

DEPARTMENT OF WATER AND SANITATION

NO. 1050

02 OCTOBER 2020

**NATIONAL WATER ACT, 1998
(ACT NO. 36 OF 1998)**

**PROPOSED RESERVE DETERMINATION OF WATER RESOURCES FOR THE CROCODILE
WEST AND MARICO CATCHMENT**

I, Lindiwe Sisulu, Minister of Human Settlements, Water and Sanitation, in terms of section 16(3) of the National Water Act, 1998 (Act No. 36 of 1998) hereby publish for public comment the proposed Reserve of the water resources for the Crocodile West catchment area, as set out in the Schedule.

Any person who wishes to submit written comments with regard to the proposed Reserve should submit their comments within 60 days from the date of publication of this Notice to:

Director: Reserve Determination
Attention: Mr Yakeen Atwaru
Department of Water and Sanitation
Ndinaye Building
178 Francis Baard Street
Private Bag X313
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0001
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SISULU L (MP)
MINISTER OF WATER AND SANITATION
DATE:

SCHEDULE

RESERVE DETERMINATION OF WATER RESOURCES FOR THE CROCODILE WEST AND MARICO CATCHMENT IN TERMS OF SECTION 16(1) AND (2) OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

1. DESCRIPTION OF WATER RESOURCE

- 1.1 The Reserve is determined for all or part of every significant water resource within the catchments of the Crocodile (West) and Marico, as set out below:

Water Management Area: Limpopo
 Drainage Region: A21 to A24, A31 & A32 Tertiary Drainage Region
 River(s): Crocodile (West) and Marico river systems

- 1.2 The Minister has in terms of section 12 of the National Water Act, 1998 (Act No.36 of 1998) ("the Act"), prescribed a system for classifying water resources by issuing Government Notice No. R. 810, published in Government Gazette No. 33541 dated 17 September 2010. In terms of section 16(1) of the Act, the Minister must, as soon as reasonably practicable after the class of all or part of a water resource has been determined, by Notice in the Gazette, determine the reserve for all or part of that water resource.
- 1.3 The Minister, in terms of section 16(3) of the Act, proposes, for the purpose of section 16(1) of the Act, the following Reserves for the Crocodile West and Marico catchments.

2. PROPOSED RESERVE DETERMINATION AS REQUIRED IN TERMS OF SECTION 16(1) AND (2) OF THE NATIONAL WATER ACT, 1998

A summary of the quantity component for the Rivers which include the EWR (**Figure 1**) and the BHN in terms of section 16(1) of the Act for the Crocodile (West) and Marico catchment is set out in Section 4. **Table 4.1 & 4.2** includes the results of the EWR sites and the biophysical nodes.

A summary of the quality component for the River at EWR sites in terms of section 16(1) of the Act for the Crocodile (West) and Marico catchments is set out in **Table 5.1-5.24**.

A summary of the groundwater contribution to the Reserve for Water Quantity in terms of section 16(1) of the Act for the Crocodile (West) and Marico catchment is set out in **Table 6.1**.

A summary of the groundwater contribution to the Reserve for Water Quality in terms of section 16(1) of the Act for the Crocodile (West) and Marico catchment is set out in **Table 7.1, 7.2 and 7.3**.

The Reserve will apply from the date signed off as determined in terms of Section 16(1) of the Act, unless otherwise specified by the Minister.

3. ACRONYMS AND DEFINITIONS

3.1. Acronyms

BHN	Basic Human Needs
EcoSpecs	Ecological Specifications
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirement
GRAII	Groundwater Resource Assessment Phase II
GRDM	Groundwater Reserve Determination Methodology
GRUs	Groundwater Resource Units
MAR	Mean Annual Runoff
MCM	Million Cubic Metres
PES	Present Ecological Status
REC	Recommended Ecological Category
TEC	Target Ecological Category
TPCs	Thresholds of Potential Concern

3.2. Definitions

Baseflow is a sustained low flow in rivers during dry or fair weather conditions, but not necessarily all contributed by groundwater; and includes contribution from delayed interflow and groundwater discharge.

EWR (Ecological Water Requirements) refers to the flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition.

Recharge the addition of water to the zone of saturation, either by downward percolation of precipitation or surface water and/ or the lateral migration of groundwater from adjacent aquifers.

Reserve the quantity and quality of the water required to satisfy the basic human needs by securing a basic water supply and to protect the aquatic ecosystem in order to secure ecologically sustainable development and use of the relevant water resource.

4. SURFACE-WATER - QUANTITY COMPONENT FOR RIVERS

Proposed results for the Reserve determination and ecological categorisation for the Crocodile (West) and Marico catchment, where the Reserve amounts are expressed as a percentage of the NMAR for the respective catchments (cumulative) in terms of section (16)(1).

Table 4.1: Summary of the quantity component for the Rivers which include the EWR & BHN for the priority sites.

Node Name	Quaternary Catchment	River Name	PES	EI_ES	Ecological Category to be maintained	NMAR (MCM) ¹	EWR % NMAR ²	BHN Reserve ³ (%NMAR)	Total Reserve ⁴ (%NMAR)
EWR CROC_EWR1	A21 H	Crocodile River from Jukskei confluence to inflow Hartbeespoort Dam	D	Moderate	D	231.05	24.07	0.17	24.24
EWR site CROC_EWR2	A21C	Jukskei River	E	Moderate	D	139.9	29.19	3.55	32.74
EWR site CROC_EWR3	A21J	Crocodile from Hartbeespoort Dam to upstream Roodekopjes Dam	C/D	High	C/D	143.3	25.02	0.84	25.87
EWR site CROC_EWR4	A23B	Pienaars from Roodeplaat Dam to outlet of quaternary catchment (outlet of IUA1)	C	High	C	28.2	30.81	1.18	31.99
EWR Site CROC_EWR5	A23J	Moretele (Pienaars) to confluence with Crocodile, outlet of IUA14	D	High	D	113.0	11.82	5.23	17.05
EWR site CROC_EWR6	A22J	Hex from Bospoort Dam to inflow Vaalkop Dam	D	Moderate	D	26.9	14.96	1.35	16.31
EWR Sites CROC_EWR7	A24C	Crocodile River outflow Roodekopjes Dam to upstream Sand River confluence, Sleepfonteinspruit, Klipspruit tributaries	D	Moderate	D	463.4	13.9	0	13.9
EWR Site CROC_EWR8	A24J	Lower Crocodile from Bierspruit confluence to confluence with Limpopo, outlet of IUA13	D	Moderate	D	565.16	7.48	0.09	7.57
CROC Rapid EWR9	A21F	Magalies below Maloney's Eye	B	Moderate	B	14.61	45.93	0.58	46.51
CROC Rapid EWR10	A22A	Upper reaches of Elands (source) to Swartuggens Dam	C	Moderate	B/C	10.1	30.48	3.66	34.14
CROC Rapid EWR11	A21K	Upper reaches of Sterkstroom (source) to inflow Buffelspoort Dam	C	High	C	13.95	28.41	5.76	34.17
CROC Rapid EWR12	A23G	Plat River	C/D	Moderate	C/D	4.864	23.08	14.20	37.28
CROC Rapid EWR13	A22E	Elands from Lindleyspoort Dam to Vaalkop Dam	C	Low	C	18.77	21.90	0.312	22.21
CROC Rapid EWR14	A22H	Waterkloofspruit to confluence with Hex	B/C	Low	B/C	5.469	28.27	38.44	66.71
CROC Rapid EWR15	A21F	Magalies, Klein Magalies, Bloubank	C/D	Low	C/D	21.89	21.18	0.39	21.57
CROC Rapid EWR_16	A21A	Rietvlei (source)	C	Low	C	4.788	27.83	28.865	56.69
EWR site MAR_EWR1	A31A	Marico Eye, Kaaloog-se-Loop, Bokkraal-se-Loop, Ribbokfontein-se-Loop, Rietspruit (southern eye), Kuilsfontein, Syferfontein, Bronkhorstfontein	B	Very high	B	10.539	76.32	0	76.32
EWR Site MAR_EWR2	A31B	Groot Marico main stem upstream to Polkadraaispruit confluence	B	Very high	B	42.08	50.26	0.03	50.29

Node Name	Quaternary Catchment	River Name	PES	EI_ES	Ecological Category to be maintained	NMAR (MCM) ¹	EWR % NMAR ²	BHN Reserve ³ (%NMAR)	Total Reserve ⁴ (%NMAR)
EWB Site MAR_EWR3	A31F	Marico Groot Marico from outflow Marico Bosveld Dam to Molatedi Dam, all tributaries	C/D	High	C/D	65.083	23.62	0.33	23.95
EWB Site MAR_EWR4	A32D	Marico from Molatedi Dam to confluence with Limpopo, Rasweu, Maselaje rivers; outlet of IUA11b	C	High	C	153.25	7.96	0.01	7.97
EWB Site MAR_EWR5	A31E	Klein Marico from Klein Maricopoort Dam to Kromelleboog Dam	C	Moderate	C	16.25	11.70	0.05	11.75
MAR Rapid_EWR6	A31B	Polkadraaispruit to confluence with Marico	B/C	Moderate	B	9.87	49.27	0.13	49.39

- 1) NMAR is the Natural Mean Annual Runoff.
- 2) This amount represent the long term mean based on the NMAR. If the NMAR changes, this volume will also change.
- 3) Represents the percentage of BHN.
- 4) The total Reserve amount accounts for both the Ecological Reserve and the Basic Human Needs Reserve (BHN).

Table 4.2: Summary of the quantity component for the hydronodes sites which include the EWR & BHN

Node Name	Quaternary Catchment	River Name	PES	EI_ES	Ecological Category to be maintained	NMAR (MCM) ¹	EWR % NMAR ²	BHN Reserve ³ (%NMAR)	Total Reserve ⁴ (%NMAR)
HN1	A21A	Hennops River upstream Rietvlei Dam	C	Low	C	11.66	27.83	11.84	39.67
HN25	A22H	Hex from Olifantsnek Dam to Bospoort Dam, Sandspruit	D	Moderate	D	12.11	15.26	17.36	32.62
HN29	A22A	Elands from Swaruggens Dam to Lindleyspoort Dam	C	High	C	12.87	23.99	2.88	26.87
HN30	A22B	Upper Koster (source) to Koster Dam	C	High	C	2.54	22.77	15.19	37.97
EWB Site MAR_EWR2	A31B	Groot Marico main stem upstream to Polkadraaispruit confluence	B	Very high	B	42.08	50.26	0.03	50.29
HN63	A31B	Groot Marico from Polkadraaispruit confluence to Marico Bosveld Dam	B	Very high	B	56.92	50.61	0.02	50.63
HN65	A31E	Klein Marico from Zeerust to Klein Maricopoort Dam	C/D	Moderate	C/D	16.25	14.26	0.05	14.31
HN43	A24H	Sand to confluence with Crocodile	B	High	B	26.56	27.04	1.93	28.97

- 1) NMAR is the Natural Mean Annual Runoff.
- 2) This amount represent the long term mean based on the NMAR. If the NMAR changes, this volume will also change.
- 3) Represents the percentage of BHN.
- 4) The total Reserve amount accounts for both the Ecological Reserve and the Basic Human Needs Reserve (BHN).

5. SUMMARY OF SURFACE-WATER - QUALITY COMPONENT FOR RIVERS AT EWR SITES

EWR 1: A21H-CROCODILE RIVER, Upstream of the Hartbeespoort Dam

Table 5.1: PES categories and overall site assessment for EWR Site 1

River	Crocodile River	DWA Water Quality Monitoring points	
WQSU	3	RC	A2H013 Magalies River at Scheerpoort 2002-2007 (n=205)
EWR Site	EWR1	PES	A2H012 at Kalkheuwel on Crocodile River 2004-2008 (n=118)
Water Quality Constituents		Value	Category/Comment
Inorganic salts(mg/L)	MgSO ₄	72.755	F(5)
	Na ₂ SO ₄	13.465	A(0)
	MgCl ₂	1.368	A(0)
	CaCl ₂	15.198	A(0)
	NaCl	109.399	B(1)
Nutrients(mg/L)	PO ₄	0.610	E(4)
	TIN	4.848	E(4)
Physical variables	pH (pH units)	7.4-8.3	B(1)
	Temperature(°C)	16 (Single measurement)	Raised due to sewage/sealed surfaces
	Dissolved oxygen (mg/L)	6.3	C(2)Riffles covered
	Electrical Conductivity (mS/m)	66.56	C(2)
Response variable	Chl-a: periphyton (mg/m ²)	-	D High algal concentrations
	Biotic community composition - macroinvertebrate (ASPT) score	4.07– 4.25	E
	Fish score (FRAI)	44.5	D
	In-stream toxicity	Weekly from waste water works, high in organics	
Toxics	Ammonia (mg/L)	32	B(1)
Overall site classification (from PAI model)		D	

Table 5.2: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 1: Upstream of the Hartbeespoort Dam

RIVER		Crocodile(West)River	WATER QUALITY MONITORING POINTS			
WQSU		3	DWA WQ WMS	A2H012 Crocodile River at Kalkheuwel		
EWRSITE		EWR1	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		>45mg/L	N/A	95 th percentile to be<45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be<20mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be<15mg/L	
	CaCl ₂		<21mg/L		95 th percentile to be<21mg/L	
	NaCl		<191mg/L		95 th percentile to be<191mg/L	
Nutrients (mg/L)	SRP	Category= E	<0.125mg/L	Yes, to D	50 th percentile to be<0.125mg/L	Monthly
	TIN	Category= E	<4.0mg/L	Yes, to D	50 th percentile to be<4.0mg/L	Monthly
Physical Variables	pH	Neutral river	5 th percentile(5.9-6.5)95 th percentile (8.0–8.8)	No	5 th percentile (5.9-6.5) 95 th percentile(8.0 –8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Initiate baseline monitoring for this variable.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>6.1mg/L. Initiate Baseline monitoring for this variable.	
	Turbidity (NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category= C.	<85mS/m	No	95 th percentile to be<85mS/m	Quarterly
Response variables	Chla: periphyton	Category= D. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m ² (D category)	N/A	50 th percentile to be<84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be<30µg/L	
	Macro invertebrates (ASPT)	E (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	D(this study)				
	In-stream toxicity		Assess only if the bio-monitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	B	<43.7ug/L		95 th percentile to be <43.7ug/L	Monthly

EWR 2: A21C-JUKSKEI RIVER at Heron Bridge School**Table 5.3: PES categories and overall site assessment for EWR site 2**

River	Jukskei River	DWAF Water Quality Monitoring points	
WQSU	1	RC	A2H013 Magalies River at Scheerpoort 2002-2007(n=205)
EWR Site	EWR2	PES	A2H023 Jukskei River at Nietgedacht 2004-2008(n=114)
Water Quality Constituents		Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	71.494	F(5)
	Na ₂ SO ₄	26.244	B(1)
	MgCl ₂	0.312	A(0)
	CaCl ₂	20.236	A(0)
	NaCl	96.146	B(1)
Nutrients(mg/L)	PO ₄	0.266	E(4)
	TIN	5.460	E(4)
Physical variables	pH(pH units)	7.1-8.1	B(1)
	Temperature (° C)	Raised temperatures from waste water treatment ponds	D
	Dissolved oxygen (mg/L)	-	D
	Electrical Conductivity (mS/m)	63	C(2)
Response variable	Chl-a: periphyton (mg/m ²)	14.41	D(1)
	Biotic community composition - macro invertebrate (ASPT) score	3.8– 4.0	E/F
	Fish score	21.4%	E/F
	In-stream toxicity	-	
Toxics	Ammonia (µg/L)	80	D(3)
Overall site classification (PAI model)		D	

Table 5.4: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 2: Jukskei River at Heron Bridge School

RIVER		Juskei River	WATER QUALITY MONITORING POINTS			
WQSU		2	DWA WQ WMS	A2H023 Juskei River at Nietgedacht		
EWRSITE		EWR2	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be<45mg/L	Monthly
	Na ₂ SO ₄		<33mg/L		95 th percentile to be<33mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be<15mg/L	
	CaCl ₂		<21mg/L		95 th percentile to be<21mg/L	
	NaCl		<191mg/L		95 th percentile to be<191mg/L	
Nutrients (mg/L)	SRP	Category= E	<0.125mg/L	Yes, to D	50 th percentile to be<0.125mg/L	Monthly
	TIN	Category= E	<4.0mg/L	Yes, to D	50 th percentile to be<4.0mg/L	Monthly
Physical Variables	pH	Good	5 th percentile(5.9-6.5)95 th percentile (8.0–8.8)	Yes, to natural	5 th percentile(5.9-6.5)95 th percentile(8.0 –8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Initiate baseline monitoring for this variable.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>6.1mg/L. Initiate Baseline monitoring for this variable.	
	Turbidity (NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category= C.	<85mS/m	No	95 th percentile to be<85mS/m	Quarterly
Response variables	Chla: periphyton	Category= C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m ² (D category)	N/A	50 th percentile to be<84mg/m ²	Quarterly
	Chla: phytoplankton		<15µg/L (D category)		50 th percentile to be<15µg/L	
	Macro invertebrates (ASPT)	E/F(this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	E/F(this study)				
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the bio-monitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	D	<100ug/L		95 th percentile to be <100ug/L	Monthly

EW R 3: A21J-CROCODILE RIVER, Downstream of the Hartbeespoort Dam**Table 5.5: PES categories and overall site assessment for EWR site 3**

River	Crocodile River	DWAF Water Quality Monitoring points	
WQSU	5	RC	A2H013 Magalies River at Scheerpoort2002-2007(<i>n</i> =205)
EWR Site	EW R3	PES	A2H083 Hartbeespoort Dam:d/sWeir2004-2008 (<i>n</i> =113)
Water Quality Constituents		Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	67.562	F(5)
	Na ₂ SO ₄	9.867	A(0)
	MgCl ₂	6.856	A(0)
	CaCl ₂	27.569	B(1)
	NaCl	96.462	B(1)
Nutrients(mg/L)	PO ₄	0.123	E(4)
	TIN	1.594	B(1)
Physical variables	pH (pH units)	7.51-8.73	B(1)
	Temperature(°C)	2data points	C(2)
	Dissolved oxygen (mg/L)	2data points	C/D
	Electrical Conductivity (mS/m)	59.24	C(2)
Response variable	Chl-a: periphyton (mg/m ²)	Visual observations	E
	Biotic community composition -macro invertebrate (ASPT) score	3.8	E
	Fish score	24.9	E
	In-stream toxicity	-	
Toxics	Ammonia (mg/L)	139	E(4)
Overall site classification		D/E	

Table 5.6: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 3: Crocodile River downstream of the Hartbeespoort Dam

RIVER		Crocodile (West) River	WATER QUALITY MONITORING POINTS			
WQSU		5	DWA WQ WMS	A2H083 Hartbeespoort Dam downstream weir		
EWR SITE		EWR3	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be <45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be <20mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be <15mg/L	
	CaCl ₂		<57mg/L		95 th percentile to be <57mg/L	
	NaCl		<191mg/L		95 th percentile to be <191mg/L	
Nutrients (mg/L)	SRP	Category= E	<0.125mg/L	Yes, to D	50 th percentile to be <0.125mg/L	Monthly
	TIN	Category= D	<4.0mg/L	Yes, to D	50 th percentile to be <4.0mg/L	Monthly
Physical Variables	pH	Good	5 th percentile(5.9-6.5)95 th percentile (8.0–8.8)	Yes, to natural	5 th percentile(5.9-6.5)95 th percentile(8.0 –8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Site is downstream from a dam which will result in fluctuations in temperature and possible biotic response. Biological assessments recommended. Initiate baseline monitoring.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be >6.1mg/L. Initiate Baseline monitoring for this variable.	
	Turbidity(NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category = C.	<85mS/m	No	95 th percentile to be <85mS/m	Quarterly
Response variables	Chla: periphyton	Category = C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m ² (D category)	N/A	50 th percentile to be <84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be <30µg/L	
	Macro invertebrates (ASPT)	E (this study)	See Ecospecs for fish and invertebrates respectively			
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the bio-monitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	E	<129ug/L		95 th percentile to be <129ug/L	Monthly

EWR 4: A23B-PIENAARS RIVER, Downstream of the Roodeplaat Dam**Table 5.7: PES categories and overall site assessment for EWR site 4**

River	Pienaars River	DWA Water Quality Monitoring points	
WQSU	15	RC	A2H013 Magalies River at Scheerpoort 2002-2007 (n=205)
EWR Site	EWR4	PES	A2H006 Pienaars River at Klipdrift 2004-2008 (n=118)
Water Quality Constituents		Value	Category/Comment
Inorganic salts(mg/L)	MgSO ₄	51.250	F(5)
	Na ₂ SO ₄	5.120	A(0)
	MgCl ₂	3.704	A(0)
	CaCl ₂	14.856	A(0)
	NaCl	81.789	B(1)
Nutrients(mg/L)	PO ₄	0.049	B(1)
	TIN	0.442	A(0)
Physical variables	pH (pH units)	7.8-8.4	B(1)
	Temperature (°C)	1data point	B(1) C(2)
	Dissolved oxygen (mg/L)	5.5 (2 data points)	
	Electrical Conductivity (mS/m)	57.1	C(2)
Response variable	Chl-a: periphyton (mg/m ²)	-	Visual observations
	Biotic community Composition macro invertebrate (ASPT) score	5.8	C(2)
	Fish score	65.4%	C(2)
	In-stream toxicity	-	
Toxics	Ammonia (µg/L)	20	A(0)
Overall site classification		C	

Table 5.8: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 4: Pienaars River downstream of the Roodeplaat Dam

RIVER		Pienaars River	WATER QUALITY MONITORING POINTS			
WQSU		15	DWA WQ WMS	A2H006 Pienaarsat Klipdrift weir		
EWR SITE		EWR4	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be <45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be <20mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be <15mg/L	
	CaCl ₂		<21mg/L		95 th percentile to be <21mg/L	
	NaCl		<191mg/L		95 th percentile to be <191mg/L	
Nutrients (mg/L)	SRP	Category= B	<0.015mg/L		50 th percentile to be <0.15mg/L	Monthly
	TIN	Category= B	<0.25mg/L		50 th percentile to be <0.25mg/L	Monthly
Physical Variables	pH	Category= B, Good	5 th percentile(5.9-6.5)95 th percentile (8.0–8.8)	Yes, to natural	5 th percentile(5.9-6.5)95 th percentile(8.0–8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Site is downstream from a dam which will result in fluctuations in temperature and possible biotic response. Biological assessments recommended. Initiate baseline monitoring.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be >6.1mg/L. Initiate Baseline monitoring for this variable.	
	Turbidity (NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category = C	<85mS/m	No	95 th percentile to be <85mS/m	Quarterly
Response variables	Chla: periphyton	Category = C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m ² (D category)	N/A	50 th percentile to be <84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be <30µg/L	
	Macro invertebrates (ASPT)	C (this study)	See Ecospecs for fish and invertebrates respectively			
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	A	<15ug/L		95 th percentile to be <15ug/L	Monthly

EWR 5: A23J-PIENAARS RIVER, Downstream of the Klipvoor Dam in Borakalalo National Park**Table 5.9: PES categories and overall site assessment for EWR site 5**

River	Pienaars River	DWA Water Quality Monitoring points	
WQSU	17	RC	A2H013 Magalies River at Scheerpoort 2002-2007 (n=205)
EWRSite	EWR5	PES	A2H021 Pienaars River at Buffelspoort 2004-2008 (n=107)
Water Quality Constituents		Value	Category/Comment
Inorganic salts(mg/L)	MgSO ₄	78.335	F(5)
	Na ₂ SO ₄	16.527	A(0)
	MgCl ₂	3.820	A(0)
	CaCl ₂	24.153	B(1)
	NaCl	131.982	B(1)
Nutrients (mg/L)	PO ₄	0.598	B(1)
	TIN	0.250	A(0)
Physical variables	pH (pH units)	7.7-8.7	B(1)
	Temperature (° C)	16(n=1)	Recovers from dam B
	Dissolved oxygen (mg/L)	5.2(n=1)	
	Electrical Conductivity (mS/m)	80.8	C(2)
Response variable	Chl-a: periphyton (mg/m ²)	-	
	Biotic community composition - macroinvertebrate (ASPT) score	5.5	D
	Fishes core (FRAI)	51.3%	D
	In-streamtoxicity	-	
Toxics	Ammonia (µg/L)	47	B(1)
	Fluoride (µg/L)	600	A(0)
Overall site classification		C	

Table 5.10: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 5: Pienaars River downstream of Klipvoor dam

RIVER		Pienaars River	WATER QUALITY MONITORING POINTS			
WQSU		17	DWA WQ WMS	A2H021 Pienaars River at Buffelspoort		
EWR SITE		EWR5	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be <45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be <20mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be <15mg/L	
	CaCl ₂		<57mg/L		95 th percentile to be <57mg/L	
	NaCl		<191mg/L		95 th percentile to be <191mg/L	
Nutrients (mg/L)	SRP	Category= D	<0.015mg/L		50 th percentile to be<0.015mg/L	Monthly
	TIN	Category= B	<0.25mg/L		50 th percentile to be<0.25mg/L	Monthly
Physical Variables	pH	Category= B, Good	5 th percentile(5.9-6.5)95 th percentile (8.0 - 8.8)	Yes, to natural	5 percentile(5.9-6.5)95 percentile(8.0 - 8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Site is downstream from a dam which will result in fluctuations in temperature and possible biotic response. Biological assessments recommended. Initiate baseline monitoring.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be >6.1mg/L. Initiate Baseline monitoring for this variable.	
	Turbidity (NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category= C	<85mS/m	No	95 th percentile to be <85mS/m	Quarterly
Response variables	Chla: periphyton	Category= C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m (D ² category)	N/A	50 th percentile to be<84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be<30µg/L	
	Macro invertebrates (ASPT)	D(this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	D(this study)				
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the bio-monitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	B	<43.75ug/L		95 th percentile to be<43.75ug/L	Monthly

EWR 6: A22J-HEX RIVER, Upstream of the Vaalkop Dam**Table B11 PES categories and overall site assessment for EWR site 6**

River	Hex River	DWAF Water Quality Monitoring points	
WQSU	9	RC	A2H013 Magalies River at Scheerpoort 2002-2007 (n=205)
EWR Site	EWR6	PES	A2H094 Bospoort Dam d/s weir at Tweedepoort 1999-2004 (n=22) LOW confidence
Water Quality Constituents		Value	Category/Comment
Inorganic salts(mg/L)	MgSO ₄	133.123	F(5)
	Na ₂ SO ₄		A(0)
	MgCl ₂	33.113	C(2)
	CaCl ₂	110.127	E(4)
	NaCl	170.523	B(1)
Nutrients(mg/L)	PO ₄	0.234	E(4)
	TIN	0.775	A(0)
Physical variables	pH (pH units)	7.6-9.1	C(2)
	Temperature (°C)	2data points	C(2)
	Dissolved oxygen (mg/L)	3data points	D(3)
	Electrical Conductivity (mS/m)	95.3	D(3)
Response variable	Chl-a: periphyton (mg/m ²)	-	Visual observations
	Biotic community composition-macroinvertebrate (ASPT) score	4.6	E
	Fish score (FRAI)	49.1%	D
	In-stream toxicity	-	
Toxics	Ammonia (µg/L)	138	E(4)
	Fluoride (µg/L)	300	A(0)
Overall site classification		D	

Table 5.12 Water quality specifications for the Reserve (Quality Ecospecs) at EWR 6: Hex River upstream of the Vaalkop Dam

RIVER		Hex River	WATER QUALITY MONITORING POINTS			
WQSU		9	DWA WQ WMS	A2H094 Bospoort Dam downstream weir		
EWR SITE		EWR6	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be<45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be<20mg/L	
	MgCl ₂		<36mg/L		95 th percentile to be<36mg/L	
	CaCl ₂		<141mg/L		95 th percentile to be<141mg/L	
	NaCl		<191mg/L		95 th percentile to be<191mg/L	
Nutrients (mg/L)	SRP	Category= E	<0.125mg/L	Yes, to D	50 th percentile to be<0.125mg/L	Monthly
	TIN	Category= C	<0.25mg/L		50 th percentile to be<25mg/L	Monthly
Physical Variables	pH	Category= C, moderate	5 th percentile (5.6-5.9) 95 th percentile (8.8–9.2)	Yes	5 th percentile(5.6-5.9)95 th percentile(8.8–9.2)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Initiate baseline monitoring for this variable.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be >6.1mg/L. Initiate baseline monitoring for this variable.	
	Turbidity (NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category= D	<85mS/m	Yes, to C	95 th percentile to be<85mS/m	Quarterly
Response variables	Chla: periphyton	Category = C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m (D ² category)	N/A	50 th percentile to be<84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be<30µg/L	
	Macro invertebrates (ASPT)	E (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	D (this study)				
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	E	<129ug/L	Yes to D	95 th percentile to be <129ug/L	Monthly

EWR 7: A24C-CROCODILE RIVER, Upstream of the confluence with the Bierspruit River**Table 5.13 PES categories and overall site assessment for EWR site 7**

River	Crocodile River	DWA Water Quality Monitoring points	
WQSU	21	RC	A2H013 MagaliesRiver at Scheerpoort 2004-2007 (n=205)
EWR Site	EWR7	PES	A2H060 Crocodile River at Nooitgedacht 2004-2008 (n=113)
Water Quality Constituents		Value	Category/Comment
Inorganic salts(mg/L)	MgSO ₄	112.138	F(5)
	Na ₂ SO ₄	12.102	A(0)
	MgCl ₂	1.507	A(0)
	CaCl ₂	20.658	A(0)
	NaCl	187.768	B(1)
Nutrients(mg/L)	PO ₄	0.243	E(4)
	TIN	0.302	A(0)
Physical variables	pH(pH units)	7.8-8.5	B(1)
	Temperature (° C)	Raised temp due to lower and shallower flows	D(3)
	Dissolved oxygen (mg/L)	As above	
	Electrical Conductivity (mS/m)	92.3	D(3)
Response variable	Chl-a: periphyton (mg/m ²)	-	Algal growth on sand (visual observation)
	Biotic community composition - macroinvertebrate (ASPT) score	4.6	C
	Fish score (FRAI)	46.2%	D
	In-stream toxicity	-	
Toxics	Ammonia (µg/L)	20	B(1)
Overall site classification		D	

Table 5.14: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 7: Crocodile River upstream of confluence with Bierspruit River

RIVER		Crocodile (West) River	WATER QUALITY MONITORING POINTS			
WQSU		21	DWA WQ WMS	A2H060 Crocodile River at Nooitgedacht		
EWR SITE		EWR7	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be <45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be <20mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be <15mg/L	
	CaCl ₂		<21mg/L		95 th percentile to be <21mg/L	
	NaCl		<191mg/L		95 th percentile to be <191mg/L	
Nutrients (mg/L)	SRP	Category= E	<0.125mg/L	Yes, to D	50 th percentile to be <0.125mg/L	Monthly
	TIN	Category= A	<0.25mg/L		50 th percentile to be <0.25mg/L	Monthly
Physical Variables	pH	Category= B, Good	5 th percentile(5.9-6.5)95 th percentile (8.0–8.8)	N/A	5 percentile(5.9-6.5) 95 percentile(8.0–8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Initiate baseline monitoring for this variable.	When assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be >6.1mg/L. Initiate baseline monitoring for this variable.	
	Turbidity (NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category = D	<85mS/m	Yes, to C	95 th percentile to be <85mS/m	Quarterly
Response variables	Chla: periphyton	Category = C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m ² (D category)	N/A	50 th percentile to be <84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be <30µg/L	
	Macro invertebrates (ASPT)	E (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	D (this study)				
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	B	≤44ug/L	Yes to D	95 th percentile to be <44ug/L	Monthly

EW8: A24J-CROCODILE RIVER, Downstream of the confluence with the Bierspruit River**Table 5.15: PES categories and overall site assessment for EW8 site 8**

River	Crocodile River	DWA Water Quality Monitoring points	
WQSU	24	RC	A2H013 Magalies River at Scheerpoort 2002-2007 (n=205)
EW8 Site	EW8	PES	A2H116 Haakdoordrift d/s weir Paul Hugo Dam 2003-2008 (n=104)
Water Quality Constituents		Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	113.147	F(5)
	Na ₂ SO ₄	10.358	A(0)
	MgCl ₂	2.622	A(0)
	CaCl ₂	38.530	B(1)
	NaCl	180.659	B(1)
Nutrients (mg/L)	PO ₄	0.107	D(3)
	TIN	0.187	A(0)
Physical variables	pH (pH units)	7.7-8.6	B(1)
	Temperature(°C)	1record	B(1)
	Dissolved oxygen (mg/L)	1record	
	Electrical Conductivity (mS/m)	91	D(3)
Response variable	Chl-a: periphyton (mg/m ²)	-	Visual observation: no algae
	Biotic community composition-macroinvertebrate (ASPT) score	4.39	C
	Fish score (FRAI)	54.7%	C/D
	In-stream toxicity	-	
Toxics	Ammonia (µg/L)	25	B(1)
Overall site classification		C/D	

Table 5.16: Water quality specifications for the Reserve (Quality Ecospecs) at EWR 8: Crocodile River downstream of confluence with Bierspruit

RIVER		Crocodile (West) River	WATER QUALITY MONITORING POINTS			
WQSU		24	DWA WQ WMS	A2H116 Crocodile River at Haakdooringdrift downstream weir		
EWR SITE		EWR8	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄		<45mg/L	N/A	95 th percentile to be<45mg/L	Monthly
	Na ₂ SO ₄		<20mg/L		95 th percentile to be<20mg/L	
	MgCl ₂		<15mg/L		95 th percentile to be<15mg/L	
	CaCl ₂		<57mg/L		95 th percentile to be<57mg/L	
	NaCl		<191mg/L		95 th percentile to be<191mg/L	
Nutrients (mg/L)	SRP	Category= D	<0.125mg/L	Yes, to C	50 th percentile to be<0.125mg/L	Monthly
	TIN	Category= A	<0.25mg/L		50 th percentile to be<0.25mg/L	Monthly
Physical Variables	pH	Category= B, Good	5 th percentile(5.9-6.5)95 th percentile (8.0–8.8)	N/A	3 rd percentile (5.9-6.5) 95 th percentile(8.0–8.8)	Monthly
	Temperature	Limited data and is impacted by waste water treatment works and urbanisation.	Maintain range	N/A	Initiate baseline monitoring for this variable.	When Biotic assessments undertaken
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>6.1mg/L. Initiate Baseline monitoring for this variable.	
	Turbidity(NTU)	Turbid after heavy rains.	Moderate change allowed	N/A	Initiate baseline monitoring for this Variable and maintain natural range.	Quarterly
	Electrical conductivity (mS/m)	Category= D	<85mS/m	Yes, to C	95 th percentile to be<85mS/m	Quarterly
Response variables	Chla: periphyton	Category= C. Visual inspection indicates high algal concentrations on rocks and in pools	<84mg/m ² (D category)	N/A	50 th percentile to be<84mg/m ²	Quarterly
	Chla: phytoplankton		<30µg/L (D category)		50 th percentile to be<30µg/L	
	Macro invertebrates (ASPT)	E (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	C/D (this study)				
	In-stream toxicity	Some toxicity from industry and waste water treatment works	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown. An impact is expected if the 95 th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996).			
Toxics	Ammonia	B	<44ug/L	Yes to D	95 th percentile to be<44ug/L	Monthly

MAR EWR1: A31A-Kaaloog se Loop, below the gorge, before confluence with Marico River**Table 5.17: PES categories and overall site assessment for Mar EWR site 1**

River	Kaaloog se Loop	Water Quality Monitoring points		
WQSU	1	RC	A2H036 Steenbokfontein on Koster River 2003-2007 (n=97)	
EWR Site	MAR EWR 1	PES	188041 Rietspruit at Bridge on Kaaloog se Loop 2004-2008 (n=9)	
Water Quality Constituents		RC Value	PES Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	14.765		Insufficient data to run TEACHA effectively. EC can be used as an indication of inorganic salts for PAI
	Na ₂ SO ₄	0		
	MgCl ₂	3.015		
	CaCl ₂	4.978		
	NaCl	8.717		
Nutrients (mg/L)	PO ₄	0.016	0.02	B(1)
	TIN	0.090	0.13	A(0)
Physical variables	pH (5 th -95 th %)	7.32-7.98	8.15-8.45	B(1)
	Temperature(°C)		9.95-19.44	A/B(0.5)
	Dissolved oxygen (mg/L)		4.65-13.32	A/B(0.5)
	Electrical Conductivity (mS/m)	16.58	31.06	B(1)
Response variable	Chl-a: periphyton (mg/m ²)			
	Macro-invertebrates		5.8	A/B
	Fish community score		86.3	B
	In-stream toxicity			
Toxics	Ammonia (µg/L)	0.003	0.14	A(0)
	Fluoride (µg/L)	0.20	0.02	B(1)
Overall site classification		A/B		

Table 5.18: Water quality specifications for the Reserve (Quality Ecospecs) at MAR EWR 1 Kaaloog se Loop River

RIVER		Kaaloog se Loop River	WATER QUALITY MONITORING POINTS			
WQSU		1	DWA WQ WMS	188041 Rietspruit at bridge on Kaaloog se Loop 2004-2008 (n=9)		
EWR SITE		EWR1	RHP	Currently several monitoring sites		
Confidence in PES assessment		Low				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄	Insufficient data to run TEACHA effectively. EC can be used as an indication of inorganic salts for PAI	≤23mg/L	N/A	95 th percentile to be<23mg/L	Monthly
	Na ₂ SO ₄		≤33mg/L		95 th percentile to be<33mg/L	
	MgCl ₂		≤30mg/L		95 th percentile to be<30mg/L	
	CaCl ₂		≤57mg/L		95 th percentile to be<57mg/L	
	NaCl		≤191mg/L		95 th percentile to be<191mg/L	
Nutrients (mg/L)	SRP	Category= B	<0.015mg/L	No	50 th percentile to be<0.015mg/L	Monthly
	TIN	Category= A	<0.75mg/L	No	50 th percentile to be<0.75mg/L	Monthly
Physical Variables	pH	Neutral river	>6.5 and <8.8	No	95 th percentile to be<8.8 and >6.5	Monthly
	Temperature	Limited data and is not impacted upstream	Maintain range	N/A	Maintain natural range	Monthly
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>7mg/L.	Monthly
	Turbidity(NTU)	Turbid after heavy rains due to upstream slate mining	Moderate change allowed	N/A	Moderate change allowed	Monthly
	Electrical conductivity (mS/m)	Category= B	≤55mS/m	No	95 th percentile to be<55mS/m	Quarterly
Response variables	Chla: periphyton	Visual inspection indicates limited algal concentrations on rocks and in pools	≤1.7mg/m (A category)	N/A	50 th percentile to be<1.7mg/m ²	Quarterly
	Chla: phytoplankton		≤10µg/L (A category)		50 th percentile to be<10µg/L	
	Macro invertebrates (ASPT)	A/B (this study and RHP)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	B (this study)				
	In-stream toxicity	No toxicity	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown.			
Toxics	Ammonia	A	≤15ug/L		95 th percentile to be<15ug/L	Monthly

MAR EWR2: A31B-Groot Marico River Upstream confluence of the Sterkstroom**Table 5.19: PES categories and overall site assessment for Mar EWR site 2**

River	Groot Marico	Water Quality Monitoring points		
WQSU	1	RC	A2H036 Steenbokfontein on Koster River 2003-2007 (n=97)	
EWR Site	MAR EWR 2	PES	188035 Koedoesfontein on Groot-Marico River 2004-2008 (n=9)	
Water Quality Constituents		RC Value	PES Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	14.765		Insufficient data to run TEACHA effectively. EC can be used as an indication of inorganic salts for PAI
	Na ₂ SO ₄	0		
	MgCl ₂	3.015		
	CaCl ₂	4.978		
	NaCl	8.717		
Nutrients (mg/L)	PO ₄	0.016	0.02	B(1)
	TIN	0.090	0.11	A(0)
Physical variables	pH (5 th -95 th %)	7.32-7.98	8.02-8.38	B(1)
	Temperature(°C)		11.95-22.65	B(1)
	Dissolved oxygen (mg/L)		2.09-8.83	B(1)
	Electrical Conductivity (mS/m)	16.58	34.1	B(1)
Response variable	Chl-a: pe riphyton (mg/m ²)			
	Macro-invertebrates			A/B
	Fish community score			B
	In-stream toxicity			
Toxics	Fluoride (µg/L)	0.20	0.02	A(0)
Overall site classification		B		

Table 5.20: Water quality specifications for the Reserve (Quality Ecospecs) at MAR EWR 2

RIVER		Marico	WATER QUALITY MONITORING POINTS			
WQSU		1	DWA WQ WMS	188035 Koedoesfontein on Groot-Marico River 2004-2008 (n=9)		
EWR SITE		MAR EWR2	RHP	Currently several monitoring sites		
Confidence in PES assessment		Low				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄	Insufficient data to run TEACHA effectively. EC can be used as an indication of inorganic salts for PAI	≤23mg/L	N/A	95 th percentile to be<23mg/L	Monthly
	Na ₂ SO ₄		≤33mg/L		95 th percentile to be<33mg/L	
	MgCl ₂		≤30mg/L		95 th percentile to be<30mg/L	
	CaCl ₂		≤57mg/L		95 th percentile to be<57mg/L	
	NaCl		≤191mg/L		95 th percentile to be<191mg/L	
Nutrients (mg/L)	SRP	Category= B	<0.015mg/L	No	50 th percentile to be<0.015mg/L	Monthly
	TIN	Category= A	<0.75mg/L	No	50 th percentile to be<0.75mg/L	Monthly
Physical Variables	pH	Neutral river	>6.5 and <8.8	No	95 th percentile to be<8.8 and >6.5	Monthly
	Temperature	Limited data and is not impacted by upstream activities	Maintain range	N/A	Maintain natural range	Monthly
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>7mg/L.	Monthly
	Turbidity(NTU)	Turbid after heavy rains due to upstream slate mining	Moderate change allowed	N/A	Moderate change allowed	Monthly
	Electrical conductivity (mS/m)	Category= B	≤55mS/m	No	95 th percentile to be<55mS/m	Quarterly
Response variables	Chla: periphyton	Visual inspection indicates limited algal concentrations on rocks and in pools	≤1.7mg/m ² (A category)	N/A	50 th percentile to be<1.7mg/m ²	Quarterly
	Chla: phytoplankton		≤10µg/L (A category)		50 th percentile to be<10µg/L	
	Macro invertebrates (ASPT)	A/B (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	B/C (this study)				
	In-stream toxicity	No toxicity	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown.			
Toxics	Ammonia	A	≤15ug/L		95 th percentile to be<15ug/L	Monthly

MAR EWR3: A31F-Groot Marico River downstream of Marico Bosveld Dam
Table 5.21: PES categories and overall site assessment for Mar EWR site 3

River	Groot Marico	Water Quality Monitoring points		
WQSU	3	RC	A2H036 Steenbokfontein on Koster River 2003-2007 (n=97)	
EWR Site	MAR EWR 3	PES	A3H028 Riekersdam on left canal from Marico-Bosveld Dam 2002-2007 (n=141)	
Water Quality Constituents		RC Value	PES Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	14.765	17.112	B(1)
	Na ₂ SO ₄	0	0	A(0)
	MgCl ₂	3.015	3.7	A(0)
	CaCl ₂	4.978	4.226	A(0)
	NaCl	8.717	5.603	A(0)
Nutrients (mg/L)	PO ₄	0.016	0.023	C(2)
	TIN	0.090	0.12	B(1)
Physical variables	pH (5 th -95 th %)	7.32-7.98	7.795-8.445	B(1)
	Temperature(°C)		12.7-24.3	B(1)
	Dissolved oxygen (mg/L)		2.29-8.33	B(1)
	Electrical Conductivity (mS/m)	16.58	37.3	B(1)
Response variable	Chl-a: pe riphyton (mg/m ²)			
	Macro-invertebrates		5.3	C(2)
	Fish community score		35	D(3)
	In-stream toxicity			
Toxics	Ammonia (µg/L)	0.003	32	B(1)
	Fluoride (µg/L)	0.20	0.2	A(0)
Overall site classification		B/C		

Table 5.22: Water quality specifications for the Reserve (Quality Ecospecs) at MAR EWR 3

RIVER		Marico	WATER QUALITY MONITORING POINTS			
WQSU		3	DWA WQ WMS	A3H028 Riekersdam on left canal from Marico-Bosveld Dam 2002-2007 (n=141)		
EWR SITE		MAR EWR3	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄	A/B	≤23mg/L	N/A	95 th percentile to be<23mg/L	Monthly
	Na ₂ SO ₄		≤20mg/L		95 th percentile to be<20mg/L	
	MgCl ₂		≤15mg/L		95 th percentile to be<15mg/L	
	CaCl ₂		≤21mg/L		95 th percentile to be<21mg/L	
	NaCl		≤45mg/L		95 th percentile to be<45mg/L	
Nutrients (mg/L)	SRP	Category= C	<0.015mg/L	Yes to D	50 th percentile to be<0.025mg/L	Monthly
	TIN	Category= B	<0.75mg/L	Yes to D	50 th percentile to be<0.7mg/L	Monthly
Physical Variables	pH	Good	>6.5 and <8.8	No	95 th percentile to be<8.8 and >6.5	Monthly
	Temperature	Limited data and is impacted by Marico Bosveld Dam	Maintain range	N/A	Maintain natural range	Monthly
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>7mg/L.	Monthly
	Turbidity(NTU)	Turbid after heavy rains due to upstream slate mining	Moderate change allowed	N/A	Moderate change allowed	Monthly
	Electrical conductivity (mS/m)	Category= B	≤55mS/m	No	95 th percentile to be<85mS/m	Quarterly
Response variables	Chla: periphyton	Category=C. Visual inspection indicates high algal concentrations on rocks and in pools due to upstream agricultural runoff	≤84mg/m ² (D category)	N/A	50 th percentile to be<84mg/m ²	Quarterly
	Chla: phytoplankton		≤30µg/L (D category)		50 th percentile to be<30µg/L	
	Macro invertebrates (ASPT)	C (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	D (this study)				
	In-stream toxicity	Some toxicity from agricultural runoff upstream	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown.			
Toxics	Ammonia	B	≤43.7ug/L	Yes to D	95 th percentile to be<43.7ug/L	Monthly

MAR EWR4: A32D-Groot Marico River downstream Tswasa weir, in the Madikwe Game Reserve**Table 5.23: PES categories and overall site assessment for Mar EWR site 4**

River	Groot Marico	Water Quality Monitoring points		
WQSU	9	RC	A2H036 Steenbokfontein on Koster River 2003-2007 (n=97)	
EWR Site	MAR EWR 4	PES	A3H040 Marico River at Mooiplaats/Tzwasa weir 2002-2007 (n=181)	
Water Quality Constituents		RC Value	PES Value	Category/Comment
Inorganic salts (mg/L)	MgSO ₄	14.765	32.787	D(3)
	Na ₂ SO ₄	0	0	A(0)
	MgCl ₂	3.015	5.949	A(0)
	CaCl ₂	4.978	5.903	A(0)
	NaCl	8.717	8.698	A(0)
Nutrients (mg/L)	PO ₄	0.016	0.018	B/C(1.5)
	TIN	0.090	0.08	B(1)
Physical variables	pH (5 th -95 th %)	7.32-7.98	8.025-8.524	B(1)
	Temperature(°C)		14.5-26.5	B(1)
	Dissolved oxygen (mg/L)		5.5-11.4	B(1)
	Electrical Conductivity (mS/m)	16.58	54.2	B(1)
Response variable	Chl-a: periphyton (mg/m ²)			
	Macro-invertebrates		4.5	C
	Fish community score		61.8	C/D
	In-stream toxicity			
Toxics	Ammonia (µg/L)	0.003	0.003	A(0)
	Fluoride (µg/L)	0.20	0.6	A(0)
Overall site classification		B		

Table 5.24: Water quality specifications for the Reserve (Quality Ecospecs) at MAR EWR 3

RIVER		Marico	WATER QUALITY MONITORING POINTS			
WQSU		9	DWA WQ WMS	A3H040 Marico River at Mooiplaats/Tzwasa weir 2002-2007 (n=181)		
EWR SITE		MAR EWR4	RHP	Currently several monitoring sites		
Confidence in PES assessment		Medium				
Water Quality constituents		PES Category	WQ Ecospecs	Improvement required?	TPC	Monitoring frequency
Inorganic salts (mg/L)	MgSO ₄	A/B	≤15mg/L	N/A	95 th percentile to be<15mg/L	Monthly
	Na ₂ SO ₄		≤20mg/L		95 th percentile to be<20mg/L	
	MgCl ₂		≤15mg/L		95 th percentile to be<15mg/L	
	CaCl ₂		≤21mg/L		95 th percentile to be<21mg/L	
	NaCl		≤45mg/L		95 th percentile to be<45mg/L	
Nutrients (mg/L)	SRP	Category= B/C	≤0.125mg/L	Yes to D	50 th percentile to be<0.125mg/L	Monthly
	TIN	Category= A	≤0.25mg/L	Yes to D	50 th percentile to be<0.25mg/L	Monthly
Physical Variables	pH	Category=B, Good	>5.9 and <8.8	No	95 th percentile to be<8.8 and >5.9	Monthly
	Temperature	Limited data and is impacted by upstream impoundments	Maintain range	N/A	Maintain natural range	Monthly
	Dissolved oxygen		7-8mg/L	N/A	5 th percentile to be>7mg/L.	Monthly
	Turbidity(NTU)	Turbid after heavy rains	Moderate change allowed	N/A	Moderate change allowed	Monthly
	Electrical conductivity (mS/m)	Category= B	≤55mS/m	No	95 th percentile to be<55mS/m	Quarterly
Response variables	Chla: periphyton	Visual inspection indicates low algal concentrations on rocks and in pools	≤12mg/m ² (B category)	N/A	50 th percentile to be<12mg/m ²	Quarterly
	Chla: phytoplankton		≤15µg/L (B category)		50 th percentile to be<15µg/L	
	Macro invertebrates (ASPT)	C (this study)	See Ecospecs for fish and invertebrates respectively			
	Fish community score	C/D (this study)				
	In-stream toxicity	Limited toxicity from upstream urbanisation, waste water treatment works and agricultural runoff	Assess only if the biomonitoring results indicate there is a serious problem and the cause is unknown.			
Toxics	Ammonia	A	≤15ug/L		95 th percentile to be<15ug/L	Monthly

6. GROUNDWATER - QUANTITY COMPONENT

Table 6.1: Groundwater Resource Directed Measures (GRDM) Template (An indicator for potential surface water resources impacts due to high groundwater abstraction is added (surface water Impact))

Quaternary Catchment	Area(km ²)	Recharge (Mm ³ /a)	Population (Water Services) 2011)	Baseflow (Mm ³ /a)	EWR_MLF (Mm ³ /a)	BHN Reserve (Mm ³ /a)	Reserve (Mm ³ /a)	Reserve as % of Recharge	Current Groundwater Use (Mm ³ /a)	Stress Index
A10A	559	8.81	49366	0.00	0.35	0.45	0.80	9.08	1.37	0.16
A10B	1015	12.56	25432	0.00	0.85	0.23	1.08	8.60	1.32	0.11
A10C	271	3.58	4099	0.00	0.19	0.04	0.23	6.42	0.85	0.24
A21A	483	27.641	151332	0.54	2.51	1.38	3.89	14.08	20.35	0.74
A21B	527	30.215	758882	0.32	1.60	6.92	8.52	28.21	11.58	0.38
A21C	761	18.684	545170	1.04	5.90	4.97	10.87	58.20	1.17	0.06
A21D	372	19.655	210207	1.51	4.20	1.92	6.12	31.13	11.53	0.59
A21E	290	9.207	15659	0.41	2.49	0.14	2.63	28.60	0.77	0.08
A21F	1,000	47.399	9362	1.26	3.10	0.09	3.19	6.72	33.62	0.71
A21G	161	6.238	110652	1.74	5.23	1.01	6.24	100.03	0.49	0.08
A21H	514	20.892	45327	2.56	3.67	0.41	4.08	19.55	3.23	0.15
A21J	1,150	29.893	133204	0.29	2.02	1.22	3.24	10.82	14.10	0.47
A21K	864	23.279	88100	1.51	2.87	0.80	3.67	15.78	13.54	0.58
A21L	213	4.497	43	0.16	0.19	0.00	0.19	4.23	0.61	0.14
A22A	706	21.318	40641	0.35	1.20	0.37	1.57	7.37	1.87	0.09
A22B	284	9.365	40288	0.19	0.66	0.37	1.03	10.97	1.80	0.19
A22C	515	17.303	40288	0.00	1.30	0.37	1.67	9.64	1.03	0.06
A22D	541	14.177	40288	0.10	0.60	0.37	0.97	6.83	4.02	0.28
A22E	812	19.386	6427	0.16	1.41	0.06	1.47	7.58	1.90	0.10
A22F	1,688	35.691	130476	0.95	2.25	1.19	3.44	9.64	4.02	0.11
A22G	499	17.989	846	0.35	1.00	0.01	1.01	5.60	1.46	0.08
A22H	579	15.612	230416	0.06	0.36	2.10	2.46	15.77	6.16	0.39
A22J	592	8.518	39935	0.22	0.81	0.36	1.17	13.79	2.20	0.26
A23A	682	28.30	391615	13.45	4.10	3.57	7.67	27.10	12.77	0.45
A23B	814	10.502	36522	0.28	2.00	0.33	2.33	22.22	1.45	0.14
A23C	491	6.2	2308	0.10	0.74	0.02	0.76	12.28	0.79	0.13
A23D	252	18.726	125166	1.77	2.43	1.14	3.57	19.08	13.73	0.73
A23E	490	6.28	75096	0.06	1.51	0.69	2.20	34.96	3.10	0.49
A23F	565	6.476	361907	0.28	0.69	3.30	3.99	61.65	0.74	0.11
A23G	951	20.58	75670	0.82	0.82	0.69	1.51	7.34	10.89	0.53
A23H	1,058	28.124	14570	0.13	2.20	0.13	2.33	8.30	2.59	0.09
A23J	930	6.782	647955	0.82	1.56	5.91	7.47	110.18	0.43	0.06

Quaternary Catchment	Area(km ²)	Recharge (Mm ³ /a)	Population (Water Services) 2011)	Baseflow (Mm ³ /a)	EWR_MLF (Mm ³ /a)	BHN Reserve (Mm ³ /a)	Reserve (Mm ³ /a)	Reserve as % of Recharge	Current Groundwater Use (Mm ³ /a)	Stress Index
A23K	1,131	10.964	452332	0.13	1.20	4.13	5.33	48.59	0.50	0.05
A23L	329	3.074	4423	0.35	0.60	0.04	0.64	20.83	0.62	0.20
A24A	493	5.73	8153	0.92	0.95	0.07	1.02	17.88	2.91	0.51
A24B	709	18.594	732	0.22	1.10	0.01	1.11	5.95	1.05	0.06
A24C	801	20.297	25539	0.13	0.07	0.23	0.30	1.49	11.18	0.55
A24D	1,327	20.547	50853	0.00	1.43	0.46	1.89	9.22	1.46	0.07
A24E	688	10.585	42926	0.00	0.73	0.39	1.12	10.60	0.01	0.00
A24F	591	12.09	25539	0.00	0.68	0.23	0.91	7.55	6.04	0.50
A24G	735	24.662	25539	0.35	2.12	0.23	2.35	9.54	0.36	0.01
A24H	1,338	37.309	56281	1.86	1.35	0.51	1.86	4.99	4.21	0.11
A24J	2,516	35.192	3778	0.60	1.71	0.03	1.74	4.96	39.50	1.12
A31A	632	16.878	9106	6.00	1.83	0.08	1.91	11.33	3.64	0.22
A31B	596	15.928	1390	6.00	3.02	0.01	3.03	19.04	2.68	0.17
A31C	485	15.045	2597	1.00	0.32	0.02	0.34	2.28	3.77	0.25
A31D	704	20.906	15615	1.00	0.55	0.14	0.69	3.31	3.42	0.16
A31E	601	17.336	936	2.00	1.25	0.01	1.26	7.26	0.81	0.05
A31F	702	22.388	24060	2.00	0.90	0.22	1.12	5.00	2.13	0.10
A31G	1,425	24.094	46990	4.00	3.17	0.43	3.60	14.94	0.67	0.03
A31H	684	15.299	32553	0.00	0.64	0.30	0.94	6.12	0.45	0.03
A31J	844	18.52	536	0.00	0.31	0.00	0.31	1.70	0.27	0.01
A32A	472	5.425	9952	0.00	0.18	0.09	0.27	4.99	0.04	0.01
A32B	641	14.587	5439	0.00	0.47	0.05	0.52	3.56	0.05	0.00
A32C	902	17.582	77	0.00	0.59	0.00	0.59	3.36	0.00	0.00
A32D	843	14.373	1538	0.00	0.59	0.01	0.60	4.20	0.13	0.01
A32E	2,499	15.775	2776	0.00	1.66	0.03	1.69	10.68	0.60	0.04

7. GROUNDWATER - QUALITY COMPONENT

Groundwater quality per quaternary catchment was determined from the data sets obtained from the Water Management System of the Department of Water and Sanitation. Groundwater quality was defined by the water quality specifications in Table 7.1 below.

Table 7.1: Water Quality Specifications

Chemical Parameter	Target Water Quality Ranges ¹⁾			
	Class 0	Class I	Class II	Class III
pH	6 – 9	5 – 6 & 9 – 9.5	4 – 5 & > 9.5 – 10	<4 & > 10
Electrical Conductivity	< 70	70 - 150	150 – 370	> 370
Calcium as Ca	< 80	80 - 150	150 – 300	> 300
Magnesium as Mg	< 70	70 - 100	100 – 200	> 200
Sodium as Na	< 100	100 - 200	200 – 400	> 400
Chloride as Cl	< 100	100 - 200	200 – 600	> 600
Sulphate as SO ₄	< 200	200 - 400	400 – 600	> 600
Nitrate as NO _x -N	< 6	6 - 10	10 – 20	> 20
Fluoride as F	<0.7	0.7 – 1.0	1.0 – 1.5	> 1.5

¹⁾ Ref: *Quality of Domestic Water Supplies, Volume 1: Assessment Guide, 2nd Ed.* 1998. Water Research Commission Report No: TT 101/98. Pretoria, South Africa.

NOTE:

- Class 0** This is ideal water quality, suitable for lifetime use, with no adverse health effects on the user. This class is essentially the same as the target water quality range in the 2nd edition of the *South African Water Quality Guidelines for Domestic Use* (DWAF, 1996).
- Class I** Water in this class is safe for lifetime use, but falls short of the ideal water quality in that there may be instances of adverse health effects, but these are usually mild, and overt health effects are almost sub-clinical and difficult to demonstrate. Water in Class I does not cause health effects under normal circumstances. Aesthetic effects may, however, be apparent.
- Class II** Water in this class is defined as that where adverse health effects are unusual for limited short-term use. Adverse health effects may become more common particularly with prolonged use over many years, or with lifetime use. This class represents water suitable for short-term or emergency use only, but not necessarily suitable for continuous use over a lifetime.
- Class III** This water has constituents in a concentration range where serious health effects might be anticipated, particularly in infants or elderly people with short-term use, and even more so with longer term use. The water in this class is not suitable for use as drinking water without adequate treatment to shift the water into a lower and safer class.

Table 7.2 Groundwater quality per Quaternary Catchment

Chemical Parameter	Unit	Quaternary Catchments A21A, A21B, A21C & A21D												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A21A	A21B	A21C	A21D	A21A	A21B	A21C	A21D		A21A	A21B	A21C	A21D
pH		377	227	19	635	7.75	7.60	7.30	7.23	5.0 – 9.5	8.53	8.36	8.03	7.95
Electrical Conductivity	mS/m	383	227	19	638	25.80	51.00	29.70	66.00	<150	28.38	56.10	32.67	72.60
Calcium as Ca	mg/l	344	227	18	635	25.40	47.00	18.60	59.00	<150	27.94	51.70	20.46	64.90
Magnesium as Mg	mg/l	344	227	18	635	15.10	31.00	7.70	28.00	<100	16.61	34.10	8.47	30.80
Sodium as Na	mg/l	344	227	16	638	3.00	10.00	19.70	25.00	<200	3.30	11.00	21.67	27.50
Chloride as Cl	mg/l	344	227	18	638	3.60	12.00	18.60	14.00	<200	3.96	13.20	20.46	15.40
Sulphate as SO ₄	mg/l	344	227	16	629	4.50	13.00	13.80	154.00	<400	4.95	14.30	15.18	169.40
Nitrate as NO _x -N	mg/l	343	227	18	578	0.80	2.30	4.50	2.30	<10	0.88	2.53	4.95	2.53
Fluoride as F	mg/l	344	227	18	578	0.12	0.14	0.20	0.05	<1.0	0.13	0.15	0.22	0.06
Chemical Parameter	Unit	Quaternary Catchments A21E, A21F, A21G & A21H												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A21E	A21F	A21G	A21H	A21E	A21F	A21G	A21H		A21E	A21F	A21G	A21H
pH		3	307	118	7	6.70	7.58	8.24	7.90	5.0 – 9.5	7.37	8.34	9.06	8.69
Electrical Conductivity	mS/m	3	324	126	7	20.10	25.60	37.00	47.10	<150	22.11	28.16	40.70	51.81
Calcium as Ca	mg/l	3	311	116	4	10.83	25.40	39.80	27.72	<150	11.92	27.94	43.78	30.49
Magnesium as Mg	mg/l	3	311	116	4	4.30	15.80	24.00	22.10	<100	4.73	17.38	26.40	24.30
Sodium as Na	mg/l	3	311	116	4	18.10	2.50	1.00	28.76	<200	19.91	2.75	1.10	31.63
Chloride as Cl	mg/l	3	311	116	4	19.73	1.50	3.70	12.89	<200	21.71	1.65	4.07	14.17
Sulphate as SO ₄	mg/l	3	311	116	4	4.47	4.80	5.05	12.23	<400	4.91	5.28	5.56	13.45
Nitrate as NO _x -N	mg/l	3	312	118	4	2.57	0.26	0.17	0.45	<10	2.82	0.29	0.19	0.49
Fluoride as F	mg/l	—	311	116	4	—	0.10	0.12	0.29	<1.0	—	0.11	0.13	0.32

Chemical Parameter	Unit	Quaternary Catchments A21J, A21K, A21L & A22A												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A21J	A21K	A21L	A22A	A21J	A21K	A21L	A22A		A21J	A21K	A21L	A22A
pH		150	1795	10	40	6.90	7.67	7.61	7.50	5.0 – 9.5	7.59	8.43	8.37	8.25
Electrical Conductivity	mS/m	150	1794	10	40	179.50	330.50	31.80	32.35	<150	179.50	330.50	34.98	35.38
Calcium as Ca	mg/l	142	1801	9	36	72.36	234.00	32.00	5.72	<150	79.60	234.00	35.20	6.29
Magnesium as Mg	mg/l	142	1801	9	36	97.98	158.00	6.10	22.43	<100	100.00	158.00	6.71	24.67
Sodium as Na	mg/l	141	1800	9	36	125.30	256.96	23.46	17.56	<200	136.83	256.96	25.80	19.32
Chloride as Cl	mg/l	142	1796	9	36	199.06	370.59	5.00	5.00	<200	200.00	370.59	5.50	5.50
Sulphate as SO ₄	mg/l	141	1796	9	36	192.65	836.09	5.20	5.79	<400	211.92	836.09	5.72	6.37
Nitrate as NO _x -N	mg/l	142	1770	9	36	7.29	3.05	3.75	0.31	<10	8.02	3.35	4.12	0.33
Fluoride as F	mg/l	142	1560	9	36	0.22	0.01	0.33	0.32	<1.0	0.24	0.011	0.37	0.35
Chemical Parameter	Unit	Quaternary Catchments A22B, A22C, A22D & A22E												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A22B ⁺	A22C ⁺	A22D ⁺	A22E	A22B ⁺	A22C ⁺	A22D ⁺	A22E		A22B ⁺	A22C ⁺	A22D ⁺	A22E
pH		29	108	4	29	7.96	7.80	7.23	7.96	5.0 – 9.5	8.75	8.58	7.96	8.75
Electrical Conductivity	mS/m	29	108	4	29	38.80	42.95	38.95	38.80	<150	42.68	47.25	42.84	42.68
Calcium as Ca	mg/l	29	101	4	29	27.40	45.50	17.20	27.40	<150	30.14	50.05	18.92	30.14
Magnesium as Mg	mg/l	29	101	4	29	25.83	26.90	23.62	25.83	<100	28.42	29.59	25.99	28.42
Sodium as Na	mg/l	29	101	4	29	6.80	4.44	13.58	6.80	<200	7.48	4.88	14.94	7.48
Chloride as Cl	mg/l	29	101	4	29	5.00	4.10	5.25	5.00	<200	5.50	4.51	5.78	5.50
Sulphate as SO ₄	mg/l	29	101	4	29	6.18	5.00	3.70	6.18	<400	6.80	5.50	4.07	6.80
Nitrate as NO _x -N	mg/l	29	101	4	29	0.56	1.04	2.01	0.56	<10	0.61	1.15	2.21	0.61
Fluoride as F	mg/l	29	101	4	29	0.35	0.12	0.35	0.35	<1.0	0.38	0.13	0.39	0.38

Chemical Parameter	Unit	Quaternary Catchments A22F, A22G, A22H & A22J												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A22F	A22G	A22H	A22J	A22F	A22G	A22H	A22J		A22F	A22G	A22H	A22J
pH		52	108	3457	25	7.88	7.80	7.64	7.94	5.0 – 9.5	8.67	8.58	8.40	8.73
Electrical Conductivity	mS/m	52	108	3457	25	58.05	42.95	412.00	108.00	<150	63.86	47.25	412.00	118.80
Calcium as Ca	mg/l	46	101	3460	20	43.75	45.50	288.84	100.68	<150	48.13	50.05	288.84	110.75
Magnesium as Mg	mg/l	46	101	3461	20	20.74	26.90	205.50	62.56	<100	22.81	29.59	205.50	68.82
Sodium as Na	mg/l	46	101	3461	20	28.27	4.44	313.50	48.37	<200	31.10	4.88	313.50	53.20
Chloride as Cl	mg/l	46	101	3456	20	18.63	4.10	325.94	43.32	<200	20.49	4.51	325.94	47.65
Sulphate as SO ₄	mg/l	46	101	3457	20	25.99	5.00	1169.29	46.64	<400	28.59	5.50	1169.29	51.30
Nitrate as NO _x -N	mg/l	46	101	3405	20	0.24	1.04	1.00	15.95	<10	0.26	1.15	1.10	15.95
Fluoride as F	mg/l	46	101	2967	20	0.48	0.12	0.01	0.15	<1.0	0.53	0.13	0.011	0.16
Chemical Parameter	Unit	Quaternary Catchments A23A, A23B, A23C & A23D												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A23A	A23B	A23C	A23D	A23A	A23B	A23C	A23D		A23A	A23B	A23C	A23D
pH		148	798	83	31	7.20	7.90	7.92	7.70	5.0 – 9.5	7.92	8.93	8.71	8.47
Electrical Conductivity	mS/m	148	817	83	31	47.00	53.00	250.00	37.20	<150	51.70	58.30	250.00	40.92
Calcium as Ca	mg/l	149	757	76	31	40.00	54.00	84.06	32.20	<150	44.00	59.40	92.47	35.42
Magnesium as Mg	mg/l	149	758	76	31	23.00	33.00	53.15	24.00	<100	25.30	36.30	58.47	26.40
Sodium as Na	mg/l	149	758	74	31	16.00	4.00	371.04	4.90	<200	17.60	4.40	371.04	5.39
Chloride as Cl	mg/l	149	758	76	31	7.00	6.00	413.64	5.30	<200	7.70	6.60	413.64	5.83
Sulphate as SO ₄	mg/l	149	758	74	31	5.00	5.00	109.77	11.50	<400	5.50	5.50	120.74	12.65
Nitrate as NO _x -N	mg/l	149	797	76	31	3.00	1.00	11.45	0.83	<10	3.30	1.10	11.45	0.91
Fluoride as F	mg/l	149	758	76	31	0.20	0.15	1.01	0.11	<1.0	0.22	0.17	1.01	0.12

Chemical Parameter	Unit	Quaternary Catchments A23E, A23F, A23G, A23H												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A23E	A23F	A23G	A23H	A23E	A23F	A23G	A23H		A23E	A23F	A23G	A23H
pH		988	6	266	68	7.66	7.32	7.93	8.47	5.0 – 9.5	8.43	8.05	8.72	8.47
Electrical Conductivity	mS/m	988	6	255	68	90.80	69.55	65.30	56.70	<150	99.88	76.51	71.83	62.37
Calcium as Ca	mg/l	988	6	255	67	82.60	41.40	24.10	53.90	<150	90.86	45.54	26.51	59.29
Magnesium as Mg	mg/l	988	6	258	67	51.80	35.70	6.49	28.30	<100	56.98	39.27	7.14	31.13
Sodium as Na	mg/l	988	6	266	67	31.46	24.65	60.90	18.60	<200	34.60	27.12	66.99	20.46
Chloride as Cl	mg/l	988	6	255	67	71.25	42.60	53.55	10.10	<200	78.38	46.86	58.91	11.11
Sulphate as SO ₄	mg/l	988	6	258	67	109.50	19.65	8.90	5.10	<400	120.45	21.62	9.79	5.61
Nitrate as NO _x -N	mg/l	988	6	266	67	5.16	5.09	0.85	2.03	<10	5.67	5.60	0.94	2.23
Fluoride as F	mg/l	988	6	258	67	0.05	0.36	0.69	0.30	<1.0	0.06	0.39	0.76	0.33
Chemical Parameter	Unit	Quaternary Catchments A23J, A23K, A23L & A24A												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A23J	A23K	A23L	A24A	A23J	A23K	A23L	A24A		A23J	A23K	A23L	A24A
pH		127	5	21	57	8.37	8.18	8.13	7.84	5.0 – 9.5	9.21	9.00	8.95	8.62
Electrical Conductivity	mS/m	127	5	21	57	38.40	63.00	112.40	89.90	<150	42.24	69.30	123.64	98.89
Calcium as Ca	mg/l	121	5	18	53	38.90	53.07	15.47	90.85	<150	42.79	58.38	17.02	99.94
Magnesium as Mg	mg/l	122	5	18	53	23.75	16.20	2.30	52.14	<100	26.13	17.82	2.53	57.36
Sodium as Na	mg/l	122	5	18	53	2.38	52.99	215.24	19.38	<200	2.62	58.29	215.24	21.32
Chloride as Cl	mg/l	122	5	18	53	5.00	64.79	226.96	63.96	<200	5.50	71.26	226.96	70.36
Sulphate as SO ₄	mg/l	121	5	18	53	6.70	11.90	10.43	10.60	<400	7.37	13.09	11.47	11.66
Nitrate as NO _x -N	mg/l	123	5	18	53	0.17	0.77	0.04	1.24	<10	0.18	0.85	0.05	1.37
Fluoride as F	mg/l	121	5	21	53	0.16	1.03	8.81	0.54	<1.0	0.18	1.03	8.81	0.59

Chemical Parameter	Unit	Quaternary Catchments A24B, A24C, A24D & A24E												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A24B	A24C	A24D	A24E	A24B	A24C	A24D	A24E		A24B	A24C	A24D	A24E
pH		36	137	24	10	7.70	7.70	8.19	7.92	5.0 – 9.5	8.47	8.47	9.01	8.71
Electrical Conductivity	mS/m	36	137	24	10	129.15	129.00	91.25	63.00	<150	142.07	141.90	119.60	69.30
Calcium as Ca	mg/l	36	139	20	8	115.50	79.50	1.96	64.10	<150	127.05	87.45	2.15	70.51
Magnesium as Mg	mg/l	36	139	20	8	85.50	58.00	129.85	34.65	<100	100.00	63.80	129.85	38.12
Sodium as Na	mg/l	36	139	20	8	77.40	90.50	5.91	26.50	<200	85.14	99.55	6.50	29.15
Chloride as Cl	mg/l	36	139	20	8	139.30	143.10	5.25	29.79	<200	153.23	157.41	5.78	32.77
Sulphate as SO ₄	mg/l	36	139	20	8	63.70	68.20	4.83	22.50	<400	70.07	75.02	5.32	24.75
Nitrate as NO _x -N	mg/l	36	139	20	8	8.63	3.75	1.98	14.95	<10	9.49	4.13	2.17	14.95
Fluoride as F	mg/l	36	139	20	8	0.81	0.84	0.10	0.25	<1.0	0.89	0.92	0.11	0.28
Chemical Parameter	Unit	Quaternary Catchments A24F, A24G, A24H & A24J												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A24F	A24G	A24H	A24J	A24F	A24G	A24H	A24J		A24F	A24G	A24H	A24J
pH		444	8	26	309	7.60	7.00	7.59	7.90	5.0 – 9.5	8.36	7.70	8.35	8.69
Electrical Conductivity	mS/m	435	8	26	309	297.00	45.00	76.35	102.40	<150	297.00	49.50	83.99	112.64
Calcium as Ca	mg/l	434	8	26	278	152.00	41.00	44.75	62.80	<150	152.00	45.10	49.23	69.08
Magnesium as Mg	mg/l	433	8	26	278	115.00	4.00	32.30	58.10	<100	115.00	4.40	35.53	63.91
Sodium as Na	mg/l	446	8	26	278	305.00	33.00	38.60	62.80	<200	305.00	36.30	42.46	69.08
Chloride as Cl	mg/l	434	8	26	278	825.60	10.00	29.50	85.35	<200	825.60	11.00	32.45	93.89
Sulphate as SO ₄	mg/l	445	8	26	278	115.50	18.00	9.90	46.70	<400	127.05	19.80	10.89	51.37
Nitrate as NO _x -N	mg/l	336	8	26	278	3.48	0.12	0.89	5.56	<10	3.82	0.13	0.98	6.12
Fluoride as F	mg/l	392	8	26	278	0.21	3.00	0.67	0.68	<1.0	0.23	3.30	0.73	0.75

Chemical Parameter	Unit	Quaternary Catchments A31, A31B, A31C & A31D												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A31A	A31B	A31C	A31D	A31A	A31B	A31C	A31D		A31A	A31B	A31C	A31D
pH		75	30	480	710	8.05	7.37	7.90	8.00	5.0 – 9.5	8.86	8.11	8.69	8.80
Electrical Conductivity	mS/m	75	30	526	758	30.50	69.75	47.40	50.90	<150	33.55	76.73	52.14	55.99
Calcium as Ca	mg/l	75	25	473	695	30.54	85.27	47.60	53.50	<150	33.59	93.80	52.36	58.85
Magnesium as Mg	mg/l	75	25	473	697	18.20	56.80	31.25	32.17	<100	20.02	62.48	34.38	35.39
Sodium as Na	mg/l	75	25	473	697	3.40	17.60	2.60	3.20	<200	3.74	19.35	2.86	3.52
Chloride as Cl	mg/l	75	25	473	698	5.69	35.90	4.60	5.69	<200	6.26	39.49	5.06	6.26
Sulphate as SO ₄	mg/l	75	25	473	697	3.00	59.33	4.50	10.10	<400	3.30	65.26	4.95	11.11
Nitrate as NO _x -N	mg/l	75	25	476	695	0.23	1.64	0.21	0.31	<10	0.25	1.81	0.23	0.35
Fluoride as F	mg/l	75	25	473	682	0.10	0.26	0.19	0.23	<1.0	0.11	0.29	0.21	0.25
Chemical Parameter	Unit	Quaternary Catchments A31E, A31F, A31G & A31H												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A31E	A31F	A31G	A31H	A31E	A31F	A31G	A31H		A31E	A31F	A31G	A31H
pH		7	26	16	27	7.50	7.79	8.13	7.92	5.0 – 9.5	8.25	8.57	8.95	8.71
Electrical Conductivity	mS/m	7	26	16	27	17.70	74.65	41.95	76.40	<150	19.47	82.12	46.15	84.04
Calcium as Ca	mg/l	7	21	13	22	14.20	18.10	20.93	44.68	<150	15.62	19.91	23.02	49.15
Magnesium as Mg	mg/l	7	21	13	22	10.00	15.50	35.00	23.11	<100	11.00	17.05	38.50	25.42
Sodium as Na	mg/l	7	21	13	22	5.80	14.70	8.55	81.63	<200	6.38	16.17	9.40	89.79
Chloride as Cl	mg/l	7	22	13	22	3.30	5.30	5.00	65.68	<200	3.63	5.83	5.50	72.24
Sulphate as SO ₄	mg/l	7	22	13	22	2.00	9.99	3.00	10.77	<400	2.20	10.99	3.30	11.85
Nitrate as NO _x -N	mg/l	7	22	13	22	0.35	2.06	0.27	8.43	<10	0.38	2.27	0.30	9.27
Fluoride as F	mg/l	7	22	13	22	0.27	0.16	0.11	0.42	<1.0	0.30	0.18	0.12	0.46

Chemical Parameter	Unit	Quaternary Catchments A31J, A32A, A32B & A32C												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A31J	A32A	A32B +	A32C +	A31J	A32A	A32B +	A32C +		A31J	A32A	A32B +	A32C +
pH		7	23	24	7	7.72	8.15	8.19	7.72	5.0 – 9.5	8.49	8.97	9.01	8.49
Electrical Conductivity	mS/m	7	23	24	7	76.00	90.10	91.25	76.00	<150	83.60	99.11	119.60	83.60
Calcium as Ca	mg/l	5	18	20	5	46.60	25.29	1.96	46.60	<150	51.26	27.82	2.15	51.26
Magnesium as Mg	mg/l	5	18	20	5	72.10	96.40	129.85	72.10	<100	79.31	106.04	129.85	79.31
Sodium as Na	mg/l	5	18	20	5	27.70	23.87	5.91	27.70	<200	30.47	26.25	6.50	30.47
Chloride as Cl	mg/l	6	18	20	6	4.70	25.39	5.25	4.70	<200	5.17	27.92	5.78	5.17
Sulphate as SO ₄	mg/l	5	18	20	5	22.40	33.30	4.83	22.40	<400	24.64	36.63	5.32	24.64
Nitrate as NO _x -N	mg/l	6	18	20	6	2.53	5.77	1.98	2.53	<10	2.78	6.35	2.17	2.78
Fluoride as F	mg/l	5	18	20	5	0.18	0.19	0.10	0.18	<1.0	0.20	0.21	0.11	0.20
Chemical Parameter	Unit	Quaternary Catchments A32D, A32E, A10A & A10B												
		No. of Samples				Ambient GW quality or median ¹⁾				BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾			
		A32D +	A32E	A10A	A10B	A32D +	A32E	A10A	A10B		A32D +	A32E	A10A	A10B
pH		24	68	503	38	8.19	8.06	7.98	7.88	5.0 – 9.5	9.01	8.87	8.78	8.67
Electrical Conductivity	mS/m	24	68	473	38	91.25	106.70	45.70	76.20	<150	119.60	117.34	50.27	83.82
Calcium as Ca	mg/l	20	63	435	31	1.96	64.97	49.10	45.20	<150	2.15	71.47	54.01	49.72
Magnesium as Mg	mg/l	20	63	499	31	129.85	67.79	29.00	26.40	<100	129.85	74.57	31.90	29.04
Sodium as Na	mg/l	20	63	499	31	5.91	66.66	2.40	56.41	<200	6.50	73.33	2.64	62.05
Chloride as Cl	mg/l	20	63	432	31	5.25	59.93	4.80	54.00	<200	5.78	65.48	5.28	59.40
Sulphate as SO ₄	mg/l	20	63	499	31	4.83	15.86	4.40	10.79	<400	5.32	17.45	4.84	11.87
Nitrate as NO _x -N	mg/l	20	67	500	32	1.98	11.81	0.79	7.34	<10	2.17	11.81	0.87	8.08
Fluoride as F	mg/l	20	63	499	31	0.10	0.41	0.10	0.40	<1.0	0.11	0.45	0.11	0.44

Chemical Parameter	Unit	Quaternary Catchment A10C			
		No. of Samples	Ambient GW quality or median ¹⁾	BHN Reserve ²⁾	Groundwater Quality Reserve ³⁾
		A10C	A10C		A10C
pH		22	7.96	5.0 – 9.5	8.75
Electrical Conductivity	mS/m	22	108.60	<150	119.46
Calcium as Ca	mg/l	17	109.10	<150	120.01
Magnesium as Mg	mg/l	17	89.65	<100	98.62
Sodium as Na	mg/l	17	6.53	<200	7.18
Chloride as Cl	mg/l	17	18.91	<200	20.80
Sulphate as SO ₄	mg/l	17	9.12	<400	10.03
Nitrate as NO _x -N	mg/l	17	8.06	<10	8.86
Fluoride as F	mg/l	17	0.24	<1.0	0.26

¹⁾ Based on data obtained from the National Groundwater Archive. Values reported are the statistical median of each parameter.

²⁾ Ref: *Quality of Domestic Water Supplies, Volume 1: Assessment Guide, 2nd Ed.* 1998. Water Research Commission Report No: TT 101/98. Pretoria, South Africa (Set for a Class 1).

³⁾ Where a difference in the water quality values for the ambient groundwater quality and basic human needs was found, the lesser or more protective value was selected for the groundwater quality Reserve. Where the ambient groundwater quality was selected as the groundwater quality Reserve, the value was scaled up by 10 per cent provided that the value does not exceed the BHN Reserve.

A total of 6 quaternary catchments do not have groundwater chemistry data, and are as highlighted in red in Table 7.2 above. The ambient groundwater quality was extrapolated from neighbouring quaternary catchments with a similar geology because geology has a huge bearing on the water quality of an area.

Table 7.3: Summary of the water quality class and parameters of concern

Quaternary catchment	Water quality class (WRC, 1998)	Water quality parameters of concern
A10A	0	None
A10B	I	None
A10C	I	Calcium, Electrical Conductivity, Magnesium, Nitrate
A21A	0	None
A21B	0	None
A21C	0	None
A21D	0	None
A21E	0	None
A21F	0	None
A21G	0	None
A21H	0	None
A21J	I	Sodium, Magnesium, Chloride, Nitrate, Electrical Conductivity
A21K	III	Sulphate, Calcium, Magnesium, Sodium, Chloride, Electrical Conductivity
A21L	0	None
A22A	0	None
A22B	0	None
A22C	0	None
A22D	0	None
A22E	0	None
A22F	0	None
A22G	0	None
A22H	III	Sulphate, Electrical Conductivity, Calcium, Magnesium, Sodium, Chloride,
A22J	I	Electrical Conductivity, Nitrate
A23A	0	None
A23B	0	None
A23C	II	Chloride, Electrical Conductivity, Fluoride, Nitrate, Sodium
A23D	0	None
A23E	I	Calcium, Electrical Conductivity
A23F	0	None
A23G	0	None
A23H	0	None
A23J	0	None
A23K	II	Fluoride
A23L	III	Fluoride, Sodium, Chloride
A24A	I	Calcium, Electrical Conductivity
A24B	I	Electrical Conductivity, Calcium, Magnesium, Sodium, Chloride
A24C	I	Chloride, Fluoride, Electrical Conductivity
A24D	I	Magnesium, Electrical Conductivity
A24E	0	None
A24F	III	Chloride, Electrical Conductivity, Sodium, Magnesium, Calcium
A24G	0	None
A24H	I	Electrical Conductivity
A24J	I	Electrical Conductivity
A31A	0	None
A31B	I	Calcium
A31C	0	None
A31D	0	None
A31E	0	None
A31F	I	Electrical Conductivity
A31G	0	None
A31H	I	Electrical Conductivity, Nitrate
A31J	I	Magnesium, Electrical Conductivity
A32A	I	Magnesium, Electrical Conductivity
A32B	I	Magnesium, Electrical Conductivity
A32C	I	Magnesium, Electrical Conductivity
A32D	I	Magnesium, Electrical Conductivity
A32E	II	Nitrate

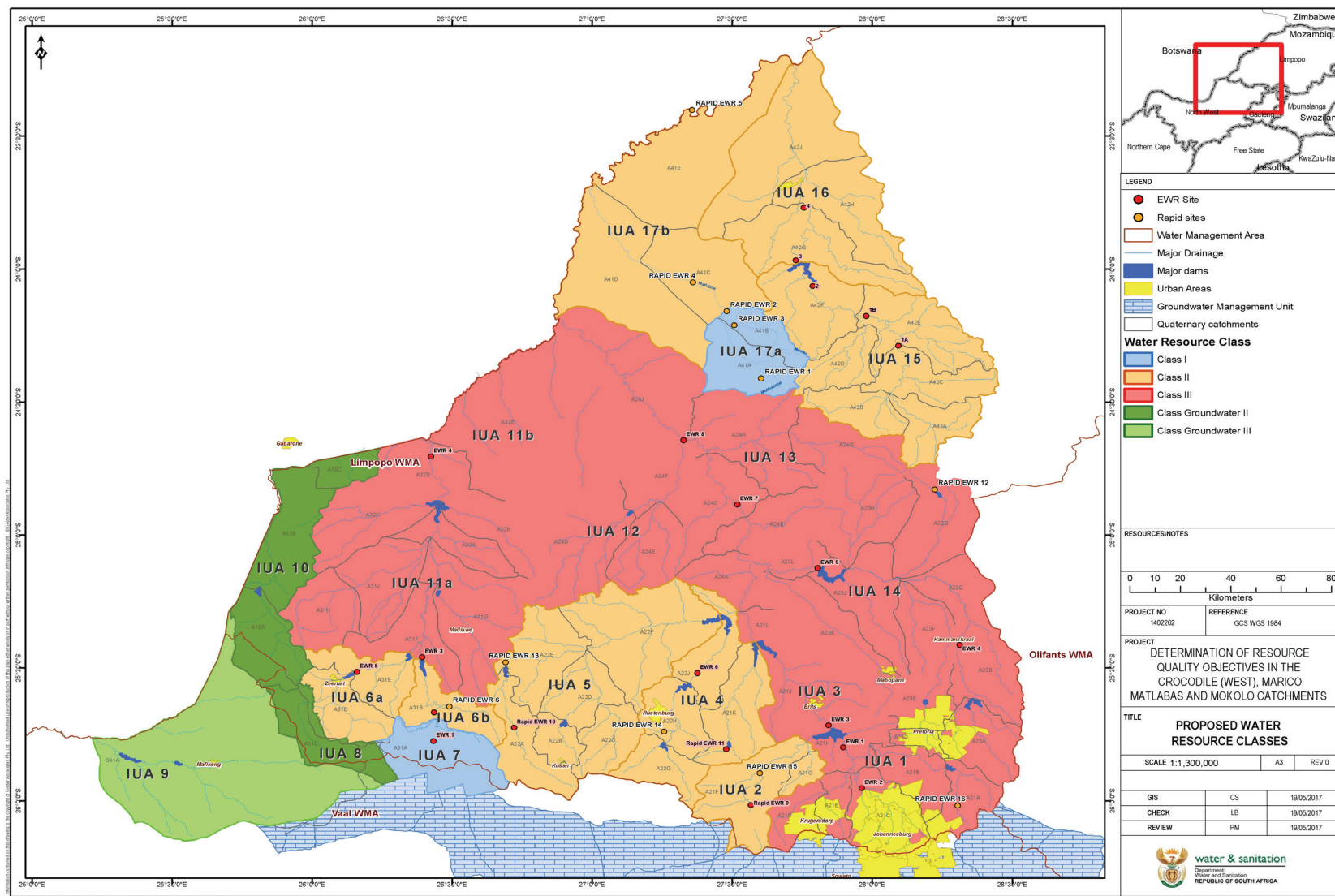


Figure 1: Locality map for the Crocodile (West), Marico catchments