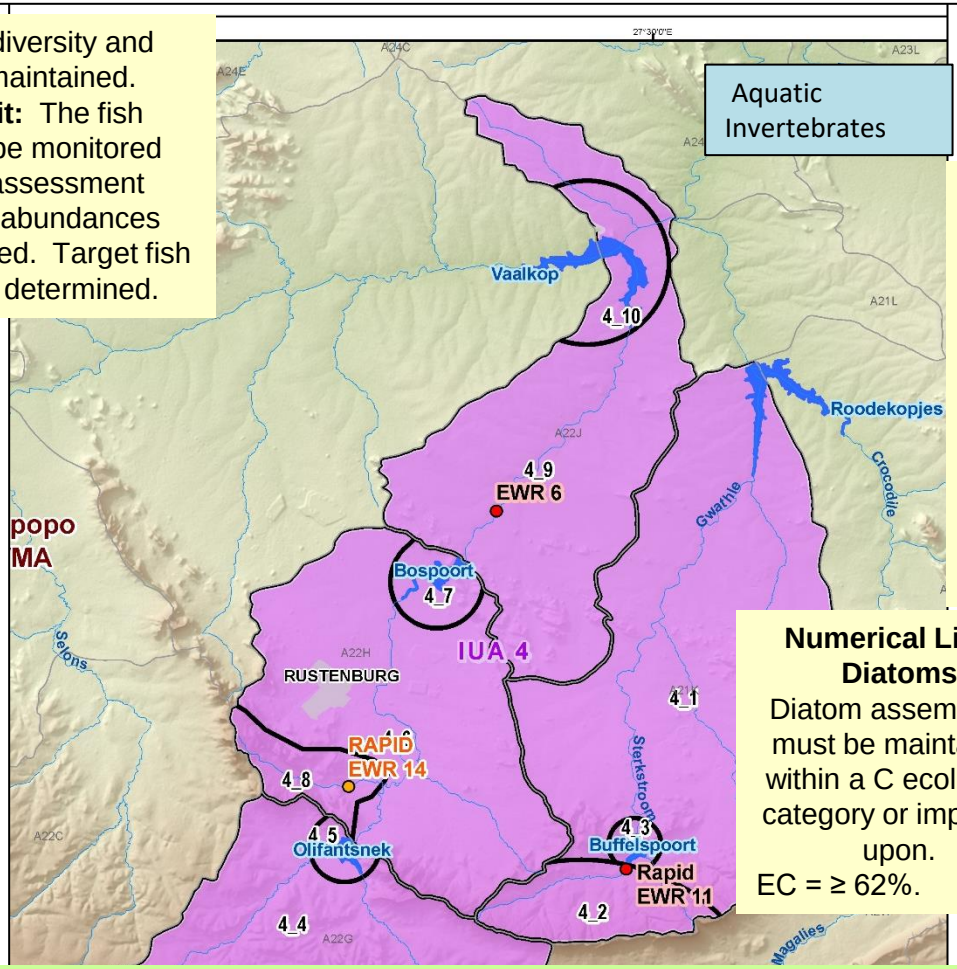
Dams

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.

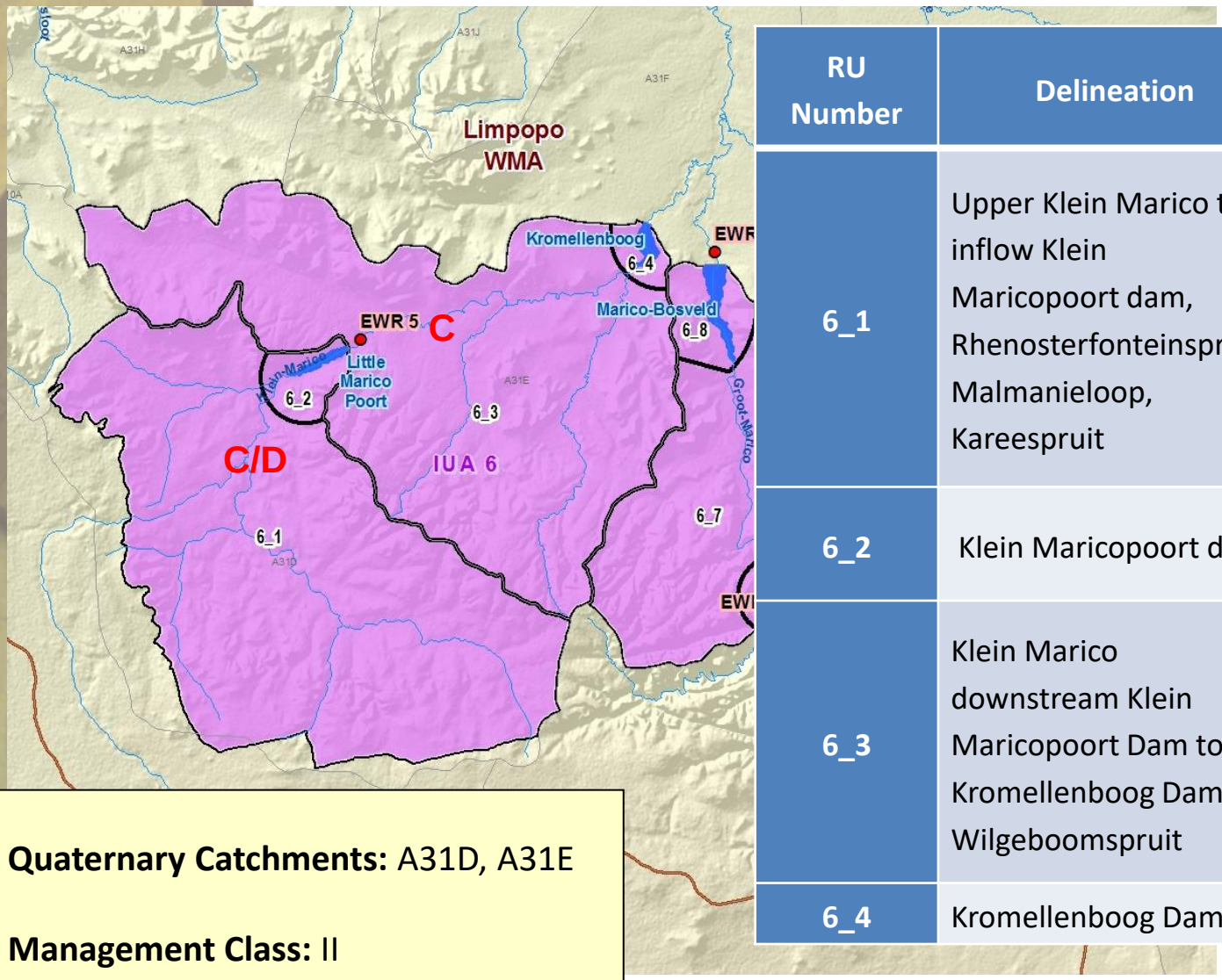
MIRAI C ecological category ≥ 62%
SASS ≥ 155
ASPT ≥ 5.5

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 6a: KLEIN MARICO CATCHMENT



RU Number	Delineation	Quaternary Catchment
6_1	Upper Klein Marico to inflow Klein Maricopoort dam, Rhenosterfonteinspruit, Malmanieloop, Kareespruit	A31D
6_2	Klein Maricopoort dam	A31D
6_3	Klein Marico downstream Klein Maricopoort Dam to Kromellenboog Dam, Wilgeboomspruit	A31E
6_4	Kromellenboog Dam	A31E

Quaternary Catchments: A31D, A31E

Management Class: II

Ecological Category: B/C

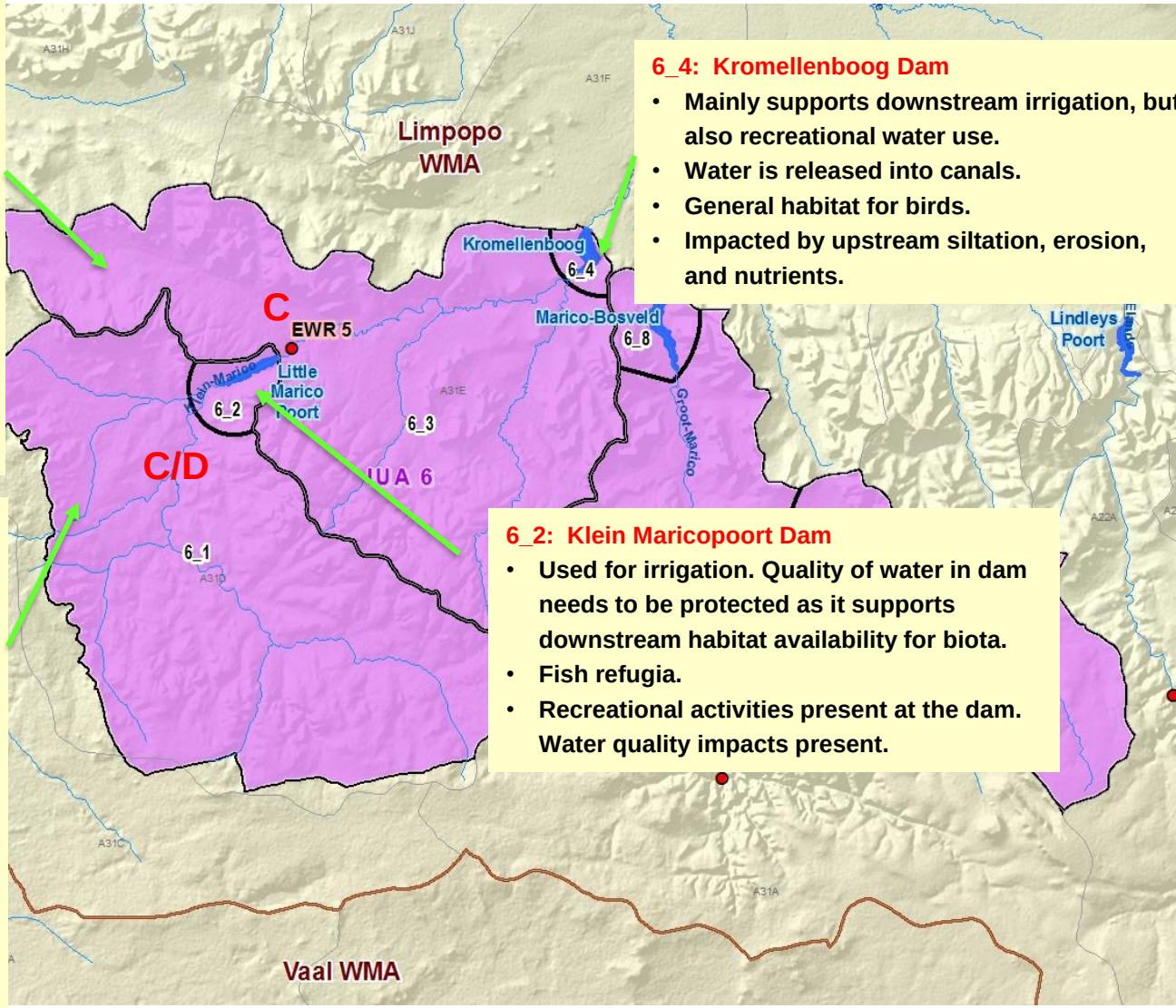
IUA 6a: KLEIN MARICO CATCHMENT

6_3: Klein Marico downstream Klein Maricopoort Dam to Kromellenboog Dam, Wilgeboomspruit

- EWR site 5
- Impacts include irrigation and over abstraction. Poor water quality due to irrigation return flows.
- River flow is very low, and is currently maintained by a leak from the dam.
- Water is released into canals for irrigation use.
- Poor fish diversity. Erosion and siltation impacts also present.
- Wilgeboomspruit -small seasonal stream.

6_1: Upper Klein Marico to inflow Klein Maricopoort dam, Rhenosterfonteinspruit, Malmanieloop, Kareespruit

- Klein Marico Eye fed by groundwater
- Reach is located upstream of the town of Zeerust - dependent on groundwater for its water supply.
- Water users – irrigation
- Abtractions from dolomites for irrigation and urban use.
- Mining activities are present.
- Impacts on Kareespruit from WWTW, irrigation and over abstraction.
- Flow impacts - macroinvertebrates.
- Groundwater impacted by bulk abstractions for municipal supplies. (quantity management)
- Quality may become an issue in future.



6_4: Kromellenboog Dam

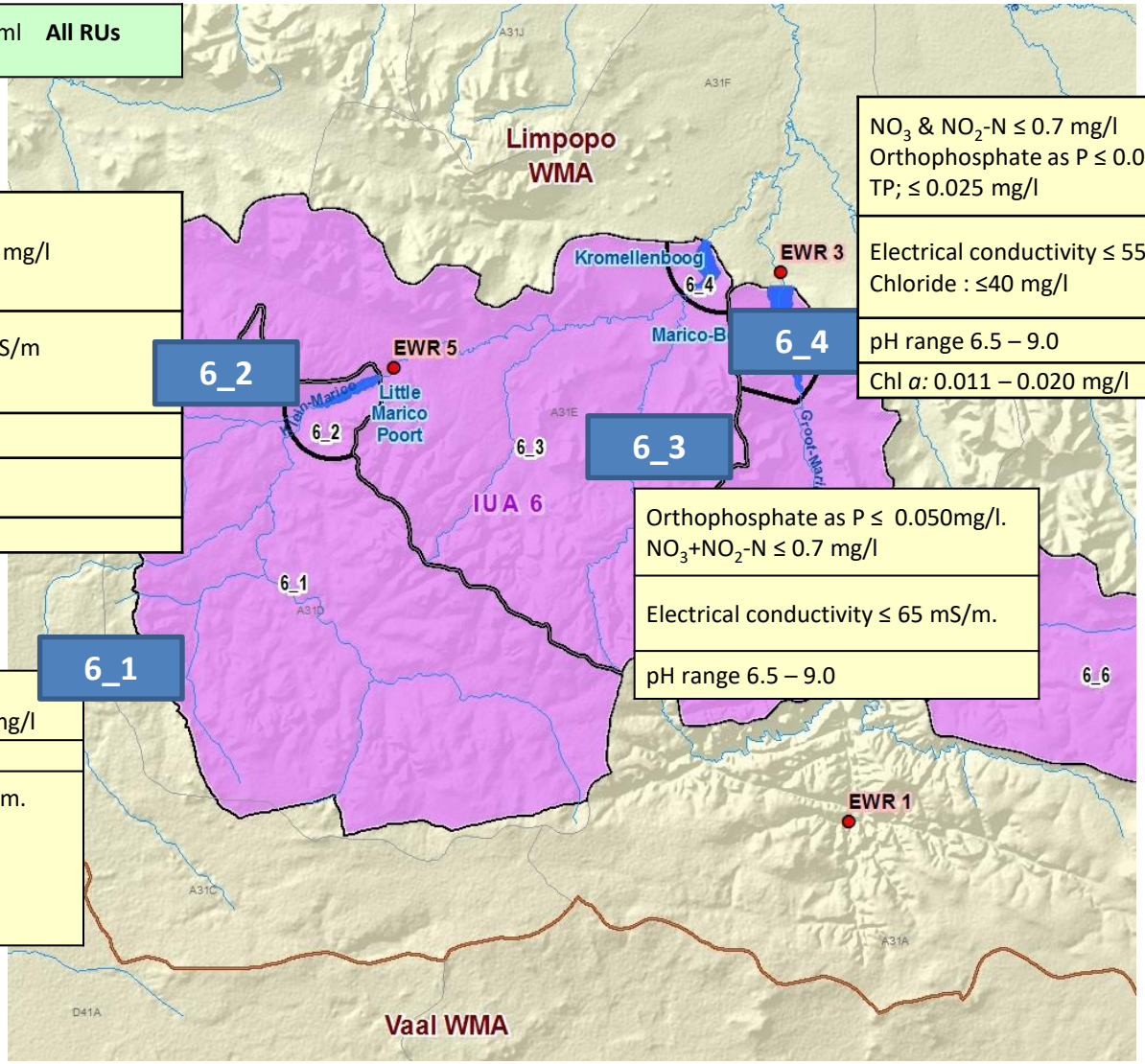
- Mainly supports downstream irrigation, but also recreational water use.
- Water is released into canals.
- General habitat for birds.
- Impacted by upstream siltation, erosion, and nutrients.

6_2: Klein Maricopoort Dam

- Used for irrigation. Quality of water in dam needs to be protected as it supports downstream habitat availability for biota.
- Fish refugia.
- Recreational activities present at the dam. Water quality impacts present.

IUA 6a: Klein Marico/Kromellenboog
RQOs QUALITY

E.coli ≤ 130 counts/100ml **All RUs**



NO_3 & NO_2-N ≤ 0.7 mg/l
Orthophosphate as P ≤ 0.025 mg/l
TP; ≤ 0.050 mg/l

Electrical conductivity ≤ 65 mS/m
Chloride : ≤40 mg/l

pH range 6.5 – 9.0

Turbidity ≥ 0.4m

Chl *a:* 0.011 – 0.020 mg/l

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

Electrical conductivity ≤ 55 mS/m
Chloride : ≤40 mg/l

pH range 6.5 – 9.0

Chl *a:* 0.011 – 0.020 mg/l

Orthophosphate as P ≤ 0.050mg/l.
NO_3+NO_2-N ≤ 0.7 mg/l

Electrical conductivity ≤ 65 mS/m.

pH range 6.5 – 9.0

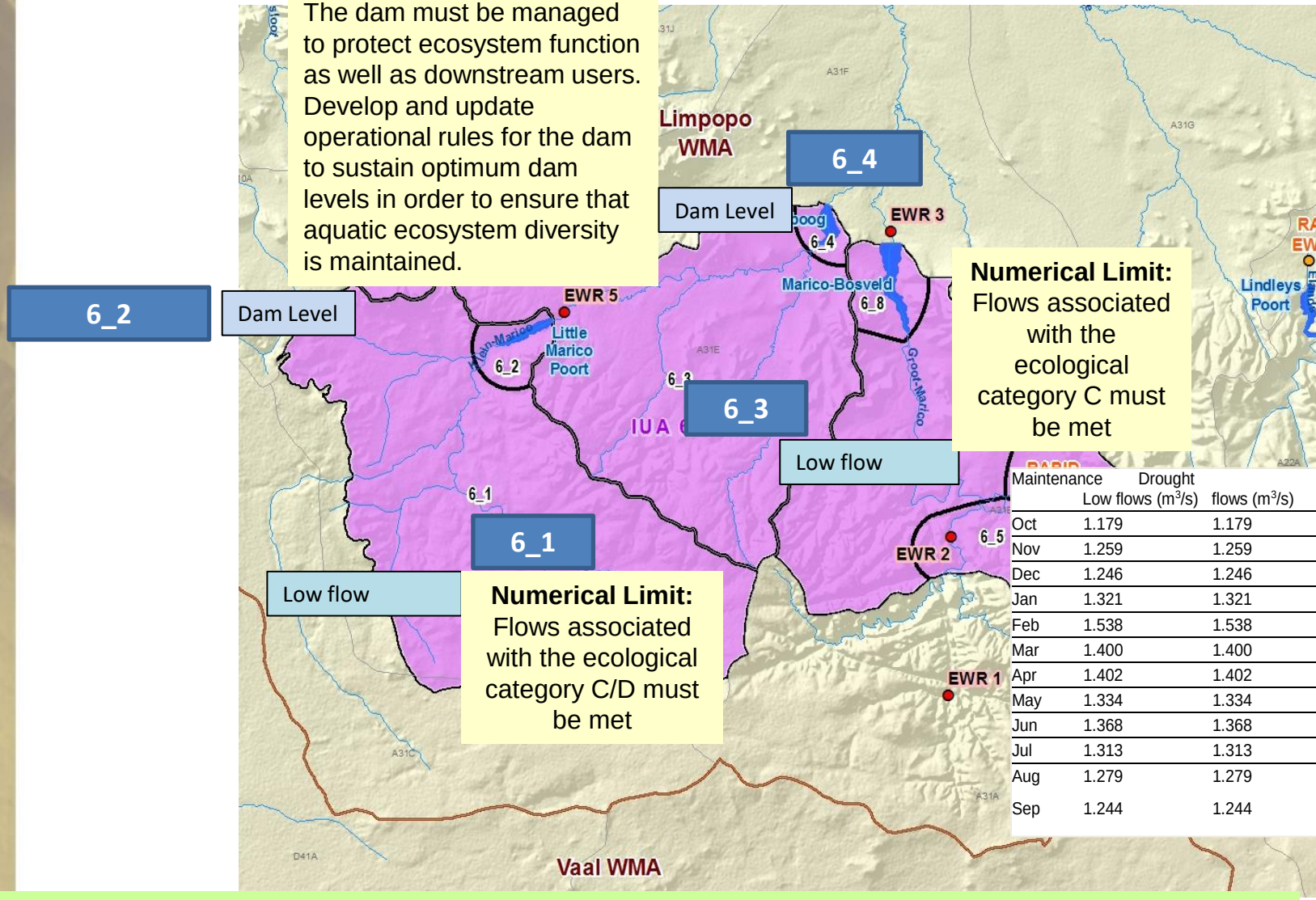
NO_3+NO_2-N ≤ 0.50 mg/l
Orthophosphate as P ≤ 0.050 mg/l

pH range 6.5 – 9.0

Electrical conductivity ≤ 55 mS/m.
Sulphate ≤ 80 mg/L.
Sodium ≤ 40 mg/l
Chloride ≤ 70 mg/l
Fluoride ≤ 2.5 mg/l

IUA 6a: Klein Marico/Kromellenboog
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.



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

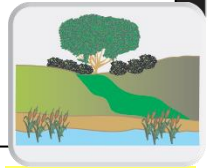
Numerical Limit: Flows associated with the ecological category C/D must be met

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

IUA 6a: Klein Marico/Kromellenboog
RQOs HABITAT



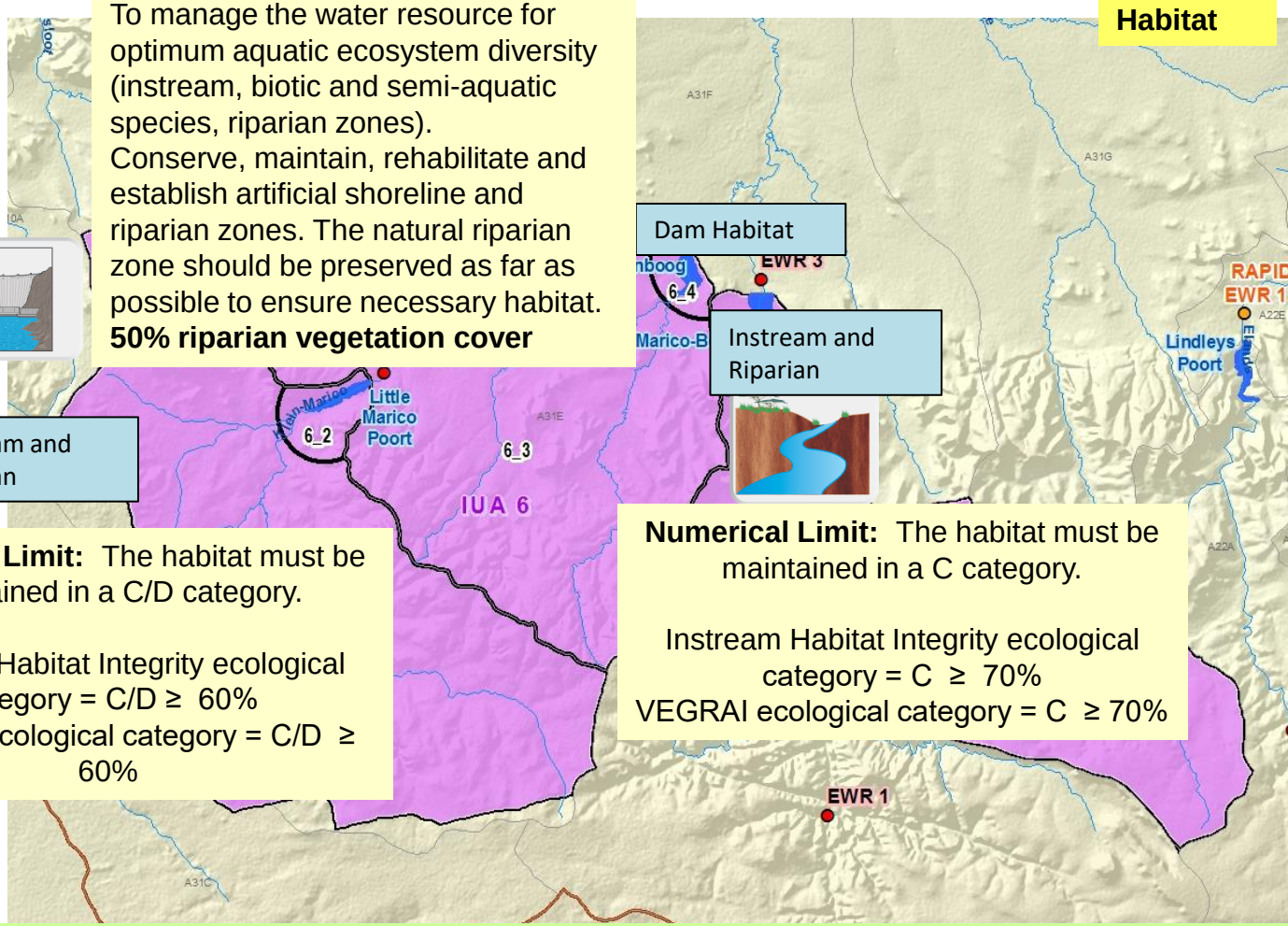
Habitat

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

Dam Habitat

Instream and Riparian

Instream and Riparian



Numerical Limit: The habitat must be maintained in a C/D category.

Instream Habitat Integrity ecological category = C/D ≥ 60%
VEGRAI ecological category = C/D ≥ 60%

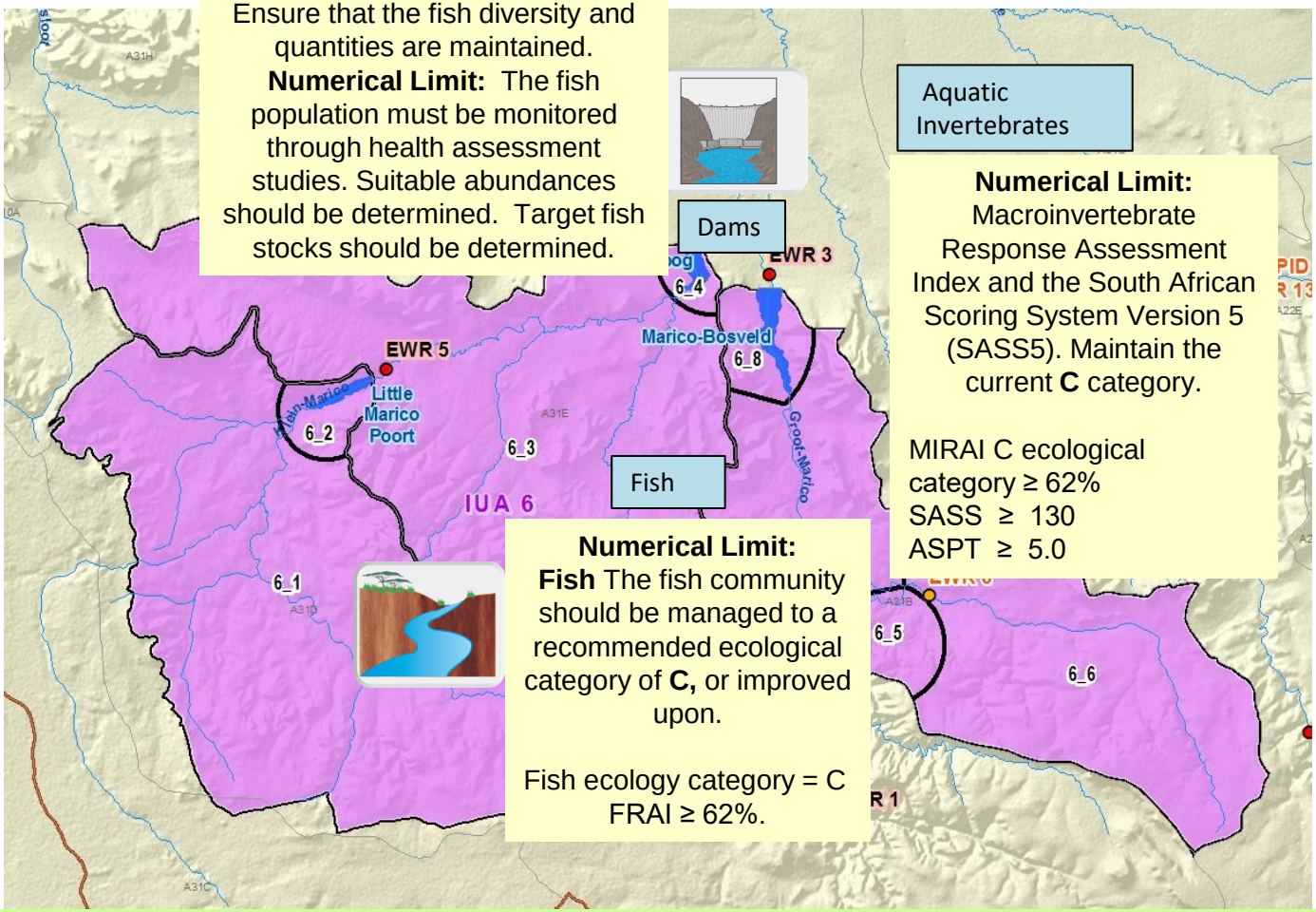
Numerical Limit: The habitat must be maintained in a C category.

Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

RQOs (Narrative)

Instream: Habitat diversity should be maintained in a C/D ecological category. Maintain marginal vegetation and in-stream substrate (velocity depth classes) for fish diversity.
Riparian: Vegetation cover should be improved from a D ecological category to a C/D ecological category. Alien vegetation control must be implemented. Riparian zone development must be limited and controlled.
Riparian: Vegetation cover should be maintained in a C ecological category or better condition.

IUA 6a: Klein Marico/Kromellenboog
RQOs BIOTA – FISH AND MACROINVERTEBRATES



RQOs: (representative)

Fish : Fish community should be maintained at a D ecological category or improved upon. Flow should be adequate for flow dependant species.

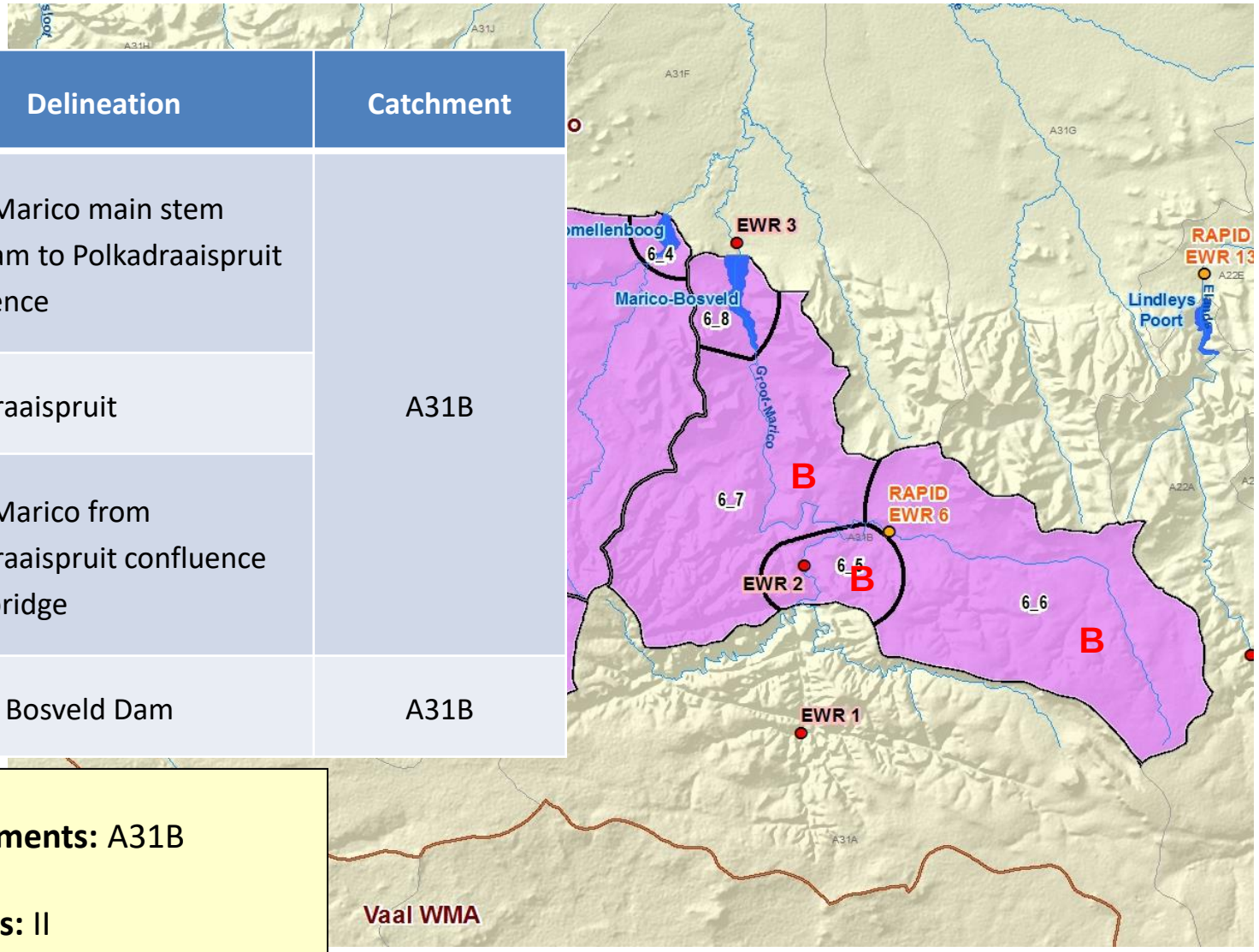
Fish: Fish community should be maintained at a B/C ecological category.

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

Resource Unit	Delineation	Catchment
6_5	Groot Marico main stem upstream to Polkadraaispruit confluence	A31B
6_6	Polkadraaispruit	
6_7	Groot Marico from Polkadraaispruit confluence to N4 bridge	
6_8	Marico Bosveld Dam	A31B

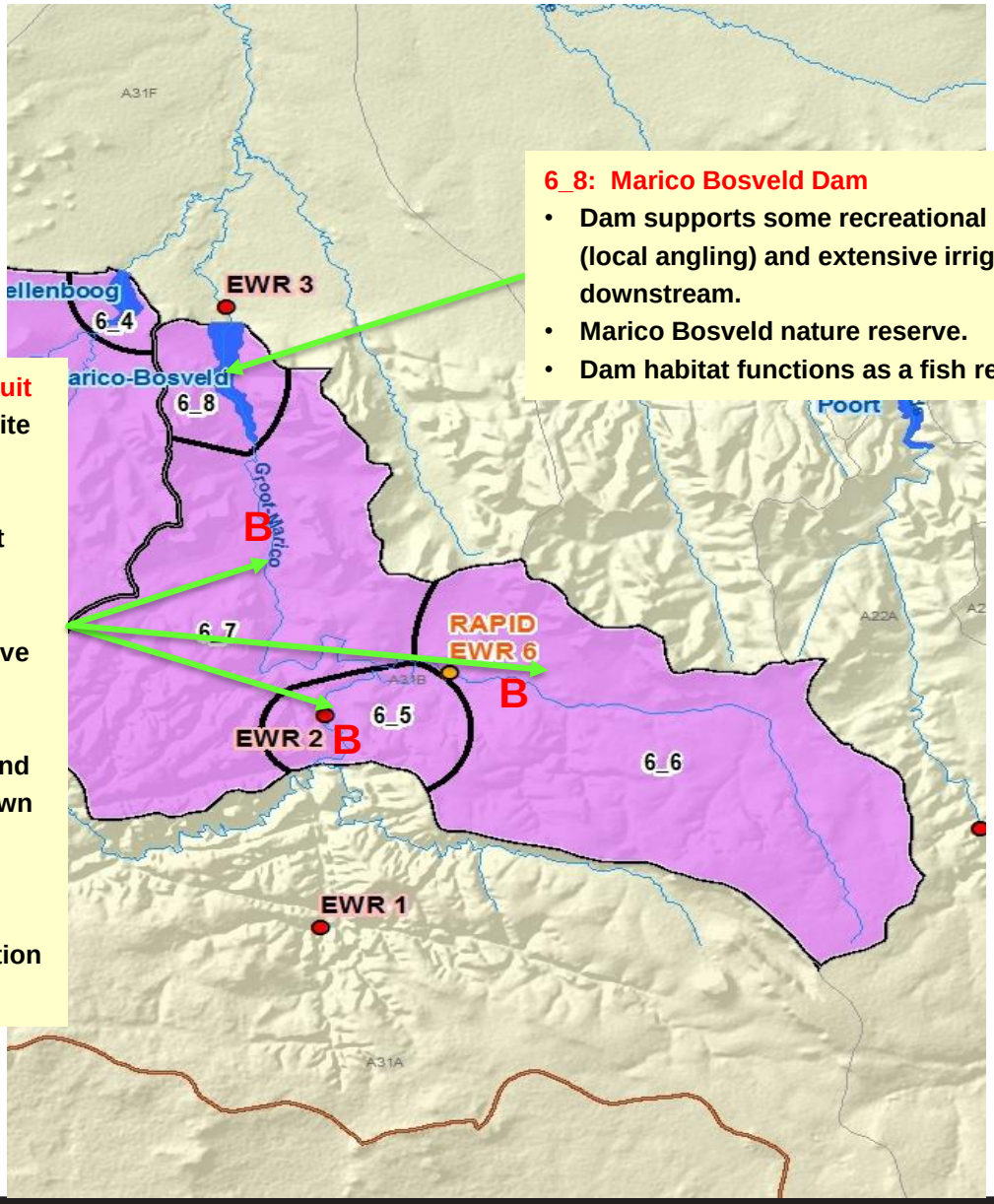


Quaternary Catchments: A31B

Management Class: II

Ecological Category: B

IUA 6b: GROOT MARICO



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

- EWR site 2 on the Marico and Rapid III site 6 on the Polkadraaispruit
- Isolated occurrences to *BMOT, AURA, CPRE* and *AMOS* in the Polkadraaispruit
- Locality of aquatic macroinvertebrate *lampyridae*
- Large number of inverts and fish sensitive to water quality changes.
- Wetlands and it is a fish support area.
- Mine prospecting activities in the area and some 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 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

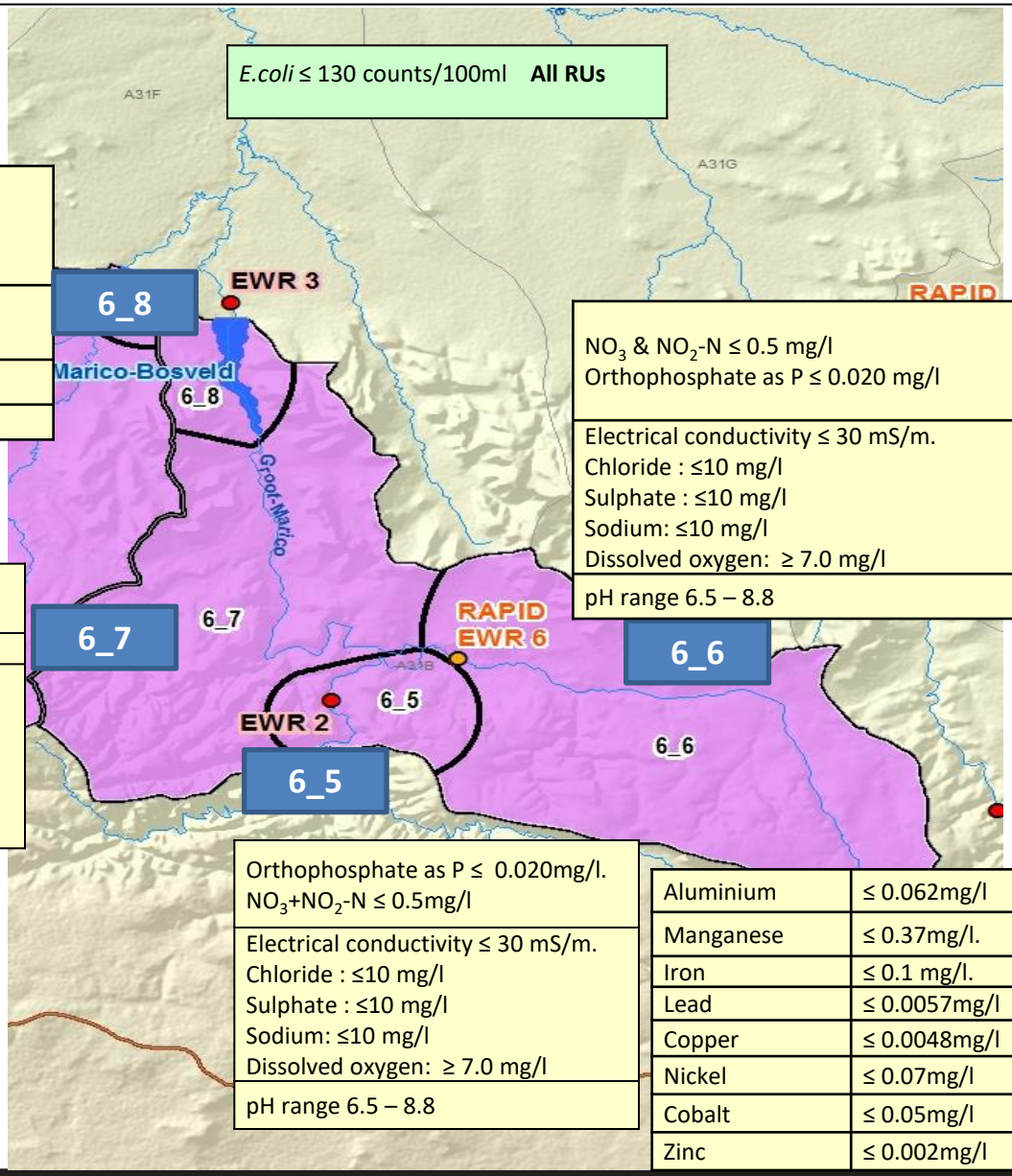
NO_3 & NO_2-N ≤ 0.5 mg/l Orthophosphate as P ≤ 0.020 mg/l
Electrical conductivity ≤ 30 mS/m. Chloride : ≤10 mg/l Sulphate : ≤10 mg/l Sodium: ≤10 mg/l Dissolved oxygen: ≥ 7.0 mg/l
pH range 6.5 – 8.8

NO_3+NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.025 mg/l
pH range 6.5 – 8.5
Electrical conductivity ≤ 55 mS/m. Sulphate ≤ 50 mg/L. Sodium ≤ 50 mg/l Chloride ≤ 40 mg/l Dissolved oxygen: ≥ 7.0 mg/l

Aluminium	≤ 0.062mg/l
Manganese	≤ 0.37mg/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

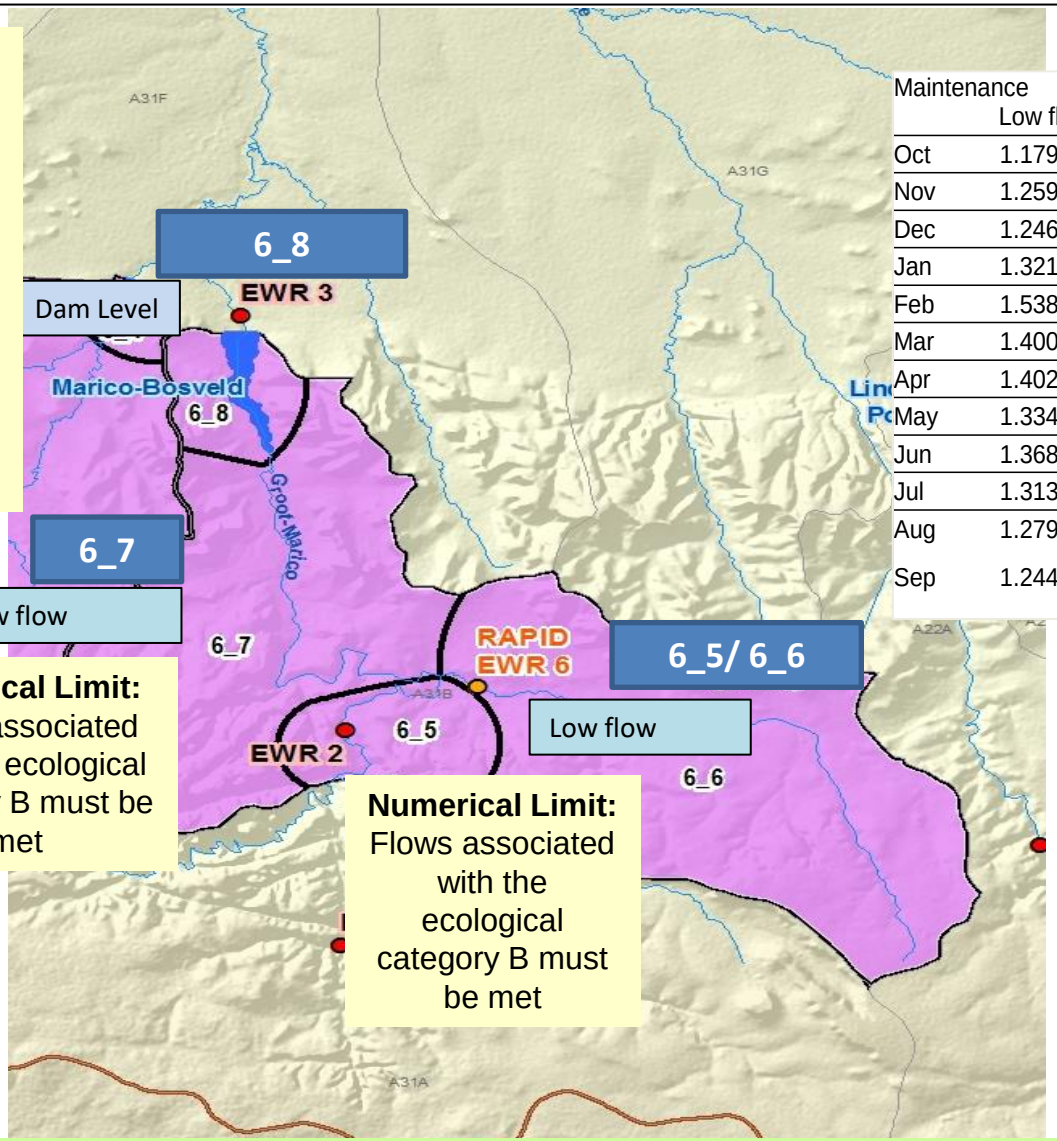
Orthophosphate as P ≤ 0.020mg/l. NO_3+NO_2-N ≤ 0.5mg/l
Electrical conductivity ≤ 30 mS/m. Chloride : ≤10 mg/l Sulphate : ≤10 mg/l Sodium: ≤10 mg/l Dissolved oxygen: ≥ 7.0 mg/l
pH range 6.5 – 8.8

Aluminium	≤ 0.062mg/l
Manganese	≤ 0.37mg/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



IUA 6b: Groot Marico
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 Low flows (m^3/s)	Drought flows (m^3/s)
Oct	1.179	1.179
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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

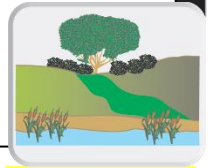
Numerical Limit: Flows associated with the ecological category B must be met

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

RQOs: FLOWS

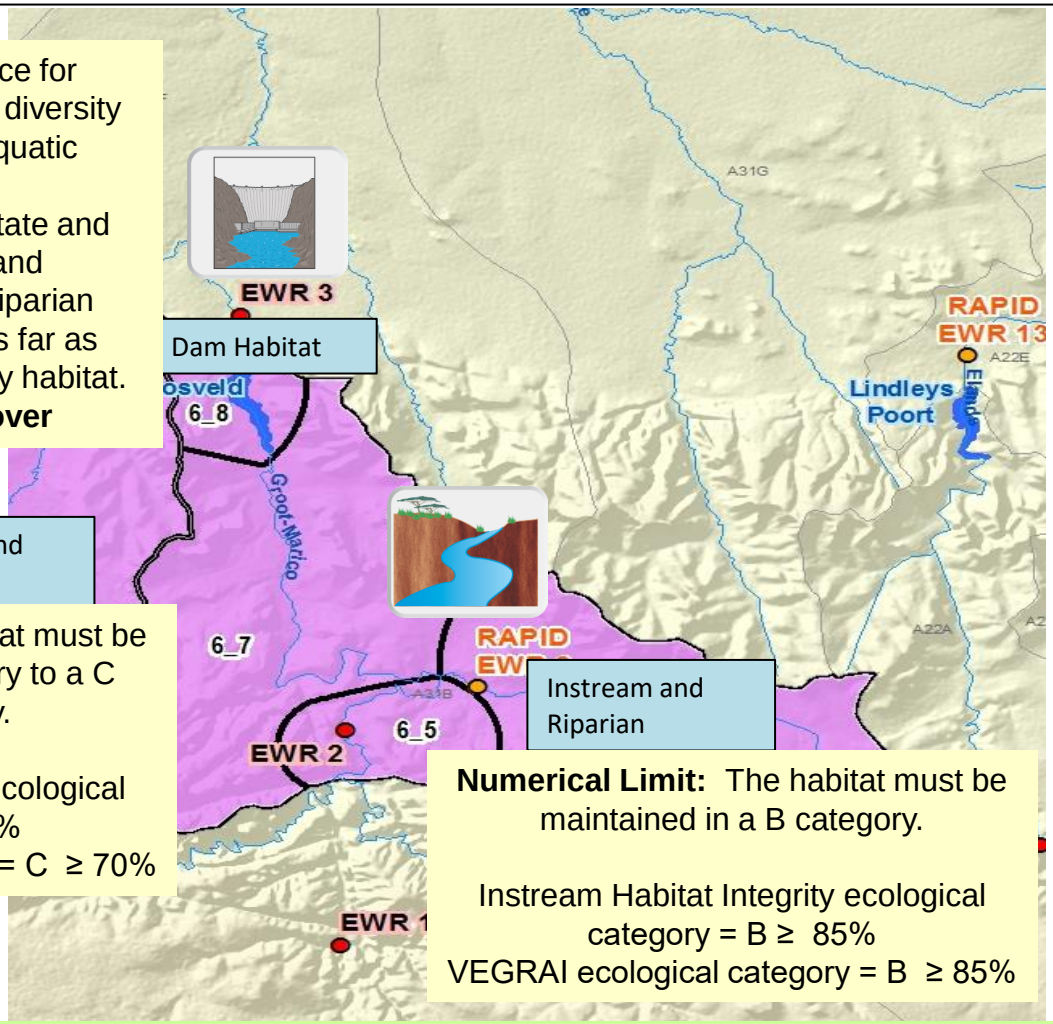
Low: The maintenance low flows and drought flows must be attained to support the aquatic ecosystem and the downstream users.

IUA 6b: Groot Marico
RQOs HABITAT



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



Numerical Limit: The habitat must be improved from a D category to a C ecological category.

Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

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

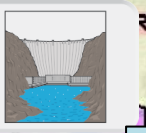
Instream Habitat Integrity ecological category = B ≥ 85%
VEGRAI ecological category = B ≥ 85%

RQOs (Narrative)

Instream: Habitat diversity should be maintained in a B ecological category. Maintain marginal vegetation and in-stream substrate (velocity depth classes) for fish diversity.
Riparian: Vegetation cover should be improved from a B/C ecological category to a B ecological category. Protection of riparian habitats required (Polkadraaispruit).
Riparian: Vegetation cover should be maintained in a B ecological category or better condition.

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.

IUA 7: KAALOOG-SE- LOOP

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

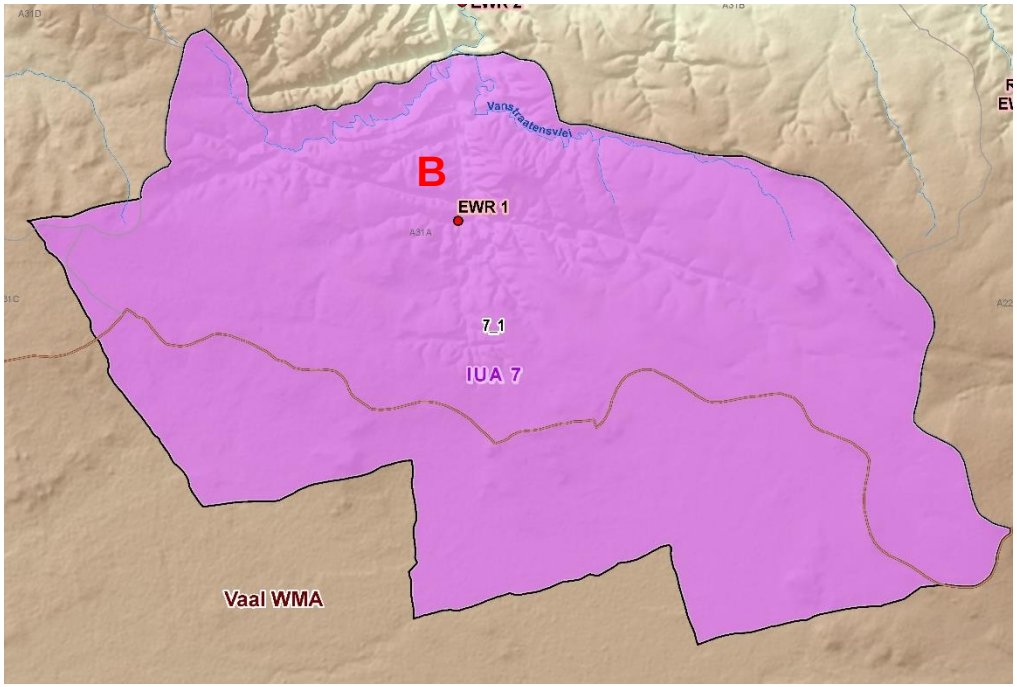
Quaternary Catchments: A31A

Management Class: I

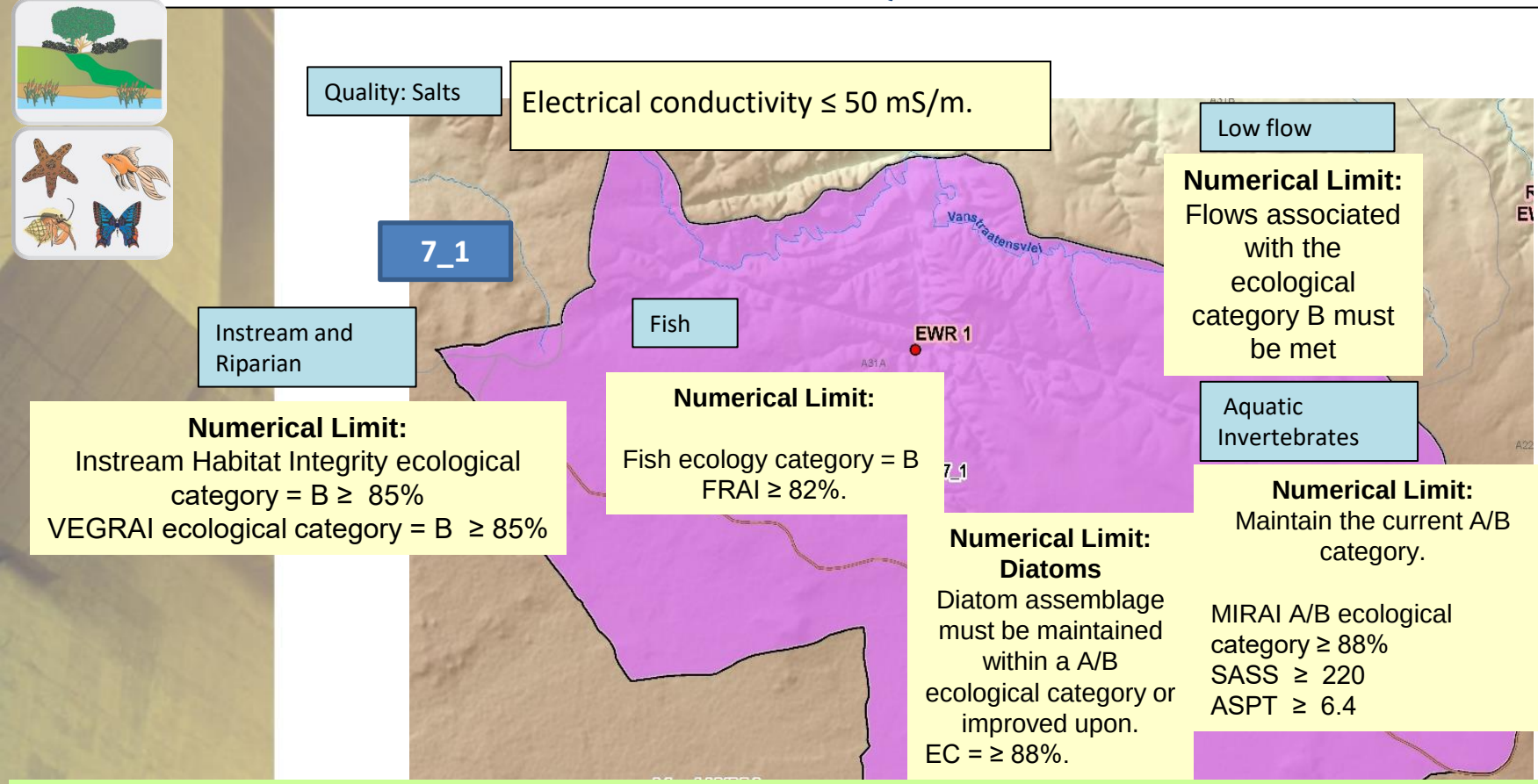
Ecological Category: B

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



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.

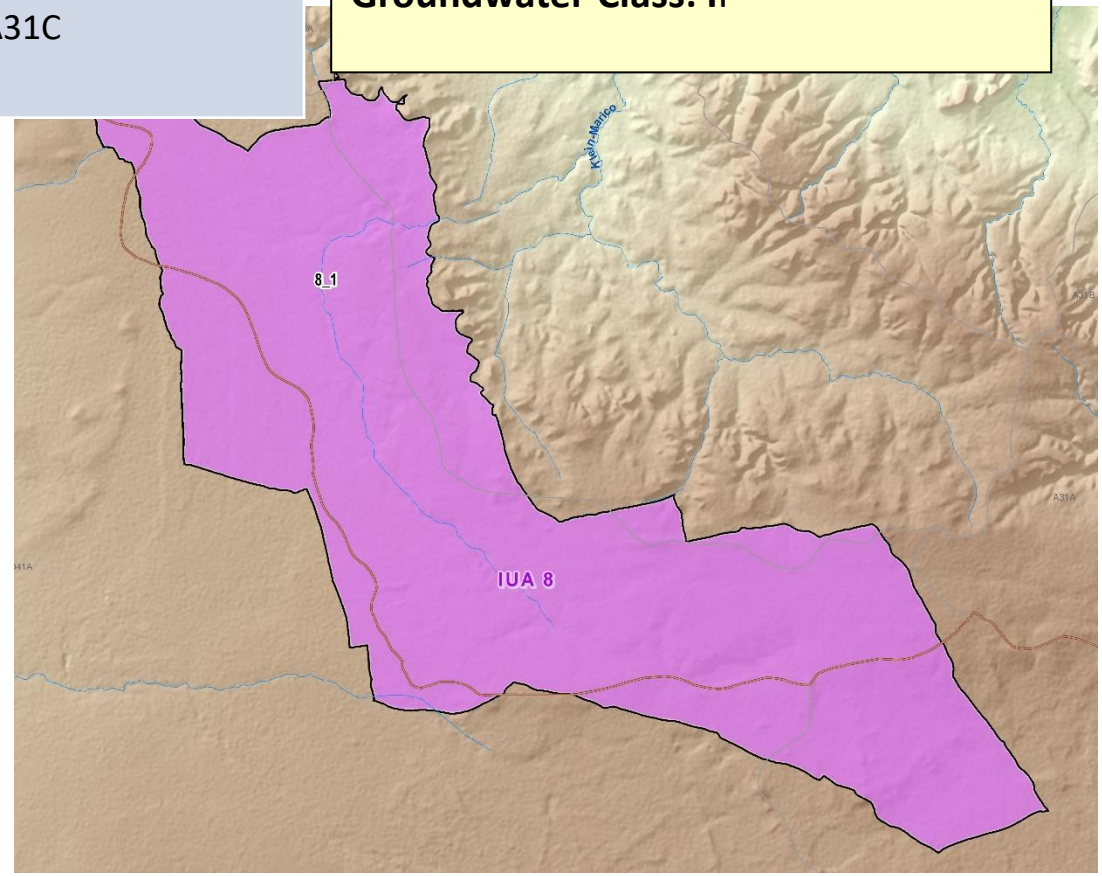
Diatoms: Diatom assemblage must be maintained within a largely natural to natural condition.

IUA 8: MALMANIESLOOP

RU Number	Delineation	Quaternary Catchment
8_1	Malmanie se Loop, Dolomites	A31C

Quaternary Catchments: A31C

Groundwater Class: II

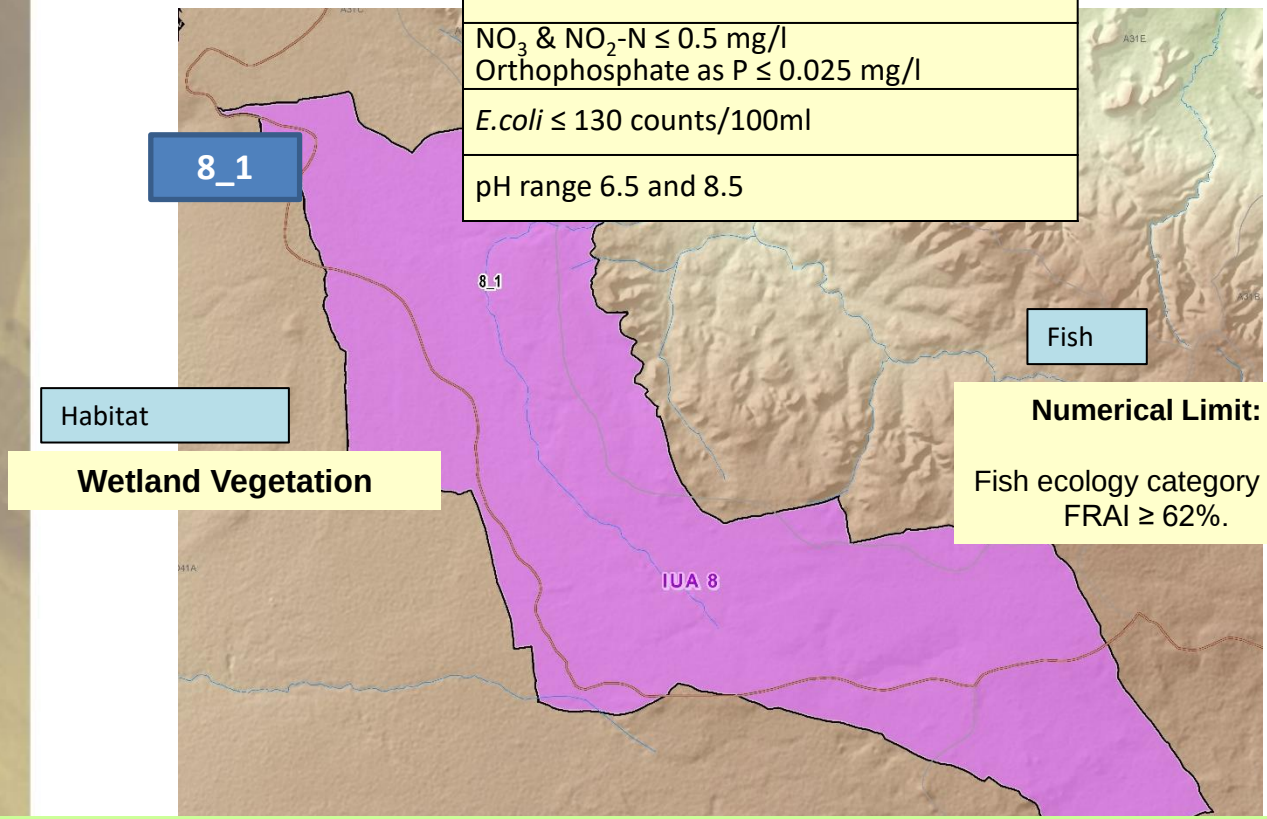


8_1: Malmanie se Loop, Dolomitic Area

- **Includes a number of game reserves and commercial agriculture.**
- **Flows are seasonal and systems are groundwater driven.**
- **Some abstractions occur at the lower reaches.**
- **Important wetland associated with the Malmanie River (peatlands)**
- **Mainly groundwater related around Malamanie Eye.**
- **Impact on groundwater sustainability due to growing demand for municipal and irrigation needs.**
- **Localised quality impacts due to mining activities.**

IUA 8: Malmanies se Loop, Dolomitic Area
RQOs

Quality	Electrical conductivity ≤ 55 mS/m.
	NO_3 & NO_2-N ≤ 0.5 mg/l Orthophosphate as P ≤ 0.025 mg/l
	E.coli ≤ 130 counts/100ml
	pH range 6.5 and 8.5



Habitat

Wetland Vegetation

Fish

Numerical Limit:

Fish ecology category = C
FRAI ≥ 62%.

RQOs (Narrative)

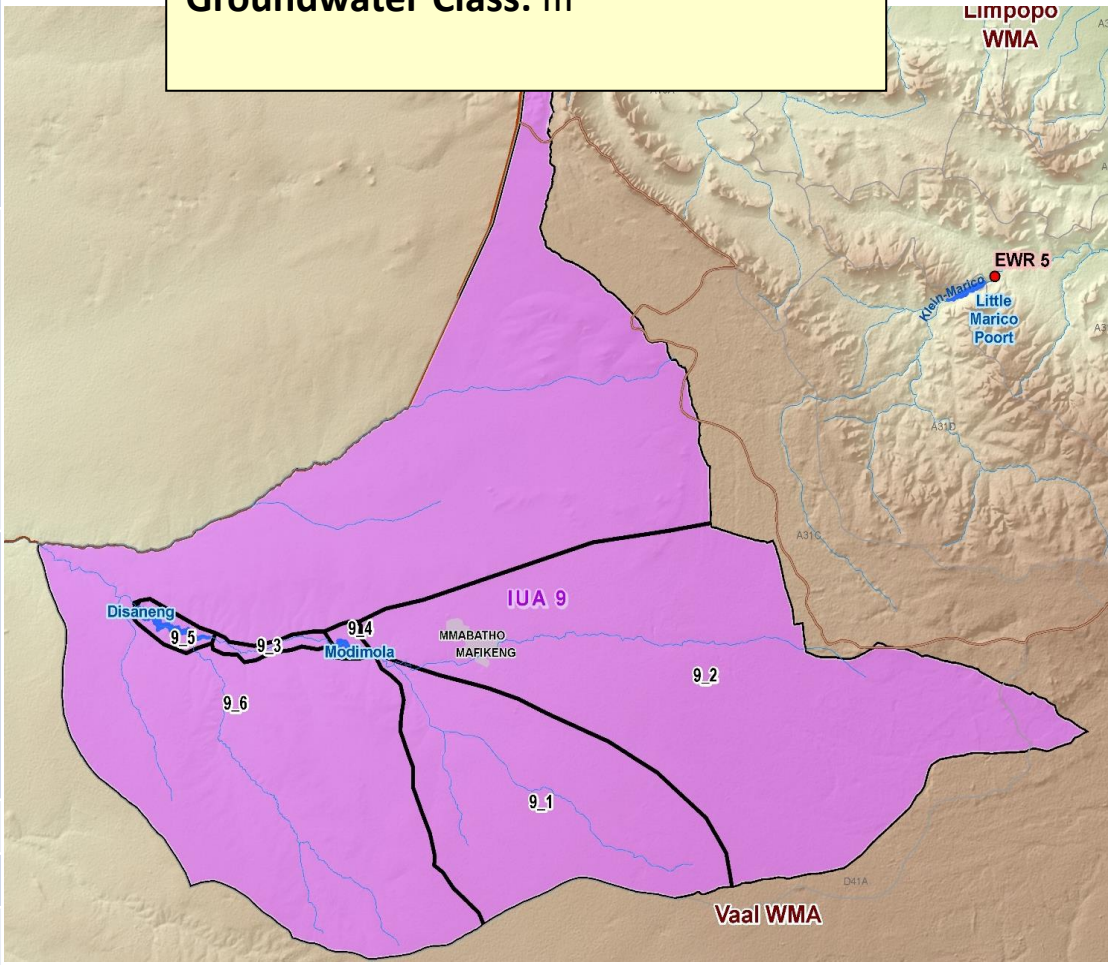
Salts: Instream salinity must be maintained to support the aquatic ecosystem and maintain the water quality present ecological state.
Pathogens: The presence of pathogens should pose a low risk to human health.
Nutrients: Instream concentration of nutrients as specified must be attained to sustain aquatic ecosystem health and to maintain the water quality present ecological state.
Fish: The fish community must be maintained in a C ecological category or better condition. Control and remove alien invasive fish species MSAL. Prevent spreading of the alien species.

IUA 9: MOLOPO

RU Number	Delineation D	Quaternary Catchment
9_1	Bodibe Eye	D41A (Polfonteinspruit and Lotlhakane tributary catchment area)
9_2	Molopo Eye, Grootfontein Eye, Molopo headwaters to inflow Modimola dam	D41A
9_3	Molopo River mainstem only from Modimola Dam to Disaneng Dam	D41A (main stem)
9_4	Modimola Dam	D41A
9_5	Disaneng Dam	D41A
9_6	All remaining tributaries - Madibe, Kabe, Mogosane	D41A

Quaternary Catchments: D41A

Groundwater Class: III



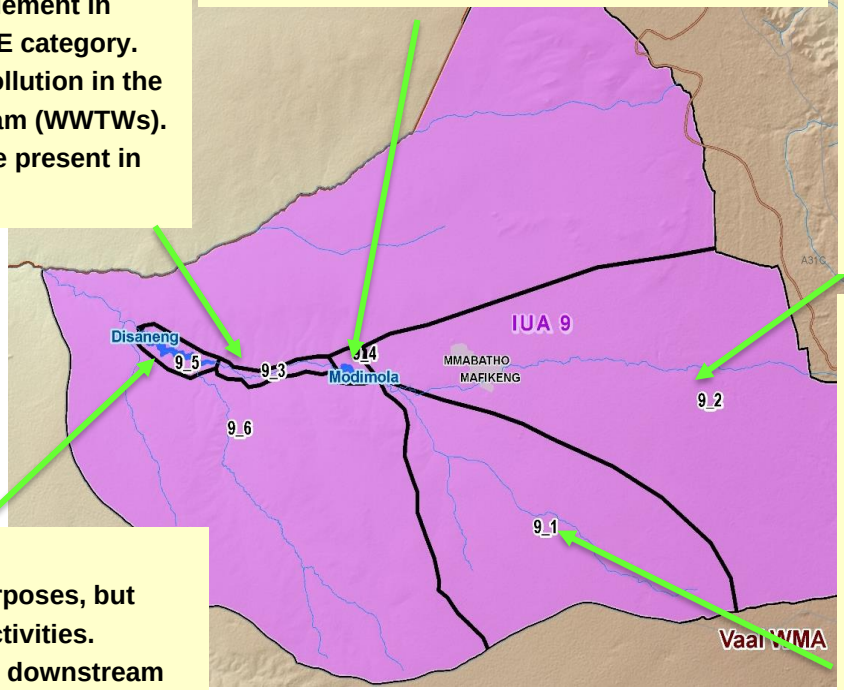
IUA 9: MOLOPO

9_4: Setumo (Modimola) Dam

- Dam supports domestic water supply and some recreational activity (fishing, etc.)
- The WWTWs of Mahikeng is located just upstream of the dam which is impacting on the dam water quality. Poor water quality.
- Habitat supporting birds.

9_3: Molopo River main stem only from Modimola Dam to Disaneng Dam

- Highly impact from urban settlement in Mahikeng - resulted in a PES E category.
- Serious problem with water pollution in the catchment of the Modimole Dam (WWTWs).
- Important wetland systems are present in this reach.



9_5: Dinaseng Dam

- Mainly used for irrigation purposes, but also supports recreational activities.
- Discharge from Dinaseng for downstream trans-boundary use (into Botswana) is important.
- Dam also supports water supply to town of Dinaseng.

9_2: Molopo Eye, Grootfontein Eye, Molopo headwaters to inflow Modimola dam

- Groundwater driven around Molopo Eye.
- important as it is inhabited by the unique fish species (Malawian Cichlids have been introduced)
- Impacts include a cement factory and urban development (Mahikeng).
- Molopo eye is a peatland and important for water supply and biodiversity support.
- Grootfontein aquifer not productive anymore
- All Mahikeng's water is sourced from Molopo's Eye - vital that the flow is maintained.
- Recreational activity in the area is also impacting on the eye. .

9_1: Bodibe Eye

- Eye supports domestic water use and agricultural use.
- Bodibe Eye is a peatland and important for water supply and biodiversity support.
- High groundwater abstraction in the area resulting in a decrease in groundwater levels - resulted in spontaneous combustion underground and the peatland oxidised and been burning for several years now.
- impacts include urban and settlement activities and sand mining for cement.
- Serious depletion of groundwater levels in this area (~25m) due to over-utilisation.
- Large eyes (springs) already impacted and dry.
- No sensitive fish or inverts.

IUA 9: Molopo
RQOs

Quality

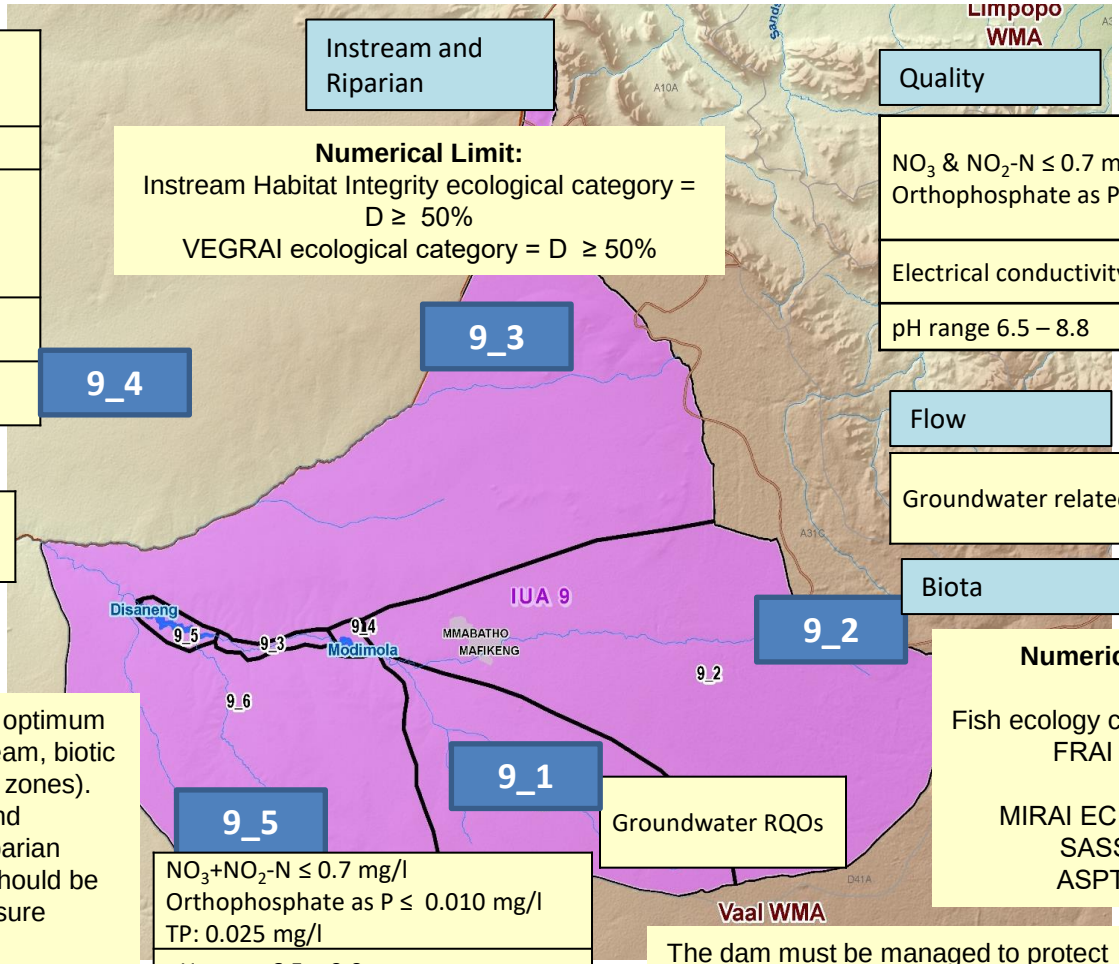
NO_3+NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.050 mg/l TP: 0.055 mg/l
pH range 6.5 – 9.0
Electrical conductivity ≤ 85 mS/m Sodium ≤ 100 mg/l Chloride ≤ 40 mg/l Dissolved oxygen: ≥ 7.0 mg/l
Chl *a*: 0.020 – 0.030mg/l
E.coli ≤ 130 counts/100ml

Fish: 9_4 and 9_5

The fish diversity and quantities must be maintained

Dam Habitat: 9_4 and 9_5

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



Instream and Riparian

Numerical Limit:
Instream Habitat Integrity ecological category = D ≥ 50%
VEGRAI ecological category = D ≥ 50%

Quality

NO_3 & NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.025 mg/l
Electrical conductivity ≤ 75 mS/m.
pH range 6.5 – 8.8

Flow

Groundwater related

Biota

Numerical Limit:

Fish ecology category = D
FRAI ≥ 42%

MIRAI EC = D ≥ 42%
SASS ≥ 80
ASPT ≥ 4.0

Groundwater RQOs

NO_3+NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.010 mg/l TP: 0.025 mg/l
pH range 6.5 – 9.0
Electrical conductivity ≤ 75 mS/m
Chl **a**: 0.011 – 0.020mg/l
E.coli ≤ 130 counts/100ml

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.

IUA 10: DINOKANA EYE/NGOTWANE DAM

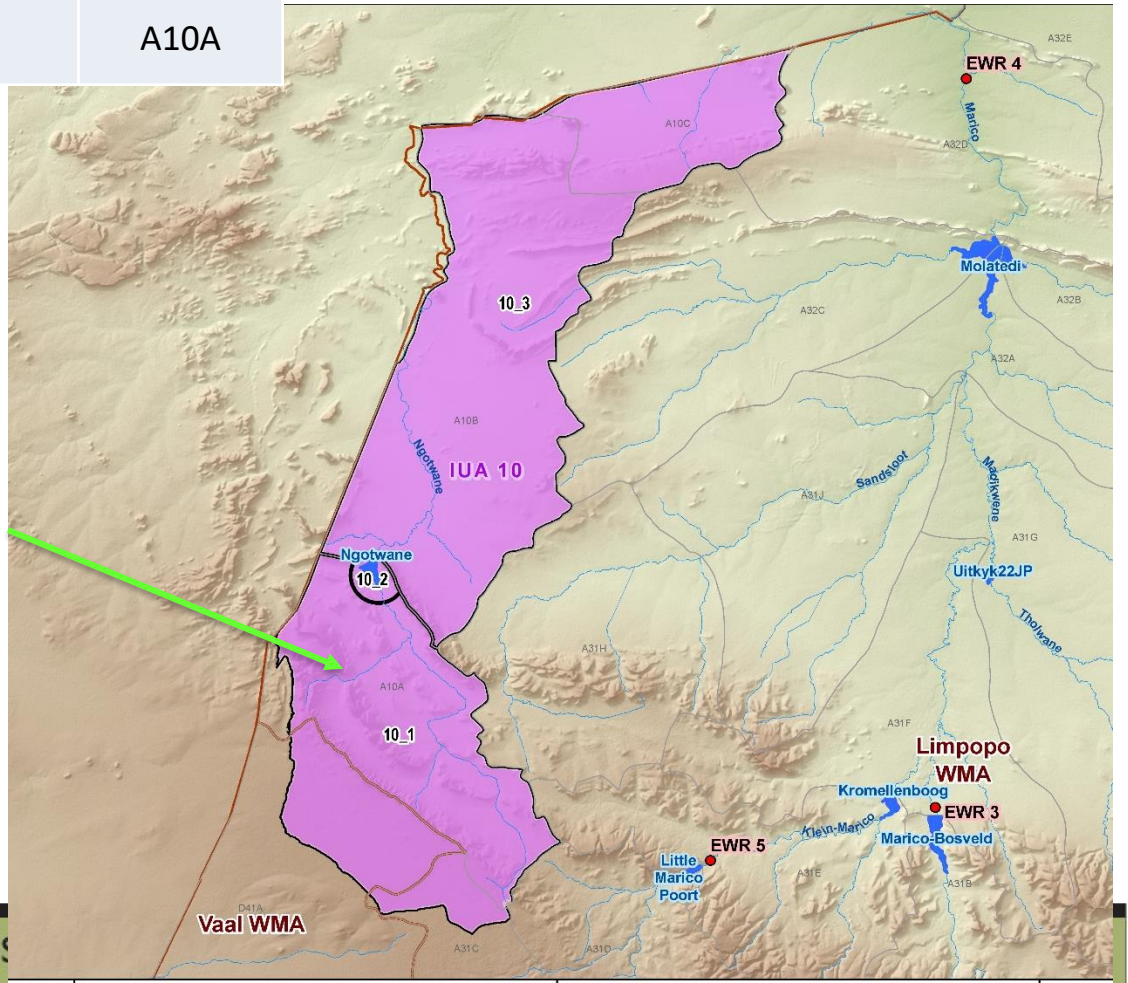
Quaternary Catchments: A10A

Groundwater Class: III

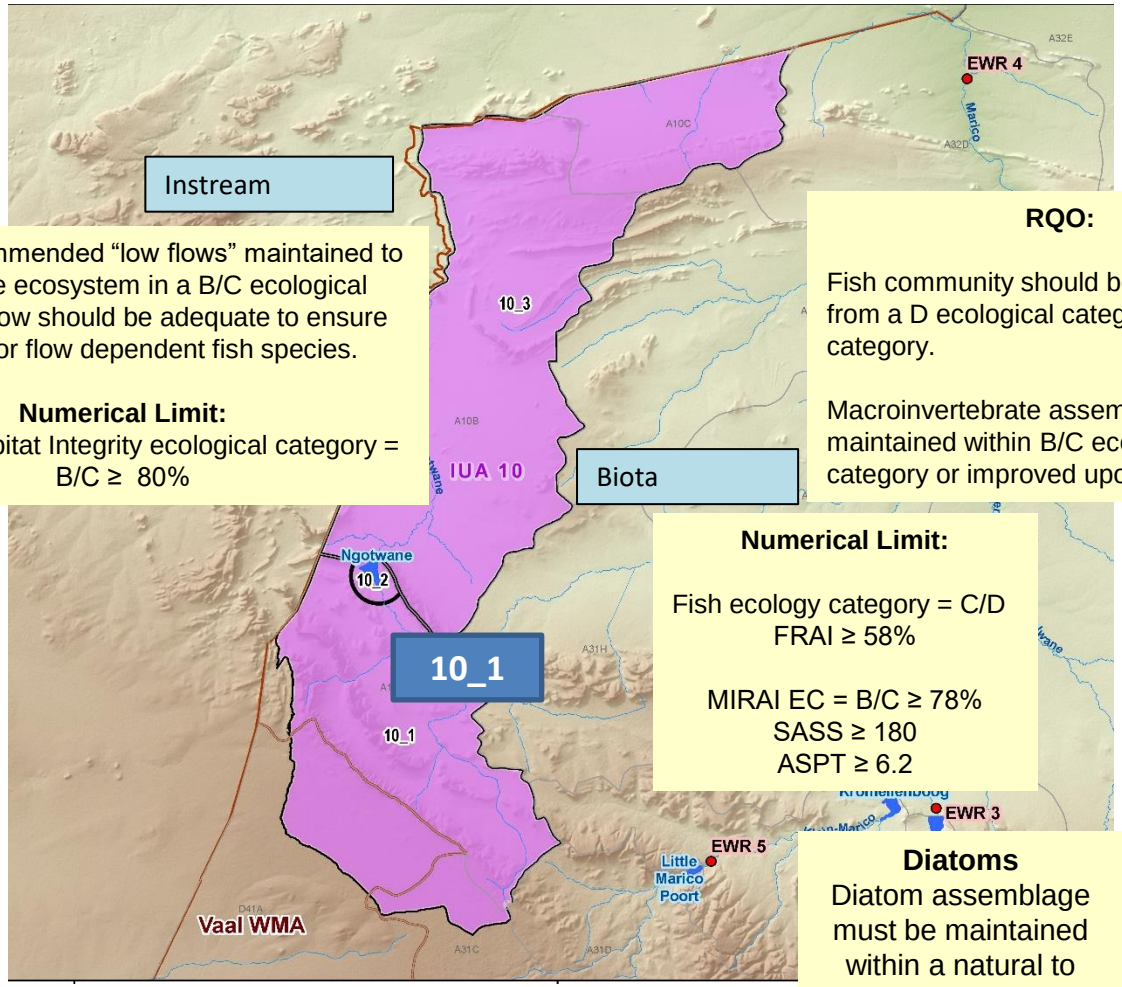
Resource Unit	Delineation	Catchment
10_1	Upper Ngotwane, Dinokane Eye (dolomite water area)	A10A
10_2	Ngotwane Dam	A10A

10_1: Upper Nogotwane, Dinokana Eye

- **Groundwater driven - Dinokana Eye**.
- Two **important wetland systems - Dinokana eye and Ngotwana wetland (high biodiversity**
- **Both supply water for livelihood support for people, livestock and wildlife.**
- **Groundwater related subsistence use.**
- **Water balance in this area is a concern as this is a sole-aquifer system for Dinokana.**
- **Water level of eye has dropped due to over abstraction.**



IUA 10: Dinokana/Ngotwane Dam
RQOs



Ensure recommended "low flows" maintained to sustain the ecosystem in a B/C ecological category. Flow should be adequate to ensure habitats for flow dependent fish species.

Numerical Limit:
Instream Habitat Integrity ecological category = B/C ≥ 80%

RQO:

Fish community should be improved from a D ecological category to a C/D category.

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

Numerical Limit:

Fish ecology category = C/D
FRAI ≥ 58%

MIRAI EC = B/C ≥ 78%
SASS ≥ 180
ASPT ≥ 6.2

Diatoms
Diatom assemblage must be maintained within a natural to largely natural condition.
EC = A/B ≥ 88%.

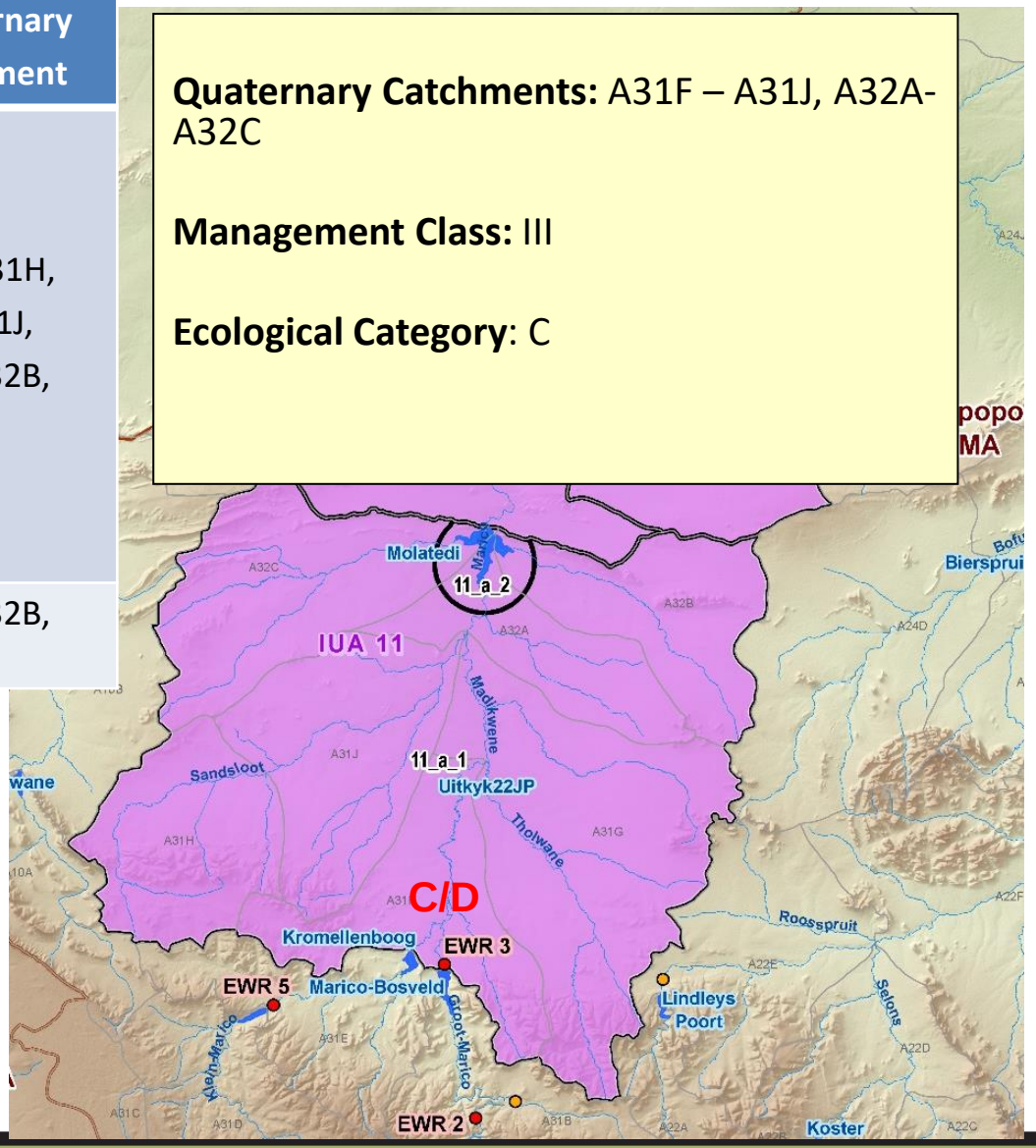
IUA 11a: GROOT MARICO/MOLATEDI DAM

RU Number	Delineation Description	Quaternary Catchment
11a_1	Groot Marico from outflow Marico Bosveld Dam to Molatedi Dam, all tributaries: Elandslaagtespruit, Lengope la Kgamanyane, Lenkwane	A31G, A31H, A31F, A31J, A32A, A32B, A32C
11a_2	Molatedi Dam	A32A, A32B, A32C

Quaternary Catchments: A31F – A31J, A32A-A32C

Management Class: III

Ecological Category: C



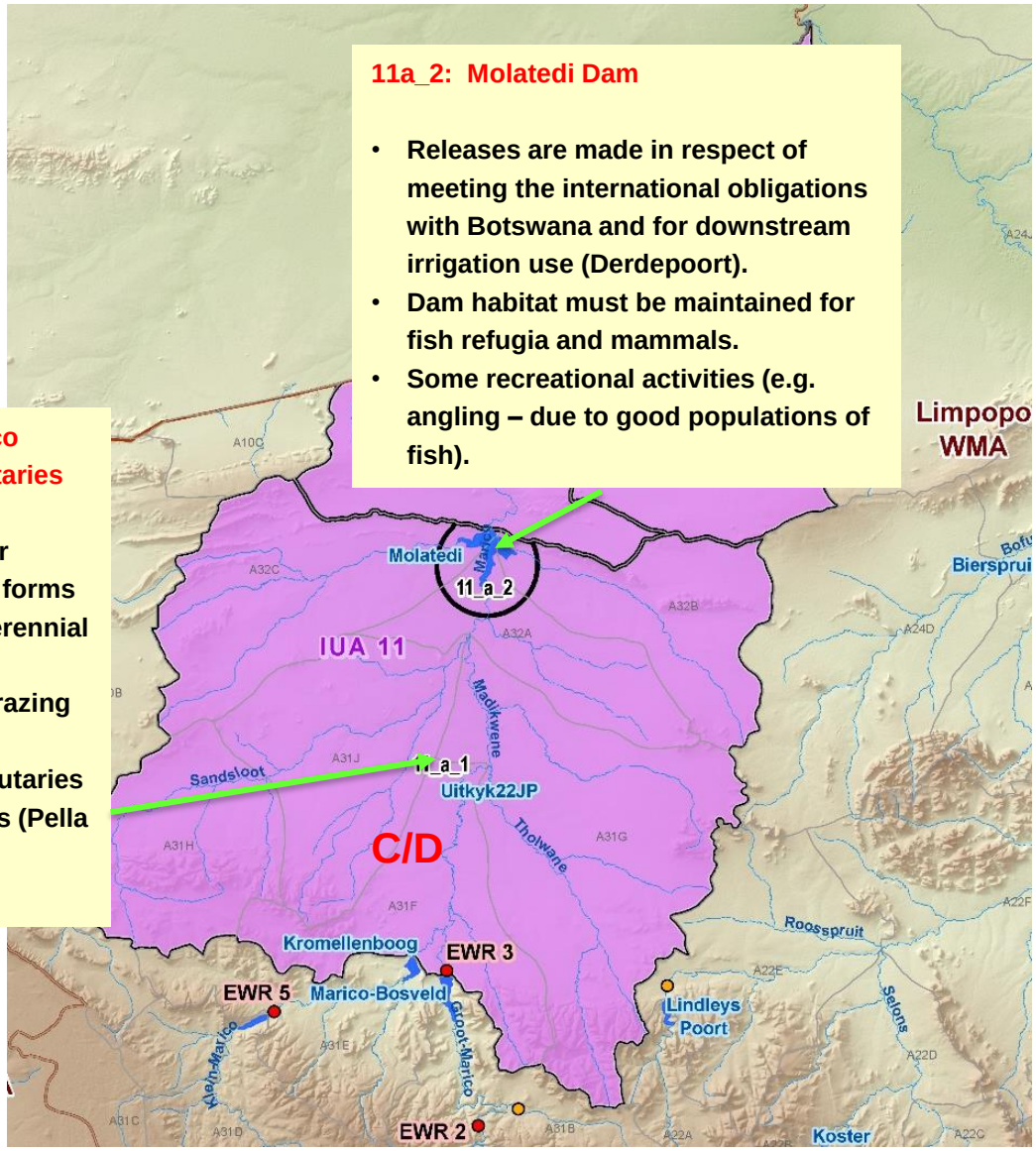
IUA 11a: GROOT MARICO/MOLATEDI DAM

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

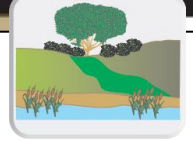
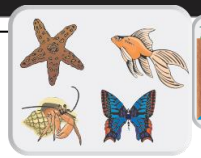
- EWR site 3 on the Groot Marico River
- A high EIS owing to the reach which forms a natural refugia with a number of perennial pools.
- Land area is degraded due to over grazing and development.
- Smaller dams are present on the tributaries supplying water to local communities (Pella Dam, Madikwe, Sehujane 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 ≥ 60%
VEGRAI ecological category = C/D ≥ 60%

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.

IUA11b: GROOT MARICO/ SEASONAL TRIBUTARIES

RU Number	Delineation	Quaternary Catchment
11b_1	Groot Marico main stem, outflow Molatedi Dam, Rasweu, Maselaje rivers	A32D
11b_2	Elandslaagtespruit, Lengope la Kgamanyane, Lenkwane	A32E

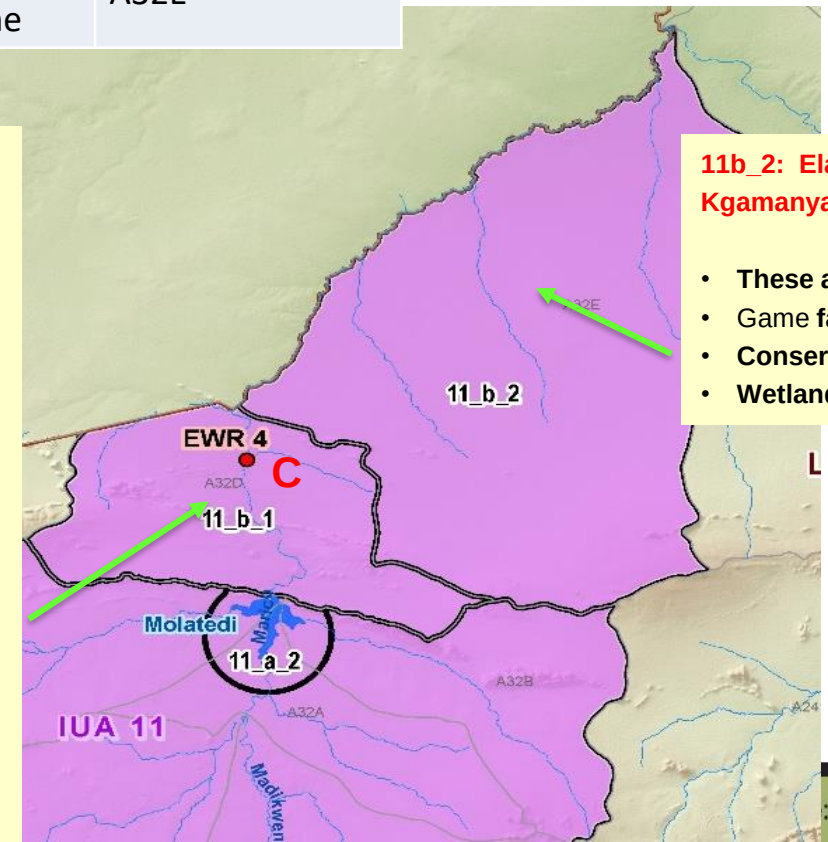
Quaternary Catchments: A32D- A32E

Management Class: III

Ecological Category: C

11b_1: Groot Marico main stem, outflow Molatedi Dam, Rasweu, Maselaje rivers

- **EWR site 4 on the Groot Marico River**
- **Impacts are primarily as a result of the Molatedi Dam upstream and the release pattern from the Tswasa Weir for irrigation purposes.**
- **Tributaries are mostly dry**
- **Recently - no releases made for Botswana.**
- **Flow dependent fish species occur**
- **Riparian zone is heavily grazed.**
- **High sedimentation following rainfall events due to heavy erosion and overgrazing.**
- **Riparian zone and flood plain wetlands present**.



11b_2: Elandslaagtespruit, Lengope la Kgamanyane, Lenkwane

- **These are ephemeral tributaries.**
- Game **farms are present.**
- **Conservation areas.**
- **Wetland areas**

IUA 11b_1: Groot Marico/Seasonal Tributaries RQOs

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 must be met.

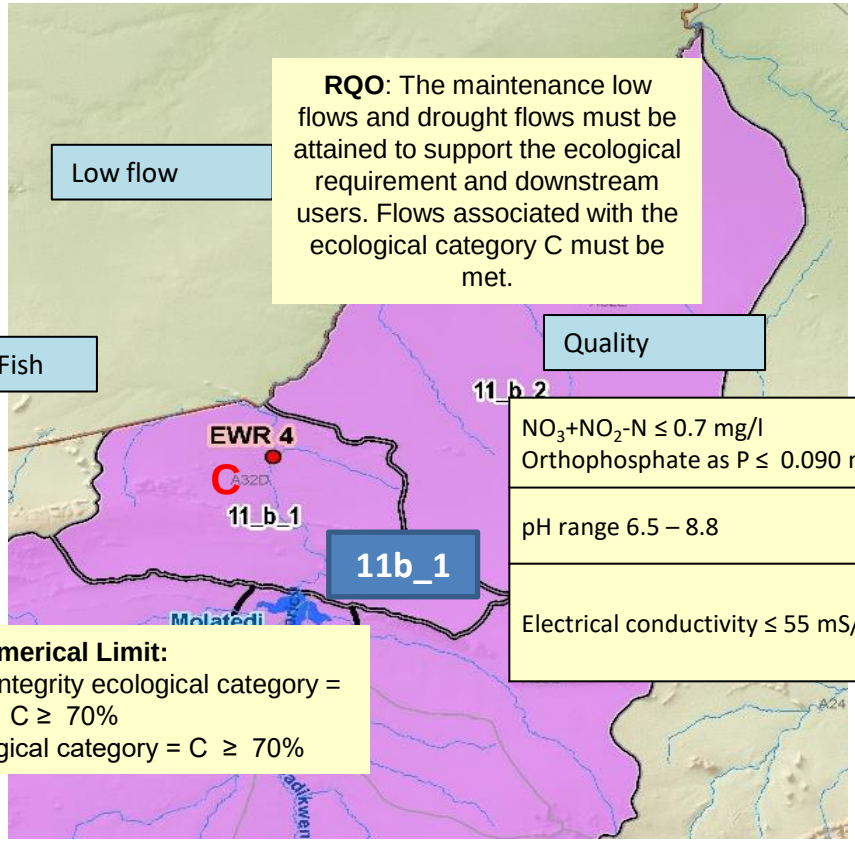
Low flow

Fish

The fish community must be maintained in a C/D ecological category or better. Fishways must be built for migratory species as currently there is no connectivity over numerous weirs.

Numerical Limit:

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



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

Instream and Riparian

Numerical Limit:
Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

Aquatic Invertebrates

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

MIRAI C ecological category ≥ 62%
SASS ≥ 120
ASPT ≥ 4.8

Numerical Limit:
Diatoms
Diatom assemblage must be maintained within a moderately modified condition or improved upon.
EC = ≥ 62%.

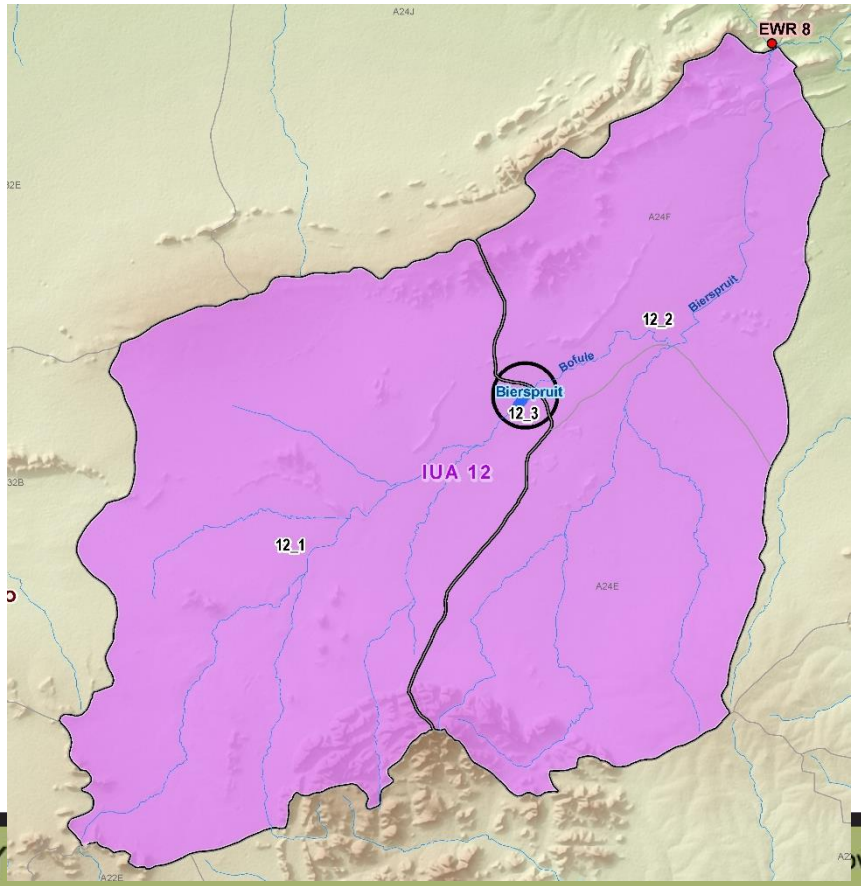
IUA 12: BIERSPRUIT

RU Number	Delineation	Quaternary Catchment
12_1	Wilgespruit, Bofule, Kolobeng, Magoditshane, Motlhabe	A24D
12_2	Bierspruit outflow Bierspruit Dam to confluence with the Crocodile River, Brakspruit, Phufane, Sefatlhane, Lesobeng, lower reach Bofule	A24E, A24F
12_3	Bierspruit Dam	A24D

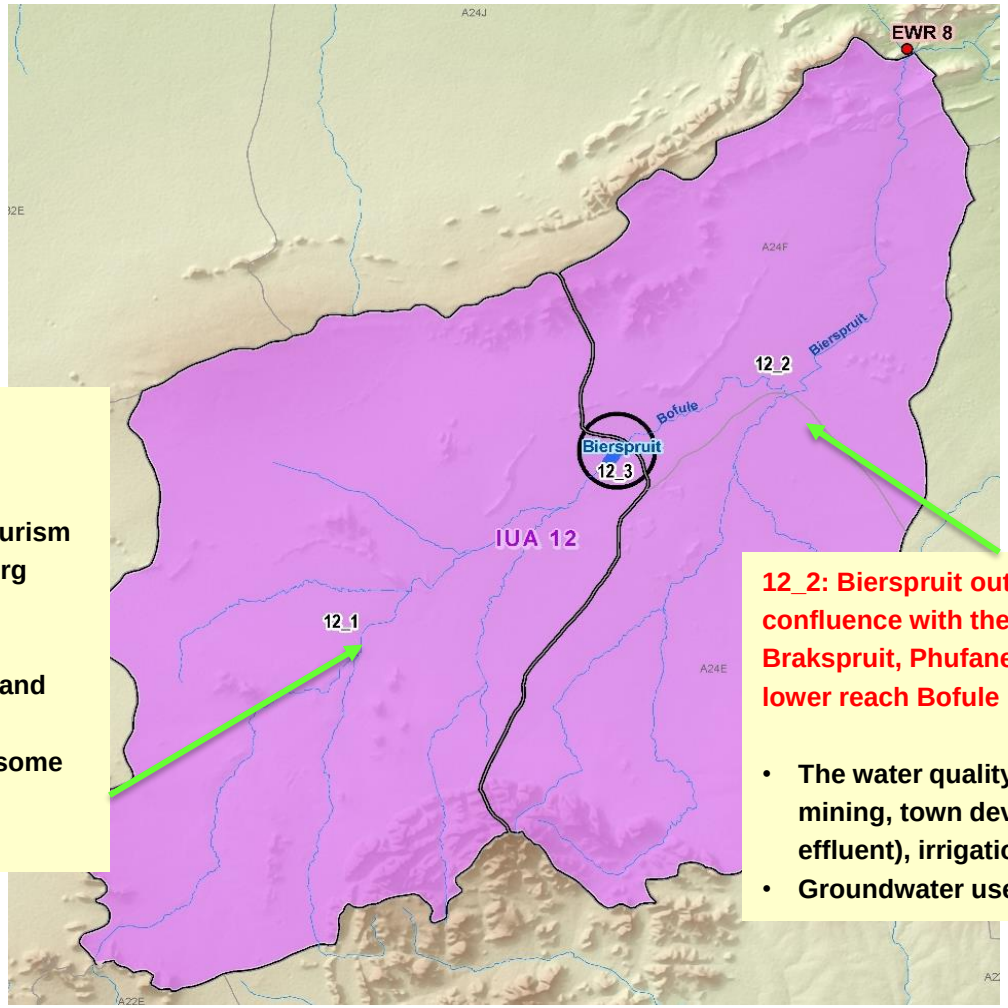
Quaternary Catchments: A24D- A24F

Management Class: III

Ecological Category: D



IUA 12: BIERSPRUIT



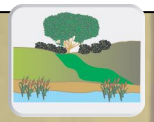
12_1: Wilgespruit, Bofule, Kolobeng, Magoditshane, Motlhabe

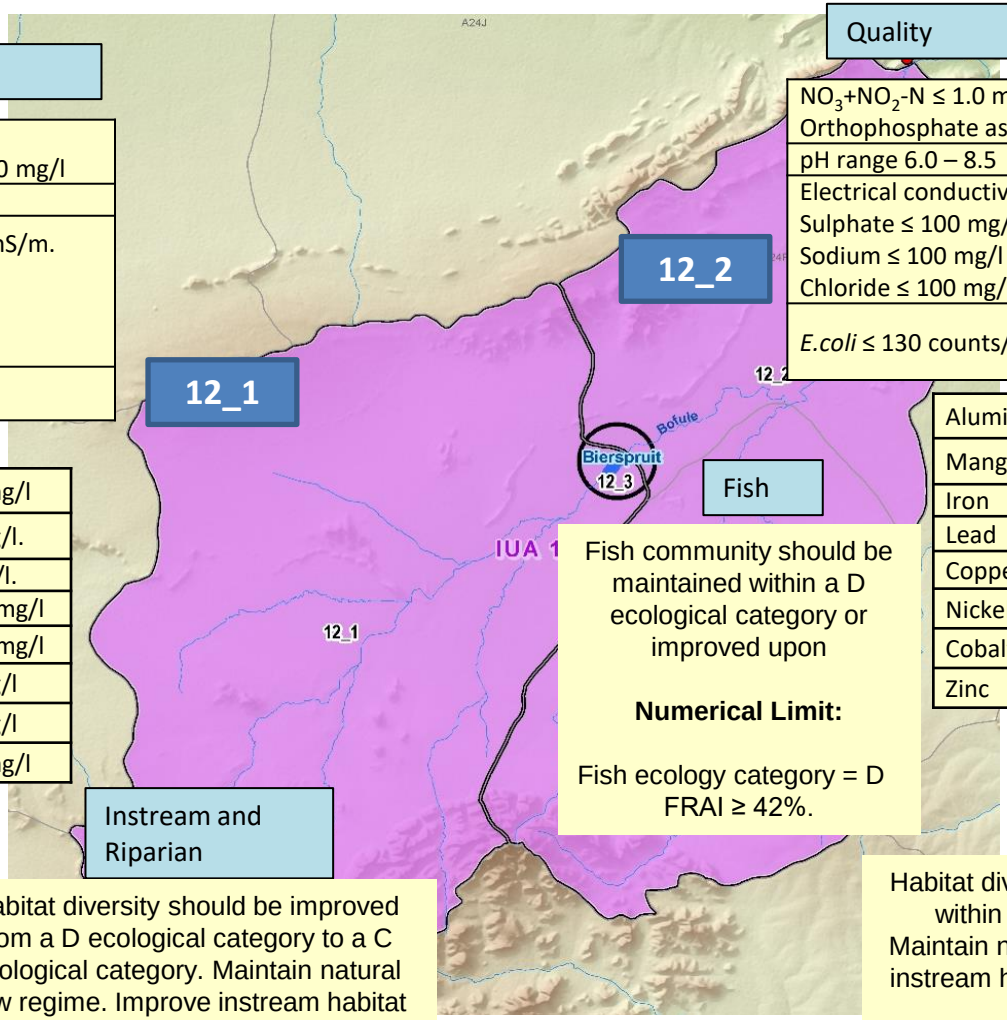
- **Area is very important from an ecotourism point of view (includes the Pilanesberg National Park).**
- **The water quality is degraded due to mining activities, town development and irrigation in the catchment.**
- **Severe water quality impacts on the some of the tributaries, *viz*. Mothlabe and Wilgespruit.**

12_2: Bierspruit outflow Bierspruit Dam to confluence with the Crocodile River, Brakspruit, Phufane, Sefatlhane, Lesobeng, lower reach Bofule

- **The water quality is degraded due to mining, town development (sewage effluent), irrigation and cultivation.**
- **Groundwater use is important in the area..**

IUA 12: Bierspruit
RQOs





Quality

NO_3+NO_2-N ≤ 0.7 mg/l Orthophosphate as P ≤ 0.090 mg/l
pH range 6.0 – 8.5
Electrical conductivity ≤ 55 mS/m. Sulphate ≤ 80 mg/L. Sodium ≤ 70 mg/l Chloride ≤ 40 mg/l
E.coli ≤ 130 counts/100ml

Aluminium	≤ 0.105mg/l
Manganese	≤ 0.37mg/l.
Iron	≤ 0.1 mg/l.
Lead	≤ 0.0095mg/l
Copper	≤ 0.0073mg/l
Nickel	≤ 0.07mg/l
Cobalt	≤ 0.05mg/l
Zinc	≤ 0.002mg/l

Fish

Fish community should be improved from a D ecological category to a C/D category. Maintain natural flow regime. Improve instream habitat and velocity/depth for fish diversity.

Numerical Limit:

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

Instream and Riparian

Habitat diversity should be improved from a D ecological category to a C ecological category. Maintain natural flow regime. Improve instream habitat and velocity/depth for fish diversity.

Numerical Limit:

Instream Habitat Integrity ecological category = C ≥ 70%

VEGRAI ecological category = C ≥ 70%

Quality

NO_3+NO_2-N ≤ 1.0 mg/l Orthophosphate as P ≤ 0.125 mg/l
pH range 6.0 – 8.5
Electrical conductivity ≤ 85 mS/m. Sulphate ≤ 100 mg/L. Sodium ≤ 100 mg/l Chloride ≤ 100 mg/l
E.coli ≤ 130 counts/100ml

Aluminium	≤ 0.1mg/l
Manganese	≤ 0.37mg/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

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. Maintain natural flow regime. Improve instream habitat and velocity/depth for fish diversity.

Numerical Limit:

Instream Habitat Integrity ecological category = D ≥ 50%

VEGRAI ecological category = D ≥ 50%

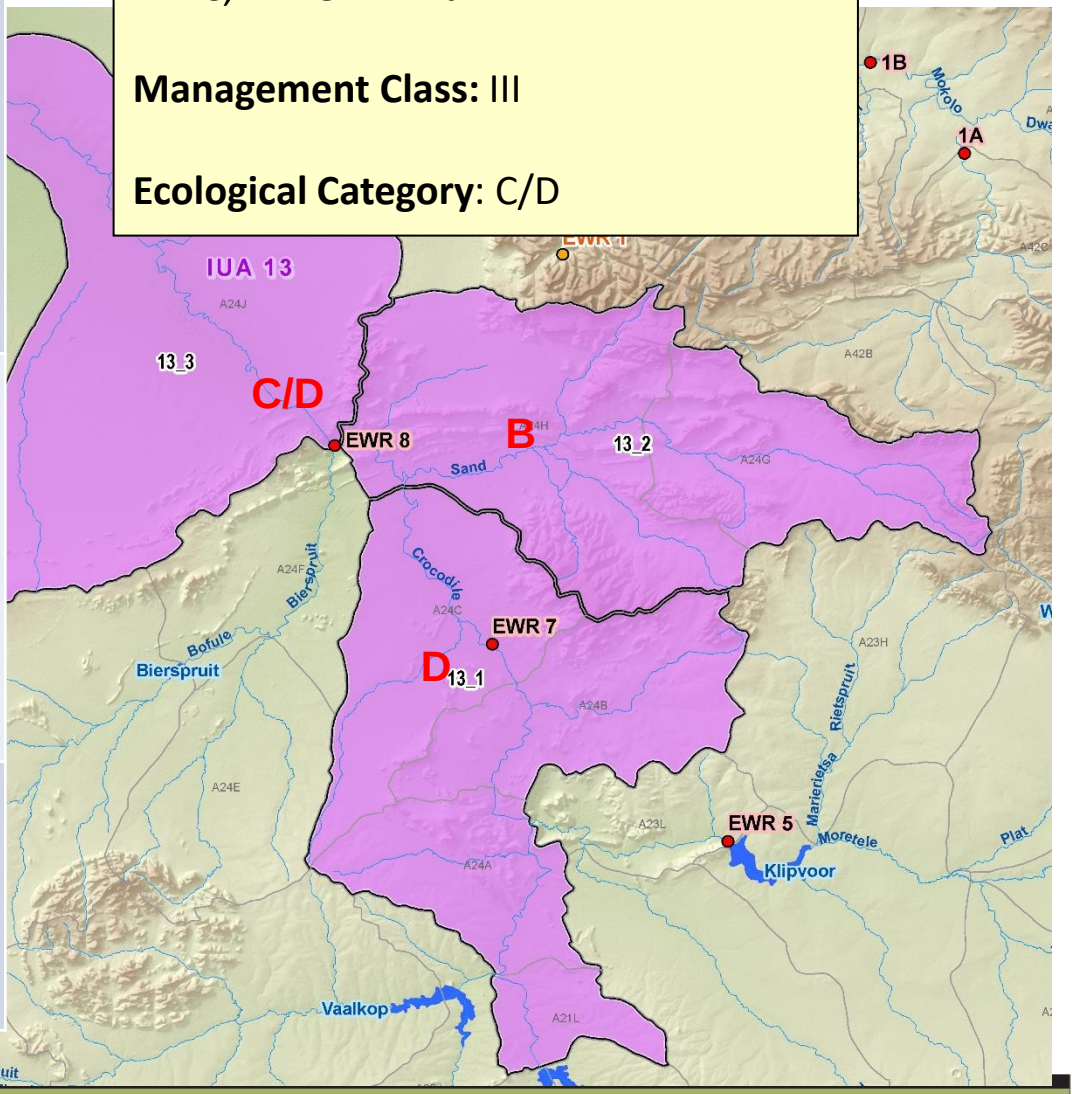
IUA 13: LOWER CROCODILE

RU Number	Delineation	Quaternary Catchment
13_1	Crocodile River outflow Roodekopjes Dam to upstream Sand River confluence, Sleepfonteinspruit, Klipspruit tributaries	A21L, A24A, A24B, A24C
13_2	Sand River to confluence with the Crocodile River to Bierspruit confluence, Sondags, Vaalwaterspruit and Monyagole tributaries	A24G, A24H
13_3	Lower Crocodile from Bierspruit confluence to the Botswana border (Limpopo River)	A24J

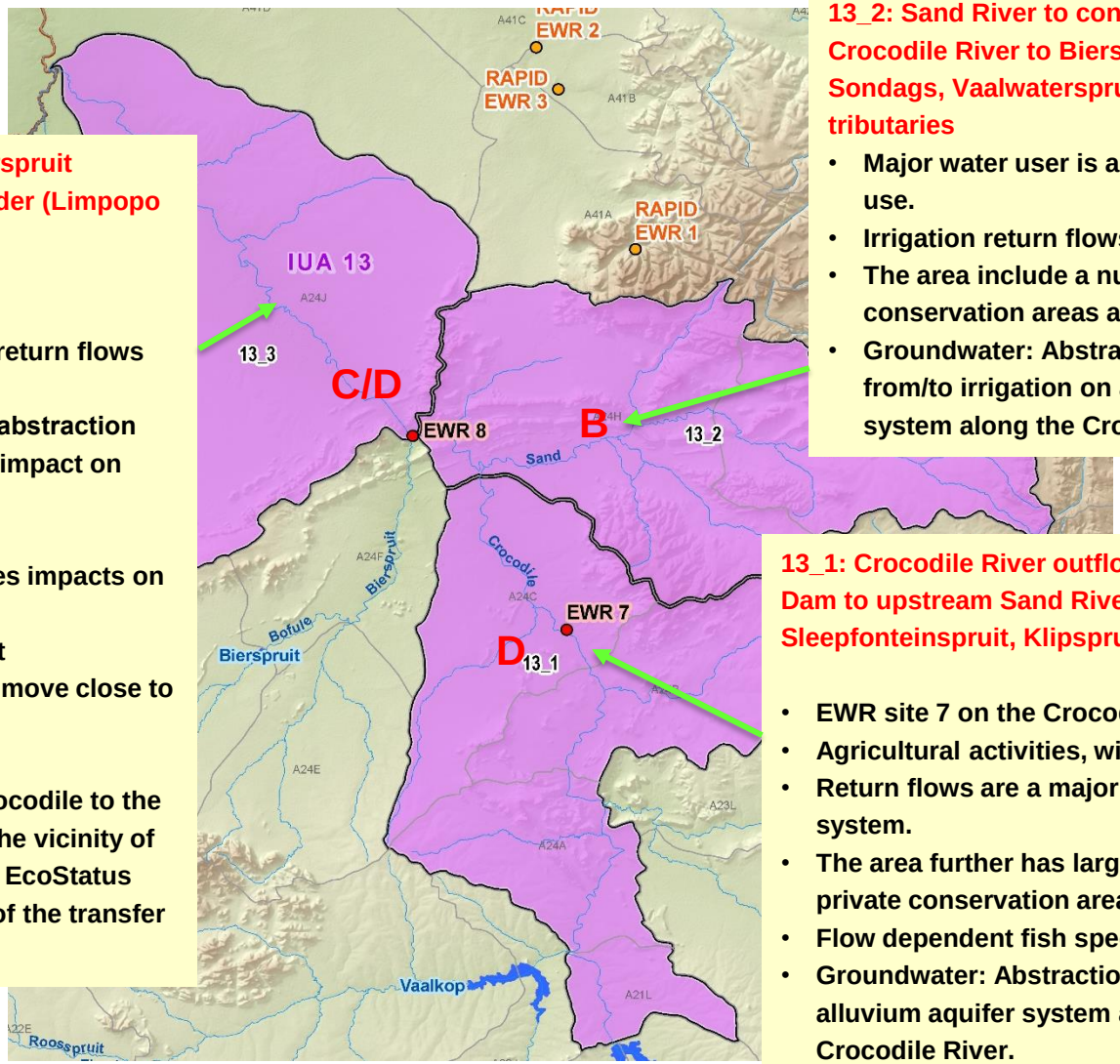
Quaternary Catchments: A21L, A24A – A24C, A24G – A24J

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 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%.

Numerical Limit:

MIRAI = C/D ecological category ≥ 58%

SASS ≥ 120

ASPT ≥ 5.0

Pesticides

Atrazine	≤0.078 mg/l
Mancozeb	0.009 mg/l
Glyphosate	0.7 mg/l
Endosulfan	0.13 ug/l

Instream and Riparian

Numerical Limit:

Instream Habitat Integrity ecological category = C/D ≥ 60%

VEGRAI ecological category = C/D ≥ 60%

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%.

Numerical Limit:

MIRAI = D ecological category ≥ 42%

SASS ≥ 60

ASPT ≥ 4.5

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:

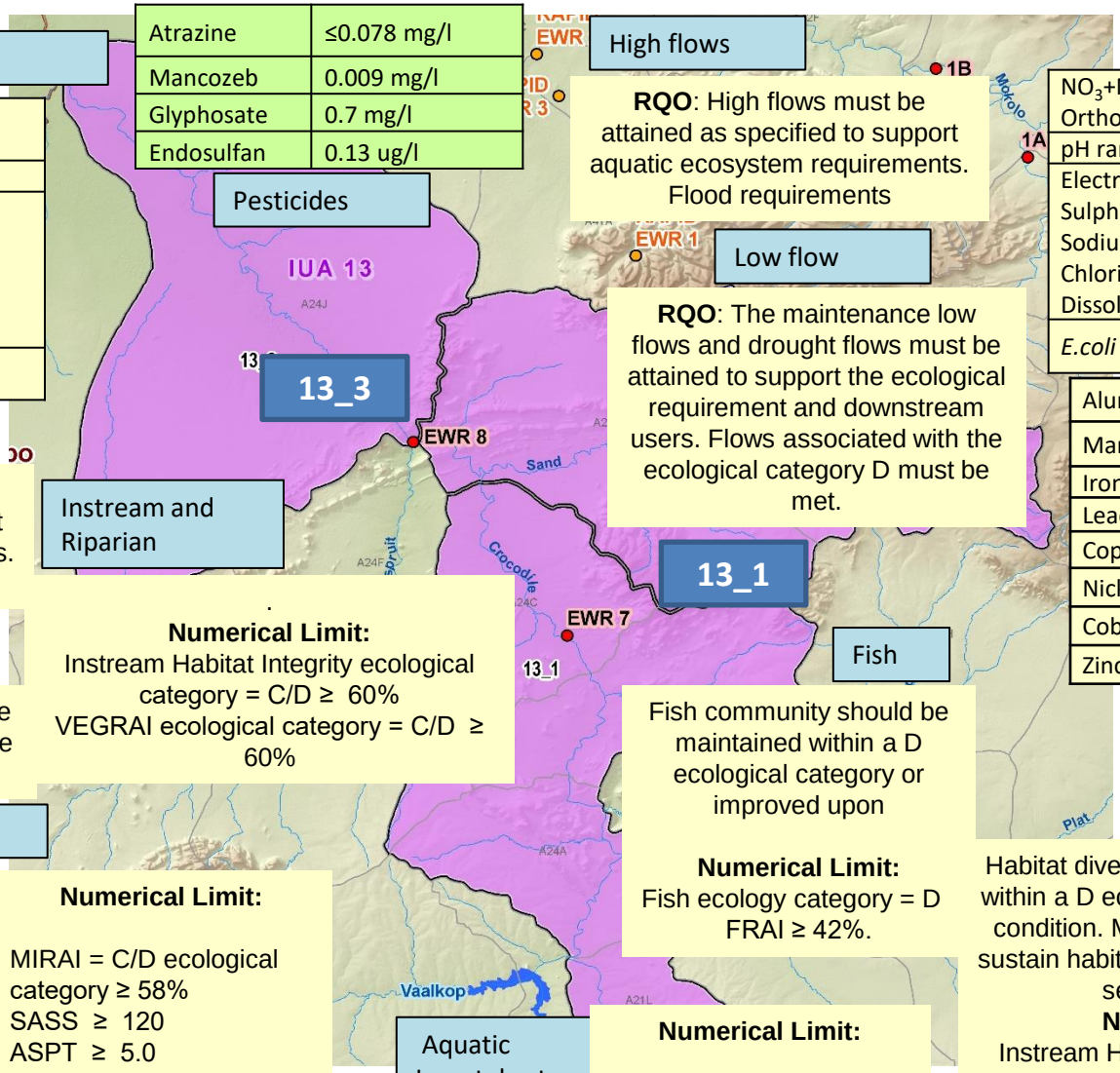
Instream Habitat Integrity ecological category = D ≥ 50%

VEGRAI ecological category = D ≥ 50%

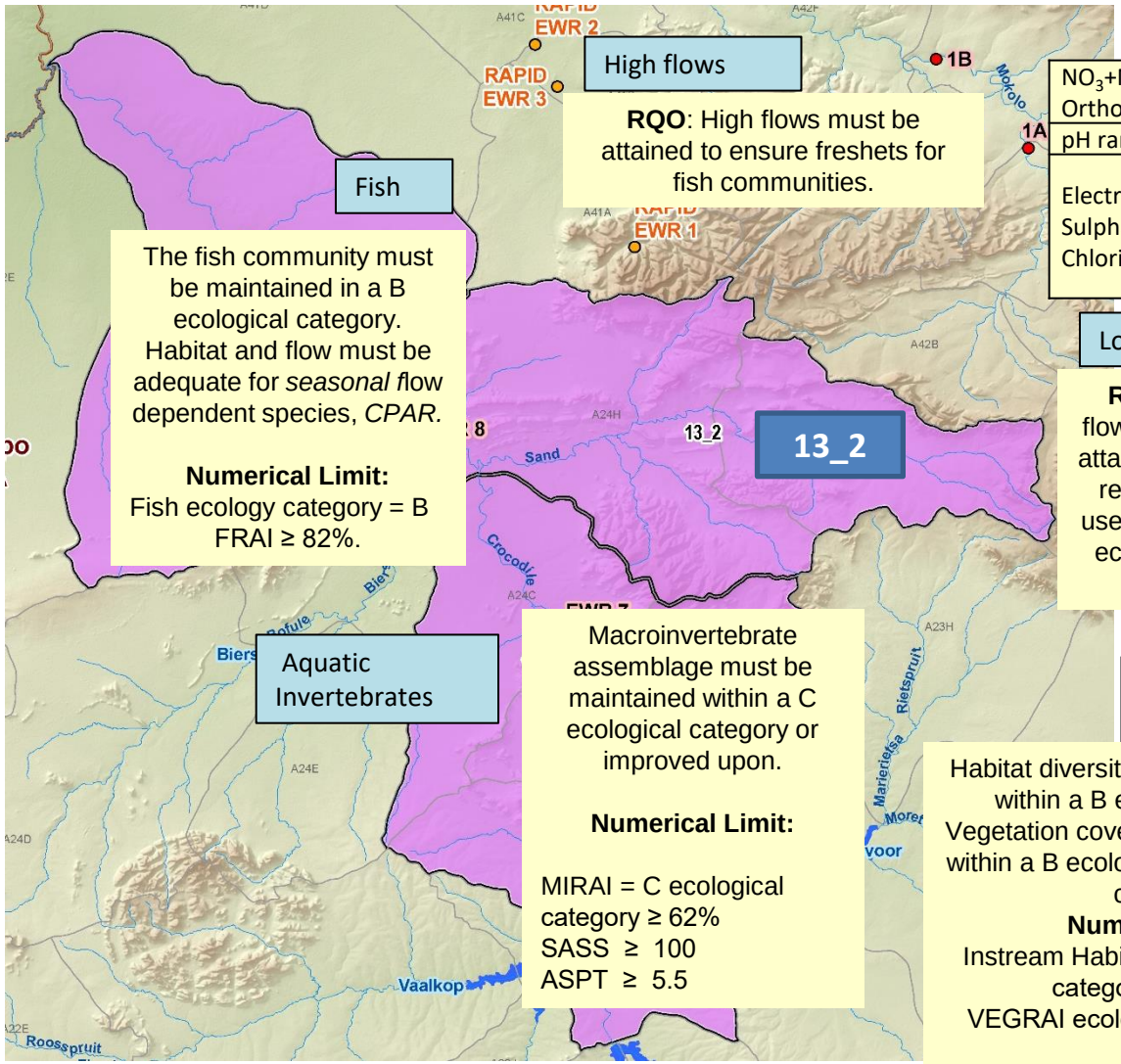
Quality

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	≤ 0.37mg/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
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.

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.

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%.

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%

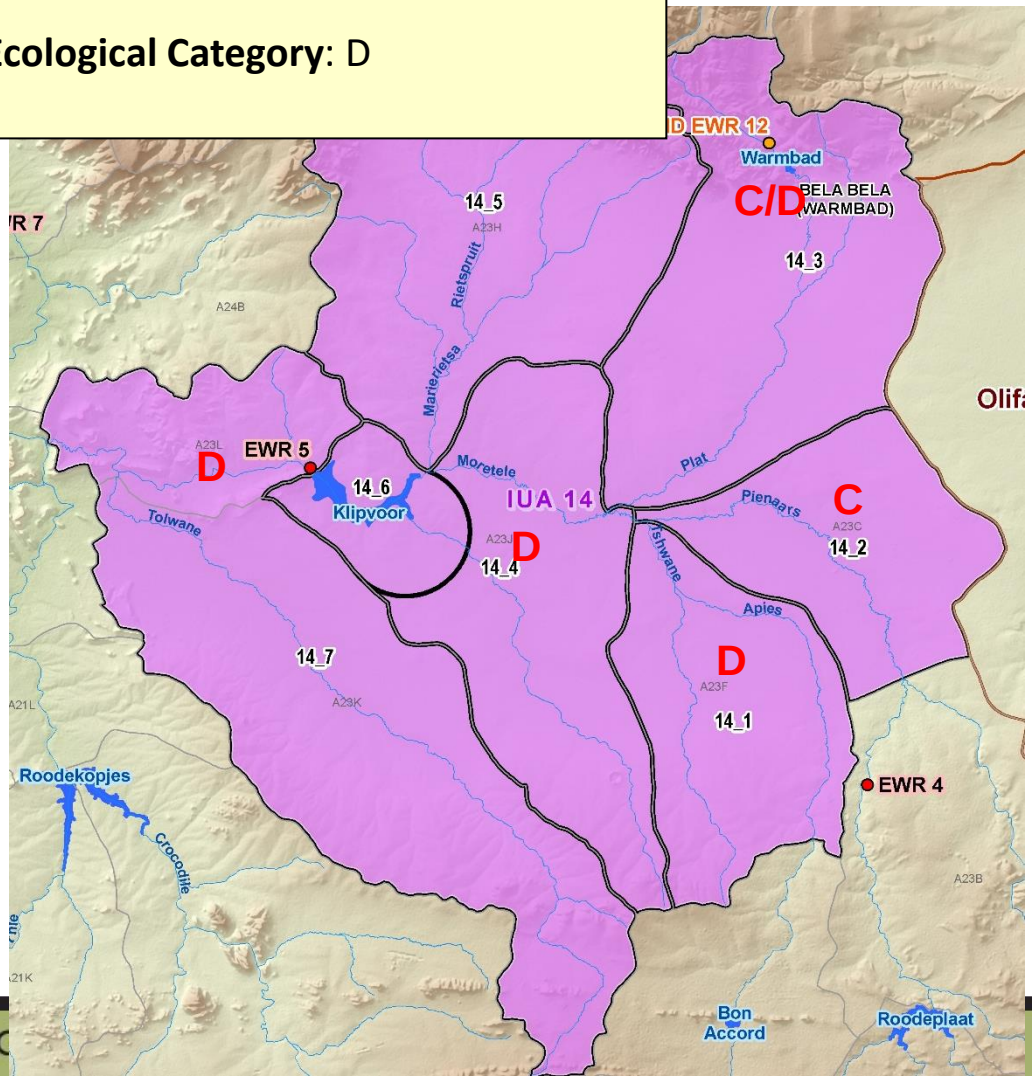
IUA 14: TOLWANE/KULWANE/MORETELE/KLIPVOOR

RU Number	Delineation Description	Quaternary Catchment
14_1	Apies River, Tshwane tributary	A23F
14_2	Pienaars River from Boekenshout confluence to Apies River confluence	A23C
14_3	Plat River	A23G
14_4	Moretele (Pienaars) River from Plat River confluence to Klipvoor Dam, Kutswane to Klipvoor Dam	A23J
14_5	Rietspruit and all tributaries	A23H
14_6	Klipvoor Dam	A23J
14_7	Pienaars River from Klipvoor Dam to Crocodile River confluence, Tolwane tributary	A23K, A23L

Quaternary Catchments: A23F – A23L

Management Class: III

Ecological Category: D



IUA 14: TOLWANE/KULWANE/MORETELE/KLIPVOOR

14_6: Klipvoor Dam

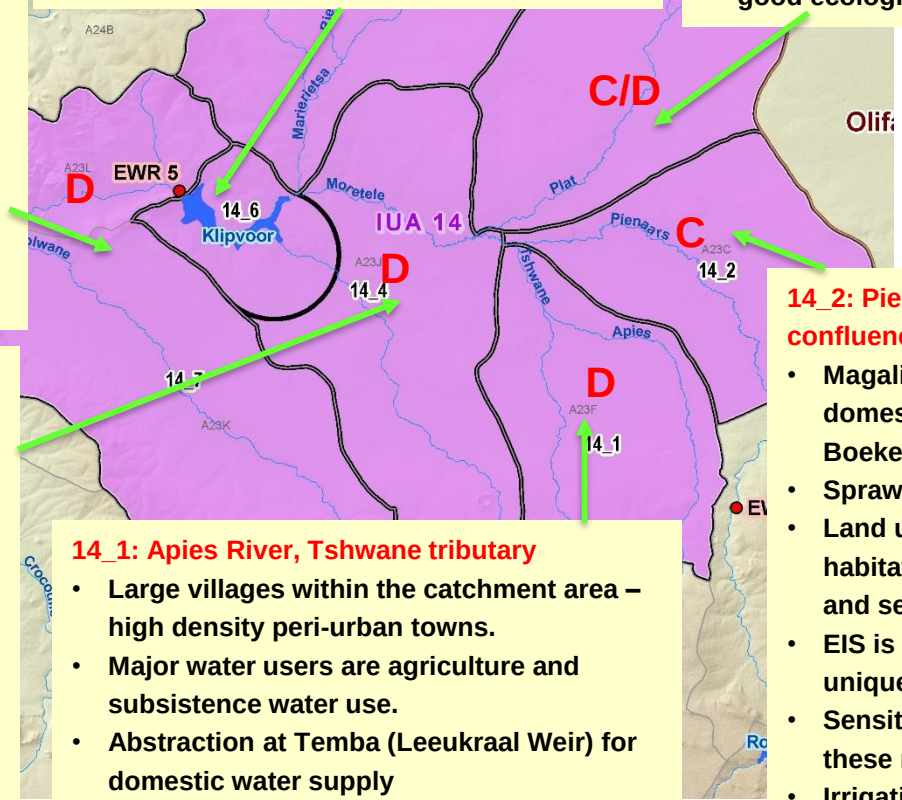
- Dam supports some recreational activities (local angling) and is located within the Borakalalo National Park.
- Dam habitat functions as a fish refugia. Will Support future domestic water supply to Bela Bela, Madibeng.
- Impacted by nutrients (high algal growth).

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.
- Introduced artificial fly fishing downstream of the dam due to the *LMAR* - flow management required to support this.
- 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.

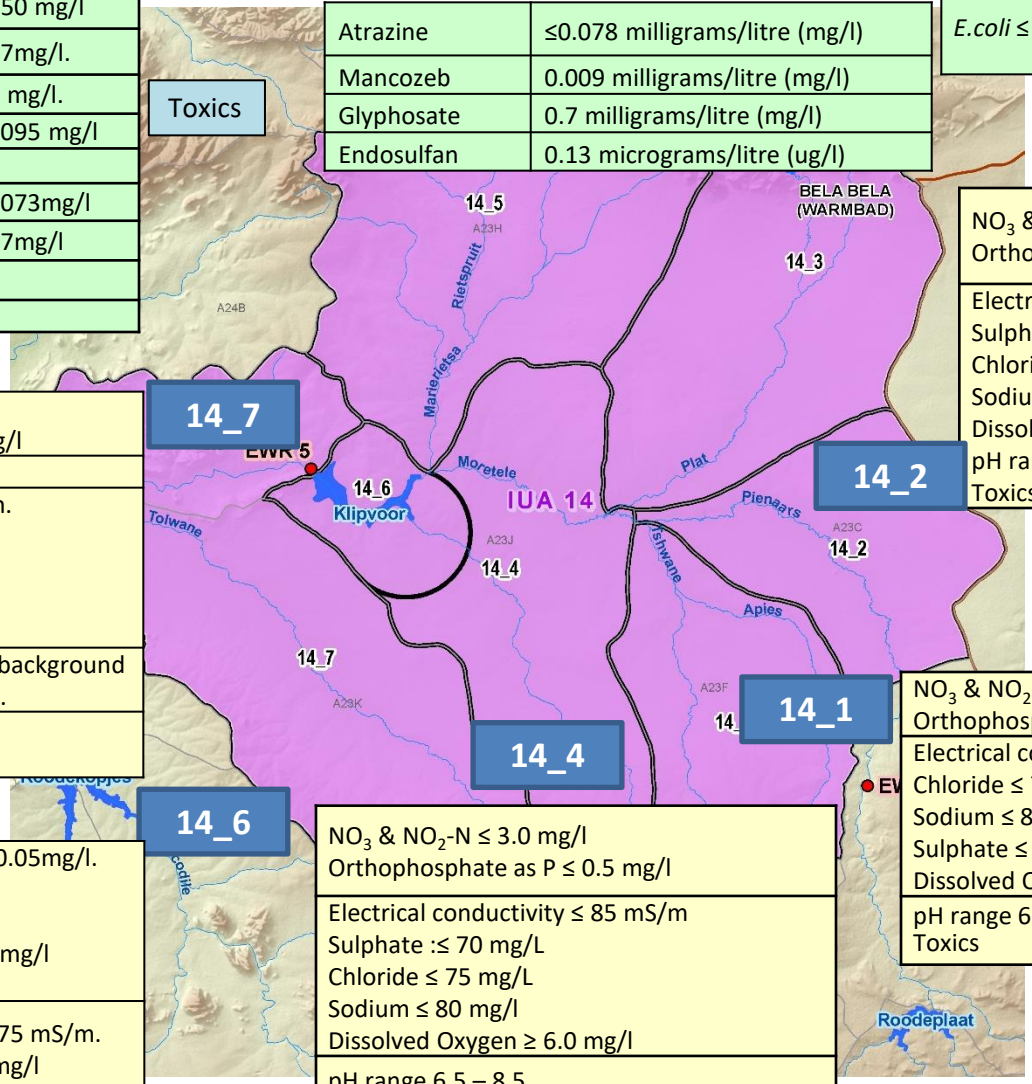
IUA 14: Tolwane/Kulwane/Moretele/Klipvoor
RQOs QUALITY

Ammonia as N	≤ 0.0725mg/l	≤ 0.100 mg/l
Aluminium	≤ 0.062 mg/l	≤ 0.150 mg/l
Manganese	≤ 0.37mg/l.	≤ 0.37mg/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	≤ 0.0073mg/l
Nickel	≤ 0.07mg/l	≤ 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)

E.coli ≤ 130 counts/100ml **All RUs**



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

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

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

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

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

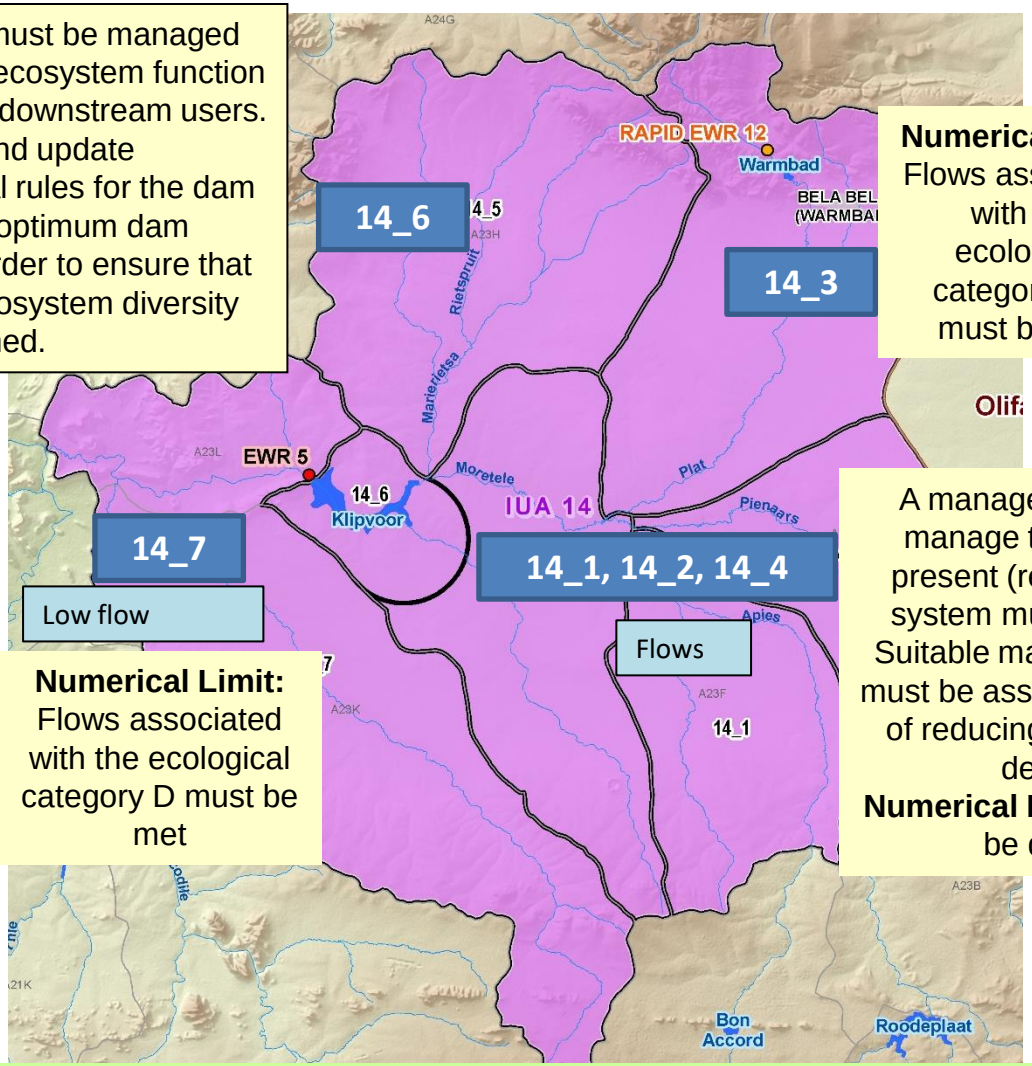
pH range 6.5 – 8.5

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

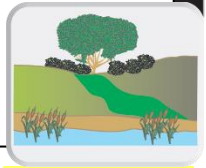
Numerical Limit: Flows associated with the ecological category D must be met

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.

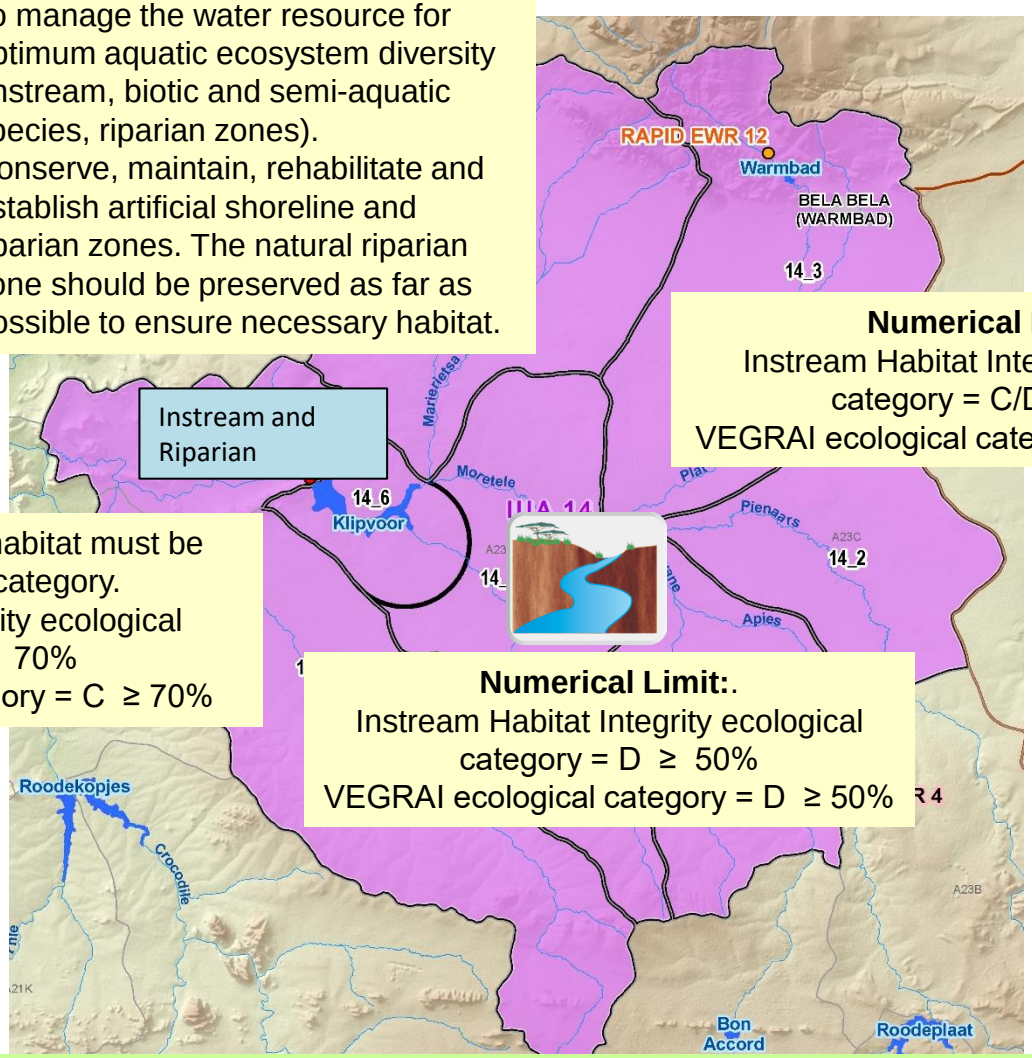
IUA 14: Tolwane/Kulwane/Moretele/Klipvoor
RQOs HABITAT – INSTREAM AND RIPARIAN



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.



Numerical Limit:.
Instream Habitat Integrity ecological category = C/D ≥ 60%
VEGRAI ecological category = C/D ≥ 60%

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

Numerical Limit:.
Instream Habitat Integrity ecological category = D ≥ 50%
VEGRAI ecological category = D ≥ 50%

RQOs (Narrative)

Instream: Habitat diversity should be improved to a D ecological category. Maintain good low flows to sustain habitat for substrate sensitive species

Riparian: Vegetation cover should be maintained within a D ecological category or better condition. Maintain riparian zone in cultivated (subsistence) areas..

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

Fish

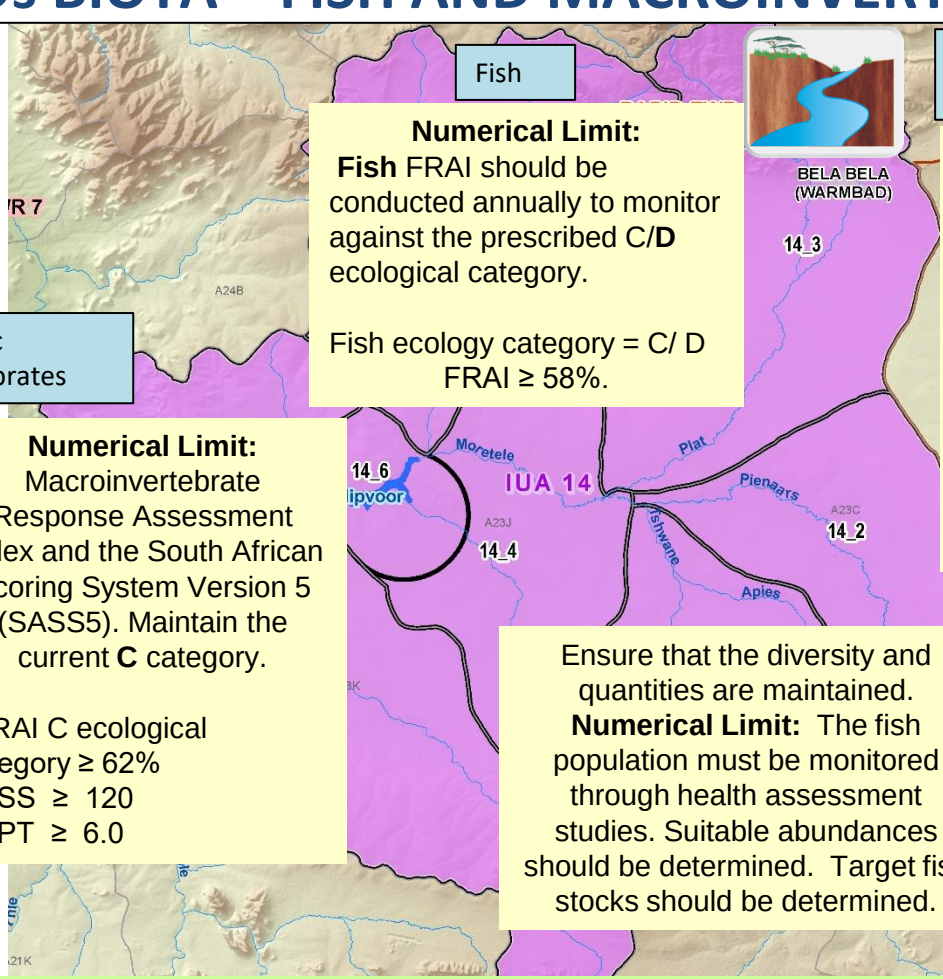
Numerical Limit:
Fish The fish community should be managed to a recommended ecological category of **C.**
FRAI should be conducted to monitor against current category.

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..

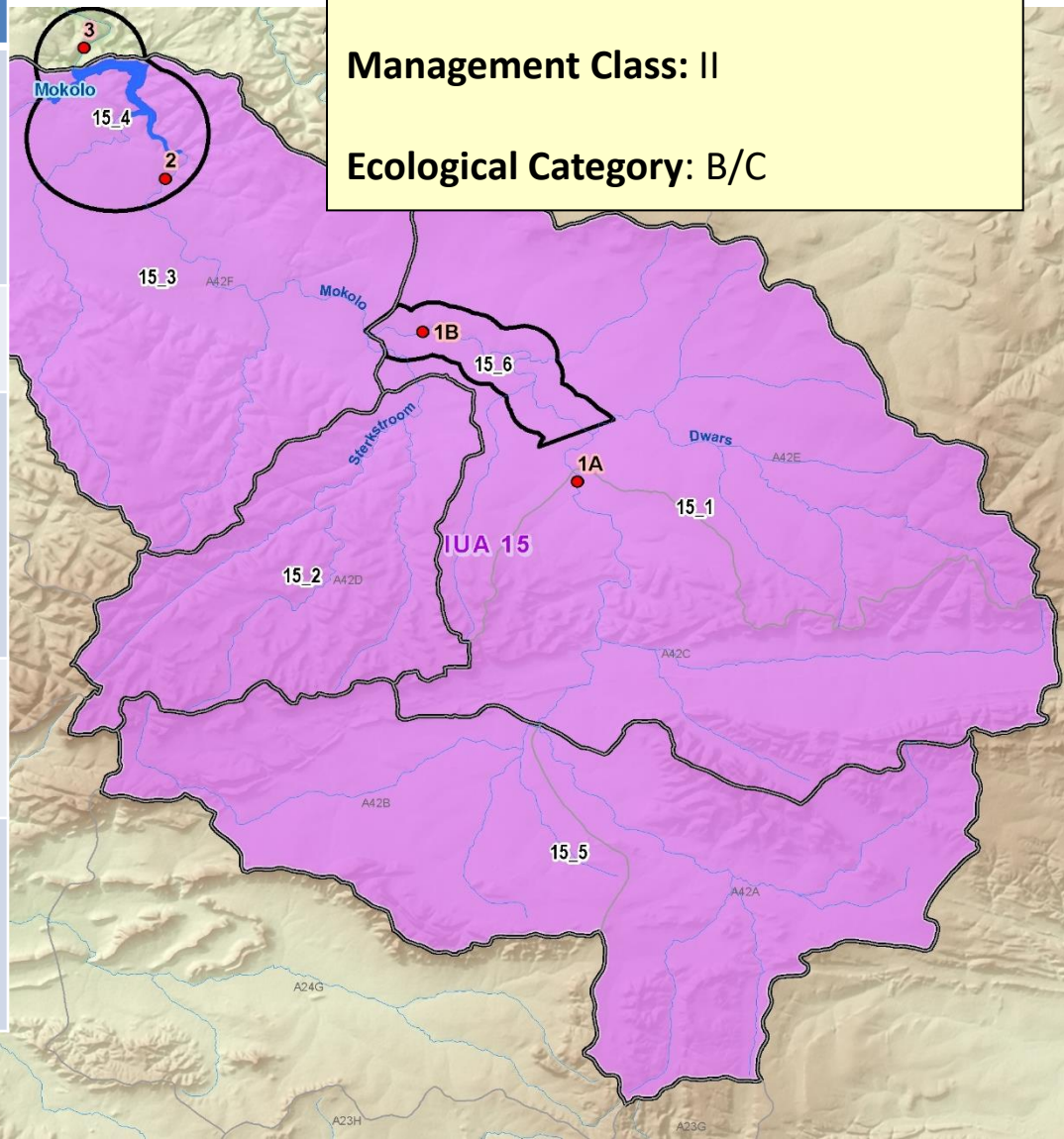
IUA 15: UPPER MOKOLO

RU Number	Delineation	Quaternary Catchment
15_1	Moloko River, Klein Sand, Sondagsloop, Heuningspruit, Dwars, Jim se loop tributaries	A42C, A42E
15_2	Sterkstroom, Frikkie-se-Loop	A42D, A42E
15_3	Mokolo River in A42F to inflow Mokolo Dam, Taaibosspruit, Malmanies and Bulspruit tributaries	A42F
15_4	Mokolo Dam to upper portion of A42G (10km downstream of dam)	A42F
15_5	Grootspruit and Sandspruit tributaries (Mokolo headwater catchment)	A42A, A42B

Quaternary Catchments: A42A – A42F

Management Class: II

Ecological Category: B/C



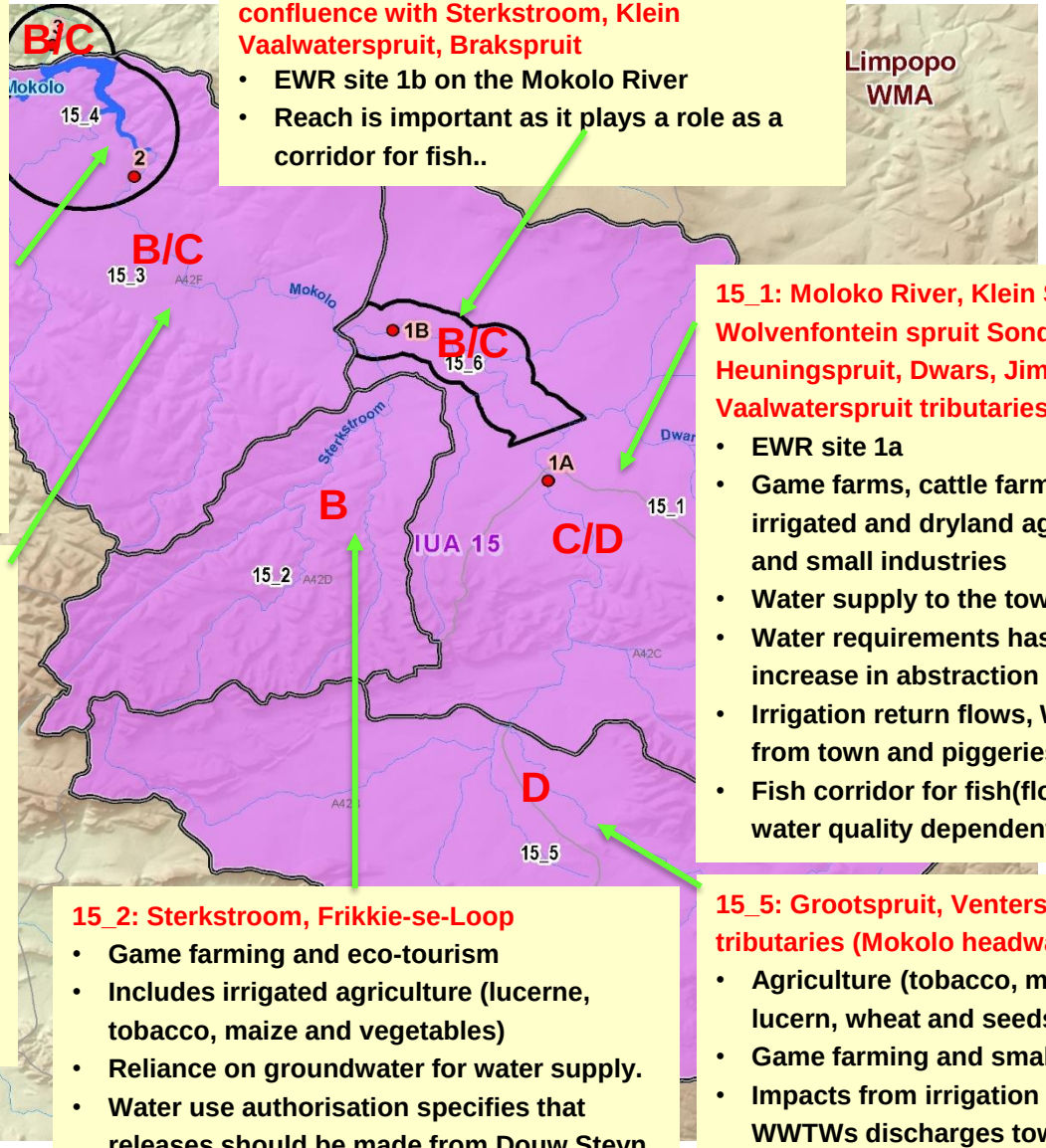
IUA 15: UPPER MOKOLO

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.

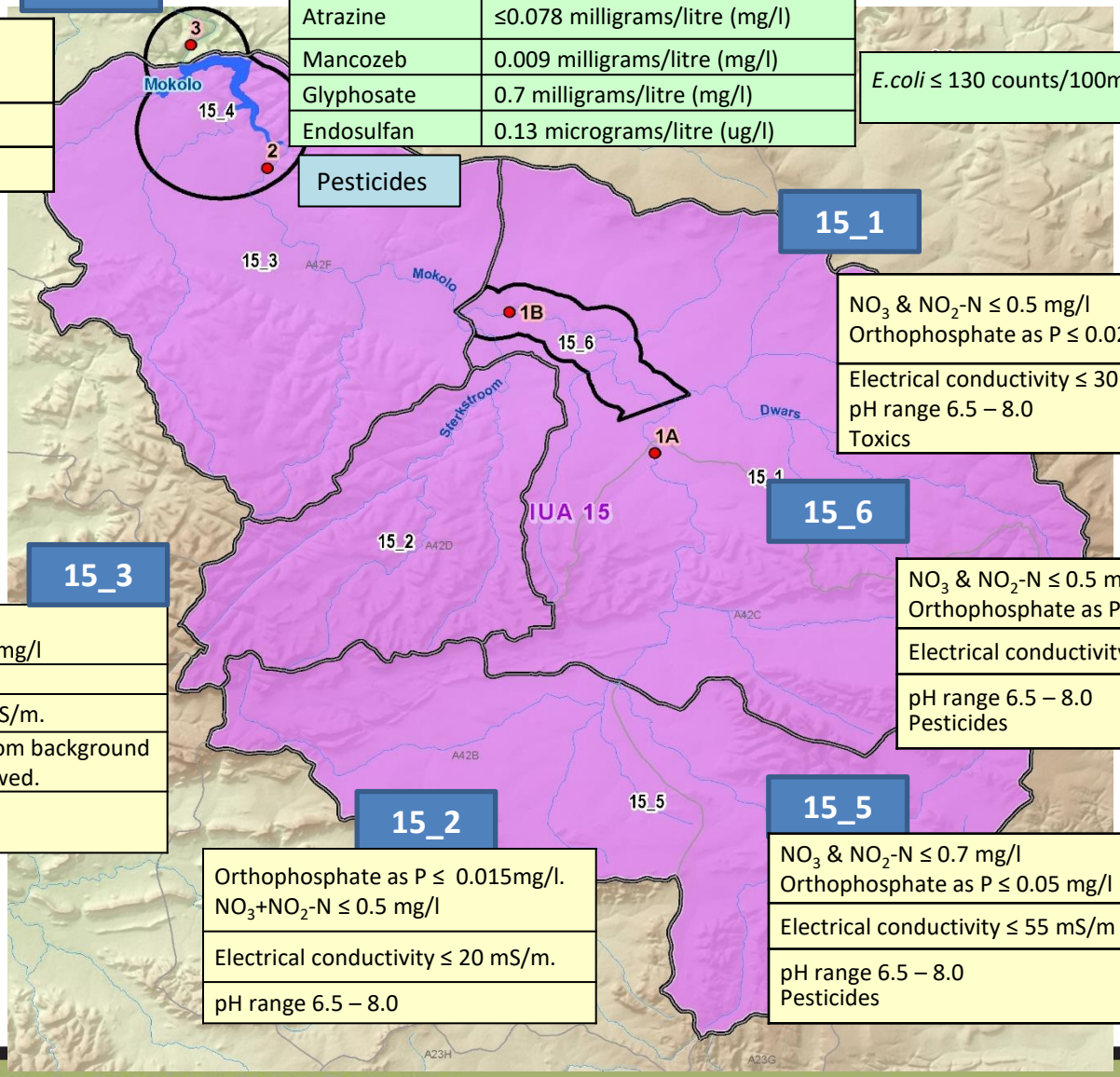
15_2: Sterkstroom, Frikkie-se-Loop

- 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

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)

Pesticides

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

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

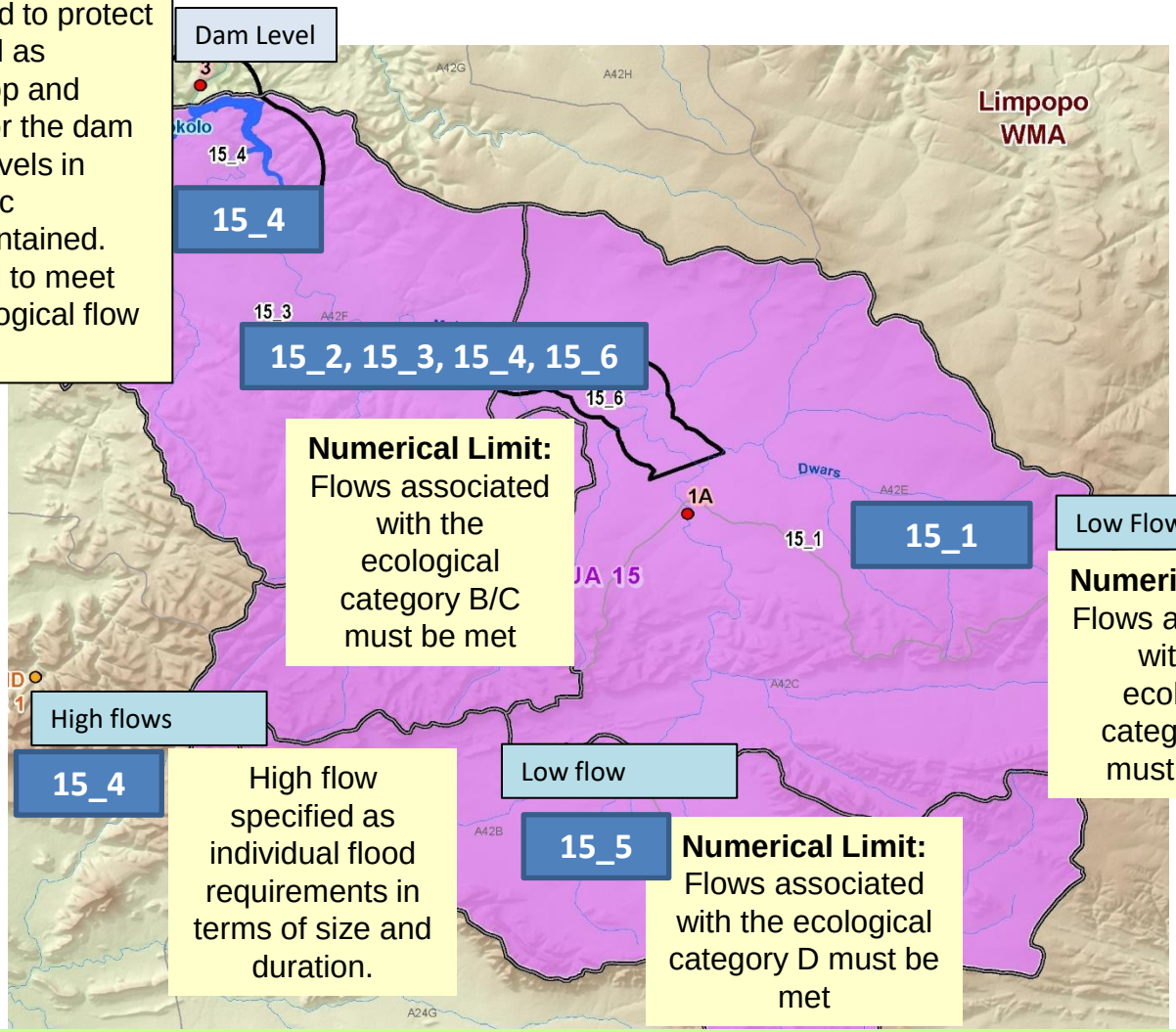
Electrical conductivity ≤ 55 mS/m

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

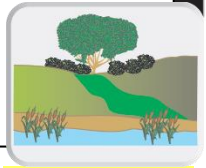


RQOs: FLOWS

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

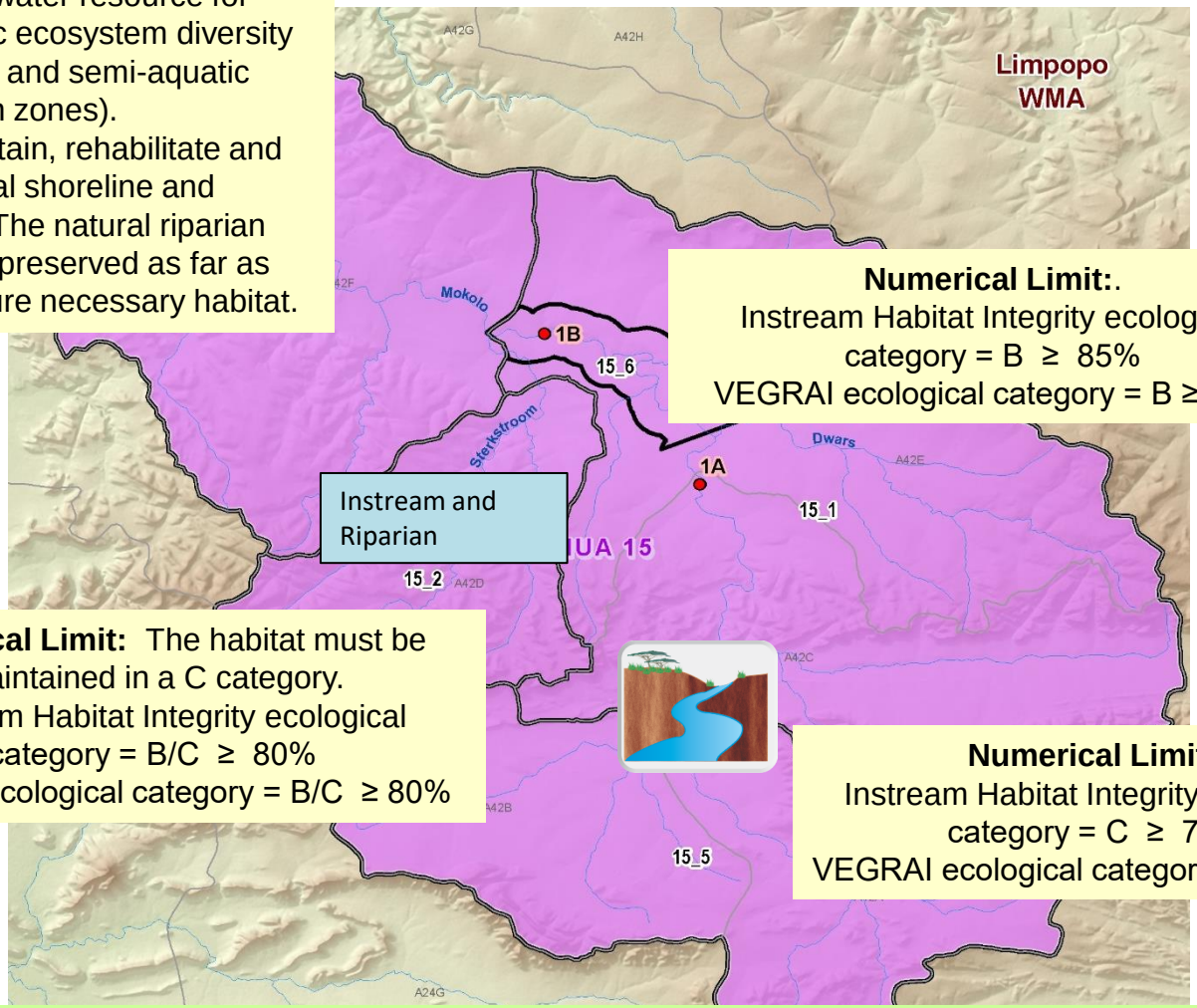
IUA 15: Upper Mokolo
RQOs HABITAT – INSTREAM AND RIPARIAN



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.



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

Instream and Riparian

Numerical Limit: The habitat must be maintained in a C category.
Instream Habitat Integrity ecological category = B/C ≥ 80%
VEGRAI ecological category = B/C ≥ 80%

Numerical Limit:.
Instream Habitat Integrity ecological category = C ≥ 70%
VEGRAI ecological category = C ≥ 70%

RQOs (Narrative)

Instream: Habitat diversity should be improved from a C/D ecological to a B/C category. Good low flows must be maintained to sustain habitat for substrate and habitat sensitive species.
Riparian: Vegetation cover must be improved from C/D to a C category
Riparian: Vegetation cover should be maintained within a B/C ecological category or better condition.

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

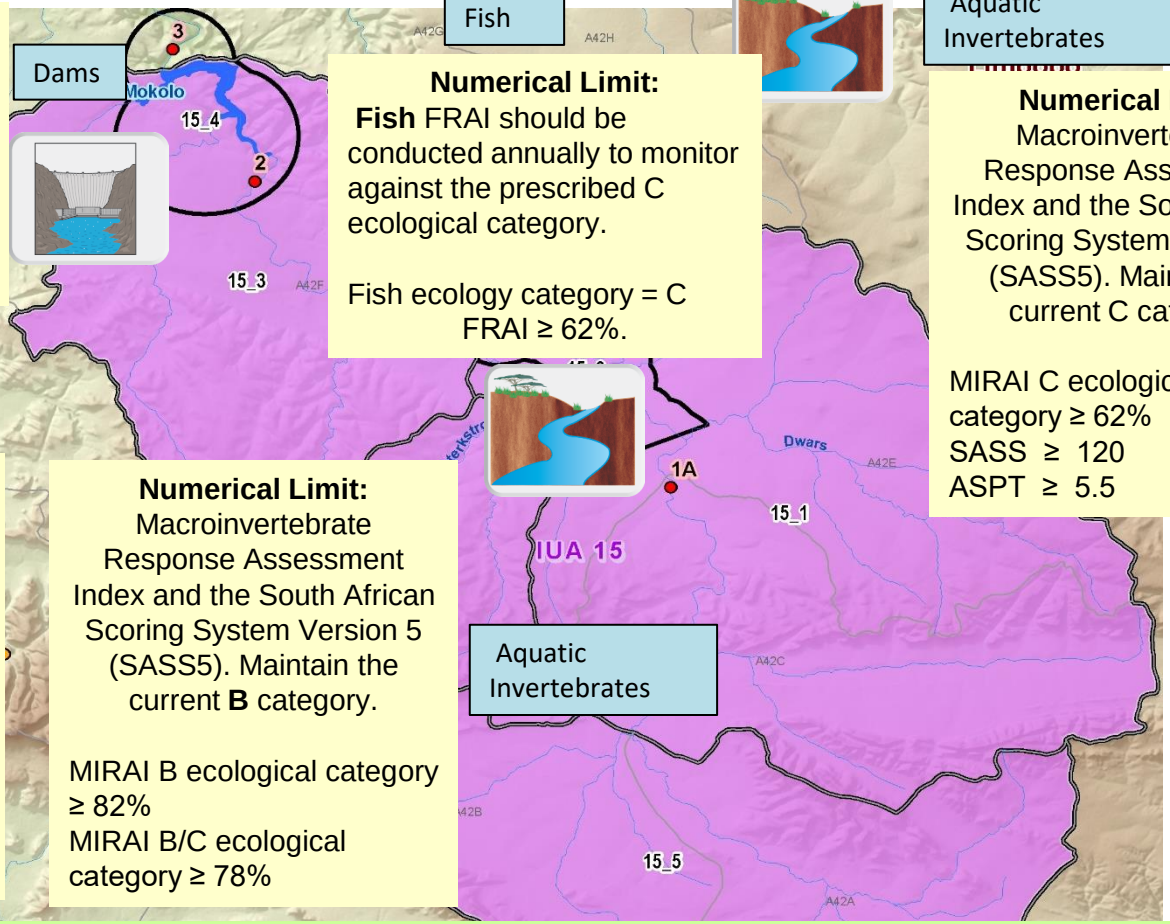
Numerical Limit:
Fish FRAI should be conducted annually to monitor against the prescribed C ecological category.

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

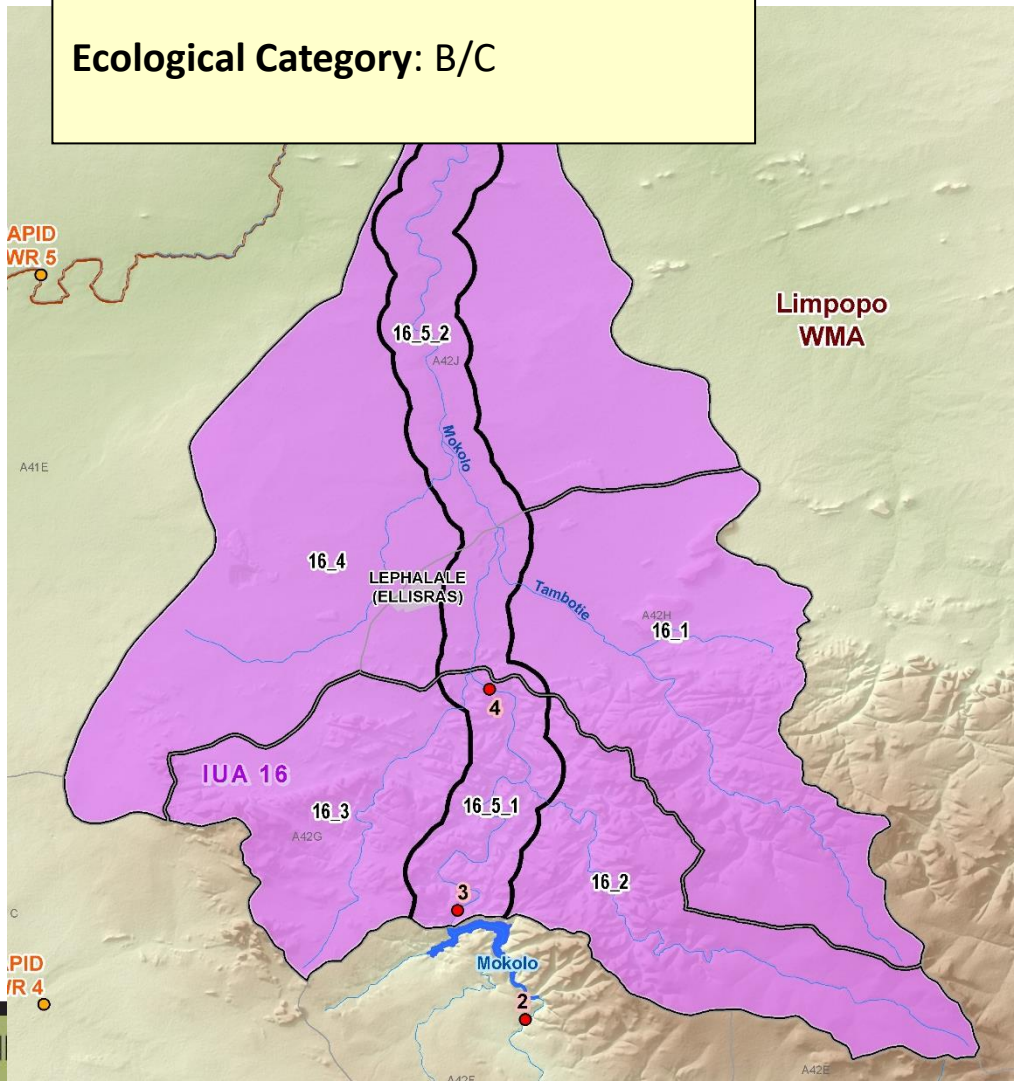
IUA 16: LOWER MOKOLO

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



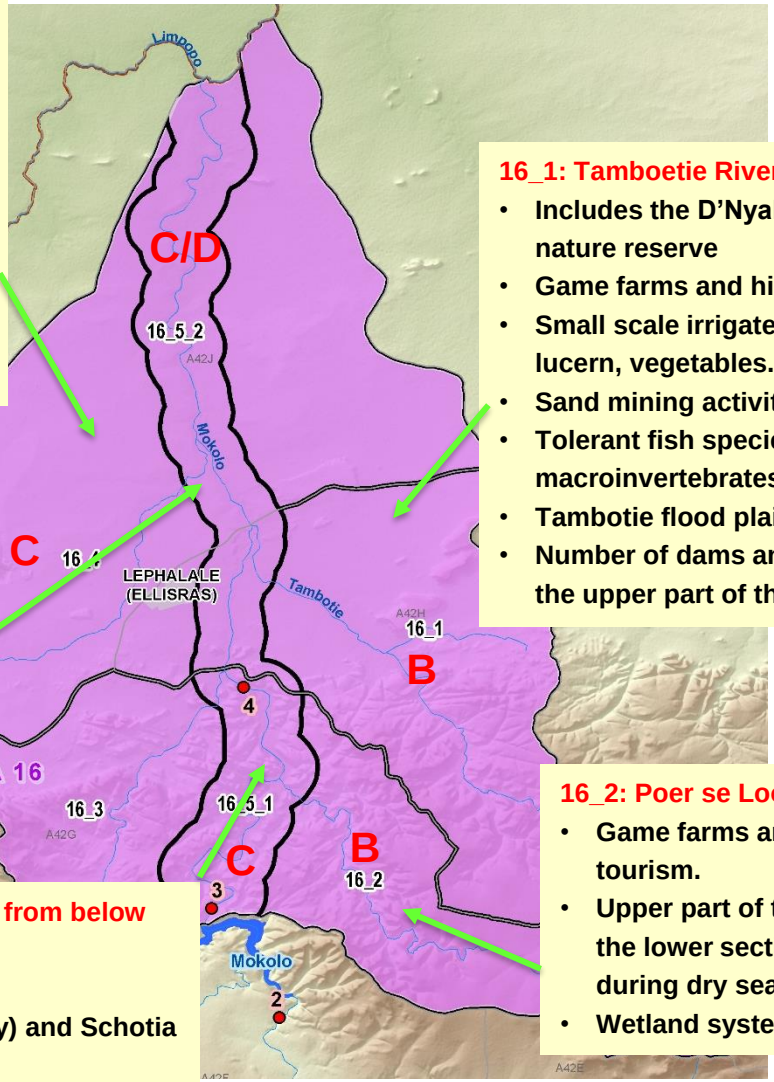
IUA 16: LOWER MOKOLO

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, with 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 considerable issue in the Lepahlale area.
- Irrigated agriculture, game farms and eco-tourism.
- Flow dependent fish occur (BMAR, LMOL).
- Oxbow lakes.
- 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

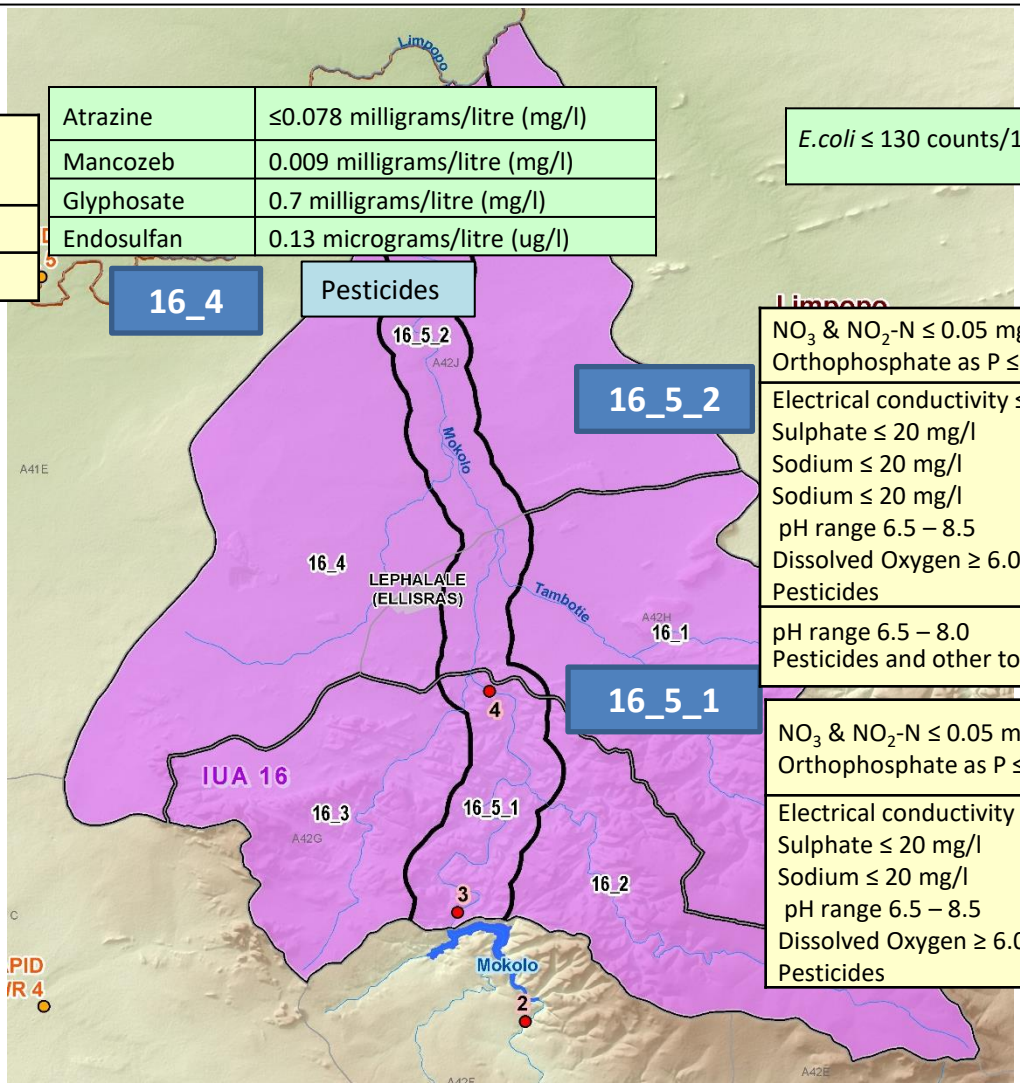
NO_3 & NO_2-N ≤ 0.1 mg/l Orthophosphate as P ≤ 0.050 mg/l	
Electrical conductivity ≤ 55 mS/m	
pH range 6.5 – 8.5	

Aluminium	≤ 0.062 mg/l
Manganese	≤ 0.37mg/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)
Mancozeb	0.009 milligrams/litre (mg/l)
Glyphosate	0.7 milligrams/litre (mg/l)
Endosulfan	0.13 micrograms/litre (ug/l)

E.coli ≤ 130 counts/100ml **All RUs**

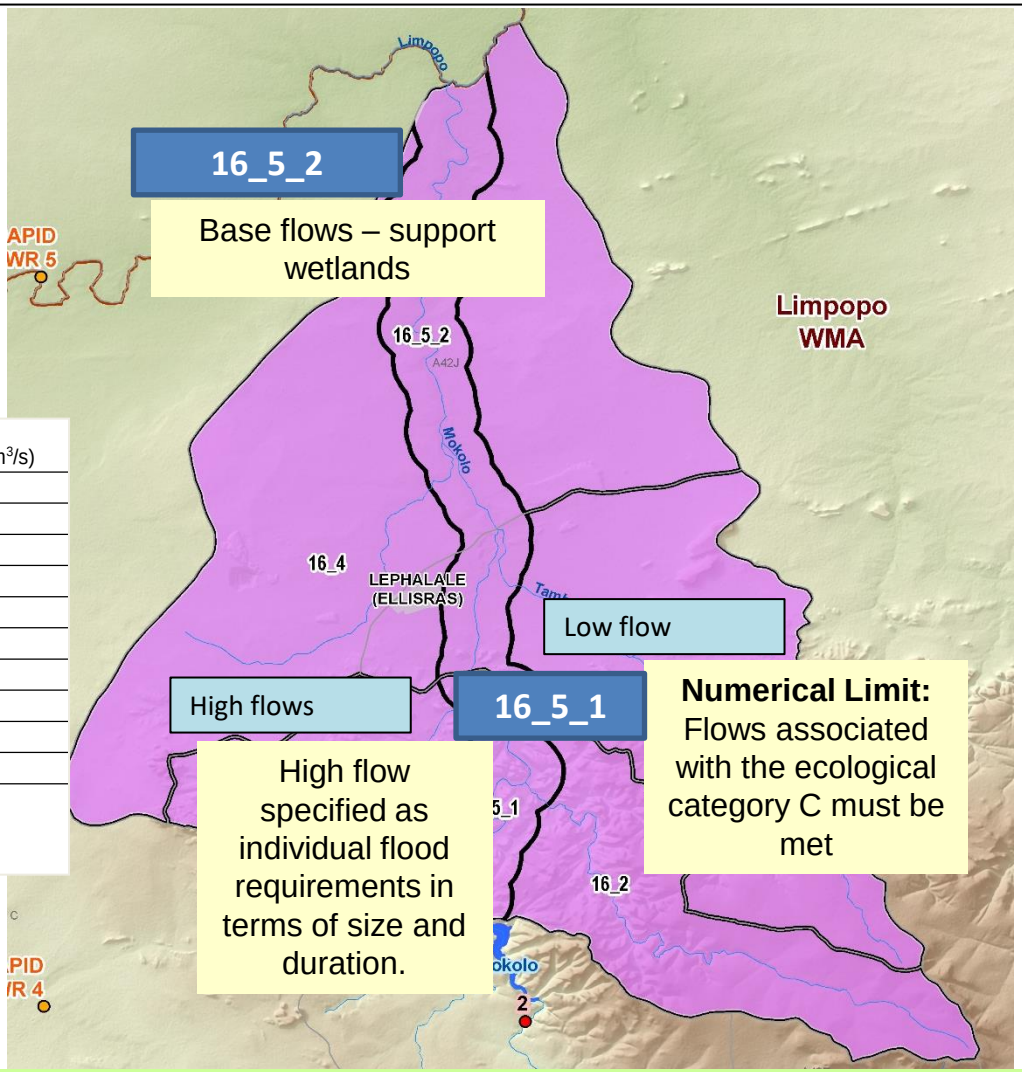


NO_3 & NO_2-N ≤ 0.05 mg/l Orthophosphate as P ≤ 0.01 mg/l	
Electrical conductivity ≤ 30 mS/m Sulphate ≤ 20 mg/l Sodium ≤ 20 mg/l Sodium ≤ 20 mg/l pH range 6.5 – 8.5 Dissolved Oxygen ≥ 6.0 mg/l Pesticides	
pH range 6.5 – 8.0 Pesticides and other toxics	

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



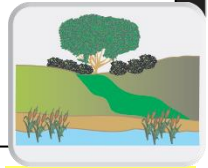
RQOs: FLOWS

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

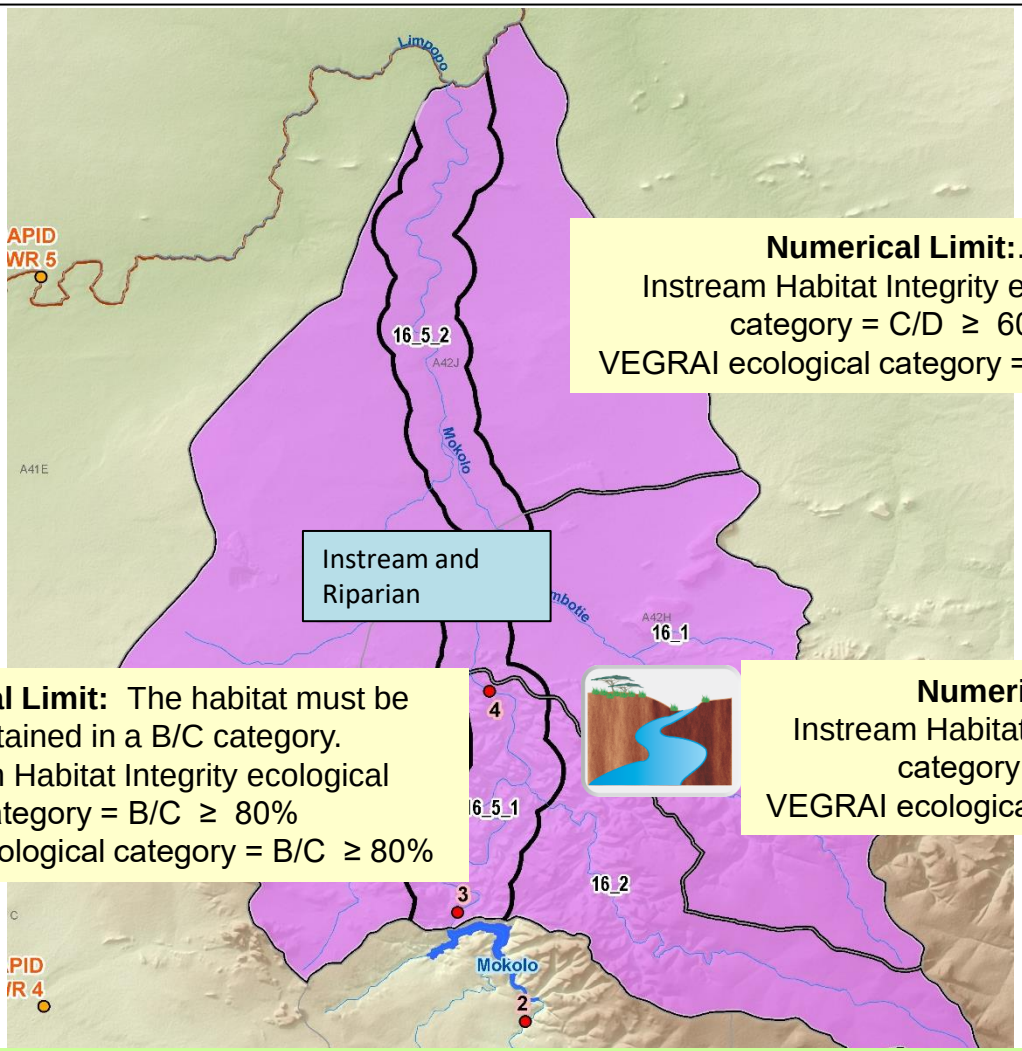
Low (16_5_2): Maintain flows in river to support wetland requirements at in A42J

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 ≥ 60%
VEGRAI ecological category = C/D ≥ 60%

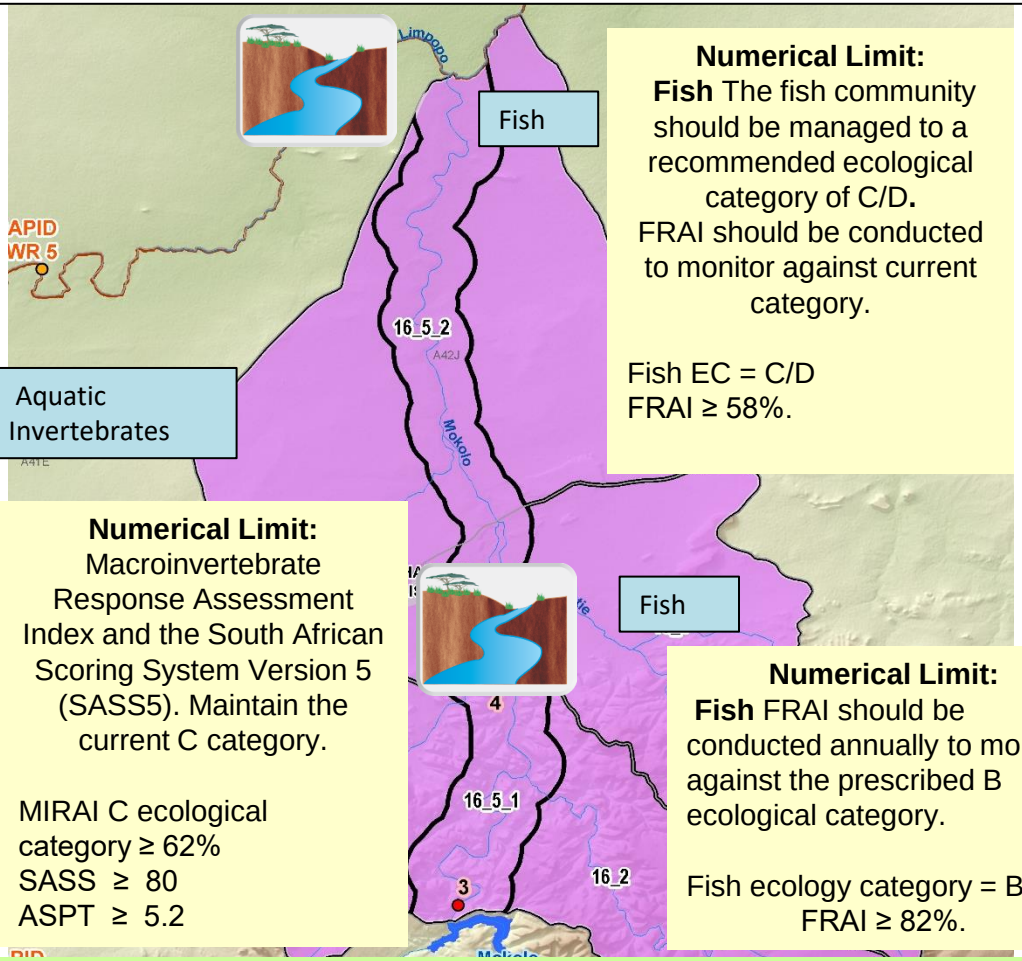
Numerical Limit: The habitat must be maintained in a B/C category.
Instream Habitat Integrity ecological category = B/C ≥ 80%
VEGRAI ecological category = B/C ≥ 80%

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

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.

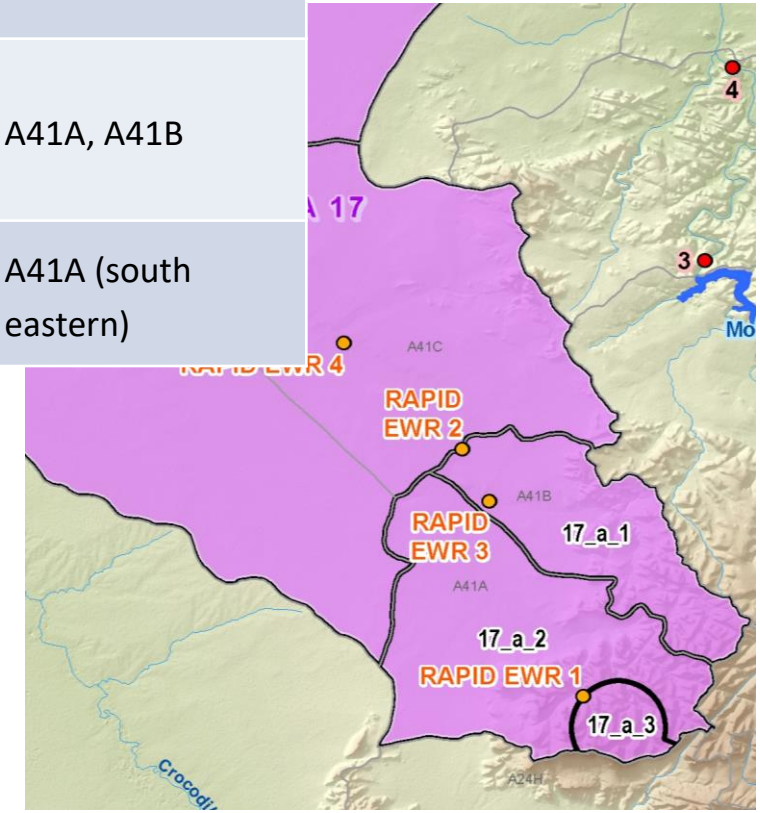
IUA 17a: MOTHLABATSI/MAMBA

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



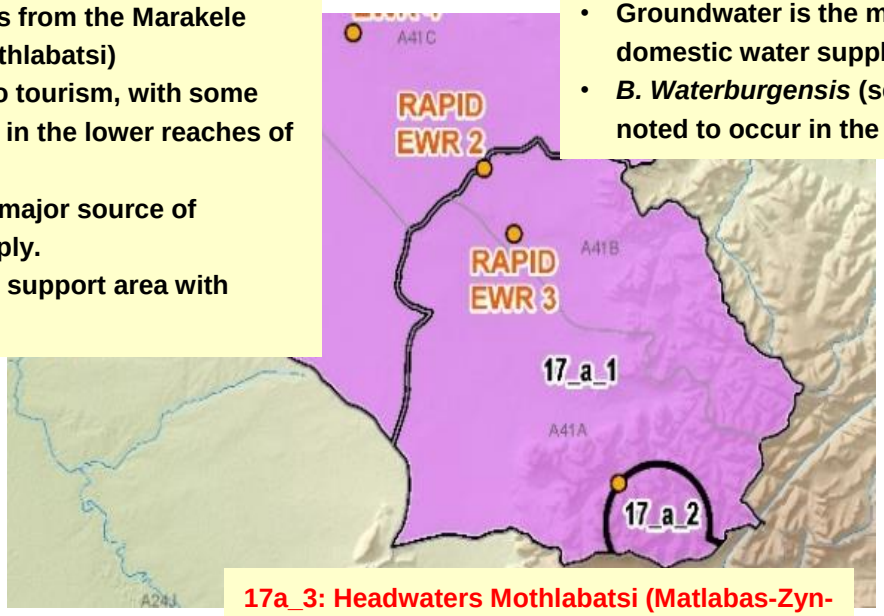
IUA 17a: MOTHLABATSI/MAMBA

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

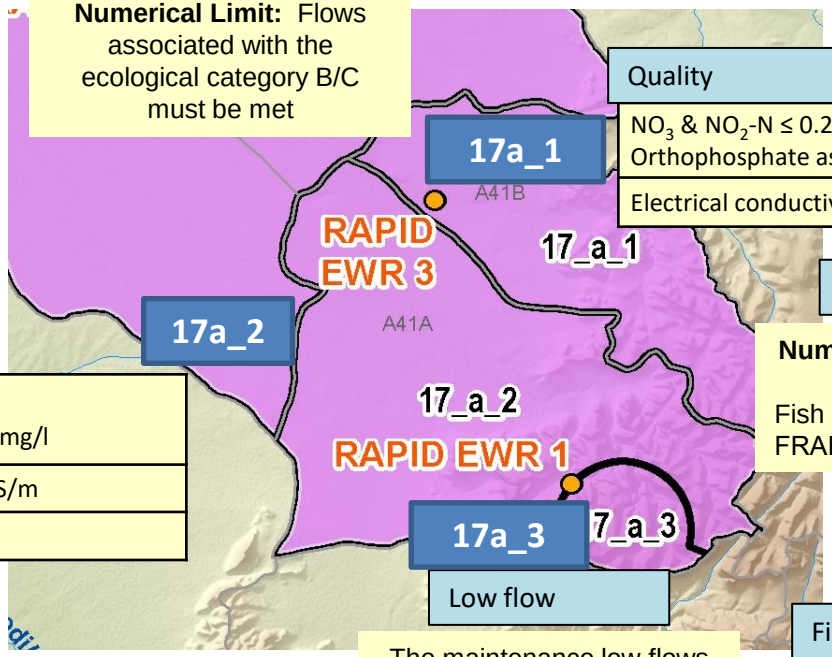
- EWR site 3 on the Mamba River
- Area is primarily eco-tourism.
- Groundwater is the major source of domestic water supply.
- *B. Waterburgensis* (secret fish) has been noted to occur in the Mamba.



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 ≥ 80%
VEGRAI ecological category = C ≥ 70%

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

Instream and Riparian

.Numerical Limit:
Instream Habitat Integrity ecological category = A ≥ 90%
VEGRAI ecological category = B ≥ 85%

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

Instream and Riparian

.Numerical Limit:
Instream Habitat Integrity ecological category = B/C ≥ 80%
VEGRAI ecological category = B/C ≥ 80%

Quality

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

Electrical conductivity ≤ 20 mS/m

Fish

Numerical Limit:

Fish EC = C
FRAI ≥ 62%.

Aquatic Invertebrates

Numerical Limit:

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

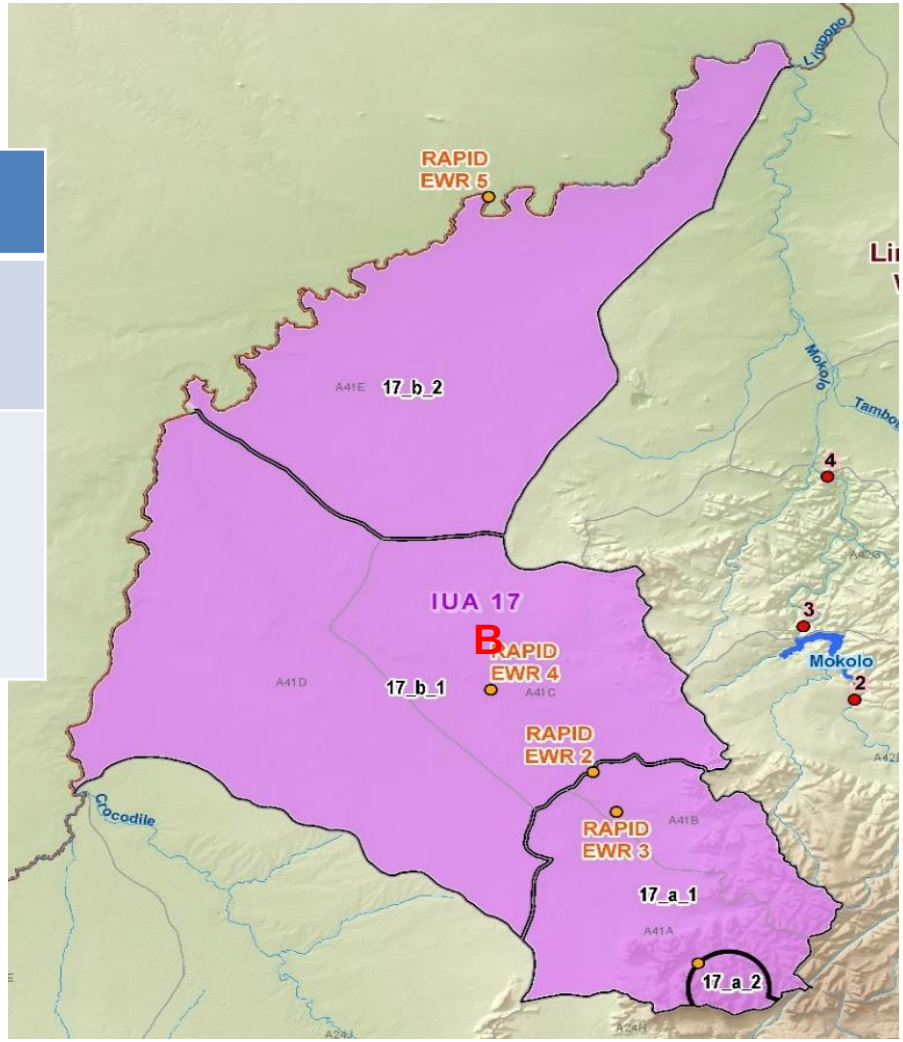
Fish

Numerical Limit:

Fish EC = B
FRAI ≥ 82%.

IUA 17b: MATLABAS

RU Number	Delineation Description	Quaternary Catchment
17b_1	Matlabas	A41D, A41C
17b_2	Catchment area including Steenbokpan (excluding Limpopo River)	A41E



Quaternary Catchments: A1C – A41E

Management Class: I

Ecological Category: B/C

IUA 17b: /Matlabas
RQOs

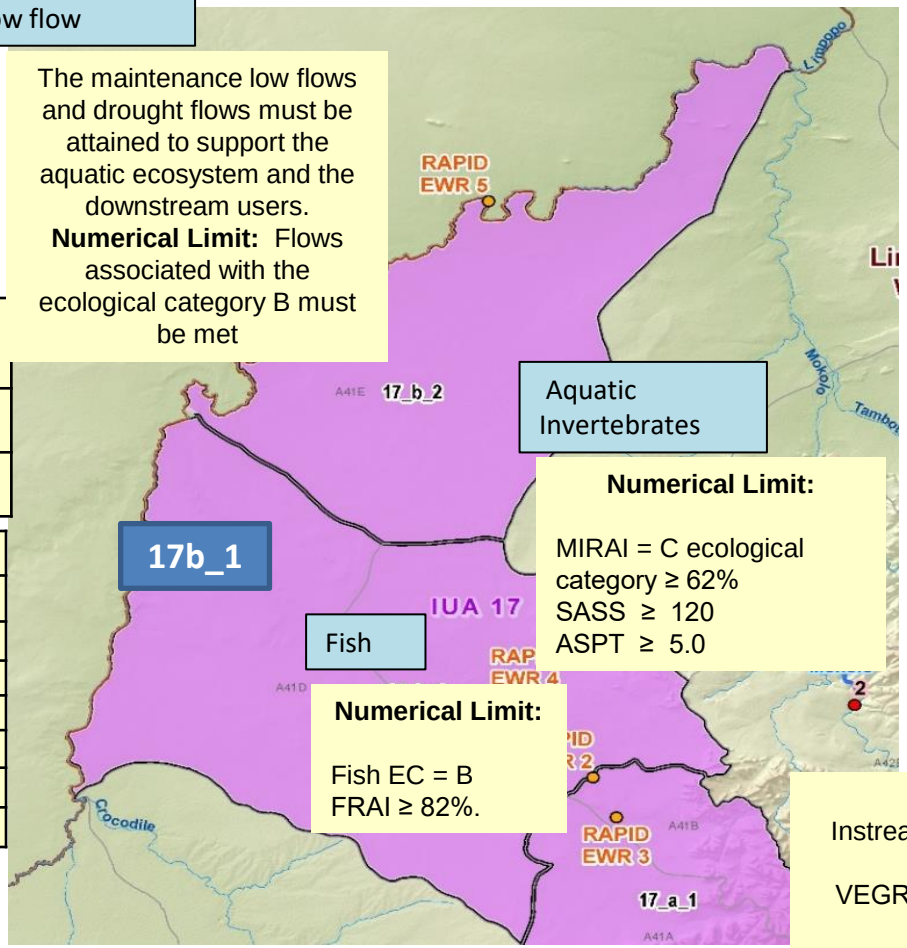
Low flow

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	≤ 0.37mg/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:

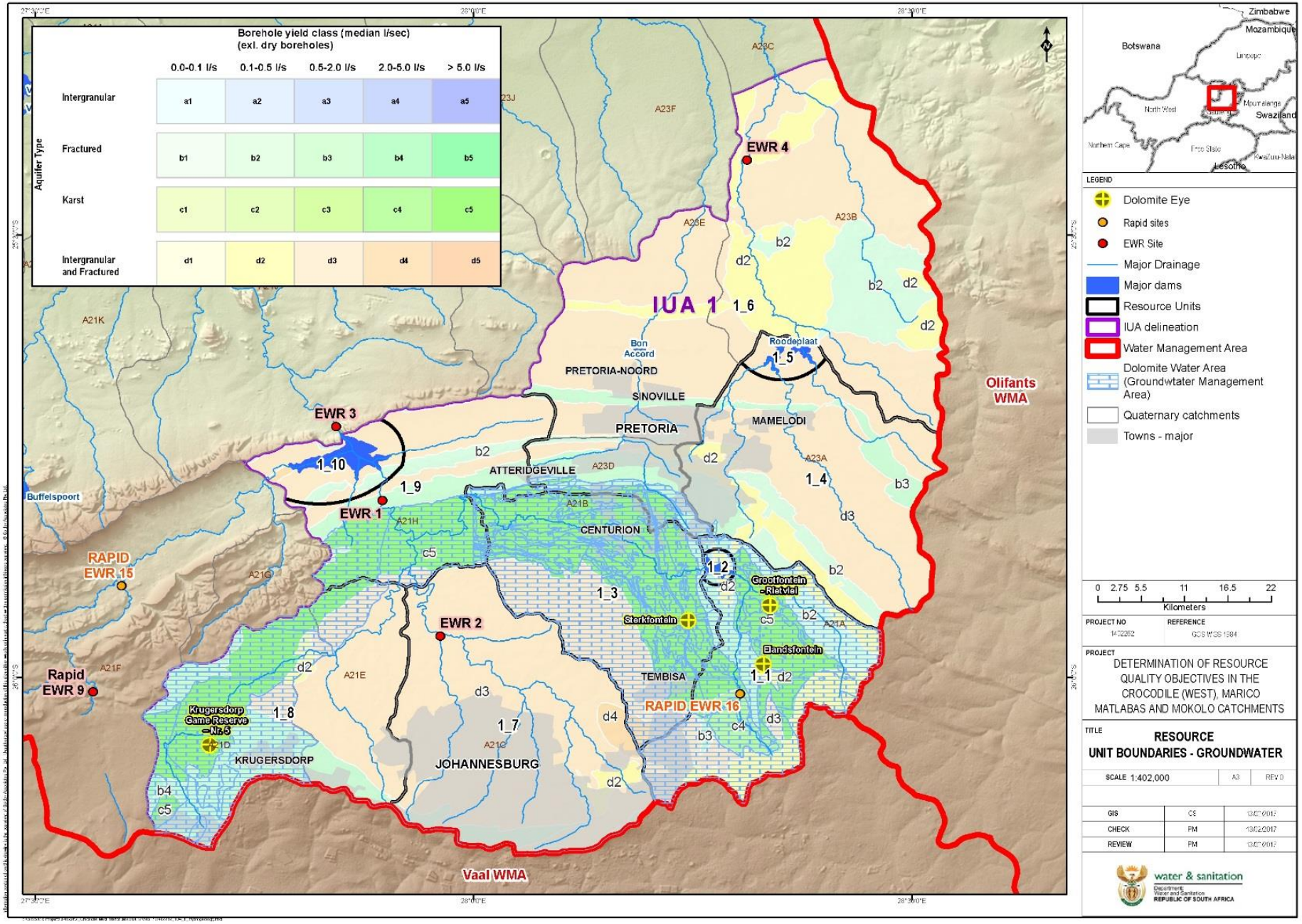
Fish EC = B
FRAI ≥ 82%.

Instream and Riparian

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

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 with respect to 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%);

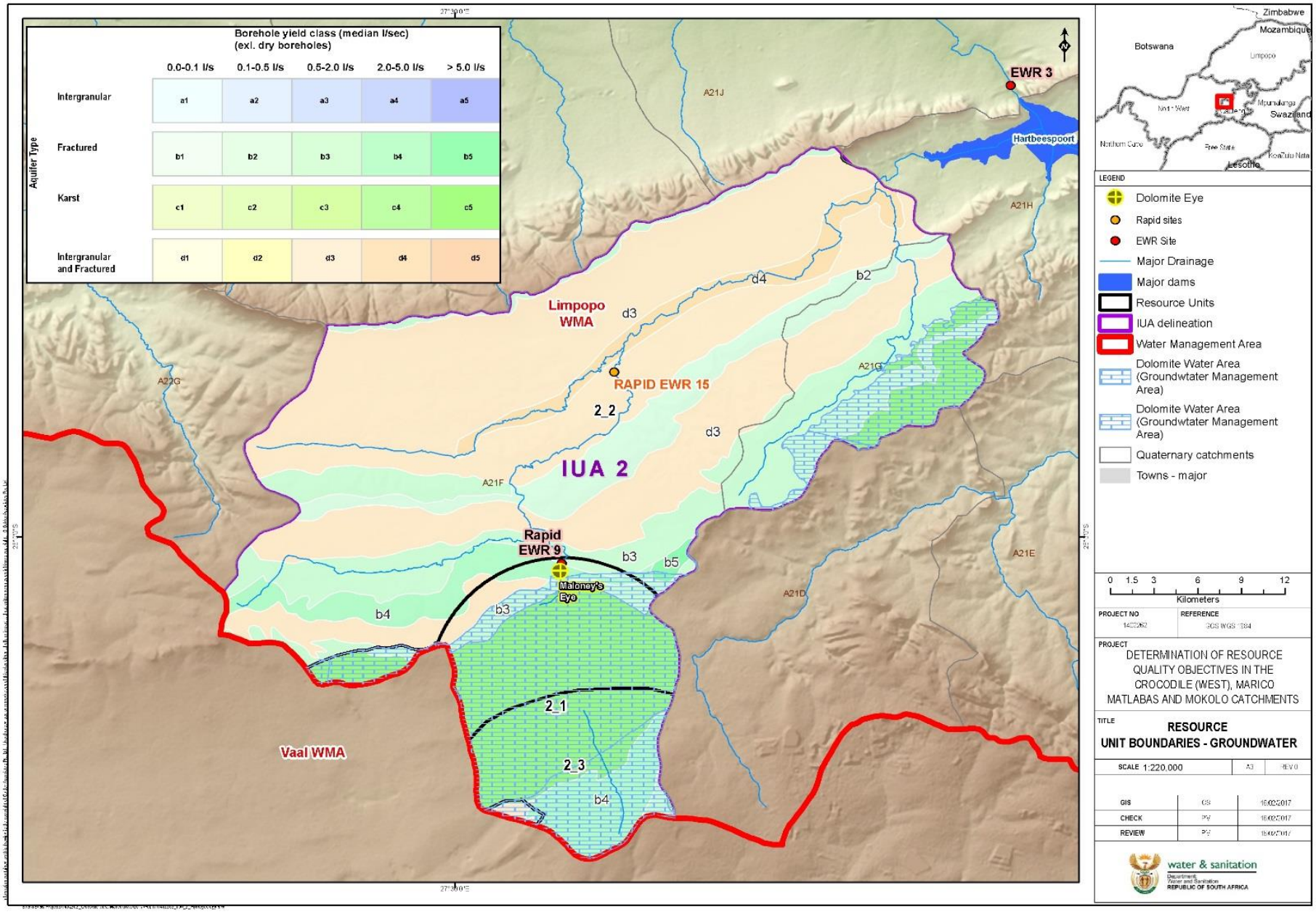
Upper Crocodile/Hennops/Hartbeespoort: RU 1_1, 1_2, 1_3, 1_8 and 1_9 QUALITY

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.

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

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Specifically dolomite aquifer systems (Hennops and Bloubankspruit, Rietvlei wet lands, Grootfontein-Rietvlei and Pretoria Eyes): Specific water resource protection requirements should become audit conditions in WUL.	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.
Specifically dolomite aquifer systems (Hennops and Bloubankspruit, Rietvlei wet lands, Grootfontein-Rietvlei and Pretoria Eyes): Specific water resource protection requirements should become audit conditions in WUL.	Limit radius of influence (r) due to abstractions	Water level drawdown limited to dolomite sub-compartment unit.

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 System).	Groundwater Levels (boreholes) in the eye's catchment, i.e. depth to groundwater level from ground elevation; Flow volumes at Maloney's Eye (compared with rainfall input, water level trends and abstractions in catchment of the eye (i.e. Steenkoppies Compartment); Abstraction of groundwater within prescribed protection zones at the Maloney's Eye (pool and downstream course as per monitor programme).	Dolomite aquifer saturation levels should not be lowered more than 6 m below an average water level depth of **~65** m in the Maloney's Eye catchment area; 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 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/ Aquifer Unit Recharge) as percentages. Only 65% of recharge value should be abstracted.	Limitation of SI value (</=65%); and Flow stage heights at discharge area (eye): <-0.50 m/a) between annual recharge events.

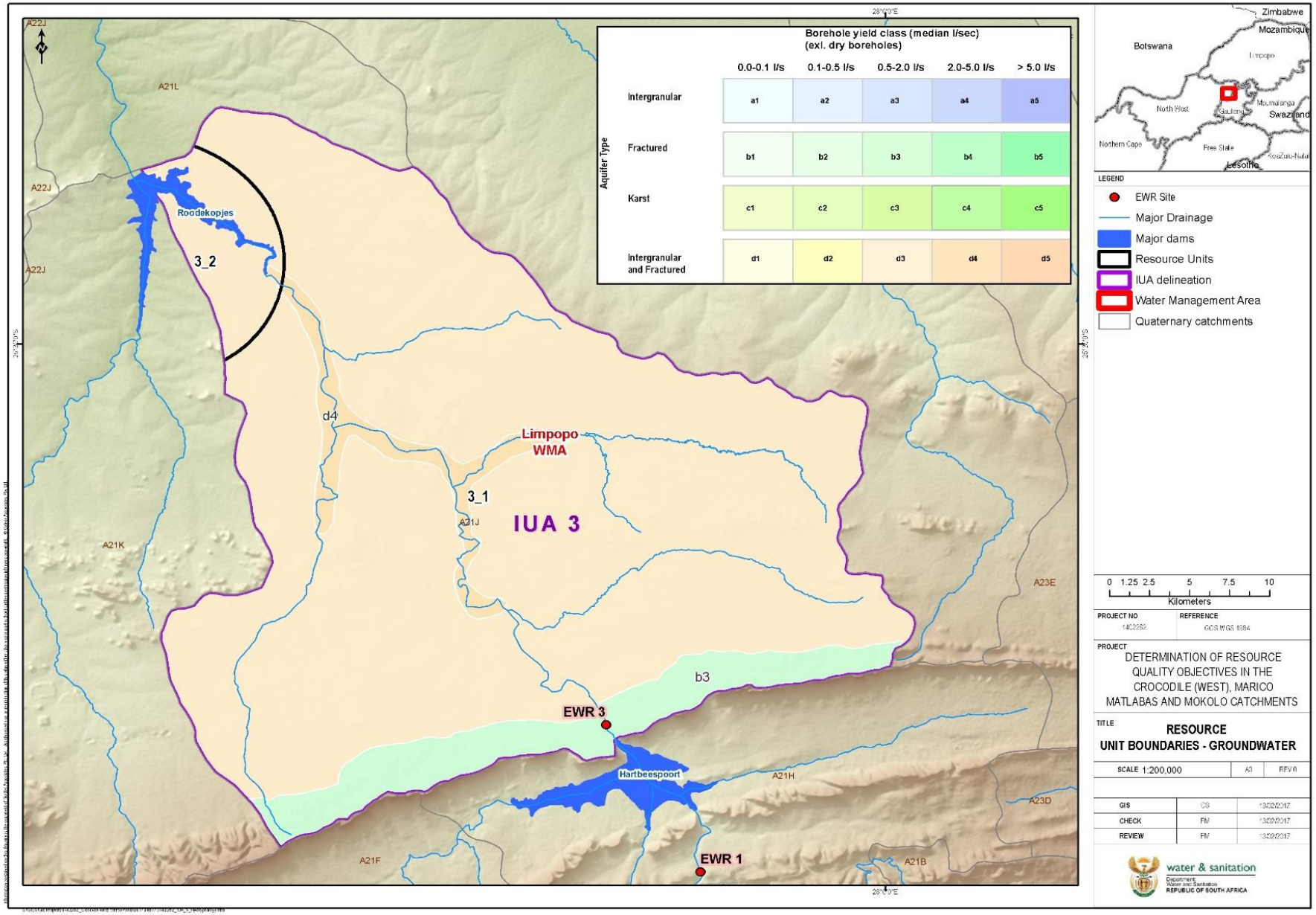
Maloney's Eye: RU 2_1, 2_2 QUALITY

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 0.5 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 and lower Magalies River.	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)	$SO_{4:}$ Less than 5 mg/l. Annual long-term trend should not approach the 95th percentile (7.5 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 ≤26 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 and Magalies River downstream).	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 Swater).	Positive/Negative water balance estimations, Volume (Q); Flow depletion at downstream gauging weirs.	Swater 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 SI value (</=65%).

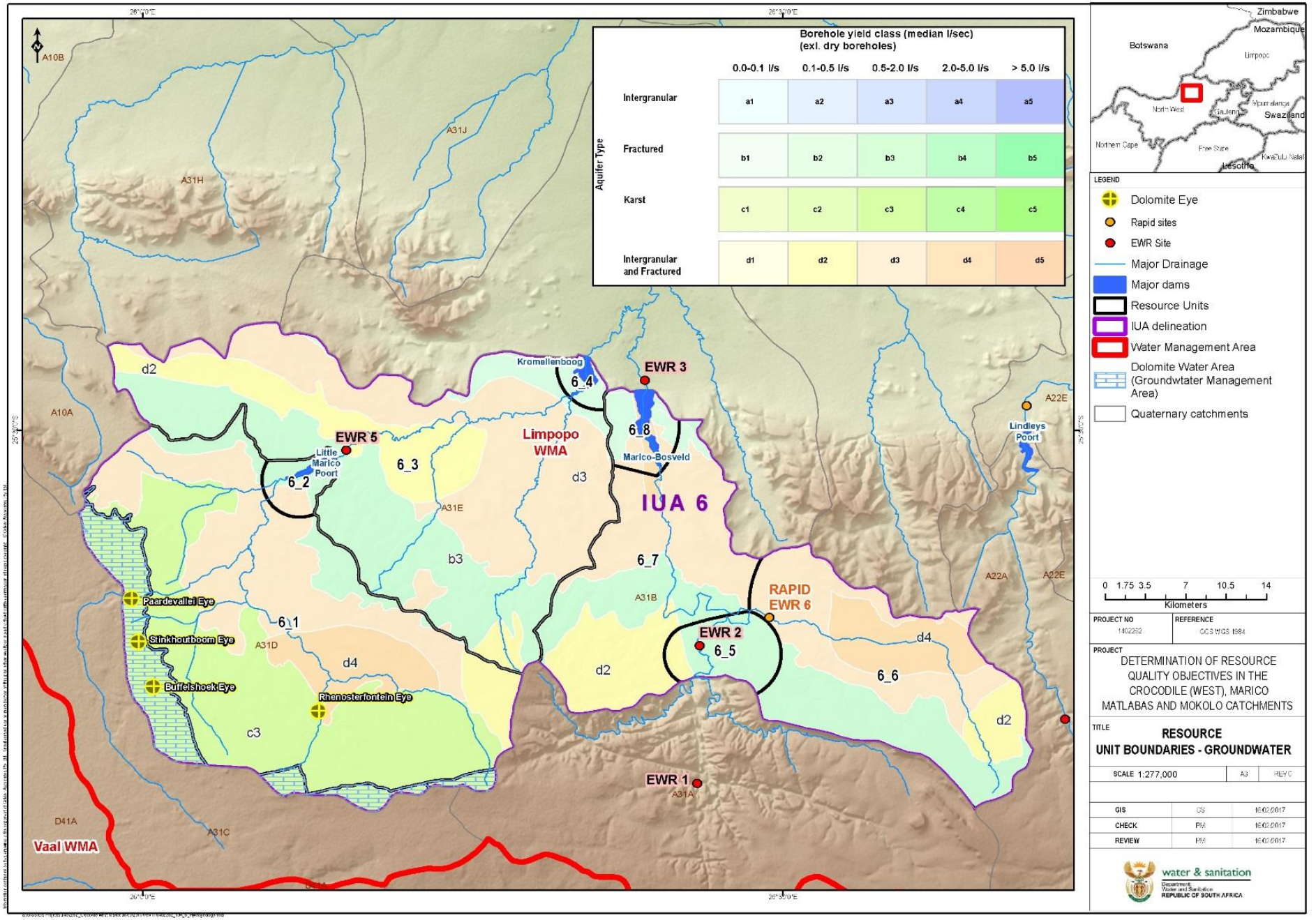
IUA3: (Upper) Crocodile River (Alluvial Aquifers): 3_1 and 3_2 QUALITY

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: less than 6.0 mg/l; Annual long-term trend should not approach the 95th percentile.
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. SAR for alluvial aquifer water	Electrical Conductivity ≤75 mS/m; (95th percentile)

PROTECTION ZONE

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Protect Intergranular (alluvial) and fractured aquifer system along central Crocodile and Rose Spruit segments in terms of Sw-Gw 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 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 ~21 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%);

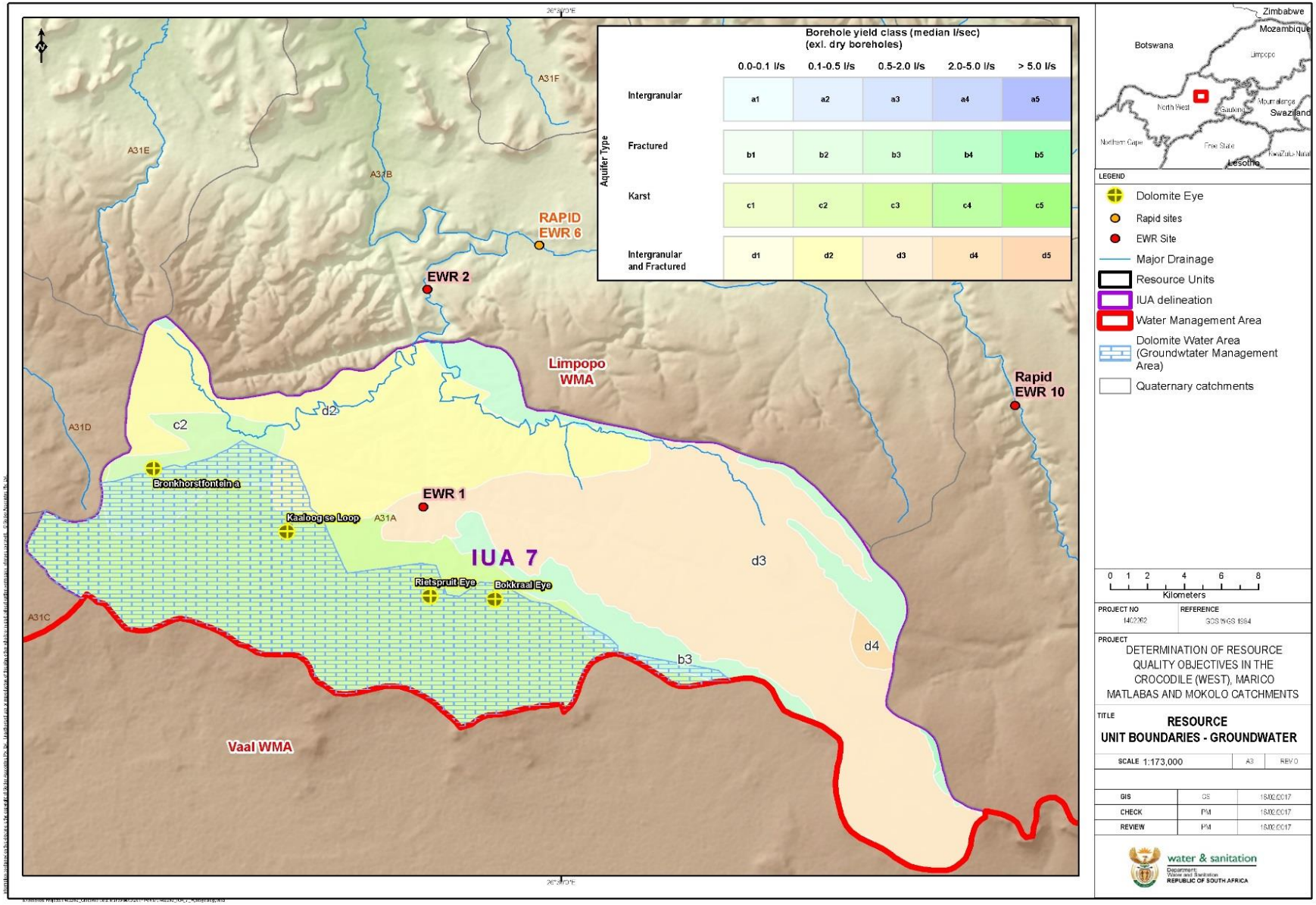
RU 6_1: Klein Marico Eyes: Groundwater Quality

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)	Fluoride: ≤ 0.2 mg/l. Annual long-term trend should not approach the 50th percentile (0.2 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). Na-Cl concentrations from mining activities in local eye catchments	EC: less than 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	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)
	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, except Rhenosterfontein, which falls in the A31D QC).	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 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/ Aquifer Unit Recharge) as percentages	Annual abstraction should not be larger than 65% of average annual recharge (i.e. SI of 65%);

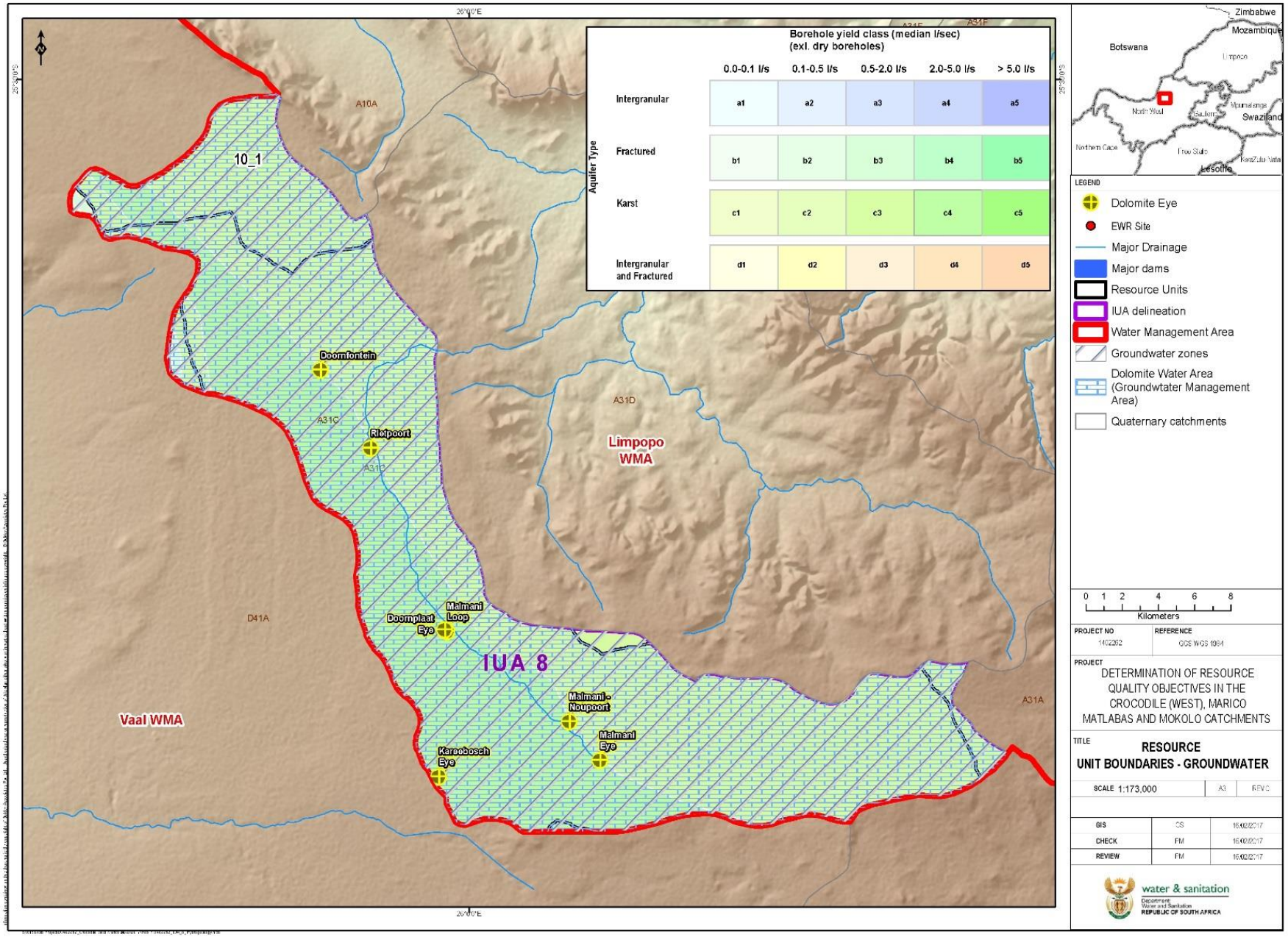
Marico Eye (ref. Kaaloog Se Loop, Rietspruit and Bokkraal Eyes): 7_1 Quality

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: ≤ 0.5 mg/l; Annual long-term trend should not approach the 75th percentile (0.5 mg/l)
Flouride – impact on 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 (1.0 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: ≤ 50 mS/m Annual long-term trend should not approach the 95th percentile (55 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 Eye's and Klein Marico 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.

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 and Doornfontein Eye) should be protected against total depletion of water table).	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/ Aquifer Unit Recharge) as percentages.	

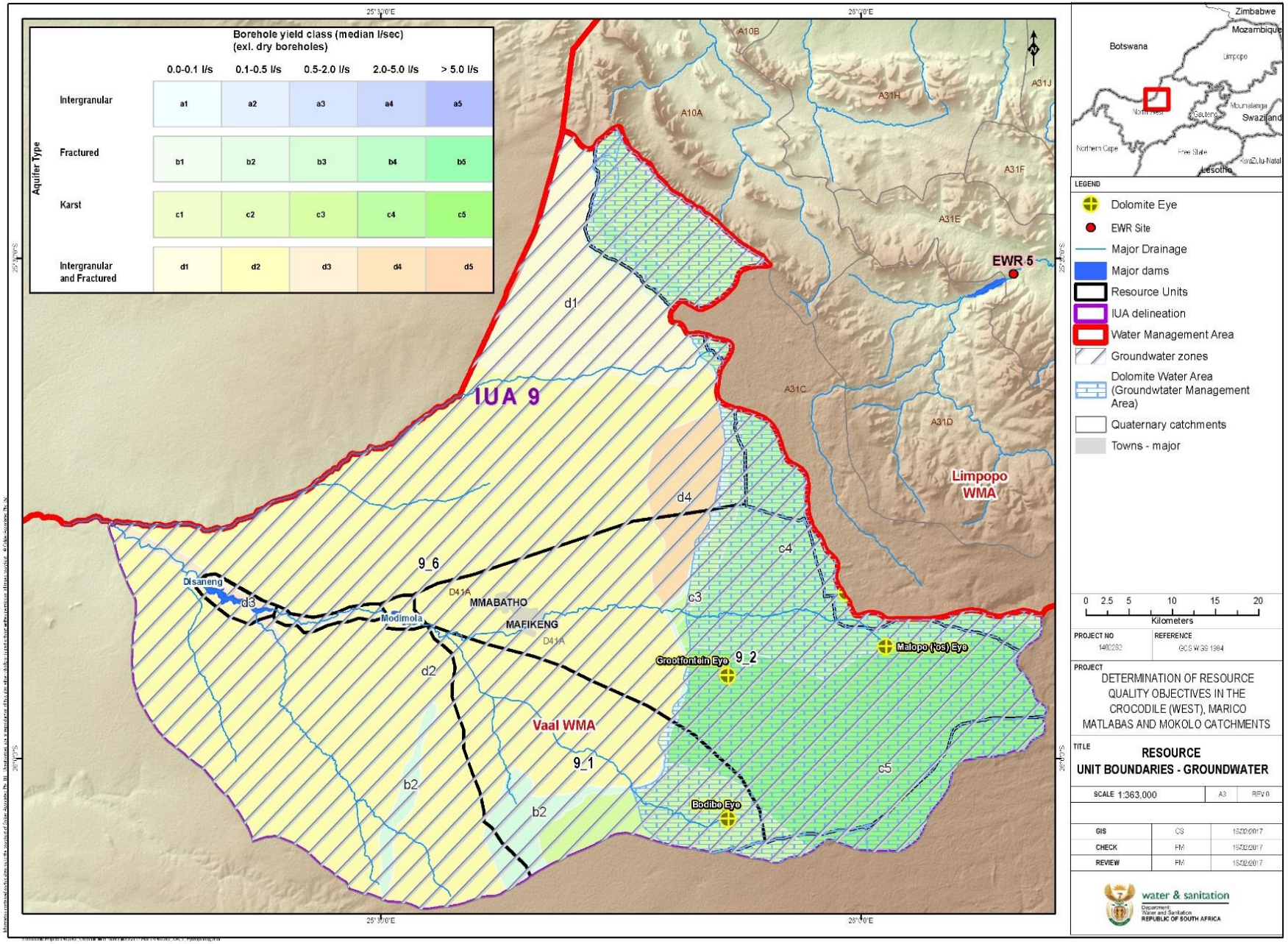
Malmanie se loop: 8_1
QUALITY

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 – impact on 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 (1.0 mg/l).

Malmanie se loop: 8_1
PROTECTION ZONING

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Specifically dolomite aquifer systems (i.e. Malmani Eye, Malmani-Noupoort, Doornplaat Eye, Rietpoort Eye and Doornfontein Eye); Specific water resource protection requirements should become audit conditions in WUL;	Waterlevel drawdown limit in dolomite compartment unit.	Maximum 6 m (unless specifically authorised)
	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 (*i.e*. SI of 65%);
Water balance Status	Calculation of Stress Indexes (Aquifer Unit Use/ Aquifer Unit Recharge) as percentages.	

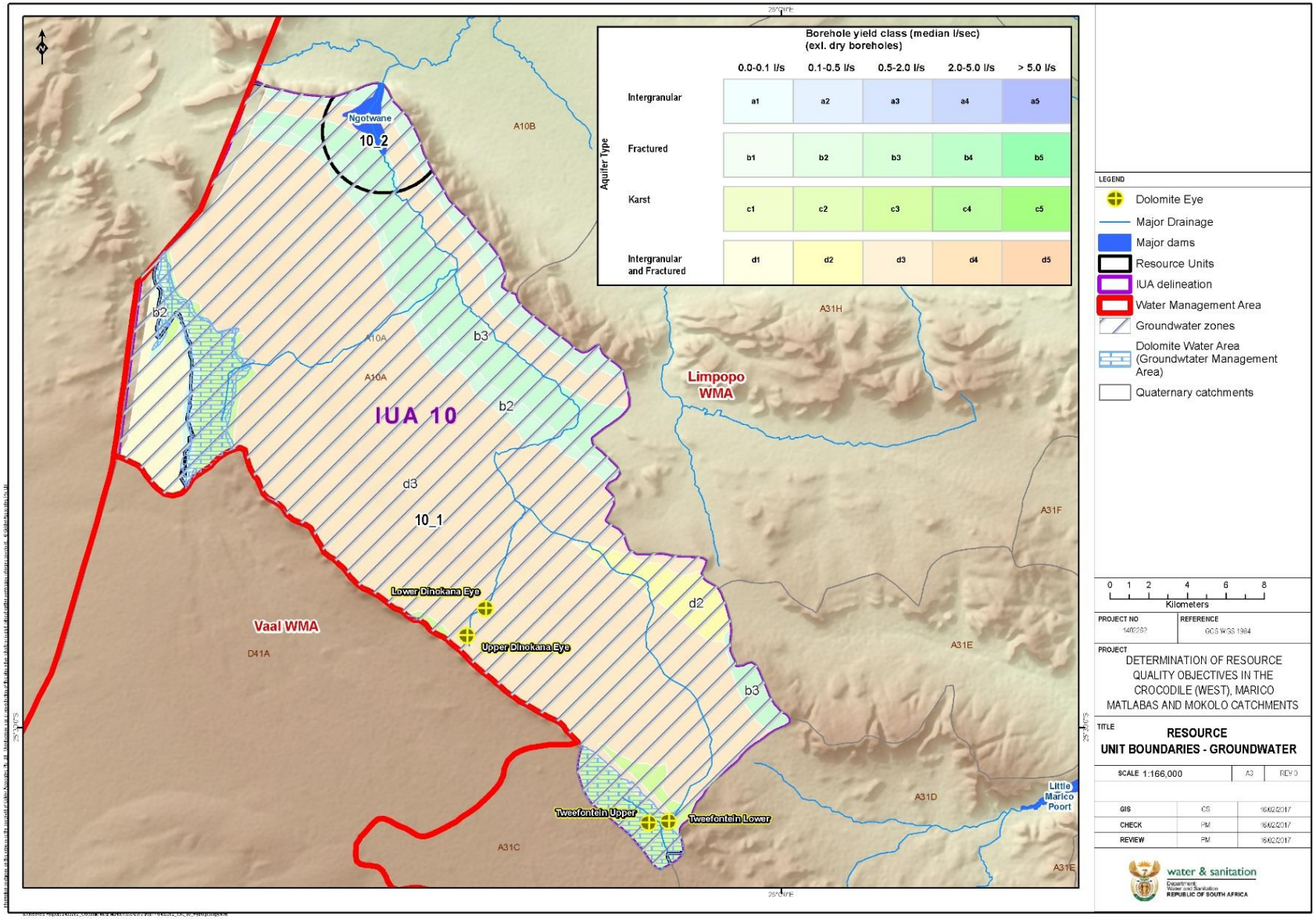
IUA 9: Upper Molop River: RU 9_1 and 9_2 QUALITY

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



IUA 10: Ngotwane: 10_1
QUANTITY

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Discharge areas (i.e. Eyes/springs) should be protected against total depletion of water table)	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%).

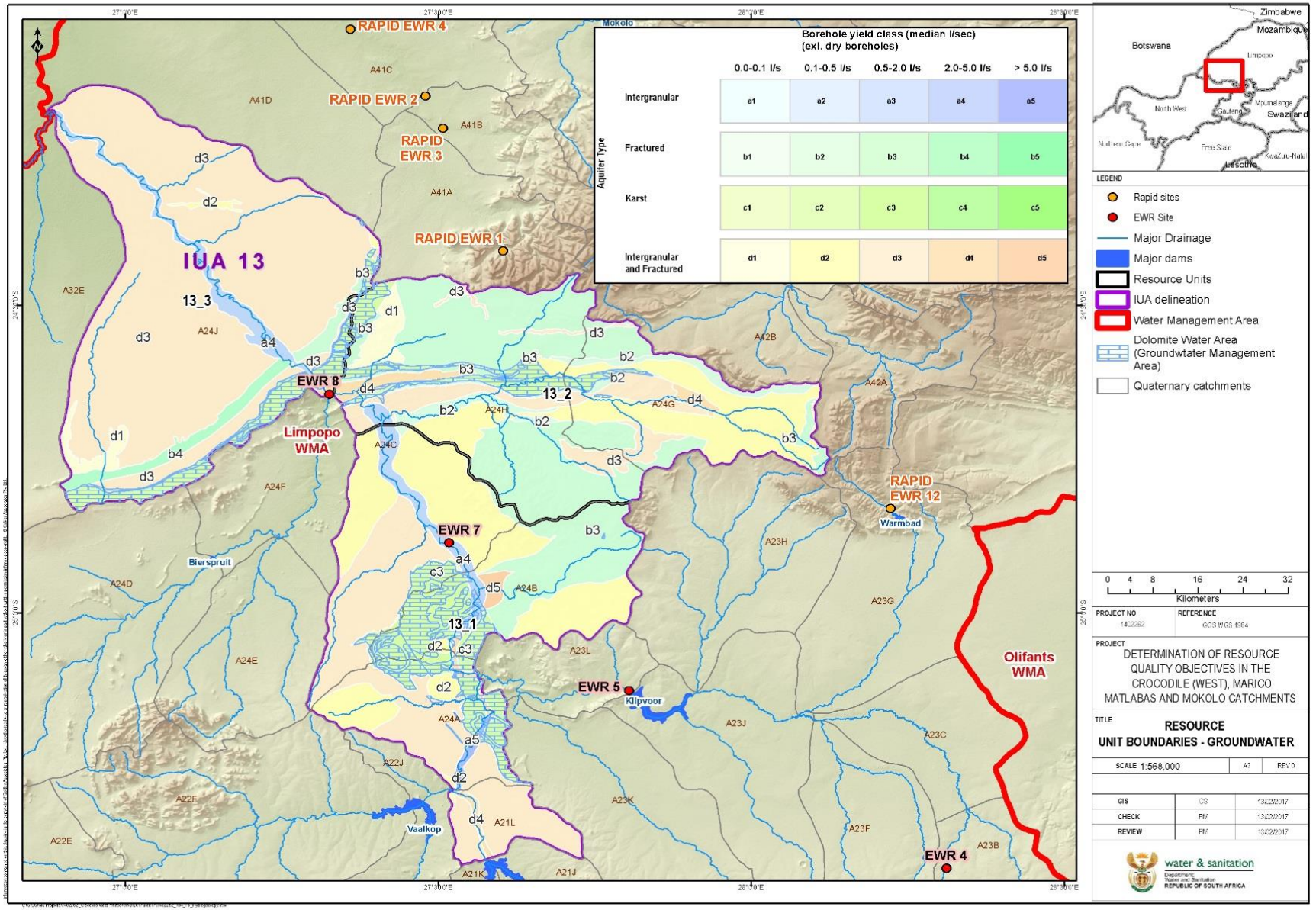
IUA 10: Ngotwane: 10_1
QUALITY

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 – impact on users – elevated fluoride levels	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_2



IUA 13: Lower Crocodile: 13_1 and 13_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).	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%).

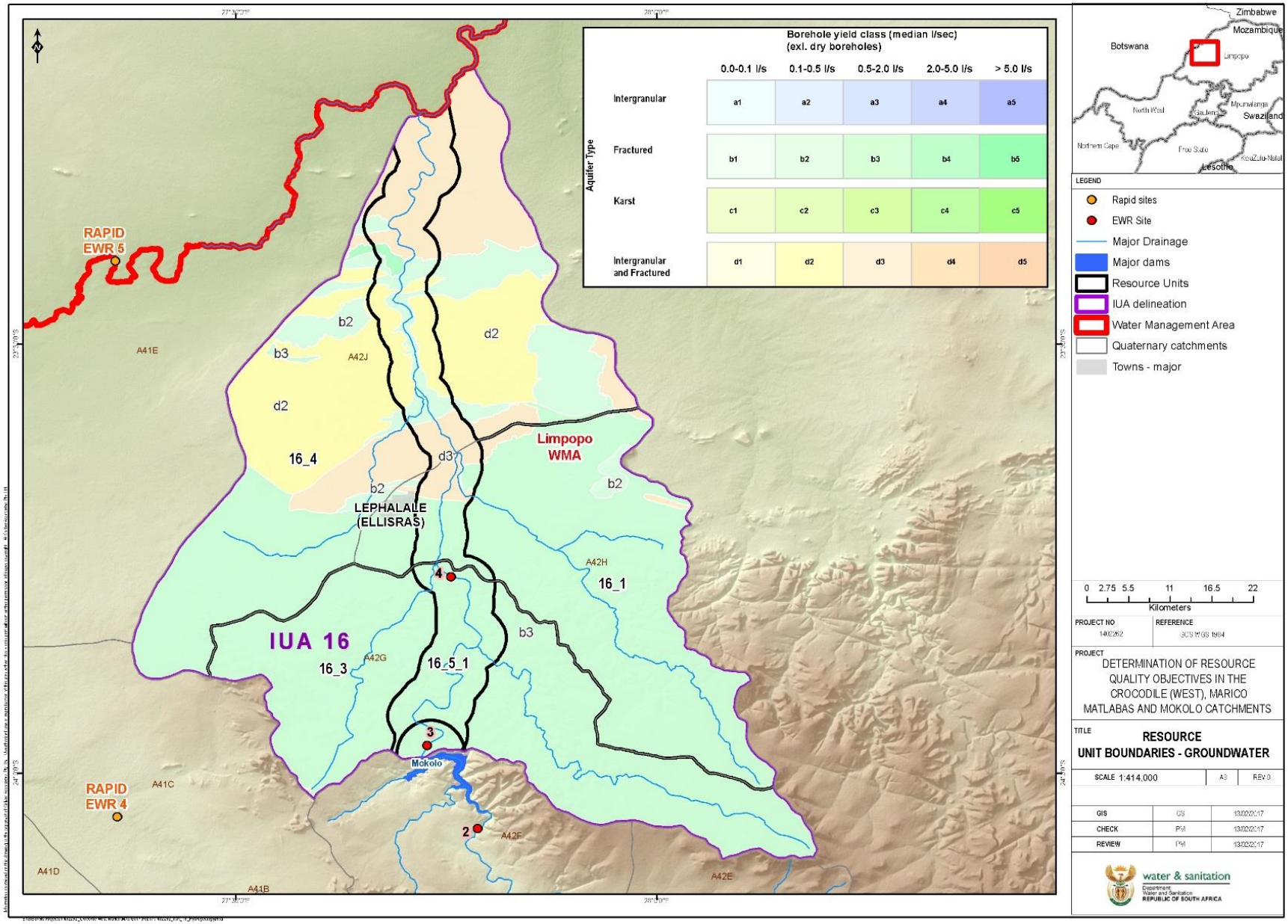
IUA 13: Lower Crocodile: 13_1 and 13_2
Quality

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: ≤ 1.0 mg/l (95^{th} percentile)
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. SAR for alluvial aquifer water	Electrical Conductivity: ≤ 85 mS/m (95^{th} percentile) SAR: Within appropriate limit for irrigation water.

IUA 13: Lower Crocodile: 13_1 and 13_2
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 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 Swater and Gwater 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%).

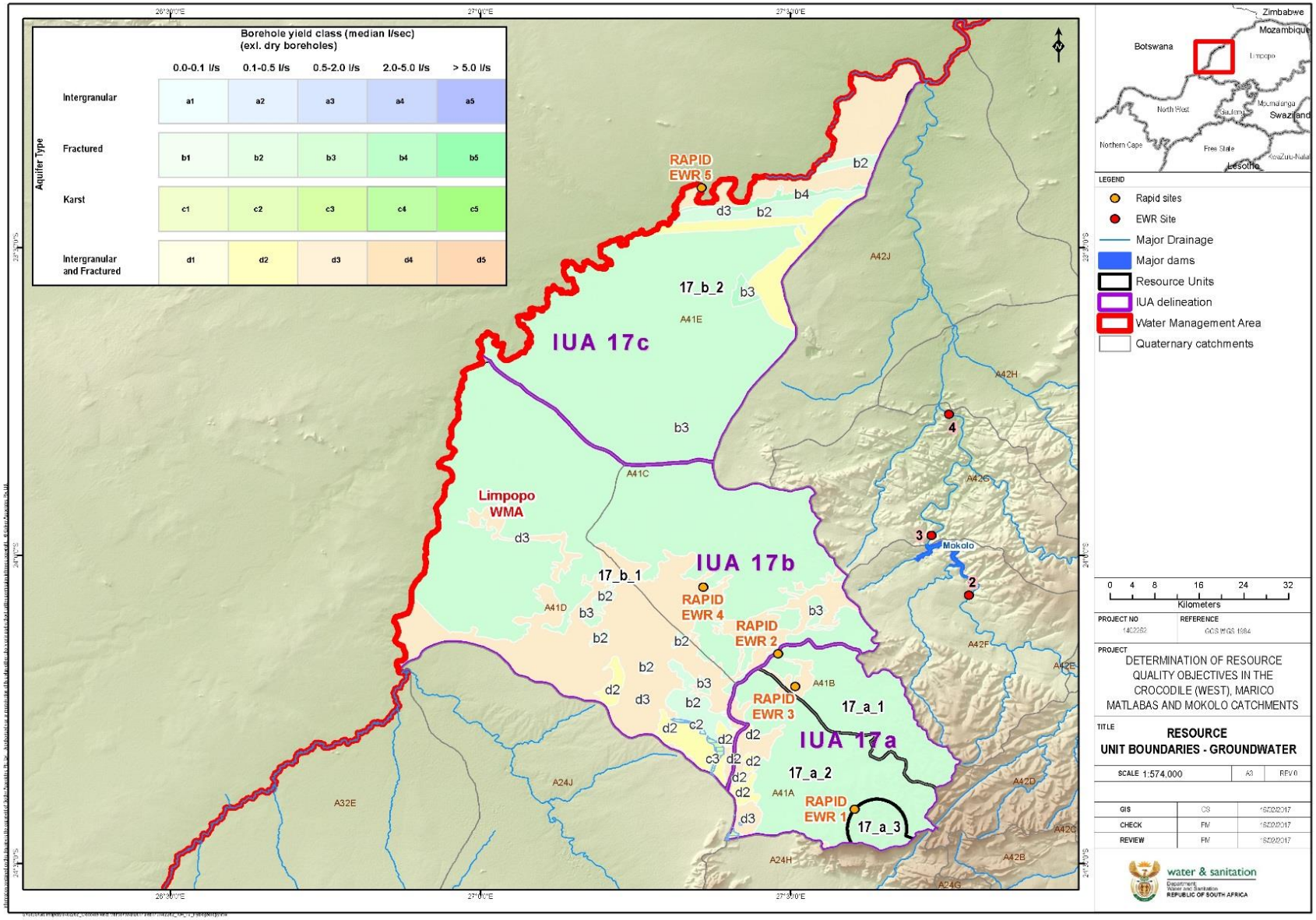
IUA 16: Sandloop and Mokolo: 16_4 Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nutrients - Nitrate	Monthly monitoring at DWS gauging stations. Establish background "natural" nitrate concentration in water resource.	Nitrate: ≤ 0.5 mg/l (95th percentile)
Dissolved salts in groundwater resources - Monitoring Medupi/ Grootegeluk and other impact related monitoring networks.	Salinity - Electrical Conductivity Establish background "natural" salinity concentration in water resource.	Electrical Conductivity: ≤ 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.	$SO_4^{:}$ ≤ 80 mg/l. (95th percentile)

IUA 16: Sandloop and Mokolo: 16_4
Protection Zoning

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%).

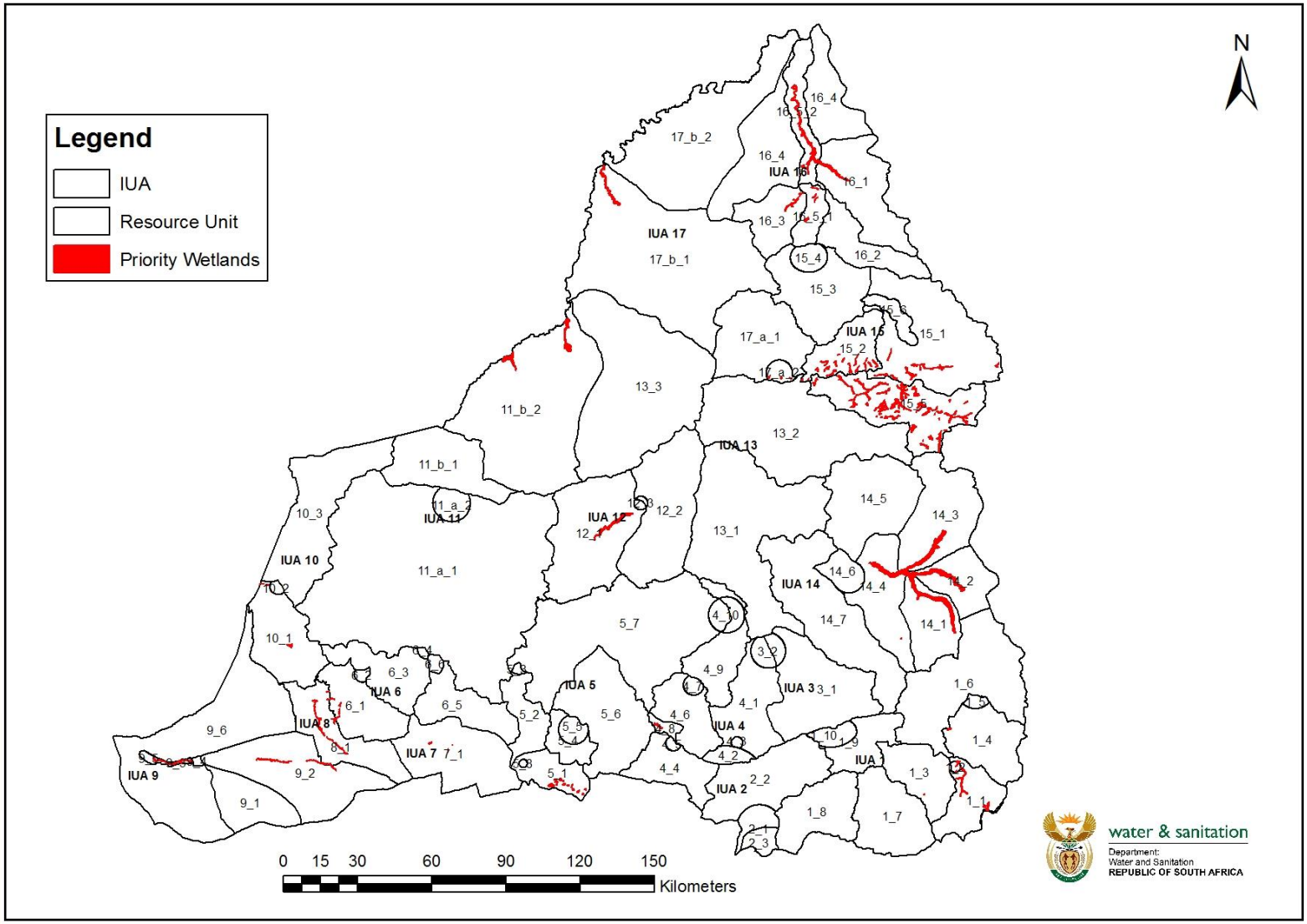
IUA 17: Matlabas: 17_b_2
Quality

Resource Quality Objective	Indicator/ Measure	Numerical Limit
Nutrition's in groundwater impacting on consumer's health.	Nitrate (NO_3-N) in groundwater.	Nitrate: ≤ 1.2 mg/l; Annual long-term trend should not approach the 75th percentile (3.5 mg/l).
Dissolved salts in groundwater resources - Monitoring Medupi/ Grootegeluk and other impact related monitoring networks.	Salinity: Electrical Conductivity (EC) of groundwater.	Electrical Conductivity ≤40 mS/m Annual long-term trend should not approach the 75th percentile (85 mS/m).
Acid Mine Water (or ARD) and decanting into surface water resources.	Sulphates (SO_4) in groundwater.	SO_4: ≤10 mg/l. Annual long-term trend should not approach the 95th percentile (45 mg/l).
Flouride concentrations in groundwater supplied to domestic users.	Fluoride (F) in groundwater.	Fluoride: ≤0.32 mg/l; Annual long-term trend should not approach the 75th percentile (0.51 mg/l).

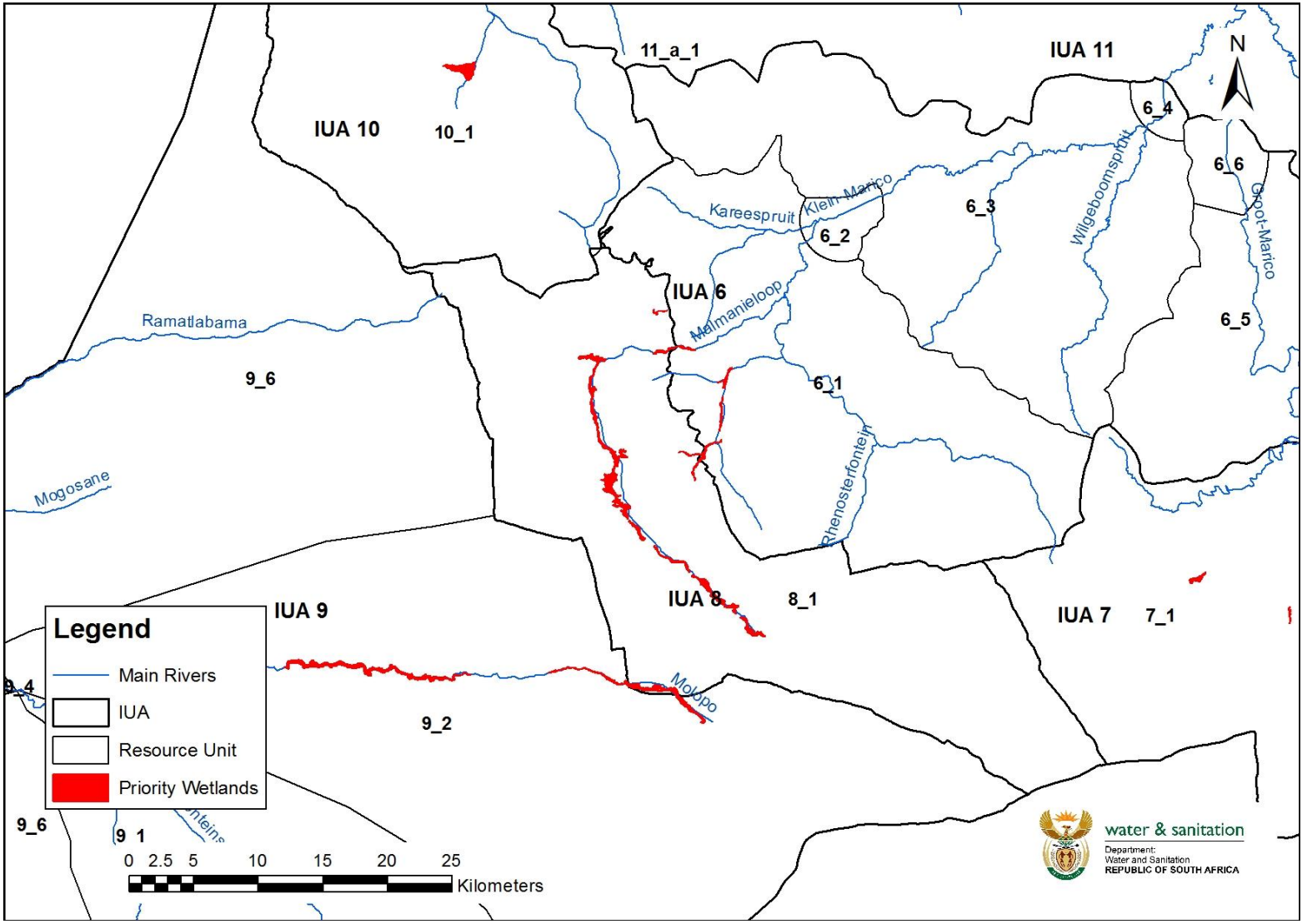
Quality
(Note that elevated background values for critical hydro-chemical elements may be a natural phenomenon and should be acknowledged).

DRAFT WETLAND RESOURCE QUALITY OBJECTIVES

Priority Wetlands



Example: Malmanieloop Wetland Complex

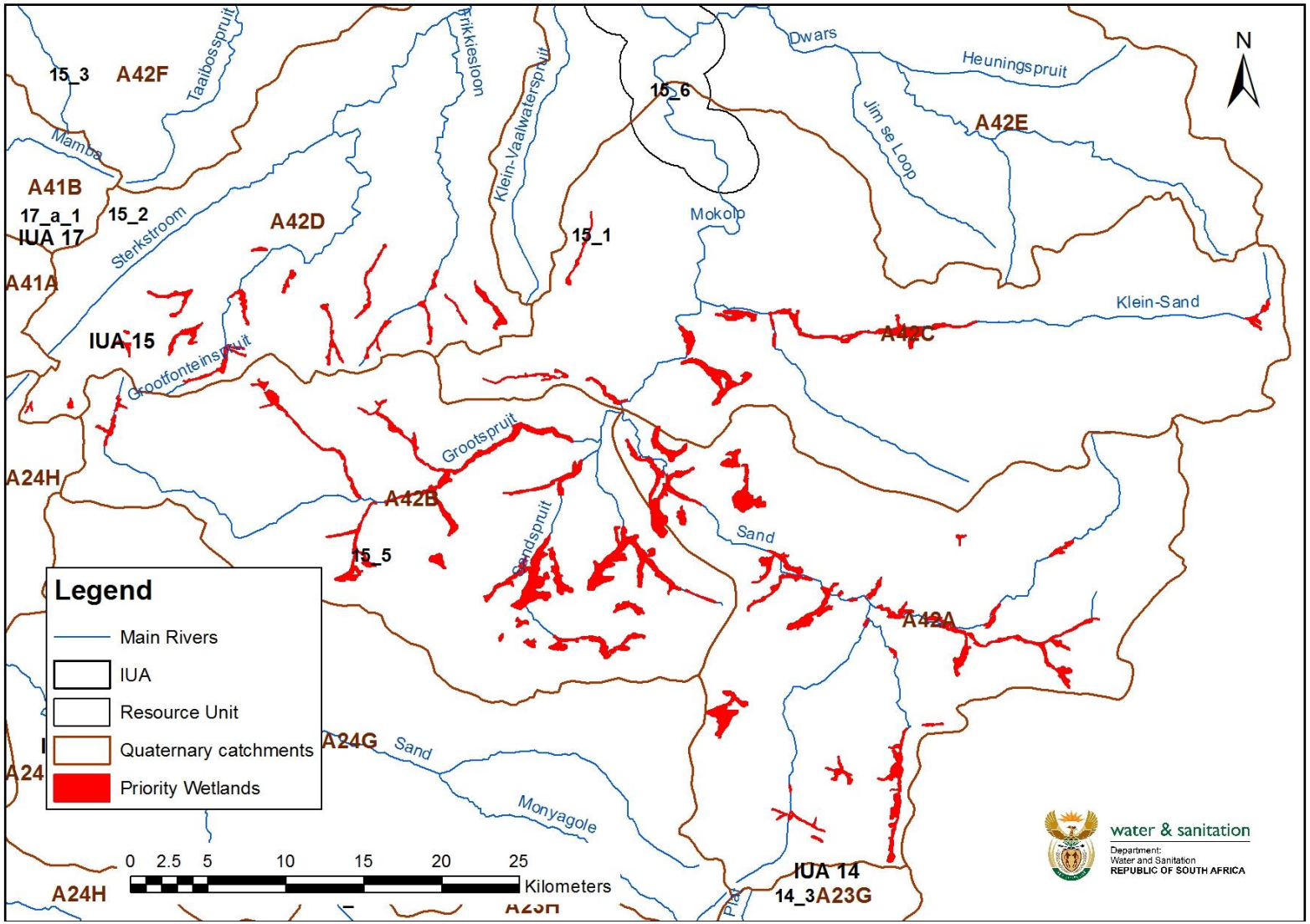


RQO Examples

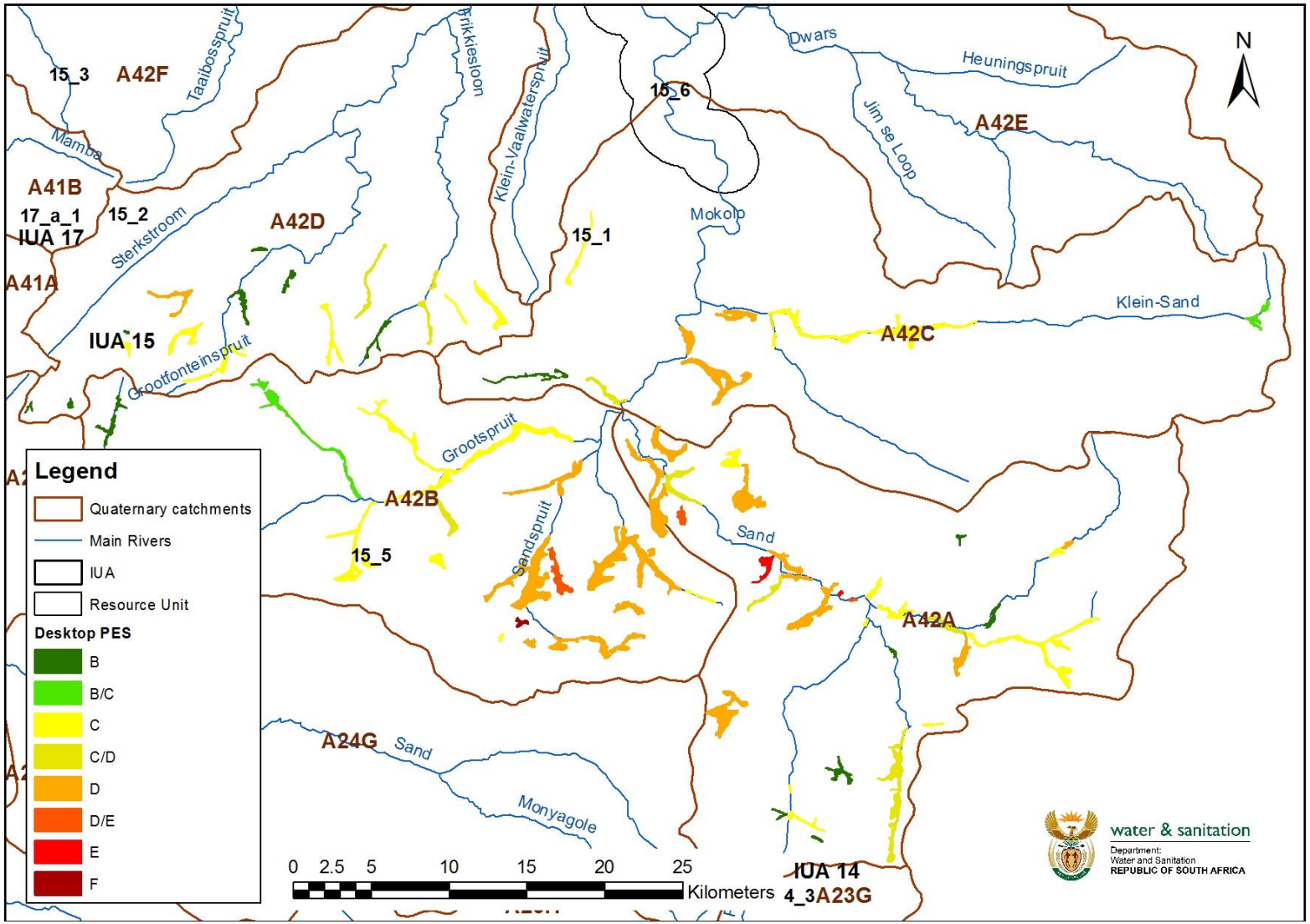
RU 8_1, **Malmanieloop Wetland Complex**, PES=B/C, EIS=Very High, REC=B

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)
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).
Habitat	Desktop PES Category (based on a semi-quantitative area based weighted average score for all wetland units in the wetland complex – see the method of Kotze, 2016).	Area based weighted Average PES Category of B/C.	Undertake a desktop PES assessment and determine the area based weighted average score for the wetland complex – see the method of Kotze, 2016. 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 representative HGM units of the wetland complex and take fixed point photographs of key features.
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

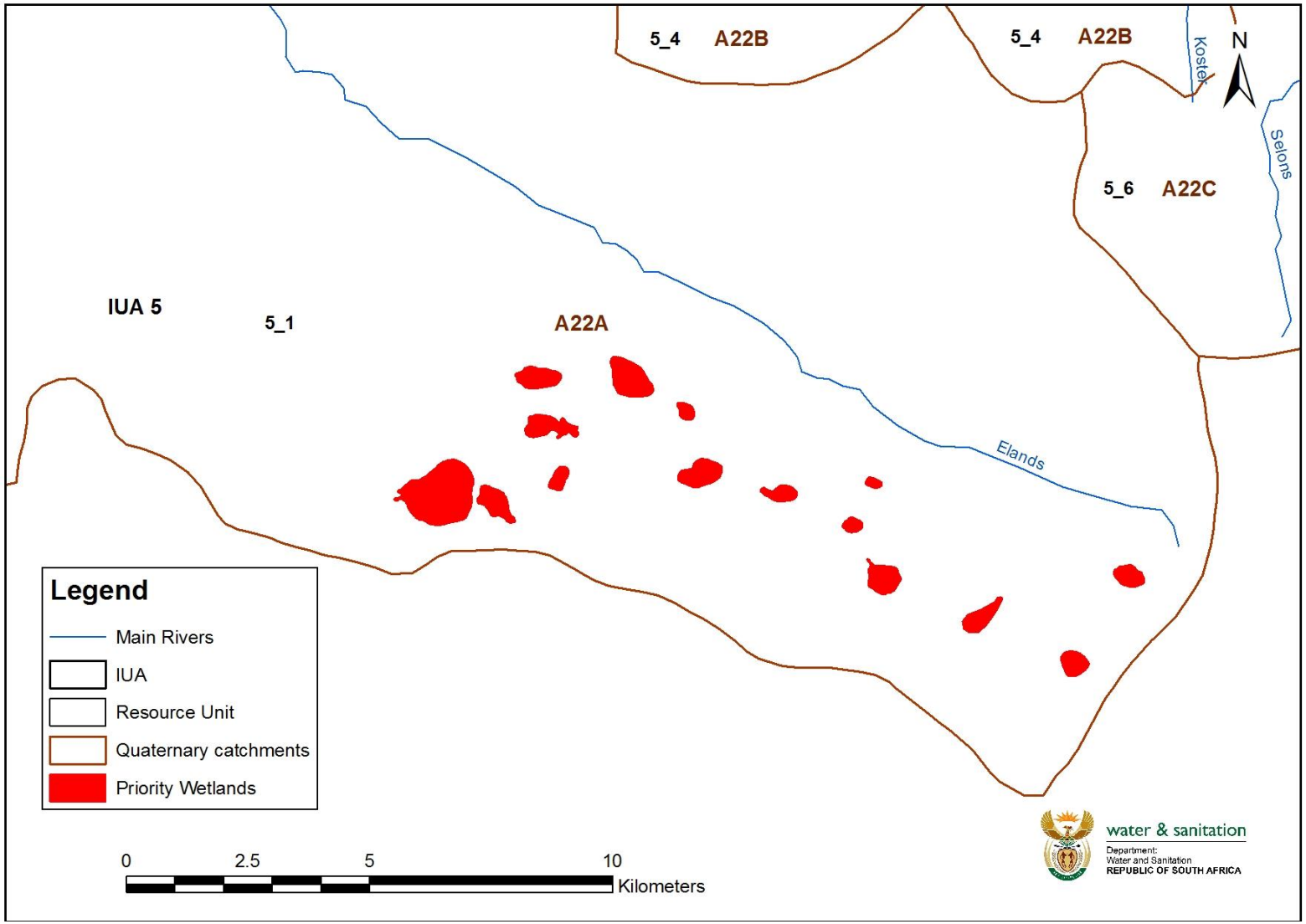


RQO Examples

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 – see the method of Kotze, 2016).	Area based weighted Average PES Category of C.	Undertake a desktop PES assessment and determine the area based weighted average score for the wetland complex – see the method of Kotze, 2016. 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	Reporting rates (RR) for aquatic/wetland dependent Red Data bird species.	Overall biodiversity and populations of wetland dependent Red Data bird species must be maintained.	Verify from monitoring records and recorded sightings from available avifaunal reporting rate data. Report on this every 3 to 5 years.

Example: Koster Pan Complex

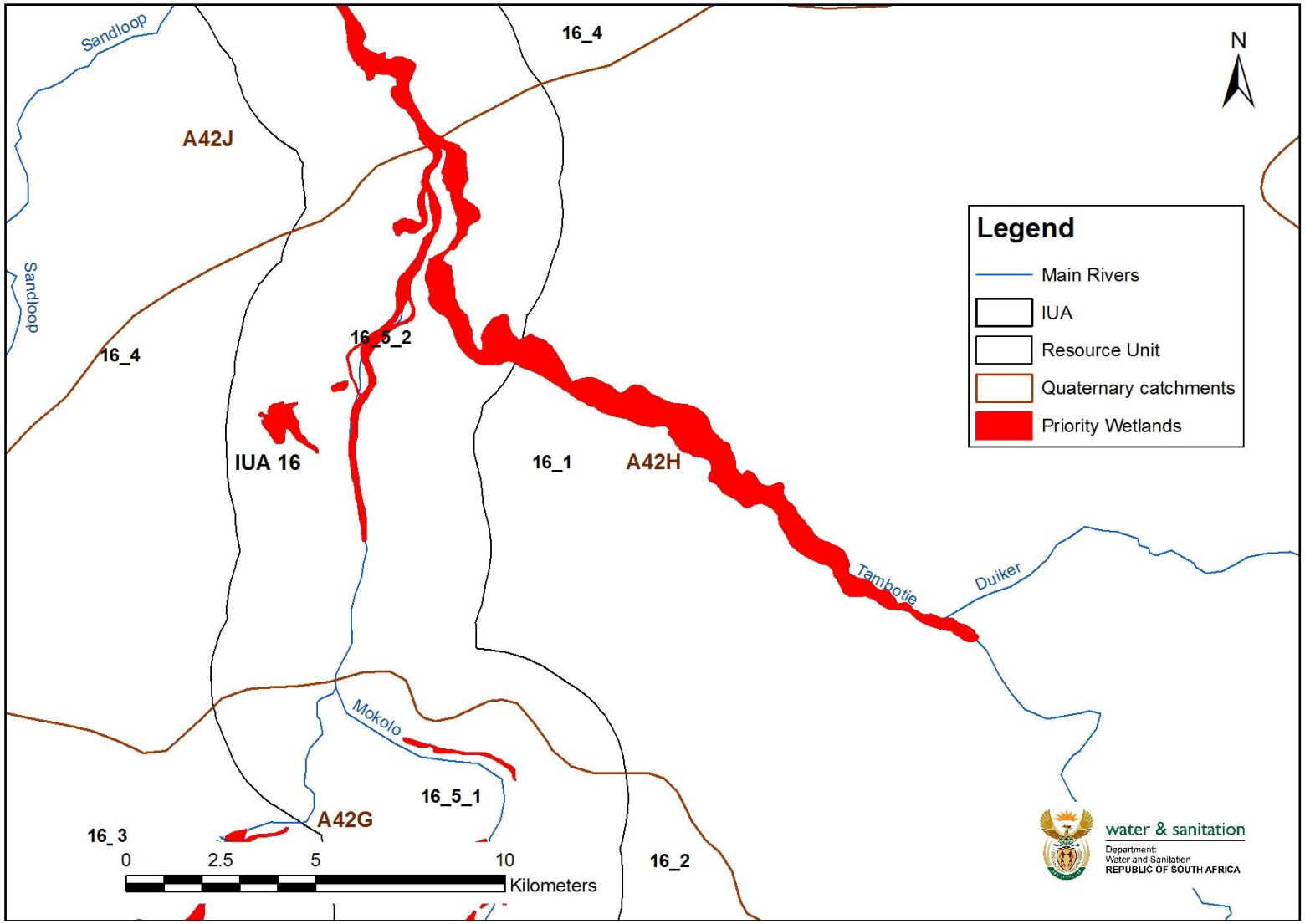


RQO Examples

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 CaCO3, 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 – see the method of Kotze, 2016).	Area based weighted Average PES Category of C.	Undertake a desktop PES assessment and determine the area based weighted average score for the wetland complex – see the method of Kotze, 2016. 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. Estimate the extent and distribution of riparian forest. 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 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 – see the method of Kotze, 2016).	Area based weighted Average PES Category of B/C.	Undertake a desktop PES assessment and determine the area based weighted average score for the wetland – see the method of Kotze, 2016. 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	Reporting rates (RR) for aquatic/wetland dependent Red Data bird species.	Overall biodiversity and populations of wetland dependent Red Data bird species must be maintained.	Verify from monitoring records and recorded sightings from available avifaunal reporting rate data. Report on this every 3 to 5 years.

5.4 NEXT STEPS

- **Finalisation based consultation and feedback**
- **PSC members input by 31st March 2017**
- **Broader Consultation – May 2017**
- **Finalise RQOs and numerical limits based on feedback (April to June 2017)**
- **Gazetting Process to be initiated from July 2017**