DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE MIDDLE VAAL WATER MANAGEMENT AREA

WP10534

RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS REPORT

REPORT NO.: RDM/WMA09/00/CON/RQO/0214

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EXECUTIVE SUMMARY

The Chief Directorate: Water Ecosystems has initiated the development of Resource Quality Objectives (RQO) for the Middle Vaal Water Management Area. The purpose of this study is to implement the RQO determination procedures in the Middle Vaal WMA and in so doing determine the RQOs of the significant resources for presentation to the delegated authority. It is recognised that the process of RQO determination of water resources requires a strongly driven stakeholder engagement and communication component supported and guided by the necessary technical and institutional components.

Establishment of RQOs is a mechanism through which the balance between sustainable and optimal water use and protection of the water resource can be achieved. RQOs are defined by the National Water Act as “clear goals relating to the quality of the relevant water resources” (DWAF, 2006).

RQOs are descriptive or quantitative, spatial or temporal, and ultimately allows realisation of the catchment vision by giving effect through the gazetting process. RQOs provide the basis for determining the allocatable water quality and water quality stress and are constituted based on the designated users of the water resource (e.g. recreational, aquatic ecosystem, industrial use, domestic etc), the goals defined to protect the water resource and the alignment to the catchment vision and class of the water resource.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource management class, the process has allowed for due of the consideration of the social and economic needs of competing interests by all who rely on the water resources.

The main objective of the study was to determine RQOs for all significant water resources in the Middle Vaal WMA. The RQOs have been determined in accordance with the DWS’s Procedures to Determine and Implement Resource Quality Objectives.

The RQO process has taken account of land based activities and considered anticipated potential impacts that these activities may have on water resources within the WMA. The RQOs have considered the requirements of meeting the management class, the desired protection level, current and future water use and the needs of water users. The study has been primarily of a technical nature being guided by stakeholder and specialists’ involvement.

As part of the RQO development process, a key component has been stakeholder consultation on the proposed RQOs and numerical limits proposed. Much of the study progress to date has been of a technical nature with stakeholder involvement being introduced at key steps in the study, with the last step being a public meeting that was recently held where stakeholders and interested and affected parties in the Middle Vaal WMA had an opportunity to provide comments, guidance and inputs on the proposed RQOs. This provided an appropriate platform where stakeholders were formally engaged on the process outcomes and the proposed RQOs and numerical limits.

The RQOs and numerical limits agreed upon for the Middle Vaal WMA will now be published by way of notice in the Government Gazette as the final step in the study process. Written comments may be submitted over a 60 day public comment period.

The purpose of this document is to serve as a technical information document on the RQOs and numerical limits formulated for the water resources of the Middle Vaal. It includes supporting

information relating to the approach followed, the context and the rationale where applicable on the proposed RQOs and numerical limits formulated.

LIST OF ABBREVIATIONS AND ACRONYMS

ASPT	Average Score per Taxon
CD: WE	Chief Directorate: Water Ecosystems
DRM	Desktop Reserve Method
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Elecrical conductivity
E. coli	*Escherichia coli*
EIS	Ecological importance and sensitivity
EWR	Ecological Water Requirements
GRAII	Groundwater Resource Assessment Phase II
IHI	Index of Habitat Integrity
IUA	Integrated Unit of analysis
IWRM	Integrated Water Resource Management
MC	Management Class
FEPA	Freshwater Ecosystem priority areas
FRAI	Fish Response Assessment Index
MAR	Mean Annual Runoff
MC	Management Class
MIRAI	Macroinvertebrate Response Assessment Index
NL	Numerical Limit
NWA	National Water Act
PES	Presentation Ecological State
REC	Recommended Ecological Category
RDM	Resource Directed Measures
RQOs	Resource Quality Objectives
RHAM	Rapid Habitat Assessment Method
RHP	River Health Programme
RO	Regional Office
RU	Resource Unit
WARMS	Water Use Authorosation and Registration Management System
WQ	Water quality
WMA	Water Management Area
WRC	Water Resource Classification
SASS5	South African Scoring System version 5
SAWQGs	South African Water Quality Guidelines
SPI	Specific Pollution sensitivity Index
TDS	Total Dissolved Solids

TPCs	Thresholds of Potential Concern
TWQR	Target Water Quality Range
VEGRAI	Vegetation Response Assessment Index
VMAR	Virgin Mean Annual Runoff

TABLE OF SCIENTIFIC UNITS AND SYMBOLS

As	Arsenic
Al	Aluminium
NH_3	Ammonia
Cd	Cadmium
Chl-*a*	Chlorophyll *a*
Cl	Chloride
CN	Cyanide (free)
Cu	Copper
DIN	Dissolved Inorganic Nitrogen
F	Flouride
Fe	Iron
EC	Electrical Conductivity
Hg	Mercury
ug/l	Micrograms per litre
Q	Abstraction Volume/Rate
l/s	litres per second
mg/l	milligrams per litre
m^3/s	cubic metres/second
ml	millilitres
Mg	Magnesium
Mn	Manganese
mS/m	milliSiemens per metre
Mm^3/a	million cubic metres per annum
Na	Sodium
NO_2	Nitrite
NO_3	Nitrate
Pb	Lead
pH	power of hydrogen
PO_4	Orthophosphate
SO_4	Sulphate
U	Uranium
Zn	Zinc

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1 INTRODUCTION

1.1 BACKGROUND AND OVERVIEW

The Chief Directorate: Water Ecosystems (WE) has initiated the development of Resource Quality Objectives (RQO) for the Middle Vaal Water Management Area. This study leads on from the recently completed the classification of the water resources of the Middle Vaal WMA where management classes were determined. The purpose of the RQO study is to implement the RQO determination procedures in the Middle Vaal WMA and in so doing determine the RQOs of the significant resources. The proposed RQOs are in the process of being published for public comment by Government Notice and once approved by the Minister of Water and Sanitation, the RQOs for the Middle Vaal WMA will be gazetted and thereafter be implemented.

1.2 RESOURCE QUALITY OBJECTIVES

RQOs are defined by the National Water Act as clear goals relating to the quality of the relevant water resources. RQOs translate the management class of the water resource (either Class I, II, or II) into flow, quality, habitat and aquatic ecosystem management goals that need to be achieved to meet the desired class.

A resource quality objective has to be determined for a significant water resource, as the means to ensure a desired level of protection. The purpose of the RQOs is to provide limits or boundaries from which it can be deduced whether the resource is being stressed by existing management practices or not.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource management class, the process will allow due of the consideration of the social and economic needs of competing interests by all who rely on the water resources.

In terms of the National Water Act (NWA) (Act 36 of 1998), the RQO's based on the class may relate to the following:

- Reserve;
- in-stream flow;
- in-stream and riparian habitat quality;
- water level;
- presence and concentration of substances in the water;
- characteristics and quality of water resource;
- characteristics and distribution of aquatic biota; and
- regulation of in-stream or land-based activities affecting water quality.

The setting of the RQOs is best carried out through establishing a vision for the WMA. The RQOs for the different water resources within the WMA are then established as management tools towards achieving the overall vision.

The RQOs encompass four components of the resource quality:

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

RQOs may be descriptive or quantitative and may account for quality over time and/or distance.

1.3 MIDDLE VAAL RESOURCE QUALITY OBJECTIVES STUDY PROCESS

The 7 step process (Figure 1) of RQO determination has been implemented in order to determine RQOs for significant water resources in the Middle Vaal WMA.

As part of the RQO process in the Middle Vaal WMA, the first step was to delineate the units of analysis and define Resource Units (RUs). Each integrated unit of analysis (IUA) represents a homogenous catchment area of similar impacts which must be considered in the determination of RQOs. A RU on the other hand is a section of a water resource within an IUA that is sufficiently ecologically distinct to warrant its own specification.

The IUA delineation of the Middle Vaal WMA was done as part of the water resource classification process, through which 8 IUAs have been delineated for the Middle Vaal WMA. The IUAs delineated form the basis for the RQO determination process. Through this study the resource units for the water resources in Middle Vaal WMA were delineated and prioritised. In terms of the various components and considerations assessed for RU delineation and prioritisation and based on the understanding and expert knowledge of the Middle Vaal WMA, the results of the delineation and prioritisation process are as follows:

- Thirty one surface water resource RUs were delineated and 28 have been prioritised;
- Six dam RUs were delineated and prioritised;
- Three groundwater priority areas were identified (Dolomite aquifer systems) however the selection of the units for groundwater RQO determination are still to be confirmed;
- The general groundwater areas have been described (Ventersdorp/Karoo Aquifer systems)
- Fifty wetlands/wetland clusters have been prioritised in the WMA.

The next step of the RQO determination process was to prioritise sub-components for RQO determination and select indicators for monitoring. The components of the water resource per resource unit *viz.* habitat, biota, quantity and quality were evaluated and sub-components were prioritised for development of RQOs for rivers (e.g. flow, salts, fish, in-stream habitat). Key indicators for monitoring the sub-components were then selected for each RU (Indicators include e.g. maintenance flows, electrical conductivity) based on the requirements to manage and protect the water resource. For wetlands RQOs related to the four components habitat, quality, quantity and biota, while for groundwater RQOs related to the water level, quality, abstraction and protection zones. Once the components and sub-components were prioritised for Resource units, groundwater systems and wetland systems/clusters draft RQOs and numerical limits for these were formulated.

RQOs were developed for the sub-components selected per RU. RQOs are essentially narrative statements but sometimes provide broad quantitative descriptions of the water resource. The RQOs relate to the components, sub-components and selected indicators of each RU in the Middle Vaal WMA. RQOs were set for rivers, dams, wetlands and groundwater. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance. Numerical limits were formulated where applicable for the RQOs set for the water resources of the Middle Vaal WMA.

Much of the study has been of a technical nature with stakeholder involvement being introduced at key steps in the study, with the last step being a public meeting that was recently held where

stakeholders and interested and affected parties in the Middle Vaal WMA had an opportunity to provide comments, guidance and inputs on the proposed RQOs. This provided an appropriate platform where stakeholders were formally engaged on the process outcomes and the proposed RQOs and numerical limits.

The RQOs and numerical limits have been agreed upon for the Middle Vaal WMA and are soon to be published by way of notice in the Government Gazette as the final step in the study process (Figure 1). Written comments may be submitted over a 60 day public comment period.

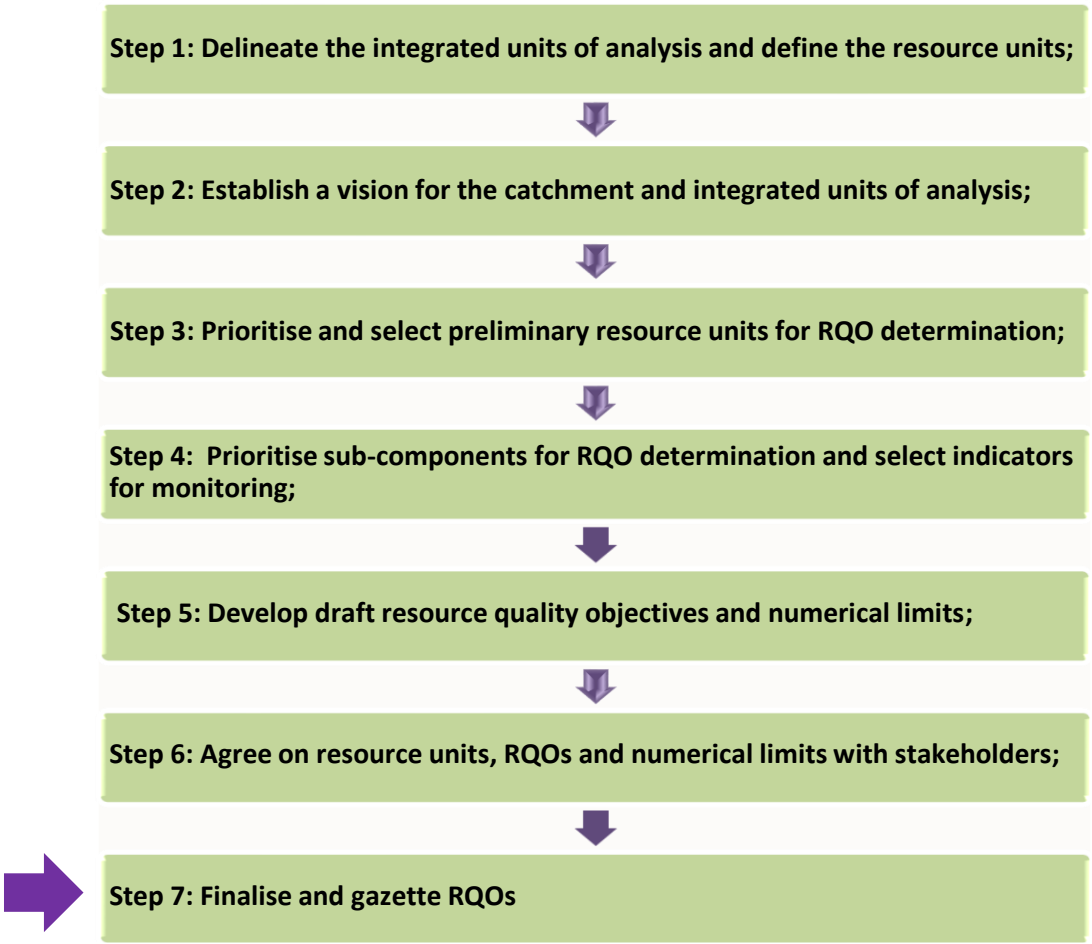


Figure 1: RQO determination process

1.4 PURPOSE OF THIS DOCUMENT

The purpose of this document is to serve as a technical information document on the RQOs and numerical limits formulated for the water resources of the Middle Vaal. It includes supporting information relating to the approach followed, the context and the rationale where applicable, on the proposed RQOs and numerical limits formulated.

It serves to guide and provide understanding to the reader on the reasoning and context to on the proposed RQOs and the numerical limits listed per resource unit for the water resources of the Middle Vaal WMA.

1.5 STUDY AREA

The Middle Vaal WMA is part of the integrated Vaal River System and falls within the C drainage region of South Africa. The Middle Vaal WMA covers a catchment area of 52 563 km^2, and includes parts of the Free State and North-West Provinces. The Vaal River is the only main river in the WMA. It flows in a westerly direction from the Upper Vaal WMA, to be joined by the Koekemoerspruit, Skoonspruit, Rhenoster, Vals and Vet rivers as main tributaries, before flowing into the Lower Vaal WMA and then into the Orange River.

There are several dams that have been developed *viz.* Bloemhof Dam on the Vaal River, Allemanskraal Dam on the Sand River, Erfenis Dam on the Vet River, and Koppies Dam in the Renoster River.

Present land use in the WMA is characterised by gold mining, extensive dry land cultivation, particularly in the central parts. Irrigation is practised downstream of dams along the main tributaries as well as at locations along the Vaal River. The remainder of the WMA is natural grassland used for livestock farming. The economy in the WMA is mainly based on mining and agriculture as primary production sectors. The largest urban areas are Klerksdorp, Welkom and Kroonstad.

The Middle Vaal WMA comprises eight sub-catchments as listed in Table 1-1. The WMA consists of the C24, C25, C41, C42, C43, C60 and C70 tertiary catchments (Figure 2).

Table 1-1: Sub-catchments and related quaternary drainage regions within the Middle Vaal WMA

Primary Catchment	Sub-Catchment Areas	Quartenary Catchments	Average Gross Area (km^2)
C	Renoster	C70A-K	6656
	Vals	C60A-J	7871
	Schoon Spruit	C24C-G	5644
	Middle Vaal	C24A-B, C24H-J, C25A-C	8281
	Bloemhof	C25D-F	4959
	Allemanskraal	C42A-E	3628
	Erfenis	C41A-E	4724
	Sand	C42F-L	3927
	Vet	C41F-J, C43A-D	6873

The Middle Vaal WMA's water quality and flow is mainly controlled by activities that take place in the Upper Vaal WMA. The Middle Vaal WMA is dependent on the Upper Vaal WMA for meeting the bulk water requirements of its mining, industrial and urban sectors. Large quantities of water are transferred into the WMA to augment local water resources. These upstream activities include releases from the Vaal Dam and Vaal River Barrage, waste water treatment works discharges, urban runoff and gold mining activities on the Witwatersrand. In the Middle Vaal WMA discharges and decants from gold mining activities in the Mooi and Koekemoer Spruits have an impact on the continued salinity build up in the Vaal River. These impacts are subject to many catchment studies.

Management of water quality and quantity in the Middle Vaal WMA is therefore integrally linked to both the Upper and Lower Vaal WMAs. Water quality issues of concern in the Middle Vaal WMA are related to salinity, eutrophication and public health. The closure of mines may have further water quality impacts. High concentrations of TDS have been identified in the Middle Vaal River which is impacting on water use in the catchment. Eutrophication as the other key water quality

problem in the Middle Vaal River is highlighted by the hypertrophic status of the middle reaches of the Vaal River from the Vaal Barrage to Bloemhof Dam.

Two dolomite aquifer systems, the Ventersdorp-Grootpan and the Klerksdorp-Orkney-Stillfontein-Hartebeesfontein (KOSH), are present in the upper reaches of the Schoonspruit and Mid Vaal sub-catchments (*viz*, C24C, C24E, C24F and C24A and C24B). These dolomite water resources are extensively used for irrigation (Schoonspruit groundwater and surface water systems) and impacted by mining activities in the KOSH area. Several studies have reviewed the status of these systems pre-2004; although recent impacts due to drought conditions and mining activities may not be well incorporated into the total hydrological context. Groundwater in the remaining part of the Mid Vaal Catchment is related to Karoo type aquifer systems which may have been impacted on a localized scale due to poor management of the quantities and qualities.

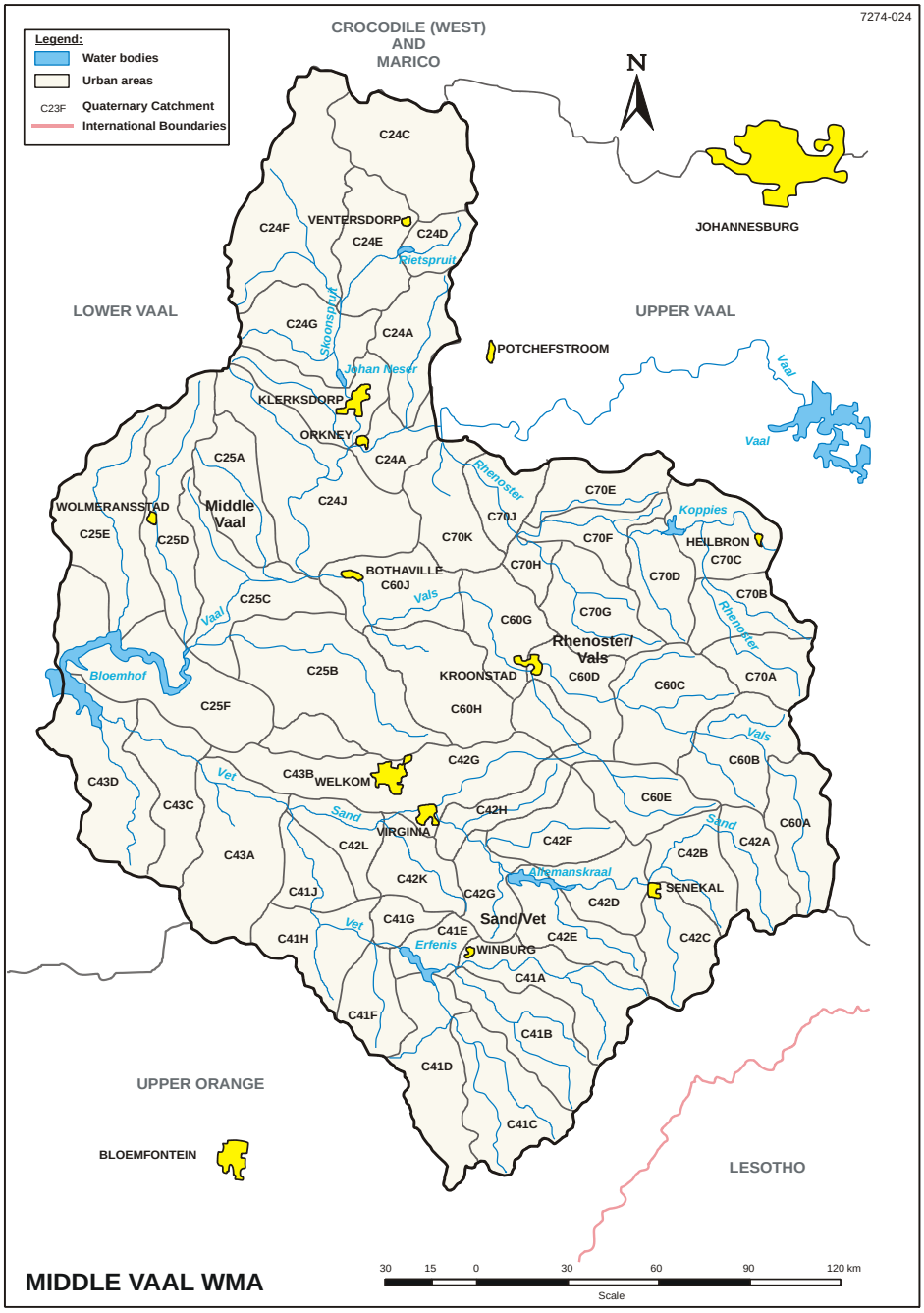


Figure 2: General layout of the Middle Vaal WMA

2 THE INTEGRATED UNITS OF ANALYSIS (IUAS)

In terms of the Middle Vaal Water Resource Classification study, eight IUAs were delineated. These are listed in Table 2-1 and shown in Figure 3. The IUAs form the boundaries for resource units delineated in the Middle Vaal.

Table 2-1: IUAs delineated for the Middle Vaal WMA

IUA (Middle Vaal)	Catchment area	Quaternary catchment
MA	Renoster River	C70A – C70K
MB	Vals River	C60A-C60J
MC	Schoonspruit River	C24C – C24H and C24 A
MD1	Upper Sand River	C42A – C42E
MD2	Lower Sand River	C42F- C42L
ME1	Upper Vet River	C41A – C41E
ME2	Lower Vet River	C41F – C41J and C43A –C43D
MF	Vaal River from Renoster confluence to Bloemhof Dam	C24B, C24J, C25A – C25F

The ecological condition of the 8 IUAs as classified in terms of the Water Resource Classification study for the Middle Vaal WMA is summarised below.

The Middle Vaal WMA includes 4 Ecological Water Requirement (EWR) sites and 26 biophysical nodes. A biophysical node is an outcome of the classification process at which a desired ecological category (nested ecological category) for each river reach upstream of the node has been provided.

The summary table of the eco-classification at the EWR sites and biophysical nodes per IUA in the Middle Vaal WMA is provided Table 2-2 (DWA, 2012). The management classes per IUA are also included in Table 2-2 (DWA, 2012).

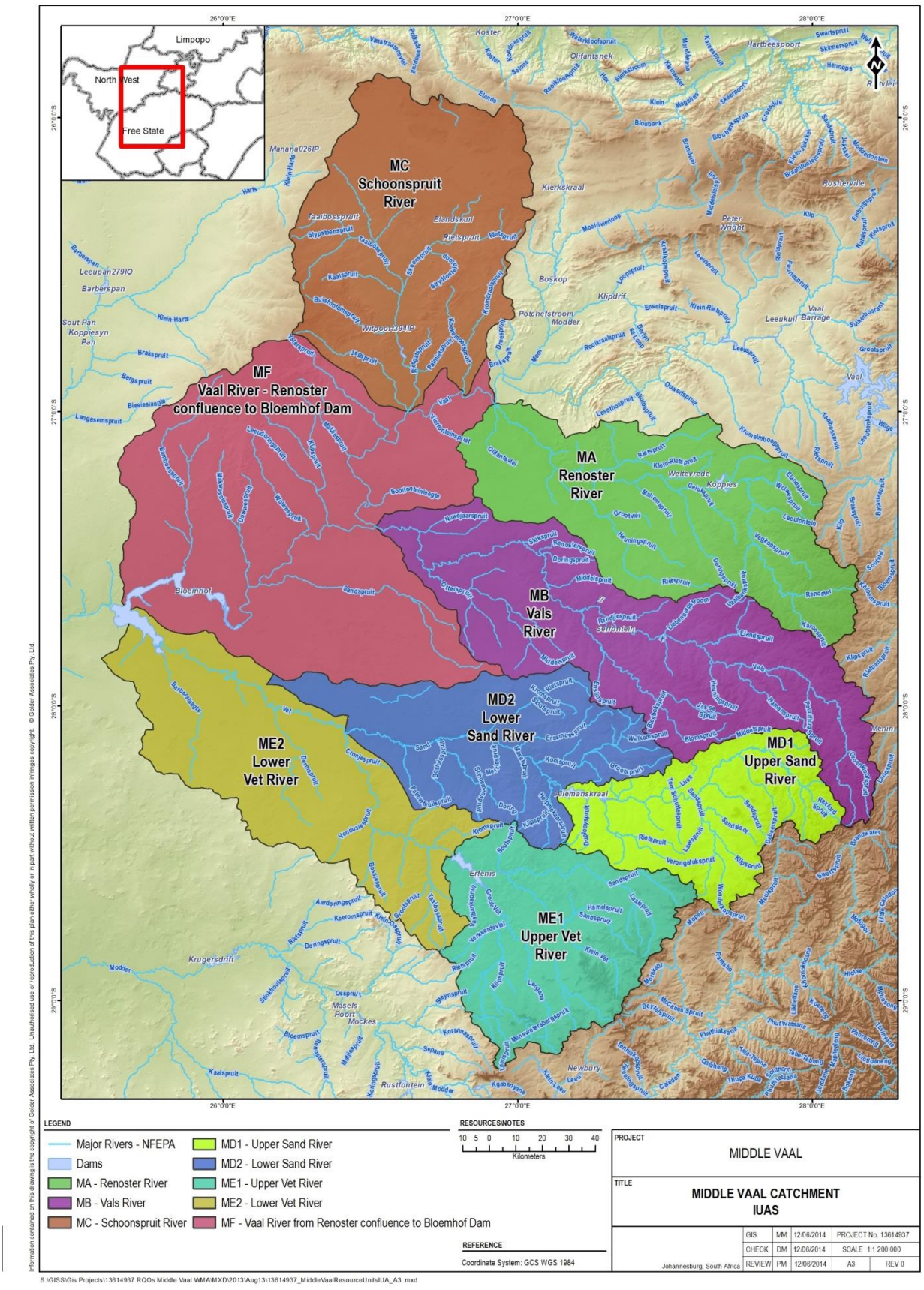


Figure 3: IUAs delineated in the Middle Vaal WMA

Table 2-2: Summary of Eco-classification at EWR sites and biophysical nodes and the IUA Management Classes in the Middle Vaal WMA

Node name	PES	REC	ES	EI	Gross catchment area (km^2)	Management Class
IUA MA Renoster River						
MA.1	C	C	moderate	moderate	613	II
MA.2	B/C	B/C	moderate	moderate	881	
MA.3	C	C	moderate	moderate	81	
MA.4	C	C	low	low	2413	
MA.5	C/D	C/D	low	low	422	
MA.6	C	C	low	low	4092	
MA.7	C	C	low	moderate	1152	
MA.8	C	C	low	low	5868	
IUA MB Vals River						
MB.1	C	C	low	low	860	III
MB.2	C	C	low	moderate	349	
MB.3	C	C	low	low	4898	
EWR14	C/D	C/D	moderate	moderate	5930	
IUA MC Schoonspruit						
MC.1	C	C	low	low	1350	III
MC.2	C	C	low	moderate	2020	
MC.3	C/D	C/D	low	low	2694	
MC.4	C/D	C/D	low	low	3503	
MC.5	D/E	D	low	low	839	
MC.6	D	D	low	low	499	
IUA MD1 Upper Sand River						
MD1.1	C	C	low	low	2215	III
IUA MD2 Lower Sand River						
MD2.1	C	C	moderate	**low**	3974	III
MD2.2	C	C	moderate	**low**	734	
MD2.3	C	C	moderate	**low**	7555	
IUA ME1 Upper Vet River						
ME1.1	C	C	low	moderate	2113	II
ME1.2	C	C	low	low	2083	
ME1.3	B/C	B/C	low	moderate	159	

Node name	PES	REC	ES	EI	Gross catchment area (km^2)	Management Class
IUA ME2 Lower Vet River						
ME2.1	C	C	low	moderate	5551	III
EWR15	C/D	C/D	moderate	moderate	16040	
IUA MF Vaal River from Renoster to Bloemhof Dam						
MF1	C	C	low	moderate	864	III
EWR12	D	D	moderate	moderate	62305	
EWR13	C/D	C/D	moderate	moderate	70809	

3 RESOURCE UNITS

The process followed in terms of IUA delineation and prioritisation was that described in the RQO Determination Guideline (DWA, February 2011). Delineation and prioritisation of RUs is required as it would not be appropriate to set the same RQOs for all water resources in a catchment.

The following was considered for delineation of RUs within the Middle Vaal WMA:

- IUA boundaries and sub-quaternary boundaries
- Geomorphological zones and Eco-regions
- EWR sites and location of biophysical nodes (in terms of the Classification study outputs)
- Ecological condition (based on the EWR and node information)
- Freshwater Ecosystem Priority Areas (FEPAs)
- Operation of the system
- Water quality sub-units/impacts
- Land use and anthropogenic activities
- Groundwater units
- Expert knowledge of the catchment area and system.
- Stakeholder guidance

Thirty one river and six dam RUs in the Middle Vaal WMA have been delineated. The RUs are shown in Figure 4 below and listed Table 3-1.

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

Based on the priority ratings obtained through application of the RU prioritisation tool, these rankings and weightings were used to select the priority RUs for RQO determination. The evaluation of the RU priority ratings for selection were done at a desktop level and discussed and confirmed at the stakeholder engagement workshops for the Middle Vaal WMA RQO study held in Klerksdorp and Welkom over 25 and 26 September 2013 respectively. The scores for all criteria are combined into a priority rating which scores the RUs relative to each other. This provides an integrated measure to inform the selection of RU.

Thirty one surface water resource RUs were delineated and 28 have been prioritised; six dam RUs were delineated and prioritised; three groundwater priority areas were prioritised (Dolomite aquifer systems). The general groundwater areas have been described (Ventersdorp/Karoo Aquifer systems) and fifty wetlands/wetland clusters have been prioritised in the WMA. The results are tabulated in Table 3-1 below and shown in Figure 6 and Figure 7.

Based on the evaluation process twenty eight river RUs and six dam RUs were prioritised. These are shown in Figure 5 and the overall prioritization rating and rationale are provided in Table 3-2. Three RUs were not selected. These include the most upstream catchments (headwaters) in the Renoster River catchment (R1), Vals River catchment (V1) and Upper Sand catchment (US1).

Table 3-1: RUs Delineated for the Middle Vaal WMA

RU	Delineation	Quartenary Catchment
IUA 8: VAAL RIVER		
VB1.1	Vaal River mainstem: Vermaasdrift to upstream Schoon spruit confluence	C24B
VB1.2	Vaal River mainstem: From the Schoonspruit confluence to just upstream Vals River confluence	C24J
VB1.3	Vaal River mainstem: From Vals River confluence to Bloemhof Dam	C25C, C25F
VB2	Tributary catchments (Vierfonteinspruit and 24J –south of Vaal River)	C24B, C24J
VB3	Ysterspruit, Matjiespruit, Klipspruit, Wolwespruit and Makwassiespruit tributary catchments	C24J, C25A, C25C, C25D
VB4	Sandspruit tributary catchment	C25C, C25B, C25F, C43B
VB5	Bamboespruit tributary catchment	C25E
VB6	Bloemhof Dam	C25E, C25F, C43D
TRIBUTARIES		
IUA 1: RENOSTER RIVER		
R1*	From origin to Vaalbankspruit and Vegkopspruit tributary confluences	C70A, C70B
R2	Downstream Vaalbankspruit tributary confluences to Koppies Dam	C70C
R3	Koppies Dam	C70C
R4	Downstream Koppies Dam to confluence with the Heuningspruit	C70E, C70D, C70F, C70G, C70H
R5	Downstream Heuningspruit confluence to confluence with the Vaal River	C70J, C70K
IUA 2: VALS RIVER		
V1*	Origin of Vals River to Pauciflora Spruit confluence	C60A
V2	Downstream Pauciflor Spruit confluence to Kroonstad	C60B, C60C, C60D, C60E, C60F
V3	Serfontein Dam	C60D
V4	Middelspruit tributary catchment	C60H
V5	From the Kroonval weir to the Vaal River confluence	C60G, C60J
IUA 3: SCHOONSPRUIT		
SK1	From origin of Koekemoerspruit to confluence with Vaal River	C24A, C24B
SK2	Schoonspruit eye	C24C
SK3	Taaibospruit tributary catchment	C24F
SK4	From Schoonspruit eye to Kaalspruit confluence	C24D, C24E
SK5	Kaalspruit and Buisfonteinspruit tributary catchment	C24G
SK6	Johan Neser Dam (Kklerksdorp Dam)	C24G
SK7	From Johan Neser Dam to confluence with the Vaal River	C24H
IUA 4: UPPER SAND RIVER		
US1*	Origin of Sand River to confluence of the Klipspruit	C42A, C42B, C42C
US2	Downstream Klipspruit confluence to Allemanskraal Dam	C42D, C42E
US3	Allemanskraal Dam	C42E

RU	Delineation	Quartenary Catchment
IUA 5: LOWER SAND RIVER		
LS1	Allemanskraal Dam to Merriespruit confluence	C42F, C42G, C42H,
LS2	Rietspruit tributary catchment	C42J
LS3	Downstream Rietspruit confluence to confluence with the Vet River	C42K, C42L, C43B
IUA 6: UPPER VET RIVER		
UV1	Klein Vet and Laaispruit tributary catchments	C41A, C41B
UV2	Origin of Vet River and Leeuspruit tributary catchment to Erfenis Dam	C41C, C41D
UV3	Soutspruit tributary catchment	C41E
UV4	Erfenis Dam	C41E
IU7 : LOWER VET RIVER		
LV1	Erfernis Dam to confluence with Sand River	C41F, C41G, C41H, C41J
LV2	Downstream Sand River confluence to Bloemhof Dam	C43A, C43C, C43D
SELECTED GROUNDWATER PRIORITY UNITS		
Dolimitic RU G1 (RU SK2; SK3)	The demarcation of the quartenary catchment covers the whole dolomite aquifer unit.	C24F, C24C
Dolimitic RU G2 (RU SK3; RU SK4)	The groundwater unit falls within the quartenary catchment boundaries.	C24C, C24F, C24E
Dolimitic RU G3 (RU SK1)	The dolomite aquifer systems fall within the boundaries of the quartenary catchment and can be included in the surface water RU.	C24A, C24B
General: Ventersdorp/Karoo Aquifers	To be included in the RUs as demarcated for the surface water resources	
PRIORITY WETLANDS/WETLAND CLUSTERS		
SK1	Pan	C24A
SK2	Pan cluster to the north of Vetpan and Klippan	C24C
	Vetpan and Klippan	
	Rietpan pan and wetland complex	
	Schoonspruit eye and upper section of the Skoonspruit peatland	
SK3	Grootpan	C24F
	Pan cluster to the north of Coligny	
	Floodplain of the Taaibosspruit	
	Lower Kaalspruit	
	Lower section – floodplain of the Skoonspruit	
SK4	Two pans to the northwest of Ventersdorp	C24D, C24E
	Lower section of the Skoonspruit peatland	
	Skoonspruit wetland system	
SK5	Floodplain of the lower Skoonspruit	C24G
R4	Floodplain of the middle reaches of the Renosterrivier, Heuningspruit, Grootvlei, central and lower reaches of the Mahemspruit, and middle to lower reaches of the Rietspruit	C70E, C70D, C70F, C70G, C70H
	Unchannelled valley bottom wetland of the Rietspruit tributary of the Heuningspruit and a tributary of the Heuningspruit	
R5	Channelled and unchannelled valley bottom wetland adjacent to Viljoenskroon	C70J, C70K

RU	Delineation	Quartenary Catchment
	Unchannelled valley bottom wetland on the farm Roodepoort	
	Northern section of Swartpan	
	Leeupan	
	Vaneedespan	
	Groot Rietpan	
V4	Channelled valley bottom wetland in the middle reaches of the Otterspruit and its tributaries	C60H
	Pan cluster associated with the middle reaches of the Otterspruit	
	Unchannelled valley bottom wetland in a tributary of the Otterspruit	
V5	Valley bottom and hillslope seepage wetlands of Hertzogsvlei	C60G, C60J
	Southern section of Swartpan	
VB4	Upper reaches of the Sandspruit (immediately north of Kutloanong)	C25C, C25B, C25F, C43B
	Pan cluster around Wesselbron including Volstruispan to the north	
	Graspan	
	Mahemspan	
LS3	Ganspan and remaining pans that form the southern part of the Wesselbron pan complex	C42K, C42L, C43B
	Wetland system along the Mahemspruit	
	Flamingo Pan	
	Stinkpan	
	Witpan	
LV2	Brakpan	C43A, C43C, C43D
	Floodplain of the Vetrivier	
	Bultfontein pan and saltworks	
	Pan cluster to the south of Bultfontein	
VB5	Pan cluster along the watershed divide to the west of the Bamboesspruit	C25E
*	Surface water RUs not prioritised	

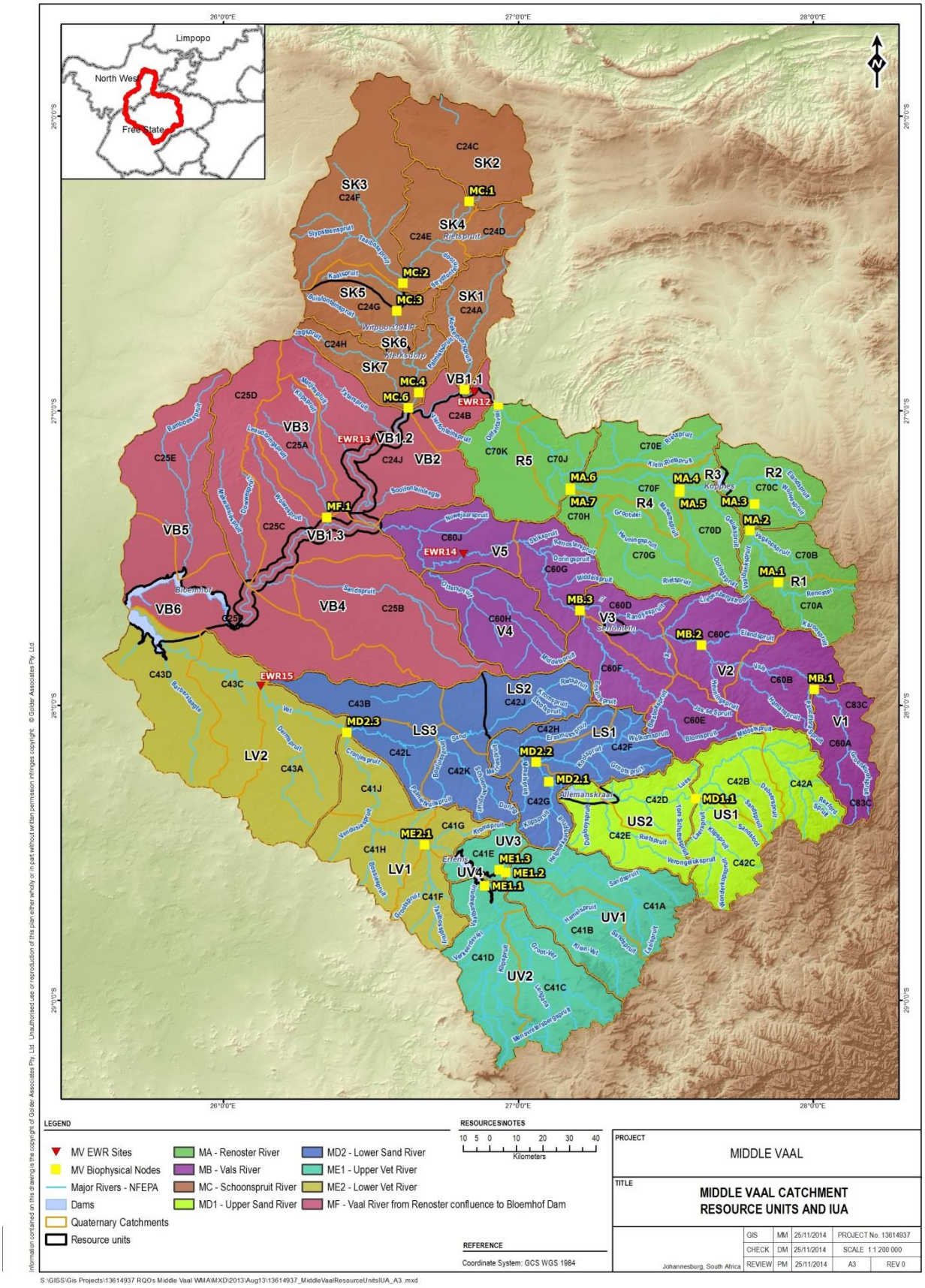


Figure 4: RUs delineated in the Middle Vaal WMA

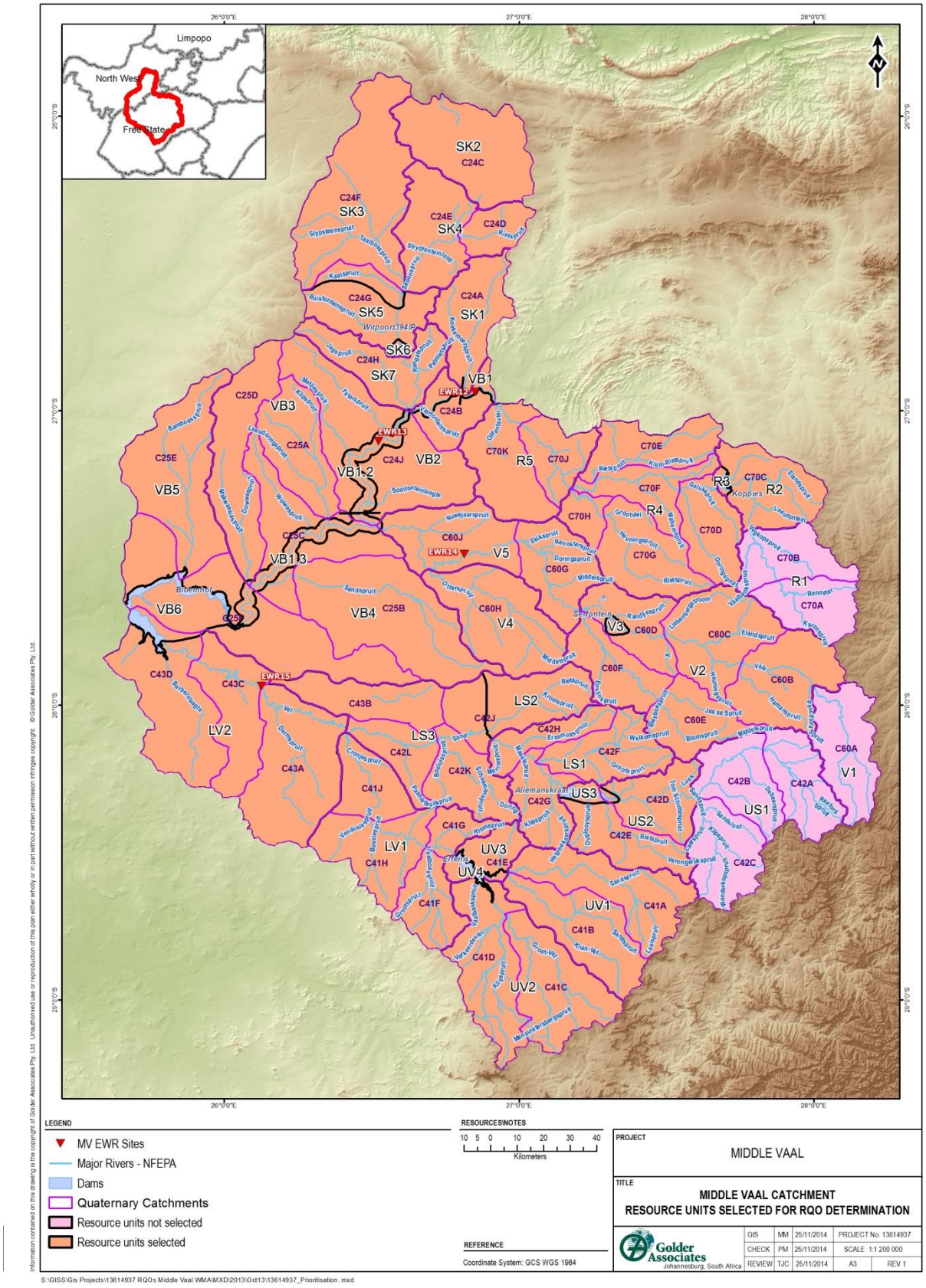


Figure 5: RUs prioritised and selected for RQO determination in the Middle Vaal

Table 3-2: Priority RUs Selected for the Middle Vaal WMA

IUA	Resource Unit	Priority Rating (0 -1)	Rationale for selection
MA Renoster	R 2	0.41	Sewage works discharges, impacts on water resource
	R 3	0.80	Operation of the dam and supporting activities need to be managed. Recreation, fishing, and cultural uses are important.
	R 4	1.00	FEPA present. High activity - mining and irrigation. Koppies town present. Wetland priority area.
	R 5	0.76	Lowest most RU within the IUA. FEPA present.
MB Vals	V2	0.4	Includes impacts from land based activities that pose a threat. FEPA present
	V3	0.5	Operation of the dam and supporting activities need to be managed.
	V4	0.1	Wetland priority area – Otterspruit system
	V5	1.0	Lowest most RU within the IUA, most impacted. FEPA present.
MC Schoon/ Koekemoerspruit	SK1	1.0	Tributary of Vaal the River. Highly impacted, requires management. Water quality deterioration.
	SK2	0.6	The Schoonspruit Eye needs to be protected. Dolomitic aquifers present (Groundwater priority area)
	SK3	0.4	Groundwater and wetland priority areas present
	SK4	0.4	Irrigation impacts on water resource
	SK5	0.4	Irrigation impacts water resource.
	SK6	0.6	Operation of the dam must be managed.
	SK7	1.0	Lowest most RU within the IUA, highly impacted
MD1 Upper Sand	US2	0.6	Impacts from the town of Senekal
	US3	1.0	Allemanskraal Dam - Operation of the dam and supporting activities need to be managed. Irrigation activity
MD2 Lower Sand	LS1	0.7	Abstraction for irrigation. FEPA present
	LS2	0.5	Mining activities in the town of Virginia to be managed.
	LS3	1.0	Wetland priority area. Upstream impacts. FEPA present
ME1 Upper Vet	UV1	0.6	Impacts from the town
	UV2	0.7	Agricultural activities
	UV3	0.2	Protect the FEPA
	UV4	1.0	Erfenis Dam – supporting activities around the dam, agricultural water use
ME2 Lower Vet	LV1	0.6	Agricultural and flow impacts. FEPA present
	LV2	1.0	Agricultural impacts and influence from the Sand River, EWR site to be maintained.
MF Vaal River	VB1.1	1.0	The Vaal main stem is important/priority water resource (WMA).
	VB1.2	1.0	
	VB1.3	1.0	
	VB2	0.5	Water quality impacts on Vaal River
	VB3	0.6	Land use impacts
	VB4	0.6	Wetland/pans priority area
	VB5	0.6	Wetlans (Pans) priority area
	VB6	0.9	Operation of the system, water quality

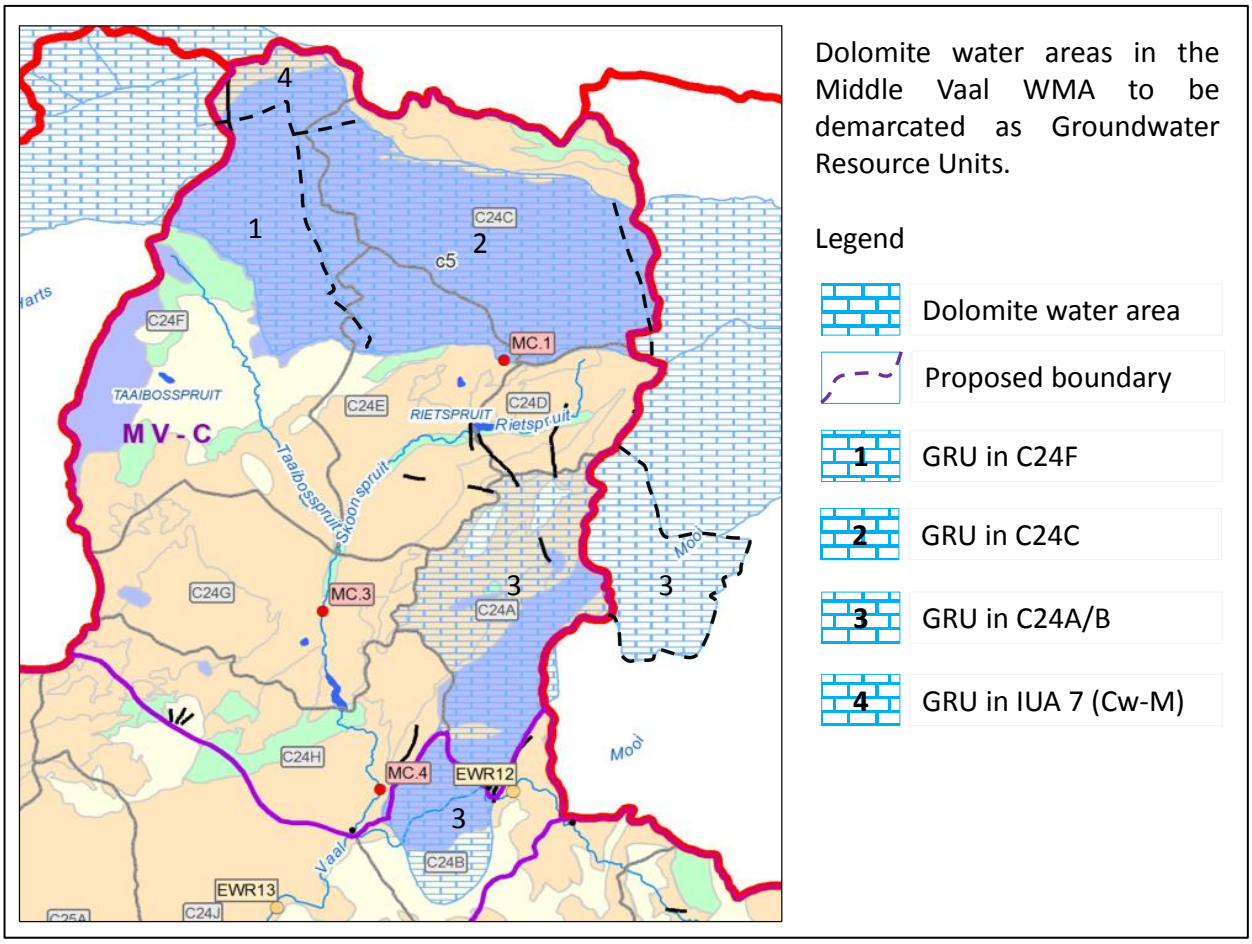


Figure 6: Groundwater priority areas (Dolomitic aquifer systems) identified in the Middle Vaal WMA

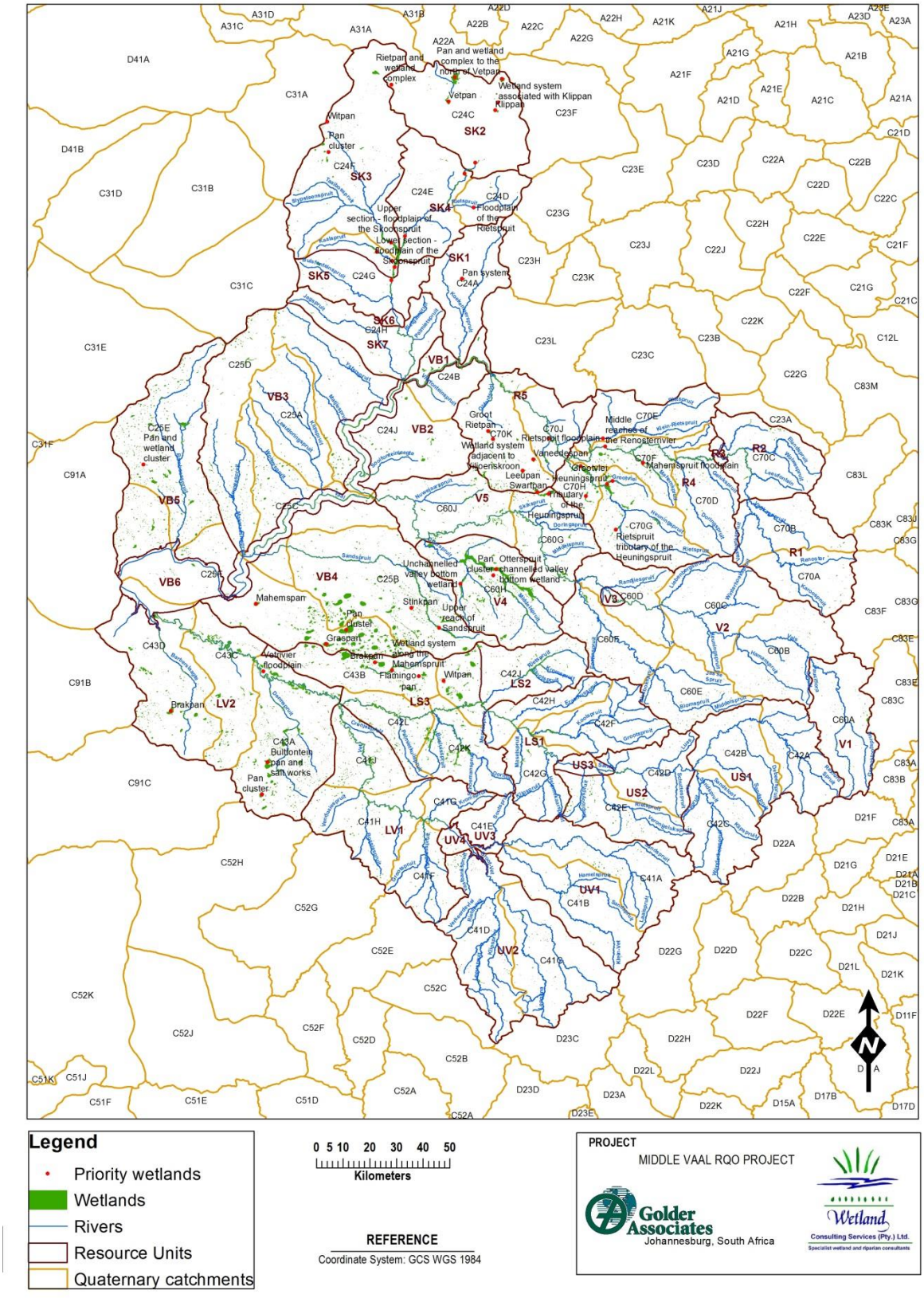


Figure 7: Wetlands/wetland clusters prioritised in the Middle Vaal WMA

4 PRIORITISATION OF SUB-COMPONENTS AND SELECTION OF INDICATORS

Step 4 of the RQO development process, required the selection of components and the identification of proposed sub-components and indicators for which RQOs should be formulated for water resources within the prioritised resource units of the Middle Vaal WMA.

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

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

The Resource Unit Evaluation Tool was applied in the Middle Vaal WMA using desktop information, local knowledge and detailed understanding of the catchment. The assessment was undertaken in a workshop environment with technical specialists, catchment managers and key stakeholders. The overall priority ratings obtained through application of the RU Evaluation Tool was used to guide the selection of sub-components for RQO determination. Once the sub-components were selected, suitable indicators for monitoring were then identified. The rankings and scorings of the evaluation provided an indication of the priority sub-components. Based on this and expert judgement and knowledge the priority sub-components were selected. The process and outcome of the evaluation assessment and prioritisation per resource unit has been captured in an evaluation information sheet. As part of the process the direction of change of the sub-components were also evaluated.

The list of sub-components, indicators selected for monitoring, their selection as a user specific measure, ecological specific measure or an integrated measure and the rationale for considering these are indicated in **Appendix A** per RU for each of the IUAs. This prioritisation has been used as the basis for developing RQOs and numerical limits.

5 SETTING OF RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS

Based on the prioritisation of sub-components undertaken in Step 4, RQOs were then developed for rivers, dams, wetlands and groundwater in the Middle Vaal WMA. The RQOs relate to the components, sub-components and selected indicators for each of the prioritised RUs in the Middle Vaal WMA. Numerical limits were then formulated where applicable for the RQOs set for the water resources. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance.

The basic approaches to the drafting of RQOs for rivers, dams, wetlands and groundwater are briefly outlined below. The RQOs once drafted were then refined based on stakeholder consultation.

5.1 Rivers and Dams

The drafting of the RQOs for rivers and dams were based on and included the following aspects which were applied accordingly in the context of each resource unit:

- Understanding of the catchment context and priorities;
- Collation and assessment of available data and information (present state and historic);
- Assessment of ecological classification and river health information;
- Assessment of water quality information;
- Incorporation of the requirements of the Water Resource Classification – Management Classes, Ecological Categories recommended;
- Present Ecological State;
- Incorporation of flow specifications (rule and tab tables as specified)
- Incorporation of any direction of change required for any sub-components;
- Consideration of land based impacts;
- Stakeholder requirements;
- Feasibility of achievement of desired state;
- Alignment between resource units;
- Specification of ‘quantifiable’ numerical limits in line with the draft RQOs;
- Determination of appropriate measures, sampling methods and sampling frequency; and
- Alignment with the Upper and Lower Vaal River RQOs.

The RQOs developed for the Middle Vaal WMA rivers and dams relate to and are based on/derived from the following:

- The Management Classes (and Reserve where applicable) and associated ecological categories:
    - As per the specifications of the Water Resource Classification in the Upper, Middle

and Lower WMA Study (DWA, 2012)

- The instream flows are prescribed as specified at ecological water requirement sites and biophysical nodes:
    - Flows were determined as part of Water Resource Classification in the Upper, Middle and Lower WMA Study (DWA, 2012) (includes ecological water requirements also considering strategic/user demands).
    - High Flows or Low Flows (Maintenance and Drought Flows) or both were selected based on prioritisation in the specific RU;
    - RQO flow specifications are those prescribed in terms of the Water Resource Classification Study.
    - RQOs are specified in terms of flow requirements at nodes and EWR sites (meeting ecological requirements and user specifications). Flow RQOs and numerical limits developed for the Middle Vaal WMA are application of the Rule and Tab flow tables.
    - The percentile value in terms of the flow duration curves is also specified.
- The presence and concentration of particular substances in the water resource (stricter of ecological category (PES or Class) or present water quality state):
    - The sub-components of salts, nutrients, pathogens, toxics or system variables were selected when water quality was prioritised in a RU. Sub-component(s) of importance/relevance to the user and /or the ecological system was selected.
    - Indicators of relevance and appropriateness to the sub-components were then identified. For example, for salts – electrical conductivity; nutrients – orthophosphate, inorganic nitrogen or system variables – pH, etc.) . Consideration of impacts and user requirements, as well as ease of monitoring was made.
    - RQOs were then developed for the sub-components and limits set for the indicators. Decision criteria applied:
        - Ecological category of water resource – Maintenance or improvement
        - Present state water quality of resource – Maintenance or improvement (or some degradation)
        - User requirements - strictest user requirements
    - RQOs were then set and numerical limits specified based on one or more of the above decision criteria. If present state water quality was stricter than ecological water quality, RQO was set based on status quo quality. If not the ecological water quality specification was adopted. The Management Class and related ecological category was met, user requirements were complied with and alignment with downstream/upstream reaches was applied.

- The characteristics and quality of the water resource and instream and riparian habitat (maintenance or improvement of ecological state):
    - Instream or Riparian component of the habitat was prioritised for a RU (or both).
    - Ecological categories, ecostatus and habitat integrity as well as the impacting activities present were considered.
    - Maintenance or improvement of a habitat was recommended based on present state and ecological category specified. Any important species as well as potential threats were also considered.
    - RQOs were specified in terms of meeting the ecological category (Management Class and Present Ecological State).
- The characteristics and distribution of aquatic and semi-aquatic biota (maintenance or improvement of ecological state):
    - Sub-components were selected for a RU, if Biota was prioritised as a component. Fish, aquatic invertebrates, Aquatic birds or Diatoms were selected based on relevance to a specific RU.
    - Ecological categories, ecostatus and habitat integrity as well as the impacting activities present were considered.
    - Maintenance or improvement of the biotic sub-component was recommended based on present state and ecological category specified. Any important species as well as potential threats were also considered.
    - RQOs were specified in terms of meeting the ecological category (Management Class and Present Ecological State); response behaviour and monitoring.

5.2 Wetlands

The approach to the development of RQOs for wetlands in the Middle Vaal WMA was as follows:

From the outset of the study it was recognized that it would be important to integrate the Middle Vaal study with those being conducted for the Upper and Lower Vaal. This was particularly important for the wetland component as much of the methodology being applied is new. In order to facilitate this integration, a number of workshops were held with the wetland team from the Upper and Lower Vaal and Olifants WMA RQO studies. The idea was to try and agree on the levels of RQO determination, outline common RQOs that could be applied at the higher levels, and discuss and RQOs that could be considered at the individual prioritised wetland level. Three workshops were held where these issues were discussed at length. These comprised of:

- A one day workshop in with the study teams to discuss the various proposed approaches to the different studies and see where there could be alignment among the teams;
- A two day workshop (during November 2013) as part of the Upper and Lower Vaal Studies

to go through the method that was being applied for these studies and provide input on the identification and assessment of priority wetlands in the IUAs identified as part of these studies; and

- Similarly a two day workshop as part of the Olifants River Study to go through the method that was being applied for that study and provide input on the RQOs as well as identification and assessment of priority wetlands in the IUAs identified as part of that study.

One of the outcomes of the workshops was a set of draft RQOs at the regional level, most of which were considered appropriate to all four RQO studies. In addition, RQOs were drafted for a resource unit scale and priority wetlands based on the workshop deliberations and on available information. RQOs for the wetlands in the Middle Vaal WMA were developed as follows:

- Regional scale wetland RQOs (Middle Vaal WMA)

  Broad generic RQOs were developed around 'no net loss' principles, conservation plans, wetland types (inferred functionality) and species targets.

- Resource Unit scale wetland RQOs

  RQOs based on clusters and wetland types were developed considering development and other risks or impacts that the systems may be exposed to.

- Priority wetland RQOs

  Specific RQOs for selected priority wetlands were developed based on expert inputs with specific knowledge of the systems being considered.

5.3 Groundwater

Two aquifer systems were identified within the Middle Vaal WMA:

- Two dolomite aquifer systems were selected as priority groundwater resource units in the Schoonspruit IUA.
- For the remaining portions of the WMA, a classification of the aquifer systems into typical Ventersdorp and Karoo Supergroups was applied.

The approach to RQO development for groundwater was as follows (based on an integrated and aligned approach for the Upper, Middle and Lower Vaal WMAs):

- Groundwater RQOs were established on a resource unit scale (regional and local)
- Numerical criteria was included where applicable for Water Level and Quality:
  - Where adequate data and catchment related studies existed then specific numeric criteria was included (as in the case of the Schoonspruit and Koekemoerspruit dolomites, where some hydrogeological data was available therefore baseline data was available to establish RU scale RQOs and numerical limits).
  - On a RU scale, where there was limited data, user and protection requirements were be applied (Fitness for use guidelines and pollution management measures). (This was in the case of Ventersdorp and Karoo Supergroups were RQOs per RU

were based on groundwater information collated from the National Groundwater database (water level data), and the National Groundwater Quality Monitoring Programme (CHART). Numerical limits were proposed where monitoring (time series) data supported this which considered user requirements and pollution management required. In the absence of any data, generically applicable Fitness for Use guidelines was applied in terms of water quality criteria)

- The localised requirements were included for all three Vaal WMAs by application of a representative measure (which provides for protection zones). This measure will require that numerical limits need to be calculated on a site by site basis during implementation of RQOs, by application of a standardised formula making use of data collected directly from the site.

6 PROPOSED RESOURCE QUALITY OBJECTIVES FOR THE MIDDLE VAAL WMA

The sections below detail the proposed RQOs for rivers, dams, wetlands and groundwater in the Middle Vaal WMA. This is detailed per resource unit per IUA and includes the context and the rationale where applicable on the proposed RQOs and numerical limits formulated.

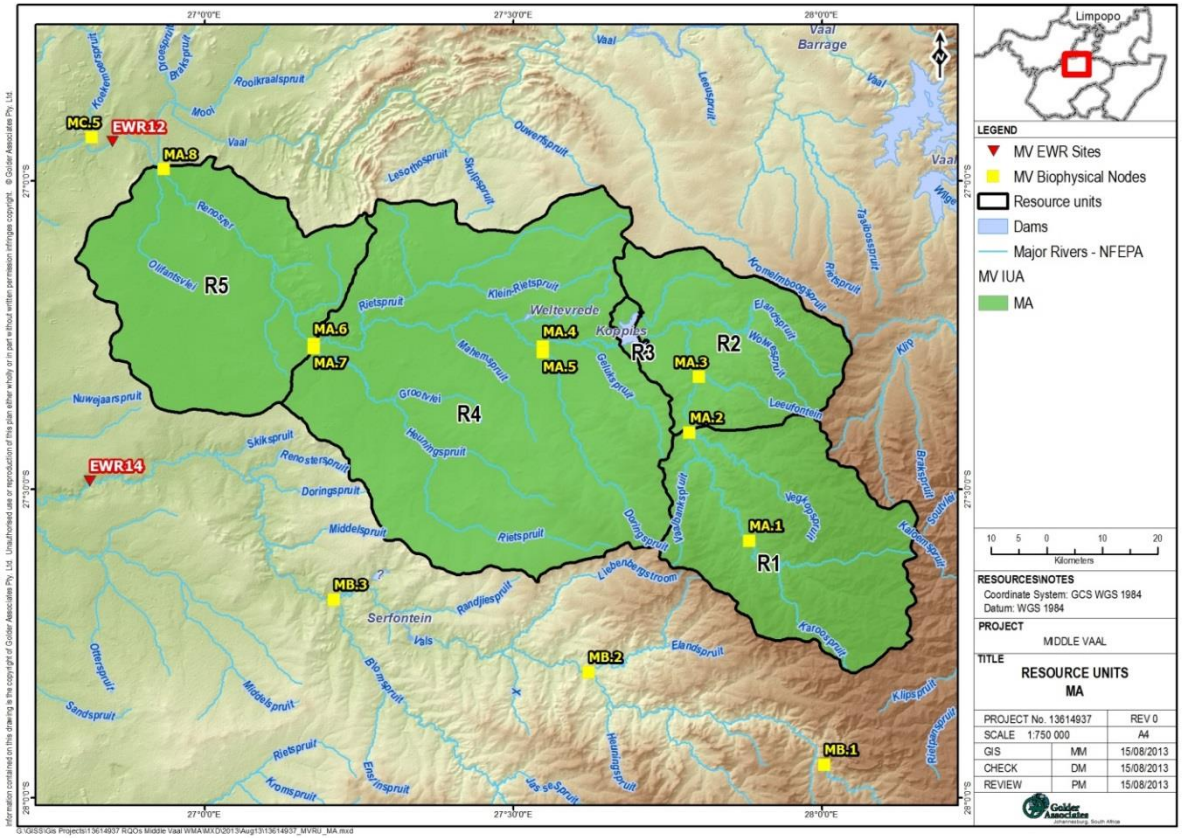
It serves to guide and provide understanding to the reader on the reasoning and context to on the proposed RQOs and the numerical limits listed per resource unit for the water resources of the Middle Vaal WMA.

The RQOs are presented in the following sub-sections for rivers and dams, wetlands and groundwater respectively.

6.1 RIVER and DAM RESOURCE QUALITY OBJECTIVES

6.1.1 IUA MA - RENOSTER

RU	Delineation area	Quaternary Catchment
	IUA 1: RENOSTER RIVER	
R2	Downstream Vaalbankspruit and Vegkopspruit tributary confluences to Koppies Dam	C70C
R3	Koppies Dam	C70C
R4	Downstream Koppies Dam to confluence with the Heuningspruit	C70E, C70D, C70F, C70G, C70H,
R5	Downstream Heuningspruit confluence to confluence with the Vaal River	C70J, C70K



IUA MA – RENOSTER RIVER
RESOURCE UNIT : R2 – RENOSTER RIVER: Downstream Vaalbankspruit and Vegkopspruit to Koppies Dam - Quaternary catchment C70C
DESCRIPTION
The IUA class is a Class II. An ecological category B/C must be maintained at biophysical node MA 2 and a C ecological category at node MA.3. The land use includes cultivated areas (irrigated agriculture) however the area is largely undeveloped. The area also includes bentonite mining. The town of Heilbron is located in the resource unit. Run of river abstractions and farm dams present along the river reach. Tributaries include the Elandspruit, Leeufontein and Wolwespruit.
RESOURCE UNIT : R3 – RENOSTER RIVER: Koppies Dam - Quaternary catchment C70C
DESCRIPTION
The IUA class is a Class II. An ecological category C must be maintained (Present Ecological State) based on the inflow and outflow of the Renoster River. The dam supports Koppies Government Water irrigation scheme and includes weirs and canals. The presence of a large number of weirs, road bridges and roads has resulted in a large to serious impact on the Renoster River. The dam provides flow regulating capability. The yield balance situation is such that the water available from the dam is fully utilised. There is also significant water use from the river downstream of the dam to the extent that there is no excess water available. The land use is irrigated agriculture and recreational fishing around the dam.
RESOURCE UNIT : R4 – RENOSTER RIVER: Downstream Koppies Dam to confluence with the Heuningspruit- Quaternary catchment C70D, C70E, C70F, C70G, C70H
DESCRIPTION
The IUA class is a Cass II. An ecological category C must be maintained at biophysical nodes MA 4 and MA 6 on the Renoster River. Resource unit R4 includes the Renoster river downstream Koppies Dam to the confluence of the Heuningspruit and Rietspruit tributaries. The towns of Koppies and Edenville are located in the resource unit. Major tributaries are the Heuningspuit, Rietspruit, Grootvlei and Mahemspruit. The RU includes some mining areas in catchments C70G and C70H and includes irrigated agriculture as a major water use. The RU has extensive areas of floodplain wetlands and some salt pans which have been identified as a priority wetland area.
RESOURCE UNIT : R5 – RENOSTER RIVER: Downstream Heuningspruit confluence to confluence with the Vaal River - Quaternary catchment C70J, C70K
DESCRIPTION
The IUA class is a Class II. RU must be maintained in a C ecological category (biophysical node MA. 8). R5 includes the Renoster River from below the confluence of the Heuningspruit to the confluence with the Vaal River. The Olifantsvlei is the major tributary in the RU. The town of Viljoenskroon is located in the RU which has some water quality impact on the river. These lower reaches (C70J and C70K) display some difference in eco-region level.

Table 6-1: Resource Quality Objectives for RIVERS AND DAMS in priority Resource Units in the Integrated Unit of Analysis MA RENOSTER

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit				Context of the RQO and/or Numerical limit
Renoster (C70C) (Tributaries Elandspruit, Leeufontein and Wolwespruit)	**R2**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MA3) = 1.097 million cubic metres/annum (Mm^3/a) (51.79% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flow limits specified are to maintain ecological state of the water resource in the recommended ecological category C and meet the Management Class II. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Percen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.0172	40	0.0000	90	
						Nov	0.0428	50	0.0000	99	
						Dec	0.0463	60	0.0000	99	
						Jan	0.0597	60	0.0037	99	
						Feb	0.0616	40	0.0000	99	
						Mar	0.0455	40	0.0000	99	
						Apr	0.0243	30	0.0000	99	
						May	0.0093	30	0.0000	90	
						Jun	0.0062	30	0.0000	90	
						Jul	0.0049	50	0.0000	99	
						Aug	0.0045	50	0.0000	99	
						Sep	0.0073	30	0.0000	99	
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and to ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)					RQO based on ecological and user specification. Present state WQ is 0.050mg/l. Limit based on target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996). Will maintain Class and C ecological category.
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)					RQO is based on ecological specifications. Limit is the ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-)& Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)					Ecological and user defined specifications. Present state WQ is 0.025mg/l. Ecosystem requirement (specialist input and N:P ratios). User based target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
			Salts	Instream salinity must be maintained to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 55 milliSiemens/metre (mS/m) (95^{th} percentile)					RQO based on integrated specifications. Present state WQ is 50 mS/m. Limit is the ecological category B upper boundary value as per the water quality component of the Ecological Reserve manual (2008).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO and/or Numerical limit
	R2		Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E. coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Ecological specification. Implementation of recommended ecological category C and Management Class II. (Water Resource Classification study, DWA, 2012).
Renoster (C70C) (Tributaries Elandspruit, Leeufontein and Wolwespruit)		**Biota**	Fish	Located upstream of the Koppies Dam the Resource Unit R2 (Renoster and Elandspruit) acts as an important refuge and nursery area for fish species moving up into the shallow waters and down into the dam. It is important to implement the necessary actions to maintain the habitat for fish species to utilise.	A baseline assessment to determine the current integrity and health of the fish community must be undertaken. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually, to monitor against the prescribed C ecological category.	Ecological specification. Implementation of recommended ecological category C and Management Class II. (Water Resource Classification study, DWA, 2012).
		Biota	Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the SASS5 methodology.	Maintain the current C ecological category by ensuring that the Average Score PerTaxon (ASPT) is >5.0.	Ecological specification. Implementation of recommended ecological category C and Management Class II. (Water Resource Classification study, DWA, 2012).
Koppies Dam (C70C)	**R3**	**Quantity**	Low flows	The downstream maintenance low flow requirements of node MA 4 must be met to support a healthy condition for the ecosystem and users.	Total EWR (node MA4) = 18.04 million cubic metres/annum (Mm^3/a) (28.82% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Maintenance Low Flows* / *Drought Flows* *Month* / m^3/ *second* / *Per-cen-tile* / m^3/ *second* / *Per-cen-tile* Oct 0.2348 60 0.0299 99 Nov 0.5204 60 0.0231 99 Dec 0.5604 70 0.0336 99 Jan 0.7187 80 0.0672 99 Feb 0.7577 70 0.0248 99 Mar 0.5892 60 0.0448 99 Apr 0.3484 60 0.0309 99 May 0.1613 50 0.0261 99 Jun 0.1181 60 0.0386 99 Jul 0.1001 60 0.0381 99 Aug 0.0900 70 0.0351 99 Sep 0.1246 50 0.0455 99	Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flow limits specified are to maintain ecological state of the water resource in the recommended ecological category C and meet the Management Class II. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO and/or Numerical limit
Koppies Dam (C70C)	**R3**	**Quality**	Nutrients	Concentration of nutrients must be maintained to sustain ecosystem health and water quality requirements of water users. The dam should be maintained in a mesotrophic state.	Dissolved Inorganic Nitrogen (DIN) as nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)	RQO based on integrated specifications. Present state is 0.05mg/l. Limit based is as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.015 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Limit is the upper boundary value as per the water quality component of the Ecological Reserve manual (2008) (mesotrophic state).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) 6 milligrams/litre (95^{th} percentile)	Ecological and user defined specifications. Ecosystem requirement (specialist input and N:P ratios). User based target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Chlorophyll-*a* (Chl-*a*) (Phytoplankton)	≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)	Response variable to monitor eutrophication. Water quality limit to maintain mesotrophic state. Ecological specifications. Ecological Reserve manual (2008) (mesotrophic state).
			Salts	The salinity in the dam must be maintained in order to support ecosystem health and the water quality requirements of the downstream water users.	Electrical conductivity (EC)	≤ 55 milliSiemens/metre (mg/l) (95^{th} percentile)	Ecological category and user requirements met. Present state quality (49 mg/l) – Limit is the ecological category B upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Dam habitat	The dam provides important refuge habitat for aquatic and semi-aquatic biota and all components of its management (recreation, eco-tourism, abstraction, water quality impacts, dam releases). All aspects of the habitat within the dam should therefore be protected.			Dam habitat can affect the sustainability of the ecosystem if not properly management. An integrated management approach is required.
		Biota	Fish	Located in the main channel of the Renoster River, the dam provides an important fish refuge area and must be managed to maintain the upstream species.	The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Monitoring should be conducted annually.		Indication of the health of the dam ecosystem.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit					Context of the RQO and/or Numerical limit
			Aquatic birds	The dam supports a variety of aquatic and semi-aquatic bird species. The suitability of the dam as bird habitat must be maintained.	A baseline assessment should be conducted to determine the aquatic bird community around the dam.						Aquatic birdlife is dependent on the dam habitat and associated ecosystem. The dependence must be determined and protected.
Renoster (C70D, C70E, C70F, C70G, C70H) (Downstream Koppies Dam to confluence with the Heuningspruit)	**R4**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MA6) = 25.413 million cubic metres/annum (Mm^3/a) (27.28% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flow limits specified are to maintain ecological state of the water resource in the recommended ecological category C and meet the Management Class II. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.2808	60	0.0373	99	
						Nov	0.6065	70	0.0617	99	
						Dec	0.6758	80	0.0971	99	
						Jan	0.9039	80	0.0821	99	
						Feb	1.0206	70	0.0661	99	
						Mar	0.8789	70	0.0485	99	
						Apr	0.5698	70	0.0887	99	
						May	0.2830	60	0.0261	99	
						Jun	0.1759	60	0.0502	99	
						Jul	0.1434	80	0.0709	99	
						Aug	0.1307	80	0.0373	99	
						Sep	0.1674	50	0.0579	99	
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.5 milligrams/litre (mg/l) (50^{th} percentile)					Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)					Ecological specifications. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.50 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)					Ecological and user defined specifications. Ecosystem requirement (specialist input and N:P ratios). User based target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO and/or Numerical limit
Renoster (C70D, C70E, C70F, C70G, C70H) (Downstream Koppies Dam to confluence with the Heuningspruit)	**R4**	**Quality**	Salts	Instream salinity must be maintained at the current state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95th percentile)	Ecological and user defined specifications. Limit based on present state quality – within category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			System variables	pH must be maintained at present state.	pH range	7.4 (5th percentile) and 8.6. (95th percentile)	Attainment of Management Class and associated ecological category. Limit based on present state quality.
				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 is required to determine present state.
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95th percentile)	Attainment of Management Class and recommended ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	Ensure the current ecological category is maintained. It is important to maintain the integrity of the habitat, flow conditions, water quality and limit migration barriers to ensure that the prescribed ecological category for fish is achieved.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state. If the current ecological category meets the recommended C category then the baseline integrity and health must be maintained. However if the baseline assessment shows that the current state does not meet the C ecological category then the C category must be met. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the current C category by ensuring the Average Score Per Taxon (ASPT) is >5.0.	Attainment of Management Class and associated ecological category.

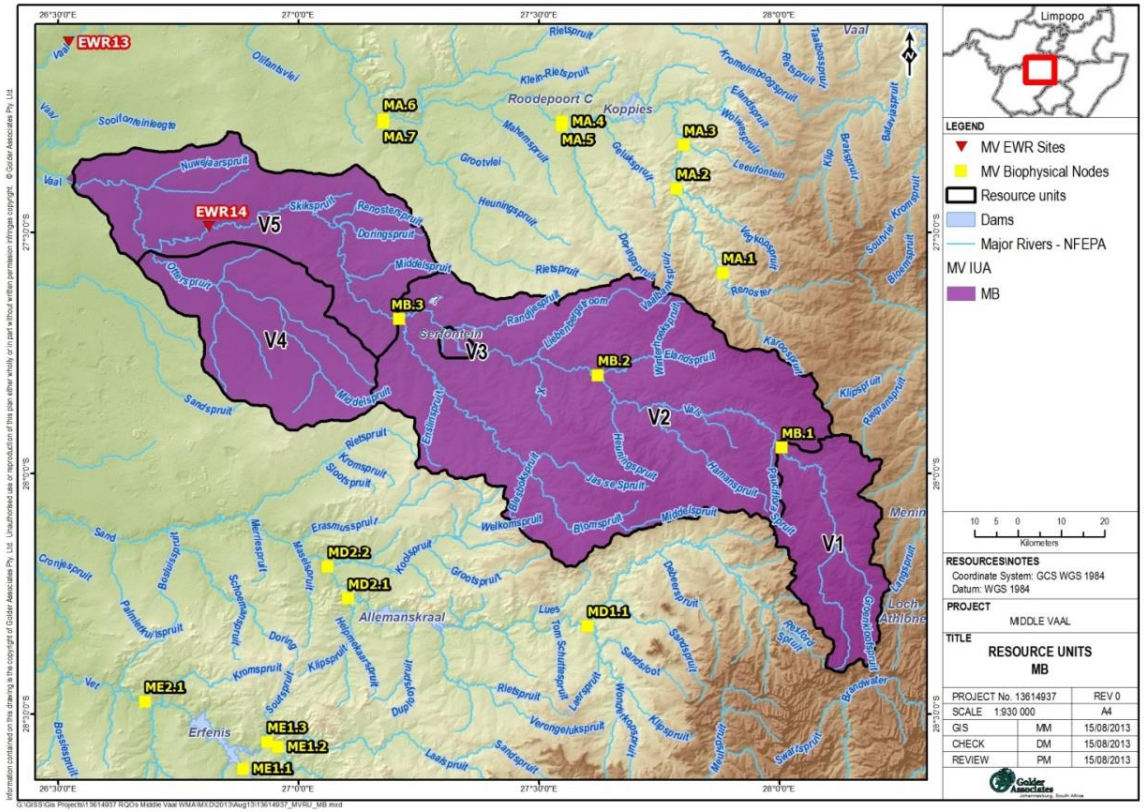
River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit					Context of the RQO and/or Numerical limit
Renoster (C70J, C70K) (Downstream Heuningspruit confluence to confluence with the Vaal River) (includes the Olifantsvlei tributary)	**R5**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem and users.	Total EWR (node MA8) = 31.578 million cubic metres/annum (Mm^3/a) (26.12% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.3226	60	0.0373	99	
						Nov	0.6848	50	0.1003	99	
						Dec	0.7743	80	0.1232	99	
						Jan	1.0600	90	0.0821	999	
						Feb	1.2269	80	0.1116	99	
						Mar	1.0977	70	0.0485	99	
						Apr	0.7311	70	0.1427	99	
						May	0.3812	60	0.0261	99	
						Jun	0.2319	80	0.0502	99	
						Jul	0.1871	90	0.0709	99	
						Aug	0.1725	90	0.0373	99	
						Sep	0.2076	60	0.0579	99	
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤1.25 milligrams/litre (mg/l) (50^{th} percentile)					Attainment of Management Class and associated ecological category. Within ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)					Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.0 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)					Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
			Salts	Instream salinity must be maintained. Salinity levels should not be allowed to deteriorate.	Electrical conductivity (EC)	≤ 55 milliSiemens/metre (mS/m) (95^{th} percentile)					Attainment of Management Class and associated ecological category as well as requirements of water users. Limit based on present state quality – corresponds to B ecological category
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)					Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO and/or Numerical limit
Renoster (C70J, C70K) (Downstream Heuningspruit confluence to confluence with the Vaal River) (includes the Olifantsvlei tributary)	**R5**		Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli (E.coli)*	130 counts/100 millilitres (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
			System variables	pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.5 (95^{th} percentile)	Attainment of Management Class and associated ecological category. Limit based on present state quality.
				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.
		Habitat	Instream Habitat	Habitat assessments must be undertaken and used in conjunction with an assessment of potential disturbances from adjacent land use activities that may be impacting on habitat integrity. This information should inform corrective management.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	In order to maintain the ecological integrity of the fish community within the Middle Vaal River the Renoster River and its tributaries need to be sustainably managed. Flow is important to accommodate species utilizing the lower reaches as a refuge area. This is important for species intolerant to no/low flow condition (*Labeobarbus Aeneus, Labeobarbus Kimberleyensis, Tilapia Sparrmanii*). Additionally water quality in terms of nutrients needs to be monitored to protect fish species moderately intolerant to modified physico-chemical conditions resulting from the land use activities within the catchment.	Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category. The presence of *Labeobarbus Kimberleyensis* should be considered significant due to its International Union for Conservation of Nature status (near threatened).	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the invertebrate community within the system must be improved, by improving the water quality from a nutrient perspective	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	An ecological category of C must be met. The Average Score Per Taxon (ASPT) value of > 5.0 must be achieved.	Attainment of Management Class and associated ecological category.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO and/or Numerical limit
			Aquatic birdlife	The Renoster River feeds into the section of the Vaal River considered and important bird area (SA038 Middle Vaal River). The suitability of this stretch of river for aquatic bird populations must be maintained through proper habitat management.	A baseline assessment should be conducted to determine the aquatic bird community and future changes in the bird communities compared to the baseline.		Aquatic birdlife is dependent on the dam habitat and associated ecosystem. Insufficient data is available. The dependence must be determined.

6.1.2 IUA MB - VALS RIVER

RU	Delineation area	Quaternary Catchment
	IUA 2: VALS RIVER	
V2	Downstream Pauciflor Spruit confluence to Kroonstad	C60B, C60C, C60D, C60E, C60F
V3	Serfontein Dam	C60D
V4	Middelspruit Tributary catchment	C60H
V5	From the Kroonval weir to the Vaal River confluence	C60G, C60J



IUA MB – VALS RIVER
RESOURCE UNIT : V2 – VALS RIVER: Downstream of Paucifloraspruit to Kroonvaal weir at Kroonstad - Quaternary catchment C60B, C60C, C60D, C60E, C60F
DESCRIPTION
The IUA class is a Class III. An ecological category C must be maintained (biophysical MB 3) which will meet the requirements of the management class set. RU V2 includes the Vals river from the Paucifloraspruit confluence to the Kroonval weir at Kroonstad. Major tributaries include the Elandspruit, Liebenbergstroom and Blomspruit. The weir forms a delineation between the upper and lower reaches of the Vals river system. This RU is largely rural in nature. In addition to Kroonstad, the towns of Lindley and Steynrus are also located in the RU. The urban requirements are dominated by the requirement of Kroonstad Municipality. Water is imported from the Vaal River by Sedibeng Water to supply the needs of the Bothaville Local Municipality. Treated sewage and storm water returns from Kroonstad in particular contribute significantly (33 % of total resource) to the water resources of the Vals area. The wastewater treatment works of the town's impact on the Vals River. Land use is large dry commercial agriculture with some irrigation. Reaches within the Elandspruit, Heuningspruit and a minor tributary in C60 are identified as FEPAs. Groundwater systems include Karoo aquifers (arenaceous rocks of the Molteno, Elliot and Clarens Formations with basaltic lava from the Drakensberg Group). These are shallow to medium aquifers (<75mbgl); moderate to minor (0.5 to 2.0l/s). Groundwater use is less than 2.5% of recharge; and baseflow contribution to surface water component in headwater areas of drainages in the order of ~3.5Mm^3/a in the upper stream parts (C60B & C) and ~2.5Mm^3/a in the downstream parts (C60E and F).
RESOURCE UNIT : V3 – VALS RIVER: Serfontein Dam - Quaternary catchment C60D
DESCRIPTION
The IUA class is a Class III. An ecological category C must be maintained (Present ecological State) based on the inflow outflow of the Vals River. It has a small storage relative to the runoff. The dam has no release capability. The dam has a small storage relative to the runoff. The Serfontein Dam has a capacity of 4.200million m^3 and a surface area of 1.58 km^2. Seasonal water releases are made from the dam. Seasonal water releases are made from the dam. The yield balance situation is such that there are deficits in supply.
RESOURCE UNIT : V4 – VALS RIVER: Middelspruit- Quaternary catchment C60H
DESCRIPTION
The IUA class is a Class III. RU should be maintained in a C ecological category based on PES. The catchment area of the Middelspruit tributary is delineated as a RU V4. The area is largely rural in nature. It includes the Otterspruit as a tributary. The upper reaches of the Middelspruit is impacted by agricultural activities. Extensive wetland systems occur along the upper reaches of the Otterspruit and its associated tributaries. Pan systems also occur along the drainage divides in this area. The Otterspruit wetland system renders this an important water resource in the study area.
RESOURCE UNIT : V5 – VALS RIVER: From Kroonvaal weir to the Vaal River confluence - Quaternary catchment C60G, C60J
DESCRIPTION

IUA MB – VALS RIVER
The IUA class is a Class III. V5 includes the Vals River from below the Kroonval weir at Kroonstad to the confluence with the Vaal River. The classification process recommended an ecological category C/D for EWR site 14 for the lower Vals River. The Nuwejaarspruit and Skikspruit are the major tributaries in the RU. Bothaville is located in the RU alongside the Vals river close to the Vaal river confluence. The RU is impacted by the town of Kroonstad and upstream activities. The catchment does not contribute to the yield of the Vaal River. This river system does not have storage regulation capability with release capabilities, with the result that high flow control and management is not possible. Water quality deterioration as a result of Kroonstad, Lindley and Bothaville Sewage Works runoff as well as runoff from irrigated and dryland agriculture has a serious to critical impact on the Vals River. Prolific growth of algae in the lower reach of the river has been observed. The overall modification to bed, channel and flow in the Vals River is moderate to large due to the presence of several weirs, roads through the river and road bridges over the river, as well as Serfontein Dam.

Table 6-2: Resource Quality Objectives for RIVERS AND DAMS in priority Resource Units in the Integrated Unit of Analysis MB VALS

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit				Context of the RQO/Numerical limit
Vals (C60B, C60C, C60D, C60E, C60F) (from the Pauciflora spruit confluence to the Kroonval weir at Kroonstad) (Major tributaries include the Elandspruit, Liebenbergstroom and Blomspruit)	**V2**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MB3) = 33.464 million cubic metres/annum (Mm^3/a) (25.41% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.3200	60	0.0261	99	
						Nov	0.6655	70	0.0077	99	
						Dec	0.8307	70	0.0000	99	
						Jan	1.1537	80	0.0373	99	
						Feb	1.2475	70	0.0703	99	
						Mar	1.1455	90	0.0523	99	
						Apr	0.6917	60	0.0000	99	
						May	0.3566	40	0.0373	99	
						Jun	0.1991	60	0.0386	99	
						Jul	0.1340	60	0.0075	99	
						Aug	0.1568	60	0.0411	99	
						Sep	0.2600	30	0.0000	99	
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0. 50 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – SAWQGs (1996).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)				Ecological and User defined specifications. Based on present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
			Salts	Instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95^{th} percentile)				Ecological category and user requirements met. Limit based on present state quality.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)				RQO is a user specification. Limit is the target water quality range for full contact recreational use - SAWQGs (1996).
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system. Monitoring should take specific cognisance of	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.				Attainment of Management Class and associated ecological category.

<table>
<tr><th>River/Dam</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th>Numerical limit</th><th>Context of the RQO/Numerical limit</th></tr>
<tr><td></td><td></td><td></td><td></td><td>changes in flow.</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Vals (C60B, C60C, C60D, C60E, C60F) (from the Pauciflora spruit confluence to the Kroonval weir) (Major tributaries Elandspruit, Liebenberg stroom and Blomspruit)</td><td rowspan="3">V2</td><td rowspan="3">Biota</td><td>Aquatic Invertebrates</td><td>The integrity of the macroinvertebrate community within the system must be improved, by improving the water quality from a nutrient perspective.</td><td>The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.</td><td>An ecological category of C/D must be met. The Average Score Per Taxon (ASPT) value of > 4.8 must be achieved.</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td>Diatoms</td><td>Water quality improvement is required from a nutrient perspective.</td><td>Conduct a diatom assessment annually.</td><td>The Specific Pollution sensitivity Index (SPI) should be > 9.2 (C category).</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td>Fish</td><td>Monitor the integrity of the fish community at a downstream point selected within the Resource Unit. In order to achieve the desired recommended ecological category maintenance of flow is important as well as improvements in the current water quality. Flow is important to accommodate species intolerant to no/low flow condition (Labeobarbus Aeneus, Labeobarbus Kimberleyensis, Labeo Umbratus), and migration barriers should be limited.</td><td>A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population.

Fish Response Assessment Index (FRAI) must be utilized.</td><td>An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.

The presence of Labeobarbus Kimberleyensis should be considered significant due to its International Union for Conservation of Nature status (near threatened).</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td>Serfontein Dam (C60D)</td><td>V3</td><td>Quantity</td><td>Low flows</td><td>The downstream maintenance low flow requirements of node MB 3 must be met to support a healthy condition for the ecosystem.</td><td>Total EWR (node MB3) = 33.464 million cubic metres/annum (Mm^3/a) (25.41% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance flows (percentage value of naturalised flow distribution)

Drought flows (percentage value of naturalised flow distribution)</td><td>
<table>
<tr><th rowspan="2">Month</th><th colspan="2">Maintenance Low Flows</th><th colspan="2">Drought Flows</th></tr>
<tr><th>m^3/ second</th><th>Per-cen-tile</th><th>m^3/ second</th><th>Per-cen-tile</th></tr>
<tr><td>Oct</td><td>0.3200</td><td>60</td><td>0.0261</td><td>99</td></tr>
<tr><td>Nov</td><td>0.6655</td><td>70</td><td>0.0077</td><td>99</td></tr>
<tr><td>Dec</td><td>0.8307</td><td>70</td><td>0.0000</td><td>99</td></tr>
<tr><td>Jan</td><td>1.1537</td><td>80</td><td>0.0373</td><td>99</td></tr>
<tr><td>Feb</td><td>1.2475</td><td>70</td><td>0.0703</td><td>99</td></tr>
<tr><td>Mar</td><td>1.1455</td><td>90</td><td>0.0523</td><td>99</td></tr>
<tr><td>Apr</td><td>0.6917</td><td>60</td><td>0.0000</td><td>99</td></tr>
<tr><td>May</td><td>0.3566</td><td>40</td><td>0.0373</td><td>99</td></tr>
<tr><td>Jun</td><td>0.1991</td><td>60</td><td>0.0386</td><td>99</td></tr>
<tr><td>Jul</td><td>0.1340</td><td>60</td><td>0.0075</td><td>99</td></tr>
</table>
</td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
</table>

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit					Context of the RQO/Numerical limit
						Aug	0.1568	60	0.0411	99	
						Sep	0.2600	30	0.0000	99	
Serfontein Dam (C60D)	**V3**	**Quality**	Nutrients	Concentration of nutrients in the dam must not be permitted toincrease. A decrease in nutrient concentrations is required tolimit algal growth, sustain ecosystem health and the water quality requirements of water users. Dam should be maintained in a mesotrophic state.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)					Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.015 milligrams/litre (mg/l) (50^{th} percentile)					Within ecological specifications and maintains mesotrophic state.
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)					Ecological and User defined specifications. Based on present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Chlorophyll-*a* (Chl-*a*)	≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)					Response variable to monitor eutrophication. Water quality limit to maintain mesotrophic state. Ecological specifications.
			Salts	Salinity in the dam must be maintained to support ecosystem health and water quality requirements of the downstream water users.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95^{th} percentile)					Ecological category and user requirements met. Limit based on present state quality.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)					RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Biota	Fish	Located in the main channel of the Vals River, the Serfontein Dam is located upstream of Kroonstad. The dam provides an important fish refuge area and must be managed to maintain the upstream species.	The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Monitoring should be conducted annually.						Indication of the health of the dam ecosystem.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/Numerical limit
Middel-spruit (C60H) (Otterspruit tributary)	**V4**	**Quantity**	Low flows	Flows must be maintained to support the wetland systems present.	Ecological Water Requirement (EWR) for maintenance low flows	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements.	Important wetland cluster is present. Flows specifications are necessary to maintain integrity of system
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological specification. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Salts	Instream salinity must be maintained to support the aquatic ecosystem.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological specification and user requirements met. Limit based on present state quality.
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method (RHAM) must be implemented	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	Ensure the current ecological category is maintained or improved if lower than the prescribed ecological category. It is important to maintain the integrity of the habitat, water quality and flow conditions and limit migration barriers.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the current C category by ensuring the Average Score Per Taxon (ASPT) is >5.0.	Attainment of Management Class and associated ecological category.

<table>
<tr><th>River/Dam</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th>Numerical limit</th><th>Context of the RQO/Numerical limit</th></tr>
<tr><td rowspan="3">Vals (C60G, C60J) (From Kroonvaal weir to the Vaal River confluence) (Nuwejaar spruit and Skikspruit tributaries)</td><td rowspan="3">V5</td><td rowspan="2">Quantity</td><td>Low flows</td><td>The maintenance low flows and drought flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem and users.</td><td>Total Maintenance low flow and drought flow Ecological Water Requirement (EWR 14) = 8.003 million cubic metres/annum (Mm^3/a)
(5.49% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance flows (percentage value of naturalised flow distribution)

Drought flows (percentage value of naturalised flow distribution)</td><td><table><tr><th rowspan="2">Month</th><th colspan="2">Maintenance Low Flows</th><th colspan="2">Drought Flows</th></tr><tr><th>m^3/ second</th><th>Per-cen-tile</th><th>m^3/ second</th><th>Per-cen-tile</th></tr><tr><td>Oct</td><td>0.153</td><td>70</td><td>0.003</td><td>99</td></tr><tr><td>Nov</td><td>0.276</td><td>80</td><td>0.005</td><td>99</td></tr><tr><td>Dec</td><td>0.333</td><td>80</td><td>0.006</td><td>99</td></tr><tr><td>Jan</td><td>0.447</td><td>90</td><td>0.008</td><td>99</td></tr><tr><td>Feb</td><td>0.484</td><td>80</td><td>0.008</td><td>99</td></tr><tr><td>Mar</td><td>0.444</td><td>80</td><td>0.008</td><td>99</td></tr><tr><td>Apr</td><td>0.285</td><td>80</td><td>0</td><td>99</td></tr><tr><td>May</td><td>0.166</td><td>70</td><td>0.003</td><td>99</td></tr><tr><td>Jun</td><td>0.112</td><td>80</td><td>0.002</td><td>99</td></tr><tr><td>Jul</td><td>0.087</td><td>90</td><td>0.002</td><td>99</td></tr><tr><td>Aug</td><td>0.095</td><td>90</td><td>0.002</td><td>99</td></tr><tr><td>Sep</td><td>0.133</td><td>70</td><td>0</td><td>99</td></tr></table></td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td>High Flows</td><td>The maintenance high flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem.</td><td>Total Maintenance high flow Ecological Water Requirement (EWR 14) = 16.969 million cubic metres/annum (Mm^3/a)
(11.64% of the Virgin Mean Annual Runoff) (VMAR)

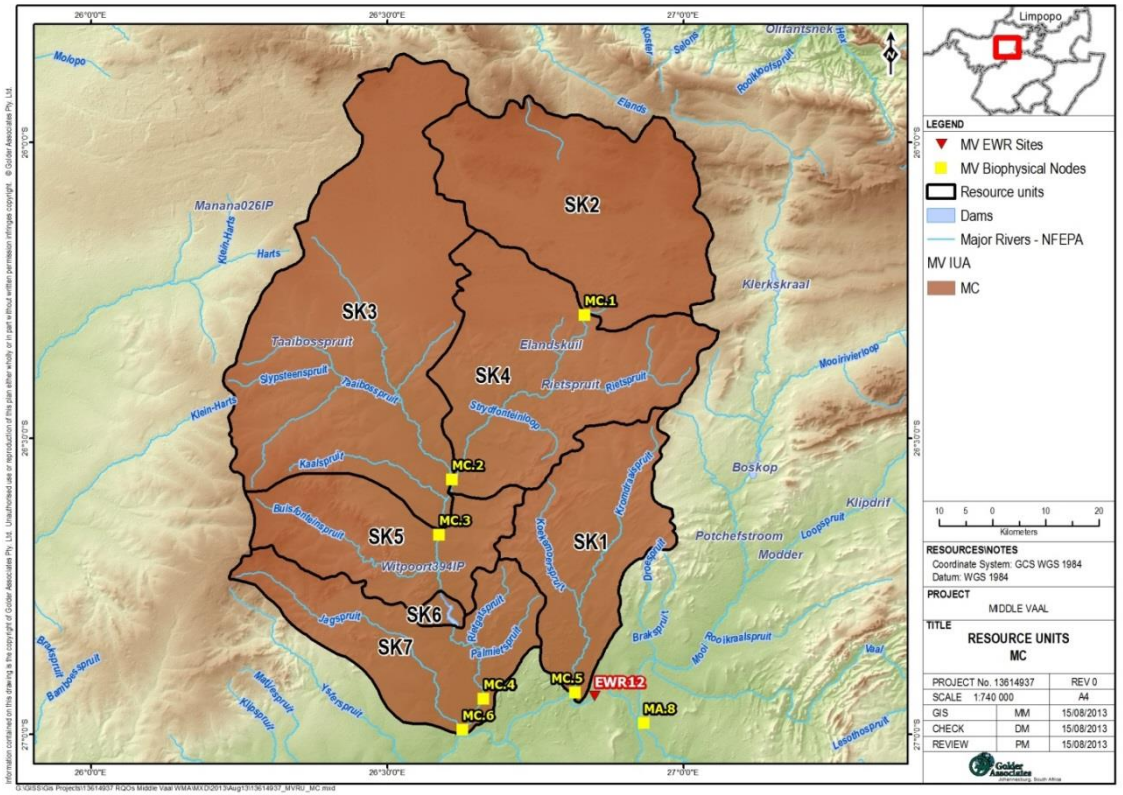
Maintenance high flows (percentage value of naturalised flow distribution)</td><td><table><tr><th rowspan="2">Month</th><th colspan="2">Maintenance High Flows</th></tr><tr><th>m^3/ second</th><th>Percentile</th></tr><tr><td>Oct</td><td>0</td><td>99</td></tr><tr><td>Nov</td><td>1.653</td><td>50</td></tr><tr><td>Dec</td><td>0</td><td>99</td></tr><tr><td>Jan</td><td>0.697</td><td>90</td></tr><tr><td>Feb</td><td>2.7</td><td>60</td></tr><tr><td>Mar</td><td>1.6</td><td>60</td></tr><tr><td>Apr</td><td>0</td><td>99</td></tr><tr><td>May</td><td>0</td><td>99</td></tr><tr><td>Jun</td><td>0</td><td>99</td></tr><tr><td>Jul</td><td>0</td><td>99</td></tr><tr><td>Aug</td><td>0</td><td>99</td></tr><tr><td>Sep</td><td>0</td><td>99</td></tr></table></td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td>Quality</td><td>Nutrients</td><td>Instream concentration of nutrients must sustain aquatic ecosystem health. Concentrations should not be allowed to deteriorate.</td><td>Dissolved Inorganic Nitrogen (DIN) as Nitrogen</td><td>≤ 1.50 milligrams/litre (mg/l) (50^{th} percentile)</td><td>Ecological specifications. Based on present state and within Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).</td></tr>
<tr><td></td><td></td><td></td><td>Orthophosphate (PO_4^-)as Phosphorus</td><td>≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)</td><td>Present state unacceptable and requires improvement. Based on Ecological category D upper boundary value as per the water quality component of the Ecological</td></tr>
</table>

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/Numerical limit
							Reserve manual (2008).
			Nutrients	Instream concentration of nutrients must sustain aquatic ecosystem health. Concentrations should not be allowed to deteriorate.	Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.35 milligrams/litre (50th percentile) ≤ 6 milligrams/litre (95th percentile)	Ecological and User defined specifications. Consideration of present state and within C/D ecological requirement. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Chlorophyll-*a* (Chl-*a*) concentrations should be monitored as a response indicator against the resource quality objective nutrient concentrations.	Chl-*a* Periphyton ≤ 1.7 mg/m^2 (50th percentile) Chl-*a* Phytoplankton ≤ 0.025 milligrams/litre (mg/l) (50th percentile)	Response variables to monitor eutrophication. Water quality limit to maintain mesotrophic state. Ecological specifications.
Vals (C60G, C60J) (From Kroonvaal weir to the Vaal River confluence) (Nuwejaar spruit and Skikspruit tributaries	**V5**	**Quality**	Salts	Instream salinity should not deteriorate.	Electrical conductivity (EC)	≤ 85 milliSiemens/metre (mS/m) (95th percentile)	Ecological specification. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Ecological category met.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
			System variables	pH must be maintained at present state.	pH range	7.0 (5th percentile) and 8.6 (95th percentile).	Ecological specification. Based on present state.
				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 todetermine present state.
		Habitat	Instream Habitat	The Resource Unit provides refuge habitat for the main stem of the Vaal River and therefore the maintenance of the morphology and form of the channel is important for aquatic and semi-aquatic biota and ecological processes. Habitat assessments must be undertaken to monitor changes within the system. Particular attention should focus on migration barriers. The prescribed ecological category must be met.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C/D ecological category is being met.	Attainment of Management Class and associated ecological category. Ecological Reserve.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/Numerical limit
Vals (C60G, C60J) (From Kroonvaal weir to the Vaal River confluence) (Nuwejaar spruit and Skikspruit tributaries	**V5**	**Biota**	Fish	In order to maintain the ecological integrity of the fish community within the Middle Vaal River the Vals River and its tributaries need to be sustainably managed.	Fish Response Assessment Index (FRAI) must be utilized. The ecological specifications and Thresholds of Potential Concern for Ecological Water Requirement site 14 must be adhered to.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category. Ecological Reserve.
			Aquatic Invertebrates	The Present Ecological State must be improved to a C category.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology. The ecological specifications and Thresholds of Potential Concern for Ecological Water Requirement site 14 must be adhered to.	The SASS5 score must be >110 and the Average Score Per Taxon (ASPT) is > 5.2.	Attainment of Management Class and associated ecological category. Ecological Reserve.

6.1.3 IUA MC - SCHOONSPRUIT KOEKEMOERSPRUIT

RU	Delineation area	Quaternary Catchment
IUA 3: SCHOONSPRUIT		
SK1	From origin of Koekemoerspruit to confluence with Vaal River	C24A
SK2	Schoonspruit eye	C24C
SK3	Taaibospruit tributary catchment	C24F
SK4	From Schoonspruit eye to Kaalspruit confluence	C24D, C24E
SK5	Schoonspruit - Kaalspruit and Buisfonteinspruit tributary catchment	C24G
SK6	Johan Neser Dam	C24G
SK7	From Johan Neser Dam to confluence with the Vaal River	C24H



IUA MC - SCHOONSPRUIT KOEKEMOERSPRUIT
RESOURCE UNIT : SK1 - KOEKEMOERSPRUIT: From the origin of river to confluence with the Vaal River - Quaternary catchment C24A
DESCRIPTION
The IUA class is a Class III. The classification process recommended an ecological category D for the Koekemoerspruit. The RU includes the Koekemoerspruit and the Kromdraaispruit as its tributary. The upper reaches of the Koekemoerspruit has a present ecological state of C. The present ecological state of the lower reaches is categorised as a D/E with the water quality being the driver for current eco-status. This catchment is highly impacted by urban development and mining activities. There are numerous tailing storage facilities. The Stilfontein urban area is located in this resource unit together with peri-urban settlements and rural areas. Some dryland agriculture is present in the upper reaches. The river is underlain by dolomites and there are linkages with the surface water and underground mine workings. Naturally the river flows are seasonal and there are periods when the river dries up. However the flow patterns have been changed due to the mine dewatering discharges as well as discharges from the Stilfontein wastewater treatment works into the system. As a result of this flow pattern changes, sections of reeds have developed in the lower reaches of the river which has provided habitats for aquatic life. The Vaal River backs up into the lower reaches of the Koekemoerspruit. These areas act as refuge areas for fish particularly during periods of high flow in the Vaal River. The flows also support subsistence livestock watering. The water quality in the river is impacted by mine dewatering discharges as well as the seepages from the tailings storage facilities, pollution control dams and storm water management systems. The mine impact on water quality is largely related to salts and toxics such as heavy metals. Cyanide can also be present in the water in times of tailings spills or leakages from the slurry pipelines that traverse the river. The wastewater treatment works discharges also impacts on water quality specifically on the nutrient concentrations in the river. The feasibility of re-mining the tailings storage facilities is being investigated. This will involve the hydraulic mining of the tailings, reprocessing to remove the remaining gold and uranium and disposing of the tailings on a central tailings storage facility. The footprint of the reprocessed tailings will be rehabilitated, which will contribute to the improvement in the water quality of the catchment. However this will only be initiated in about 5 years' time. The discharges from the Margaret and Buffels shafts will be used for re-mining and will no longer be discharged to the Koekemoerspruit. RU G3 consists of dolomite aquifer systems; characteristically high yielding aquifer systems with a high vulnerability for pollution, but also a high recharge rate; thus flushing out the aquifer system occurs frequently. The dolomite aquifer can be divided in a northern part (north of latitude 26°46') which hosts agricultural based land use activities (cultivated commercial dry land practices).Towards the south, extensive mining activity associated with gold mining (Klerksdorp Gold Field) consisting of deep, underground mine workings and extensive mine residue deposits on surface (tailings dams and waste rock dumps). Shallow aquifer systems in the southern part of RU G3 are polluted due to the mine residue deposits; especially within the local drainages of waste rock dumps and tailings storage facilities. This aquifer system is current used by the operating mines for water supply; thus controlling the lateral migration of pollutants. Due to closure of mining operations, rewatering of the underground works have started but is currently managed by existing gold mining companies – future post-mining scenarios may include a total re-watering of the mine void and underlying dolomite rock formation. Interaction with surface water bodies through spring discharges in the Vaal River valley (dolomite outcrops) is foreseen for the future. The extent of the dolomite aquifers is not fully researched, especially south of the Vaal River in terms of groundwater flow regimes and interaction with Vaal River water body as well. Decants from deep mine shafts north and south of the Vaal River are predicted by the operational mines in the catchment (water quality AMD type). The decanting mine water will require treatment to discharge standards. A local monitoring network is currently operated by the operational mines, but future responsibilities will require refinement. Zones with elevated water quality constituents (total dissolved salts, nitrate, sodium and chloride) should be identified as point source polluted areas. The RU has priority wetland pans present. The pans have a PES of B, and have a high to very high ecological importance and sensitivity. The pans are defined as endoreic seasonal pans fed by a relatively large localised catchment and drainage lines. They are part of the Vaal Vet Sandy Grassland ecosystem which is considered threatened.

RESOURCE UNIT : SK2 - SCHOONSPRUIT EYE Quaternary catchment C24C
DESCRIPTION
The IUA class is a Class III. The water resources (Schoonpruit Eye) must be maintained in a C ecological category. The classification process recommended an ecological category C for the Schoonspruit Eye (biophysical node MC1). The PES is a D ecological category due to disturbance and impacts on the riparian vegetation and in-stream habitat that is impacted upon by peatland mining and irrigation activities. Groundwater fed irrigated agriculture is present in the vicinity of the eye. There is depletion of the groundwater resources which is impacting on the flow and water quality of the Schoonspruit Eye water. The water quality of the eye is currently good and it is important to maintain this quality as irrigation and domestic water users are dependent on the Schoonspruit eye for water supply. ,. The dolomite aquifer systems in the catchment are significantly impacted by irrigation practices. There are extensive abstractions from the dolomitic aquifer for irrigation which has resulted in the reduction of flow from the Schoonspruit Eye and falling groundwater levels in the dolomitic groundwater compartment over time. Fertilizers are also applied to the irrigation areas. This has resulted in local nitrate concentrations in the groundwater exceeding 10 mg/L as nitrogen. Elevated salt concentrations in the groundwater have also been identified in places. The reduction in flow and potential deterioration in the water quality at the Eye will impact on the water users and ecology of the Schoonspruit downstream of the Eye. The interaction between the Eye discharge and the flow and water quality requirements of the Schoonspruit fed by the Eye discharge requires careful management of the water balance of the dolomitic compartment. The current groundwater monitoring protocols and programme need to be reassessed. The RU includes six priority wetlands and wetland clusters. They include the Lelie fontein pan and wetland complex (PES B to D), the pan and wetland complex to the north of Vetpan (PES C to E), Vetpan (PES D) and Klippan (PES B), wetland system associated with Klippan (PES C/D), Rietpan pan and wetland complex (PES D) and upper section of the Schoonspruit peatland and the Schoonspruit eye (PES B to D). The pans, wetland complexes and peatlands vary in their PES however all are rated as high to very high ecological importance and sensitivity. The systems are identified as wetland FEPAs. The wetland systems are characterised as endorheic seasonal pans and depressions linked to other wetland complexes, seasonal pans and depressions connected to river systems, seasonal pan connected to wetland and river systems and peatland associated with dolomites and dolomitic eye.
RESOURCE UNIT : SK3 – Taaibospruit Catchment, Quaternary catchment C24F
DESCRIPTION
The IUA class is a Class III. The classification process recommended an ecological category C for SK3 (biophysical node MC.2). The water resources must be maintained in a C ecological category. Current land use activities include dryland agriculture, livestock grazing and water quality impacts from the sewage works overflow and maturation ponds present. These localised impacts need to be managed. The RU is important primarily due to the dolomitic aquifer systems present and the associated wetlands (peatlands). The dolomite aquifer systems in the catchment are significantly impacted by irrigation practices which is directly impacting on downstream users. Several large-scale irrigation systems are noted in the north. A large portion (~20%) of RU G1 are not part of the water balance but have been added to the Crocodile (West) and Marico WMA. Southern parts of RU G2 consist of various formations of the Ventersdorp Supergroup. The RU includes six priority wetlands and wetland clusters. They include the Eastern section of Witpan (PES B), Pan cluster north of Coligny (PES B to D), Floodplain of the Taaibosspruit (PES D), Middle Kaalspruit (PES C/D), Lower Kaalspruit (PES B) and Lower section – floodplain of the Schoonspruit (PES C/D). The pans, wetland complexes and floodplains vary in their PES however all are rated as high to very high ecological importance and sensitivity. Four of the systems are identified as wetland FEPAs. The wetland systems in the RU are characterised as endorheic seasonal pans and depressions, floodplains, channelled valley bottom and floodplain complex and unchannelled valley bottom linked to a floodplain complex.

RESOURCE UNIT : SK4 - SCHOONSPRUIT: From below eye to the Kaalspruit confluence - Quaternary catchment C24D, C24E
DESCRIPTION
The IUA class is a Class III. The water resources should an ecological category C/D as recommended in terms of the Classification process (at the node just below the outflow of the RU). The RU includes the Schoonspruit and Rietspruit and Strydfonteinloop as tributaries. The upper reaches of the Schoonspruit is highly modified with canal systems. Reduced flow in the river is experienced and there are impacts from upstream agricultural activities and urban use. The RU is largely driven by dolomitic groundwater which discharges into the Schoonspruit (and Taaibosspruit). Surface water interaction between local aquifer systems in the Schoon- and Taabosspruit systems is possible below the Eye's contribution. The RU has several large irrigation schemes. The Schoonspruit Eye flow at times is insufficient to supply downstream users. Ventersdorp is reliant on the water resource for its water supply. The flows in the RU need to be maintained to support ecological functioning and downstream users. The water quality impacts need to be managed to prevent deterioration of the resource. Groundwater includes mainly localised Ventersdorp aquifers, minor to insignificant aquifer types (<2.0l/s yield classes) and shallow Karoo aquifers towards the south east which are localised minor aquifer types. The RU includes three priority wetlands and wetland clusters. They include the Lower section of the Schoonspruit peatland (PES D), the floodplain of Rietspruit and the Upper section – floodplain of the Schoonspruit (PES C/D). The wetland systems are rated as high to very high ecological importance and sensitivity. Only the Lower section of the Schoonspruit peatland is identified as a wetland FEPA. The wetland systems are characterised as peatlands, floodplains or extensive valley bottom and floodplain wetland system. The floodplain provides important livestock grazing, flow regulation, sediment trapping and flood attenuation function in this RU. It has been impacted by a number of factors ranging from agricultural practices to flow pattern modification from linear infrastructure and draining, all of which has resulted in a deterioration in its PES. Most significantly there are noticeable impacts which have resulted from changes in the flow and flooding regime as a result of water use and abstraction upstream, including from the dolomitic aquifer which feeds the system.
RESOURCE UNIT : SK5 – SCHOONSPRUIT: Kaalspruit and Buisfontein tributary catchment - Quaternary catchment C24G
DESCRIPTION
The IUA class is a Class III. The water resources should be maintained in a C/D ecological category as recommended by the classification process. This middle reach of the Schoonspruit extends from the Kaalspruit confluence to Johan Neser Dam (Klerksdorp Dam) and includes the Buisfonteinspruit as a tributary. Current overuse (over abstraction) is prevalent and the water quality is impacted by agricultural activities, urban impacts and piggeries present in the catchment. It is important that the ecosystem is maintained in its present state. Groundwater includes mainly localised Ventersdorp aquifers, minor to insignificant aquifer types (<2.0l/s yield classes). Good quality groundwater is present due to shallow resources and spontaneous recharge events during high rainfall events. The RU includes the Floodplain of the lower Schoonspruit as a priority wetland. The wetland has a PES of C/D and is rated as a high ecological importance and sensitivity. It is identified as a wetland FEPA.
RESOURCE UNIT : SK6 – SCHOONSPRUIT: Johan Neser (Klerksdorp Dam) –Quaternary catchment C24G
DESCRIPTION

The IUA class is a Class III. The classification process recommended an ecological category C/D upstream and downstream of the dam (at biophysical MC.3 and MC.4). Thus the dam should be managed to maintain a C/D ecological status.

The dam is important for commercial irrigated agricultural use and recreation and ecotourism. The dam does not have any bottom outlets and this limits the flow downstream. This is an important consideration in meeting downstream flow requirements. The dam serves as a refuge for fish.

RESOURCE UNIT : SK7 - SCHOONSPRUIT: From the downstream Johan Neser Dam to confluence with the Vaal River - Quaternary catchment C24H

DESCRIPTION

The IUA class is a Class III. Water resources must be maintained in a C/D ecological category as recommended by the classification process for the lower reaches of the Schoonspruit (biophysical node MC.4) and a D ecological category for the Jagspruit tributary (biophysical node MC.6). The present ecological state of the lower reaches is categorised as a D with the water quality being the driver for current eco-status. This catchment is highly impacted by urban development and mining activities. Some irrigated and dryland agriculture is present in the catchment. The Klerksdorp, Hartbeesfontein and Orkney urban areas are located in this resource unit together with peri-urban settlements and rural areas. The water quality in the river is impacted by mining activities such as seepages from the tailings storage facilities and pollution control dams. The mine impact on water quality is largely related to salts and toxics such as heavy metals. The wastewater treatment works discharges also impact on water quality specifically on the nutrient concentrations in the river. The Vaal River backups into the lower reaches of the Schoonspruit. These areas act as refuge areas for fish particularly during periods of high flow in the Vaal River.

Groundwater includes mainly localised Ventersdorp aquifers, minor to insignificant aquifer types (<2.0l/s yield classes). Groundwater dependant ecosystems include: Klerksdorp and Kimberly Thornveld – Woodlands with trees and shrubs with a number of species that may be deep rooted and depended on groundwater and may be sensitive to lowering of the water table. Good quality groundwater is present due to shallow resources and spontaneous recharge events during high rainfall events.

Table 6-3: Resource Quality Objectives for RIVERS AND DAMS in priority Resource Units in the Integrated Unit of Analysis MC SCHOONSPRUIT

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit					Context of the RQO/ Numerical limit
						Month	*Maintenance Low Flows*		*Drought Flows*		
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
Koekemoer-spruit (C24A)	**SK1**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MC5) = 4.691 million cubic metres/annum (Mm^3/a) (17.91% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution) The mine water and wastewater treatment works discharges in relation to the required instream flows will have to be managed in future to ensure the maintenance low in the river.	Oct	0.0202	70	0.0037	99	Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
						Nov	0.0409	80	0.0039	99	
						Dec	0.0571	40	0.0112	99	
						Jan	0.1038	40	0.0112	99	
						Feb	0.1682	40	0.0165	99	
						Mar	0.2012	70	0.0149	99	
						Apr	0.1246	60	0.0000	99	
						May	0.0504	50	0.0037	99	
						Jun	0.0243	70	0.0039	99	
						Jul	0.0179	70	0.0000	99	
						Aug	0.0138	80	0.0000	99	
						Sep	0.0104	70	0.0000	99	
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 3.0 milligrams/litre (mg/l) (50^{th} percentile					Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Improvement required.
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)					Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)					Ecological and User defined specifications. Consideration of present state. Status quo exceeds tolerable range for aquatic ecosystem Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Koekemoer-spruit (C24A)	**SK1**		Salts	Instream salinity must be improved to acceptable levels to support a healthy aquatic ecosystem and the water quality requirements of water users.	Electrical conductivity (EC) The salinity needs to be improved significantly from the present state to meet the required limit of 85 milliSiemens/ metre. A phased approach over a twenty year period is to be used to achieve the limit of 85 milliSiemens/metre (mS/m)	≤ 85 mS/m) (95thpercentile) A numerical limit of 110 mS/m (95thpercentile) to be met by the 10th year after publication date of the Government Notice. Resource Quality Objective numerical limit to be achieved by the 20th year after publication date of the Government Notice.	Attainment of Management Class and associated ecological category as well as user requirements. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem.
					Sulphate (SO_4)	≤ 250 mg/l (95thpercentile) A numerical limit of 400 mg/l (95thpercentile) to be met by the 10th year after publication date of the Government Notice. Resource Quality Objective numerical limit to be achieved by the 20th year after publication date of the Government Notice.	Attainment of Management Class and associated ecological category as well as user requirements. Target water quality range limit: Tolerable – Stricter user – South African Water Quality Guidelines (1996). Status quo exceeds tolerable range.
					Magnesium (Mg)	≤100 milligrams/litre (mg/l) (95thpercentile)	Target water quality range limit: Acceptable range strictest user. South African Water Quality Guidelines (1996).
Koekemoer-spruit (C24A)	**SK1**	**Quality**	Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Cyanide (free) (CN)	≤ 0.050 mg/l (95thpercentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Aluminium (Al)	≤ 0.1 mg/l (95thpercentile)	
					Manganese (Mn)	≤ 0.250 mg/l (95thpercentile)	
					Iron (Fe)	≤ 0.25 mg/l (95thpercentile)	
					Uranium (U)	≤ 0.03 mg/l (95thpercentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.1 mg/l (95thpercentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Koekemoer-spruit (C24A)	**SK1**	**Habitat**	Instream Habitat	The system should be maintained in its current state based on a baseline habitat assessment. No further degradation of the habitat and riparian zone should occur.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be maintained in a D ecological category.	Attainment of Management Class and associated ecological category.
		Biota	Fish	The integrity of fish community must be maintained. The potential presence of *Labeobarbus Kimberleyensis* must be confirmed and if found, measures should be put in place to protect a viable population.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed D ecological category.	Attainment of Management Class and associated ecological category.
			Diatoms	Water quality improvement is required from a nutrient perspective.	Specific Pollution sensitivity Index (SPI). Conduct a diatom assessment annually.	The Specific Pollution sensitivity Index (SPI) score should be > 5.0.	Attainment of Management Class and associated ecological category.
Schoonspruit Eye (C24C)	**SK2**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Ecological Water Requirement (EWR) for maintenance low flows and drought flows	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements.	There is depletion of the groundwater resources which is impacting on the flow and water quality of the Schoonspruit Eye water due to irrigation water use Flows are required to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set.
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health of the Eye and protect the good water quality present. Concentrations should not be allowed to deteriorate. The current water quality ecological status of the Schoonspruit Eye must be maintained.	Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	The water quality of the eye is currently good and it is important to maintain this quality as irrigation and domestic water users are dependent on the Schoonspruit eye for water supply.
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.020 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category A/B upper boundary value as per the water quality component of the Ecological Reserve manual (2008).

<table>
<tr><th>River/Dam</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th>Numerical limit</th><th>Context of the RQO/ Numerical limit</th></tr>
<tr><td rowspan="4">Schoonspruit Eye (C24C)</td><td rowspan="4">SK2</td><td rowspan="3">Quality</td><td>Nutrients</td><td></td><td>Chlorophyll-a (Chl-a)</td><td>≤ 0.010 milligrams/litre (mg/l) (50th percentile)</td><td>Attainment of Management Class and associated ecological category. Ecological category A/B upper boundary value as per the water quality component of the Ecological Reserve manual (2008).</td></tr>
<tr><td>Salts</td><td>Salinity levels at the Schoonspruit eye are low and must be maintained at the present state. Salinity levels should not deteriorate.</td><td>Electrical conductivity (EC)</td><td>≤ 55 milliSiemens/metre (mS/m) (95th percentile)</td><td>Attainment of Management Class and associated ecological category. Ecological category B upper boundary value as per the water quality component of the Ecological Reserve manual (2008).</td></tr>
<tr><td>System variables</td><td>pH must be maintained at present state.</td><td>pH range</td><td>6.0 (5th percentile) and 8.5 (95th percentile)</td><td>Attainment of Management Class and associated ecological category. Limit based on present state quality.</td></tr>
<tr><td>Habitat</td><td>Instream Habitat</td><td>The habitat is unique to the catchment area and must be maintained at the prescribed ecological condition.</td><td>The Rapid Habitat Assessment Method (RHAM) must be implemented.</td><td>The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td rowspan="2">Taaibosspruit (C24F)</td><td rowspan="2">SK3</td><td>Quantity</td><td>Low flows</td><td>The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.</td><td>Total EWR (node MC2) = 4.147 million cubic metres/annum (Mm^3/a) (21.27% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance flows (percentage value of naturalised flow distribution)

Drought flows (percentage value of naturalised flow distribution)</td><td>
<table>
<tr><th rowspan="2">Month</th><th colspan="2">Maintenance Low Flows</th><th colspan="2">Drought Flows</th></tr>
<tr><th>m^3/ second</th><th>Per-cen-tile</th><th>m^3/ second</th><th>Per-cen-tile</th></tr>
<tr><td>Oct</td><td>0.0239</td><td>60</td><td>0.0075</td><td>99</td></tr>
<tr><td>Nov</td><td>0.0278</td><td>70</td><td>0.0039</td><td>99</td></tr>
<tr><td>Dec</td><td>0.0310</td><td>70</td><td>0.0037</td><td>99</td></tr>
<tr><td>Jan</td><td>0.0743</td><td>70</td><td>0.0149</td><td>99</td></tr>
<tr><td>Feb</td><td>0.1484</td><td>60</td><td>0.0124</td><td>99</td></tr>
<tr><td>Mar</td><td>0.1605</td><td>60</td><td>0.0112</td><td>99</td></tr>
<tr><td>Apr</td><td>0.1073</td><td>70</td><td>0.0270</td><td>99</td></tr>
<tr><td>May</td><td>0.0489</td><td>80</td><td>0.0224</td><td>99</td></tr>
<tr><td>Jun</td><td>0.0313</td><td>90</td><td>0.0201</td><td>99</td></tr>
<tr><td>Jul</td><td>0.0246</td><td>99</td><td>0.0153</td><td>99</td></tr>
<tr><td>Aug</td><td>0.0202</td><td>99</td><td>0.0119</td><td>99</td></tr>
<tr><td>Sep</td><td>0.0170</td><td>70</td><td>0.0096</td><td>99</td></tr>
</table>
</td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td>Quality</td><td>Salts</td><td>The instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users. Salinity levels should not deteriorate.</td><td>Electrical conductivity (EC)</td><td>≤ 65 milliSiemens/metre (mS/m) (95th percentile)</td><td>Present state specified. Present state quality better that ecological specification for ecological category.</td></tr>
</table>

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Schoonspruit (C24D, C24E) (From below eye to the Kaalspruit confluence) (Rietspruit and Strydfontein-loop tributaries)	**SK4**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Ecological Water Requirement (EWR) for maintenance low flows	Use Desktop Reserve Model (DRM) and updated Present Ecological State data to determine low flow requirements.	Reduced flows in the RU are experienced. Flows need to be specified in order to maintain ecological categories of the water resource in prescribed ecological state and to meet the Management Class set.
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 3.0 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
			Salts	The instream salinity must be maintained at the current state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 75 milliSiemens/metre (mS/m) (95^{th}percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Schoonspruit (C24D, C24E) (From below eye to the Kaalspruit confluence) (Rietspruit and Strydfontein-loop tributaries)	**SK4**	**Habitat**	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system. Monitoring should take specific cognisance of flow, erosion and sedimentation.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C/D ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	Maintain the species diversity present (e.g. *Labeobarbus Aeneus*, *Labeo Capensis* and *Labeo Umbratus*)	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against present state B ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the current C category by ensuring the Average Score Per Taxon (ASPT) is >5.0.	Attainment of Management Class and associated ecological category.
Schoonspruit (24F) From Kaalspruit confluence to Johan Neser Dam) (includes Buisfontein-spruit)	**SK5**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Ecological Water Requirement (EWR) for maintenance low flows	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements.	Flows need to be specified in order to maintain ecological categories of the water resource in prescribed ecological state and to meet the Management Class set.
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.0 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Improvement required.
					Orthophosphate (PO_4^-) as Phosphorus	0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Status quo exceeds tolerable range for aquatic ecosystem TWQR limit: Domestic use – SAWQGs (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Schoonspruit (24F) From Kaalspruit confluence to Johan Neser Dam) (includes Buisfontein-spruit)	**SK5**	**Quality**	Salts	The instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95th percentile)	Ecological specifications. Based on present 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)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
			System variables	pH must be maintained at present state.	pH range	6.0 (5th percentile) and 8.5 (95th percentile)	Ecological specification. Based on present state.
Schoonspruit (24F) From Kaalspruit confluence to Johan Neser Dam) (includes Buisfontein-spruit)	**SK5**	**Habitat**	Instream Habitat	The prescribed aecological category for the habitat must be maintained. Habitat assessments must be undertaken to monitor changes within the system. Monitoring should take specific cognisance of changes in flow.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C/D ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	Maintain the species diversity present (e.g. *Austroglanis Sclateri, Labeobarbus Kimberleyensis* and *Barbus Trimaculatus)*	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C/D ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the current C ecological category by ensuring the Average Score Per Taxon (ASPT) is >5.0.	Attainment of Management Class and associated ecological category.
Johan Neser (Klerksdorp Dam) (C24G)	**SK6**	**Quality**	Nutrients	Concentrations of nutrients must be maintained to sustain ecosystem health and the water quality requirements of water users. Concentrations should not be allowed to deteriorate. Nutrient concentrations must be maintained in a mesotrophic state.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.5 milligrams/litre (mg/l) (50th percentile)	Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – SAWQGs (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.025 milligrams/litre (mg/l) (50th percentile)	Within ecological specifications and maintains mesotrophic state.
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50th percentile) ≤ 6 milligrams/litre (95th percentile)	Ecological and User defined specifications. Based on present state.TWQR limit: Domestic use – SAWQGs (1996).

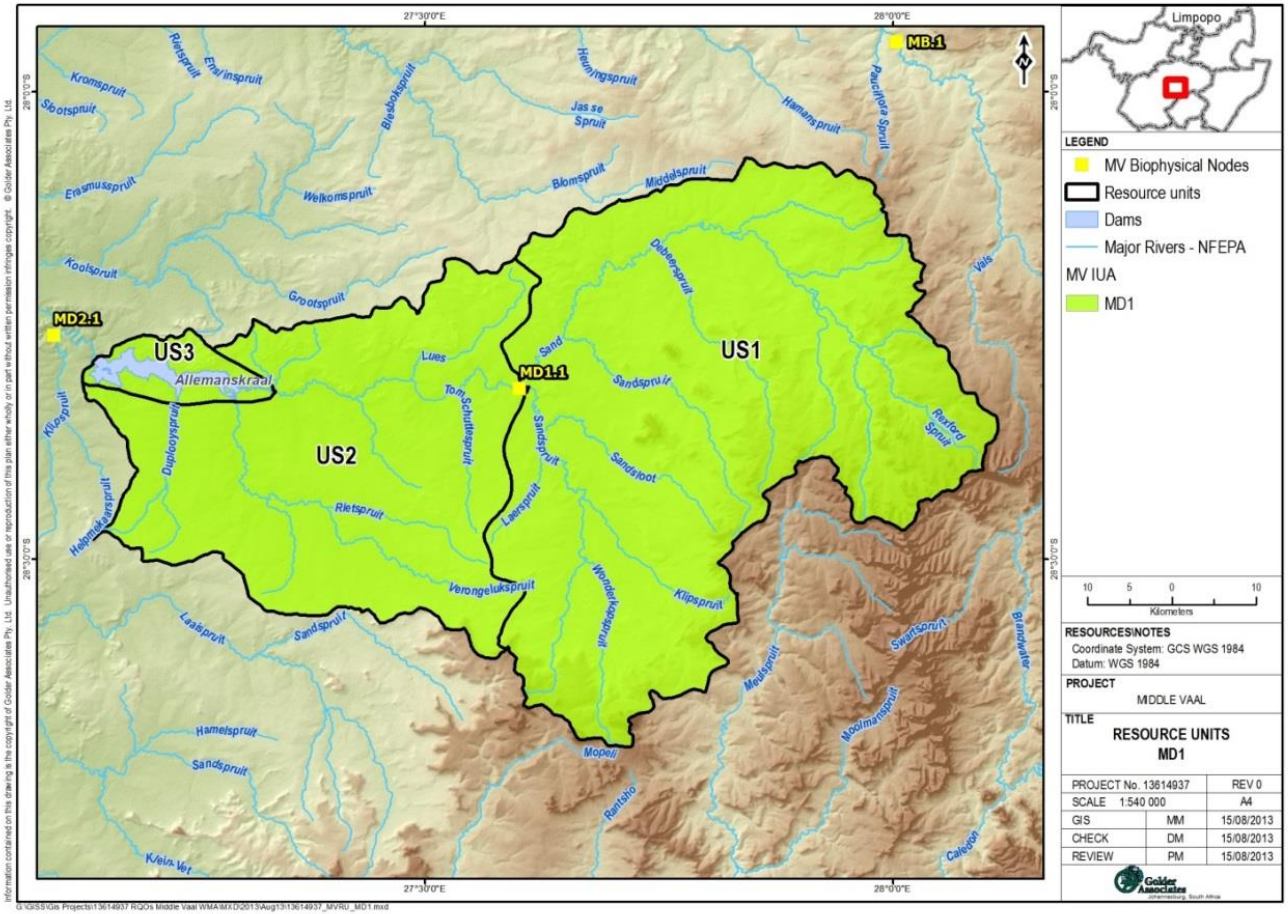
River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Johan Neser (Klerksdorp Dam) (C24G)	**SK6**	**Quality**			Chlorophyll-*a* (Chl-*a*)	≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)	Response variable to monitor eutrophication. Water quality limit to maintain mesotrophic state.
			Salts	Salinity must be maintained to support ecosystem health and the water quality requirements of the water users.	Electrical conductivity	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Maintain present state.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Biota	Fish	The dam provides a fish refuge area and is important in maintaining the upstream species. The fish population must be maintained.	The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Monitoring should be conducted annually.		Indication of the health of the dam ecosystem.
Schoonspruit (24H) (From Johan Neser Dam to the confluence of the Vaal River) (includes Jagspruit tributary	**SK7**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Ecological Water Requirement (EWR) for maintenance and drought low flows.	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements for node MC 4 on the Schoonspruit.	Flows need to be specified in order to maintain ecological categories of the water resource in prescribed ecological state and to meet the Management Class set.
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 3.0 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Improvement required.
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{h} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Status quo exceeds tolerable range for aquatic ecosystem Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Schoonspruit (24H) (From Johan Neser Dam to the confluence of the Vaal River) (includes Jagspruit tributary	**SK7**	**Quality**	Salts	The instream salinity must be improved to support the aquatic ecosystem and the water quality requirements ofwater users.	Electrical conductivity (EC)	≤ 85 milliSiemens/metre (mS/m) (95^{th}percentile)	Attainment of Management Class and associated ecological category as well as user requirements. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem.
					Sulphate	≤ 200 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and associated ecological category as well as user requirements. South African Water Quality Guidelines (1996). Within Tolerable range of strictest user.
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Cyanide (free) (CN)	≤ 0.050 milligrams/litre (mg/l) (95^{th} percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Aluminium (Al)	≤0.1 milligrams/litre (mg/l) (95^{th} percentile)	
					Manganese (Mn)	≤ 0.250 milligrams/litre (mg/l) (95^{th} percentile)	
					Uranium (U)	≤ 0.03 milligrams/litre (mg/l) (95^{th} percentile)	
					Ammonia (NH_3) as Nitrogen (N)	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	
					Iron (Fe)	≤ 0.25 milligrams/litre (mg/l) (95^{th} percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Schoonspruit (24H) (From Johan Neser Dam to the confluence of the Vaal River) (includes Jagspruit tributary	**SK7**	**Habitat**	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system. The prescribed ecological category must be met.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C/D ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	A baseline assessment to determine the integrity of the fish community should be conducted to determine the current state. The resource unit must be managed to the baseline ecological state determined if higher than the prescribed ecological category. If lower, then the state must be improved to the ecological category.	A baseline assessment to determine the current integrity and health of the fish community must be undertaken. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C/D ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be improved through the implementation of the water quality objective specified above.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	The current ecological category D/E must be improved to a D ecological category. Aim to reach an Average Score Per Taxon value (ASPT) of > 4.2	Attainment of Management Class and associated ecological category.

6.1.4 IUA MD1 – UPPER SAND

RU	Delineation area	Quaternary Catchment
IUA 4: UPPER SAND RIVER		
US2	Downstream Klipspruit confluence to Allemanskraal Dam	C42D, C42E
US3	Allemanskraal Dam	C42E



IUA 4: MD1 – UPPER SAND RIVER
RESOURCE UNIT : US 2 – SAND RIVER: From Klipspruit confluence to Allemanskraal Dam - Quaternary catchment C42D, C42E
DESCRIPTION
The IUA class is a Class III. An ecological category C must be maintained (biophysical MD 1.1). Reach has water quality impacts related to the town of Senekal. The catchment area includes the Willem Pretorius Game Park in area around Allemanskraal Dam. Most of the area is potentially in a C ecological category. Ecological importance is low. Groundwater systems include Karoo aquifers. These are shallow aquifers (<45mbgl); Minor to Insignificant; thus <0.5l/s. Good quality groundwater present due to shallow resources
RESOURCE UNIT : US 3 – SAND RIVER: Allemanskraal Dam - Quaternary catchment - C42E
DESCRIPTION
The IUA class is a class III. An ecological category C must be maintained (Present ecological State) based on the inflow outflow of the Sand River. The dam supports irrigation and some urban and bulk water users further downstream. Forms part of the Sand Vet Government Water Scheme and serves as a source of water for Virginia. It regulates flow in the Sand River.

Table 6-4: Resource Quality Objectives for RIVERS AND DAMS in priority Resource Units in the Integrated Unit of Analysis MD1 UPPER SAND

River/ Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit				Context of the RQO/ Numerical limit
Upper Sand (C42D, C42E) (From Klipspruit confluence to Allemanskraal Dam)	**US2**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MD1.1) = 17.349 million cubic metres/annum (Mm^3/a) (26.13% of the Virgin Mean Annual Runoff) (VMAR Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.2225	60	0.0373	99	
						Nov	0.3673	80	0.0193	99	
						Dec	0.4066	80	0.0112	99	
						Jan	0.5615	80	0.0411	99	
						Feb	0.7068	70	0.0496	99	
						Mar	0.6213	70	0.0299	99	
						Apr	0.4201	70	0.0231	99	
						May	0.2640	50	0.0187	99	
						Jun	0.1659	50	0.0000	99	
						Jul	0.1094	70	0.0299	99	
						Aug	0.1057	80	0.0302	99	
						Sep	0.1644	60	0.0444	99	
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and to ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – SAWQGs (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)				Ecological and User defined specifications. Based on present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Salts	Instream salinity must be maintained to support the aquatic ecosystem health and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 75 milliSiemens/metre (mS/m) (95^{th} percentile)				Ecological specifications and user requirements met. Limit based on present state quality – within to C ecological category limit.
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (95^{th} percentile)				Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)				RQO is a user specification. Limit is the target water quality range for full contact recreational use – SAWQGs (1996).

<table>
<tr><th>River/ Dam</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th>Numerical limit</th><th>Context of the RQO/ Numerical limit</th></tr>
<tr><td rowspan="2">Upper Sand (C42D, C42E) (From Klipspruit confluence to Allemanskraal Dam)</td><td rowspan="2">US2</td><td rowspan="2">Biota</td><td>Fish</td><td>Located upstream of the Allemanskraal Dam the Sand River and its tributaries provide a refuge and nursery area for fish species moving up into the shallow waters and down into the dam. Flow should be maintained to accommodate species intolerant to no/low flow condition (Labeobarbus Aeneus, Labeobarbus Kimberleyensis and Labeo Umbratus.</td><td>A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population.

Fish Response Assessment Index (FRAI) must be utilized.</td><td>An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category and to ensure that the current ecological state is maintained.</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td>Aquatic Invertebrates</td><td>The integrity of the macroinvertebrate community within the system must be maintained.</td><td>The integrity of the invertebrate community should be determined using the MIRAI. Conduct aquatic biomonitoring annually using the SASS5 methodology.</td><td>Maintain the current C ecological category by ensuring that the Average Score Per Taxon (ASPT) is >5.0.</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td rowspan="3">Allemanskraal Dam (C42E)</td><td rowspan="3">US3</td><td rowspan="2">Quantity</td><td rowspan="2">Low flows</td><td rowspan="2">The maintenance low flow requirements of the downstream node MD 2.1 must be met to support a healthy condition for the ecosystem and users.</td><td rowspan="2">Total EWR (node MD2.1) = 29.516 million cubic metres/annum (Mm^3/a)
(28.34% of the Virgin Mean Annual Runoff) (VMAR)

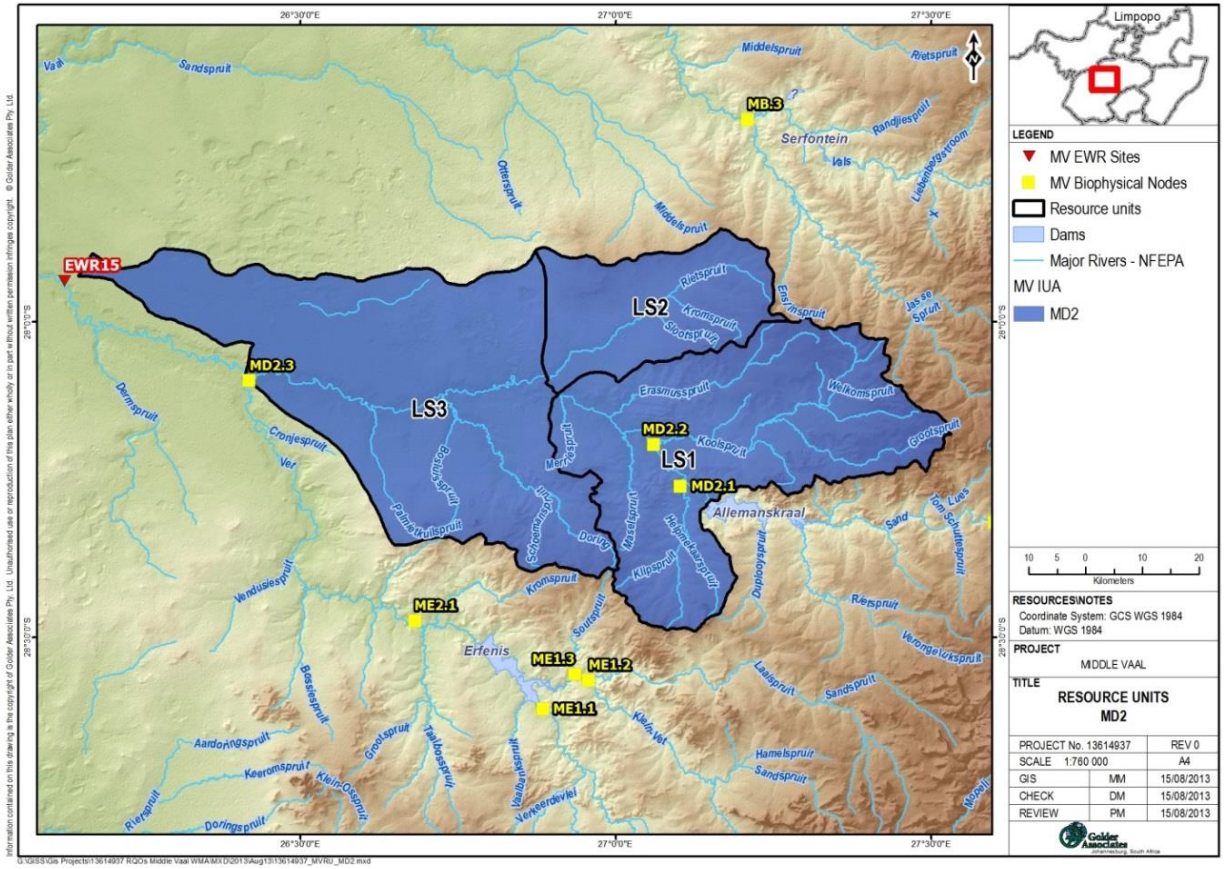
Maintenance flows (percentage value of naturalised flow distribution)

Drought flows (percentage value of naturalised flow distribution)</td><td colspan="5"><table>
<tr><th rowspan="2">Month</th><th colspan="2">Maintenance Low Flows</th><th colspan="2">Drought Flows</th></tr>
<tr><th>m^3/ second</th><th>Per-cen-tile</th><th>m^3/ second</th><th>Per-cen-tile</th></tr>
<tr><td>Oct</td><td>0.3558</td><td>60</td><td>0.0523</td><td>99</td></tr>
<tr><td>Nov</td><td>0.6034</td><td>70</td><td>0.0270</td><td>99</td></tr>
<tr><td>Dec</td><td>0.6743</td><td>80</td><td>0.0187</td><td>99</td></tr>
<tr><td>Jan</td><td>0.9457</td><td>80</td><td>0.0709</td><td>99</td></tr>
<tr><td>Feb</td><td>1.1913</td><td>70</td><td>0.0827</td><td>99</td></tr>
<tr><td>Mar</td><td>1.0629</td><td>70</td><td>0.0523</td><td>99</td></tr>
<tr><td>Apr</td><td>0.7284</td><td>70</td><td>0.0424</td><td>99</td></tr>
<tr><td>May</td><td>0.4529</td><td>40</td><td>0.0336</td><td>99</td></tr>
<tr><td>Jun</td><td>0.2662</td><td>50</td><td>0.0193</td><td>99</td></tr>
<tr><td>Jul</td><td>0.1635</td><td>70</td><td>0.0448</td><td>99</td></tr>
<tr><td>Aug</td><td>0.1591</td><td>80</td><td>0.0627</td><td>99</td></tr>
<tr><td>Sep</td><td>0.2600</td><td>60</td><td>0.0887</td><td>99</td></tr>
</table></td><td rowspan="2">Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td rowspan="4">Quality</td><td rowspan="4">Nutrients</td><td rowspan="4">Concentration of nutrients must be maintained to sustain ecosystem health and water quality requirements of water users. Dam should be maintained in a mesotrophic state.</td><td>Dissolved Inorganic Nitrogen (DIN) as Nitrogen</td><td colspan="2">≤ 0.5 milligrams/litre (mg/l) (50^{th} percentile)</td><td>Based on present state and as per target water quality range limit: Aquatic Ecosystem – SAWQGs (1996).</td></tr>
<tr><td>Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen</td><td colspan="2">≤ 0.25 milligrams/litre (50^{th} percentile)
≤ 6 milligrams/litre (95^{th} percentile)</td><td>Ecological and User defined specifications. Consideration of present state. TWQR limit: Domestic use – SAWQGs (1996).</td></tr>
<tr><td>Orthophosphate (PO_4^-) as Phosphorus</td><td colspan="2">≤ 0.025 milligrams/litre (50^{th} percentile)</td><td>Within ecological specifications and maintains mesotrophic state.</td></tr>
<tr><td>Chlorophyll-a (Chl-a)</td><td colspan="2">≤ 0.025 milligrams/litre (50^{th} percentile)</td><td>Response variable to monitor eutrophication. Water quality limit to maintain mesotrophic state.</td></tr>
</table>

River/ Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of the RQO/ Numerical limit
Allemanskraal Dam (C42E)	**US3**	**Quality**	Salts	The salinity in the dam must be maintained in order to support ecosystem health and the water quality requirements of the downstream water users.	Electrical conductivity (EC)	≤ 30 milliSiemens/metre (mS/m) (95th percentile).	Maintain present state. Good quality present.
			System variables	pH must be maintained at present state.	pH range	7.0 (5th percentile) and 8.5 (95th percentile)	Attainment of Management Class and associated ecological category. Limit based on present state quality.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Biota	Fish	The dam provides an important fish refuge area and must be managed to maintain the upstream species.	The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Monitoring should be conducted annually.		Indication of the health of the dam ecosystem.
			Aquatic birds	The dam supports large numbers of a rich diversity of locally resident and migratory water fowl and associated birds. Of these the Greater Flamingo (*Phoenicopterus roseus*), Lesser Flamingo (*Phoenicopterus minor),* the Caspian Tern (*Sterna caspia*) are of conservation importance. The suitability of the dam for aquatic bird populations must be maintained through proper habitat management.	A baseline assessment should be conducted to determine the aquatic bird community around the dam.		Aquatic birdlife is dependent on the dam habitat and associated ecosystem. The dependence must be determined and protected.

6.1.5 IUA MD2 – LOWER SAND

RU	Delineation area	Quaternary Catchment
IUA 5: LOWER SAND RIVER		
LS1	Allemanskraal Dam to Merriespruit confluence	C42F, C42G, C42H,
LS2	Rietspruit tributary catchment	C42J
LS3	Downstream Rietspruit confluence to confluence with the Vet River	C42K, C42L, C43B



IUA 4: MD2 – LOWER SAND RIVER
RESOURCE UNIT : LS-1 – SAND RIVER: From Allemanskraal Dam to Merriespruit confluence- Quaternary catchment C42F, C42G, C42H
DESCRIPTION
The IUA class is a Class III. An ecological category C must be maintained (biophysical MD 2.1 and 2.2). Tributaries include the Klipspruit, Koolspruit, Maselspruit and Erasmusspruit. Only major town in the RU is Ventersburg. The RU includes irrigation agriculture as the main land use. The RU has impacts related to abstraction. Sub-catchments of the Klipspruit, Maselspruit, Erasmuspruit and Welkomspruit include FEPAs. Groundwater systems include Karoo aquifers.
RESOURCE UNIT : LS2 – SAND RIVER: Rietspruit tributary catchment - Quaternary catchment - C42J
DESCRIPTION
The IUA class is a Class III. An ecological category D must be maintained (Present ecological State). The RU includes the Rietspruit tributary catchment with the Slootspruit and Kromspruit tributaries. The catchment is characterised by mining and urbanisation related impacts. Area is also impacted by return flows from the urban centres, bulk water users and irrigation. The RU includes the major towns of Virginia, Welkom, Henneman and Riebeeckstad. Water quality is impacted by the mining activities in the Welkom and Virginia. The Slootspruit tributary has been identified as a FEPA.
RESOURCE UNIT : LS3 – SAND RIVER: Downstream Rietspruit tributary to confluence with the Vet River - Quaternary catchment - C42J
DESCRIPTION
The IUA class is a Class III. An ecological category C must be maintained (biophysical MD 2.3). The RU is impacted by return flows from the urbanisation, abstraction, agricultural activities and irrigation from the upstream catchments. A portion of Welkom does fall within this RU (C43B). The RU includes a significant area of salt pans towards the northern part of the C43B catchment area. This area has been identified as a priority wetland area of the Middle Vaal WMA and a FEPA wetland cluster. Groundwater systems include Karoo aquifers. These are shallow aquifers (<45mbgl) that are minor to Insignificant; thus <0.5l/s.

Table 6-5: Resource Quality Objectives for RIVERS in priority Resource Units in the Integrated Unit of Analysis MD2 LOWER SAND

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit				Context of RQO/Numerical Limit
Lower Sand (C42F, C42G,C42H) (From Allemanskraal Dam to Merriespruit confluence)	**LS1**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MD2.2) = 5.989 million cubic metres/annum (Mm^3/a) (31.08% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.0459	50	0.0000	99	
						Nov	0.1076	60	0.0000	99	
						Dec	0.1307	60	0.0000	99	
						Jan	0.2106	70	0.0037	99	
						Feb	0.2534	60	0.0000	99	
						Mar	0.2699	60	0.0000	99	
						Apr	0.1956	50	0.0000	99	
						May	0.1064	30	0.0000	99	
						Jun	0.0444	30	0.0000	99	
						Jul	0.0004	50	0.0000	99	
						Aug	0.0056	50	0.0000	99	
						Sep	0.0343	30	0.0000	99	
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.50 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)				Ecological and User defined specifications. Based on present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Salts	The instream salinity must be maintained to support the aquatic ecosystem and the water quality requirements of the water users. Salinity levels should not deteriorate.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95^{th} percentile)				Ecological category and user requirements met. Limit based on present state quality.
			System variables	pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.5 (95^{th} percentile)				Ecological specification. Based on present state.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)				RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Sand (C42F, C42G,C42H) (From Allemanskraal Dam to Merriespruit confluence)	**LS1**	**Habitat**	Instream Habitat	The maintenance of the morphology and form of the channel is important for species specific habitat and ecological processes. Habitat assessments must be undertaken to monitor changes within the system. The prescribed ecological category must be met.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	In order to achieve the desired recommended ecological category, the required improvements improvements in fish diversity will be achieved through objectives set above for instream habitat and water quality and quantity.	Monitor the integrity of the fish community at a downstream point selected within the Resource Unit. A baseline assessment to determine the current integrity and health of the fish community must be undertaken. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the current C ecological category by ensuring that the Average Score Per Taxon (ASPT) is >5.0.	Attainment of Management Class and associated ecological category.
Rietspruit tributary (C42J)	**LS2**	**Quality**	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 3.0 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Improvement required.
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (mg/l) (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Status quo exceeds tolerable range for aquatic ecosystem Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Rietspruit tributary (C42J)	**LS2**	**Quality**	Salts	Instream salinity must be improved to support the aquatic ecosystem and the water quality requirements of the water users and to ensure the prescribed ecological category is met.	Electrical conductivity (EC) The salinity needs to be improved significantly from the present state to meet the electrical conductivity required limit of 85 milliSiemens/ metre. A phased approach over a twenty year period is to be used to achieve the limit of 85 mS/m.	≤ 85 milliSiemens/metre (mS/m) (95th percentile). A numerical limit of 185 milliSiemens/ metre (95thpercentile) to be met by the 10th year after publication date of the Government Notice. Resource Quality Objective numerical limit to be achieved by the 20th year after publication date of the Government Notice.	Attainment of Management Class and associated ecological category as well as user requirements. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem.
			System variables	pH must be maintained at present state.	pH range	6.5 (5th percentile) and 9.2 (95th percentile).	Ecological specification. Based on present state.
				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
Rietspruit tributary (C42J)	**LS2**	**Quality**	Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Cyanide (free) (CN)	≤ 0.050 milligrams/litre (mg/l) (95th percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Aluminium (Al)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
					Manganese (Mn)	≤0.25 milligrams/litre (mg/l) (95th percentile)	
					Iron (Fe)	≤ 0.25 milligrams/litre (mg/l) (95th percentile)	
					Uranium (U)	≤ 0.030 milligrams/litre (mg/l) (95th percentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

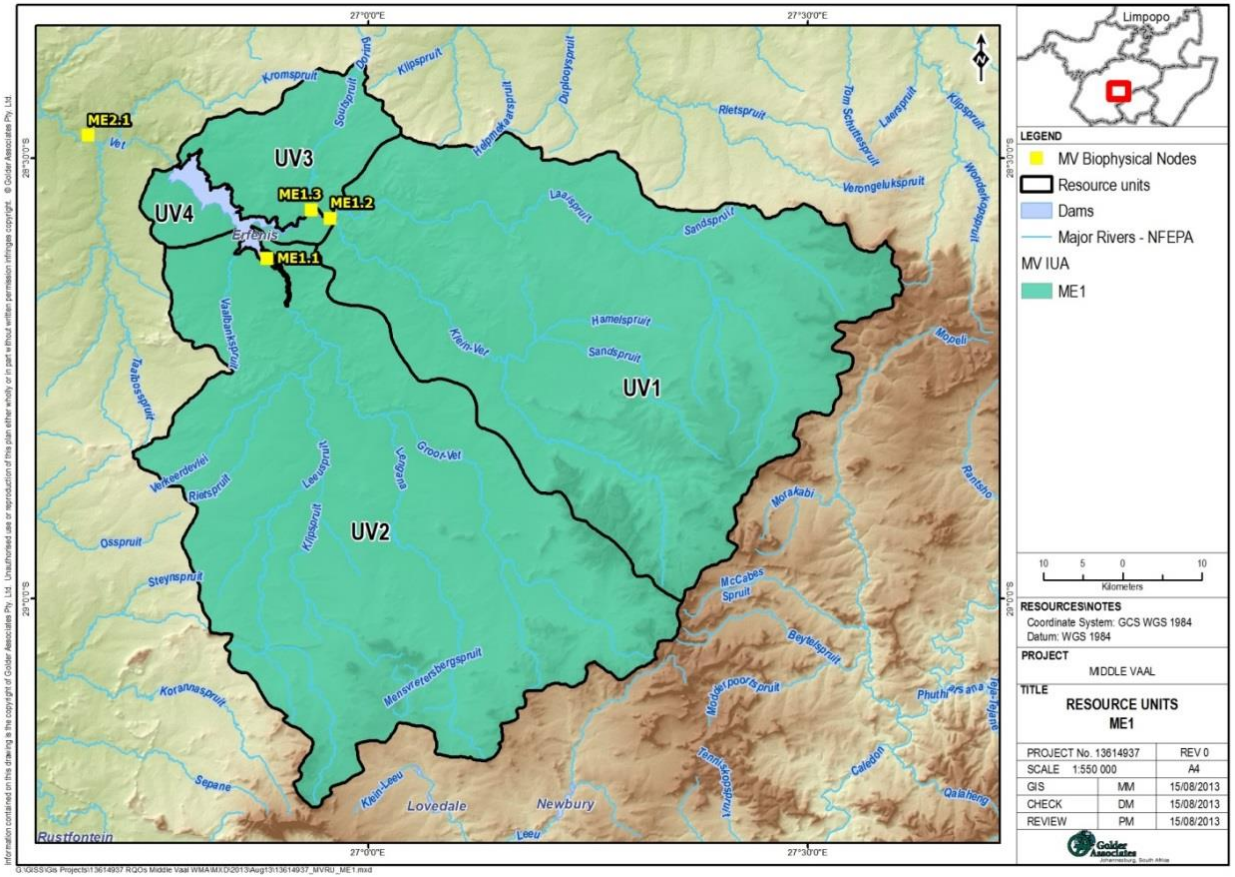
River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Rietspruit tributary (C42J)	**LS2**	**Habitat**	Instream Habitat	No further degradation of the habitat and riparian zone should occur. Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required D ecological category is being met.	Attainment of Management Class and associated ecological category.
		Biota	Fish	The presence of Yellow fish must be verified in the Sand River downstream of Virginia. The integrity of the habitat, water quality and flow conditions must be maintained.	A baseline assessment to determine the integrity of the fish community should be conducted to determine the current state and localised impacts. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed D ecological category.	Attainment of Management Class and associated ecological category.
Lower Sand (C42J) (Downstream Rietspruit tributary to confluence with the Vet River)	**LS3**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node MD 2.3) = 43.933 million cubic metres/annum (Mm^3/a) (24.37% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month* / *Maintenance Low Flows* (m^3/second / Per-centile) / *Drought Flows* (m^3/second / Per-centile) Oct 0.4014 70 0.0523 99 Nov 0.7481 80 0.0270 99 Dec 0.8658 80 0.0187 99 Jan 1.2769 80 0.1792 99 Feb 1.5828 80 0.1819 99 Mar 1.5177 80 0.1120 99 Apr 1.0849 70 0.0849 99 May 0.6440 40 0.0933 99 Jun 0.3306 50 0.0849 99 Jul 0.1404 80 0.0448 99 Aug 0.1493 90 0.0493 99 Sep 0.2986 60 0.0876 99	Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management 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 is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.5 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and as per Acceptable limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.0 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Ecological category met. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Sand (C42J) (Downstream Rietspruit tributary to confluence with the Vet River)	**LS3**	**Quality**	Salts	Salinity levels are significantly high. Instream salinity must be improved to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 85 milliSiemens/metre (mS/m) (95th percentile)	Attainment of Management Class and associated ecological category as well as user requirements. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem.
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Cyanide (free) (CN)	≤ 0.045 milligrams/litre (95th percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Aluminium (Al)	≤ 0.1 milligrams/litre (95th percentile)	
					Manganese (Mn)	≤ 0.25 milligrams/litre (95th percentile)	
					Iron (Fe)	≤ 0.3 milligrams/litre (95th percentile)	
					Uranium (U)	≤ 0.03 milligrams/litre (95th percentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (95th percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
Lower Sand (C42J) (Downstream Rietspruit tributary to confluence with the Vet River)	**LS3**	**Quality**	Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
			System variables	pH must be maintained at present state.	pH range	6.5 (5th percentile) and 9.2 (95th percentile)	Ecological specification. Based on present state.
				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
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being met.	Attainment of Management Class and associated ecological category

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Sand (C42J) (Downstream Rietspruit tributary to confluence with the Vet River)	**LS3**	**Biota**	Fish	Ensure the current ecological category is maintained and that the downstream trend from the Welkom/Virginia area is monitored and does not degrade the Lower Sand River resource unit LS3.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the D ecological category by ensuring that the Average Score Per Taxon (ASPT) is > 5.0.	Attainment of Management Class and associated ecological category

6.1.6 IUA ME1 – UPPER VET

	Delineation area	Quaternary Catchment
IUA 6: UPPER VET RIVER		
UV1	Klein Vet and Laaispruit tributary catchments	C41A, C41B
UV2	Origin of Vet River and Leeuspruit tributary catchment to Erfenis Dam	C41C, C41D
UV3	Soutspruit tributary catchment	C41E
UV4	Erfenis Dam	C41E



RESOURCE UNIT : UV1 – VET RIVER: Klein Vet and Laaispruit tributary catchments - Quaternary catchment C41A, C41B
RESOURCE UNIT : UV 2 – VET RIVER: Vet and Leeuspruit tributary catchments to Erfenis Dam - Quaternary catchment - C41C, C41D
DESCRIPTION
The IUA class is a Class II. An ecological category C must be maintained in both RUs (biophysical ME 1.1 and 1.2). RU UV1 comprises the Klein Vet and Laaispruit tributary catchment areas. The towns of Winburg and Marquard are located in the RU, with the majority of the area being rural in nature. Land use is mainly agriculture. Flow modification is the main impact due to farm dams and erosion. A FEPA is present on a minor tributary of the Hamelspruit. RU UV2 comprises the Groot Vet River catchment to Erfenis Dam, and the Klipspruit and Lengana tributaries. The region is also rural in nature and includes irrigated agriculture as major land use. As in the Klein Vet sub-catchment flow modification is the main impact due to farm dams and erosion. Small towns in the RU UV2 include Excelsior and Verkeerdevlei. The RU has two small FEPAs (on the Verkeerdevlei and Mensvretersbergspruit). Groundwater systems in the catchment area include the Karoo Aquifer systems (arenaceous rocks of the Molteno, Elliot and Clarens Formations with basaltic lava from the Drakensberg Group in the head water regions, which are shallow aquifers (<45mbgl) and moderate to minor systems; thus <2.0l/s. Good quality groundwater is present due to shallow resources.
RESOURCE UNIT : UV 3 – VET RIVER: Soutspruit catchment - Quaternary catchment - C41E
DESCRIPTION
The IUA class is a Class II. RU must be maintained in an ecological category B/C. The Soutspruit catchment area is less impacted and is in a better ecological condition. Area is largely rural in nature. Catchment area has a moderate ecological importance rating. There is a biophysical node located at the outlet of the RU (MD1.3) in B/C ecological category. The Soutspruit is identified as a FEPA. Groundwater systems include Karoo aquifers (arenaceous rocks of the Molteno, Elliot and Clarens Formations with basaltic lava from the Drakensberg Group in the head water regions). These are shallow aquifers (<45mbgl); minor to insignificant (<0.5l/s). Good quality groundwater present due to shallow resources.
RESOURCE UNIT : UV 4 – VET RIVER: Erfenis Dam - Quaternary catchment - C41E
DESCRIPTION
The IUA class is a Class II. Erfenis Dam is delineated as a resource unit UV4. An ecological category C must be maintained (Present ecological State) based on the inflow outflow of the Upper Vet River. Dam supports irrigation and some urban and bulk water users. Forms part of the Sand Vet Government Water Scheme.

Table 6-6: Resource Quality Objectives for RIVERS AND DAMS in priority Resource Units in the Integrated Unit of Analysis ME1 UPPER VET

River / Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit				Context of RQO/Numerical limit
Upper Vet (C41A, C41B) (Klein Vet and Laaispruit tributary catchments) **(C41C, C41D)** (Vet and Leeuspruit tributary catchments to Erfenis Dam)	**UV1 and UV2**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node ME 1.1) = 18.861 million cubic metres/annum (Mm^3/a) (26.19% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.2180	60	0.0373	99	
						Nov	0.3376	70	0.0386	99	
						Dec	0.2950	80	0.0187	99	
						Jan	0.4719	70	0.0075	99	
						Feb	0.6477	70	0.0289	99	
						Mar	0.6481	70	0.0261	99	
						Apr	0.6320	60	0.0248	99	
						May	0.3188	50	0.0336	99	
						Jun	0.1917	50	0.0270	99	
						Jul	0.1299	70	0.0362	99	
						Aug	0.1254	80	0.0351	99	
						Sep	0.1539	60	0.0424	99	
					Total EWR (node ME 1.2) = 20.946 million cubic metres/annum (Mm^3/a) (25.59% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.2386	60	0.0448	99	
						Nov	0.3684	70	0.0463	99	
						Dec	0.3218	80	0.0224	99	
						Jan	0.5141	70	0.0075	99	
						Feb	0.7056	70	0.0331	99	
						Mar	0.7056	70	0.0299	99	
						Apr	0.6424	60	0.0231	99	
						May	0.3480	50	0.0336	99	
						Jun	0.2099	50	0.0309	99	
						Jul	0.1426	70	0.0403	99	
						Aug	0.1378	80	0.0392	99	
						Sep	0.1690	70	0.0471	99	
		Quality	Nutrients	Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)				Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – SAWQGs (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)				Ecological and User defined specifications. Based on present state. Target water quality range limit: Domestic use – SAWQGs (1996).

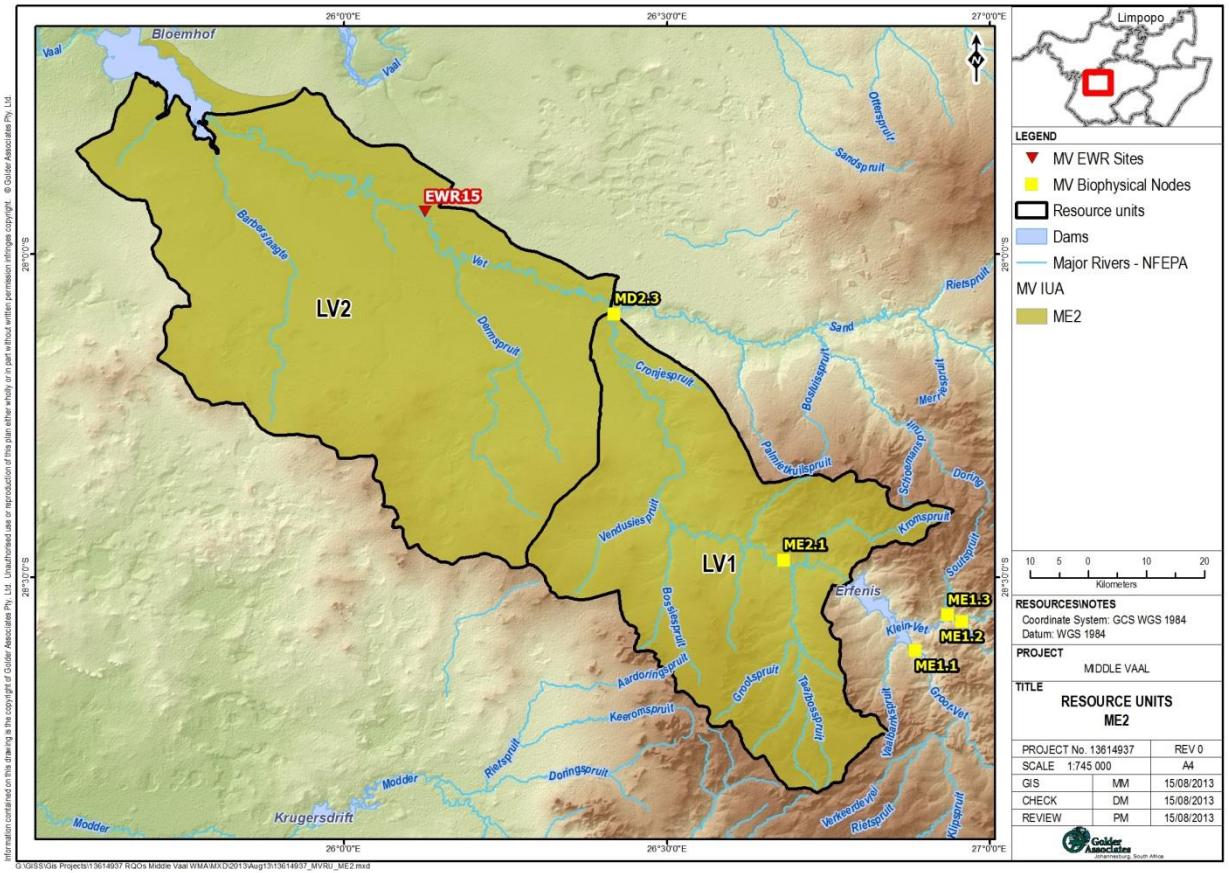
River / Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical limit
Upper Vet (C41A, C41B) (Klein Vet and Laaispruit tributary catchments) **(C41C, C41D)** (Vet and Leeuspruit tributary catchments to Erfenis Dam)	**UV1 and UV2**	**Quality**			Orthophosphate (PO_4^-) as Phosphorus	≤ 0.020 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category B upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Salts	Instream salinity must be maintained to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological category and user requirements met. Limit based on present state quality.
			System variables	pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.4 (95^{th} percentile)	Ecological specification. Based on present state.
				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.
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system. Monitoring should take specific cognisance of changes in flow and erosion.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	Located upstream of the Erfenis Dam the Vet River and its tributaries provide a refuge and nursery area for fish species moving up into the shallow waters and down into the dam. The fish community should be managed to the recommended ecological category.	A baseline assessment to determine the current integrity and health of the fish community must be undertaken. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category.
		Biota	Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the MIRAI. Conduct aquatic biomonitoring annually using the SASS5 methodology.	Maintain the current C ecological category by ensuring that the Average Score PerTaxon (ASPT) is > 4.8.	Attainment of Management Class and associated ecological category.

River / Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit					Context of RQO/Numerical limit
Soutspruit (C41E)	**UV3**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Total EWR (node ME 1.3) = 2.369 million cubic metres/annum (Mm^3/a) (61.17% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance Low Flows*		*Drought Flows*		Implementation of the rule and tab tables as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Per-cen-tile*	*m^3/ second*	*Per-cen-tile*	
						Oct	0.0310	40	0.0000	99	
						Nov	0.0563	50	0.0000	99	
						Dec	0.0474	50	0.0000	99	
						Jan	0.0859	40	0.0000	99	
						Feb	0.1228	40	0.0000	99	
						Mar	0.1247	40	0.0000	99	
						Apr	0.1115	30	0.0000	99	
						May	0.0526	20	0.0000	99	
						Jun	0.0243	20	0.0000	99	
						Jul	0.0116	40	0.0000	99	
						Aug	0.0105	50	0.0015	99	
						Sep	0.0166	40	0.0019	99	
		Quality	Salts	Instream salinity must be maintained at the current state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 55 milliSiemens/metre (mS/m) (95^{th} percentile)					Attainment of Management Class and associated ecological category. Limit based on present state quality – corresponds to B ecological category
			System variables	pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.5 (95^{th} percentile)					Attainment of Management Class and associated ecological category. Limit based on present state quality
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor changes within the system. Monitoring should take specific cognisance of changes in flow and erosion.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required B/C ecological category is being maintained.					Attainment of Management Class and associated ecological category.
		Biota	Fish	Draining into the Klein-Vet River the Soutspruit River is a short section of river in a largely unmodified state. The fish community should be managed to the prescribed ecological category.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state. Fish Response Assessment Index (FRAI) must be utilized	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.					Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the SASS5 methodology.	Maintain the current B category by ensuring the Average Score Per Taxon (ASPT) is >5.0.					Attainment of Management Class and associated ecological category.

River / Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical limit
Erfenis Dam	UV4	**Quantity**	Low flows	The downstream maintenance low flow requirements of node ME 2.1 must be met to support a healthy condition for the ecosystem and users.	Ecological Water Requirement (EWR) for maintenance low flows.	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements.	Flows need to be specified in order to maintain ecological categories of the water resource in prescribed ecological state and to meet the Management Class set.
		Quality	Nutrients	Concentration of nutrients must be improved to sustain ecosystem health and water quality requirements of water users. Dam should be maintained in a mesotrophic state.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)	Within ecological specifications and maintains mesotrophic state.
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Consideration of present state. Maintain mesotrophic state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Chlorophyll-*a* (Chl-*a*)	≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)	Response variable to monitor eutrophication. Water quality limit to maintain mesotrophic state.
			Salts	The salinity in the dam must be maintained in order to support ecosystem health and the water quality requirements of the downstream water users.	Electrical conductivity (EC)	≤ 30 milliSiemens/ metre (mS/m) (95^{th} percentile)	Ecological category and user requirements met. Limit based on present state quality – corresponds to A ecological category.
			System variables	pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.5 (95^{th} percentile)	Limit based on present state quality.
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Dam	The dam provides important refuge habitat for aquatic and semi-aquatic biota and all components of its management (recreation, eco-tourism, abstraction, water quality impacts, dam releases). All aspects of the habitat within the dam should therefore be protected.			Dam habitat can affect the sustainability of the ecosystem if not properly management. An integrated management approach is required
		Biota	Fish	The dam provides an important fish refuge area and must be managed to maintain the upstream recruitment.	The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Monitoring should be conducted annually.		Indication of the health of the dam ecosystem.

6.1.7 IUA ME2 – LOWER VET

RU	Delineation area	Quaternary Catchment
IUA 7: LOWER VET RIVER		
LV1	Erfernis Dam to confluence with Sand River	C41F, C41G, C41H, C41J
LV2	Downstream Sand River confluence to Bloemhof Dam	C43A, C43C, C43D



IUA ME2 – LOWER VET RIVER
RESOURCE UNIT : LV1 – VET RIVER: Erfenis Dam to confluence with the Sand River - Quaternary catchment C41F, C41G, C41H, C41J
DESCRIPTION
The IUA class is a Class III. An ecological category C must be maintained in the Lower Vet RU LV1 (biophysical ME 2.1). The major tributary is the Taaibosspruit. The region is rural in nature. Irrigated agriculture is a major land use. The town of Theunissen is located in the RU. Flow modification, alien vegetation and agricultural lands are the major impacts. Areas of the Taaisbospruit quaternary catchment have been identified as FEPAs. Groundwater systems include Karoo aquifers.
RESOURCE UNIT : LV 2 – VET RIVER: Downstream Sand River Confluence to Bloemhof Dam - Quaternary catchment - C43A, C43C, C43D
DESCRIPTION
The IUA class is a Class III. The classification process recommended an ecological category C/D for EWR site 15 for the lower Vet River. RU LV2 includes the Vet River from its confluence with Sand River to the inflow into Bloemhof Dam. The Dermspruit is a tributary of the Lower Vet River. The catchment area is dominated by irrigated agriculture. The major towns in the RU are Hoopstad and Bultfontein, but as in the Upper Vet the population is sparse. Irrigation agriculture is the major land use. Area has a moderate ecological importance rating. Flow modification, alien vegetation and agricultural lands are also the major impacts.

Table 6-7: Resource Quality Objectives for RIVERS in priority Resource Units in the Integrated Unit of Analysis ME2 LOWER VET

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Vet (C41F, C41G, C41H, C41J) (From Erfenis Dam to Sand River confluence) (includes the Taaibosspruit tributary)	**LV1**	**Quantity**	Low flows	The maintenance low flows and drought flows must be attained to support a healthy condition for the ecosystem and users.	Ecological Water Requirement (EWR) for maintenance low flows (ME 2.1)	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements.	Flows need to be specified in order to maintain ecological categories of the water resource in prescribed ecological state and to meet the Management Class set.
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.030 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state. Within ecological category B/C - C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Salts	Instream salinity must be maintained. Salinity levels should not be allowed to deteriorate.	Electrical conductivity (EC)	≤ 75 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological category and user requirements met. Limit based on present state quality – within to C ecological category limit.
			System variables	pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.5 (95^{th} percentile)	Limit based on present state quality.
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Instream Habitat	No further degradation of the riparian zone and instream habitat should occur from erosion and sedimentation.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being maintained.	Attainment of Management Class and associated ecological category.

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Vet (C41F, C41G, C41H, C41J) (From Erfenis Dam to Sand River confluence) (includes the Taaibosspruit tributary)	**LV1**	**Biota**	Fish	Monitor the integrity of the fish community at a downstream point selected within the Resource Unit to compare with the lower Vet Resource Unit (Ecological Water Requirement site14), so that the influence of discharge from the Sand River on the downstream receiving water bodies can be quantified. The fish community should be managed to the recommended ecological category.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state. Fish Response Assessment Index (FRAI) must be utilized	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be improved to the recommended ecological category.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	An ecological category of C must be met. The Average Score Per Taxon (ASPT) value of > 4.8 must be achieved.	Attainment of Management Class and associated ecological category.
Lower Vet (C43A, C43C, C43D) (Downstream Sand River Confluence to Bloemhof Dam)	**LV2**	**Quantity**	Low flows	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.	Total Maintenance low flow and drought flow Ecological Water Requirement (EWR 15) = 19.765 million cubic metres/annum (Mm^3/a) (7.81% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month* / *Maintenance Low Flows* (m^3/second, Per-centile) / *Drought Flows* (m^3/second, Per-centile) Oct 0.250 99 0.142 99 Nov 0.420 99 0.135 99 Dec 0.446 99 0.071 99 Jan 0.67 99 0.34 99 Feb 0.857 90 0.327 99 Mar 0.849 90 0.213 99 Apr 0.701 90 0.17 99 May 0.403 99 0.269 99 Jun 0.227 99 0.177 99 Jul 0.129 99 0.129 99 Aug 0.130 99 0.13 99 Sep 0.190 99 0.19 99	Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).

<table>
<tr><th>River</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th colspan="3">Numerical limit</th><th>Context of RQO/Numerical Limit</th></tr>
<tr><td rowspan="12">Lower Vet (C43A, C43C, C43D) (Downstream Sand River Confluence to Bloemhof Dam)</td><td rowspan="12">LV2</td><td rowspan="12">Quantity</td><td rowspan="12">High Flows</td><td rowspan="12">The high flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem</td><td rowspan="12">Total Maintenance high flow Ecological Water Requirement (EWR 15) = 32.309 million cubic metres/annum (Mm^3/a) (12.76% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance high flows (percentage value of naturalised flow distribution)</td><td rowspan="2">Month</td><td colspan="2">Maintenance High Flows</td><td rowspan="12">Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set.

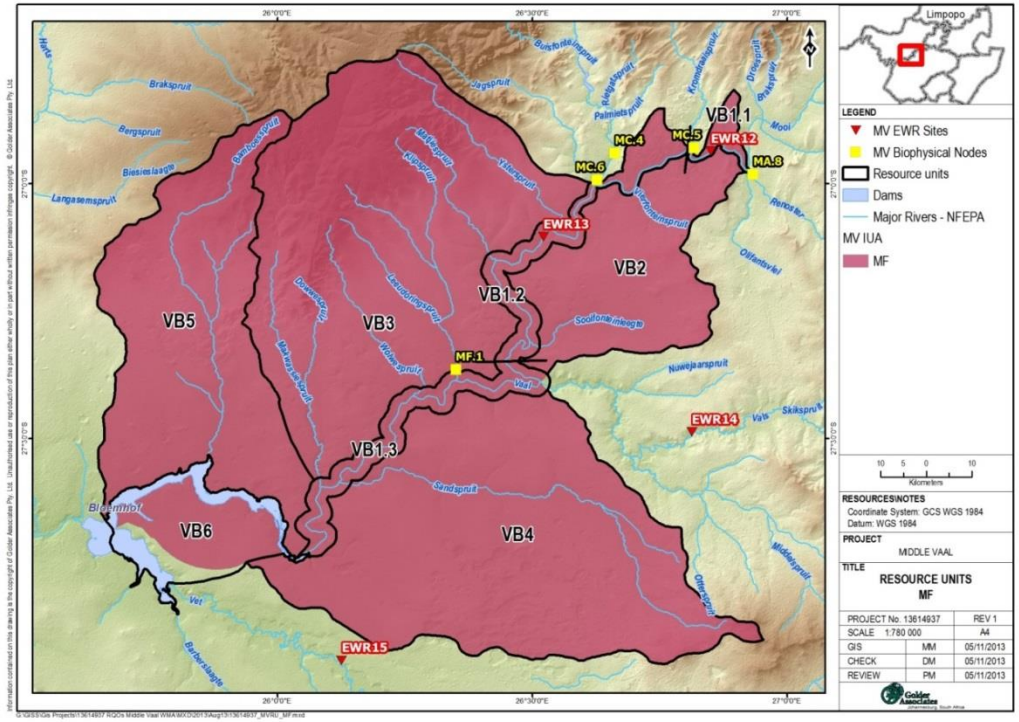
Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td>m^3/ second</td><td>Percentile</td></tr>
<tr><td>Oct</td><td>0.00</td><td>99</td></tr>
<tr><td>Nov</td><td>3.462</td><td>30</td></tr>
<tr><td>Dec</td><td>0.00</td><td>99</td></tr>
<tr><td>Jan</td><td>6.358</td><td>30</td></tr>
<tr><td>Feb</td><td>0.00</td><td>99</td></tr>
<tr><td>Mar</td><td>2.355</td><td>60</td></tr>
<tr><td>Apr</td><td>0.00</td><td>99</td></tr>
<tr><td>May</td><td>0.00</td><td>99</td></tr>
<tr><td>Jun</td><td>0.00</td><td>99</td></tr>
<tr><td>Jul</td><td>0.00</td><td>99</td></tr>
<tr><td>Aug</td><td>0.00</td><td>99</td></tr>
<tr><td>Sep</td><td>0.00</td><td>99</td></tr>
<tr><td rowspan="3">Lower Vet (C43A, C43C, C43D) (Downstream Sand River Confluence to Bloemhof Dam)</td><td rowspan="3">LV2</td><td rowspan="3">Quality</td><td rowspan="3">Nutrients</td><td rowspan="3">Instream concentration of nutrients must sustain aquatic ecosystem health. Concentrations should not be allowed to deteriorate.</td><td>Dissolved Inorganic Nitrogen (DIN) as Nitrogen</td><td colspan="3">≤ 0.7 milligrams/litre (mg/l) (50^{th} percentile)</td><td>Ecological specifications. Based on present state.</td></tr>
<tr><td>Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen</td><td colspan="3">≤ 0.50 milligrams/litre (50^{th} percentile)
≤ 6 milligrams/litre (95^{th} percentile)</td><td>Ecological and User defined specifications. Consideration of present state.
Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).</td></tr>
<tr><td>Orthophosphate (PO_4^-) as Phosphorus</td><td colspan="3">≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)</td><td>Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).</td></tr>
<tr><td colspan="2"></td><td>Chlorophyll-a (Chl-a) concentrations should be monitored as a response indicator against the resource quality objective nutrient concentrations.</td><td colspan="3">Chl-a Periphyton should be between ≤ 84 milligrams/m^2 (50^{th} percentile)
Chl-a Phytoplankton ≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)</td><td>Response variables to monitor eutrophication. Ecological specifications.</td></tr>
</table>

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Vet (C43A, C43C, C43D) (Downstream Sand River Confluence to Bloemhof Dam)	**LV2**	**Quality**	Salts	Salinity levels must be maintained.	Electrical conductivity (EC)	≤ 80 milliSiemens/metre (mS/m) (95th percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Sulphate (SO_4)	≤ 120 milligrams/litre (mg/l) (95th percentile)	
					Chloride (Cl)	≤100 milligrams/litre (mg/l) (95th percentile)	
			System variables	pH must be maintained at present state.	pH range	6.5 (5th percentile) and 9.2 (95th percentile)	
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Aluminium (Al)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
					Manganese (Mn)	≤ 0.25 milligrams/litre (mg/l) (95th percentile)	
					Iron (Fe)	≤0.75 milligrams/litre (mg/l) (95th percentile)	
					Uranium (U)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95th percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
Lower Vet (C43A, C43C, C43D) (Downstream Sand River Confluence to Bloemhof Dam)	**LV2**	**Quality**	Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Instream Habitat	Habitat assessments must be undertaken to monitor that no significant changes occur with specific focus on erosion and sedimentation. No further degradation of the instream habitat. The prescribed ecological category must be met.	The Rapid Habitat Assessment Method (RHAM) must be implemented. The ecological specifications for Ecological Water Requirement site (EWR) 15 as determined in terms of the Comprehensive Reserve Determination Study (2010) must be implemented.	The instream habitat should be monitored annually to ensure that the required C/D ecological category is being met	Attainment of Management Class and associated ecological category. Ecological Reserve

River	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical limit	Context of RQO/Numerical Limit
Lower Vet (C43A, C43C, C43D) (Downstream Sand River Confluence to Bloemhof Dam)	**LV2**	**Habitat**	Riparian Habitat	The Recommended Ecological must be maintained. Exotic invasive plant species must be controlled.	Vegetation Response Assessment Index (VEGRAI). The ecological specifications for Ecological Water Requirement (EWR) site 15 must be implemented.	The riparian habitat should be monitored annually to ensure that the required C/D ecological category is being met	Attainment of Management Class and associated ecological category. Ecological Reserve
		Biota	Fish	Upstream of the Bloemhof Dam the lower Vet River Resource Unit provides refuge for fish species moving upstream, and those migrating downstream into the dam. Migration barriers must be limited. The fish community should be managed to a recommended ecological category	Fish Response Assessment Index (FRAI) must be utilized. The ecological specifications and thresholds of potential concern (TPCs) for Ecological Water Requirement (EWR) site 15 must be adhered to.	An assessment of the fish community should be conducted annually to monitor against the prescribed C/D ecological category.	Attainment of Management Class and associated ecological category. Ecological Reserve
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology. The ecological specifications and thresholds of potential concern (TPCs) for Ecological Water Requirement (EWR) site 15 must be adhered to.	Maintain the current C/D ecological category by ensuring the SASS5 score must be > 90 and the Average Score Per Taxon (ASPT) is > 4.8.	Attainment of Management Class and associated ecological category. Ecological Reserve

6.1.8 IUA MF – MIDDLE VAAL

RU	Delineation area	Quaternary Catchment
IUA 8: Vaal River		
VB1.1	Vaal River mainstem: Vermaasdrift to upstream Schoon spruit confluence	C24B
VB1.2	Vaal River mainstem: From the Schoonspruit confluence to just upstream Vals River confluence	C24J
VB1.3	Vaal River mainstem: From Vals River confluence to Bloemhof Dam	C25C, C25F
VB2	Tributary catchments (Vierfonteinspruit and 24J –south of Vaal River)	C24B, C24J
VB3	Ysterspruit, Matjiespruit, Klipspruit, Wolwespruit and Makwassiespruit tributary catchments	C24J, C25A, C25C, C25D
VB4	Sandspruit tributary catchment	C25C, C25B, C25F, C43B
VB5	Bamboespruit tributary catchment	C25E
VB6	Bloemhof Dam	C25E, C25F, C43D



IUA MF - VAAL RIVER

RESOURCE UNIT : VB 1.1 – VAAL RIVER MAINSTEM: From Vermaasdrift to upstream Schoonspruit confluence - Quaternary catchment C24B

DESCRIPTION

The IUA class is a Class III. The classification process recommended an ecological category D for EWR site 12.

The Vaal River in this RU is driven primarily by water quality influences. Midvaal Water and AngloGold Ashanti abstract water from this reach, which is a significant use in the catchment. Much of the water use, impacts and activity occur in the Upper Vaal WMA through this reach of the Vaal River. The area is characterised by mining, dryland agriculture and irrigation, some cattle feedlots and bulk water use. Recreation is also a major water user in this RU. Major impacts include flow modification and water quality impacts of mining and treated wastewater from urban areas. Water quality is in a D/E ecological category and requires improvement. There is a degree of salinisation and high levels of nutrients. These components therefore need to be managed. The ecological importance of the river is characterised as moderate. The Middle Vaal River is identified as a Yellowfish Conservation Area.

Releases are made from Vaal Dam via the Vaal Barrage to supply urban and industrial demands as well as riparian irrigation. The releases from Vaal Dam to these users are dependent on the run-off from the incremental catchments and the return flow volumes. The releases are adjusted on a short term basis to account for these influences. Due to the limiting storage capacity at the intakes of these users, no flexibility exists in terms of the short term release rate. During prolonged droughts additional releases are made from Vaal Dam for users downstream of Bloemhof Dam. These releases can be reasonably flexible with respect to the discharge rate and pattern within a monthly period due to the buffering capacity of Bloemhof Dam. The governing rule for these releases (in terms of seasonal and annual timescales) is to only release sufficient water to satisfy the demand. To achieve specific water quality blending objective (the additional release of Vaal Dam water to maintain the TDS concentration in Vaal Barrage at 600 mg/l) may cause additional water to be released from Vaal Dam. This is necessary due to the high salinity (TDS) concentrations of the underground mine water that is pumped out of the gold mines into the river system and surface runoff from the highly urbanised areas in the incremental catchment of the Vaal Barrage. The flow rate into this reach is also flexible over the short term.

In general the flows in this reach of the river have been regulated since 1919. The base flow in winter has been raised and the smaller summer floods reduced by upstream impoundments and industrial water use.

The groundwater resources (dolomitic aquifer that extends from C24A further south) in the catchment are highly impacted by mining activities in the Koekemoerspruit, Upper Vaal and along the middle Vaal River (tailings dams, waste rock dumps, upstream mine water discharge). The dewatering of the underground workings is currently managed by the operational gold mining companies – future post-mining scenarios may include a total re-watering of the mine voids and underlying dolomite rock formation. The extent of the dolomite aquifers is not fully researched, especially south of the Vaal River in terms of groundwater flow regimes and interaction with the Vaal River. Decants from deep mine shafts north and south of the Vaal River are predicted and water quality is likely to be acid mine drainage type. The decanting mine water will require treatment to discharge standards (and RQO limits set). A monitoring network is currently operated by the existing mines but future responsibilities will require refinement. Zones with elevated water quality constituents (total dissolved salts, nitrate, sodium, chloride and sulphates) should be identified as point source polluted areas and special monitoring/management protocols should be established.

No priority wetlands were identified for this RU.

RESOURCE UNIT : VB 1.2 – VAAL RIVER MAINSTEM: From Schoonspruit confluence to upstream Vals River confluence - Quaternary catchment C24J

RESOURCE UNIT : VB 1.3 – VAAL RIVER MAINSTEM: From Vals River confluence to Bloemhof Dam- Quaternary catchment C25C, C25F

DESCRIPTION

IUA MF - VAAL RIVER

The IUA class is a Class III. The classification process recommended an ecological category C/D for EWR site 13 and for the reach from the Vals River confluence to Bloemhof Dam.

RU VB 1.2 and VB 1.3 are an extension of RU VB1.1 described above. Conditions are the same and the Vaal River is regulated and managed as described.

In RU VB1.2 the Klipplaatdrift weir is situated approximately 60 km downstream of the Pilgrims Estate weir (at Balkfontein). Sedibeng Water abstracts it water at the Klipplaatdrift weir. There is an operational problem at the Balkfontein abstraction point as storage at the Balkfontein weir is too low. Consequently releases from the Vaal Dam need to coincide with actual water requirements in this catchment to ensure that the weir does not overflow or that water shortages do not occur. Sedibeng Water also enjoys a conditional water use from Allemanskraal Dam when the dam is overflowing, provided that the Reserve requirements are catered for.

In RU VB1.3 the catchment area is dominated by dryland agriculture, grasslands and with some irrigated areas. The Vaal River in this RU is impacted by the river flow modification due to system operation and the water quality impacts of upper reaches of the Vaal River and by the tributaries in the catchment, as well as alien vegetation.

Groundwater includes the Karoo aquifer system, localised, minor to insignificant aquifers. The groundwater dependant ecosystems (GDEs) are the Central Free Sate Grassland to Vaal-Vet Sandy Grassland. Drier conditions and higher groundwater abstractions make GDEs more sensitive to impacts (depleting groundwater levels).

No priority wetlands were identified for this RU.

RESOURCE UNIT : VB 2 – Vierfonteinspruit Tributary catchment - Quaternary catchment C24J)

DESCRIPTION

The IUA class is a Class III. The Vierfonteinspruit tributary catchment should be managed to an ecological category D. The RU comprises the incremental catchment area between the Renoster and Vals River IUAs and the Vaal River. The only significant land use is coal mining in the catchment. The RU also includes some areas of irrigation and dryland agriculture. The water quality of the middle Vaal River and dolomitic aquifer system is potentially impacted by the land-use activities in the catchment.
Groundwater resources are localised Karoo aquifers which are minor to insignificant aquifers. Groundwater dependant ecosystems (GDE) include Central Free State Grasslands. Drier conditions and higher groundwater abstractions make GDE's more sensitive to impacts (depleting groundwater levels).

RESOURCE UNIT : VB 3 – VAAL RIVER M: Ysterspruit, Matjiespruit, Klipspruit, Leeudoringspruit, Wolwespruit, Makwassiespruit tributary catchments- Quaternary catchment C24J, C25A, C25C, C25D

DESCRIPTION

The IUA class is a Class III. The RU includes the Ysterspruit, Matjiespruit, Klipspruit, Leeudoringspruit, Wolwespruit, Makwassiespruit tributaries. This implies that the water resources should at least be in an ecological category D. The Present Ecological State of the tributaries will be maintained (B and C ecological category). The Wolwespruit nature reserve is present in the RU. There is extensive small scale diamond digging in the RU specifically in the Makwassiespruit and Bamboesspruit tributary catchments. Water is abstracted for irrigation purposes. Most of the towns are supplied with drinking water from Sedibeng Water. The wastewater generated in the towns is managed through oxidation ponds which are in some cases overflowing and non- compliant.
These tributaries especially their lower reaches are important refuge areas for fish. The tributaries include a complement of all fish species, including yellow fish. When problems/stresses are experienced in the Vaal River main stem then the confluences of these tributaries are important as refuges for fish (particularly during floods). The current land use impacts (effluents, agriculture and mining) therefore pose a threat to fish communities within the Middle Vaal River.

Groundwater systems comprise mainly Ventersdorp aquifers in the northwest which are localised, minor to insignificant aquifer types and shallow Karoo aquifers towards the south east which are localised, minor aquifer types. Groundwater dependant ecosystems include Klerksdorp and Kimberly Thornveld – Woodlands with trees and shrubs with a number of species that may be deep rooted and depended on groundwater and may be sensitive to lowering of the water table.

IUA MF - VAAL RIVER
RESOURCE UNIT : VB 4 – SANDSPRUIT TRIBUTARY CATCHMENT (C25C, C25B, C25F, C43B)
DESCRIPTION
The IUA class is a Class III. The Sandspruit tributary must be maintained in a C ecological category based on current PES. The RU includes the incremental Vaal catchment between the Vals and Vet River catchments. Land use is limited to agriculture. The towns of Odendaalrus, Allanridge and Wesselsbron are located in the RU. Due to the non-perennial nature of the stream, the RQOs for habitat and biota apply specifically to the lower reaches of the river. Groundwater resources are localised Karoo aquifers which are minor to insignificant aquifers. The RU is significant as it incorporates the Wesselbron cluster as a priority wetland area in the RU.
RESOURCE UNIT : VB 5 Bamboesspruit tributary catchment (C25E)
DESCRIPTION
The IUA class is a Class III. This implies that the water resources should at least be in an ecological category D. The RU includes the Bamboesspruit tributary which has a PES of E. It must be improved to a D ecological category. Wetlands: Pan cluster along the watershed divide to the west of the Bamboesspruit Groundwater systems include localised, aquifers Ventersdorp (northern ~50%) and Karoo (southern ~50%) aquifer systems, minor to moderate and minor to insignificant aquifers respectively.
RESOURCE UNIT : VB 6 BLOEMHOF DAM (C25E, C25F, C43D)
DESCRIPTION
The IUA class is a Class III. This RU comprises Bloemhof Dam, and is inundated with water. The Vaal River inflow into the dam is to be maintained a C/D ecological category. Bloemhof Dam serves as a critical point from an operation point of view in the Vaal River System. Water is released to supply downstream irrigation and urban users. EWR site 16 is located in the Lower Vaal WMA just downstream of the dam. An ecological category D must be maintained at EWR 16 and water quality must be suitable for agricultural and domestic water user requirements.

Table 6-8: Resource Quality Objectives for RIVERS AND DAMS in priority Resource Units in the Integrated Unit of Analysis MF VAAL RIVER

<table>
<tr><th>River/Dam</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th>Numerical Limit</th><th>Context of RQO/Numerical Limit</th></tr>
<tr><td rowspan="14">Vaal River (C24B) (From Vermaasdrift to upstream Schoonspruit confluence)</td><td rowspan="14">VB 1.1</td><td rowspan="12">Quantity</td><td rowspan="11">Low flows</td><td rowspan="11">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.</td><td rowspan="11">Total Maintenance low flow and drought flow Ecological Water Requirement (EWR 12) = 346.444 million cubic metres/annum (Mm^3/a)
(22% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance flows (percentage value of naturalised flow distribution)

Drought flows (percentage value of naturalised flow distribution)</td><td><table><tr><th rowspan="2">Month</th><th colspan="2">Maintenance Low Flows</th><th colspan="2">Drought Flows</th></tr><tr><th>m^3/ second</th><th>Per-cen-tile</th><th>m^3/ second</th><th>Per-cen-tile</th></tr><tr><td>Oct</td><td>5.421</td><td>99</td><td>4.284</td><td>99</td></tr><tr><td>Nov</td><td>6.592</td><td>99</td><td>5.21</td><td>99</td></tr><tr><td>Dec</td><td>6.783</td><td>99</td><td>5.361</td><td>99</td></tr><tr><td>Jan</td><td>7.588</td><td>99</td><td>5.997</td><td>99</td></tr><tr><td>Feb</td><td>9.845</td><td>99</td><td>6.486</td><td>99</td></tr><tr><td>Mar</td><td>7.72</td><td>99</td><td>6.101</td><td>99</td></tr><tr><td>Apr</td><td>6.521</td><td>99</td><td>5.154</td><td>99</td></tr><tr><td>May</td><td>5.619</td><td>99</td><td>4.441</td><td>99</td></tr><tr><td>Jun</td><td>5.184</td><td>99</td><td>4.097</td><td>99</td></tr><tr><td>Jul</td><td>5.035</td><td>99</td><td>3.98</td><td>99</td></tr><tr><td>Aug</td><td>3.954</td><td>99</td><td>3.125</td><td>99</td></tr><tr><td>Sep</td><td>4.321</td><td>99</td><td>3.415</td><td>99</td></tr></table></td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set.
Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td>High flows</td><td>The high flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem</td><td>Total Maintenance high flow Ecological Water Requirement (EWR 12) = 250.042 million cubic metres/annum (Mm^3/a)
(15.88% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance high flows (percentage value of naturalised flow distribution)</td><td><table><tr><th rowspan="2">Month</th><th colspan="2">Maintenance High Flows</th></tr><tr><th>m^3/second</th><th>Percentile</th></tr><tr><td>Oct</td><td>0</td><td>99</td></tr><tr><td>Nov</td><td>14.6</td><td>90</td></tr><tr><td>Dec</td><td>0</td><td>99</td></tr><tr><td>Jan</td><td>14.129</td><td>90</td></tr><tr><td>Feb</td><td>72.071</td><td>20</td></tr><tr><td>Mar</td><td>0</td><td>99</td></tr><tr><td>Apr</td><td>0</td><td>99</td></tr><tr><td>May</td><td>0</td><td>99</td></tr><tr><td>Jun</td><td>0</td><td>99</td></tr><tr><td>Jul</td><td>0</td><td>99</td></tr><tr><td>Aug</td><td>0</td><td>99</td></tr><tr><td>Sep</td><td>0</td><td>99</td></tr></table></td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
<tr><td rowspan="2">Quality</td><td rowspan="2">Nutrients</td><td rowspan="2">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.</td><td>Dissolved Inorganic Nitrogen (DIN) as Nitrogen</td><td>≤ 1.35 milligrams/litre (mg/l) (50^{th} percentile)
≤ 6 milligrams/litre (95^{th} percentile)</td><td>Ecological and User defined specifications.
Consideration of present state.
South African Water Quality Guidelines (1996).</td></tr>
<tr><td>Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen</td><td>≤1.65 milligrams/litre (mg/l)
(50^{th} percentile)</td><td>Ecological specifications.
Consideration of present state.
Acceptable level: South African Water Quality Guidelines (1996).</td></tr>
</table>

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Vaal River (C24B) (From Vermaasdrift to upstream Schoonspruit confluence)	**VB 1.1**	**Quality**	Nutrients		Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem
					Chlorophyll-*a* (Chl-*a*)	≤ 0.075 milligrams/litre (mg/l) (50^{th} percentile)	Response variables to monitor eutrophication. Ecological specifications
		Quality	Salts	Instream salinity must be improved to meet the recommended ecological category and the water quality requirements of the water users in the Middle Vaal River. The river must be managed to assimilate the impacts of the land based activities and inflow of the Koekemoerspruit and Schoonspruit.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Based on present state quality. Meets ecological specifications and user requirements.
					Sulphate (SO_4)	≤160 milligrams/litre (mg/l) (95^{th} percentile)	
					Magnesium (Mg)	≤ 33 milligrams/litre (mg/l) (95^{h} percentile)	
					Total Dissolved Solids (TDS)	≤ 560 milligrams/litre (mg/l) (95^{th} percentile)	
			System variables	pH must be maintained at present state.	pH range	pH range 7.5 (5^{th} percentile) - 9.2 (95^{th} percentile)	
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Cyanide (free) (CN)	≤ 0.050 milligrams/litre (mg/l) (95^{th} percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Aluminium (Al)	≤ 0.1 milligrams/litre (mg/l) (95^{th} percentile)	
					Manganese (Mn)	≤ 0.25 milligrams/litre (mg/l) (95^{th} percentile)	
					Iron (Fe)	≤ 0.25 milligrams/litre (mg/l) (95^{th} percentile)	
					Uranium (U)	≤ 0.030 milligrams/litre (mg/l) (95^{th} percentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.1 milligrams/litre (mg/l) (95^{th} percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Vaal River (C24B) (From Vermaasdrift to upstream Schoonspruit confluence)	**VB 1.1**	**Habitat**	Instream Habitat	The maintenance of the morphology and form of the channel is important for species specific habitat and ecological processes. Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method must be implemented. The ecological specifications for Ecological Water Requirement (EWR) site 12 as determined in terms of the Comprehensive Reserve Determination Study (2010) must be implemented.	The instream habitat should be monitored annually to ensure that the required D ecological category is being met.	Attainment of Management Class and associated ecological category. Ecological Reserve
			Riparian Habitat	The Recommended Ecological must be maintained. Exotic invasive plant species must be controlled.	Vegetation Response Assessment Index (VEGRAI). The ecological specifications for Ecological Water Requirement site (EWR) 12 must be implemented.	The riparian habitat should be monitored annually to ensure that the required D ecological category is being met	Attainment of Management Class and associated ecological category. Ecological Reserve
		Biota	Fish	While the site has an overall Recommended Ecological category of D, the fish community should be managed to a C ecological category. It is important to specifically maintain flow conditions in the river to support fish species that are moderately intolerant to no/low flow conditions (*Labeobarbus Aeneus* and *Labeobarbus Kimberleyensis*). Any observance of *Labeobarbus Kimberleyensis* should be considered significant due to its International Union for Conservation of Nature status (near threatened).	Fish Response Assessment Index (FRAI) must be utilized. The ecological specifications and thresholds of potential concern (TPCs) for Ecological Water Requirement site 12 must be adhered to.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category. Ecological Reserve
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system and recommended ecological category must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology. The ecological specifications and thresholds of potential concern (TPCs) for Ecological Water Requirement (EWR) site 12 must be adhered to.	Maintain the current C/D ecological category by ensuring the SASS5 score must be >100 and the Average Score Per Taxon (ASPT) value must be > 5.0.	Attainment of Management Class and associated ecological category. Ecological Reserve

<table>
<tr><th>River/Dam</th><th>RU</th><th>Component</th><th>Sub-component</th><th>Resource Quality Objective</th><th>Indicator/measure</th><th colspan="5">Numerical Limit</th><th>Context of RQO/Numerical Limit</th></tr>
<tr><td rowspan="2">Vaal River (C24B)</td><td rowspan="2">VB 1.1</td><td rowspan="2">Biota</td><td>Aquatic Birds</td><td>The suitability of this stretch of river for aquatic bird populations must be maintained through proper habitat management.</td><td colspan="6">A baseline assessment should be conducted to determine the aquatic bird community around the dam.</td><td>The area supports more 5000 water fowl and occasionally exceeds the 1% of the bio-geographical population threshold of several water fowl species although no comprehensive data are available. This is one of few sites in South Africa holding a substantial population of a White-backed Night Heron (Gorsachius leuconotus) and over twenty pairs of Goliath Heron (Ardea goliath). Aquatic birdlife is dependent on the dam habitat and associated ecosystem. Insufficient data is available. The dependence must be determined.</td></tr>
<tr><td>Diatoms</td><td>Water quality improvement is required from a nutrient perspective.</td><td>Conduct a diatom assessment annually.</td><td colspan="5">The Specific Pollution Index should be > 5.0.</td><td>Attainment of Management Class and associated ecological category.</td></tr>
<tr><td>Vaal River (C24J) (From Schoonspruit confluence to upstream Vals River confluence) (C25C, C25F) (From Vals River confluence to Bloemhof Dam-Quaternary catchment)</td><td>VB 1.2, VB 1.3</td><td>Quantity</td><td>Low flows</td><td>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.</td><td>Total Maintenance low flow and drought flow Ecological Water Requirement (EWR 13) = 309.184 million cubic metres/annum (Mm^3/a) (11.65% of the Virgin Mean Annual Runoff) (VMAR)

Maintenance flows (percentage value of naturalised flow distribution)

Drought flows (percentage value of naturalised flow distribution)</td><td colspan="5"><table>
<tr><th rowspan="2">Month</th><th colspan="2">Maintenance Low Flows</th><th colspan="2">Drought Flows</th></tr>
<tr><th>m^3/ second</th><th>Per-cen-tile</th><th>m^3/ second</th><th>Per-cen-tile</th></tr>
<tr><td>Oct</td><td>7.254</td><td>90</td><td>0.029</td><td>99</td></tr>
<tr><td>Nov</td><td>10.7</td><td>99</td><td>0.043</td><td>99</td></tr>
<tr><td>Dec</td><td>11.931</td><td>99</td><td>0.047</td><td>99</td></tr>
<tr><td>Jan</td><td>13.892</td><td>99</td><td>0.055</td><td>99</td></tr>
<tr><td>Feb</td><td>18.531</td><td>99</td><td>0.073</td><td>99</td></tr>
<tr><td>Mar</td><td>15.172</td><td>99</td><td>0.06</td><td>99</td></tr>
<tr><td>Apr</td><td>11.532</td><td>90</td><td>0.046</td><td>80</td></tr>
<tr><td>May</td><td>7.732</td><td>90</td><td>0.031</td><td>90</td></tr>
<tr><td>Jun</td><td>5.863</td><td>99</td><td>0.024</td><td>99</td></tr>
<tr><td>Jul</td><td>5.278</td><td>99</td><td>0.022</td><td>99</td></tr>
<tr><td>Aug</td><td>4.78</td><td>99</td><td>0.02</td><td>99</td></tr>
<tr><td>Sep</td><td>5.177</td><td>99</td><td>0.022</td><td>99</td></tr>
</table></td><td>Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).</td></tr>
</table>

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit			Context of RQO/Numerical Limit
Vaal River (C24J) (From Schoonspruit confluence to upstream Vals River confluence) **(C25C, C25F)** (From Vals River confluence to Bloemhof Dam-Quaternary catchment)	**VB 1.2, VB 1.3**	**Quantity**	High flows	The high flows must be attained so that the environmental flows requirements are met to support a healthy condition for the ecosystem	Total Maintenance high flow Ecological Water Requirement (EWR 13) = 298.797 million cubic metres/annum (Mm^3/a) (11.26% of the Virgin Mean Annual Runoff) (VMAR) Maintenance high flows (percentage value of naturalised flow distribution)	*Month*	*Maintenance High Flows*		Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).
							m^3/ second	*Percentile*	
						Oct	0.00	99	
						Nov	14.6	90	
						Dec	0.00	99	
						Jan	14.129	99	
						Feb	92.225	50	
						Mar	0.00	99	
						Apr	0.00	99	
						May	0.00	99	
						Jun	0.00	99	
						Jul	0.00	99	
						Aug	0.00	99	
						Sep	0.00	99	
		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.	Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.35 milligrams/litre (mg/l) (50^{th} percentile) ≤ 6 milligrams/litre (mg/l) (95^{th} percentile)			Ecological and User defined specifications. Consideration of present state. South African Water Quality Guidelines (1996).
					Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.65 milligrams/litre (mg/l) (50^{th} percentile)			Ecological specifications. Consideration of present state. Acceptable level: South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)			Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem
					Chlorophyll-*a*	≤ 0.075 milligrams/litre (mg/l) (50^{th} percentile)			Response variables to monitor eutrophication. Ecological specifications
			Salts	Instream salinity must be improved to meet the recommended ecological category and the water quality requirements of the water users in the Middle Vaal River. The water resource must be managed to assimilate the impacts of the land based activities.	Electrical conductivity	≤ 70 milliSiemens/metre (mS/m)) (95^{th} percentile)			Based on present state quality. Meets ecological specifications and user requirements.
					Sulphate (SO_4)	≤160 milligrams/litre (mg/l) (95^{th} percentile)			
					Magnesium (Mg)	≤ 33 milligrams/litre (mg/l) (95^{h} percentile)			
					Total Dissolved Solids (TDS)	≤ 560 milligrams/litre (mg/l) (95^{th} percentile)			
			System variables	pH must be maintained at present state.	pH range	7.5 (5^{th} percentile) - 9.2 (95^{th} percentile)			Ecological specification. Based on present state.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Vaal River (C24J) (From Schoonspruit confluence to upstream Vals River confluence) **(C25C, C25F)** (From Vals River confluence to Bloemhof Dam- Quaternary catchment)	**VB 1.2, VB 1.3**	**Quality**	Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Cyanide (free) (CN)	≤ 0.050 milligrams/litre (mg/l) (95^{th} percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Aluminium (Al)	≤ 0.1 milligrams/litre (mg/l) (95^{th} percentile)	
					Manganese (Mn)	≤ 0.25 milligrams/litre (mg/l) (95^{th} percentile)	
					Iron (Fe)	≤ 0.25 milligrams/litre (mg/l) (95^{th} percentile)	
					Uranium (U)	≤ 0.030 milligrams/litre (mg/l) (95^{th} percentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.1 milligrams/litre (mg/l) (95^{th} percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Instream Habitat	The maintenance of the morphology and form of the channel is important for species specific habitat and ecological processes. Dry season bed material composition must be maintained. Habitat assessments must be undertaken to monitor changes within the system.	The Rapid Habitat Assessment Method (RHAM) must be implemented at prescribed intervals as stated in the ecological specifications to ensure that a 10% increase or decrease in current habitat integrity is avoided as this is undesirable. The ecological specifications for Ecological Water Requirement (EWR) site 13 as determined in terms of the Comprehensive Reserve Determination Study (2010) must be implemented.	The instream habitat should be monitored annually to ensure that the required C/D ecological category is being maintained.	Attainment of Management Class and associated ecological category. Ecological Reserve
			Riparian Habitat	The Recommended Ecological must be maintained. Exotic invasive plant species must be controlled.	Vegetation Response Assessment Index (VEGRAI). The ecological specifications for Ecological Water Requirement site (EWR) 13 must be implemented.	The riparian habitat should be monitored annually to ensure that the required C/ D ecological category is being met	Attainment of Management Class and associated ecological category. Ecological Reserve

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Vaal River (C24J) (From Schoonspruit confluence to upstream Vals River confluence) **(C25C, C25F)** (From Vals River confluence to Bloemhof Dam-Quaternary catchment)	**VB 1.2, VB 1.3**	**Biota**	Fish	The fish community should be managed to the recommended ecological category. It is important to specifically maintain flow conditions in the river to support fish species that are moderately intolerant to no/low flow conditions (*Labeobarbus Aeneu, Labeobarbus Kimberleyensis* and *Labeo Umbratus*). Any observation of *Labeobarbus Kimberleyensis* should be considered significant due to its International Union for Conservation of Nature status (near threatened).	Fish Response Assessment Index (FRAI) must be utilized. The ecological specifications and thresholds of potential concern (TPCs) for Ecological Water Requirement (EWR) site 13 must be adhered to.	An assessment of the fish community should be conducted annually to monitor against the prescribed C/D ecological category.	Attainment of Management Class and associated ecological category. Ecological Reserve
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology. The ecological specifications and thresholds of potential concern (TPCs) for Ecological Water Requirement (EWR) site 13 must be adhered to.	An ecological category of C/D must be met. To ensure this the SASS5 score must be >100 and the Average Score Per Taxon (ASPT) value must > than 5.0.	Attainment of Management Class and associated ecological category. Ecological Reserve
			Diatoms	Water quality improvement is required from a nutrient perspective.	Conduct a diatom assessment annually.	The Specific Pollution sensitivity (SPI) Index should be > 8.9 (C/D category).	Attainment of Management Class and associated ecological category. Ecological Reserve
Vierfontein-spruit	**VB2**	**Quality**	Salts	Instream salinity must be improved to sustain the aquatic ecosystem.	Electrical conductivity (EC)	≤ 85 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological specification. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Ecological category met. Status quo must be improved.
					Sulphate (SO_4)	≤ 300 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and associated ecological category. Consideration of present state. Status quo must be improved.
			System variables	pH must be maintained at present state.	pH range	7.5 (5^{th}percentile) - 9.2 (95^{th} percentile)	Ecological specification.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
			Toxics	The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Aluminium (Al)	≤ 0.1 milligrams/litre (mg/l) 95th percentile)	Ecological specification.
					Manganese (Mn)	≤ 0.25 milligrams/litre (mg/l) (95th percentile)	
					Iron (Fe)	≤ 0.25 milligrams/litre (mg/l) (95th percentile)	
Ysterspruit, Matjiespruit, Klipspruit, Leeudoring-spruit, Wolwespruit , Makwassie-spruit (C24J, C25A, C25C,C25D)	**VB3**	**Quantity**	Low flows	The maintenance and drought flows must be maintained.	Ecological Water Requirement (EWR) for maintenance low flows	Use Desktop Reserve Model (DRM) and updated Present Ecological State (PES) data to determine low flow requirements.	Flows need to be specified in order to maintain ecological categories of the water resource in prescribed ecological state and to meet the Management Class set.
		Quality	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.35 milligrams/litre (mg/l) (50th percentile) ≤ 6 milligrams/litre (95th percentile)	Ecological and User defined specifications. Consideration of present state. South African Water Quality Guidelines (1996).
					Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.65 milligrams/litre (mg/l) (50th percentile)	Ecological specifications.
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50th percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Chlorophyll-*a* (Chl-*a*)	≤ 0.05 milligrams/litre (mg/l) (50th percentile)	Response variables to monitor eutrophication. Ecological specifications
			Salts	Instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	Matjiespruit and Leeudoringspruit: ≤ 55 milliSiemens/metre (mS/m) (95th percentile)	Ecological category and user requirements met. Limit based on present state quality.
						Ysterspruit, Makwassiespruit and Wolwespruit: ≤ 85 milliSiemens/metre (mS/m) (95th percentile)	Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			System variables	pH must be maintained at present state.	pH range	7.5 (5th percentile) - 9.2 (95th percentile)	Ecological specification
				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 todetermine present state.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
Ysterspruit, Matjiespruit, Klipspruit, Leeudoring-spruit, Wolwespruit, Makwassie-spruit (C24J, C25A, C25C,C25D)	**VB3**	**Habitat**	Instream Habitat	The instream habitat is important for maintaining biotic integrity. The present ecological state of the tributaries must be maintained.	The Rapid Habitat Assessment Method (RHAM) must be implemented. All land use activities impacting on the riparian zone and thus causing an effect on water resources should be authorised and regulated to prevent deterioration of the habitat.	The instream habitat should be monitored annually to ensure that the required B ecological category is being maintained in the Matjiespruit and Leeudoringspruit and the required C ecological category is being maintained in the Ysterspruit, Makwassiespruit and Wolwespruit.	Attainment of Management Class and associated ecological category.
			Riparian Habitat	The riparian habitat is important for maintaining bank stabilisation and thus must be maintained.	Vegetation Response Assessment Index (VEGRAI). All land use activities impacting on riparian zone should be authorised and regulated to prevent deterioration of the habitat.	The riparian habitat should be monitored annually to ensure that the required ecological category is being met.	Attainment of Management Class and associated ecological category.
		Biota	Fish	In order to maintain the ecological integrity of the fish community within the Middle Vaal River the tributaries need to be sustainably managed.	A baseline assessment to determine the integrity of the fish community should be conducted to determine the current state. Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	In order to maintain the ecological integrity of the macroinvertebrate community within the Middle Vaal River the tributaries need to be sustainably managed. The Present Ecological State must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	The Present Ecological State must be maintained.	Attainment of Management Class and associated ecological category.
Sandspruit (C25C, C25B, C25F, C43B)	**VB4**	**Quality**	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the present ecological category is maintained.	Orthophosphate (PO_4^-) as Phosphorus	≤ 0.091 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
			Salts	Instream salinity must be improved to sustain the aquatic ecosystem.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological category and user requirements met. Limit based on present state quality – corresponds to C ecological category

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Sandspruit (C25C, C25B, C25F, C43B)	**VB4**	**Habitat**	Instream Habitat	The system should be maintained in its current state. Habitat assessments must be undertaken to monitor changes within the system. No further degradation of the habitat and riparian zone should occur.	The Rapid Habitat Assessment Method (RHAM) must be implemented.	The instream habitat should be monitored annually to ensure that the required C ecological category is being met.	Attainment of Management Class and associated ecological category.
		Biota	Fish	The integrity of fish community must be maintained in at the present ecological category. Focus should be placed on the lower reaches of the river due to its non-perennial nature as this provides a refuge area.	Fish Response Assessment Index (FRAI) must be utilized.	An assessment of the fish community should be conducted annually to monitor against the prescribed C ecological category.	Attainment of Management Class and associated ecological category.
			Aquatic Invertebrates	The integrity of the macroinvertebrate community within the system must be maintained.	The integrity of the invertebrate community should be determined using the Macroinvertebrate Response Assessment Index (MIRAI). Conduct aquatic biomonitoring annually using the South African Scoring System 5 (SASS5) methodology.	Maintain the current C category by ensuring the Average Score Per Taxon (ASPT) is >5.0.	Attainment of Management Class and associated ecological category.
Bamboes-spruit (C25E)	**VB5**	**Quality**	Nutrients	Instream concentration of nutrients must be improved to sustain aquatic ecosystem health.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.62 milligrams/litre (mg/l) (50^{th} percentile)	Present state within Ecological specifications
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.50 milligrams/litre (mg/l) (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Salts	The instream salinity must be maintained to support the aquatic ecosystem and the water quality requirements of the water users. Salinity levels should not deteriorate.	Electrical conductivity (EC)	≤ 80 milliSiemens/metre (mS/m) (95^{th} percentile)	Present state within Ecological specifications
					Sulphate (SO_4)	≤160 milligrams/litre (mg/l) (95^{th} percentile)	South African Water Quality Guidelines (1996).
			System variables	pH must be maintained.	pH range	7.5 (5^{th} percentile) - 9.2 (95^{th} percentile)	Ecological specifications

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Bamboes-spruit (C25E)	**VB5**	**Habitat**	Instream Habitat	The current habitat has been degraded due to mining activities in the catchment. The ecological integrity must be improved.	Ensure that mining activities impacting on the riparian zone and instream habitats are authorised and regulated to prevent deterioration of the habitat. Rehabilitation management plans must be developed to improve the habitat integrity to obtain a minimum D category. The RHAM must be implemented.	The instream habitat should be monitored annually to ensure that the required D ecological category is attained.	Attainment of Management Class and associated ecological category.
			Riparian Habitat	The riparian habitat has been degraded due to mining activities in the catchment. The ecological integrity must be improved.	VEGRAI. Rehabilitation must be undertaken which must include the removal of invasive exotic species from the riparian zone.	The riparian habitat should be monitored annually to ensure that the required D ecological category is attained.	Attainment of Management Class and associated ecological category.
		Biota	Fish	Located in close proximity to the Bloemhof Dam the Bomboesspruit acts as an important refuge and nursery area for fish species moving up into the shallow waters and down into the dam. With the current impacts it is important to implement the necessary actions to maintain the habitat for fish species to utilise.	A baseline assessment to determine the integrity and health of the fish community should be conducted to determine the current state and potential impacts to the population. This assessment should include a fish tissue contamination study to determine heavy metal concentrations. FRAI must be utilized.	An assessment of the fish community should be conducted annually to monitor against the Present Ecological State.	Attainment of Management Class and associated ecological category.
Bloemhof Dam (C25E, C25F, C43D)	**VB6**	**Quantity**	Low flows	The downstream maintenance low flow requirements of EWR 16 must be met to support a healthy condition for the ecosystem.	Total Maintenance low flow and drought flow Ecological Water Requirement (EWR 16) = 360.296 million cubic metres/annum (Mm^3/a) (21.2% of the Virgin Mean Annual Runoff) (VMAR) Maintenance flows (percentage value of naturalised flow distribution) Drought flows (percentage value of naturalised flow distribution)	*Month* / *Maintenance Low Flows* (m^3/second / Percentile) / *Drought Flows* (m^3/second / Percentile): Oct: 6.333 / 99 / 4.905 / 99 Nov: 6.794 / 99 / 5.262 / 99 Dec: 6.971 / 99 / 5.4 / 99 Jan: 8.266 / 99 / 6.403 / 99 Feb: 11.052 / 99 / 2.646 / 99 Mar: 8.974 / 99 / 6.952 / 99 Apr: 7.086 / 99 / 5.489 / 99 May: 5.71 / 99 / 4.423 / 99 Jun: 4.717 / 99 / 3.654 / 99 Jul: 4.669 / 99 / 3.617 / 99 Aug: 4.46 / 99 / 3.454 / 99 Sep: 5.632 / 99 / 4.363 / 99	Implementation of the rule and tab tables (Appendix B) as specified in terms of the Water Resource classification study (DWA, 2012). Flows specified are to maintain ecological categories of the water resource in prescribed ecological state and meet the Management Class set. Percentiles (of required flow rate) determined through EWR determination process as per application of appropriate Reserve models and methodology (rule curves).

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Bloemhof Dam (C25E, C25F, C43D)	**VB6**	**Quality**	Nutrients	Concentration of nutrients in the dam must be improved to sustain ecosystem health and the water quality requirements of water users. Nutrient levels must not be allowed to deteriorate. Dam has the potential to be hypertrophic. Dam should be maintained in a mesotrophic state.	Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.15 milligrams/litre (mg/l) (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Consideration of present state. Limit eutrophication. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.25 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.015 milligrams/litre (mg/l) (50^{th} percentile)	Limit eutrophication.
					Chlorophyll – *a* (Chl-*a*)	≤ 0.050 milligrams/litre)mg/l) (50^{th} percentile)	Response variable to monitor eutrophication. Water quality limit to maintain mesotrophic state.
			Salts	The salinity in the dam must be maintained in order to support ecosystem health and the water quality requirements of the downstream water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Present state. Support downstream user requirements and ecological specifications.
					Sulphate (SO_4)	≤150 milligrams/litre (mg/l) (95^{th} percentile)	
					Sodium (Na)	≤ 80 milligrams/litre (mg/l) (95^{th} percentile)	
					Chloride (Cl)	≤ 75 milligrams/litre (mg/l) (95^{th} percentile)	
					Total Dissolved Solids (TDS)	≤ 560 milligrams/litre (mg/l) (95^{th} percentile)	
		Quality	System variables	pH must be maintained.	pH range	7.5 (5^{th} percentile) - 9.2 (95^{th} percentile)	
			Pathogens	The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Habitat	Dam Habitat	The dam provides important refuge habitat for aquatic and semi-aquatic biota and all components of its management (recreation, eco-tourism, abstraction, water quality impacts, dam releases). All aspects of the habitat within the dam should therefore be protected.			Dam habitat can affect the sustainability of the ecosystem if not properly management. An integrated management approach is required
		Biota	Fish	The dam provides a refuge area and is important in maintaining the upstream species.	The fish population must be monitored through health assessment studies. Suitable abundances should be determined. Monitoring should be conducted annually.		Indication of the health of the dam ecosystem.

River/Dam	RU	Component	Sub-component	Resource Quality Objective	Indicator/measure	Numerical Limit	Context of RQO/Numerical Limit
Bloemhof Dam (C25E, C25F, C43D)	**VB6**	**Biota**	Aquatic Birds	The suitability of the dam for aquatic bird populations must be maintained through proper habitat management.	A baseline assessment should be conducted to determine the aquatic bird community around the dam.		The dam supports a high number of water fowl, with several mixed heronries supporting a variety of breeding egrets, herons and cormorants. A number of bird species recorded at the dam and in the adjacent terrestrial habitats are listed as threatened species. These include amongst others the Greater Flamingo (*Phoenicopterus roseus*), Lesser Flamingo (*Phoenicopterus minor),* the Caspian Tern (*Sterna caspia*) and African Marsh Harrier (*Circus ranivorus*).

6.2 WETLANDS RESOURCE QUALITY OBJECTIVES

Table 6-9: Regional Resource Quality Objectives for WETLANDS in the MIDDLE VAAL WMA

Integrated Units of Analysis	Wetlands	Resource Unit	Resource Quality Objective	Indicator/ measure	Numerical Limit
All	**All**	**All**	There must be no net loss in wetland functioning within the Integrated Unit of Analysis.	Condition of wetlands in the Integrated Units of Analysis. Integrated Units of Analysis level desktop wetland assessment supplemented with a site-level assessment of a subset of indicator wetlands within the Integrated Units Of Analysis	No reduction in hectare equivalents of wetlands in the Integrated Units of Analysis. This assessment should be repeated every 5 years.
			Validated wetland Freshwater Ecosystem Priority Areas in a good condition (equivalent to an A or B ecological category) must at least be maintained whilst wetland Freshwater Ecosystem Priority Areas that are not in a good condition must be improved to their best attainable ecological condition.	Condition of validated wetland Freshwater Ecosystem Priority Areas in the Integrated Units of Analysis. Integrated Units Of Analysis level desktop assessment of validated wetland Freshwater Ecosystem Priority Areas supplemented with a site-level assessment of a subset of these wetlands within the Integrated Units of Analysis.	No reduction in hectare equivalents of validated Freshwater Ecosystem Priority Area wetlands and wetland clusters in the Integrated Units of Analysis. This assessment should be repeated every 5 years.
			Land uses associated with validated wetland Freshwater Ecosystem Priority Area wetlands and wetland clusters must be controlled to maintain hydrological drivers and linkages (connectivity) between wetlands.	Land use associated with validated wetland Freshwater Ecosystem Priority Area wetland clusters (determined by calculating the Buffer Zone Integrity Score). Desktop assessment of land use (Buffer Zone Integrity) within a 500m buffer of validated Freshwater Ecosystem Priority Area wetlands and wetland clusters.	No reduction in landuse integrity (determined by calculating the Buffer Zone Integrity Score) around validated Freshwater Ecosystem Priority Area wetlands and wetland clusters. This assessment should be repeated every 5 years.
			Resource protection measures must be implemented to ensure biodiversity protection, particularly related to validated Freshwater Ecosystem Priority Area wetlands and wetland clusters. Such resource protection measures should take into account national and regional wetland conservation targets.	Integrated Units of Analysis level compliance audit of the resource protection measures implemented for the protection of validated Freshwater Ecosystem Priority Area wetlands and wetland clusters.	No reduction in the hectare equivalents of validated Freshwater Ecosystem Priority Area wetlands and wetland clusters. This assessment should be repeated every 5 years.
			The condition of wetlands with a High and Very High Ecological Importance and Sensitivity must at least be maintained and where possible improved through the implementation of resource protection measures.	Integrated Units of Analysis level compliance audit of the resource protection measures implemented for the protection of wetlands and wetland clusters with High and Very High Ecological Importance and Sensitivities.	No reduction in hectare equivalents of wetlands and wetland clusters with High and Very High Ecological Importance and Sensitivities. This assessment should be repeated every 5 years.

Table 6-10: Resource Quality Objectives for PRIORITY WETLAND CLUSTERS AND SYSTEMS in selected Resource Units in the MIDDLE VAAL WMA

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Floodplain of the middle reaches of the Renosterrivier, Heuningspruit, Grootvlei, central and lower reaches of the Mahemspruit, and middle to lower reaches of the Rietspruit (wetland Freshwater Ecosystem Priority Areas or parts that are Freshwater Ecosystem Priority Areas)**	**R4**	**Quantity**	Floods are necessary to inundate the floodplain and must be part of the system regime to maintain the integrity of the wetland system. These flows also inundate the terrace and upper bank of the riparian zone.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) need to be verified. An assessment of the current condition is required. The verified PES must be maintained or where possible improved. This should be undertaken every 3-5 years.	Floods are necessary to provide the wetting regime required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles.
			Quality	As per river Resource Quality Objectives listed below			The wetland systems are a part of the river system (middle reaches) and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.
				Nutrients: Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.5 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.50 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and user defined specifications. Ecosystem requirement (specialist input and N:P ratios). User based target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
				Salts: Instream salinity must be maintained at the current state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological and user defined specifications. Limit based on present state quality – within category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Floodplain of the middle reaches of the Renosterrivier, Heuningspruit, Grootvlei, central and lower reaches of the Mahemspruit, and middle to lower reaches of the Rietspruit (wetland Freshwater Ecosystem Priority Areas or parts that are Freshwater Ecosystem Priority Areas)**	**R4**	**Quality**	*System Variables*: pH must be maintained at present state.	pH range	7.4 (5^{th} percentile) and 8.6. (95^{th} percentile)	Attainment of Management Class and associated ecological category. Limit based on present state quality.
				System Variables: 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 is required to determine present state.
				Toxics: The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and recommended ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Habitat	Linkages between wetland habitats within these systems must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.
			Biota	Overall biodiversity must be maintained and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork. Presence of important species such as both flamingo species.	Reporting rates (RR): Reporting rates in Resource Unit R4: Yellow-billed Stork RR 9 - 24%. Greater Flamingo RR 18 - 29%. Lesser Flamingo RR 6%.	The floodplain systems are likely to provide an important refuge for Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Blue Korhaan, Black-winged Pratincole..

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	Unchannelled valley bottom wetland of the Rietspruit tributary of the Heuningspruit and a tributary of the Heuningspruit (wetland Freshwater Ecosystem Priority Areas)	R4	Quantity	The flows in the system should be such that they do not pose a threat to the unchannelled structure/geomorphology of the wetland system. Land-use changes that result in elevated stormflows or changes in the post development hydrological regime must be avoided. Where this is not possible, mitigation measures should be put in place to ensure that the post development hydrology is maintained within 10% of the pre-development hydrology so as to protect the unchannelled character of the system.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The structure/geomorphology of the wetland system needs to be maintained.
			Quality	As per river Resource Quality Objectives listed below.			The wetland systems are a part of the river system (middle reaches) and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.
				Nutrients: Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.5 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.50 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and user defined specifications. Ecosystem requirement (specialist input and N:P ratios). User based target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
				Salts: Instream salinity must be maintained at the current state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological and user defined specifications. Limit based on present state quality – within category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Unchannelled valley bottom wetland of the Rietspruit tributary of the Heuningspruit and a tributary of the Heuningspruit (wetland Freshwater Ecosystem Priority Areas)**	**R4**	**Quality**	*System Variables*: pH must be maintained at present state.	pH range	7.4 (5^{th} percentile) and 8.6. (95^{th} percentile)	Attainment of Management Class and associated ecological category. Limit based on present state quality.
				System Variables: 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 is required to determine present state.
				Toxics: The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and recommended ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
			Habitat	Wetland vegetation and geomorphology must be maintained or where necessary improved.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	Required to protect the unchannelled character of the system.
			Biota	Overall biodiversity must be maintained and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork. Presence of important species such as both flamingo species.	Reporting rates (RR) in Resource Unit R4: Yellow-billed Stork RR 9 - 24%; Greater Flamingo 18 - 29%. Lesser Flamingo RR 6%.	These wetland systems are likely to provide an important refuge for Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Blue Korhaan, Black-winged Pratincole.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Leeupan, Vaneedespan, Groot Rietpan and the wetland Freshwater Ecosystem Priority Area Swartpan (northern section)**	**R5**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	Water quality impacts to the pan systems must be restricted to ensure that the water and sediment chemistry remains within an acceptable normal range (anion and cation concentration to pan volume relationship).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	Maintain pan type integrity.Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems should be avoided.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	Toprevent the deterioration of the current condition of the pan and wetland systems and alteration of the associated habitats
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Black Stork, Yellow-billed Stork and African Marsh-Harrier. Presence of both important species such as flamingos and African Grass-Owl	Reporting rates (RR) in Resource Unit R5: Black Stork RR 4 - 5%. Yellow-billed Stork RR 2 - 9%; African Marsh-Harrier RR 4%. Greater Flamingo RR 18 - 20%. Lesser Flamingo RR 35%. African Grass-Owl RR 2%.	The pans are likely to provide an important refuge for Red Data Birds such as Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Blue Korhaan, Black-winged Pratincole, African Marsh-Harrier and African Grass-Owl.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Channelled and unchannelled valley bottom wetland adjacent to Viljoenskroon**	**R5**	**Quantity**	The baseflows in the system are likely to have been altered due to return flows/discharge from the adjacent sewage works. Non-flow related measures are required to prevent channel formation and further incision in already channelled sections of the system.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The elevated baseflows pose a threat to unchannelled section of the wetland system and need to be managed to prevent channelization.
			Quality	The nutrient concentrations must be maintained at a level; that does not pose a threat to biodiversity and long-term wetland functioning.	Increased levels of sewage pollution in the system.	Assessment of the sewage levels is required. Limits to be determined. This should be undertaken every 3-5 years.	The system is threatened by sewage pollution from the adjacent sewage plant. There is a growing risk of eutrophication caused by increased; nutrient inputs from the discharge as well as agricultural activities in the catchment.
			Habitat	Wetland vegetation and geomorphology must be maintained or where necessary improved.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years.	Sections of this wetland system have been extensively canalized. In addition, some sections of the wetland have also been cultivated. These impacts have compromised the wetland systems ecosystem structure and functioning.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Unchannelled valley bottom wetland on the farm Roodepoort (wetland Freshwater Ecosystem Priority Area)**	**R5**	**Quantity**	Land-use changes that result in elevated stormflows or changes in the post development hydrological regime must be avoided. Where this is not possible, mitigation measures should be put in place to ensure that the post development hydrology is maintained within 10% of the pre-development hydrology so as to protect the unchannelled character of the system.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The flows in the system should be such that they do not pose a threat to the unchannelled structure/geomorphology of the wetland system.
			Quality	As per river Resource Quality Objectives listed below.			The wetland systems are a part of the river system (middle reaches) and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.
				Nutrients: Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤1.25 milligrams/litre (mg/l) (50th percentile)	Attainment of Management Class and associated ecological category. Within ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50th percentile)	Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.0 milligrams/litre (50th percentile) ≤ 6 milligrams/litre (95th percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
				Salts: Instream salinity must be maintained. Salinity levels should not be allowed to deteriorate.	Electrical conductivity (EC)	≤ 55 milliSiemens/metre (mS/m) (95th percentile)	Attainment of Management Class and associated ecological category as well as requirements of water users. Limit based on present state quality – corresponds to B ecological category

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MA Renoster	**Unchannelled valley bottom wetland on the farm Roodepoort (wetland Freshwater Ecosystem Priority Area)**	**R5**	**Quality**	*Toxics:* The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
				Pathogens: The presence of pathogens should pose a low risk to human health.	*Escherichia coli (E.coli)*	130 counts/100 millilitres (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
				System variables: pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 8.5 (95^{th} percentile)	Attainment of Management Class and associated ecological category. Limit based on present state quality.
				System variables: 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.
			Habitat	Wetland vegetation and geomorphology must be maintained or where necessary improved to protect the unchannelled character of the system.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years.	To ensure that the Wetland character *viz.*unchannelled valley bottom type is maintained.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as African Marsh-Harrier. Presence of important species such as Greater and Lesser Flamingo.	Reporting rates (RR) in Resource Unit R5: African Marsh-Harrier RR 3%. Greater Flamingo RR 7%. Lesser Flamingo 3%.	The wetland system is likely to provide an important refuge for Red Data Birds such as Blue Korhaan, Black-winged Pratincole, Yellow-billed Stork, African Marsh-Harrier, Black Harrier, Blue Crane, White-bellied Korhaan, Greater Painted-Snipe and African Grass-Owl.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	Pan and associated wetland cluster along the middle reaches of the Otterspruit	V4	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided. Habitat linkages between the various pan and associated wetland system must be maintained.	Wet-Health not applicable to Pans.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years.	To prevent the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of important bird species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit V4: Blue Crane RR 31%. Greater Flamingo RR 15%. Lesser Flamingo RR 8%.	The pans and associated hillslope seepage wetlands are likely to support viable populations of Red Data Listed birds such as Greater Flamingo, Lesser Flamingo and Blue Crane.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	**Channelled valley bottom wetland in the middle reaches of the Otterspruit and its tributaries (wetland Freshwater Ecosystem Priority Areas)**	**V4**	**Quantity**	The water distribution and retention patterns must be maintained.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The integrity of wetland hydrology can be affected by alterations in the catchment that affects the quantity and timing of inputs, which in turn affects the distribution and retention patterns within the wetland system itself.
			Quality	As per river Resource Quality Objectives listed below.			The wetland systems are a part of the river system (middle reaches) and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.
				Nutrients: Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological specification. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
				Salts: Instream salinity must be maintained to support the aquatic ecosystem.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological specification and user requirements met. Limit based on present state quality.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	**Channelled valley bottom wetland in the middle reaches of the Otterspruit and its tributaries (wetland Freshwater Ecosystem Priority Areas)**	V4	**Habitat**	The wetland vegetation and geomorphology must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of important bird species such as Blue Crane and both Flamingo species.	Reporting rates (RR) in Resource Unit V4: Blue Crane RR 31%. Greater Flamingo RR 15%. Lesser Flamingo RR 8%.	The wetland system is likely to support viable populations of Red Data Listed birds such as Greater Flamingo, Lesser Flamingo and Blue Crane.
	Unchannelled valley bottom wetland in a tributary of the Otterspruit (wetland Freshwater Ecosystem Priority Area)		**Quantity**	Land-use changes that result in elevated stormflows or changes in the post development hydrological regime must be avoided. Where this is not possible, mitigation measures should be put in place to ensure that the post development hydrology is maintained within 10% of the pre-development hydrology so as to protect the unchannelled character of the system.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The flows in the system should be such that they do not pose a threat to the unchannelled structure/geomorphology of the wetland system.
			Quality	As per river Resource Quality Objectives listed below.			The wetland systems are a part of the river system and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	Unchannelled valley bottom wetland in a tributary of the Otterspruit (wetland Freshwater Ecosystem Priority Area)	V4	Quality	*Nutrients*: Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.50 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Based on present state and as per target water quality range limit: Aquatic Ecosystem – South African Water Quality Guidelines (1996).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological specification. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
				Salts: Instream salinity must be maintained to support the aquatic ecosystem.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological specification and user requirements met. Limit based on present state quality.
			Habitat	Wetland vegetation and geomorphology must be maintained or where necessary improved to protect the unchannelled character of the system.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	The character and integrity of the unchannelled valley bottom wetland needs to be maintained and not be allowed to change/deteriorate.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of important bird species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit V4: Blue Crane RR 31%. Greater Flamingo RR 15%. Lesser Flamingo RR 8%.	The wetland system is likely to support viable populations of Red Data Listed birds such as Greater Flamingo, Lesser Flamingo and Blue Crane.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	Swartpan (southern section) - (wetland Freshwater Ecosystem Priority Area)	V5	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	The pan system and associated wetland habitat is likely to support viable populations of Red Data Listed birds such as Greater Flamingo, Black Stork, Yellow-billed Stork, Secreatrybird, Blue Korhaan and Black-winged Pratincole.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Black Stork and Yellow-billed Stork. Presence of important bird species such as Greater Flamingo.	Reporting rates (RR) in Resource Unit V5: Black Stork RR 5%. Yellow-billed Stork 9%. Greater Flamingo 18%.	The pan system and associated wetland habitat is likely to support viable populations of Red Data Listed birds that must be protected.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	Valley bottom and hillslope seepage wetlands of Hertzogsvlei (wetland Freshwater Ecosystem Priority Area)	V5	**Quantity**	The water distribution and retention patterns must be maintained.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The integrity of wetland hydrology can be affected by alterations in the catchment that affects the quantity and timing of inputs, which in turn affects the distribution and retention patterns within the wetland system itself.
			Quality	As per river Resource Quality Objectives as listed below.			The wetland systems are a part of the river system and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.
				Nutrients: Instream concentration of nutrients must sustain aquatic ecosystem health. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.50 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state and within Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Orthophosphate (PO_4^-)as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Present state unacceptable and requires improvement. Based on Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 1.35 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state and within C/D ecological requirement. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Chlorophyll-*a* (Chl-*a*) concentrations should be monitored as a response indicator against the resource quality objective nutrient concentrations.	Chl-*a* Periphyton ≤ 1.7 mg/m^2 (50^{th} percentile) Chl-*a* Phytoplankton ≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)	Response variables to monitor eutrophication. Water quality limit to maintain mesotrophic state. Ecological specifications.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MB Vals	**Valley bottom and hillslope seepage wetlands of Hertzogsvlei (wetland Freshwater Ecosystem Priority Area)**	**V5**	**Quality**	*Salts:* Instream salinity should not deteriorate.	Electrical conductivity (EC)	≤ 85 milliSiemens/metre (mS/m) (95th percentile)	Ecological specification. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Ecological category met.
				Pathogens: The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95th percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
				System variables: pH must be maintained at present state.	pH range	7.0 (5th percentile) and 8.6 (95th percentile).	Ecological specification. Based on present state.
				System variables: 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 todetermine present state.
			Habitat	The wetland vegetation and geomorphology must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Black Stork and Yellow-billed Stork. Presence of important bird species such as Greater Flamingo.	Reporting rates (RR) in Resource Unit V5: Black Stork RR 5%. Yellow-billed Stork 9%. Greater Flamingo 18%.	The wetland system is likely to support viable populations of Red Data Listed birds such as Greater Flamingo, Black Stork, Yellow-billed Stork, Secretarybird and Black-winged Pratincole.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**Pan**	**SK1**	**Quantity**	Abstraction should be limited so that the depth and duration of inundation is maintained within the normal range for high, average and low rainfall years.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan system.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of this pan system.
			Quality	Water quality impacts to the pan system 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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, that will lead to the deterioration in the current condition of the pan system and alteration of the pan habitat should be avoided.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years.	To ensure that the pan system character and integrity is not altered or deterotiated.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork and African Marsh-Harrier. Presence of important bird species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit SK1: Yellow-billed Stork RR 8%. African Marsh-Harrier RR 2%. Blue Crane RR 2%. Greater Flamingo RR 5%. Lesser Flamingo 2%.	The pan system and associated wetland habitat is likely to support populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, African Marsh-Harrier and Blue Crane .

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**Pan and wetland systems associated with these pans including the pans at Leliefontein and north of Vetpan and the wetland Freshwater Ecosystem Priority Areas including Vetpan, Klippan and Rietpan**	**SK2**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided. Habitat linkages between the various pan and associated wetland system must be maintained.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	The Schoonspruit peatland and associated dolomitic eye provide essential stream flow regulation functions in the catchment. Targeted wetland management actions and rehabilitation interventions should be implemented to safeguard and improve the wetland structure and functioning of the Schoonspruit peatland and associated dolomitic eye.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Black Stork, Yellow-billed Stork, African Marsh-Harrier. Presence of important bird species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit SK2: Black Stork RR 1 - 8%. Yellow-billed Stork 5%. African Marsh-Harrier RR 4%. Blue Crane RR 5 - 7%.	The pan systems and associated wetland habitat are likely to provide a refuge for Red Data Listed birds such as Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, African Marsh-Harrier, Blue Crane, Black-winged Pratincole, White-bellied Korhaan and Chestnut-banded Plover.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**The Schoonspruit eye and the wetland Freshwater Ecosystem Priority Area which includes the upper section of the Skoonspruit (Schoonspruit) peatland**	**SK2**	**Quantity**	A variable scale should be developed for the adjustment of water abstraction volumes in relation to spring/eye yield and rainfall in order to maintain an adequate water supply to the peatland that ensures perennial inundation of the peat.	Water supply to the system using dryness of peat as an indicator. Abstraction permits.	Assessment of water inputs is required. Assessment of the current condition is required. This should be undertaken every 3-5 years.	Maintenance of water inputs to the wetland is critical for peat formation and to prevent oxidation.
				A constant baseflow should be maintained that ensure that the system remains perennial. These flows will ensure 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.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	This is a requirement for enabling perennial obligate hydrophytes to complete their life cycle and reproduce. This will also assist in keeping the exotic woody components out of the wetland.
				Water abstraction (via the canal) should be carefully monitored, with only the minimum being abstracted to fill water quotas. Mechanisms to limit water loss from the canal system must be implemented.	No increase in abstraction from the system	Water volume measurements. This should be undertaken every year.	To prevent over-abstraction of water and ensure that the integrity of the wetland is maintained by maintaining adequate flow.
				Water abstraction via boreholes should be monitored and water allocations enforced .	No increase in boreholes and/or abstraction from the system	Water volume measurements. This should be undertaken every year.	This is a requirement to limit water loss via excess irrigation and over use.
				The status of the spring/eye yield must be constantly monitored in relation to rainfall. Rainfall figures for individual years should not be taken in isolation and used in the determination of abstraction volumes without the spring yield also being taken into consideration.	No increase in abstraction from the system	Rainfall and water volume measurements. This should be undertaken every year.	Required to monitor the staus of the Eye to ensure that the pristine wetland character and integrity remains intact.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	The Schoonspruit eye and the wetland Freshwater Ecosystem Priority Area which includes the upper section of the Skoonspruit (Schoonspruit) peatland	SK2	**Quantity**	Water abstraction from the system should not be increased under the present conditions.	No increase in boreholes and/or abstraction from the system	Water volume measurements. This should be undertaken every year.	This is required toprevent over-abstaction so that an adequate water supply to the peatland is maintained that ensures perennial inundation of the peat.
			Quality	Measures must be investigated to limit water contamination in the vicinity of the eye/spring by livestock.	Nitrate levels	Limits to be calculated	To limit the potential health hazards of elevated nitrate levels in drinking water.
				Being from a dolomitic eye, the water quality in the system is expected to be good (of high quality) and as such should be maintained as such.	Deteriorating water quality	Water quality assessment required	A protection measure to ensure the pristine water quality of the system is maintained and not allowed to deteriorate.
			Habitat	Conservation effort should include the maintenance of riparian vegetation in order to ensure water quality, the preservation of the genetic diversity of inhabiting biota and the correct management in order to limit further human impact.	Maintain current extent of riparian vegetation. Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The numerical criteria should equate to 10% less than the Present Ecological State score determined. Present Vegetation Score required.	Preservation and maintenance of the wetland area upstream from the weir in the vicinity of the spring/eye is required to maintain the integrity and character of the system.
				The wetland vegetation including the habitat and geomorphology, including the habitat associated with the peats must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The numerical criteria should equate to 10% less than the Present Ecological State score determined. Present Vegetation Score required.	
			Biota	The wetland system is likely to support viable populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Black-winged Pratincole and Caspian Tern. Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork. Presence of important species such as both flamingo species.	Reporting rates (RR) in Resource Unit SK2: Yellow-billed Stork RR 8%. Greater Flamingo RR 6%. Lesser Flamingo RR 1%.	The wetland system is likely to support viable populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Black-winged Pratincole and Caspian Tern.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**The wetland Freshwater Ecosystem Priority Areas including Witpan and the pan cluster north of Coligny**	**SK3**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	To be determined. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
				The toxins must be kept at a level that does not pose a threat to biodiversity and long-term wetland functioning.		To be determined.	There is a risk of toxic accumulation of contaminants in the pans as a result of catchment related agricultural practices.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basins, including in the pan catchments, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pans and wetland systems and alteration of the associated habitats should be avoided. Habitat linkages between the various pan and associated wetland system must be maintained.	Wet-Health not applicable to Pans.	Verify Freshwater Ecosystem Priority Area	To prevent deterioration in the condition of the wetland and to maintain its integrity and structure.
			Biota (Pans only)	Viable populations of both flamingo species must be maintained.	Number of observed Greater Flamingo and Lesser Flamingo present annually. Reporting rate or total numbers counted annually. Formal surveys could be planned. Data obtained from local bird clubs and conservation authorities.	Reporting rates (RR) in Resource Unit SK3: Greater Flamingo 7%. Lesser Flamingo 3%.	The pan systems are likely to support viable populations of the Red Data Listed Greater Flamingo and Lesser Flamingo.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	Floodplain of the Taaibosspruit and lower section of the Schoonspruit (wetland Freshwater Ecosystem Priority Areas)	SK3	**Quantity**	Floods are needed to inundate the floodplain thereby providing the wetting regime. These flows also inundate the terrace and upper bank of the riparian zone dominated by *Rhus pyroides.*	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 yrs.	The floods are required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles.
			Quality	*Salts:* The instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users. Salinity levels should not deteriorate.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95th percentile)	Present state specified. Present state quality better that ecological specification for ecological category.
			Habitat	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	Targeted wetland management actions and rehabilitation interventions should be implemented to safeguard and improve the wetland structure and functioning of the Schoonspruit wetlands and associated dolomitic eye.
	Channelled valley bottom wetland of the middle Kaalspruit		**Quantity**	The water distribution and retention patterns must be maintained.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Should be undertaken every 3-5 years.	The integrity of wetland hydrology can be affected by alterations in the catchment that affects the quantity and timing of inputs, which in turn affects the distribution and retention patterns within the wetland system itself.
			Quality	*Salts:* The instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users. Salinity levels should not deteriorate.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95th percentile)	Present state specified. Present state quality better that ecological specification for ecological category.
			Habitat	The wetland vegetation and geomorphology must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. Should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**Unchannelled valley bottom wetland of the lower Kaalspruit**	**SK3**	**Quantity**	Land-use changes that result in elevated stormflows or changes in the post development hydrological regime must be avoided. Where this is not possible, mitigation measures should be put in place to ensure that the post development hydrology is maintained within 10% of the pre-development hydrology so as to protect the unchannelled character of the system.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The flows in the system should be such that they do not pose a threat to the unchannelled structure/geomorphology of the wetland system.
			Quality	*Salts:* The instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users. Salinity levels should not deteriorate.	Electrical conductivity (EC)	≤ 65 milliSiemens/metre (mS/m) (95th percentile)	Present state specified. Present state quality better that ecological specification for ecological category.
			Habitat	Wetland vegetation and geomorphology must be maintained or where necessary improved to protect the unchannelled character of the system.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years.	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services.
			Biota (Excluding pan system mentioned above)	Overall biodiversity and populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork. Presence of important species such as Blue Crane, White-bellied Korhaan and both flamingo species.	Reporting rates (RR) in Resource Unit SK3: Yellow-billed Stork RR 1%. Greater Flamingo RR 3%. Lesser Flamingo RR 1%. Blue Crane RR 1%.	The wetland system is likely to support populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Blue Crane, White-bellied Korhaan and Greater Painted-Snipe.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**Lower section of the Schoonspruit peatland (wetland Freshwater Ecosystem Priority Area)**	**SK4**	**Quantity**	A variable scale should be developed for the adjustment of water abstraction volumes in relation to spring/eye yield and rainfall in order to maintain an adequate water supply to the peatland that ensures perennial inundation of the peat.	Water supply to the system using dryness of peat as an indicator. Abstraction permits.	Assessment of water inputs is required. Assessment of the current condition is required. This should be undertaken every 3-5 years.	Maintenance of water inputs to the wetland is critical for peat formation and to prevent oxidation.
				A constant baseflow should be maintained that ensure that the system remains perennial . These flows will ensure 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.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	This is a requirement for enabling perennial obligate hydrophytes to complete their life cycle and reproduce. This will also assist in keeping the exotic woody components out of the wetland.
				Water abstraction (via the canal) should be carefully monitored, with only the minimum being abstracted to fill water quotas. Mechanisms to limit water loss from the canal system must be implemented.	No increase in abstraction from the system	Water volume measurements. This should be undertaken every year.	The Schoonspruit peatland and associated dolomitic eye provide essential stream flow regulation functions in the catchment. Targeted wetland management actions and rehabilitation interventions should be implemented to to safeguard and improve the wetland structure and functioning of the Schoonspruit peatland and associated dolomitic eye.
				Water abstraction via boreholes should be monitored and water allocations enforced to limit water loss via excess irrigation and over use.	No increase in boreholes and/or abstraction from the system	Water volume measurements. This should be undertaken every year.	
				The status of the spring/eye yield must be constantly monitored in relation to rainfall. Rainfall figures for individual years should not be taken in isolation and used in the determination of abstraction volumes without the spring yield also being taken into consideration.	No increase in abstraction from the system	Rainfall and water volume measurements. This should be undertaken every year.	
				Water abstraction from the system should not be increased under the present conditions.	No increase in boreholes and/or abstraction from the system	Water volume measurements. This should be undertaken every year.	

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**Lower section of the Schoonspruit peatland (wetland Freshwater Ecosystem Priority Area)**	**SK4**	**Quality**	Being from a dolomitic eye, the water quality in the system is expected to be good (of high quality) and as such should be maintained as such.	Deteriorating water quality.	Water quality indicators to be determined. This should be undertaken every 3-5 years.	A protection measure to ensure the pristine water quality of the system is maintained and not allowed to deteriorate.
			Habitat	Conservation effort should be directed at the preservation and maintenance of the wetland area upstream from the weir in the vicinity of the spring/eye. This should include the maintenance of riparian vegetation in order to ensure water quality, the preservation of the genetic diversity of inhabiting biota and the correct management in order to limit further human impact.	Maintain current extent of riparian vegetation. Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Assessment of Present Vegetation Score required. This should be undertaken every 3-5 years.	Preservation and maintenance of the wetland area is required to maintain the integrity and character of the system.
				The wetland vegetation including the habitat and geomorphology, including the habitat associated with the peats must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	Preservation and maintenance of the wetland area upstream from the weir in the vicinity of the spring/eye is required to maintain the integrity and character of the system.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork. Presence of important species such as both flamingo species.	Reporting rates (RR) in Resource Unit SK4: Yellow-billed Stork RR 8%. Greater Flamingo RR 6%. Lesser Flamingo RR 1%.	The wetland system is likely to support viable populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Black-winged Pratincole and Caspian Tern.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	**Floodplain of the Rietspruit and the wetland Freshwater Ecosystem Priority Area including the upper section of the floodplain of the Schoonspruit**	**SK4**	**Quantity**	Floods are necessary to inundate the floodplain thereby providing the wetting regime. These flows also inundate the terrace and upper bank of the riparian zone.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	This is required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles.
			Quality	As per river Resource Quality Objectives listed below.			Preservation and maintenance of the wetland area upstream from the weir in the vicinity of the spring/eye is required to maintain the integrity and character of the system.
				Nutrients: Instream concentration of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 3.0 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
				Salts: The instream salinity must be maintained at the current state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 75 milliSiemens/metre (mS/m) (95^{th}percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
				Pathogens: The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	Floodplain of the Rietspruit and the wetland Freshwater Ecosystem Priority Area including the upper section of the floodplain of the Schoonspruit	SK4	Habitat	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	Targeted wetland management actions and rehabilitation interventions should be implemented to safeguard and improve the wetland structure and functioning of the Schoonspruit wetlands and associated dolomitic eye.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork. Presence of important species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit SK4: Yellow-billed Stork RR 1-8%. Greater Flamingo RR 3-6%. Lesser Flamingo RR 1%. Blue Crane RR 1%.	The wetland system is likely to support viable populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Black-winged Pratincole, Caspian Tern, Blue Crane, White-bellied Korhaan and Greater Painted-Snipe.
	Floodplain of the lower Schoonspruit (wetland Freshwater Ecosystem Priority Area)	SK5	Quantity	Floods are necessary to inundate the floodplain thereby providing the wetting regime. These flows also inundate the terrace and upper bank of the riparian zone.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	This is required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles.
			Quality	As per river Resource Quality Objectives listed below.			The wetland systems are a part of the river system and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MC Schoon-spruit	Floodplain of the lower Schoonspruit (wetland Freshwater Ecosystem Priority Area)	SK5	Quality	*Nutrients:* Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 1.0 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Improvement required.
					Orthophosphate (PO_4^-) as Phosphorus	0.125 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category D upper boundary value as per the water quality component of the Ecological Reserve manual (2008). Status quo exceeds tolerable range for aquatic ecosystem
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 2.5 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Status quo exceeds tolerable range for aquatic ecosystem TWQR limit: Domestic use – SAWQGs (1996).
				Salts: The instream salinity must be maintained at the present state to support the aquatic ecosystem and the water quality requirements of the water users.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological specifications. Based on present state.
				The presence of pathogens should pose a low risk to human health.	*Escherichia coli* (*E.coli*)	130 counts/100 millilitres (ml) (95^{th} percentile)	RQO is a user specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
				pH must be maintained at present state.	pH range	6.0 (5^{th} percentile) and 8.5 (95^{th} percentile)	Ecological specification. Based on present state.
			Habitat	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified PES must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify FEPA	Targeted wetland management actions and interventions should be implemented to safeguard and improve the wetland structure and functioning of the Schoonspruit wetlands.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered bird species such as Yellow-billed Stork. Presence of important species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit SK5: Yellow-billed Stork RR 1-8%. Greater Flamingo RR 3-6%. Lesser Flamingo RR 1%. Blue Crane RR 1%.	The wetland system is likely to support populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Black-winged Pratincole, Caspian Tern, Blue Crane, White-bellied Korhaan and Greater Painted-Snipe.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MD2 Lower Sand	**Ganspan and remaining pans that form the southern part of the Wesselbron pan complex/cluster (most are wetland Freshwater Ecosystem Priority Areas)**	**LS3**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided. Habitat linkages between the various pan and associated wetland system must be maintained.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	To prevent deterioration in the condition of the wetland and to maintain its integrity and structure. To ensure that there is ongoing supply of ecosystem services.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork and African Marsh-Harrier. Presence of important species such as African Grass-Owl and both flamingo species.	Reporting rates (RR) in Resource Unit LS3: Black Stork RR 1-5%. Yellow-billed Stork RR 5%. Greater Flamingo RR 10-62%. Lesser Flamingo RR 10-61%. African Marsh-Harrier RR 3%. African Grass-Owl RR 1%.	The pan systems and associated wetland habitat are likely to support viable populations of Red Data Listed birds such as Great White Pelican, Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Greater Painted-Snipe, African Grass-Owl and African Marsh-Harrier.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MD2 Lower Sand	**Wetland system along the Mahemspruit and associated pans including Brakpan (wetland Freshwater Ecosystem Priority Areas)**	**LS3**	**Quantity**	Abstraction 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.	Water distribution & retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2). Wet-Health not applicable to Pans.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided. Habitat linkages between the various pan and associated wetland system must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2). Wet-Health not applicable to Pans.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	To prevent deterioration in the condition of the wetland and to maintain its integrity and structure. To ensure that there is ongoing supply of ecosystem services.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork and African Marsh-Harrier. Presence of important species such as African Grass-Owl and both flamingo species.	Reporting rates (RR) in Resource Unit LS3: Black Stork RR 1-5%. Yellow-billed Stork RR 5%. Greater Flamingo RR 10-62%. Lesser Flamingo RR 10-61%. African Marsh-Harrier RR 3%. African Grass-Owl RR 1%.	The pan systems and associated wetland habitat are likely to support viable populations of Red Data Listed birds such as Great White Pelican, Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, African Marsh-Harrier, Greater Painted-Snipe and African Grass-Owl.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MD2 Lower Sand	Flamingo Pan, Stinkpan and Witpan	LS3	**Quantity**	The flow in the pan systems must be maintained.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The flows into these pan systems are likely to have been altered due to return flows/discharge from the adjacent sewage works. Therefore no specific quantity requirements are proposed
			Quality	The nutrient concentrations must be maintained at a level that does not pose a threat to biodiversity and long-term wetland functioning. Measures should be put in place to improve the water quality entering the systems and to reduce health and other environmental risks associated with sewage/wastewater contamination.	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	The systems are threatened and currently impacted by sewage pollution from the adjacent sewage plants. There is a growing risk of eutrophication caused by increased nutrient inputs from the discharge as well as the surrounding land use and urban developments in and around the pan catchments.
			Habitat	The habitat is largely dependent on water inputs and quality and measures should be put in place to improve the water quality entering the systems to improve habitat conditions.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years.	Sections of these pans and pan catchments have been impacted by infrastructure and sewage water inputs. These impacts have compromised the pan systems ecosystem structure and functioning and resulted in changes in wetland vegetation and biota.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork and African Marsh-Harrier. Presence of important species such as African Grass-Owl and both flamingo species.	Reporting rates (RR) in Resource Unit LS3: Black Stork RR 1-5%. Yellow-billed Stork RR 5%. Greater Flamingo RR 24-62%. Lesser Flamingo RR 8-61%. African Marsh-Harrier RR 3%. African Grass-Owl RR 1%.	The pan systems and associated wetland habitat are likely to support viable populations of Red Data Listed birds such as Great White Pelican, Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, African Marsh-Harrier, Greater Painted-Snipe, African Grass-Owl and Blue Crane.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
ME2 Lower Vet	**Brakpan and pan cluster to the south of Bultfontein (most are wetland Freshwater Ecosystem Priority Areas)**	**LV2**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Areas.	To prevent deterioration in the condition of the wetland and to maintain its integrity and structure. To ensure that there is ongoing supply of ecosystem services.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Black Stork. Presence of important species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit LV2: Black Stork RR 7%. Greater Flamingo RR 14-54%. Lesser Flamingo RR 14-42%. Blue Crane RR 12%.	The pan systems are likely to support viable populations of Red Data Listed birds such as Black Stork, Greater Flamingo, Lesser Flamingo, Pallid Harrier, Blue Crane and Blue Korhaan.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
ME2 Lower Vet	Bultfontein pan and salt works	LV2	Quality	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.	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	The pan provides an important ecosystem service through salt production and as such maintaining a suitable water quality that does not compromise salt quality will be essential.
			Biota	The pan provides an important ecosystem service through salt production and as such maintaining a suitable water quality that does not compromise salt quality while at the same time assisting in maintain viable populations of Greater and Lesser flamingo is likely to be important.	Number of observed Greater and Lesser Flamingo present annually. Reporting rate or total numbers counted annually. Formal surveys could be planned. Data obtained from local bird clubs and conservation authorities.	Reporting rates (RR) in Resource Unit LV2: Greater Flamingo RR 14-54%. Lesser Flamingo RR 14-42%.	The pan system is likely to support populations of Red Data Listed birds such as Greater and Lesser Flamingo in particular.
	Floodplain of the Vet River (wetland Freshwater Ecosystem Priority Area)		Quantity	Floods are necessary to inundate the floodplain thereby providing the wetting regime. These flows also inundate the terrace and upper bank of the riparian zone.	Water distribution and retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Fdloods are required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles.
			Quality	As per river Resource Quality Objectives listed below.			To prevent deterioration in the condition of the wetland and to maintain its integrity and structure. To ensure that there is ongoing supply of ecosystem services.
				Salinity levels must be maintained.	Electrical conductivity (EC)	≤ 80 milliSiemens/metre (mS/m) (95^{th} percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
					Sulphate (SO_4)	≤ 120 milligrams/litre (mg/l) (95^{th} percentile)	
					Chloride (Cl)	≤100 milligrams/litre (mg/l) (95^{th} percentile)	

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
ME2 Lower Vet	**Floodplain of the Vet River (wetland Freshwater Ecosystem Priority Area)**	**LV2**	**Quality**	*System variables:* pH must be maintained at present state.	pH range	6.5 (5^{th} percentile) and 9.2 (95^{th} percentile)	Strictest of Ecological specifications and human health limits. Present state adopted if better quality than specifications.
				Toxics: The concentrations of toxins should not be at a level that is toxic to aquatic organisms and a threat to human health.	Aluminium (Al)	≤ 0.1 milligrams/litre (mg/l) (95^{th} percentile)	
					Manganese (Mn)	≤ 0.25 milligrams/litre (mg/l) (95^{th} percentile)	
					Iron (Fe)	≤0.75 milligrams/litre (mg/l) (95^{th} percentile)	
					Uranium (U)	≤ 0.07 milligrams/litre (mg/l) (95^{th} percentile)	
					Ammonia (NH_3) as Nitrogen	≤ 0.072 milligrams/litre (mg/l) (95^{th} percentile)	
					A screening level whole effluent toxicity test should be conducted at four trophic levels and should the results show toxicity greater than 1 (limited to not acutely toxic) further definitive tests are required.		
				Nutrients: Instream concentration of nutrients must sustain aquatic ecosystem health. Concentrations should not be allowed to deteriorate.	Dissolved Inorganic Nitrogen (DIN) as Nitrogen	≤ 0.7 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specifications. Based on present state.
					Nitrate (NO_3^-) & Nitrite NO_2^-) as Nitrogen	≤ 0.50 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
					Orthophosphate (PO_4^-) as Phosphorus	≤ 0.058 milligrams/litre (mg/l) (50^{th} percentile)	Attainment of Management Class and associated ecological category. Ecological category C upper boundary value as per the water quality component of the Ecological Reserve manual (2008).
					Chlorophyll-*a* (Chl-*a*) concentrations should be monitored as a response indicator against the resource quality objective nutrient concentrations.	Chl-*a* Periphyton should be between ≤ 84 milligrams/m^2 (50^{th} percentile) Chl-*a* Phytoplankton ≤ 0.025 milligrams/litre (mg/l) (50^{th} percentile)	Response variables to monitor eutrophication. Ecological specifications.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
ME2 Lower Vet	**Floodplain of the Vet River (wetland Freshwater Ecosystem Priority Area)**	**LV2**	**Habitat**	This system has been identified as an important biodiversity corridor by Free State DETEA and as such habitat linkages along this system must be maintained.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	Management of the wetland is important to ensure that the ecosystem structure and function are maintained and that there is ongoing supply of ecosystem services, particularly regulating and supporting services for the downstream river including the riparian and instream habitats.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Black Harrier. Presence of important species such as Blue Crane.	Reporting rates (RR) in Resource Unit LV2: No reporting rates available for this area. Presence of Endangered species.	The floodplain system is likely to support viable populations of Red Data Listed birds such as Greater Painted-Snipe, Black Harrier and Blue Crane.
MF Vaal River from Renoster to Bloemhof Dam	**Pan cluster around Wesselbron including Volstruispan, Graspan and Mahemspan (wetland Freshwater Ecosystem Priority Areas)**	**VB4**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.
			Habitat	Habitat linkages between the various pan and associated wetland system must be maintained.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MF Vaal River from Renoster to Bloemhof Dam	**Pan cluster around Wesselbron including Volstruispan, Graspan and Mahemspan (wetland Freshwater Ecosystem Priority Areas)**	VB4	**Biota**	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork and African Marsh-Harrier. Presence of important species such as African Grass-Owl and both flamingo species.	Reporting rates (RR) in Resource Unit VB4: Black Stork RR 1-5%. Yellow-billed Stork RR 5%. Greater Flamingo RR 10-62%. Lesser Flamingo RR 10-61%. African Marsh-Harrier RR 3%. African Grass-Owl RR 1%.	The pan systems and associated wetland habitat are likely to support viable populations of Red Data Listed birds such as Great White Pelican, Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, African Marsh-Harrier, Greater Painted-Snipe and African Grass-Owl.
	Unchannelled valley bottom wetland in the upper reaches of the Sandspruit immediately north of Kutloanong (wetland Freshwater Ecosystem Priority Area)		**Quantity**	Landuse changes that result in elevated stormflows or changes in the post development hydrological regime must be avoided. Where this is not possible, mitigation measures should be put in place to ensure that the post development hydrology is maintained within 10% of the pre-development hydrology so as to protect the unchannelled character of the system.	Water distribution & retention patterns score. Water distribution and retention assessment, hydrology module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	The flows in the system should be such that they do not pose a threat to the unchannelled structure/geomorphology of the wetland system.
			Quality	As per river Resource Quality Objectives listed below.			The wetland systems are a part of the river system and must thus be managed as a 'continuum'. Water quality must be aligned to ensure that the system objectives are met
				Nutrients: Instream concentration of nutrients must be improved to sustain aquatic ecosystem health and ensure the present ecological category is maintained.	Orthophosphate (PO_4^-) as Phosphorus	≤ 0.091 milligrams/litre (mg/l) (50^{th} percentile)	Ecological specification. Ecological category C/D upper boundary value as per the water quality component of the Ecological Reserve manual (2008
					Nitrate (NO_3^-) & Nitrite (NO_2^-) as Nitrogen	≤ 0.25 milligrams/litre (50^{th} percentile) ≤ 6 milligrams/litre (95^{th} percentile)	Ecological and User defined specifications. Consideration of present state. Target water quality range limit: Domestic use – South African Water Quality Guidelines (1996).
				Salts: Instream salinity must be improved to sustain the aquatic ecosystem.	Electrical conductivity (EC)	≤ 70 milliSiemens/metre (mS/m) (95^{th} percentile)	Ecological category and user requirements met. Limit based on present state quality – corresponds to C ecological category

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MF Vaal River from Renoster to Bloemhof Dam	**Unchannelled valley bottom wetland in the upper reaches of the Sandspruit immediately north of Kutloanong (wetland Freshwater Ecosystem Priority Area)**	**VB4**	**Habitat**	Wetland vegetation and geomorphology must be maintained or where necessary improved to protect the unchannelled character of the system.	Wetland vegetation score. Vegetation module of Wet-Health (Level 2).	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	To ensure that the Wetland character *viz.*unchannelled valley bottom type is maintained.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork and African Marsh-Harrier. Presence of important species such as African Grass-Owl, Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit VB4: Black Stork RR 1%. Yellow-billed Stork RR 3%. Greater Flamingo RR 16-62%. Lesser Flamingo RR 12-61%. African Marsh-Harrier RR 3%. African Grass-Owl RR 1%. Blue Crane RR 2%.	The wetland system likely to support viable populations of Red Data Listed birds such as Great White Pelican, Black Stork, Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, African Marsh-Harrier, Greater Painted-Snipe, Blue Crane and African Grass-Owl.
MF Vaal River from Renoster to Bloemhof Dam	**Pan cluster along the watershed divide to the west of the Bamboesspruit (some are wetland Freshwater Ecosystem Priority Areas)**	**VB5**	**Quantity**	Abstraction 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.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. This should be undertaken every 3-5 years.	Water quantity impacts must be managed so as not to undermine the ecological value of these pan systems and their associated wetlands.
			Quality	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).	Water quality sampling of key cations and anions. For the conservative highly soluble element chloride, to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans.	Water quality assessment required. This should be undertaken every 3-5 years.	To ensure that the pan type integrity is maintained. Required to maintain the particular water chemistry pan type.

IUA	Wetlands	RU	Resource Quality Objective		Indicator/measure	Numerical Limit	Context
MF Vaal River from Renoster to Bloemhof Dam	**Pan cluster along the watershed divide to the west of the Bamboesspruit (some are wetland Freshwater Ecosystem Priority Areas)**	**VB5**	**Habitat**	Developments and/or land-use practices or activities in and adjacent to the pan basin, including in the pan catchment, and wetlands and the wetland catchments associated with the pan systems, that will lead to the deterioration in the current condition of the pan and wetland systems and alteration of the associated habitats should be avoided.	Wet-Health not applicable to Pans. A new Present Ecological State assessment tool must be developed for pan systems.	Present Ecological State and Ecological Importance and Sensitivity need to be verified. An assessment of the current condition is required. The verified Present Ecological State must be maintained or where possible improved. Present Vegetation Score required. This should be undertaken every 3-5 years. Verify Freshwater Ecosystem Priority Area.	To prevent deterioration in the condition of the wetland and to maintain its integrity and structure. To ensure that there is ongoing supply of ecosystem services.
			Biota	Overall biodiversity and viable populations of Red Data bird species must be maintained.	Presence of endangered species such as Yellow-billed Stork. Presence of important species such as Blue Crane and both flamingo species.	Reporting rates (RR) in Resource Unit VB 5: Yellow-billed Stork RR 3%. Greater Flamingo 50%. Lesser Flamingo RR 28%. Blue Crane RR 6%.	The pan systems are likely to support viable populations of Red Data Listed birds such as Yellow-billed Stork, Greater Flamingo, Lesser Flamingo, Greater Painted-Snipe, Black-winged Pratincole and Blue Crane.

6.3 GROUNDWATER RESOURCE QUALITY OBJECTIVES

Table 6-11: Regional and Resource Unit specific Resource Quality Objectives for GROUNDWATER in the MIDDLE VAAL WMA

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MC – Schoon-spruit	**RU G1**	**SK3**	Groundwater flow directions in the non-dolomite aquifer part of the resource unit should not be reversed from it natural flow directions towards the drainage systems (specifically the Schoonspruit and Taaiboschspruit cases).	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) required to comply with limits.	Dolomite aquifer systems: Saturation levels should not be lowered >6metres below an average water level depth of ~23metres in the dolomite aquifer area. Due to ground stability risks, the water table range limit should remain 100% compliance	Based on water level declines and appearances of sinkholes in the Far West Rand by the Council for Geosciences.
			Groundwater balance (aquifer recharge and irrigation abstraction) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods).	Abstraction - Abstraction Volume (Q) Time series water level monitoring (Monthly) required to comply with limits.	Annual abstraction rates should be in balance with recharge rates. Abstraction of groundwater within a 500m zone from the river course should be regulated.	High abstractions within the 500m zone could impact on the surface water resource (distance is based on high T-values for dolomite aquifer systems)
			Nitrate values in the recharge area must be maintained to support domestic water users.	Nutrients - Nitrate	Nitrate < 6 mlligrams/litre in recharge area (based on quality dataset). Specified annual trend should not approach the 95th percentile. Bi-annual monitoring	Long-term groundwater quality observations in dolomite aquifer systems where pristine conditions occurs.
			Salinity levels should not increase. Concentrations must be maintained at levels to support water users.	Salts - Electrical Conductivity	Electrical Conductivity ≤ 50milliSiemens/metre; based on typical groundwater quality in dolomite aquifers Specified annual trend should not approach the 95th percentile. Bi-annual monitoring	Long-term groundwater quality observations in dolomite aquifer systems where pristine conditions occurs.
			The radius of influence should not intersect any other protection zone. In cases where infringements already exist, the infringements will be used as baseline measures.	Radius of influence (r): r = 1.5*SQRT(T*t/S) T= Transmissivity (square metres/day), t = time (days), S = Storativity	The radius of influence should not overlap with any other protection zones or increase zone infringements all the time (100% compliance). Once off assessment of hydraulic parameters (site specific) required.	Application of numerical algorithm based on hydraulic properties of aquifer systems.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MC – Schoon-spruit	**RU G1**	**SK3**	A protection zone along a river is required to protect the aquatic ecosystem.	Distance from river (L) L = (T*i)/R, T= Transmissivity (square metres/day), i = Groundwater gradient, R = Recharge (square metres/day)	Distance from the river should not overlap with any other protection zones at all times (100% compliance). Once off assessment of hydraulic parameters (site specific).	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone around a wetland is required to protect the ecological system.	Distance from wetland (L) L=SQRT(T*i*W*π/R) T= Transmissivity (square metres/day), i = Groundwater gradient, W = Wetland Perimeter R = Recharge (metres/day)	Wetland Perimeter should not overlap any other protection zone at all times (100% compliance). Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
MC – Schoon-spruit	**RU - G2**	**SK 2, SK 4**		Water Level - Depth to groundwater level Time series water level monitoring (Monthly) required to comply to limits.	Dolomite aquifer systems: Saturation levels should not be lowered >6 metres below an average water level depth of ~23 metres in the dolomite aquifer area. Due to ground stability risks, the water table range limit should remain 100% compliance.	Based on water level declines and appearances of sinkholes in the Far West Rand by the Council for Geosciences.
			The flow at the Schoonspruit Eye must be maintained at a sustainable volume maintain the Eye and to support downstream users.	Abstraction - Abstraction rate (Q) Continuous Flow measurement at Eye	The allocable volumes in the catchment of the Eye should not be higher than 4Mm^3/m (~48 million cubic metres/annum) – and should be correlated with latest flow data at flow gauge C2H024 and irrigation requirements downstream from the Eye (based on historical flow measurements). Proper irrigation schedules need to be developed and applied at all times (100% compliance). Groundwater balance (aquifer recharge and irrigation abstraction) needs to be assessed for wet and dry cycles.	Water balance assessed during a hydrogeological study of the area and long-term observations of eye discharges.
			Nitrate values in the recharge area should not increase to > 2 milligrams /litre.	Nutrients - Nitrate Bi-annual monitoring	Nitrate values in the recharge area should not increase to > 2 milligrams /litre.	Groundwater quality data from DWS National Groundwater Monitoring Programme in the area.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MC – Schoon-spruit	**RU - G2**	**SK 2, SK 4**	Salinity levels should not increase. Concentrations must be maintained at levels to support the catchment of the Eye.	Salts - Electrical Conductivity	Electrical conductivity ≤ 50 milliSiemens/metre in the catchment of the Eye Groundwater criteria for the dolomite aquifer should be based on the groundwater quality criteria of the Schoonspruit dolomite water compartment as observed by the Department of Water and Sanitation. The Schoonspruit Eye catchment area (~5 square kilometre area) must be managed as a protected area in terms of the Department of Water Affair's Dolomitic Guidelines Document (August 2006). Bi-annually	Groundwater quality data from DWS National Groundwater Monitoring Programme in the area.
			The radius of influence should not intersect any other protection zone. In cases where infringements already exist, the infringements will be used as baseline measures.	Radius of influence (r): r = 1.5*SQRT(T*t/S) T= Transmissivity (square metres/day), t = time (days), S = Storativity	Radius of influence should not overlap with any other protection zones or increase zone infringements all the time (100% compliance) Once off assessment of hydraulic parameters (site specific) required.	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone along a river is required to protect the aquatic ecosystem.	Distance from river (L) L = (T*i)/R, T= Transmissivity (square metres/day), i = Groundwater gradient, R = Recharge (metres/day)	Distance from river should not overlap with any other protection zones at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone around a wetland is required to protect the ecological system.	Distance from wetland (L) L=SQRT(T*i*W*π/R) T= Transmissivity (square metres/day), i = Groundwater gradient, W = Wetland Perimeter R = Recharge (metres/day)	Wetland Perimeter should not overlap any other protection zone at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			Dolomitic aquifers must adhere to the Dolomitic Guidelines Document (August 2006)	Schoonspruit Eye (Refer to measures specified in Dolomite Guideline)	Refer to numerical limits specified in Dolomite Guideline 100% compliance.	DWS Guideline specifications based on several high-level hydrogeological studies on dolomite aquifers.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MC – Schoon-spruit	**RU – G3**	**SK 1**	The radius of influence should not intersect any other protection zone. In cases where infringements already exist, the infringements will be used as baseline measures.	Radius of influence (r): r = 1.5*SQRT(T*t/S) T= Transmissivity (square metres/day), t = time (days), S = Storativity	Radius of influence should not overlap with any other protection zones or increase zone infringements all the time (100% compliance) Once off assessment of hydraulic parameters (site specific) required.	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone along a river is required to protect the aquatic ecosystem.	Distance from river (L) L = (T*i)/R, T= Transmissivity (square metres/day), i = Groundwater gradient, R = Recharge (metres/day)	Distance from river should not overlap with any other protection zones at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone around a wetland is required to protect the ecological system.	Distance from wetland (L) L =SQRT(T*i*W*π/R) T= Transmissivity (square metres/day), i = Groundwater gradient, W = Wetland Perimeter R = Recharge (metres/day)	Wetland Perimeter should not overlap any other protection zone at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
MC – Schoon-spruit; MF – Vaal; MA - Renoster	**Venters-dorp aquifers**	**VB 3, VB 5, SK 5, SK 6, SK 7 and R5**	Medium to long-term declining water level trends should be managed in a sustainable manner.	Water Level (metres below ground level) Water level (wl) recession rate, dh (metres/day): dh=(h_0-h_n)/t; where h_0=wl on day1; h_n=wl on day 30; t=number of days. Water use monitoring dataset	A specific recession rate must be calculated for each licensed water user based on the area, use and compliance status (in cubic metres/square kilometres/annum). Critical rate: <0.25 metres/month.	Groundwater level trends indicate the impact on groundwater saturations levels and once assessed it can be used to manage groundwater abstraction on an annual interval. Compare aquifer saturation levels against previous year's levels with known abstraction rates and water level trends. This information is crucial for resource modelling.
			The regional groundwater quality criteria should be managed to meet the water use requirements for domestic, agricultural and or industrial users.	Nutrients – Nitrate (as Nitrogen) Annual water quality analysis	Domestic:< 10 milligrams/litre; Stock water:<110 milligrams/litre; Irrigation: <10 milligrams/litre	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MC – Schoon-spruit; MF – Vaal; MA - Renoster	**Venters-dorp aquifers**	**VB 3, VB 5, SK 5, SK 6, SK 7 and R5**	The regional groundwater quality criteria should be managed to meet the water use requirements for domestic, agricultural and or industrial users.	Electrical conductivity and specific macro elements for domestic use; Electrical Conductivity and Sodium Adsorption Ratio for Irrigation water use. Annual water quality analysis.	Salinity: Electrical conductivity <150 milliSiemens/metre for domestic use; Total dissolved solids <1000 milligrams/litre for stock watering; Electrical conductivity < 40 milliSiemens/metre for irrigation water Macro elements – Specific levels for fluoride (<1.0 milligrams/litre), sodium (<200 milligrams/litre), chloride (<200 milligrams/litre) and sulphate (<400 milligrams/litre). 100% compliance	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.
				Toxics: specific trace metal constituents. Annual water quality analyses must be undertaken.	Domestic Use: Trace metals –Arsenic (<0.05 milligrams/litre), Cadmium (<0.005 milligrams/litre), Copper (<1.0 milligrams/litre), Iron (<0.5 milligrams/litre), manganese (<0.4 milligrams/litre) and zinc (<10 milligrams/litre). For stock and irrigation water: Refer to appropriate guideline.	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.
			Basic human need (BHN) water supply boreholes require a protection zone from microbial pollution sources (pit latrines, stock kraals, municipal sewer discharge points, stock feedlots, municipal waste dumps sites)	Microbial Radius (r) r = 2(0.28*T) + 53; T=Transmissivity (m^2/d) Annual water quality analysis	Distance to microbial pollution source > microbial radius (r)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			The radius of influence should not intersect any other protection zone. In cases where infringements already exist, the infringements will be used as baseline measures.	Radius of influence (r): r = 1.5*SQRT(T*t/S) T= Transmissivity (m^2/d), t = time (days), S = Storativity	Radius of influence should not overlap with any other protection zones or increase zone infringements all the time (100% compliance) Once off assessment of hydraulic parameters (site specific) required.	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.
			A protection zone along a river is required to protect the aquatic ecosystem.	Distance from river (L) L = (T*i)/R, T= Transmissivity (m^2/d), i = Groundwater gradient, R = Recharge (m/d)	Distance from river should not overlap with any other protection zones at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MC – Schoon spruit; MF – Vaal; MA - Renoster	**Venters-dorp aquifers**	**VB 3, VB 5, SK 5, SK 6, SK 7 and R5**	A protection zone around a wetland is required to protect the ecological system.	Distance from wetland (W) L=SQRT(T*i*W*π/R) T= Transmissivity (m^2/d), I = Groundwater gradient, W = Wetland Perimeter R = Recharge (m/d)	Wetland Perimeter should not overlap any other protection zone at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
MA - Renoster, MB - Vals, MD1 - Upper Sand, MD2 - Lower Sand, ME1- Upper Vet, ME2 - Lower Vet, MF - Vaal to Bloemhof Dam	**Karoo aquifers**	**UV1, UV2, UV3, UV4, LV1, LV2, US2, US3, LS1, LS2, LS3, V2, V3, V4, V5, R2, R3, R4, R5, VB4, VB2, VB6**	Medium to long-term declining water level trends should remain sustainable	Water Level (m below ground level) Water level (wl) recession rate, dh (metres/day): dh=(h_0-h_n)/t; where h_0=wl on day1; h_n=wl on day 30; t=number of days. Water use monitoring dataset	A specific recession rate must be calculated for each licensed water user based on the area and use and compliance (in m^3/km^2/a). Critical rate: <0.25metres/month	Groundwater level trends indicate the impact on groundwater saturations levels and once assessed it can be used to manage groundwater abstraction on an annual interval. Compare aquifer saturation levels against previous year's levels with known abstraction rates and water level trends. This information is crucial for resource modelling.
			Where water use (m^3/a) is higher than requirements for Reserve, Schedule 1 and General Authorizations, balance between annual recharge and abstraction on specified property area (hectares) must be satisfied.	Water use > Reserve, Schedule 1 and General Authorisations Abstraction rate Q (mm/km^2/a) and recharge (mm/km^2/a). (Refer to Groundwater Resources Assessment Phase II or more recent updated recharge estimation in mm/km^2/a). Estimate local Stress Index, SI(%): SI(%)=Use (Q)/Recharge	Abstraction rate < Average recharge (based on the licensed area average recharge estimation). Stress Index <60% - Category A investigation, Stress Index =60-100% - Category B investigation; and Stress Index >100% - Category C investigation Water Use Registration (million cubic metres/annum)	Based on standard empirical algorithm used in DWS during evaluation of water use licensing (S21(a)) specifications. Each water user must log his/her water use against WARMS and operate abstraction accordingly.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MA - Renoster, MB - Vals, MD1 - Upper Sand, MD2 - Lower Sand, ME1- Upper Vet, ME2 - Lower Vet, MF - Vaal to Bloemhof Dam	**Karoo aquifers**	**UV1, UV2, UV3, UV4, LV1, LV2, US2, US3, LS1, LS2, LS3, V2, V3, V4, V5, R2, R3, R4, R5, VB4, VB2, VB6**	The regional groundwater quality criteria should be based on the water use requirement for domestic, agricultural and or industrial limits.	Nutrients: Nitrate (as Nitrogen) Annual water quality analysis	Domestic use:<10 milligrams/litre; Stock water use:<110 milligrams/litre; Irrigation use: <10 milligrams/litre	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.
				Salts: Electrical conductivity and specific macro elements for all domestic use. Electrical Conductivity and Sodium Adsorption Ratio for Irrigation waters. Annual water quality analysis.	Electrical conductivity <150 milliSiemens/metre for domestic use; Total dissolved solids <1000 milligrams/litre for stock watering; Electrical conductivity < 40 milliSiemens/metre for irrigation water Macro elements – Specific levels for fluoride (<1.0 milligrams/litre), sodium (<200 milligrams/litre), chloride (<200 milligrams/litre) and sulphate (<400 milligrams/litre). 100% compliance	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.
				Toxics: Specific trace metal constituents Annual water quality analyses must be undertaken.	Domestic Use: Trace metals –Arsenic (<0.05 milligrams/litre), Cadmium (<0.005 milligrams/litre), Copper (<1.0 milligrams/litre), Iron (<0.5 milligrams/litre), Manganese (<0.4 milligrams/litre) and Zinc (<10 milligrams/litre). For stock and irrigation water: Refer to appropriate guideline.	Based on DWA, Dept. Health and WRC water quality guideline (TT 101/98) for untreated water supplies.
			Basic human need (BHN) water supply borehole require a protection zone from microbial pollution sources (pit latrines, stock kraals, municipal sewer discharge points, stock feedlots, municipal waste dumps sites)	Microbial Radius (r) r = 2(0.28*T) + 53; T=Transmissivity (m^2/d) Annual water quality analysis.	Distance to microbial pollution source > microbial radius	Application of numerical algorithm based on hydraulic properties of aquifer systems.

IUA	Ground-water unit	RU	Resource Quality Objective	Indicator/ Measure	Numerical Limit	Context of RQO/Proposed Limit
MA - Renoster, MB - Vals, MD1 - Upper Sand, MD2 - Lower Sand, ME1- Upper Vet, ME2 - Lower Vet, MF - Vaal to Bloemhof Dam	**Karoo aquifers**	**UV1, UV2, UV3, UV4, LV1, LV2, US2, US3, LS1, LS2, LS3, V2, V3, V4, V5, R2, R3, R4, R5, VB4, VB2, VB6**	The radius of influence should not intersect any other protection zone. In cases where infringements already exist, the infringements will be used as baseline measures.	Radius of influence (r): r = 1.5*SQRT(T*t/S) T= Transmissivity (m^2/d), t = time (days), S = Storativity	Radius of infuence should not overlap with any other protection zones or increase zone infringements all the time (100% compliance) Once off assessment of hydraulic parameters (site specific) required.	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone along a river is required to protect the aquatic ecosystem.	Distance from river (L) L = (T*i)/R, T= Transmissivity (m^2/d), i = Groundwater gradient, R = Recharge (m/d)	Distance from river should not overlap with any other protection zones at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems.
			A protection zone around a wetland is required to protect the ecological system.	Distance from wetland (L) L=SQRT(T*i*W*π/R) T= Transmissivity (m^2/d), I = Groundwater gradient, W = Wetland Perimeter R = Recharge (m/d)	Wetland perimeter should not overlap any other protection zone at all times (100% compliance) Once off assessment of hydraulic parameters (site specific)	Application of numerical algorithm based on hydraulic properties of aquifer systems

7 IMPLEMENTATION CONSIDERATIONS

The implementation considerations that must be taken into account in terms of the development of a proposed plan to facilitate the implementation of the RQOs in the Middle Vaal WMA should cover the following components/steps:

- *Capacity Building on the RQOs and Integration in the DWS:*
  - A key component to the success of the RQOs is a common understanding of purpose in the DWS on RQOs between the National Office, Regional Offices and between Chief Directorates (e.g. Water Ecosystems, Regulation, Water Resource Information Management, and Integrated Water Resource Planning).
  - It is critical that buy in be obtained from regional offices, specifically Regional Directors to ensure that they understand what RQOs mean and the implications to the DWS and to ensure that the regional personnel are given the necessary mandate, resources and support as the critical role players regarding RQOs.
  - RQOs can only be effectively implemented if the regional personnel are sufficiently capacitated in terms of the gazetted RQOs, their enforcement, reporting and compliance.
- *Definition of Responsibilities:*
  - This component should focus on defining the specific Offices (National and Regional), Directorates and Chief Directorates within the DWS that are responsible for the specific components of the RQOs implementation.
  - This will require definition of ownership and clear roles and mandates. This will involve the Chief Directorate Water Ecosystems developing a 'roles and responsibilities' document sanctioned by the necessary delegated authority. This will need to be developed with the relevant DWS officials.
  - It is of paramount importance that the responsibilities and roles regarding the monitoring of the habitat, biota, quality and quantity for rivers and wetlands, and groundwater (water levels, water quality sampling) are specified.
- *Implementing RQOs:*
  - This step entails defining the technical detail of the implementation of the RQO components.
  - In terms of the Middle Vaal WMA the following technical detail needs to be defined:
    - Confirmation of the location of the RQO sites (nodes)/boreholes/wetlands that will be used for collection of data and compliance monitoring.
    - Identification of RQO sites where baseline monitoring is required as a first phase of implementation in order for the baseline conditions to be defined so that numerical limits can be set. This relates in many instances to habitat, biota (fish, macroinvertebrates) and water quality for rivers and wetlands.
    - Development of a monitoring plan detailing the sub-components and indicators to be monitored, the frequency, seasonality, sampling methods and chain of custody.

- Establish a repository database to store the data collected for all sub-components *viz*: water quality, flows, riparian vegetation, in-stream habitat, fish, macroinvertebrates, groundwater and wetlands. These datasets will support the determination of the indices specified the RQOs.
- Strategies need to be developed for the Rietspruit (RU LS2) and the Koekemoerspruit (RU SK1) to achieve the phased implementation of the RQOs that have been set.
- Establishment of a waste load discharge and abstraction plan to ensure that the water quality and quantity (flow) RQOs are met.
- The operation of the system to meet the flow requirement RQOs must be implemented.

- *Reporting and Compliance:*
  - The implementation plan must detail the information required in terms of the reporting component of the RQOs to assess compliance in terms of achieving the RQOs.
    - A report detailing the reporting and compliance requirements that the DWS will need to meet must be developed. This should include frequency of reporting, the distribution of the report, the format and level of detail.
    - The actions that should follow to address non-compliance.
    - In assessing compliance cognisance must be taken of the length of the data record available as many of the numerical limits set require at least a year's data to establish values and trends. As more data becomes available the confidence in the assessment will increase.
    - In cases of RUs with interim RQOs, the success of the strategies must be evaluated and refined where required.

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APPENDIX A

SUB-COMPONENT PRIORITIZATION LISTS

PER RESOURCE UNIT PER INTEGRATED UNIT OF ANALYSIS

Table A1: Sub-component Prioritisation for Integrated Unit of Analysis - MA RENOSTER

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
R2	Low flows		✓		Maintain maintenance low flows as specified at the biophysical node which is important for ecological integrity of resource.	Maintenance flows Drought flows
	Nutrients			✓	Water resource has water quality impacts from the towns in the catchment (sewage effluent. This poses a potential risk.	Dissolved Inorganic Nitrogen; Nitrate& Nitrate
						Orthophosphate
	Salts	✓			There is a need to monitor baseline for any potential impact from agricultural activities and the towns which could potentially impact on user water quality requirements.	Electrical conductivity
R2	Pathogens	✓			Need to maintain fitness for use for recreation. Due to public health concerns, pathogens are important. (upstream impacts).	*Escherichia coli*
	Instream Habitat		✓		Maintenance of instream status (Management Class II) is important (Biophysical nodes)	Rapid Habitat Assessment Method
	Fish		✓		Need to maintain population/ species present as well as present ecological state.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Need to maintain present ecological state.	Macroinvertebrate Response Assessment Index
R3	Low flows		✓		Maintain maintenance low flows as specified at the biophysical node which is important for ecological integrity of resource.	Maintenance flows Drought flows
	Nutrients			✓	Water resource has water quality impacts from the towns in the catchment (sewage effluent). Potential for eutrophication exists.	Dissolved Inorganic Nitrogen
						Orthophosphate
						Phytoplankton
	Salts	✓			Fitness for use for irrigation and recreation and downstream user requirements (acceptable salinity levels) must be maintained.	Electrical conductivity
	Pathogens	✓			Need to maintain fitness for use for recreation. Due to public health concerns, pathogens are important. (upstream impacts)	*Escherichia coli*
	Dam habitat		✓		Dam is an important refuge for fish. Link to upstream species should be maintained.	Health assessment studies and indicator species.
	Fish		✓			
	Aquatic birds			✓	Birds in the area must be protected by ensuring the dam habitat remains sustainable in order to supports the birdlife present.	Indicator bird species and population
R4	Low flows			✓	Maintain maintenance low flows as specified at the biophysical node. Flow modification present due to activities in catchment.	Maintenance flows Drought flows
	Nutrients			✓	Water resource has significant water quality impacts. Need to maintain the management class. Baseline monitoring is required.	Dissolved Inorganic Nitrogen; Nitrate& Nitrate
						Orthophosphate
	Salts			✓	Monitor baseline for any potential impact from agriculture and towns. Need to maintain prescribed ecological category.	Electrical conductivity

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
R4	System variables			✓	Water resource has significant water quality impacts. Need to maintain instream health to meet management class. Baseline monitoring required.	pH
						Turbidity
	Toxics		✓		Ammonia concentrations pose a threat to river health. The water quality in the river is impacted by wastewater treatment works discharges. Ammonia originates from the sewage works discharges.	Ammonia
	Instream Habitat		✓		Maintenance of present ecological state and management class is important to sustaining ecological integrity of system. River Health Programme site present (biomonitoring done)	Rapid Habitat Assessment Method
	Fish		✓		It is important to maintain population/ species present. River Health Programme site (biomonitoring done) is present.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present. Biomonitoring is done. Maintenance of present ecological state and management class is required.	Macroinvertebrate Response Assessment Index
R5	Low flows		✓		Maintain maintenance low flows as specified at the biophysical node. Important to support aquatic ecosystem.	Maintenance flows Drought flows
	Nutrients			✓	Water resource has significant water quality impacts. Level of nutrients is high	Dissolved Inorganic Nitrogen; Nitrate& Nitrate
						Orthophosphate
	Salts			✓	Monitor baseline for any potential impact from upstream. Need to maintain management class.	Electrical conductivity
	Toxics		✓		Ammonia concentrations pose a threat to river health. The water quality in the river is impacted by wastewater treatment works discharges (tributary and upstream). Ammonia originates from the sewage works discharges.	Ammonia
	Pathogens	✓			It is important to maintain fitness for use for recreation. Due to public health concerns, pathogens are important. (upstream impacts)	*Escherichia coli*
	System variables			✓	Need to maintain instream health to meet management class. Baseline monitoring required.	pH
						Turbidity
	Instream Habitat		✓		Maintenance of instream status (Management Class II) is important	Rapid Habitat Assessment Method
	Fish		✓		It is important to maintain population/ species present. River Health Programme site is present (biomonitoring done).	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present. Biomonitoring is done. Maintenance of present ecological state and management class is required.	Macroinvertebrate Response Assessment Index.
	Aquatic birdlife		✓		The Renoster River feeds into the section of the Vaal River considered and important bird area (SA038 Middle Vaal River). The suitability of this stretch of river for aquatic bird populations must be maintained.	Indicator bird species and population

Table A2: Sub-component Prioritisation for Integrated Unit of Analysis – MB VALS

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
V2	Low flows			✓	Maintain maintenance low flows as specified at the biophysical nodes. Need to maintain present ecological state and ensure water supply to the town.	Maintenance flows Drought flows
	Nutrients			✓	Water resource has water quality impacts from the towns in the catchment (sewage effluent). Need to manage nutrient levels.	Dissolved Inorganic Nitrogen; Nitrate & Nitrate
						Orthophosphate
	Salts	✓			Requirement to monitor baseline for any potential impact from agricultural activities and the towns.	Electrical conductivity
	Pathogens	✓			Fitness for use requirements should be met. Due to public health concerns, pathogens are important. There is domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		Maintenance of instream status (Management Class II) is important. River Health programme sire is present. (Biophysical nodes)	Rapid Habitat Assessment Method
	Aquatic Invertebrates		✓		Maintain population/ species present. River Health programme site (biomonitoring done)	Macroinvertebrate Response Assessment Index, South African Scoring System 5
	Diatoms		✓		Poor water quality identified in terms of river health assessment. Need to improve nutrient levels to support aquatic health.	Specific Pollution Index
	Fish		✓		It is important to maintain population/ species present. River Health Programme site (biomonitoring done) is present.	Fish Response Assessment Index (FRAI)
V3	Low flows		✓		Maintain maintenance low flows as specified at the downstream biophysical node.	Maintenance flows
	Nutrients			✓	Water resource has water quality impacts from the town and agricultural activity in the catchment. Potential for eutrophication.	Dissolved Inorganic Nitrogen; Nitrate& Nitrate
						Orthophosphate
						Chlorophyll-*a*
	Salts	✓			Fitness for use for recreation and downstream use water quality requirements (domestic water supply) must be met.(acceptable salinity levels)	Electrical conductivity
	Pathogens	✓			Fitness for use requirements should be met. Due to public health concerns, pathogens are important. There is domestic use of the water resource.	*Escherichia coli*
	Fish		✓		Dam is an important refuge for fish. Forms a link to upstream species. Need to maintain present ecological state.	Health assessment surveys and indicator species.
V4	Low flows			✓	Important to maintain present ecological state. (lower reach is a B category)	Maintenance flows Drought flows
	Nutrients	✓			Water resource has water quality impacts from agricultural activity. Need to maintain present ecological state. Baseline monitoring required.	Dissolved Inorganic Nitrogen; Nitrate& Nitrate
						Orthophosphate
	Salts	✓			Monitor baseline for any potential impact from agriculture. Important to maintain present ecological state.	Electrical conductivity

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
V4	Instream Habitat	✓			Maintain instream status. River Health Programme site (biomonitoring done) is present. (Biophysical nodes)	Rapid Habitat Assessment Method
	Fish	✓			It is important to maintain population/ species present. River Health Programme site (biomonitoring done) is present.	Fish Response Assessment Index (FRAI) must be utilized.
	Aquatic Invertebrates	✓			Maintain population/ species present. River Health programme site (biomonitoring done)	Macroinvertebrate Response Assessment Index, South African Scoring System 5
V5	Low flows			✓	Must maintain ecological specifications at EWR 14.	Maintenance flows Drought flows
	High Flows			✓	Must maintain ecological specifications at EWR 14.	High flows
	Nutrients			✓	Water resource has water quality impacts from the towns and agricultural activities in the catchment. Nutrients in the water resource a high.	Dissolved Inorganic Nitrogen; Nitrate& Nitrate
						Orthophosphate
						Chlorophyll-*a*
	Salts			✓	Agricultural impacts and the upstream impacts from Kroonstad need to be monitored. Salinity levels are high.	Electrical conductivity
	Pathogens	✓			Fitness for use requirements should be met. Due to public health concerns, pathogens are important. There is domestic use of the water resource.	*Escherichia coli*
	System variables			✓	Need to maintain instream health to meet management class. Baseline monitoring required.	pH
						Turbidity
	Instream Habitat		✓		Ecological specifications for EWR site 14 must be implemented. . River Health Programme site is present (biomonitoring done).	Rapid Habitat Assessment Method
	Fish		✓		Ecological specifications for EWR 14 site must be implemented. . River Health Programme site is present (biomonitoring done).	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Ecological specifications for EWR 14 site must be implemented. . River Health Programme site is present (biomonitoring done).	Macroinvertebrate Response Assessment Index, South African Scoring System 5

Table A3: Sub-component Prioritisation for Integrated Unit of Analysis – MC SCHOONSPRUIT

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
SK1	Low flows			✓	Required for ecosystem functioning and to support the needs of subsistence domestic and agricultural use.	Maintenance flows Drought flows
	Nutrients			✓	The wastewater treatment works discharges impacts on water quality specifically on the nutrient concentrations in the river.	Dissolved Inorganic Nitrogen
						Orthophosphate
						Nitrate & Nitrite

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
SK1	Salts			✓	The water quality in the river is impacted by mine dewatering discharges as well as the seepages from the tailings storage facilities. and pollution control dams. The mine impact on water quality is largely related to salts.	Electrical conductivity
						Sulphate
						Magnesium
	Toxics			✓	The water quality in the river is impacted by mining activities and wastewater treatment works discharges. The mine impact on water quality is largely related to toxics such as cyanide and heavy metals. Ammonia originates from the sewage works discharges.	Cyanide (free) , Aluminium, Manganese, Iron, Uranium, Ammonia
	Pathogens	✓			The wastewater treatment works discharges impacts on water quality on the river. It is reported to be compliant. Due to public health concerns, pathogens are important.	*Escherichia coli*
	Instream Habitat		✓		The instream habitat has been degraded and requires improvement.	Rapid Habitat Assessment Method
	Fish			✓	Need to protect fish species present.	Fish Response Assessment Index (FRAI)
	Diatoms		✓		Provides an indication of water quality state - sensitive to pollution. Species-specific sensitivities and tolerances can be used to infer environmental conditions in a habitat.	Specific Pollution Index. Conduct a diatom assessment annually.
SK2	Low flows			✓	Conservation of the eye is required, of ecological importance. Prevention of over-abstraction.	Maintenance flows Drought flows
	Nutrients			✓	Agricultural impact is a potential threat.	Nitrate & Nitrite
						Orthophosphate
						Chlorophyll-*a*
	Salts	✓			Important to monitor baseline to determine any potential impact.	Electrical conductivity
	System variables		✓		Detection of any WQ impacts on dolomites. Need to protect dolomites.	pH
	Instream Habitat		✓		Maintain ecosystem habitat - support biota present.	Rapid Habitat Assessment Method
SK3	Low flows		✓		Required for ecosystem functioning. There is a need to specify seasonal flows.	Maintenance flows Drought flows
	Salts			✓	Important to monitor baseline to determine any potential impact.	Electrical conductivity

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
SK4	Low flows			✓	Flows required to support downstream ecosystem functioning and users	Maintenance flows Drought flows
	Nutrients			✓	The wastewater treatment works discharges and agricultural activities impacts on water quality specifically on the nutrient concentrations in the river.	Dissolved Inorganic Nitrogen
						Orthophosphate
						Nitrate & Nitrite
	Salts			✓	There is an impact of agricultural activity on the water resource.	Electrical conductivity
	Pathogens	✓			The wastewater treatment works discharges impacts on water quality on the river. Due to public health concerns, pathogens are important. There is informal domestic use of the river water and recreational use.	*Escherichia coli*
SK5	Instream Habitat		✓		The instream habitat needs to be maintained to support the biota.	The Rapid Habitat Assessment Method.
	Fish		✓		Need to maintain fish population present. Fish data is available and monitoring has been done.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Need to maintain ecosystem integrity. Supported by River Health Programme.	Macroinvertebrate Response Assessment Index, South African Scoring System 5
	Low flows			✓	Current overuse -of resource through abstraction (agriculture).	Maintenance flows Drought flows
	Nutrients			✓	Land use activities *viz*. agriculture and piggeries are impacting on the water quality of the resource.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	To monitor the salinity in the main stem Schoonspruit (alignment of resource units).	Electrical conductivity
	Pathogens			✓	The piggeries impact on water quality on the river. Due to public health concerns, pathogens are important.	*Escherichia coli*
	System variables			✓	Need to understand behaviour of system.	pH
	Instream Habitat		✓		Need to maintain present ecological state.	Rapid Habitat Assessment Method
	Fish		✓		Need to maintain present ecological state.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Need to maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
SK6	Nutrients			✓	Potential for eutrophication exists. Need to manage nutrient levels.	Dissolved Inorganic Nitrogen, Orthophosphate
						Nitrate & Nitrite, Chlorophyll-*a*
	Salts	✓			Fitness for use for irrigation, recreation and downstream use required (acceptable salinity levels).	Electrical conductivity
	Pathogens	✓			Need to maintain fitness for use for recreation. Due to public health concerns, pathogens are important. (upstream impacts)	*Escherichia coli*
	Fish		✓		Dam is an important refuge for fish. Serves as a link to upstream species.	Health assessment surveys and indicator species.

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
SK7	Low flows			✓	Flows required to support downstream ecosystem functioning and users	Maintenance flows Drought flows
	Nutrients			✓	Water resource has significant water quality impacts. Water quality needs improvement.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	Highly impacted by mining, industrial and urban areas in catchment (Jagspruit tributary). Salinity must be improved.	Electrical conductivity
						Sulphate
	Toxics			✓	The water quality in the river is impacted by mining activities and wastewater treatment works discharges. The mine impact on water quality is largely related to toxics such as cyanide and heavy metals. Ammonia originates from the sewage works discharges.	Cyanide (free) , Aluminium, Manganese, Iron, Uranium, Ammonia
	Pathogens	✓			Wastewater discharges and untreated sewage entering the water have a potential public health concern.	*Escherichia coli*
	Instream Habitat		✓		The instream habitat has been degraded and requires improvement.	Rapid Habitat Assessment Method
	Fish		✓		Need to maintain present ecological state. Prevent further deterioration.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Need to maintain present ecological state. Prevent further deterioration.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Table A4: Sub-component Prioritisation for Integrated Unit of Analysis – MD1 UPPER SAND

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
US2	Low flows		✓		Maintain maintenance low flows as specified at biophysical node.	Maintenance flows Drought flows
	Nutrients			✓	The wastewater treatment works discharges from the town impact on water quality specifically on the nutrient levels in the river.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	Catchment is impacted by agricultural activities. There is a need to manage salinity levels.	Electrical conductivity
	Toxics		✓		The water quality in the river is impacted by wastewater treatment works discharges. Ammonia as a toxin needs to be monitored.	Ammonia
	Pathogens	✓			The wastewater treatment works discharges impact on water quality on the river. Due to public health concerns, pathogens are important. There is informal domestic use of the river water.	*Escherichia coli*
	Fish		✓		River Health Programme site present - good site - supporting data available. Monitor ecological integrity of system.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present - good site - support data available. Monitor ecological integrity of invertebrates in system. Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
US3	Low flows		✓		Need to maintain maintenance low flows as specified at biophysical node downstream of the dam.	Maintenance flows Drought flows
	Nutrients			✓	The wastewater treatment works discharges from the town upstream impact on the nutrient concentrations in the dam.	Nitrate & Nitrite
						Orthophosphate
						Chlorophyll-*a*
	Salts			✓	Catchment is impacted by agricultural activities. There is a need to manage salinity levels.	Electrical conductivity
	System variables			✓	Monitor the water clarity to understand the limiting of algal growth in Dam.	pH
	Pathogens	✓			The upstream of the impacts of the wastewater treatment works discharges need to be determined. Due to recreational activity and domestic use of water pathogens are important from a public health point of view.	*Escherichia coli*
	Fish		✓		Serves as a fish refuge for a number of species. Must be monitored.	Health assessment surveys and indicator species.
	Aquatic Birds		✓		The dam ecosystem supports birdlife in the area. The habitat must be managed to ensure that the bird populations are maintained.	Indicator bird species and population

Table A5: Sub-component Prioritisation for Integrated Unit of Analysis – MD2 LOWER SAND

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
LS1	Low flows		✓		Maintain maintenance low flows as specified at biophysical node.	Maintenance flows Drought flows
	Nutrients			✓	Intensive irrigated agriculture, return flows in water resource have a potential significant impact.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	Impacts of agriculture are significant. Need to manage salinity levels.	Electrical conductivity
	System Variables			✓	Need to monitor system behaviour.	pH
	Pathogens	✓			Fitness for use requirements. Due to public health concerns, pathogens are important. There is informal domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		River Health Programme site present - support data available. Monitor ecological integrity of system. Maintain present ecological state.	Rapid Habitat Assessment Method
	Fish		✓		River Health Programme site present. Monitor ecological integrity of system.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present - support data available. Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
LS2	Nutrients			✓	Water resource has significant water quality impacts from the towns and agricultural activities in the catchment.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	Highly impacted by mining, industrial and urban areas in catchment.	Electrical conductivity
	System Variables			✓	Need to monitor system behaviour.	pH, Turbidity
	Toxics			✓	The water quality in the river is impacted by mining activities and wastewater treatment works discharges. The mine impact on water quality is largely related to toxics such as heavy metals. Ammonia originates from the sewage works discharges.	A Cyanide (free) , Aluminium, Manganese, Iron, Uranium, Ammonia
	Pathogens	✓			Fitness for use requirements. Due to public health concerns, pathogens are important. There is informal domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		Need to maintain biota - flow/quality in tributary must be managed to support this.	Rapid Habitat Assessment Method
	Fish		✓		Maintain population (species present)	Fish Response Assessment Index (FRAI)
LS3	Low flows		✓		Maintain maintenance low flows as specified at biophysical node.	Maintenance flows Drought flows
	Nutrients			✓	Towns waste water treatment works discharges and return flows from agriculture have a significant water quality impact.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	Impacts of mining need to be monitored.	Electrical conductivity
	Toxics			✓	The water quality in the river is impacted by mining activities and wastewater treatment works discharges. The mine impact on water quality is largely related to toxics such as heavy metals. Ammonia originates from the sewage works discharges.	Cyanide (free) , Aluminium, Manganese, Iron, Uranium, Ammonia
	System Variables			✓	Need to monitor system behaviour.	pH, Turbidity
	Pathogens	✓			Fitness for use requirements. Due to public health concerns, pathogens are important. There is informal domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		River Health Programme site present.- support data available. Monitor ecological integrity of system (flow/biota). Maintain present ecological state.	Rapid Habitat Assessment Method
	Fish		✓		Need to maintain population/ species present. River Health Programme site present (biomonitoring done).	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present (biomonitoring done). Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Table A6: Sub-component Prioritisation for Integrated Unit of Analysis – ME1 UPPER VET

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
UV1/UV2	Low flows		✓		Maintain maintenance low flows as specified at biophysical node.	Maintenance flows Drought flows
	Nutrients			✓	The agricultural activities impact on the nutrient levels in the water resource.	Dissolved Inorganic Nitrogen
						Orthophosphate
						Nitrate & Nitrite
	Salts			✓	Impacted by agricultural activities in the catchment. Need to manage salinity levels.	Electrical conductivity
	System variables			✓	Erosion a problem as a result of agricultural practices.	pH, Turbidity
	Toxics		✓		The water quality in the river is impacted by wastewater treatment works discharges. Ammonia as a potential toxin needs to be monitored.	Ammonia
	Pathogens	✓			Fitness for use requirements. Due to public health concerns, pathogens are important. There is informal domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		River Health Programme site present - suitable for habitat assessment. Good condition must be maintained.	Rapid Habitat Assessment Method
	Fish		✓		Yellow fish, rock barbels, good populations possibly present. Need to maintain ecological integrity of system.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Habitat exists to support invertebrate communities. River Health Programme site present (biomonitoring - data available). Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
UV3	Low flows		✓		Maintain maintenance low flows as specified at biophysical node.	Maintenance flows Drought flows
	Salts			✓	Monitor baseline to maintain ecological status.	Electrical conductivity
	System variables			✓	Need to monitor system behaviour.	pH
	Instream Habitat		✓		Need to maintain good ecological condition.	Rapid Habitat Assessment Method
	Fish		✓		Presence of species as in main stem (Yellow fish). Need to protect species.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Habitat present to support invertebrate communities. Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
UV4	Low flows		✓		Maintain flows required at downstream EWR site and biophysical node (maintenance flows) must be met.	Maintenance flows
	Nutrients			✓	Agricultural activities have a potential impact on the dam. Need to manage nutrient levels.	Dissolved Inorganic Nitrogen; Nitrate & Nitrite, Orthophosphate, Chlorophyll-*a*
	Salts			✓	There is a need to monitor salts to track upstream impacts.	Electrical conductivity
	System variables			✓	Monitor the water clarity to understand the limiting of algal growth in Dam. Measure pH to understand behaviour.	pH
	Pathogens	✓			Due to recreational activity pathogens are important from a public health point of view.	*Escherichia coli*
	Dam Habitat			✓	Need to manage habitat and ecosystem and water requirements of users.	Habitat Assessment
	Fish		✓		Serves as a refuge for a number of fish species. Must be monitored	Health assessment surveys and indicator species.

Table A7: Sub-component Prioritisation for Integrated Unit of Analysis – ME2 LOWER VET

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
LV1	Low flows		✓		Maintain maintenance low flows as specified at biophysical node.	Maintenance flows Drought flows
	Nutrients			✓	Agricultural impacts are present. Nutrients need to be monitored.	Dissolved Inorganic Nitrogen, Orthophosphate, Nitrate & Nitrite
	Salts			✓	Salinity levels must not be allowed to deteriorate due to impacts of agricultural activities in the catchment.	Electrical conductivity
	System Variables			✓	Need to monitor system behaviour	pH
	Toxics		✓		A wastewater treatment works is present in the catchment. Need to protect aquatic biota against the impact of the presence of toxins such as ammonia.	Ammonia
	Pathogens	✓			Fitness for use requirements. Due to public health concerns, pathogens are important. There is informal domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		The instream status must be maintained.	Rapid Habitat Assessment Method
	Fish		✓		Need to maintain population/ species present. River Health Programme site present (biomonitoring done).	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present (biomonitoring done). Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
LV2	Low flows		✓		Must maintain ecological specifications at EWR 15.	Maintenance flows Drought flows
	High flows		✓		Must maintain ecological specifications at EWR 15.	High flows
	Nutrients			✓	Significant agricultural impacts are present in the catchment. Nutrient levels must be managed.	Dissolved Inorganic Nitrogen , Nitrate & Nitrite., Orthophosphate
	Salts			✓	Salinity levels from agricultural impacts and the upstream impacts from the Sand River need to be monitored.	Electrical conductivity, Sulphate, Chloride
	System Variables			✓	Need to monitor system behaviour	pH
	Toxics			✓	Mining impacts from the Sand River and the impacts of ammonia from the wastewater treatment works are a potential threat.	Aluminium, Manganese, Iron, Uranium, Ammonia
	Pathogens	✓			Fitness for use requirements. Due to public health concerns, pathogens are important. There is informal domestic use of the water resource.	*Escherichia coli*
	Instream Habitat		✓		Ecological specifications for EWR site 15 must be implemented.	Rapid Habitat Assessment Method
	Riparian Habitat		✓		Ecological specifications for EWR site 15 must be implemented.	Vegetation Response Assessment Index
	Fish		✓		Ecological specifications for EWR site 15 must be implemented.	Fish Response Assessment Index (FRAI)

Table A8: Sub-component Prioritisation for Integrated Unit of Analysis – MF VAAL RIVER

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
VB 1.1	Low flows		✓		Must maintain ecological specifications at EWR 12. Need to implement Reserve.	Maintenance flows Drought flows
	High flows	✓			Must maintain ecological specifications at EWR 12. Need to implement Reserve. Potential impact on infrastructure along River (property, water supply infrastructure). Need to implement EWR specifications.	Maintenance flows
	Nutrients			✓	The wastewater treatment works discharges (in the catchment and from Upper Vaal) impact on water quality specifically on the nutrient concentrations in the river. Water hyacinth a key issue, nuisance macrophytes - need to be managed.	Dissolved Inorganic Nitrogen, Nitrate & Nitrite Orthophosphate , Chlorophyll-*a*
	Salts			✓	High degree of salinisation (impact of Upper Vaal. Need to maintain fitness for use. Dilution rule in place)	Electrical conductivity, Total Dissolved Solids Sulphate Magnesium
	System variables		✓		User requirements -need to maintain fitness for use.	pH

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
VB1.1	Toxics			✓	The water quality in the river is impacted by mining activities and wastewater treatment works discharges. Toxics need to be monitored.	Cyanide (free) , Aluminium, Manganese, Iron, Uranium, Ammonia
	Pathogens	✓			The wastewater treatment works discharges impact on water quality on the river. Due to public health concerns, pathogens are important. There is informal domestic use of the river water, recreation, bulk water supply.	*Escherichia coli*
	Instream Habitat		✓		Ecological specifications for EWR site 12 must be implemented.	Rapid Habitat Assessment Method
	Riparian Habitat		✓		Ecological specifications for EWR site 12 must be implemented.	Vegetation Response Assessment Index
	Fish		✓		Ecological specifications for EWR site 12 must be implemented.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Ecological specifications for EWR site 12 must be implemented.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
	Aquatic Birds		✓		The section of the Vaal River considered and important bird area (SA038 Middle Vaal River). The suitability of this stretch of river for aquatic bird populations must be maintained.	Indicator bird species and population
	Diatoms		✓		Provides an indication of water quality state - sensitive to pollution. Species-specific sensitivities and tolerances can be used to infer environmental conditions in a habitat.	Specific Pollution Index.
VB 1.2/ VB 1.3	Low flows		✓		Must maintain ecological specifications at EWR 13. Need to implement Reserve.	Maintenance flows Drought flows
	High flows	✓			Must maintain ecological specifications at EWR 13. Potential impact on infrastructure along River (property, water supply infrastructure). Need to implement EWR specifications.	Maintenance flows
	Nutrients			✓	The wastewater treatment works discharges (in the catchment and from Upper Vaal) impact on water quality specifically on the nutrient concentrations in the river. Water hyacinth a key issue, nuisance macrophytes - need to be managed.	Dissolved Inorganic Nitrogen, Nitrate & Nitrite, Orthophosphate, Chlorophyll-*a*
	Salts			✓	High degree of salinisation (impact of Upper Vaal. Need to maintain fitness for use. Dilution rule in place).	Electrical conductivity, Total Dissolved Solids, Sulphate, Magnesium
	System variables	✓			User requirements -need to maintain fitness for use.	pH
	Toxics			✓	The water quality in the river is impacted by mining activities and wastewater treatment works discharges. Toxics need to be monitored.	Cyanide (free) , Aluminium, Manganese, Iron, Uranium, Ammonia

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
VB 1.2/ VB1.3	Pathogens	✓			The wastewater treatment works discharges impact on water quality on the river. Due to public health concerns, pathogens are important. There is informal domestic use of the river water, recreation, bulk water supply.	Escherichia coli
	Instream Habitat		✓		Ecological specifications for EWR site 13 must be implemented.	Rapid Habitat Assessment Method
	Riparian Habitat		✓		Ecological specifications for EWR site 13 must be implemented.	Vegetation Response Assessment Index
	Fish		✓		Yellowfish conservation area. Need to implement EWR ecological specifications.	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Ecological specifications for EWR site 13 must be implemented.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
	Diatoms		✓		Provides an indication of water quality state - sensitive to pollution. Species-specific sensitivities and tolerances can be used to infer environmental conditions in a habitat.	Specific Pollution Index.
VB2	Salts			✓	Impact of coal mining activities potentially increasing salinisation river.	Electrical conductivity
	System variables			✓	Need to monitor to obtain an indication of the impact of the mining. Protect against deterioration.	pH
	Toxics			✓	The water quality in the river is impacted by mining activities. Toxics need to be monitored.	Aluminium, Manganese, Iron
VB3	Low flows			✓	Maintenance low flows are required to maintain ecological integrity.	Maintenance flows Drought flows
	Nutrients		✓		The wastewater treatment works discharges impact on water quality specifically on the nutrient concentrations. Nutrient levels must be managed.	Dissolved Inorganic Nitrogen, Nitrate & Nitrite, Orthophosphate, Chlorophyll-*a*
	Salts	✓			Agricultural and mining activities in catchments are impacting on water resources. Salinity levels must be managed.	Electrical conductivity
	System Variables			✓	Mining activities are resulting in high suspended solids.	pH, Turbidity
	Pathogens	✓			The wastewater treatment works discharges impact on water quality on the river. Due to public health concerns, pathogens are important. There is informal domestic use of the river water.	*Escherichia coli*

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
VB3	Instream Habitat			✓	Significant modification of bed and banks by diamond mining (specifically in Makwassie catchment). The present ecological state must be maintained to maintain the ecological health of the tributaries.	Rapid Habitat Assessment Method
	Riparian Habitat			✓	Significant modification of bed and banks has occurred due to diamond mining (specifically in Makwassie catchment). The present ecological state must be maintained to maintain the ecological health of the tributaries.	Vegetation Response Assessment Index
	Fish		✓		All species including Yellowfish – Tributaries confluences are an important refuge for main stem species (Vaal River species).	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		River Health Programme site present (biomonitoring done). Maintain present ecological state.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
VB4	Nutrients			✓	Potential impact from agricultural activities and informal settlements. There is a need to ensure that the resource does not deteriorate with respect to nutrients.	Orthophosphate, Nitrate & Nitrite
	Salts			✓	Agricultural activity in catchment is impacting on water resources. Salinity levels must be managed.	Electrical conductivity
	Instream Habitat		✓		Present ecological state and ecological integrity of water resource must be maintained. (Hydrology of stream: Highveld tributaries - pools)	Rapid Habitat Assessment Method
	Fish		✓		Need to protect fish species present (possibly Barbus).	Fish Response Assessment Index (FRAI)
	Aquatic Invertebrates		✓		Need to maintain ecological integrity of invertebrate community.	Macroinvertebrate Response Assessment Index, South African Scoring System 5.
VB5	Nutrients			✓	Potential impact from agricultural activities and informal settlements. There is a need to ensure that the resource does not deteriorate with respect to nutrients.	Dissolved Inorganic Nitrogen Orthophosphate Nitrate & Nitrite
	Salts			✓	Agricultural and diamond mining activities are impacting on water resources. Salinity levels must be managed.	Electrical conductivity, sulphate
	System variables			✓	Impacts of mining and agriculture must be monitored. Need to understand behaviour of system.	pH
	Instream Habitat		✓		Significant bed, banks modification due to diamond mining is impacting on ecological integrity of system. The habitat must be improved.	Rapid Habitat Assessment Method
	Riparian Habitat		✓		Significant bed, banks modification due to diamond mining is impacting on ecological integrity of system. The habitat must be improved.	Vegetation Response Assessment Index
	Fish		✓		Species present in tributary serve as a source population in Bloemhof Dam. In stream species will improve if habitat improves.	Fish Response Assessment Index (FRAI)

Resource Unit	Sub-component	User specific-ation	Ecological specific-ation	Integrated Measure	Rationale	Indicator
VB6	Low flows		✓		The maintenance flows required at the downstream EWR site 16 must be implemented to sustain prescribed ecological condition.	Maintenance flows
	Nutrients			✓	Hypertrophic state is present in the dam. Important to manage nutrient levels.	Dissolved Inorganic Nitrogen, Nitrate & Nitrite
						Orthophosphate
						Chlorophyll-*a*
	Salts			✓	High degree of salinisation in Middle Vaal River (impact of Upper Vaal WMA). Need to maintain fitness for use water quality requirements of use. Dilution rule in place. Need to manage salinity levels at acceptable levels to support downstream Lower Vaal River.	Electrical conductivity, Total Dissolved Solids
						Sulphate, Sodium, Chloride
	System variables			✓	Need to monitor system behaviour to maintain fitness for use.	pH
	Pathogens	✓			Need to maintain fitness for use for recreational and domestic users.	*Escherichia coli*
	Dam Habitat			✓	Need to manage habitat and ecosystem and water requirements of users.	Habitat Assessment
	Fish			✓	Serves as a refuge for a number of fish species. Must be monitored	Health assessment surveys and indicator species.
	Aquatic Birds			✓	The dam ecosystem supports birdlife in the area. The habitat must be managed to ensure that the bird populations are maintained.	Indicator bird species and population

APPENDIX B

RULE AND TAB TABLES FOR THE ECOLOGICAL WATER REQUIREMENT (EWR) SITES AND NODES

(TOTAL EWRs, TABULATED MONTHLY DISTRIBUTIONS AND RULE CURVES)

NODE	**MA.1**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R1**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC24

Annual Flows (Mill. cu. m or index values):

MAR	=	18.450
S.Dev.	=	16.493
CV	=	0.894
Q75	=	0.080
Q75/MMF	=	0.052
BFI Index	=	0.242
CV(JJA+JFM) Index	=	3.390

Ecological Category = C

Total IFR	=	6.230	(33.77 %MAR)
Maint. Lowflow	=	4.158	(22.54 %MAR)
Drought Lowflow	=	0.284	(1.54 %MAR)
Maint. Highflow	=	2.072	(11.23 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.353	3.409	2.519	0.233	0.020	0.163	0.396
Nov	3.266	7.447	2.281	0.523	0.010	0.357	0.880
Dec	2.980	3.990	1.339	0.580	0.020	0.179	0.759
Jan	3.677	4.308	1.172	0.742	0.050	0.824	1.566
Feb	2.848	4.313	1.515	0.693	0.020	0.179	0.872
Mar	2.144	4.596	2.144	0.572	0.030	0.228	0.800
Apr	0.913	1.741	1.908	0.312	0.020	0.085	0.398
May	0.243	0.295	1.211	0.137	0.010	0.000	0.137
Jun	0.146	0.140	0.956	0.097	0.020	0.000	0.097
Jul	0.196	0.579	2.947	0.086	0.028	0.000	0.086
Aug	0.172	0.248	1.437	0.075	0.026	0.000	0.075
Sep	0.511	2.581	5.048	0.108	0.030	0.057	0.165

NODE	MA.2
RIVER	Renoster
IUA	MA RENOSTER
RU	R1
RULE TABLE	RULE CURVES

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC24
Total Naturalised Runoff (MCM) : 18.45
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.194	0.188	0.175	0.145	0.089	0.029	0.012	0.009	0.008	0.005
Nov	0.623	0.531	0.442	0.346	0.220	0.138	0.070	0.036	0.022	0.003
Dec	0.465	0.413	0.354	0.280	0.185	0.112	0.058	0.026	0.017	0.010
Jan	1.151	0.955	0.773	0.588	0.351	0.219	0.123	0.072	0.053	0.013
Feb	0.580	0.519	0.447	0.355	0.236	0.124	0.072	0.034	0.019	0.010
Mar	0.395	0.379	0.345	0.287	0.120	0.085	0.060	0.033	0.020	0.008
Apr	0.207	0.201	0.187	0.153	0.089	0.059	0.041	0.021	0.011	0.002
May	0.071	0.069	0.053	0.024	0.018	0.010	0.008	0.006	0.003	0.002
Jun	0.052	0.046	0.033	0.022	0.014	0.010	0.009	0.008	0.005	0.002
Jul	0.045	0.037	0.025	0.016	0.013	0.010	0.008	0.007	0.006	0.003
Aug	0.039	0.038	0.027	0.018	0.015	0.011	0.008	0.007	0.006	0.004
Sep	0.084	0.052	0.036	0.017	0.010	0.009	0.008	0.008	0.006	0.005
Reserve Flows without High Flows										
Oct	0.121	0.118	0.110	0.093	0.068	0.029	0.011	0.008	0.007	0.005
Nov	0.278	0.267	0.242	0.199	0.144	0.087	0.040	0.016	0.007	0.003
Dec	0.299	0.285	0.257	0.210	0.149	0.089	0.044	0.018	0.010	0.008
Jan	0.382	0.365	0.329	0.269	0.191	0.116	0.061	0.032	0.021	0.013
Feb	0.395	0.378	0.340	0.278	0.197	0.098	0.057	0.024	0.011	0.009
Mar	0.295	0.282	0.257	0.212	0.065	0.048	0.038	0.020	0.012	0.008
Apr	0.168	0.163	0.151	0.122	0.073	0.051	0.033	0.014	0.008	0.002
May	0.071	0.069	0.053	0.024	0.018	0.010	0.008	0.006	0.003	0.002
Jun	0.052	0.046	0.033	0.022	0.014	0.010	0.009	0.008	0.005	0.002
Jul	0.045	0.037	0.025	0.016	0.013	0.010	0.008	0.007	0.006	0.003
Aug	0.039	0.038	0.027	0.018	0.015	0.011	0.008	0.007	0.006	0.004
Sep	0.058	0.032	0.025	0.014	0.010	0.008	0.007	0.006	0.006	0.005
Natural Duration curves										
Oct	1.878	0.493	0.250	0.157	0.097	0.045	0.030	0.019	0.011	0.007
Nov	2.735	1.767	1.196	0.764	0.513	0.247	0.112	0.077	0.031	0.004
Dec	3.274	1.949	1.064	0.795	0.523	0.411	0.265	0.123	0.049	0.011
Jan	3.659	1.908	1.725	1.206	0.963	0.564	0.399	0.187	0.153	0.019
Feb	3.547	1.914	1.306	0.632	0.492	0.327	0.203	0.145	0.058	0.012
Mar	2.009	1.139	0.657	0.448	0.217	0.161	0.127	0.067	0.037	0.011
Apr	0.841	0.586	0.274	0.166	0.123	0.077	0.058	0.035	0.023	0.008
May	0.287	0.161	0.093	0.056	0.045	0.030	0.026	0.019	0.007	0.004
Jun	0.139	0.081	0.062	0.042	0.035	0.031	0.027	0.023	0.015	0.008
Jul	0.105	0.078	0.052	0.045	0.037	0.026	0.026	0.022	0.019	0.011
Aug	0.131	0.082	0.063	0.052	0.041	0.034	0.026	0.022	0.019	0.015
Sep	0.154	0.081	0.066	0.042	0.035	0.027	0.023	0.019	0.015	0.012

NODE	**MA.2**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R1**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC25

Annual Flows (Mill. cu. m or index values):

MAR	=	25.532
S.Dev.	=	22.827
CV	=	0.894
Q75	=	0.110
Q75/MMF	=	0.052
BFI Index	=	0.242
CV(JJA+JFM) Index	=	3.392

Ecological Category = B/C

Total IFR	=	11.358 (44.49 %MAR)
Maint. Lowflow	=	8.128 (31.84 %MAR)
Drought Lowflow	=	0.390 (1.53 %MAR)
Maint. Highflow	=	3.230 (12.65 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.873	4.718	2.519	0.449	0.030	0.254	0.702
Nov	4.519	10.307	2.281	1.035	0.010	0.557	1.591
Dec	4.125	5.521	1.339	1.150	0.030	0.278	1.428
Jan	5.088	5.961	1.172	1.477	0.070	1.285	2.761
Feb	3.940	5.970	1.515	1.379	0.020	0.278	1.657
Mar	2.967	6.361	2.144	1.132	0.040	0.355	1.487
Apr	1.264	2.410	1.907	0.608	0.030	0.133	0.741
May	0.337	0.408	1.211	0.253	0.010	0.000	0.253
Jun	0.202	0.194	0.958	0.174	0.030	0.000	0.174
Jul	0.271	0.801	2.952	0.149	0.040	0.000	0.149
Aug	0.239	0.343	1.436	0.128	0.040	0.000	0.128
Sep	0.707	3.572	5.048	0.195	0.040	0.090	0.284

NODE	**MA.2**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R1**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC25
Total Naturalised Runoff (MCM) : 25.53
Regional Type : Vaal
Ecological Category : BC

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.327	0.317	0.296	0.183	0.093	0.032	0.010	0.002	0.001	0.001
Nov	1.052	0.906	0.759	0.596	0.383	0.238	0.118	0.057	0.034	0.000
Dec	0.814	0.729	0.628	0.498	0.331	0.199	0.101	0.044	0.016	0.001
Jan	1.909	1.599	1.304	0.996	0.600	0.370	0.203	0.114	0.081	0.001
Feb	1.023	0.923	0.799	0.635	0.423	0.220	0.122	0.053	0.022	0.005
Mar	0.697	0.668	0.607	0.489	0.144	0.126	0.098	0.040	0.021	0.001
Apr	0.365	0.354	0.329	0.190	0.109	0.077	0.056	0.029	0.016	0.001
May	0.123	0.119	0.082	0.037	0.025	0.013	0.009	0.007	0.002	0.001
Jun	0.088	0.065	0.047	0.035	0.020	0.014	0.014	0.012	0.006	0.002
Jul	0.073	0.053	0.040	0.025	0.018	0.013	0.011	0.008	0.007	0.002
Aug	0.063	0.061	0.038	0.027	0.021	0.016	0.010	0.007	0.006	0.004
Sep	0.138	0.069	0.042	0.020	0.015	0.011	0.009	0.007	0.006	0.001
Reserve Flows without High Flows										
Oct	0.219	0.212	0.197	0.145	0.090	0.032	0.010	0.002	0.001	0.001
Nov	0.515	0.493	0.447	0.368	0.265	0.159	0.071	0.027	0.010	0.000
Dec	0.554	0.530	0.477	0.389	0.276	0.163	0.079	0.031	0.005	0.001
Jan	0.712	0.680	0.612	0.498	0.352	0.209	0.106	0.051	0.030	0.001
Feb	0.735	0.702	0.632	0.507	0.362	0.181	0.098	0.038	0.010	0.001
Mar	0.546	0.523	0.475	0.376	0.130	0.089	0.064	0.021	0.005	0.001
Apr	0.306	0.297	0.276	0.183	0.109	0.074	0.051	0.019	0.010	0.001
May	0.123	0.119	0.082	0.037	0.025	0.013	0.009	0.007	0.002	0.001
Jun	0.088	0.065	0.047	0.035	0.020	0.014	0.014	0.012	0.006	0.002
Jul	0.073	0.053	0.040	0.025	0.018	0.013	0.011	0.008	0.007	0.002
Aug	0.063	0.061	0.038	0.027	0.021	0.016	0.010	0.007	0.006	0.004
Sep	0.098	0.044	0.037	0.020	0.014	0.009	0.007	0.004	0.004	0.001
Natural Duration curves										
Oct	2.599	0.683	0.347	0.217	0.134	0.060	0.041	0.026	0.015	0.011
Nov	3.785	2.446	1.655	1.057	0.710	0.340	0.154	0.108	0.042	0.004
Dec	4.533	2.699	1.475	1.101	0.724	0.568	0.366	0.172	0.067	0.015
Jan	5.063	2.643	2.386	1.669	1.333	0.780	0.553	0.258	0.213	0.026
Feb	4.911	2.646	1.806	0.876	0.678	0.451	0.281	0.198	0.079	0.017
Mar	2.778	1.576	0.907	0.620	0.299	0.224	0.175	0.093	0.052	0.015
Apr	1.165	0.810	0.378	0.231	0.170	0.108	0.081	0.050	0.031	0.012
May	0.399	0.224	0.131	0.078	0.060	0.041	0.034	0.026	0.011	0.004
Jun	0.193	0.112	0.085	0.058	0.050	0.042	0.039	0.031	0.023	0.012
Jul	0.146	0.108	0.075	0.063	0.052	0.037	0.037	0.030	0.026	0.015
Aug	0.179	0.116	0.090	0.071	0.056	0.049	0.037	0.030	0.026	0.022
Sep	0.212	0.112	0.089	0.058	0.046	0.035	0.031	0.027	0.023	0.015

NODE	**MA.3**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R2**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC26

Annual Flows (Mill. cu. m or index values):

MAR	=	2.118
S.Dev.	=	1.890
CV	=	0.892
Q75	=	0.010
Q75/MMF	=	0.057
BFI Index	=	0.242
CV(JJA+JFM) Index	=	3.349

Ecological Category = C

Total IFR	=	1.097 (51.79 %MAR)
Maint. Lowflow	=	0.860 (40.57 %MAR)
Drought Lowflow	=	0.010 (0.47 %MAR)
Maint. Highflow	=	0.238 (11.22 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.155	0.391	2.518	0.046	0.000	0.019	0.065
Nov	0.374	0.854	2.284	0.111	0.000	0.041	0.152
Dec	0.342	0.457	1.337	0.124	0.000	0.020	0.144
Jan	0.422	0.494	1.171	0.160	0.010	0.095	0.255
Feb	0.327	0.494	1.513	0.149	0.000	0.020	0.170
Mar	0.246	0.527	2.144	0.122	0.000	0.026	0.148
Apr	0.105	0.199	1.906	0.063	0.000	0.010	0.073
May	0.028	0.034	1.216	0.025	0.000	0.000	0.025
Jun	0.017	0.016	0.956	0.016	0.000	0.000	0.016
Jul	0.023	0.066	2.872	0.013	0.000	0.000	0.013
Aug	0.020	0.028	1.390	0.012	0.000	0.000	0.012
Sep	0.059	0.296	4.977	0.019	0.000	0.007	0.026

NODE	**MA.3**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R2**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC26
Total Naturalised Runoff (MCM) : 2.11
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.032	0.031	0.029	0.015	0.009	0.002	0.002	0.002	0.000	0.000
Nov	0.098	0.087	0.074	0.059	0.039	0.024	0.008	0.003	0.001	0.000
Dec	0.083	0.075	0.066	0.050	0.033	0.019	0.009	0.004	0.000	0.000
Jan	0.171	0.146	0.122	0.095	0.059	0.037	0.018	0.011	0.008	0.003
Feb	0.106	0.098	0.085	0.068	0.046	0.025	0.012	0.004	0.002	0.000
Mar	0.074	0.071	0.064	0.052	0.021	0.015	0.010	0.003	0.001	0.000
Apr	0.039	0.037	0.029	0.016	0.012	0.006	0.006	0.001	0.001	0.000
May	0.013	0.012	0.009	0.005	0.001	0.001	0.001	0.001	0.000	0.000
Jun	0.008	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.007	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.006	0.006	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.013	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Reserve Flows without High Flows										
Oct	0.024	0.023	0.022	0.015	0.009	0.001	0.001	0.001	0.000	0.000
Nov	0.059	0.056	0.051	0.042	0.030	0.018	0.005	0.002	0.001	0.000
Dec	0.064	0.061	0.055	0.042	0.029	0.017	0.007	0.003	0.000	0.000
Jan	0.082	0.079	0.071	0.058	0.041	0.025	0.012	0.007	0.004	0.003
Feb	0.085	0.081	0.073	0.059	0.041	0.022	0.011	0.002	0.001	0.000
Mar	0.063	0.060	0.054	0.045	0.021	0.015	0.008	0.002	0.000	0.000
Apr	0.034	0.033	0.029	0.016	0.012	0.005	0.005	0.001	0.001	0.000
May	0.013	0.012	0.009	0.005	0.001	0.001	0.001	0.001	0.000	0.000
Jun	0.008	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.007	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.006	0.006	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.010	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Duration curves										
Oct	0.217	0.056	0.030	0.019	0.011	0.004	0.004	0.004	0.000	0.000
Nov	0.313	0.204	0.139	0.089	0.058	0.027	0.012	0.008	0.004	0.000
Dec	0.377	0.224	0.123	0.090	0.060	0.049	0.030	0.015	0.004	0.000
Jan	0.418	0.220	0.198	0.138	0.112	0.063	0.045	0.022	0.019	0.004
Feb	0.405	0.219	0.149	0.074	0.058	0.037	0.025	0.017	0.008	0.000
Mar	0.231	0.131	0.075	0.052	0.026	0.019	0.015	0.007	0.004	0.000
Apr	0.096	0.066	0.031	0.019	0.015	0.008	0.008	0.004	0.004	0.000
May	0.034	0.019	0.011	0.007	0.004	0.004	0.004	0.004	0.000	0.000
Jun	0.015	0.008	0.008	0.004	0.004	0.004	0.004	0.004	0.000	0.000
Jul	0.011	0.007	0.007	0.004	0.004	0.004	0.004	0.004	0.004	0.000
Aug	0.015	0.011	0.007	0.007	0.004	0.004	0.004	0.004	0.004	0.000
Sep	0.019	0.008	0.008	0.004	0.004	0.004	0.004	0.004	0.004	0.000

NODE	**MA.4**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R4**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : EEWR_R

Annual Flows (Mill. cu. m or index values):

MAR	=	63.855
S.Dev.	=	55.916
CV	=	0.876
Q75	=	0.320
Q75/MMF	=	0.060
BFI Index	=	0.248
CV(JJA+JFM) Index	=	3.248

Ecological Category = C

Total IFR	=	18.404	(28.82 %MAR)
Maint. Lowflow	=	11.287	(17.68 %MAR)
Drought Lowflow	=	1.154	(1.81 %MAR)
Maint. Highflow	=	7.117	(11.15 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	4.536	11.222	2.474	0.629	0.080	0.541	1.171
Nov	10.907	24.674	2.262	1.349	0.060	1.212	2.561
Dec	10.063	13.325	1.324	1.501	0.090	0.606	2.107
Jan	12.581	14.927	1.186	1.925	0.180	2.811	4.735
Feb	9.994	14.760	1.477	1.833	0.060	0.606	2.439
Mar	7.866	16.115	2.049	1.578	0.120	0.838	2.415
Apr	3.349	5.977	1.785	0.903	0.080	0.309	1.212
May	0.951	1.180	1.241	0.432	0.070	0.000	0.432
Jun	0.543	0.503	0.928	0.306	0.100	0.000	0.306
Jul	0.683	1.859	2.722	0.268	0.102	0.000	0.268
Aug	0.614	0.849	1.383	0.241	0.094	0.000	0.241
Sep	1.767	8.741	4.945	0.323	0.118	0.195	0.518

NODE	MA.4
RIVER	Renoster
IUA	MA RENOSTER
RU	R4
RULE TABLE	RULE CURVES

Desktop Version 2, Generated on 2011/08/24
Summary of IFR rule curves (Desktop Version 2) for :
Total Runoff : Runoff : EEWR_R
Regional Type : Vaal
Ecological Category = C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.568	0.551	0.515	0.452	0.361	0.157	0.108	0.071	0.045	0.030
Nov	1.886	1.586	1.305	1.014	0.634	0.406	0.229	0.126	0.083	0.023
Dec	1.338	1.173	0.995	0.785	0.513	0.319	0.174	0.094	0.064	0.049
Jan	3.612	2.959	2.372	1.793	1.050	0.666	0.387	0.239	0.184	0.075
Feb	1.670	1.479	1.262	0.997	0.654	0.397	0.205	0.100	0.060	0.050
Mar	1.183	1.135	1.034	0.864	0.641	0.412	0.235	0.132	0.089	0.049
Apr	0.627	0.608	0.568	0.496	0.394	0.274	0.165	0.090	0.053	0.046
May	0.225	0.219	0.205	0.182	0.148	0.107	0.070	0.044	0.030	0.026
Jun	0.165	0.161	0.153	0.139	0.118	0.094	0.070	0.052	0.042	0.039
Jul	0.140	0.137	0.131	0.120	0.103	0.084	0.064	0.050	0.042	0.039
Aug	0.126	0.123	0.117	0.107	0.092	0.074	0.057	0.045	0.038	0.036
Sep	0.264	0.257	0.224	0.158	0.123	0.093	0.081	0.069	0.058	0.046
Reserve Flows without High Flows										
Oct	0.328	0.318	0.297	0.261	0.209	0.148	0.092	0.054	0.035	0.030
Nov	0.718	0.688	0.625	0.518	0.378	0.234	0.123	0.058	0.031	0.023
Dec	0.773	0.739	0.668	0.548	0.394	0.240	0.126	0.064	0.040	0.038
Jan	0.992	0.949	0.856	0.703	0.506	0.314	0.175	0.101	0.073	0.073
Feb	1.045	0.998	0.900	0.735	0.521	0.310	0.152	0.066	0.033	0.031
Mar	0.813	0.780	0.710	0.592	0.437	0.278	0.155	0.084	0.054	0.049
Apr	0.486	0.471	0.439	0.384	0.304	0.211	0.126	0.068	0.039	0.034
May	0.225	0.219	0.205	0.182	0.148	0.107	0.070	0.044	0.030	0.026
Jun	0.165	0.161	0.153	0.139	0.118	0.094	0.070	0.052	0.042	0.039
Jul	0.140	0.137	0.131	0.120	0.103	0.084	0.064	0.050	0.042	0.039
Aug	0.126	0.123	0.117	0.107	0.092	0.074	0.057	0.045	0.038	0.036
Sep	0.174	0.170	0.161	0.146	0.123	0.093	0.074	0.057	0.048	0.046
Natural Duration curves										
Oct	6.119	1.665	0.806	0.560	0.396	0.157	0.108	0.071	0.045	0.030
Nov	9.641	5.930	3.943	2.531	1.786	0.837	0.382	0.289	0.127	0.023
Dec	10.794	6.399	3.543	2.718	1.740	1.393	0.963	0.455	0.217	0.049
Jan	12.074	6.728	5.742	4.394	3.166	1.841	1.505	0.620	0.523	0.075
Feb	11.859	6.572	4.336	2.220	1.811	1.290	0.748	0.546	0.281	0.050
Mar	7.217	4.185	2.998	1.538	0.967	0.612	0.459	0.314	0.198	0.049
Apr	3.302	2.079	0.945	0.629	0.467	0.355	0.255	0.170	0.127	0.050
May	1.019	0.653	0.325	0.224	0.164	0.116	0.090	0.071	0.056	0.026
Jun	0.463	0.285	0.212	0.150	0.131	0.120	0.108	0.093	0.077	0.050
Jul	0.373	0.287	0.213	0.161	0.134	0.108	0.093	0.086	0.071	0.056
Aug	0.470	0.306	0.220	0.179	0.142	0.123	0.097	0.075	0.071	0.056
Sep	0.532	0.262	0.224	0.158	0.123	0.093	0.081	0.069	0.062	0.046

NODE	**MA.6**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R4**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : EEWR_R

Annual Flows (Mill. cu. m or index values):

MAR	=	93.141
S.Dev.	=	77.763
CV	=	0.835
Q75	=	0.540
Q75/MMF	=	0.070
BFI Index	=	0.263
CV(JJA+JFM) Index	=	2.948

Ecological Category = C

Total IFR	=	25.413	(27.28 %MAR)
Maint. Lowflow	=	15.238	(16.36 %MAR)
Drought Lowflow	=	1.900	(2.04 %MAR)
Maint. Highflow	=	10.174	(10.92 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	5.756	13.164	2.287	0.752	0.100	0.668	1.419
Nov	13.668	29.849	2.184	1.572	0.160	1.644	3.216
Dec	13.262	16.902	1.274	1.810	0.260	0.822	2.632
Jan	17.618	22.949	1.303	2.421	0.220	3.905	6.326
Feb	15.384	21.621	1.405	2.469	0.160	0.822	3.291
Mar	13.936	25.922	1.860	2.354	0.130	1.517	3.871
Apr	5.915	9.017	1.524	1.477	0.230	0.528	2.004
May	1.994	3.049	1.529	0.758	0.070	0.000	0.758
Jun	0.996	0.962	0.965	0.456	0.130	0.000	0.456
Jul	1.027	1.929	1.879	0.384	0.190	0.000	0.384
Aug	1.010	1.447	1.433	0.350	0.100	0.000	0.350
Sep	2.575	11.573	4.495	0.434	0.150	0.268	0.703

NODE	**MA.6**
RIVER	**Renoster**
IUA	**MA RENOSTER**
RU	**R4**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Generated on 2011/08/24
Summary of IFR rule curves (Desktop Version 2) for :
Total Runoff : Runoff : EEWR_R
Regional Type : Vaal
Ecological Category = C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.688	0.667	0.624	0.548	0.438	0.287	0.157	0.108	0.074	0.041
Nov	2.422	2.022	1.656	1.287	0.806	0.531	0.317	0.193	0.141	0.066
Dec	1.700	1.484	1.259	1.001	0.667	0.437	0.266	0.173	0.137	0.119
Jan	4.888	3.986	3.182	2.398	1.390	0.882	0.512	0.316	0.243	0.116
Feb	2.257	1.999	1.709	1.356	0.899	0.559	0.305	0.167	0.113	0.091
Mar	1.882	1.805	1.643	1.371	1.012	0.645	0.360	0.195	0.126	0.052
Apr	1.037	1.007	0.942	0.829	0.666	0.477	0.303	0.184	0.126	0.115
May	0.395	0.383	0.358	0.314	0.251	0.177	0.108	0.059	0.034	0.028
Jun	0.246	0.240	0.228	0.206	0.174	0.135	0.098	0.071	0.056	0.051
Jul	0.201	0.197	0.189	0.175	0.154	0.129	0.105	0.086	0.075	0.072
Aug	0.183	0.178	0.169	0.153	0.129	0.100	0.073	0.053	0.042	0.038
Sep	0.358	0.348	0.329	0.239	0.189	0.143	0.132	0.094	0.075	0.066
Reserve Flows without High Flows										
Oct	0.392	0.380	0.355	0.312	0.250	0.178	0.112	0.066	0.044	0.040
Nov	0.838	0.804	0.733	0.614	0.458	0.298	0.173	0.101	0.071	0.066
Dec	0.934	0.896	0.815	0.680	0.504	0.331	0.202	0.131	0.104	0.102
Jan	1.247	1.193	1.077	0.884	0.636	0.394	0.217	0.124	0.090	0.090
Feb	1.408	1.347	1.217	1.001	0.720	0.441	0.234	0.121	0.077	0.075
Mar	1.213	1.163	1.057	0.878	0.643	0.403	0.216	0.108	0.062	0.052
Apr	0.795	0.772	0.723	0.637	0.513	0.368	0.237	0.146	0.102	0.093
May	0.395	0.383	0.358	0.314	0.251	0.177	0.108	0.059	0.034	0.028
Jun	0.246	0.240	0.228	0.206	0.174	0.135	0.098	0.071	0.056	0.051
Jul	0.201	0.197	0.189	0.175	0.154	0.129	0.105	0.086	0.075	0.072
Aug	0.183	0.178	0.169	0.153	0.129	0.100	0.073	0.053	0.042	0.038
Sep	0.235	0.229	0.217	0.196	0.166	0.130	0.097	0.074	0.062	0.059
Natural Duration curves										
Oct	6.649	2.221	1.053	0.806	0.519	0.287	0.157	0.108	0.086	0.041
Nov	14.186	6.759	5.185	3.538	2.049	1.154	0.640	0.448	0.231	0.066
Dec	15.356	7.508	4.984	3.749	2.434	1.882	1.449	0.650	0.329	0.119
Jan	15.226	9.330	7.015	5.836	4.641	2.961	1.841	1.101	0.739	0.116
Feb	19.647	9.553	6.188	3.679	2.687	1.992	1.529	0.823	0.463	0.091
Mar	12.082	7.967	4.622	2.707	1.897	1.086	0.844	0.590	0.310	0.052
Apr	6.181	3.326	2.716	1.142	0.829	0.610	0.517	0.374	0.228	0.131
May	1.807	0.974	0.728	0.418	0.306	0.250	0.194	0.157	0.105	0.056
Jun	0.829	0.490	0.428	0.309	0.266	0.216	0.197	0.162	0.139	0.077
Jul	0.638	0.489	0.385	0.280	0.224	0.187	0.164	0.153	0.131	0.078
Aug	0.806	0.489	0.332	0.280	0.220	0.183	0.157	0.138	0.127	0.101
Sep	0.795	0.502	0.343	0.239	0.189	0.143	0.135	0.120	0.108	0.066

NODE	**MA.8**
RIVER	**Rietspruit**
IUA	**MA RENOSTER**
RU	**R5**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC30

Annual Flows (Mill. cu. m or index values):

MAR	=	120.918
S.Dev.	=	100.510
CV	=	0.831
Q75	=	0.760
Q75/MMF	=	0.075
BFI Index	=	0.269
CV(JJA+JFM) Index	=	2.854

Ecological Category = C

Total IFR	=	31.578	(26.12 %MAR)
Maint. Lowflow	=	18.477	(15.28 %MAR)
Drought Lowflow	=	2.320	(1.92 %MAR)
Maint. Highflow	=	13.101	(10.83 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	6.905	14.966	2.167	0.864	0.100	0.787	1.650
Nov	16.399	35.094	2.140	1.775	0.260	2.058	3.833
Dec	16.363	20.484	1.252	2.074	0.330	1.029	3.103
Jan	22.571	31.693	1.404	2.839	0.220	4.981	7.820
Feb	20.377	28.636	1.405	2.968	0.270	1.029	3.997
Mar	19.573	35.677	1.823	2.940	0.130	2.157	5.098
Apr	8.239	12.035	1.461	1.895	0.370	0.733	2.628
May	2.983	4.923	1.651	1.021	0.070	0.000	1.021
Jun	1.453	1.440	0.991	0.601	0.130	0.000	0.601
Jul	1.393	2.066	1.483	0.501	0.190	0.000	0.501
Aug	1.393	2.025	1.454	0.462	0.100	0.000	0.462
Sep	3.268	13.743	4.205	0.538	0.150	0.327	0.865

NODE	**MA.8**
RIVER	**Rietspruit**
IUA	**MA RENOSTER**
RU	**R5**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Generated on 2011/08/24
Summary of IFR rule curves (Desktop Version 2) for :
Total Runoff : Runoff : VVC30
Regional Type : Vaal
Ecological Category = C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.799	0.775	0.724	0.635	0.506	0.357	0.213	0.126	0.080	0.060
Nov	2.930	2.434	1.988	1.545	0.968	0.649	0.402	0.258	0.198	0.100
Dec	2.029	1.763	1.492	1.184	0.787	0.521	0.322	0.214	0.172	0.170
Jan	6.106	4.961	3.946	2.963	1.700	1.074	0.618	0.377	0.287	0.161
Feb	2.756	2.437	2.085	1.658	1.107	0.701	0.399	0.234	0.170	0.132
Mar	2.466	2.365	2.152	1.793	1.321	0.840	0.465	0.248	0.157	0.052
Apr	1.357	1.318	1.236	1.091	0.883	0.641	0.419	0.267	0.193	0.179
May	0.532	0.515	0.481	0.421	0.335	0.233	0.138	0.071	0.037	0.029
Jun	0.324	0.315	0.298	0.267	0.223	0.169	0.117	0.079	0.058	0.052
Jul	0.262	0.256	0.244	0.224	0.193	0.156	0.120	0.093	0.078	0.072
Aug	0.241	0.235	0.222	0.199	0.166	0.126	0.087	0.059	0.043	0.039
Sep	0.440	0.428	0.403	0.320	0.262	0.208	0.152	0.103	0.079	0.066
Reserve Flows without High Flows										
Oct	0.450	0.436	0.407	0.357	0.285	0.201	0.124	0.071	0.045	0.040
Nov	0.946	0.910	0.833	0.703	0.532	0.357	0.222	0.143	0.110	0.100
Dec	1.070	1.027	0.935	0.782	0.584	0.388	0.242	0.162	0.131	0.129
Jan	1.462	1.398	1.261	1.032	0.738	0.451	0.242	0.132	0.091	0.091
Feb	1.693	1.622	1.469	1.213	0.882	0.554	0.309	0.176	0.124	0.122
Mar	1.515	1.452	1.318	1.093	0.797	0.494	0.259	0.123	0.066	0.052
Apr	1.021	0.992	0.931	0.824	0.670	0.491	0.327	0.214	0.159	0.148
May	0.532	0.515	0.481	0.421	0.335	0.233	0.138	0.071	0.037	0.029
Jun	0.324	0.315	0.298	0.267	0.223	0.169	0.117	0.079	0.058	0.052
Jul	0.262	0.256	0.244	0.224	0.193	0.156	0.120	0.093	0.078	0.072
Aug	0.241	0.235	0.222	0.199	0.166	0.126	0.087	0.059	0.043	0.039
Sep	0.290	0.283	0.267	0.240	0.200	0.153	0.109	0.079	0.063	0.059
Natural Duration curves										
Oct	9.099	2.584	1.408	0.937	0.668	0.358	0.213	0.146	0.119	0.060
Nov	16.134	7.508	5.648	3.765	2.724	1.308	0.880	0.556	0.343	0.100
Dec	20.650	8.557	6.874	4.499	3.114	2.416	1.912	0.769	0.377	0.183
Jan	20.423	11.809	9.722	6.537	5.421	3.976	2.221	1.534	0.937	0.161
Feb	25.265	13.248	7.548	4.981	3.596	2.517	2.145	1.062	0.699	0.132
Mar	16.256	9.412	6.347	3.719	3.032	1.773	1.206	0.866	0.429	0.052
Apr	8.993	5.093	3.538	1.744	1.223	0.856	0.698	0.536	0.324	0.193
May	2.740	1.643	0.870	0.571	0.463	0.355	0.276	0.228	0.164	0.056
Jun	1.235	0.822	0.575	0.428	0.382	0.301	0.266	0.228	0.204	0.077
Jul	1.057	0.694	0.526	0.388	0.306	0.261	0.235	0.213	0.187	0.082
Aug	1.038	0.687	0.429	0.362	0.295	0.254	0.224	0.202	0.172	0.127
Sep	1.292	0.702	0.417	0.320	0.262	0.208	0.189	0.177	0.154	0.066

NODE	**MB3**
RIVER	**Vals**
IUA	**MB VALS RIVER**
RU	**V2**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC35

Annual Flows (Mill. cu. m or index values):

MAR	=	131.706
S.Dev.	=	130.466
CV	=	0.991
Q75	=	0.430
Q75/MMF	=	0.039
BFI Index	=	0.255
CV(JJA+JFM) Index	=	3.514

Ecological Category = C

Total IFR	=	33.464	(25.41 %MAR)
Maint. Lowflow	=	18.699	(14.20 %MAR)
Drought Lowflow	=	0.830	(0.63 %MAR)
Maint. Highflow	=	14.765	(11.21 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	7.382	16.727	2.266	0.857	0.070	0.862	1.719
Nov	16.599	36.137	2.177	1.725	0.020	2.206	3.931
Dec	18.851	28.075	1.489	2.225	0.000	1.103	3.327
Jan	25.490	42.452	1.665	3.090	0.100	5.663	8.752
Feb	20.404	30.936	1.516	3.018	0.170	1.103	4.120
Mar	21.723	42.257	1.945	3.068	0.140	2.477	5.545
Apr	7.700	12.758	1.657	1.793	0.000	0.680	2.473
May	3.027	6.211	2.051	0.955	0.100	0.000	0.955
Jun	1.405	1.933	1.376	0.516	0.100	0.000	0.516
Jul	1.155	1.640	1.421	0.359	0.020	0.000	0.359
Aug	2.146	5.621	2.619	0.420	0.110	0.000	0.420
Sep	5.825	29.715	5.102	0.674	0.000	0.672	1.346

NODE	**MB3**
RIVER	**Vals**
IUA	**MB VALS RIVER**
RU	**V2**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC35
Total Naturalised Runoff (MCM) : 131.71
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.828	0.803	0.750	0.366	0.243	0.045	0.038	0.022	0.012	0.005
Nov	3.043	2.512	2.034	1.558	0.939	0.393	0.193	0.123	0.094	0.000
Dec	2.173	1.882	1.578	1.228	0.775	0.462	0.214	0.055	0.044	0.004
Jan	6.869	5.568	4.416	3.301	1.869	1.161	0.645	0.372	0.223	0.028
Feb	2.859	2.520	2.146	1.696	1.115	0.689	0.372	0.062	0.048	0.026
Mar	2.673	2.564	2.333	1.945	1.434	0.913	0.248	0.143	0.105	0.001
Apr	1.275	1.234	1.147	0.995	0.449	0.212	0.086	0.049	0.031	0.028
May	0.498	0.483	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jun	0.278	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.187	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.219	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.671	0.307	0.041	0.036	0.020	0.005	0.000	0.000	0.000	0.000
Reserve Flows without High Flows										
Oct	0.446	0.432	0.403	0.062	0.000	0.000	0.000	0.000	0.000	0.000
Nov	0.918	0.879	0.796	0.656	0.472	0.080	0.000	0.000	0.000	0.000
Dec	1.145	1.093	0.982	0.797	0.557	0.320	0.130	0.000	0.000	0.000
Jan	1.590	1.518	1.363	1.106	0.775	0.452	0.218	0.093	0.000	0.000
Feb	1.721	1.646	1.486	1.219	0.874	0.532	0.277	0.000	0.000	0.000
Mar	1.581	1.515	1.375	1.141	0.832	0.517	0.012	0.000	0.000	0.000
Apr	0.964	0.932	0.865	0.748	0.267	0.091	0.000	0.000	0.000	0.000
May	0.498	0.483	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jun	0.278	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.187	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.219	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.362	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Duration curves										
Oct	7.355	3.118	2.016	0.941	0.642	0.202	0.127	0.105	0.063	0.034
Nov	18.804	7.103	4.537	2.701	1.956	0.957	0.544	0.328	0.116	0.012
Dec	23.271	11.570	5.981	4.122	3.132	1.953	1.064	0.437	0.265	0.011
Jan	27.487	12.000	10.159	6.388	4.454	2.655	1.654	1.038	0.538	0.075
Feb	28.423	12.405	8.019	4.948	4.398	3.270	1.286	0.690	0.236	0.107
Mar	23.410	8.303	5.936	4.137	3.398	1.654	0.665	0.500	0.299	0.063
Apr	9.394	4.483	2.400	1.721	1.038	0.787	0.451	0.228	0.131	0.035
May	3.659	1.557	0.859	0.485	0.276	0.194	0.142	0.123	0.101	0.063
Jun	1.844	0.729	0.490	0.289	0.251	0.181	0.147	0.116	0.077	0.042
Jul	1.277	0.568	0.362	0.258	0.194	0.153	0.127	0.108	0.075	0.011
Aug	2.718	0.571	0.362	0.299	0.228	0.168	0.134	0.108	0.097	0.067
Sep	2.778	0.826	0.274	0.185	0.162	0.139	0.108	0.077	0.066	0.000

EWR SITE	**EWR 14**
RIVER	**Vals**
IUA	**MB VALS RIVER**
RU	**V5**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Printed on 04/12/2009
Summary of IFR estimate for: EWR3 Cum Natural Flows
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):

MAR	=	145.794
S.Dev.	=	144.419
CV	=	0.991
Q75	=	0.470
Q75/MMF	=	0.039
BFI Index	=	0.255
CV(JJA+JFM) Index	=	3.513

ERC = C/D

Total IFR	=	24.849	(17.04 %MAR)
Maint. Lowflow	=	7.880	(5.41 %MAR)
Drought Lowflow	=	0.123	(0.08 %MAR)
Maint. Highflow	=	16.969	(11.64 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.051	6.912	0.846	0.153	0.003	0.000	0.153
Nov	7.089	15.431	0.840	0.276	0.005	1.653	1.929
Dec	7.791	11.603	0.556	0.333	0.006	0.000	0.333
Jan	10.535	17.544	0.622	0.447	0.008	0.697	1.144
Feb	9.336	14.155	0.627	0.484	0.008	2.700	3.184
Mar	8.977	17.464	0.726	0.444	0.008	1.600	2.044
Apr	3.288	5.448	0.639	0.285	0.000	0.000	0.285
May	1.251	2.567	0.766	0.166	0.003	0.000	0.166
Jun	0.600	0.825	0.530	0.112	0.002	0.000	0.112
Jul	0.477	0.677	0.530	0.087	0.002	0.000	0.087
Aug	0.887	2.323	0.978	0.095	0.002	0.000	0.095
Sep	2.487	12.690	1.968	0.133	0.000	0.000	0.133

EWR SITE	**EWR 14**
RIVER	**Vals**
IUA	**MB VALS RIVER**
RU	**V5**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Printed on 04/12/2009
Summary of IFR rule curves for : EWR3 Cum Natural Flows
Determination based on defined BBM Table with site specific assurance rules.
Regional Type : Vaal ERC = C/D

Data are given in m^3/s mean monthly flow

	% Points								
Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.225	0.223	0.206	0.163	0.102	0.048	0.019	0.007	0.004	0.004
Nov	5.875	4.119	2.083	1.886	1.22	0.551	0.268	0.196	0.089	0.019
Dec	0.602	0.602	0.602	0.602	0.559	0.383	0.14	0.025	0.01	0.01
Jan	3.444	2.505	1.599	1.599	1.599	0.783	0.309	0.088	0.087	0.078
Feb	10.249	6.992	3.56	3.56	2.798	1.067	0.41	0.307	0.24	0.112
Mar	2.774	2.774	2.774	2.506	1.598	0.686	0.301	0.203	0.184	0.063
Apr	0.42	0.42	0.404	0.348	0.241	0.125	0.048	0.014	0.004	0.003
May	0.226	0.224	0.211	0.177	0.124	0.069	0.031	0.013	0.006	0.004
Jun	0.128	0.124	0.114	0.096	0.07	0.044	0.022	0.01	0.005	0.003
Jul	0.086	0.083	0.078	0.07	0.057	0.041	0.025	0.013	0.006	0.003
Aug	0.109	0.106	0.097	0.081	0.06	0.037	0.019	0.009	0.004	0.003
Sep	0.181	0.176	0.158	0.122	0.077	0.038	0.015	0.005	0.002	0
Reserve flows without High Flows										
Oct	0.225	0.222	0.205	0.163	0.101	0.048	0.018	0.007	0.004	0.004
Nov	0.439	0.439	0.439	0.417	0.336	0.194	0.073	0.02	0.008	0.008
Dec	0.602	0.602	0.602	0.602	0.559	0.383	0.14	0.025	0.01	0.01
Jan	0.906	0.906	0.906	0.906	0.906	0.783	0.309	0.025	0.013	0.013
Feb	0.875	0.875	0.875	0.875	0.812	0.556	0.203	0.037	0.014	0.014
Mar	0.706	0.706	0.706	0.671	0.54	0.312	0.118	0.033	0.012	0.012
Apr	0.42	0.42	0.404	0.348	0.241	0.125	0.048	0.014	0.004	0.003
May	0.226	0.224	0.21	0.177	0.123	0.069	0.031	0.013	0.006	0.004
Jun	0.128	0.124	0.114	0.095	0.07	0.043	0.022	0.01	0.005	0.003
Jul	0.086	0.083	0.078	0.07	0.057	0.041	0.025	0.013	0.005	0.002
Aug	0.109	0.106	0.097	0.081	0.06	0.037	0.019	0.009	0.004	0.002
Sep	0.181	0.176	0.158	0.122	0.077	0.038	0.015	0.005	0.002	0
Natural Duration curves										
Oct	6.526	3.446	2.165	1.038	0.470	0.220	0.127	0.116	0.063	0.037
Nov	16.451	7.863	4.641	2.986	2.025	1.057	0.590	0.363	0.089	0.019
Dec	24.937	12.810	6.287	4.559	3.256	2.158	1.169	0.485	0.243	0.019
Jan	21.315	13.280	10.652	7.068	4.540	2.938	1.736	1.150	0.582	0.078
Feb	30.448	13.732	8.800	5.473	4.791	3.617	1.331	0.765	0.240	0.112
Mar	25.620	9.188	6.340	4.577	3.592	1.826	0.657	0.553	0.265	0.063
Apr	9.765	4.961	2.616	1.906	1.092	0.872	0.432	0.251	0.139	0.042
May	3.125	1.725	0.926	0.538	0.287	0.213	0.157	0.138	0.105	0.060
Jun	1.921	0.806	0.509	0.320	0.266	0.201	0.158	0.131	0.093	0.050
Jul	1.273	0.624	0.377	0.280	0.209	0.164	0.134	0.123	0.086	0.019
Aug	2.020	0.631	0.385	0.325	0.254	0.183	0.146	0.123	0.101	0.075
Sep	2.608	0.914	0.285	0.208	0.177	0.150	0.120	0.093	0.069	0.000

NODE	**MC5**
RIVER	**Koekemoerspruit**
IUA	**MC SCHOONSPRUIT**
RU	**SK1**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/18
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC22

Annual Flows (Mill. cu. m or index values):

MAR	=	26.190
S.Dev.	=	31.684
CV	=	1.210
Q75	=	0.060
Q75/MMF	=	0.027
BFI Index	=	0.223
CV(JJA+JFM) Index	=	4.283

Ecological Category = D

Total IFR	=	4.691	(17.91 %MAR)
Maint. Lowflow	=	2.168	(8.28 %MAR)
Drought Lowflow	=	0.180	(0.69 %MAR)
Maint. Highflow	=	2.523	(9.63 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.664	1.544	2.324	0.054	0.010	0.065	0.119
Nov	1.574	2.973	1.889	0.106	0.010	0.254	0.360
Dec	2.147	2.706	1.260	0.153	0.030	0.127	0.280
Jan	4.183	8.532	2.039	0.278	0.030	0.127	0.405
Feb	5.889	12.130	2.060	0.407	0.040	0.954	1.361
Mar	7.627	17.204	2.256	0.539	0.040	0.764	1.302
Apr	2.692	5.707	2.120	0.323	0.000	0.225	0.548
May	0.756	2.741	3.623	0.135	0.010	0.000	0.135
Jun	0.245	0.757	3.083	0.063	0.010	0.000	0.063
Jul	0.177	0.252	1.430	0.048	0.000	0.000	0.048
Aug	0.121	0.239	1.982	0.037	0.000	0.000	0.037
Sep	0.113	0.300	2.644	0.027	0.000	0.006	0.033

NODE	MC5
RIVER	Koekemoerspruit
IUA	MC SCHOONSPRUIT
RU	SK1
RULE TABLE	RULE CURVES

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC22
Total Naturalised Runoff (MCM) : 26.19
Regional Type : Vaal
Ecological Category : D

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.069	0.067	0.062	0.051	0.013	0.012	0.010	0.005	0.004	0.004
Nov	0.315	0.255	0.204	0.155	0.087	0.060	0.036	0.020	0.011	0.005
Dec	0.216	0.185	0.154	0.121	0.075	0.052	0.032	0.021	0.017	0.007
Jan	0.295	0.254	0.221	0.174	0.114	0.071	0.040	0.023	0.017	0.007
Feb	1.272	1.030	0.819	0.617	0.356	0.228	0.133	0.078	0.058	0.014
Mar	0.725	0.696	0.633	0.529	0.391	0.251	0.141	0.078	0.051	0.008
Apr	0.339	0.328	0.305	0.265	0.187	0.123	0.078	0.035	0.015	0.011
May	0.089	0.086	0.045	0.030	0.022	0.017	0.013	0.011	0.005	0.002
Jun	0.043	0.041	0.025	0.020	0.016	0.014	0.012	0.006	0.005	0.002
Jul	0.031	0.031	0.025	0.013	0.012	0.012	0.006	0.001	0.001	0.000
Aug	0.024	0.024	0.015	0.009	0.008	0.008	0.006	0.001	0.000	0.000
Sep	0.022	0.018	0.012	0.007	0.007	0.004	0.004	0.000	0.000	0.000
Reserve Flows without High Flows										
Oct	0.035	0.034	0.032	0.024	0.008	0.005	0.004	0.001	0.001	0.001
Nov	0.070	0.067	0.061	0.051	0.035	0.024	0.013	0.007	0.002	0.001
Dec	0.097	0.094	0.085	0.071	0.051	0.035	0.022	0.015	0.012	0.002
Jan	0.177	0.167	0.152	0.125	0.090	0.055	0.030	0.017	0.012	0.002
Feb	0.287	0.274	0.248	0.205	0.148	0.092	0.050	0.027	0.019	0.007
Mar	0.342	0.328	0.298	0.248	0.182	0.115	0.062	0.032	0.019	0.006
Apr	0.220	0.212	0.197	0.170	0.118	0.070	0.046	0.018	0.004	0.001
May	0.089	0.086	0.045	0.030	0.022	0.017	0.013	0.011	0.005	0.002
Jun	0.043	0.041	0.025	0.020	0.016	0.014	0.012	0.006	0.005	0.002
Jul	0.031	0.031	0.025	0.013	0.012	0.012	0.006	0.001	0.001	0.000
Aug	0.024	0.024	0.015	0.009	0.008	0.008	0.006	0.001	0.000	0.000
Sep	0.018	0.015	0.010	0.006	0.006	0.004	0.004	0.000	0.000	0.000
Natural Duration curves										
Oct	0.657	0.280	0.131	0.056	0.026	0.022	0.019	0.015	0.011	0.007
Nov	1.806	0.837	0.475	0.289	0.177	0.089	0.066	0.031	0.015	0.008
Dec	2.292	1.217	0.907	0.564	0.485	0.343	0.209	0.123	0.045	0.019
Jan	3.203	1.919	1.445	0.885	0.683	0.459	0.336	0.179	0.090	0.019
Feb	8.573	2.604	1.376	1.095	0.938	0.397	0.223	0.128	0.058	0.025
Mar	7.680	3.118	1.729	1.221	0.646	0.422	0.258	0.112	0.067	0.019
Apr	2.469	1.439	0.687	0.370	0.204	0.147	0.104	0.054	0.035	0.012
May	0.482	0.168	0.093	0.060	0.045	0.037	0.030	0.026	0.019	0.007
Jun	0.204	0.085	0.054	0.042	0.035	0.031	0.027	0.019	0.015	0.008
Jul	0.198	0.090	0.052	0.030	0.026	0.026	0.022	0.019	0.015	0.004
Aug	0.119	0.056	0.034	0.022	0.022	0.022	0.019	0.011	0.007	0.004
Sep	0.085	0.039	0.027	0.019	0.019	0.015	0.015	0.004	0.004	0.000

NODE	**MC2**
RIVER	**Taaibosspruit**
IUA	**MC SCHOONSPRUIT**
RU	**SK3**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC21

Annual Flows (Mill. cu. m or index values):

MAR	=	19.502
S.Dev.	=	29.851
CV	=	1.531
Q75	=	0.090
Q75/MMF	=	0.055
BFI Index	=	0.223
CV(JJA+JFM) Index	=	4.628

Ecological Category = C

Total IFR	=	4.147 (21.27 %MAR)
Maint. Lowflow	=	1.862 (9.55 %MAR)
Drought Lowflow	=	0.420 (2.15 %MAR)
Maint. Highflow	=	2.286 (11.72 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.494	3.294	6.662	0.064	0.020	0.056	0.120
Nov	0.579	1.463	2.528	0.072	0.010	0.156	0.229
Dec	0.773	1.801	2.330	0.083	0.010	0.078	0.161
Jan	2.839	6.871	2.421	0.199	0.040	0.078	0.277
Feb	5.268	14.491	2.751	0.359	0.030	0.939	1.299
Mar	5.618	12.872	2.291	0.430	0.030	0.684	1.114
Apr	2.616	6.784	2.593	0.278	0.070	0.291	0.569
May	0.602	1.802	2.993	0.131	0.060	0.000	0.131
Jun	0.317	1.117	3.523	0.081	0.052	0.000	0.081
Jul	0.195	0.433	2.223	0.066	0.041	0.000	0.066
Aug	0.114	0.077	0.674	0.054	0.032	0.000	0.054
Sep	0.087	0.074	0.852	0.044	0.025	0.002	0.047

NODE	MC2
RIVER	Taaibosspruit
IUA	MC SCHOONSPRUIT
RU	SK3
RULE TABLE	RULE CURVES

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC21
Total Naturalised Runoff (MCM) : 19.50
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.058	0.052	0.036	0.021	0.016	0.015	0.013	0.007	0.003	0.001
Nov	0.189	0.153	0.085	0.055	0.045	0.035	0.021	0.014	0.007	0.001
Dec	0.116	0.097	0.080	0.062	0.033	0.025	0.013	0.008	0.007	0.001
Jan	0.175	0.154	0.132	0.106	0.072	0.048	0.030	0.022	0.011	0.004
Feb	1.175	0.941	0.579	0.302	0.182	0.145	0.103	0.073	0.054	0.006
Mar	0.523	0.502	0.458	0.347	0.202	0.153	0.107	0.061	0.042	0.022
Apr	0.284	0.275	0.258	0.220	0.152	0.131	0.086	0.058	0.042	0.034
May	0.068	0.067	0.063	0.057	0.051	0.041	0.031	0.026	0.020	0.013
Jun	0.044	0.043	0.041	0.036	0.033	0.027	0.022	0.020	0.020	0.015
Jul	0.035	0.034	0.033	0.028	0.026	0.021	0.016	0.016	0.016	0.013
Aug	0.028	0.027	0.025	0.020	0.018	0.018	0.016	0.013	0.013	0.011
Sep	0.025	0.023	0.015	0.014	0.011	0.011	0.008	0.006	0.006	0.006
Reserve Flows without High Flows										
Oct	0.033	0.030	0.023	0.016	0.012	0.010	0.007	0.004	0.002	0.001
Nov	0.039	0.037	0.034	0.027	0.021	0.014	0.008	0.006	0.004	0.001
Dec	0.043	0.041	0.037	0.031	0.020	0.015	0.007	0.005	0.004	0.001
Jan	0.103	0.098	0.090	0.075	0.057	0.038	0.024	0.018	0.009	0.004
Feb	0.205	0.196	0.177	0.146	0.106	0.066	0.036	0.020	0.014	0.006
Mar	0.222	0.213	0.193	0.161	0.114	0.075	0.041	0.022	0.014	0.013
Apr	0.150	0.146	0.137	0.122	0.095	0.076	0.051	0.037	0.029	0.023
May	0.068	0.067	0.063	0.057	0.051	0.041	0.031	0.026	0.020	0.013
Jun	0.044	0.043	0.041	0.036	0.033	0.027	0.022	0.020	0.020	0.015
Jul	0.035	0.034	0.033	0.028	0.026	0.021	0.016	0.016	0.016	0.013
Aug	0.028	0.027	0.025	0.020	0.018	0.018	0.016	0.013	0.013	0.011
Sep	0.024	0.021	0.014	0.013	0.011	0.011	0.008	0.006	0.006	0.006
Natural Duration curves										
Oct	0.116	0.056	0.045	0.034	0.026	0.022	0.019	0.015	0.011	0.007
Nov	0.482	0.239	0.085	0.058	0.046	0.035	0.027	0.023	0.012	0.004
Dec	0.762	0.388	0.246	0.149	0.082	0.060	0.037	0.022	0.015	0.004
Jan	3.760	0.754	0.396	0.254	0.190	0.138	0.067	0.037	0.022	0.015
Feb	5.890	1.943	0.579	0.302	0.182	0.145	0.103	0.074	0.054	0.012
Mar	8.356	1.818	0.515	0.347	0.209	0.153	0.116	0.082	0.056	0.022
Apr	3.252	0.455	0.274	0.220	0.158	0.131	0.096	0.069	0.050	0.039
May	0.336	0.198	0.127	0.105	0.090	0.071	0.056	0.045	0.034	0.022
Jun	0.170	0.120	0.081	0.062	0.058	0.046	0.039	0.035	0.035	0.027
Jul	0.093	0.078	0.056	0.049	0.045	0.037	0.034	0.034	0.030	0.022
Aug	0.071	0.049	0.045	0.037	0.034	0.034	0.030	0.026	0.026	0.022
Sep	0.073	0.039	0.027	0.027	0.023	0.023	0.019	0.015	0.015	0.015

NODE	**MC6**
RIVER	**Schoonspruit**
IUA	**MC SCHOONSPRUIT**
RU	**SK7**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/18
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC23

Annual Flows (Mill. cu. m or index values):

MAR	=	5.244
S.Dev.	=	8.463
CV	=	1.614
Q75	=	0.000
Q75/MMF	=	0.000
BFI Index	=	0.190
CV(JJA+JFM) Index	=	10.176

Ecological Category = D

Total IFR	=	1.084	(20.68 %MAR)
Maint. Lowflow	=	0.535	(10.19 %MAR)
Drought Lowflow	=	0.000	(0.00 %MAR)
Maint. Highflow	=	0.550	(10.48 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.213	1.433	6.729	0.016	0.000	0.024	0.040
Nov	0.299	0.670	2.237	0.026	0.000	0.056	0.083
Dec	0.366	0.482	1.315	0.036	0.000	0.028	0.064
Jan	0.933	2.628	2.816	0.084	0.000	0.028	0.112
Feb	1.304	4.029	3.090	0.124	0.000	0.227	0.352
Mar	1.294	3.475	2.685	0.135	0.000	0.135	0.270
Apr	0.525	1.441	2.743	0.074	0.000	0.050	0.124
May	0.240	1.675	6.981	0.029	0.000	0.000	0.029
Jun	0.058	0.479	8.261	0.010	0.000	0.000	0.010
Jul	0.001	0.005	5.618	0.000	0.000	0.000	0.000
Aug	0.002	0.015	8.057	0.000	0.000	0.000	0.000
Sep	0.007	0.038	5.201	0.001	0.000	0.001	0.001

NODE	**MC6**
RIVER	**Schoonspruit**
IUA	**MC SCHOONSPRUIT**
RU	**SK7**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC23
Total Naturalised Runoff (MCM) : 5.24
Regional Type : Vaal
Ecological Category : D

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.023	0.017	0.005	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Nov	0.071	0.056	0.046	0.028	0.019	0.005	0.005	0.000	0.000	0.000
Dec	0.049	0.042	0.035	0.027	0.017	0.010	0.005	0.002	0.001	0.000
Jan	0.079	0.071	0.061	0.048	0.031	0.017	0.008	0.003	0.001	0.000
Feb	0.322	0.264	0.211	0.153	0.091	0.042	0.021	0.015	0.007	0.000
Mar	0.153	0.147	0.133	0.111	0.078	0.045	0.026	0.013	0.000	0.000
Apr	0.077	0.073	0.058	0.038	0.019	0.005	0.001	0.000	0.000	0.000
May	0.019	0.010	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Reserve Flows without High Flows										
Oct	0.011	0.010	0.005	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Nov	0.017	0.016	0.015	0.011	0.009	0.002	0.002	0.000	0.000	0.000
Dec	0.023	0.022	0.020	0.016	0.011	0.006	0.003	0.001	0.000	0.000
Jan	0.053	0.051	0.045	0.037	0.025	0.013	0.006	0.002	0.000	0.000
Feb	0.087	0.083	0.075	0.061	0.043	0.022	0.008	0.004	0.001	0.000
Mar	0.086	0.082	0.074	0.061	0.044	0.026	0.012	0.004	0.000	0.000
Apr	0.050	0.048	0.042	0.032	0.019	0.005	0.001	0.000	0.000	0.000
May	0.019	0.010	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Duration curves										
Oct	0.067	0.019	0.007	0.004	0.000	0.000	0.000	0.000	0.000	0.000
Nov	0.347	0.181	0.062	0.035	0.019	0.008	0.008	0.000	0.000	0.000
Dec	0.429	0.231	0.179	0.101	0.067	0.045	0.022	0.007	0.004	0.000
Jan	0.933	0.392	0.246	0.168	0.131	0.067	0.041	0.022	0.007	0.000
Feb	0.934	0.434	0.236	0.153	0.091	0.045	0.025	0.017	0.008	0.000
Mar	1.116	0.332	0.220	0.112	0.078	0.045	0.026	0.015	0.000	0.000
Apr	0.374	0.131	0.069	0.046	0.027	0.008	0.004	0.000	0.000	0.000
May	0.030	0.015	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sep	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NODE	**MD1.1**
RIVER	**Upper Sand River**
IUA	**MD1 UPPER SAND RIVER**
RU	**US2**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC40

Annual Flows (Mill. cu. m or index values):

MAR	=	66.397
S.Dev.	=	61.646
CV	=	0.928
Q75	=	0.400
Q75/MMF	=	0.072
BFI Index	=	0.254
CV(JJA+JFM) Index	=	3.308

Ecological Category = C/D

Total IFR	=	17.349	(26.13 %MAR)
Maint. Lowflow	=	10.742	(16.18 %MAR)
Drought Lowflow	=	0.876	(1.32 %MAR)
Maint. Highflow	=	6.607	(9.95 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	4.172	12.236	2.933	0.596	0.100	0.434	1.030
Nov	7.513	15.075	2.007	0.952	0.050	0.979	1.930
Dec	7.774	11.656	1.499	1.089	0.030	0.489	1.578
Jan	11.232	16.421	1.462	1.504	0.110	0.489	1.993
Feb	11.601	19.367	1.669	1.710	0.120	2.351	4.061
Mar	10.900	26.580	2.438	1.664	0.080	1.099	2.763
Apr	5.354	11.034	2.061	1.089	0.060	0.485	1.574
May	2.801	7.482	2.672	0.707	0.050	0.000	0.707
Jun	1.060	2.276	2.146	0.430	0.000	0.000	0.430
Jul	0.527	0.402	0.763	0.293	0.080	0.000	0.293
Aug	0.720	1.040	1.445	0.283	0.081	0.000	0.283
Sep	2.743	13.395	4.883	0.426	0.115	0.281	0.706

NODE	**MD2.1**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS1**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC40
Total Naturalised Runoff (MCM) : 66.40
Regional Type : Vaal
Ecological Category : CD

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.551	0.534	0.492	0.427	0.352	0.214	0.124	0.060	0.029	0.015
Nov	1.496	1.255	1.031	0.800	0.499	0.320	0.182	0.101	0.067	0.014
Dec	1.069	0.935	0.770	0.621	0.400	0.242	0.125	0.060	0.036	0.008
Jan	1.302	1.158	0.992	0.784	0.518	0.317	0.161	0.094	0.065	0.037
Feb	3.492	2.882	2.328	1.773	1.058	0.670	0.381	0.223	0.162	0.034
Mar	1.447	1.388	1.262	1.051	0.773	0.489	0.269	0.141	0.087	0.013
Apr	0.888	0.860	0.802	0.699	0.550	0.377	0.219	0.110	0.053	0.010
May	0.409	0.397	0.353	0.233	0.134	0.099	0.081	0.049	0.022	0.007
Jun	0.257	0.249	0.200	0.132	0.088	0.070	0.051	0.024	0.008	0.002
Jul	0.170	0.154	0.122	0.099	0.090	0.072	0.058	0.044	0.034	0.020
Aug	0.164	0.160	0.147	0.118	0.103	0.080	0.057	0.044	0.034	0.025
Sep	0.393	0.335	0.230	0.153	0.124	0.089	0.074	0.054	0.033	0.026
Reserve Flows without High Flows										
Oct	0.345	0.335	0.309	0.268	0.222	0.126	0.068	0.028	0.012	0.009
Nov	0.553	0.530	0.482	0.400	0.292	0.182	0.096	0.046	0.026	0.006
Dec	0.612	0.585	0.515	0.430	0.304	0.179	0.086	0.036	0.016	0.004
Jan	0.846	0.808	0.728	0.595	0.423	0.256	0.126	0.070	0.046	0.018
Feb	1.065	1.019	0.921	0.757	0.544	0.333	0.177	0.091	0.058	0.016
Mar	0.936	0.897	0.814	0.675	0.492	0.305	0.160	0.076	0.041	0.008
Apr	0.652	0.631	0.587	0.511	0.400	0.272	0.155	0.074	0.034	0.010
May	0.409	0.397	0.353	0.233	0.134	0.099	0.081	0.049	0.022	0.007
Jun	0.257	0.249	0.200	0.132	0.088	0.070	0.051	0.024	0.008	0.002
Jul	0.170	0.154	0.122	0.099	0.090	0.072	0.058	0.044	0.034	0.020
Aug	0.164	0.160	0.147	0.118	0.103	0.080	0.057	0.044	0.034	0.025
Sep	0.255	0.201	0.158	0.120	0.093	0.064	0.048	0.032	0.020	0.015
Natural Duration curves										
Oct	3.730	1.381	0.978	0.657	0.422	0.254	0.168	0.097	0.060	0.045
Nov	8.858	3.368	2.141	1.292	1.011	0.667	0.451	0.305	0.154	0.031
Dec	7.960	5.429	2.487	1.673	1.128	0.836	0.605	0.403	0.108	0.019
Jan	12.272	7.355	5.126	3.524	1.605	1.146	0.732	0.459	0.205	0.082
Feb	12.136	7.841	4.952	3.034	1.777	1.389	0.880	0.554	0.203	0.074
Mar	8.333	3.778	2.688	2.255	1.538	1.247	0.892	0.474	0.157	0.041
Apr	5.008	2.091	1.609	1.154	0.729	0.575	0.436	0.231	0.089	0.027
May	2.722	0.683	0.422	0.325	0.224	0.172	0.127	0.086	0.041	0.019
Jun	0.652	0.401	0.289	0.212	0.162	0.131	0.100	0.062	0.054	0.023
Jul	0.429	0.254	0.213	0.183	0.168	0.138	0.116	0.093	0.075	0.052
Aug	0.414	0.340	0.276	0.224	0.194	0.164	0.127	0.116	0.097	0.071
Sep	0.567	0.382	0.309	0.243	0.204	0.154	0.120	0.100	0.081	0.073

NODE	**MD2.1**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS1**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : EEWR_V

Annual Flows (Mill. cu. m or index values):

MAR	=	104.159
S.Dev.	=	96.408
CV	=	0.926
Q75	=	0.600
Q75/MMF	=	0.069
BFI Index	=	0.255
CV(JJA+JFM) Index	=	3.320

Ecological Category = C

Total IFR	=	29.516	(28.34 %MAR)
Maint. Lowflow	=	17.915	(17.20 %MAR)
Drought Lowflow	=	1.558	(1.50 %MAR)
Maint. Highflow	=	11.601	(11.14 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	6.374	18.432	2.892	0.953	0.140	0.742	1.695
Nov	11.668	23.171	1.986	1.564	0.070	1.707	3.271
Dec	12.104	17.931	1.481	1.806	0.050	0.853	2.660
Jan	17.671	25.946	1.468	2.533	0.190	4.118	6.651
Feb	18.123	29.530	1.629	2.882	0.200	0.853	3.736
Mar	17.471	42.219	2.417	2.847	0.140	1.979	4.826
Apr	8.549	17.263	2.019	1.888	0.110	0.859	2.747
May	4.454	11.734	2.634	1.213	0.090	0.000	1.213
Jun	1.628	3.553	2.182	0.690	0.050	0.000	0.690
Jul	0.763	0.584	0.765	0.438	0.120	0.000	0.438
Aug	1.091	1.637	1.499	0.426	0.168	0.000	0.426
Sep	4.263	20.466	4.801	0.674	0.230	0.489	1.163

NODE	**MD2.1**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS1**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Generated on 2011/08/24
Summary of IFR rule curves (Desktop Version 2) for :
Total Runoff : Runoff : EEWR_V
Regional Type : Vaal
Ecological Category = C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.826	0.801	0.750	0.659	0.528	0.375	0.236	0.140	0.094	0.067
Nov	2.477	2.062	1.683	1.299	0.800	0.514	0.292	0.163	0.109	0.046
Dec	1.725	1.499	1.262	0.986	0.631	0.384	0.200	0.099	0.060	0.026
Jan	5.144	4.192	3.345	2.516	1.453	0.916	0.525	0.318	0.241	0.161
Feb	2.525	2.249	1.933	1.539	1.029	0.641	0.352	0.194	0.133	0.112
Mar	2.339	2.244	2.042	1.702	1.255	0.799	0.444	0.238	0.152	0.078
Apr	1.409	1.365	1.272	1.110	0.876	0.604	0.355	0.183	0.100	0.050
May	0.631	0.612	0.572	0.501	0.377	0.258	0.166	0.087	0.047	0.034
Jun	0.372	0.361	0.338	0.299	0.235	0.172	0.106	0.057	0.030	0.022
Jul	0.229	0.223	0.212	0.192	0.162	0.127	0.092	0.066	0.051	0.046
Aug	0.223	0.218	0.208	0.190	0.164	0.132	0.102	0.080	0.067	0.064
Sep	0.588	0.573	0.509	0.401	0.313	0.231	0.174	0.143	0.116	0.108
Reserve Flows without High Flows										
Oct	0.497	0.482	0.451	0.397	0.319	0.228	0.145	0.088	0.060	0.055
Nov	0.833	0.798	0.724	0.601	0.438	0.272	0.143	0.068	0.037	0.032
Dec	0.930	0.888	0.800	0.653	0.462	0.273	0.133	0.056	0.026	0.024
Jan	1.304	1.247	1.124	0.919	0.657	0.401	0.214	0.116	0.079	0.079
Feb	1.644	1.573	1.422	1.170	0.843	0.519	0.278	0.146	0.095	0.093
Mar	1.467	1.406	1.277	1.060	0.774	0.482	0.256	0.124	0.069	0.061
Apr	1.015	0.983	0.915	0.797	0.626	0.428	0.246	0.121	0.060	0.049
May	0.631	0.612	0.572	0.501	0.377	0.258	0.166	0.087	0.047	0.034
Jun	0.372	0.361	0.338	0.299	0.235	0.172	0.106	0.057	0.030	0.022
Jul	0.229	0.223	0.212	0.192	0.162	0.127	0.092	0.066	0.051	0.046
Aug	0.223	0.218	0.208	0.190	0.164	0.132	0.102	0.080	0.067	0.064
Sep	0.364	0.355	0.336	0.304	0.257	0.201	0.150	0.113	0.095	0.090
Natural Duration curves										
Oct	5.507	2.143	1.434	0.978	0.661	0.388	0.246	0.153	0.105	0.067
Nov	13.310	5.764	3.187	2.361	1.566	1.065	0.725	0.448	0.243	0.046
Dec	12.582	7.915	3.793	2.938	1.729	1.337	0.915	0.650	0.161	0.026
Jan	18.612	11.175	7.953	5.496	2.513	1.703	1.213	0.672	0.411	0.161
Feb	19.101	12.760	7.999	4.754	2.798	2.125	1.517	0.872	0.343	0.112
Mar	12.873	6.086	4.323	3.558	2.513	1.990	1.385	0.750	0.276	0.078
Apr	7.249	3.673	2.523	1.794	1.157	0.995	0.667	0.401	0.154	0.050
May	4.118	1.086	0.717	0.582	0.377	0.258	0.198	0.138	0.093	0.034
Jun	1.061	0.590	0.444	0.340	0.235	0.193	0.174	0.123	0.085	0.042
Jul	0.620	0.366	0.310	0.265	0.243	0.202	0.164	0.134	0.108	0.075
Aug	0.609	0.508	0.411	0.332	0.284	0.239	0.183	0.168	0.138	0.108
Sep	0.903	0.617	0.509	0.401	0.313	0.231	0.174	0.143	0.116	0.108

NODE	**MD2.2**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS1**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC42

Annual Flows (Mill. cu. m or index values):

MAR	=	19.268
S.Dev.	=	20.750
CV	=	1.077
Q75	=	0.000
Q75/MMF	=	0.000
BFI Index	=	0.215
CV(JJA+JFM) Index	=	6.220

Ecological Category = C

Total IFR	=	5.989	(31.08 %MAR)
Maint. Lowflow	=	3.664	(19.02 %MAR)
Drought Lowflow	=	0.010	(0.05 %MAR)
Maint. Highflow	=	2.325	(12.06 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.804	2.009	2.499	0.123	0.000	0.102	0.225
Nov	1.896	3.815	2.012	0.279	0.000	0.307	0.586
Dec	2.035	4.236	2.082	0.350	0.000	0.154	0.504
Jan	3.379	6.115	1.810	0.564	0.010	0.813	1.377
Feb	3.184	4.840	1.520	0.613	0.000	0.154	0.767
Mar	4.050	10.420	2.573	0.723	0.000	0.497	1.220
Apr	1.915	4.170	2.177	0.507	0.000	0.206	0.713
May	0.957	3.132	3.272	0.285	0.000	0.000	0.285
Jun	0.224	0.812	3.622	0.115	0.000	0.000	0.115
Jul	0.001	0.005	6.082	0.001	0.000	0.000	0.001
Aug	0.121	0.369	3.052	0.015	0.000	0.000	0.015
Sep	0.702	2.715	3.867	0.089	0.000	0.092	0.182

NODE	**MD2.2**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS1**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC42
Total Naturalised Runoff (MCM) : 19.27
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.109	0.106	0.098	0.080	0.005	0.003	0.002	0.000	0.000	0.000
Nov	0.444	0.369	0.301	0.231	0.141	0.069	0.029	0.009	0.000	0.000
Dec	0.323	0.282	0.238	0.186	0.118	0.070	0.030	0.015	0.007	0.000
Jan	1.048	0.858	0.687	0.485	0.297	0.182	0.098	0.054	0.038	0.001
Feb	0.508	0.455	0.392	0.295	0.204	0.120	0.057	0.023	0.010	0.008
Mar	0.591	0.566	0.514	0.410	0.311	0.193	0.101	0.048	0.012	0.000
Apr	0.367	0.355	0.330	0.270	0.143	0.071	0.033	0.012	0.008	0.000
May	0.148	0.143	0.042	0.025	0.015	0.007	0.001	0.000	0.000	0.000
Jun	0.062	0.049	0.021	0.005	0.002	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.008	0.004	0.004	0.002	0.001	0.000	0.000	0.000	0.000	0.000
Sep	0.090	0.088	0.008	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Reserve Flows without High Flows										
Oct	0.064	0.062	0.057	0.043	0.005	0.003	0.002	0.000	0.000	0.000
Nov	0.148	0.142	0.128	0.106	0.076	0.032	0.008	0.003	0.000	0.000
Dec	0.180	0.172	0.155	0.126	0.088	0.050	0.019	0.007	0.001	0.000
Jan	0.290	0.277	0.248	0.192	0.140	0.080	0.037	0.014	0.006	0.001
Feb	0.349	0.333	0.300	0.233	0.170	0.098	0.044	0.014	0.003	0.002
Mar	0.372	0.356	0.322	0.254	0.190	0.113	0.053	0.019	0.003	0.000
Apr	0.272	0.263	0.244	0.211	0.112	0.063	0.032	0.008	0.002	0.000
May	0.148	0.143	0.042	0.025	0.015	0.007	0.001	0.000	0.000	0.000
Jun	0.062	0.049	0.021	0.005	0.002	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.008	0.004	0.004	0.002	0.001	0.000	0.000	0.000	0.000	0.000
Sep	0.048	0.046	0.008	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Natural Duration curves										
Oct	0.799	0.295	0.146	0.105	0.026	0.015	0.011	0.000	0.000	0.000
Nov	2.284	1.053	0.521	0.316	0.189	0.085	0.042	0.015	0.000	0.000
Dec	2.151	1.042	0.571	0.426	0.306	0.205	0.082	0.041	0.011	0.000
Jan	3.808	1.826	0.971	0.620	0.429	0.358	0.235	0.093	0.052	0.004
Feb	4.865	1.988	1.306	0.670	0.492	0.265	0.145	0.074	0.033	0.008
Mar	3.181	1.422	0.904	0.616	0.508	0.243	0.119	0.063	0.015	0.000
Apr	1.987	0.664	0.440	0.270	0.166	0.116	0.054	0.023	0.012	0.000
May	0.945	0.280	0.075	0.049	0.034	0.015	0.004	0.000	0.000	0.000
Jun	0.228	0.081	0.035	0.015	0.008	0.000	0.000	0.000	0.000	0.000
Jul	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aug	0.175	0.022	0.019	0.011	0.004	0.000	0.000	0.000	0.000	0.000
Sep	0.513	0.154	0.039	0.027	0.000	0.000	0.000	0.000	0.000	0.000

NODE	**MD2.3**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS3**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC46

Annual Flows (Mill. cu. m or index values):

MAR	=	180.262
S.Dev.	=	171.192
CV	=	0.950
Q75	=	0.750
Q75/MMF	=	0.050
BFI Index	=	0.244
CV(JJA+JFM) Index	=	3.559

Ecological Category = C

Total IFR	=	43.933	(24.37 %MAR)
Maint. Lowflow	=	23.592	(13.09 %MAR)
Drought Lowflow	=	2.649	(1.47 %MAR)
Maint. Highflow	=	20.341	(11.28 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	9.550	25.591	2.680	1.075	0.140	1.127	2.202
Nov	19.159	36.896	1.926	1.939	0.070	2.859	4.798
Dec	20.139	31.290	1.554	2.319	0.050	1.430	3.748
Jan	31.014	48.385	1.560	3.420	0.480	7.175	10.595
Feb	30.698	45.707	1.489	3.829	0.440	1.430	5.259
Mar	33.467	80.699	2.411	4.065	0.300	3.862	7.927
Apr	16.115	31.679	1.966	2.812	0.220	1.622	4.434
May	8.233	22.356	2.715	1.725	0.250	0.000	1.725
Jun	2.514	6.379	2.538	0.857	0.220	0.000	0.857
Jul	0.766	0.594	0.776	0.376	0.120	0.000	0.376
Aug	1.569	2.987	1.904	0.400	0.132	0.000	0.400
Sep	7.038	30.845	4.383	0.774	0.227	0.836	1.611

NODE	**MD2.3**
RIVER	**Lower Sand River**
IUA	**MD2 LOWER SAND RIVER**
RU	**LS3**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Generated on 2011/08/24
Summary of IFR rule curves (Desktop Version 2) for :
Total Runoff : Runoff : VVC46
Regional Type : Vaal
Ecological Category = C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	1.060	1.028	0.961	0.844	0.674	0.477	0.297	0.172	0.112	0.067
Nov	3.788	3.106	2.502	1.912	1.145	0.738	0.421	0.237	0.161	0.046
Dec	2.527	2.163	1.799	1.395	0.873	0.532	0.278	0.139	0.085	0.026
Jan	8.452	6.821	5.400	4.051	2.319	1.500	0.904	0.589	0.472	0.187
Feb	3.661	3.227	2.756	2.195	1.470	0.946	0.557	0.344	0.261	0.215
Mar	3.798	3.645	3.322	2.778	2.063	1.333	0.765	0.436	0.298	0.119
Apr	2.257	2.187	2.040	1.784	1.413	0.983	0.589	0.318	0.186	0.147
May	0.899	0.873	0.818	0.702	0.560	0.396	0.265	0.165	0.111	0.098
Jun	0.463	0.451	0.427	0.385	0.323	0.249	0.178	0.125	0.096	0.085
Jul	0.196	0.192	0.182	0.166	0.142	0.112	0.084	0.062	0.050	0.046
Aug	0.209	0.204	0.194	0.176	0.150	0.119	0.088	0.066	0.054	0.050
Sep	0.801	0.779	0.706	0.471	0.382	0.255	0.181	0.143	0.116	0.108
Reserve Flows without High Flows										
Oct	0.560	0.543	0.508	0.446	0.357	0.253	0.159	0.093	0.062	0.055
Nov	1.032	0.989	0.897	0.743	0.540	0.333	0.171	0.078	0.039	0.033
Dec	1.193	1.140	1.027	0.837	0.591	0.347	0.166	0.066	0.028	0.026
Jan	1.763	1.690	1.532	1.269	0.932	0.603	0.363	0.236	0.189	0.187
Feb	2.185	2.095	1.901	1.577	1.158	0.742	0.432	0.263	0.198	0.195
Mar	2.095	2.010	1.829	1.525	1.124	0.715	0.397	0.213	0.135	0.119
Apr	1.513	1.465	1.366	1.193	0.942	0.650	0.384	0.200	0.111	0.094
May	0.899	0.873	0.818	0.702	0.560	0.396	0.265	0.165	0.111	0.098
Jun	0.463	0.451	0.427	0.385	0.323	0.249	0.178	0.125	0.096	0.085
Jul	0.196	0.192	0.182	0.166	0.142	0.112	0.084	0.062	0.050	0.046
Aug	0.209	0.204	0.194	0.176	0.150	0.119	0.088	0.066	0.054	0.050
Sep	0.418	0.407	0.385	0.346	0.289	0.223	0.161	0.117	0.095	0.090
Natural Duration curves										
Oct	8.150	3.894	2.016	1.478	0.986	0.601	0.310	0.202	0.127	0.067
Nov	17.870	11.404	5.486	3.233	2.485	1.779	1.123	0.563	0.313	0.046
Dec	20.128	10.853	7.654	4.686	3.114	2.229	1.579	0.926	0.187	0.026
Jan	34.241	17.929	12.590	9.192	4.488	2.916	2.397	1.844	0.736	0.187
Feb	31.787	22.255	15.621	7.730	5.336	3.228	2.414	1.397	0.521	0.215
Mar	20.766	11.955	8.363	5.858	3.999	3.319	2.300	1.116	0.385	0.119
Apr	11.987	7.404	4.371	3.272	2.388	1.539	1.046	0.548	0.320	0.147
May	9.793	2.770	1.202	0.702	0.560	0.396	0.265	0.220	0.183	0.127
Jun	2.160	0.837	0.594	0.486	0.367	0.278	0.235	0.189	0.158	0.085
Jul	0.620	0.366	0.310	0.265	0.243	0.202	0.164	0.134	0.108	0.075
Aug	1.404	0.665	0.508	0.403	0.340	0.280	0.198	0.175	0.157	0.127
Sep	3.160	1.080	0.706	0.471	0.382	0.255	0.181	0.143	0.116	0.108

NODE	**ME1.2**
RIVER	**Upper Vet**
IUA	**ME1 UPPER VET RIVER**
RU	**UV1**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC52

Annual Flows (Mill. cu. m or index values):

MAR	=	81.857
S.Dev.	=	77.413
CV	=	0.946
Q75	=	0.500
Q75/MMF	=	0.073
BFI Index	=	0.245
CV(JJA+JFM) Index	=	3.406

Ecological Category = C

Total IFR	=	20.946	(25.59 %MAR)
Maint. Lowflow	=	11.761	(14.37 %MAR)
Drought Lowflow	=	1.044	(1.28 %MAR)
Maint. Highflow	=	9.185	(11.22 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	4.541	13.450	2.962	0.639	0.120	0.518	1.157
Nov	7.837	15.822	2.019	0.955	0.120	1.037	1.992
Dec	5.838	10.007	1.714	0.862	0.060	0.519	1.380
Jan	12.033	23.760	1.975	1.377	0.020	0.519	1.896
Feb	14.286	25.597	1.792	1.707	0.080	3.094	4.801
Mar	16.009	32.017	2.000	1.890	0.080	1.887	3.776
Apr	11.993	21.673	1.807	1.665	0.060	1.350	3.015
May	3.874	10.253	2.646	0.932	0.090	0.000	0.932
Jun	1.316	2.485	1.888	0.544	0.080	0.000	0.544
Jul	0.790	1.107	1.400	0.382	0.108	0.000	0.382
Aug	0.888	1.032	1.162	0.369	0.105	0.000	0.369
Sep	2.453	9.392	3.829	0.438	0.122	0.262	0.700

NODE	ME1.2
RIVER	Upper Vet
IUA	ME1 UPPER VET RIVER
RU	UV1
RULE TABLE	RULE CURVES

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC52
Total Naturalised Runoff (MCM) : 81.86
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.563	0.546	0.512	0.451	0.360	0.231	0.148	0.079	0.042	0.012
Nov	1.509	1.257	1.000	0.800	0.502	0.334	0.203	0.128	0.065	0.021
Dec	0.927	0.796	0.664	0.518	0.330	0.207	0.116	0.066	0.047	0.004
Jan	1.192	1.047	0.886	0.691	0.441	0.260	0.119	0.058	0.032	0.024
Feb	4.167	3.382	2.692	2.025	1.167	0.738	0.419	0.245	0.178	0.007
Mar	1.805	1.732	1.576	1.315	0.970	0.619	0.345	0.187	0.120	0.090
Apr	1.514	1.467	1.367	1.120	0.939	0.645	0.377	0.192	0.101	0.064
May	0.485	0.471	0.433	0.298	0.211	0.136	0.113	0.074	0.043	0.020
Jun	0.293	0.283	0.219	0.184	0.148	0.103	0.093	0.059	0.035	0.028
Jul	0.200	0.195	0.185	0.143	0.122	0.108	0.076	0.059	0.046	0.029
Aug	0.193	0.188	0.178	0.157	0.136	0.102	0.077	0.055	0.043	0.036
Sep	0.357	0.347	0.327	0.291	0.193	0.162	0.123	0.084	0.063	0.052
Reserve Flows without High Flows										
Oct	0.333	0.323	0.303	0.268	0.211	0.128	0.084	0.043	0.019	0.010
Nov	0.509	0.489	0.438	0.376	0.282	0.187	0.113	0.070	0.021	0.012
Dec	0.444	0.425	0.384	0.316	0.228	0.140	0.075	0.040	0.026	0.004
Jan	0.709	0.676	0.606	0.490	0.341	0.195	0.082	0.033	0.012	0.006
Feb	0.973	0.930	0.839	0.688	0.491	0.296	0.151	0.071	0.041	0.007
Mar	0.974	0.933	0.847	0.702	0.511	0.317	0.165	0.078	0.041	0.036
Apr	0.895	0.866	0.806	0.656	0.547	0.368	0.206	0.094	0.039	0.027
May	0.485	0.471	0.433	0.298	0.211	0.136	0.113	0.074	0.043	0.020
Jun	0.293	0.283	0.219	0.184	0.148	0.103	0.093	0.059	0.035	0.028
Jul	0.200	0.195	0.185	0.143	0.122	0.108	0.076	0.059	0.046	0.029
Aug	0.193	0.188	0.178	0.157	0.136	0.102	0.077	0.055	0.043	0.036
Sep	0.237	0.230	0.218	0.195	0.133	0.109	0.089	0.064	0.051	0.041
Natural Duration curves										
Oct	5.018	1.520	0.952	0.504	0.411	0.280	0.209	0.131	0.093	0.049
Nov	8.044	3.900	2.492	1.570	1.107	0.675	0.440	0.289	0.104	0.058
Dec	7.635	2.953	1.833	1.296	0.870	0.597	0.437	0.343	0.164	0.022
Jan	14.311	6.504	4.002	1.859	1.452	0.963	0.605	0.358	0.187	0.030
Feb	20.118	10.818	4.241	2.067	1.546	0.971	0.612	0.446	0.285	0.033
Mar	15.614	6.717	3.883	2.714	1.299	1.116	0.777	0.560	0.310	0.090
Apr	16.366	8.083	3.241	1.235	1.042	0.648	0.467	0.282	0.208	0.066
May	4.421	0.862	0.642	0.474	0.351	0.231	0.194	0.134	0.078	0.041
Jun	0.698	0.451	0.363	0.313	0.247	0.177	0.158	0.112	0.066	0.046
Jul	0.519	0.366	0.317	0.246	0.209	0.187	0.146	0.138	0.086	0.056
Aug	0.624	0.459	0.355	0.280	0.239	0.179	0.164	0.149	0.123	0.063
Sep	0.899	0.544	0.424	0.351	0.224	0.185	0.162	0.143	0.120	0.081

NODE	**ME1.1**
RIVER	**Upper Vet**
IUA	**ME1 UPPER VET RIVER**
RU	**UV2**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC49

Annual Flows (Mill. cu. m or index values):

MAR	=	72.021
S.Dev.	=	68.108
CV	=	0.946
Q75	=	0.450
Q75/MMF	=	0.075
BFI Index	=	0.245
CV(JJA+JFM) Index	=	3.406

Ecological Category = C

Total IFR	=	18.861	(26.19 %MAR)
Maint. Lowflow	=	10.780	(14.97 %MAR)
Drought Lowflow	=	0.932	(1.29 %MAR)
Maint. Highflow	=	8.082	(11.22 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.994	11.834	2.963	0.584	0.100	0.456	1.040
Nov	6.894	13.921	2.019	0.875	0.100	0.913	1.788
Dec	5.137	8.804	1.714	0.790	0.050	0.456	1.246
Jan	10.587	20.904	1.975	1.264	0.020	0.456	1.721
Feb	12.569	22.521	1.792	1.567	0.070	2.722	4.290
Mar	14.085	28.170	2.000	1.736	0.070	1.660	3.396
Apr	10.553	19.071	1.807	1.529	0.060	1.188	2.717
May	3.410	9.021	2.645	0.854	0.090	0.000	0.854
Jun	1.157	2.188	1.890	0.497	0.070	0.000	0.497
Jul	0.695	0.973	1.399	0.348	0.097	0.000	0.348
Aug	0.781	0.908	1.163	0.336	0.094	0.000	0.336
Sep	2.158	8.264	3.830	0.399	0.110	0.230	0.630

NODE	ME1.1
RIVER	Upper Vet
IUA	ME1 UPPER VET RIVER
RU	UV2
RULE TABLE	RULE CURVES

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC49
Total Naturalised Runoff (MCM) : 72.02
Regional Type : Vaal
Ecological Category : C

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.507	0.492	0.460	0.372	0.284	0.167	0.101	0.054	0.038	0.010
Nov	1.346	1.124	0.896	0.717	0.450	0.298	0.180	0.107	0.070	0.019
Dec	0.832	0.716	0.598	0.467	0.298	0.186	0.103	0.058	0.040	0.005
Jan	1.076	0.947	0.803	0.627	0.401	0.236	0.109	0.053	0.030	0.019
Feb	3.704	3.012	2.400	1.808	1.045	0.660	0.373	0.217	0.156	0.006
Mar	1.626	1.560	1.419	1.183	0.873	0.556	0.309	0.166	0.106	0.078
Apr	1.367	1.324	1.234	1.076	0.848	0.571	0.341	0.174	0.093	0.054
May	0.445	0.432	0.404	0.305	0.221	0.115	0.093	0.062	0.035	0.015
Jun	0.267	0.260	0.198	0.147	0.113	0.071	0.064	0.039	0.014	0.008
Jul	0.182	0.177	0.139	0.106	0.083	0.070	0.051	0.045	0.022	0.010
Aug	0.175	0.171	0.145	0.111	0.086	0.058	0.046	0.039	0.024	0.011
Sep	0.321	0.312	0.256	0.209	0.110	0.088	0.055	0.041	0.032	0.024
Reserve Flows without High Flows										
Oct	0.304	0.295	0.277	0.211	0.155	0.077	0.040	0.022	0.017	0.008
Nov	0.466	0.448	0.401	0.343	0.257	0.169	0.100	0.058	0.032	0.010
Dec	0.407	0.389	0.352	0.289	0.208	0.127	0.067	0.034	0.022	0.004
Jan	0.651	0.621	0.557	0.450	0.313	0.179	0.076	0.031	0.012	0.005
Feb	0.894	0.854	0.771	0.631	0.450	0.271	0.137	0.064	0.036	0.006
Mar	0.894	0.857	0.777	0.644	0.469	0.290	0.151	0.070	0.036	0.032
Apr	0.822	0.796	0.740	0.643	0.503	0.340	0.190	0.088	0.038	0.024
May	0.445	0.432	0.404	0.305	0.221	0.115	0.093	0.062	0.035	0.015
Jun	0.267	0.260	0.198	0.147	0.113	0.071	0.064	0.039	0.014	0.008
Jul	0.182	0.177	0.139	0.106	0.083	0.070	0.051	0.045	0.022	0.010
Aug	0.175	0.171	0.145	0.111	0.086	0.058	0.046	0.039	0.024	0.011
Sep	0.216	0.210	0.162	0.125	0.061	0.042	0.028	0.025	0.021	0.015
Natural Duration curves										
Oct	4.413	1.337	0.836	0.441	0.366	0.243	0.179	0.112	0.086	0.041
Nov	7.076	3.434	2.191	1.381	0.972	0.594	0.386	0.251	0.096	0.050
Dec	6.720	2.599	1.613	1.142	0.765	0.526	0.385	0.299	0.142	0.022
Jan	12.590	5.724	3.521	1.635	1.277	0.848	0.530	0.317	0.168	0.026
Feb	17.700	9.520	3.733	1.815	1.364	0.856	0.537	0.397	0.256	0.029
Mar	13.740	5.910	3.420	2.386	1.142	0.982	0.683	0.493	0.276	0.078
Apr	14.402	7.114	2.851	1.088	0.918	0.571	0.409	0.247	0.185	0.058
May	3.890	0.762	0.564	0.422	0.310	0.205	0.168	0.116	0.071	0.037
Jun	0.613	0.397	0.316	0.270	0.220	0.154	0.139	0.100	0.058	0.039
Jul	0.459	0.325	0.276	0.220	0.183	0.161	0.127	0.119	0.078	0.049
Aug	0.549	0.403	0.310	0.246	0.213	0.161	0.146	0.127	0.108	0.056
Sep	0.791	0.475	0.370	0.309	0.197	0.162	0.139	0.123	0.104	0.073

NODE	**ME1.3**
RIVER	**Soutspruit**
IUA	**ME1 UPPER VET RIVER**
RU	**UV3**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Generated on 2011/08/24
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
Total Runoff : Runoff : VVC51

Annual Flows (Mill. cu. m or index values):

MAR	=	3.873
S.Dev.	=	3.665
CV	=	0.946
Q75	=	0.020
Q75/MMF	=	0.062
BFI Index	=	0.244
CV(JJA+JFM) Index	=	3.423

Ecological Category = B

Total IFR	=	2.369 (61.17 %MAR)
Maint. Lowflow	=	1.811 (46.74 %MAR)
Drought Lowflow	=	0.009 (0.24 %MAR)
Maint. Highflow	=	0.559 (14.42 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.215	0.637	2.967	0.083	0.000	0.031	0.114
Nov	0.371	0.749	2.021	0.146	0.000	0.063	0.209
Dec	0.276	0.474	1.717	0.127	0.000	0.032	0.158
Jan	0.569	1.125	1.977	0.230	0.000	0.032	0.262
Feb	0.676	1.213	1.794	0.297	0.000	0.188	0.485
Mar	0.758	1.515	1.999	0.334	0.000	0.115	0.448
Apr	0.568	1.027	1.808	0.289	0.000	0.082	0.371
May	0.183	0.485	2.652	0.141	0.000	0.000	0.141
Jun	0.062	0.118	1.903	0.063	0.000	0.000	0.063
Jul	0.037	0.053	1.425	0.031	0.000	0.000	0.031
Aug	0.042	0.049	1.172	0.028	0.004	0.000	0.028
Sep	0.117	0.445	3.812	0.043	0.005	0.016	0.059

NODE	**ME1.3**
RIVER	**Soutspruit**
IUA	**ME1 UPPER VET RIVER**
RU	**UV3**
RULE TABLE	**RULE CURVES**

MODIFIED Reserve Desktop (Version 2), Generated on 2011/11/30
Summary of IFR rule curves for : VC51
Total Naturalised Runoff (MCM) : 3.88
Regional Type : Vaal
Ecological Category : B

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.053	0.051	0.041	0.016	0.013	0.010	0.003	0.003	0.000	0.000
Nov	0.132	0.115	0.094	0.070	0.048	0.027	0.014	0.007	0.003	0.003
Dec	0.090	0.080	0.067	0.054	0.034	0.021	0.010	0.003	0.001	0.000
Jan	0.139	0.127	0.110	0.075	0.053	0.028	0.014	0.003	0.001	0.000
Feb	0.350	0.298	0.203	0.069	0.053	0.034	0.029	0.016	0.009	0.000
Mar	0.207	0.198	0.179	0.119	0.050	0.041	0.033	0.014	0.007	0.004
Apr	0.178	0.172	0.154	0.049	0.035	0.027	0.016	0.015	0.005	0.004
May	0.067	0.034	0.023	0.017	0.010	0.008	0.005	0.005	0.000	0.000
Jun	0.024	0.016	0.011	0.011	0.008	0.004	0.004	0.000	0.000	0.000
Jul	0.014	0.010	0.010	0.008	0.002	0.002	0.002	0.002	0.000	0.000
Aug	0.013	0.013	0.010	0.010	0.008	0.002	0.002	0.002	0.002	0.002
Sep	0.027	0.017	0.014	0.011	0.008	0.003	0.003	0.003	0.003	0.003
Reserve Flows without High Flows										
Oct	0.039	0.038	0.031	0.016	0.013	0.010	0.002	0.002	0.000	0.000
Nov	0.072	0.069	0.061	0.049	0.035	0.019	0.009	0.004	0.000	0.000
Dec	0.060	0.057	0.051	0.042	0.028	0.017	0.008	0.001	0.000	0.000
Jan	0.109	0.104	0.093	0.063	0.047	0.024	0.012	0.002	0.001	0.000
Feb	0.156	0.149	0.134	0.069	0.052	0.032	0.019	0.005	0.001	0.000
Mar	0.158	0.152	0.137	0.101	0.047	0.037	0.023	0.007	0.002	0.001
Apr	0.142	0.137	0.127	0.047	0.035	0.027	0.016	0.011	0.002	0.001
May	0.067	0.034	0.023	0.017	0.010	0.008	0.005	0.005	0.000	0.000
Jun	0.024	0.016	0.011	0.011	0.008	0.004	0.004	0.000	0.000	0.000
Jul	0.014	0.010	0.010	0.008	0.002	0.002	0.002	0.002	0.000	0.000
Aug	0.013	0.013	0.010	0.010	0.008	0.002	0.002	0.002	0.002	0.002
Sep	0.021	0.016	0.014	0.011	0.008	0.002	0.002	0.002	0.002	0.002
Natural Duration curves										
Oct	0.239	0.071	0.045	0.022	0.019	0.015	0.007	0.007	0.004	0.000
Nov	0.382	0.185	0.116	0.073	0.050	0.031	0.019	0.015	0.004	0.004
Dec	0.362	0.138	0.086	0.063	0.041	0.030	0.022	0.015	0.007	0.000
Jan	0.676	0.306	0.190	0.090	0.067	0.045	0.030	0.015	0.007	0.000
Feb	0.955	0.513	0.203	0.099	0.074	0.045	0.029	0.021	0.012	0.000
Mar	0.739	0.317	0.183	0.131	0.063	0.052	0.037	0.026	0.015	0.004
Apr	0.775	0.382	0.154	0.058	0.050	0.031	0.023	0.015	0.008	0.004
May	0.209	0.041	0.030	0.022	0.015	0.011	0.007	0.007	0.004	0.000
Jun	0.035	0.023	0.015	0.015	0.012	0.008	0.008	0.004	0.004	0.000
Jul	0.022	0.015	0.015	0.011	0.007	0.007	0.007	0.007	0.004	0.004
Aug	0.030	0.022	0.015	0.015	0.011	0.007	0.007	0.007	0.007	0.004
Sep	0.042	0.023	0.019	0.015	0.012	0.008	0.008	0.008	0.008	0.004

EWR SITE	**EWR 15**
RIVER	**Lower Vet River**
IUA	**ME2 LOWER VET RIVER**
RU	**LV2**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Printed on 04/12/2009
Summary of IFR estimate for: EWR4 Present Day Flows
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):

MAR	=	253.152
S.Dev.	=	321.554
CV	=	1.270
Q75	=	1.710
Q75/MMF	=	0.081
BFI Index	=	0.266
CV(JJA+JFM) Index	=	3.973

ERC = D

Total IFR	=	46.075	(18.20 %MAR)
Maint. Lowflow	=	13.766	(5.44 %MAR)
Drought Lowflow	=	5.999	(2.37 %MAR)
Maint. Highflow	=	32.309	(12.76 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	5.022	20.335	1.512	0.250	0.142	0.000	0.250
Nov	7.814	19.739	0.975	0.420	0.135	3.462	3.882
Dec	7.490	18.375	0.916	0.446	0.071	0.000	0.446
Jan	13.817	33.320	0.900	0.670	0.340	6.358	7.028
Feb	18.123	38.948	0.888	0.857	0.327	0.000	0.857
Mar	20.901	57.031	1.019	0.849	0.213	2.355	3.204
Apr	11.663	25.508	0.844	0.701	0.170	0.000	0.701
May	5.347	15.980	1.116	0.403	0.269	0.000	0.403
Jun	1.656	3.726	0.868	0.227	0.177	0.000	0.227
Jul	0.657	0.829	0.471	0.129	0.129	0.000	0.129
Aug	0.857	0.958	0.417	0.130	0.130	0.000	0.130
Sep	3.726	17.346	1.796	0.190	0.190	0.000	0.190

EWR SITE	**EWR 15**
RIVER	**Lower Vet River**
IUA	**ME2 LOWER VET RIVER**
RU	**LV2**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Printed on 04/12/2009
Summary of IFR rule curves for : EWR4 Present Day Flows
Determination based on defined BBM Table with site specific assurance rules.
Regional Type : Vaal ERC = D

Data are given in m^3/s mean monthly flow

	% Points								
Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.746	0.746	0.743	0.739	0.73	0.683	0.638	0.616	0.489	0.217
Nov	9.907	8.036	3.773	2.527	1.705	1.096	0.829	0.691	0.613	0.515
Dec	1.286	1.286	1.278	1.263	1.232	1.173	1.061	0.859	0.527	0.134
Jan	20.168	11.72	6.668	4.951	3.446	2.89	2.001	1.161	0.877	0.638
Feb	2.429	2.429	2.416	2.389	2.336	2.234	1.546	1.215	0.885	0.435
Mar	6.811	6.811	6.495	4.742	3.543	2.164	1.508	1.198	0.87	0.489
Apr	1.986	1.986	1.975	1.952	1.833	1.416	1.03	0.837	0.741	0.264
May	1.295	1.295	1.217	0.952	0.806	0.698	0.653	0.62	0.605	0.397
Jun	0.741	0.741	0.738	0.734	0.687	0.671	0.652	0.624	0.501	0.247
Jul	0.514	0.514	0.513	0.511	0.508	0.504	0.495	0.478	0.434	0.26
Aug	0.425	0.425	0.423	0.421	0.417	0.409	0.394	0.364	0.299	0.299
Sep	0.62	0.62	0.618	0.618	0.609	0.598	0.576	0.531	0.438	0.243
Reserve flows without High Flows										
Oct	0.746	0.746	0.743	0.739	0.73	0.683	0.638	0.616	0.489	0.217
Nov	1.211	1.211	1.204	1.191	1.164	1.096	0.829	0.691	0.539	0.191
Dec	1.286	1.286	1.278	1.263	1.232	1.173	1.061	0.859	0.527	0.134
Jan	1.9	1.9	1.89	1.87	1.831	1.755	1.611	1.161	0.877	0.42
Feb	2.429	2.429	2.416	2.389	2.336	2.234	1.546	1.215	0.885	0.435
Mar	2.364	2.364	2.35	2.323	2.269	2.164	1.508	1.198	0.87	0.324
Apr	1.986	1.986	1.975	1.952	1.833	1.416	1.03	0.837	0.741	0.264
May	1.295	1.295	1.217	0.952	0.806	0.698	0.653	0.62	0.605	0.397
Jun	0.741	0.741	0.738	0.734	0.687	0.671	0.652	0.624	0.501	0.247
Jul	0.514	0.514	0.513	0.511	0.508	0.504	0.495	0.478	0.434	0.26
Aug	0.425	0.425	0.423	0.421	0.417	0.409	0.394	0.364	0.299	0.299
Sep	0.62	0.62	0.618	0.618	0.609	0.598	0.576	0.531	0.438	0.243
Natural Duration curves										
Oct	5.458	2.722	1.456	1.225	0.747	0.683	0.638	0.616	0.590	0.571
Nov	17.708	9.942	3.773	2.527	1.705	1.096	0.829	0.691	0.613	0.571
Dec	16.054	8.098	4.103	3.192	2.438	1.889	1.113	0.881	0.661	0.620
Jan	38.482	11.720	6.668	4.951	3.446	2.890	2.001	1.161	0.877	0.638
Feb	51.372	23.280	9.788	5.783	3.679	2.331	1.546	1.215	0.885	0.682
Mar	40.121	17.671	7.389	4.742	3.543	2.445	1.508	1.198	0.870	0.803
Apr	39.032	14.653	4.730	2.832	1.833	1.416	1.030	0.837	0.741	0.667
May	9.065	4.439	1.217	0.952	0.806	0.698	0.653	0.620	0.605	0.590
Jun	2.141	1.200	0.872	0.760	0.687	0.671	0.652	0.648	0.633	0.610
Jul	0.605	0.582	0.575	0.564	0.556	0.553	0.549	0.541	0.538	0.478
Aug	1.538	0.706	0.624	0.579	0.560	0.549	0.541	0.538	0.530	0.530
Sep	3.318	1.385	0.799	0.799	0.791	0.787	0.775	0.756	0.714	0.621

EWR SITE	**EWR 12**
RIVER	**Vaal River**
IUA	**MF VAAL RIVER FROM RENOSTER TO BLOEMHOF DAM**
RU	**VB1.1**
TAB RABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Printed on 09/12/2009
Summary of IFR estimate for: Ewr1 Present Day Flows
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):

MAR	= 1574.637
S.Dev.	= 1404.751
CV	= 0.892
Q75	= 41.570
Q75/MMF	= 0.317
BFI Index	= 0.390
CV(JJA+JFM) Index	= 2.484

ERC = D

Total IFR	= 445.299	(28.28 %MAR)
Maint. Lowflow	= 195.257	(12.40 %MAR)
Drought Lowflow	= 151.187	(9.60 %MAR)
Maint. Highflow	= 250.042	(15.88 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	42.607	80.158	0.702	5.421	4.284	0.000	5.421
Nov	68.840	115.865	0.649	6.592	5.210	14.600	21.192
Dec	73.214	103.555	0.528	6.783	5.361	0.000	6.783
Jan	82.480	102.190	0.463	7.588	5.997	14.129	21.717
Feb	121.884	266.756	0.905	9.845	6.486	72.071	81.916
Mar	68.161	113.670	0.623	7.720	6.101	0.000	7.720
Apr	39.038	42.024	0.415	6.521	5.154	0.000	6.521
May	28.181	40.761	0.540	5.619	4.441	0.000	5.619
Jun	19.596	6.113	0.120	5.184	4.097	0.000	5.184
Jul	21.938	31.654	0.539	5.035	3.980	0.000	5.035
Aug	12.781	7.688	0.225	3.954	3.125	0.000	3.954
Sep	25.925	80.754	1.202	4.321	3.415	0.000	4.321

EWR SITE	**EWR 12**
RIVER	**Vaal River**
IUA	**MF VAAL RIVER FROM RENOSTER TO BLOEMHOF DAM**
RU	**VB1.1**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Printed on 09/12/2009
Summary of IFR rule curves for : Ewr1 Present Day Flows
Determination based on defined BBM Table with site specific assurance rules.
Regional Type : Vaal ERC = D

Data are given in m^3/s mean monthly flow

	% Points									
Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	10.61	10.557	10.467	10.3112	10.049	9.611	8.902	7.804	6.236	4.565
Nov	42.724	37.698	33.369	29.4198	22.628	19.838	16.217	12.25	8.832	6.929
Dec	12.514	12.395	12.165	11.7537	11.077	10.077	8.78	7.36	6.135	5.466
Jan	51.287	41.664	33.731	26.6477	17.978	13.931	11.001	9.331	7.891	7.561
Feb	216.896	75.405	56.225	39.3977	33.404	29.357	23.137	17.566	13.91	8.747
Mar	16.102	16.019	15.876	15.6312	15.215	14.522	13.402	11.666	9.187	6.545
Apr	12.944	12.85	12.678	12.3722	11.857	11.039	9.842	8.277	6.567	5.333
May	10.932	10.853	10.71	10.4555	10.026	9.344	8.347	7.043	5.618	4.59
Jun	10.607	10.553	10.46	10.3010	10.03	9.579	8.85	7.72	6.106	4.386
Jul	10.86	10.823	10.765	10.6711	10.514	10.252	9.797	8.987	7.469	4.721
Aug	9.045	9.027	9.001	8.9633	8.903	8.807	8.638	8.315	7.564	4.947
Sep	9.02	8.99	8.943	8.8666	8.739	8.525	8.154	7.494	6.258	4.019

Reserve flows without High Flows

Oct	10.61	10.557	10.467	10.311	10.049	9.611	8.902	7.804	6.236	4.565
Nov	12.226	12.11	11.885	11.48	10.817	9.836	8.564	7.171	5.97	5.313
Dec	12.514	12.395	12.165	11.753	11.077	10.077	8.78	7.36	6.135	5.466
Jan	14.312	14.213	14.029	13.703	13.152	12.279	11.001	9.331	7.505	6.188
Feb	19.546	19.438	19.251	18.931	18.387	17.484	16.02	13.753	10.516	7.065
Mar	16.102	16.019	15.876	15.631	15.215	14.522	13.402	11.666	9.187	6.545
Apr	12.944	12.85	12.678	12.372	11.857	11.039	9.842	8.277	6.567	5.333
May	10.932	10.853	10.71	10.455	10.026	9.344	8.347	7.043	5.618	4.59
Jun	10.607	10.553	10.46	10.301	10.03	9.579	8.85	7.72	6.106	4.386
Jul	10.86	10.823	10.765	10.671	10.514	10.252	9.797	8.987	7.469	4.721
Aug	9.045	9.027	9.001	8.963	8.903	8.807	8.638	8.315	7.564	4.947
Sep	9.02	8.99	8.943	8.866	8.739	8.525	8.154	7.494	6.258	4.019

Natural Duration curves

Oct	63.176	40.237	33.445	28.819	22.517	20.404	17.466	15.550	12.817	7.807
Nov	119.973	84.001	46.728	38.900	32.269	28.650	24.117	19.201	14.745	6.929
Dec	150.370	83.774	53.390	45.445	37.997	30.122	25.732	21.759	19.153	8.117
Jan	251.818	114.412	75.978	47.510	43.201	35.618	25.877	19.736	16.103	9.233
Feb	452.579	75.405	56.225	39.397	33.404	29.357	24.434	20.176	13.910	8.747
Mar	184.356	70.979	39.987	34.446	27.192	22.282	18.963	17.421	12.761	9.173
Apr	82.153	47.133	32.928	28.939	24.749	22.361	21.165	18.198	15.556	10.802
May	33.878	25.833	20.882	19.560	18.380	17.581	15.927	14.777	12.754	11.443
Jun	25.675	22.971	20.621	19.101	18.140	17.130	16.883	16.073	13.592	12.288
Jul	25.358	20.964	20.613	18.907	18.410	16.891	16.088	15.338	11.335	10.708
Aug	19.967	16.338	12.634	10.585	10.107	9.513	9.147	8.759	8.509	7.635
Sep	31.188	25.606	17.936	13.646	11.852	11.107	9.448	8.248	6.944	6.389

EWR SITE	**EWR 13**
RIVER	**Vaal River**
IUA	**MF VAAL RIVER FROM RENOSTER TO BLOEMHOF DAM**
RU	**VB1.2; VB 1.3**
TAB TABLE	**MONTHLY DISTRIBUTION**

Desktop Version 2, Printed on 09/12/2009
Summary of IFR estimate for: Ewr2 Cum Natural Flows
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):

MAR	= 2654.289
S.Dev.	= 1877.750
CV	= 0.707
Q75	= 35.510
Q75/MMF	= 0.161
BFI Index	= 0.340
CV(JJA+JFM) Index	= 2.337

ERC = C

Total IFR	= 606.747	(22.86 %MAR)
Maint. Lowflow	= 307.950	(11.60 %MAR)
Drought Lowflow	= 1.234	(0.05 %MAR)
Maint. Highflow	= 298.797	(11.26 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Vaal

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	64.651	105.441	0.609	7.254	0.029	0.000	7.254
Nov	130.295	156.933	0.465	10.700	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	157.520	0.465	15.172	0.060	0.000	15.172
Apr	58.900	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	14.180	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	4.780	0.020	0.000	4.780
Sep	29.095	87.843	1.165	5.177	0.022	0.000	5.177

EWR SITE	**EWR 13**
RIVER	**Vaal River**
IUA	**MF VAAL RIVER FROM RENOSTER TO BLOEMHOF DAM**
RU	**VB1.2; VB 1.3**
RULE TABLE	**RULE CURVES**

Desktop Version 2, Printed on 09/12/2009
Summary of IFR rule curves for : Ewr2 Cum Natural Flows
Determination based on defined BBM Table with site specific assurance rules.
Regional Type : Vaal ERC = C

Data are given in m^3/s mean monthly flow

	% Points									
Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	26.614	25.893	24.379	21.724	17.895	13.44	11.1	8.504	5.201	4.693
Nov	47.496	43.814	40.809	38.287	35.855	31.353	27.877	21.169	10.106	4.974
Dec	21.342	21.342	21.282	21.067	20.62	19.708	17.895	14.458	8.508	5.517
Jan	53.945	45.779	44.073	42.188	40.713	36.206	33.993	29.834	21.598	7.883
Feb	255.162	200.899	153.15	113.43	96.495	84.668	75.318	58.168	36.987	17.283
Mar	27.098	26.975	26.776	26.445	25.888	24.805	22.852	20.041	13.012	6.963
Apr	20.628	20.517	20.31	19.931	19.242	17.416	15.839	11.849	7.002	4.921
May	13.831	13.831	13.713	13.451	12.902	11.832	9.931	6.974	3.751	3.645
Jun	10.488	10.488	10.488	10.442	10.241	9.738	8.606	6.423	3.13	2.817
Jul	9.441	9.441	9.441	9.441	9.39	9.132	8.396	6.626	3.401	2.549
Aug	8.55	8.55	8.55	8.55	8.55	8.395	7.876	6.425	3.418	2.328
Sep	9.26	9.26	9.26	9.26	9.21	8.957	8.236	6.5	3.336	2.511

Reserve flows without High Flows

Oct	26.614	25.893	24.379	21.724	17.895	13.44	9.371	6.566	5.201	4.693
Nov	14.354	13.948	13.085	11.637	9.73	7.784	6.27	5.392	5.025	4.974
Dec	15.998	15.52	14.499	12.794	10.587	8.399	6.769	5.879	5.535	5.517
Jan	53.905	45.118	37.229	29.455	19.475	14.337	10.597	8.62	7.883	7.883
Feb	255.162	200.899	153.15	113.43	65.126	44.883	29.804	21.57	18.389	17.283
Mar	20.351	19.772	18.541	16.473	13.751	10.973	8.813	7.56	7.036	6.963
Apr	15.6	15.244	14.498	13.19	11.303	9.108	7.103	5.721	5.049	4.921
May	10.469	10.247	9.783	8.971	7.793	6.408	5.122	4.212	3.751	3.645
Jun	7.939	7.781	7.452	6.875	6.031	5.02	4.051	3.331	2.939	2.817
Jul	7.149	7.011	6.723	6.219	5.479	4.584	3.714	3.053	2.68	2.549
Aug	6.474	6.346	6.079	5.612	4.929	4.111	3.327	2.743	2.426	2.328
Sep	7.009	6.863	6.558	6.022	5.245	4.333	3.485	2.885	2.581	2.511

Natural Duration curves

Oct	190.890	95.053	42.174	30.350	23.887	20.912	14.356	11.652	5.948	4.693
Nov	373.110	177.450	141.698	107.577	76.030	50.895	40.579	27.083	13.642	9.379
Dec	379.081	230.171	155.824	124.257	106.433	80.948	59.106	39.505	21.240	11.074
Jan	340.472	208.509	167.593	145.411	122.185	102.143	74.742	58.546	31.765	16.095
Feb	562.223	265.724	153.150	113.430	96.495	84.668	75.318	58.168	36.987	17.283
Mar	247.689	190.438	118.810	85.361	68.855	55.895	45.565	39.315	24.059	14.867
Apr	148.368	84.086	59.742	46.049	38.403	32.998	24.792	21.304	13.789	7.006
May	54.712	35.984	24.279	21.020	17.869	14.886	13.288	11.753	8.027	4.495
Jun	34.684	25.567	17.677	15.691	12.766	11.076	10.258	8.762	7.299	4.626
Jul	32.534	20.934	16.010	14.490	13.448	11.753	10.279	8.886	7.799	4.641
Aug	25.026	18.209	16.140	14.240	12.407	11.410	10.353	8.718	7.557	6.145
Sep	36.215	25.120	17.666	13.777	12.257	10.498	9.306	7.816	6.354	5.548