Determination of Water Resources Classes and Resource Quality Objectives in the Breede-Gouritz WMA

July 2018

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Outline of Resource Quality Objectives Report

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Bold type indicates this Report.

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List of Abbreviations

CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Areas
DRM V2	= Version 2 of the Desktop Reserve Model
DWA	*(Previous) Department of Water Affairs*
DWAF	*(Previous) Department of Water Affairs and Forestry*
DWS	*Department of Water and Sanitation*
EC	*Ecological Category (A to E based on Kleynhans et al, 1996)*
EIA	*Environmental Impact Assessment*
EIS	*Ecological Importance and Sensitivity*
EWR	*Ecological Water Requirements*
FEPA	*Freshwater Ecosystem Priority Area*
GA	*General Authorization*
GRU	*Groundwater Resource Unit*
IUA	*Integrated Unit of Analysis*
MMP	*Maintenance Management Plan*
NEMA	*National Environmental Management Act*
NFEPA	*National Freshwater Ecosystem Priority Area*
NL	*Numerical Limit*
NWA	*National Water Act*
nMAR	*Natural Mean Annual Runoff*
NWA	*National Water Act*
PES	*Present Ecological Status*
RDRM	Revised Desktop Reserve Model
REC	*Recommended Ecological Condition*
RQOs	*Resource Quality Objectives*
RU	*Resource Unit*
TEC	*Targeted Ecological Category*
WMA	*Water Management Area*
WRC	*Water Resource Classes*
WRCS	*Water Resources Classification System*
WSA	*Water Source Area*
WULA	*Water Use License Application*

Executive Summary

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS) has commissioned a study to determine Water Resource Classes (WRCs) and associated Resource Quality Objectives (RQOs) for all significant water resources in the Breede-Gouritz Water Management Area (WMA).

The Water Resources Classification procedure have been completed in in the Breede-Gouritz and the determination of the RQOs follows on from this process. The 7-step procedure established by the Department of Water Affairs in 2011 (DWA, 2011) is being applied to determine the Resource Quality Objectives (RQOs) for river, estuary, wetland, dam and groundwater resources in the Breede-Gouritz WMA. These procedural steps to determine RQOs in the Breede-Gouritz WMA include the following:

- Step 1. Delineate the Integrated Units of Analysis (IUAs) and define the Resource Units (RUs)
- Step 2. Establish a vision for the catchment and key elements for the IUAs
- Step 3. Prioritise and select preliminary Resource Units for RQO determination
- Step 4. Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change
- Step 5. Develop draft RQOs and Numerical Limits
- Step 6. Agree Resource Units, RQOs and Numerical Limits with stakeholders
- Step 7. Finalise and Gazette RQOs.

In terms of the RQO determination process, Step 1 (Delineation), Step 2 (Visioning) have been completed as part of the Classification phase of this study. Step 3 (Prioritisation) involved the iterative process of prioritizing Resource Units using the RU prioritization tool and it is documented in the Resource Units Prioritization Report (DWS, 2018). Step 4 (Evaluation), documented in the Evaluation of Resource Units Report (DWS, 21018), entailed the selection of sub-components for RQO determination, and the selection of indicators for monitoring and propose the direction of change.

This report documents the approach adopted and the outcomes of the implementation of Step 5 (Outline) and step 6 (Stakeholder engagement) of the RQO determination procedure. Step 5 comprises the proposed draft ROQs and numerical limits (NL) for the significant water resources in the Breede-Gouritz WMA that have been developed. RQOs are narrative statements, but sometimes provide broad quantitative descriptions of the water resource. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance. Step 6 followed on Step 5 and entailed the presentation and debate of the outcomes from Steps 3 (Prioritisation), 4 (Evaluation) and 5 (Outline and Confidence Assessment) in multiple workshop sessions.

The components for which RQOs and numerical limits were provided include:

- Quantity.
- Quality
- Habitat
- Biota

There are key limitations and uncertainties which may influence the confidence of the outcomes of the RQOs and numerical limits process. These are discussed for each significant water resource on section 4.

The next step of the RQO determination process, Sub-step 5.8, involves the confidence assessment in both the RQOs and in the process followed in determining the narrative statements. The confidence in the RQOs is dependent on the accuracy of information used in the process. The assessment of confidence was undertaken for the processes applied and associated outputs at both the catchment and Resource Unit scale and is included in the Determination of Water Resources Classes and Resource Quality Objectives in the Breede-Gouritz Water Management Area: Confidence Assessment of Resource Quality Objectives report.

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1 Introduction

1.1 Background

Chapter 3 of the National Water Act prescribes a series of measures which are jointly intended to ensure protection of water resources. In accordance with these measures, the Department of Water and Sanitation (DWS), in line with Section 12 of the National Water Act (NWA), established a Water Resources Classification System that is formally prescribed by Regulations 810, dated 17 September 2010.

The Water Resources Classification System (WRCS) (DWAF, 2007a; DWA, 2011) provides guidelines and procedures for determining Water Resource Classes, Reserves and Resource Quality Objectives (RQOs).

Section 13 of the NWA states that "as soon as reasonably practicable after the Minister prescribed a system for classifying water resources, the Minister must, subject to subsection (4), by notice in the Gazette, determine for all or part of every significant water resource-

a) A class in accordance with the prescribed classification system; and

b) Resource quality objectives based on the class determined in terms of paragraph (a)."

In this context, the Chief Directorate: Water Ecosystems has commissioned the current study to determine Water Resource Classes and associated Resource Quality Objectives for all significant water resources in the Breede-Gouritz Water Management Area (WMA). Hitherto, the 7-step Water Resource Classification procedure described in the WRCS Overview Report (DWAF, 2007a) has been completed for the Breede-Gouritz WMA and has resulted in the delineation of 18 integrated units of analysis (IUAs), as well as a recommended Water Resource Class for each IUA or part thereof.

The three Water Resource Classes are defined as:

- *Class I: Minimally used*: The configuration of ecological categories of the water resources within a catchment results in an overall water resource condition that is minimally altered from its pre-development condition.
- *Class II: Moderately used*: The configuration of ecological categories of the water resources within a catchment results in an overall water resource condition that is moderately altered from its pre-development condition.
- *Class III: Heavily used*: The configuration of ecological categories of the water resources within a catchment results in an overall water resource condition that is significantly altered from its pre-development condition.

With the Classification phase of this study completed, the next phase of the study comprises the 7-step procedure (DWA, 2011) towards determination of RQOs for all significant water resources in the Breede-Gouritz WMA. The Resource Quality Objectives give effect to the Water Resource Class (Figure 1-1).

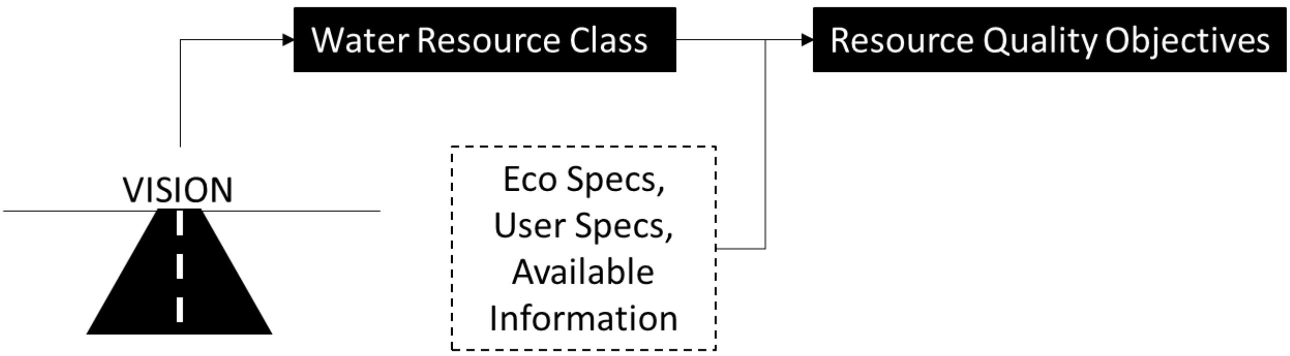

Figure 1-1 Link between Water Resource Classes and Resource Quality Objectives

During the Classification phase each Resource Unit (RU) was classified with a Targeted Ecological Category (TEC) for water resources. These RUs where then evaluated through an iterative process of prioritising the RUs within the study area, based on levels of threat in relation to conservation and socio-economic importance. To guide this selection process, and to facilitate the standard selection of prioritised resource units/sub-quaternaries, a decision support tool, named the Resource Unit Prioritisation Tool (RUPT), has been developed, using an MS Office Excel spreadsheet (DWA 2011). This tool incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU, as part of management operations, to identify important RUs. The outputs were then used for the Resource Unit Prioritisation step.

After the prioritisation of RUs the next step entailed two main tasks: firstly, the identification of sub-components that may be important to either users of the environment; and secondly, the selection of those sub-components and associated indicators for which RQOs and Numerical Limits should be developed. In order to complete these tasks, the Resource Evaluation Tool was used for the selection of sub-components and indicators for RQO determination, for RUs in the study area. The Resource Evaluation tool is a decision support tool which serves two main functions:

i. Determine the level of threat posed to each of the sub-components by impacting activities in the catchment

ii. Identify which sub-components should be protected in order to support water resource dependent activities and/or maintain the integrity and ecological functioning of the water resource (DWS< 2011:57)

Previous RQO determination studies were reviewed to determine an appropriate approach for the current study. Reports of relevant previous studies that are referred to are the RQO determination reports for the Crocodile (West), Marico, Mokolo and Matlabas catchments (DWS, 2015), for the Olifants WMA (DWS, 2014) and the Upper Vaal WMA (DWS, 2014).

1.2 Scope of this phase of the study

The main objective of this study is to determine Resource Quality Objectives (RQOs) for all significant water resources in the Breede-Gouritz WMA that must give effect to the Water Resources Classes that have been determined in the previous phase of the study. To this end the RQOs are the qualifying management factor, not the classification of the IUA and it is the requirements within the RQOs that development has to adhere to. To this end, the 7-step process for determining RQOs, described in DWA (2011) and depicted in Figure 1-2, is being implemented.

Once gazetting has been finalised, implementation, monitoring and review would then follow.

Step 1: Delineate the Integrated Units of Analysis (IUAs) and define the Resource Units (RUs)

Step 2: Establish a vision for the catchment and key elements for the IUAs

Step 3: Prioritise and select preliminary Resource Units for RQO determination

Step 4: Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change

Step 5: Develop draft RQOs and Numerical Limits

Step 6: Agree Resource Units, RQOs and Numerical Limits with stakeholders

Step 7: Finalise and Gazette RQOs

Figure 1-2 The seven-step process for RQO determination (DWA, 2011)

In terms of the RQO process outlined in Figure 1.1, Step 1 (Delineation), Step 2 (Visioning) have been completed as part of the Classification phase of this study. Step 3 (Prioritisation) involved the iterative process of prioritizing Resource Units using the RU prioritization tool and it is documented in the Resource Units Prioritization Report (DWS, 2018). Step 4 (Evaluation), documented in the Evaluation of Resource Units Report (DWS, 21018), entailed the selection of sub-components for RQO determination, and the selection of indicators for monitoring and propose the direction of change.

This report documents the approach adopted and the outcomes of the implementation of Step 5 (Outline) and step 6 (Stakeholder engagement) of the RQO determination procedure. Step 5 comprises the proposed ROQs and numerical limits (NL) for the significant water resources in the Breede-Gouritz WMA that have been developed. RQOs are narrative statements, but sometimes provide broad quantitative descriptions of the water resource. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance. Step 6 followed on Step 5 and entailed the presentation and debate of the outcomes from Steps 3 (Prioritisation), 4 (Evaluation) and 5 (Outline and Confidence Assessment) in multiple workshop sessions.

1.3 Study area

The study area covers all significant water resources of the Breede-Gouritz WMA. The catchments of the Breede River and Gouritz River and their primary tributaries, Riviersonderend, Groot, Gamka and Olifants Rivers, dominate the study area, but it also includes numerous smaller coastal catchments.

During the Classification phase of the study Resource Units for rivers, wetlands, dams, groundwater and estuaries as well as a total of 18 Integrated Units of Analysis (IUAs) were delineated in the Breede-Gouritz WMA. The IUAs approximate socio-economic boundaries, delineated to facilitate the integration of ecological and socio-economic aspects required for the evaluation of scenarios during the Classification phase of the study (DWS, 2017). The delineation of the Resource Units and the IUAs is described in the *Resource Unit and Integrated Units of Analysis Delineation Report* (DWS, 2016b).

A visioning exercise for the Breede-Gouritz WMA was undertaken with key stakeholders in the Classification phase of the study. The purpose of the visioning exercise was to articulate the aspirations of the various stakeholders for the future of the WMA. The stakeholders highlighted the key water resource issues relevant to their respective sectors, including issues relating to policy and legislation, resources, administration, capacity/empowerment and technology, and then presented their critical considerations for determining the water resource class.

The details and outcomes of the visioning exercise are documented in the Evaluation of Scenarios Report (DWS, 2017).

1.3.1 Breede River Basin and Overberg Area

Ten IUAs were delineated and a total of 114 biophysical and allocation nodes were identified in the Breede River catchment and Overberg area. The RUs delineated in the Breede River catchment and Overberg area comprise the following: 17 River RUs; 11 Estuary RUs, 6 Dam RUs; 12 Wetland RUs and 27 Groundwater RUs.

1.3.2 Gouritz River Basin and Coastal Area

Eight IUAs were delineated and a total of 148 biophysical and allocation nodes were identified in the Gouritz River catchment and Coastal area. The RUs delineated in the Gouritz River catchment and Coastal area comprise the following: 20 River RUs; 23 Estuary RUs; 2 Dam RUs; 9 Wetland RUs; and 14 Groundwater RUs.

1.4 Spatially Targeted Classification Scenario, Recommended ECs and Proposed Water Resource Classes

Chapter 5 of the Determination of Water Resources Classes and Resource Quality Objectives in the Breede-Gouritz Water Management Area: Evaluation of Scenarios Report. (DWS, 2018, Report No: RDM/WMA8/00/CON/CLA/0417), summary of results for the Ecology-driven Scenarios (Scenario 1-3), the Demand-driven Unconstrained (No EC) Scenario (Scenario 4) and the Demand-driven, Unconstrained Climate Change Scenario (Scenario 5) indicated that there is a need to find a balance between demand for water and improved ecological condition. This was also highlighted as an important consideration during the visioning exercise conducted with stakeholders (Chapter 2). Stakeholders mentioned that there is a need to meet agricultural needs for a growing population in certain IUAs, whilst there is a parallel need to meet the high ecological conditions required for important conservation areas. A spatially targeted scenario was considered to address these comments and to provide a more balanced scenario in terms of socio-economics and ecological requirements. Appendix B contains the summary of Spatially Targeted Classification Scenario, Recommended ECs and Proposed Water Resource Classes.

1.5 Prioritisation of RUs outcomes

A summary of the priority RUs for rivers, estuaries, dams, wetlands and groundwater resource units are presented below. These represent the list of proposed RUs for which RQOs should be developed.

The prioritized RUs for determining RQOs have been identified using the following criteria:

- The top 17 river priority RUs in the Breede and Overberg IUAs and the top 20 river priority RUs in the Gouritz and Coastal IUAs
- Estuaries with a priority weighting of ≥ 0.5
- Dams determined from prioritisation process with a priority weighting of > 0.5
- Wetlands RUs as determined from the prioritisation process
- Groundwater RUs with a priority level of 3.

The resource units listed in Table 1-1 and Table 1-2 and mapped in Figure 1-2 and Figure 1-4 are the preliminary RU prioritised during the previous step (Step 3) of the RQO process.

Table 1-1 Summary of results of the prioritisation process for the Breede and Overberg IUAs

IUA	Prioritised Resource Units (RUs)				
	River	Estuary	Dam	Wetland	Groundwater
A1 Upper Breede Tributaries	nviii1 Breede nvii2 Molenaars		Ceres Koekedouw	Strategic Water Source wetlands	BB-1 (H10A) BB-1 (H10B) BB-1 (H10C) BB-3 (H10F) BB-3 (H10J) BB-2 (H20B) BB-2 (H20C)
A2 Breede Working Tributaries	nvii7 Hex		Greater Brandvlei	East Coast Shale Renosterveld Channelled Floodplain (Papenkuils)	BB-3 (H10G) BB-3 (H10H) BB-3 (H10L) BB-2 (H20A) BB-2 (H20F) BB-5 (H20H) BB-6 (H30B) BB-4 (H40B) BB-5 (H40C) BB-7 (H40J)
A3 Middle Breede Renosterveld	nvii8 Breede ni2 Breede			East Coast Shale Renosterveld Floodplain (Breede)	BB-7 (H40K)

IUA	Prioritised Resource Units (RUs) River	Estuary	Dam	Wetland	Groundwater
B4 Riviersonderend Theewaters	nvii10 Du Toits nv7 Riviersonderend niv28 Baviaans nv9 Riviersonderend		Theewaterskloof	Strategic Water Source wetlands	BR-1 (H60A) BR-1 (H60B) BR-1 (H60C)
F9 Lower Riviersonderend	ni3 Riviersonderend				
B5 Overberg West	piii1 Palmiet piii2 Palmiet piii3 Palmiet	Palmiet	Eikenhof Kogelberg Arieskraal No.2	Strategic Water Source wetlands (Palmiet)	BO-1 (G40C) BO-1 (G40D)
H16 Overberg West Coastal		Buffels Rooiels Bot Onrus		Southwest Sand Fynbos Channelled Valley Bottom (Kleinmond) Strategic Water Source wetlands	BO-2 (G40H)
F10 Overberg East Renosterveld	nv23 Klein			Southwest Ferricrete Fynbos Floodplain (Kars)	BO-3 (G50D)
H17 Overberg East Fynbos	ni4 Nuwejaar nv24 Kars	Klein Uilkraals Ratel Heuningnes Klipdriftsfontein		Southwest Ferricrete Fynbos Floodplain, Flat, Depression (Agulhas) East Coast Shale Renosterveld Floodplain (De Hoop Vlei) South Strandveld Western Strandveld Flat/Seep (Heuningnes)	BO-3 (G50B) BO-3 (G50E)
F11 Lower Breede Renosterveld	niii4 Breede	Breede		East Coast Shale Renosterveld Floodplain (Breede)	
TOTALS	**17**	**11**	**6**	**12**	**27**

Table 1-2 Summary of results of the prioritisation process for the Gouritz and Coastal IUAs

IUA	Prioritised Resource Units (RUs) River	Estuary	Dam	Wetland	Groundwater
C6 Gamka Buffels				Upper Nama Karoo Depression Lower Nama Karoo Depression	GGr-3 (J11E) GGa-2a, 2b and 2c (J21A) GGa-2a, 2b and 2c (J21B) GGa-2a, 2b and 2c (J23A) GGa-1 (J24B)
E8 Touws	gviii1 Doring gv5 Touws gv4 Buffels gv6 Groot gii3 Groot			Strategic Water Source Wetlands	GGr-1 (J12C) GGr-1 (J12D)
D7 Gouritz-Olifants	giv20 Gamka giii2 Olifants gv36 Kammanassie		Stompdrift		GO-4 (J35B)
F13 Lower Gouritz	gi4 Gouritz	Gouritz		Albany Thicket Floodplain (Gouritz)	GGo-1 (J40C) GGo-1 (J40D)

IUA	Prioritised Resource Units (RUs)				
	River	Estuary	Dam	Wetland	Groundwater
F12 Duiwenhoks	giii8 Duiwenhoks	Duiwenhoks		East Coast Shale Renosterveld Channelled Valley Bottom (Goukou) East Coast Shale Renosterveld Channelled Valley Bottom (Duiwenhoks)	
I18 Hessequa	giii7 Goukou	Goukou			GGo-2A and 2B (H90E)
G14 Groot-Brak	gviii2 Groot-Brak	Klein Brak Groot Brak Blinde Tweekuilen Gericke Hartenbos	Wolwedans		GC-1 (K20A)
G15 Coastal	gvii9 Malgas gvii11 Kaaimans giii10 Diep gvii13 Karatara gviii9 Goukamma gvii14 Knysna gviii11 Gouna giv6 Keurbooms	Maalgate Gwaing Kaaimans Wilderness Swartvlei Goukamma Knysna Noetsie Piesang Keurbooms Matjies Sout (Oos) Groot (Wes) Bloukrans		Freshwater Lake (Groenvlei) Freshwater Lake (Wilderness Lakes) Strategic Water Source wetlands	GC-2 (K40D) GC-3 (K70A)
TOTALS	**20**	**23**	**2**	**9**	**14**

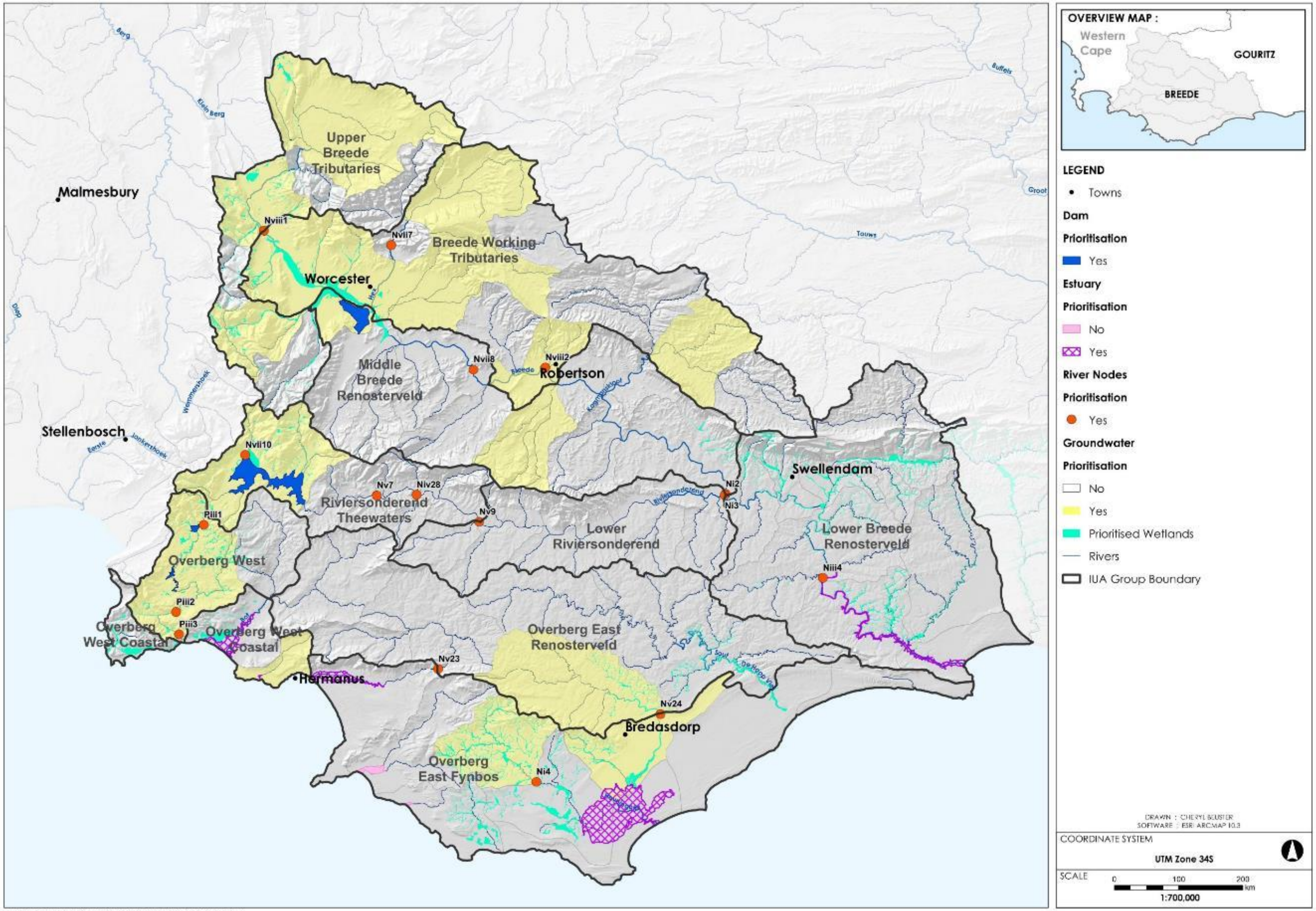

Figure 1-3 Summary of results of the prioritisation process for the Breede and Overberg IUAs

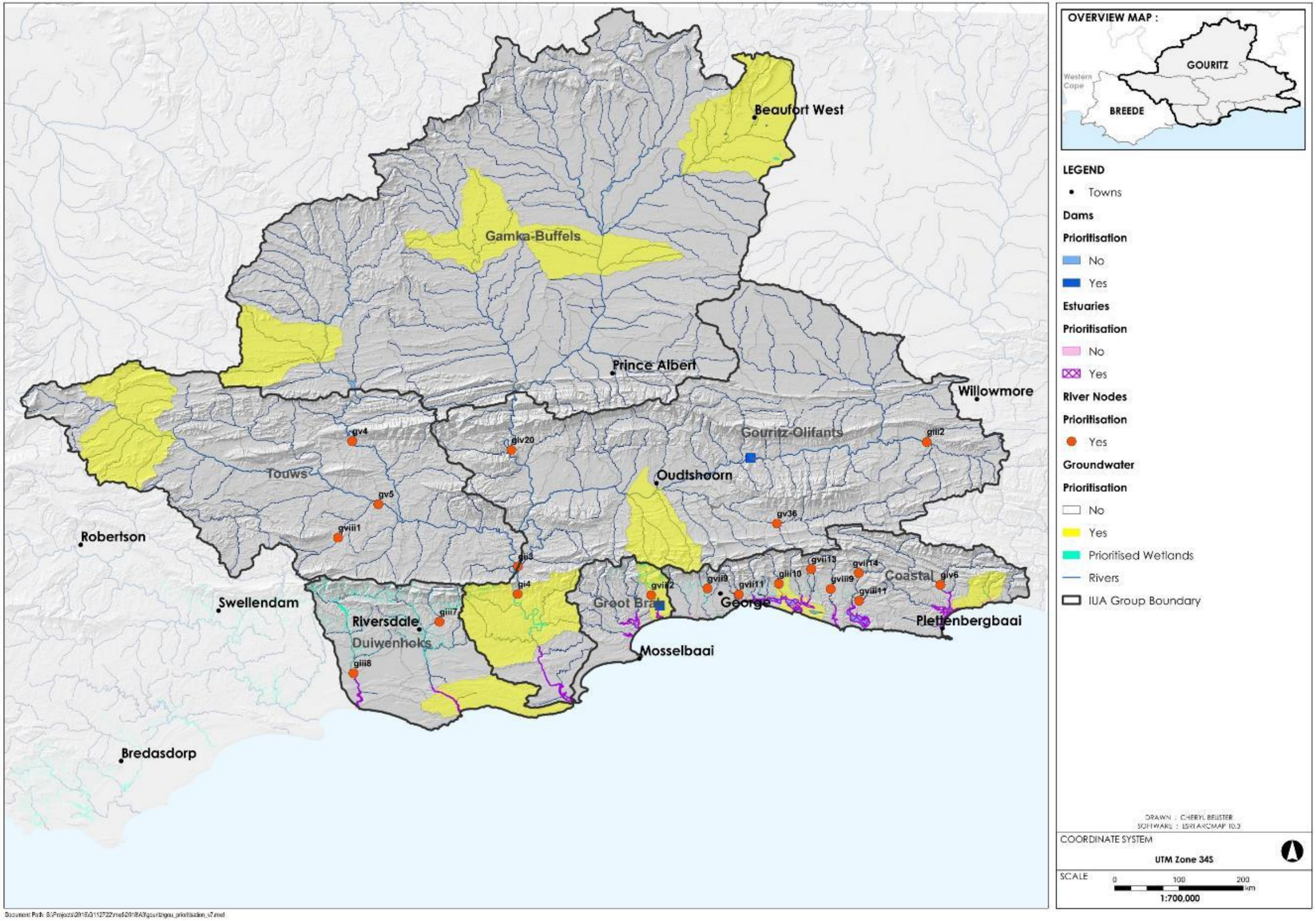

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Figure 1-4 **Summary of results of the prioritisation process for the Gouritz and Coastal IUAs**

1.6 Evaluation of RUs outcomes

A total of 47 sub-components were selected for RQO determination during Step 4 of the RQO determination procedure in the Breede-Gouritz WMA, including:

- 11 sub-components were selected to represent river resources from 37 prioritised RUs.
- 13 sub-components were selected to represent estuaries resources from 34 prioritised RUs.
- 7 sub-components were selected to represent dam resources from 8 prioritised RUs.
- 9 sub-components were selected to represent wetlands resources from 21 prioritised RUs.
- 7 sub-components were selected to represent groundwater resources from 41 prioritised RUs.

Table 1-3 comprises a summary of the selected sub-components on the different significant water resources for the Breede-Gouritz WMA.

Table 1-3 Summary of sub-component prioritisation selection for the Breede-Gouritz WMA

Component	Sub-component	Rivers	Estuaries	Dams	Wetlands	Groundwater
Quantity	Abstraction					x
	Groundwater level					x
	High flows	x	x	x	x	
	Low flows	x	x	x		x
	Discharge					x
	Hydroperiod				x	
Quality	Nutrients	x	x	x	x	x
	Salts	x	x	x		x
	System variables (temperature, oxygen, pH, turbidity	x	x			
	Toxins	x				
	Pathogens	x	x	x		x
Habitat	Geomorphology	x			x	
	Vegetation/Riparian vegetation	x			x	
	Hydrodynamics		x			
	Sediments		x			
Biota	Micro-algae		x			
	Macrophytes		x			
	Invertebrates	x	x		x	
	Fish	x	x	x		
	Birds		x		x	
	Amphibians & reptiles				x	
	Diatoms				x	
	Phytoplankton			x		
	Totals	**11**	**13**	**7**	**9**	**7**

2 Approach

2.1 Resource Quality Objectives process overview

For the determination and implementation of RQOs, a seven-step procedure was established (DWA, 2011). This process is interlinked with the Water Resources Classification process and forms part of an Adaptive Management Cycle that is used as an improved water resources management practice. Overall the Adaptive Management Cycle process consists of delineating the resource units (RU), setting a vision for the catchment, prioritise, select and evaluate RU for RQO, drafting RQOs and numerical limits, agree these with the stakeholders to finalise and Gazette the RQOs, and finally moving to implementing, monitoring and reviewing before restarting the process for corrections and improvements.

Ideally the RQOs should be set for each Resource Unit, as per the Water Resource Classification System recommendations. In reality however, due to the large number of Resource Units within Breede-Gouritz WMA, it is necessary to prioritise and select the most useful Resource Units for RQO determination. In terms of the seven step RQO determination process, Step 1 (Delineation) and Step 2 (Visioning) have been explained and completed as part of the Classification phase of this study (Figure 2-1). The Step 3 of the Procedure to Determine and Implement Resource Quality Objectives (DWA, 2011) purpose is to select and prioritise preliminary Resource Units using the RU prioritisation tool for RQO determination. The evaluation of the RU priority ratings for selection are then done (Step 4), and the RQOs and numerical limits are drafted (Step 5). These will then be discussed and agreed at the stakeholder engagement workshops (Step 6). This process will allow to select at least one RU to represent each IUA that will then be monitored after the gazetting of the RQOs (Step 7).

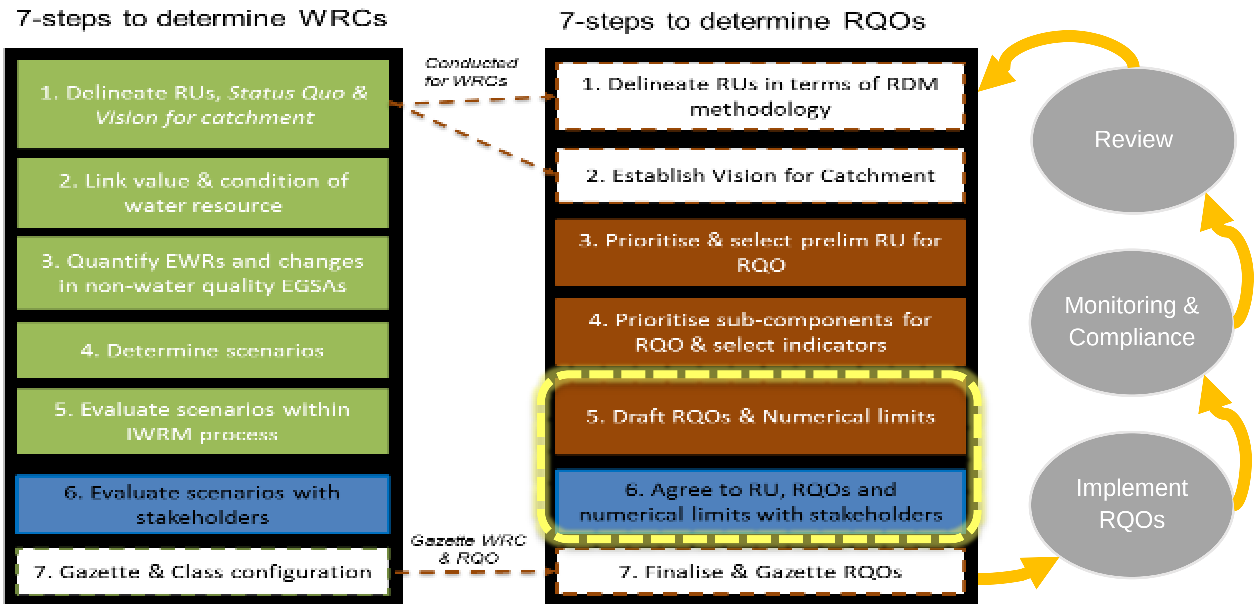


Figure 2-1 Integration of the seven-step processes for WRC determination and the RQO determination (DWA, 2011), incorporating the three additional steps to implement the Adaptive Management Cycle

Management, monitoring and compliance are the three additional steps of the Adaptive Management Cycle to be implemented after the seven step RQO process. This introduces a continual learning and improvement procedure to be in place which allows to make changes to align the RQOs with the vision for the resource. The changes, if needed, will indicate that the measures in place to protect the water resource are not sufficient to comply with the RQOs set, or alternatively that the RQOs set are not realistic, and it will be required to restart the process to correct these issues.

2.2 Resource Quality Objectives and numerical limits overview

Based on the prioritisation of sub-components undertaken in Step 4 (Evaluation), Step 5 (Outline) focuses on developing of Resource Quality of Objectives and proposing Numerical Limits, where applicable, for rivers, estuaries, dams, wetlands and groundwater in the Breede-Gouritz WMA. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance.

A few sub-steps are followed during Step 5. These are briefly enumerated below:

1. Carry over sub-component and indicator information from the Resource Unit Evaluation Tool
2. Extract available data to determine the present state for selected sub-components and indicators
3. Assess the suitability of the data
4. Where necessary, collect data to determine the Present State for selected indicators
5. Determine the level at which to set RQOs
6. Set appropriate draft RQOs
7. Set appropriate draft Numerical Limits in line with the draft RQO
8. Determine confidence in the RQOs and process

The components for which RQOs and numerical limits were provided include:

- Quantity.
- Quality
- Habitat
- Biota

2.3 Stakeholder engagement workshops overview

Step 6 of the RQO determination process, entailed the presentation and debate of the outcomes from Steps 3 (Prioritisation), 4 (Evaluation) and 5 (Outline and Confidence Assessment) in multiple workshop sessions. The aim of this step is to present and refine:

1. The Resource Unit selection with stakeholders;
2. The sub-components and indicators selected for RQO determination;
3. The proposed direction of change and associated rationale; and
4. The Draft RQOs and Numerical Limits.

The workshop sessions were held between March and June 2018, as follows:

- Technical Task Group Meeting 2, from 12 to 16 March 2018
- Sector Meeting 1: Estuaries, on 17 April 2018
- Sector Meeting 2: Agriculture, on 24 May 2018
- Project Steering Committee Meeting 3, on 12 June 2018
- Sector Meeting 3: Municipalities (and Agriculture), on 13 June 2018.

At the stakeholder workshop sessions, the proposed RUs, sub-components and indicators were presented and discussed with stakeholders and the final RUs, sub-components and indicators were reviewed, updated and refined. Furthermore, all the comments received have been addressed and incorporated in the relevant sections of this report.

3 Results

3.1 River RQOs and numerical limits

RQOs over and above the standard Ecological Reserve hydrological data are only generated for priority resource units/sub-quaternaries represented by priority nodes.

To facilitate the standard selection of priority nodes, a Resource Unit Prioritisation Tool was developed (DWA 2011), which uses criteria, ratings and weights to assist in prioritization of RUs for which RQOs should be developed. The application of this tool to the Breede River Basin is reported in DWA (2018): Breede Gouritz Resource Unit Prioritization Report. The high priority nodes coincide with the sites at which EWR determinations were done, and it is these studies that provide the detail needed for the RQOs and TPCs.

The RQOs and TPC for these nodes are provided in this Section. Additional detail on status at the time of the EWR study (ies), and reasoning behind selection of the RQOs is provided in DWS 2002a, in DWS 2015 and in DWA (2009).

3.1.1 Ecological infrastructure

Ecological infrastructure has been accounted for in the tables below (Table 3-1and Table 3-2) and the figures that follow (Figure 3-1 to Figure 3-18). Data in the tables are presented for all quaternary catchments in the study area. The Recommended Ecological Category from the various EWR studies are presented next to the baseline conditions (PES 2014, DWS 2014) and the Target Ecological Category (TEC) and the percentage of the natural Mean Annual Runoff (DWS 2018 Scenarios Report). Quaternary catchments are annotated where the TEC is greater than a C category, (EC>C) the rivers are in good condition, where the baseline flow is greater than 70% of natural (WSA = water source area, flowing close to natural), where there are Freshwater Ecosystem Protected Areas (FEPA), where indigenous fish populations occur (FishCons), and where there are Critical Biodiversity Areas (CBA) and Ecological Support Areas.

Quaternary catchments that contain one of these important features that were not modelled in the analysis of scenarios as part of the Classification project are highlighted in yellow. These areas are expanded upon in the figures that follow and are represented to highlight ecological infrastructure for the purposes of water resource planning and future developments. It is proposed that should plans to develop water resource infrastructure or other developments in these sensitive areas then all requirements of Conservation of Agricultural Resources Act (CARA), National Environmental Management Act (NEMA) and the National Water Act (NWA), as required, must be fulfilled. This may include but not be limited to a General Authorization (GA), a Water Use License Application (WULA), a Rapid III Reserve study, an Environmental Impact Assessment (EIA), an Maintenance Management Plan (MMP) and so on.

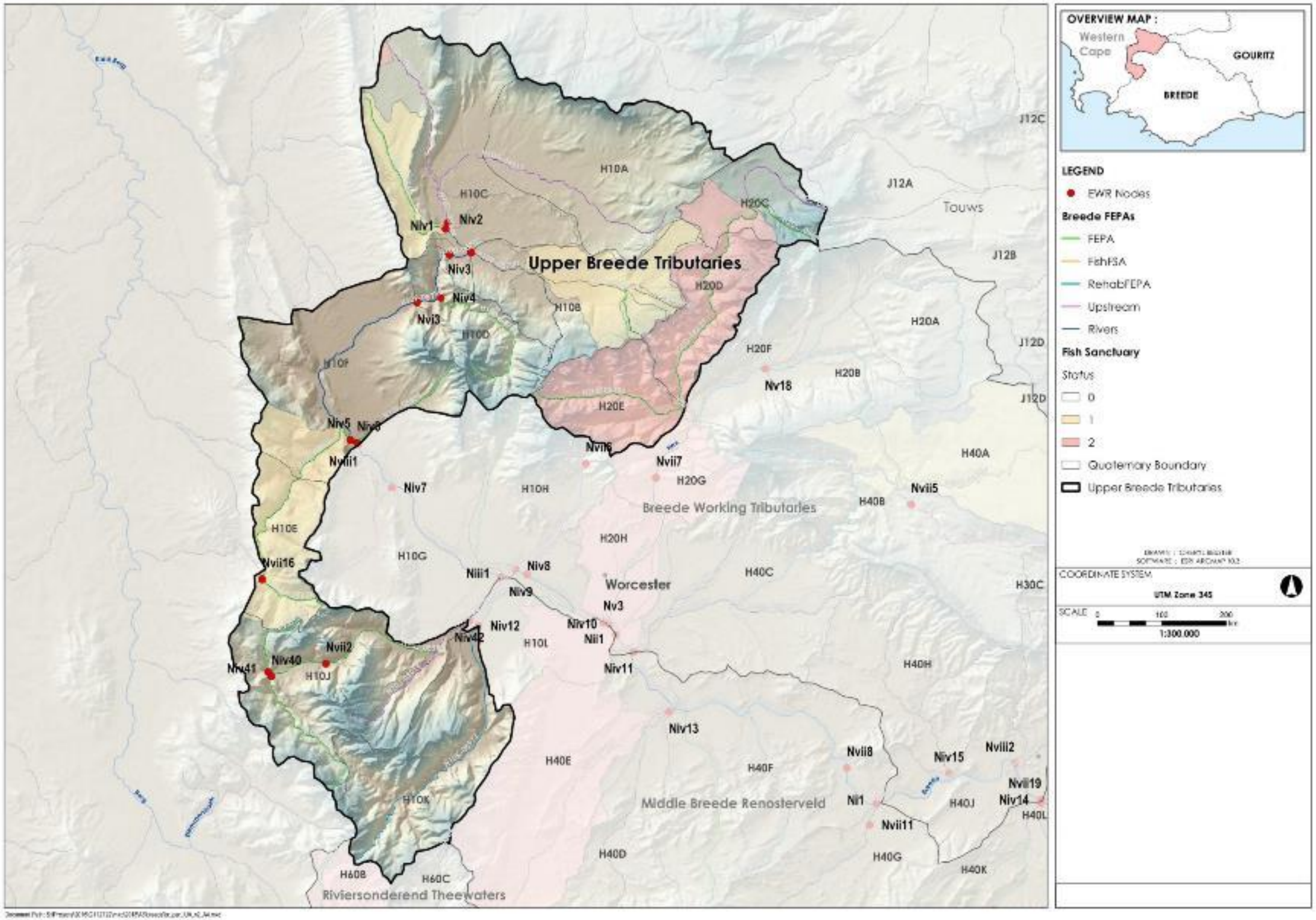
Table 3-1 Ecological infrastructure in the Breede River basin and the Overberg region

IUA	RU	Quat	Node	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
A1 UppBreedeTributaries		H10A		Modder		D					Upstream			
A1 UppBreedeTributaries		H10B	Niv3	Titus		C	C	52.13			Fish	x		
A1 UppBreedeTributaries		H10C	Niv1	Koekedou		D	D	73.22			FEPA	x		
A1 UppBreedeTributaries		H10C	Niv2	Dwars		C	C	59.59			Upstream			
A1 UppBreedeTributaries		H10C	nvi4	Breede		C	C	55.94						
A1 UppBreedeTributaries		H10D	Niv4	Witels		A	A	100.00	x	x	FEPA			
A1 UppBreedeTributaries		H10D	Nvi3	Breede		C	C	56.44						
A1 UppBreedeTributaries		H10E	Nvii16	Witte		A	A	91.71	x	x	FEPA	x		
A1 UppBreedeTributaries		H10F	Niv5	Witte		A	A	83.13	x	x	FEPA	x	x	
A1 UppBreedeTributaries		H10F	Niv6	Wabooms		D	D	36.67			FEPA			
A1 UppBreedeTributaries		H10F	Nviii1	Breede	D	D/E	D/E	55.19			FEPA			
A1 UppBreedeTributaries		H10J	Niv40	Elands		B	B	89.88	x	x	FEPA			
A1 UppBreedeTributaries		H10J	Niv41	Krom		B	B	89.88	x	x	FEPA	x		
A1 UppBreedeTributaries		H10J	Nvii2	Molenaars	B	B	B	89.88	x	x	FEPA			
A2 MiddleBreede-Renoster		H40D	Niv13	Doring		E	E	66.94			Fish			
A2 MiddleBreede-Renoster		H40E		Hoeks		D					Fish			
A2 MiddleBreede-Renoster		H40F	Nvii8	Breede	C/D	C/D	D	50.52			Rehab		x	
A2 MiddleBreede-Renoster		H40F	Ni1	Breede		B	B	48.90	x		Rehab		x	
A2 MiddleBreede-Renoster		H40G	Nvii11	Poesjenels		D	D	47.11						
A2 MiddleBreede-Renoster		H40H	Niv15	Vink		D	D	71.91		x				
A2 MiddleBreede-Renoster		H40J	Nviii2	Willem Nels		D	D	84.27		x				x
A2 MiddleBreede-Renoster		H40J	Nvii19	Breede		B	B	48.93	x				x	
A2 MiddleBreede-Renoster		H40K	Nvii12	Keisers		D	D	50.65			FEPA		x	
A2 MiddleBreede-Renoster		H40K	Niv14	Keisers		D	D	48.55						
A2 MiddleBreede-Renoster		H40L	Nvi1	Breede		D	D	48.99					x	
A2 MiddleBreede-Renoster		H30E	Nii2	Kogmanskloof		D	D	64.11					x	
A2 MiddleBreede-Renoster		H50A	Niii3	Breede		D	D	49.08					x	
A2 MiddleBreede-Renoster		H50B	Ni2	Breede		D	D	49.09					x	
A3 BreedeWorkTributaries		H10G	Niv7	Slanghoek		D	D	47.88			Upstream		x	
A3 BreedeWorkTributaries		H10G	Niii1	Breede		D	D	54.82					x	

IUA	RU	Quat	Node	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
A3 BreedeWorkTributaries		H10J	Niv42	Smalblaar		E	E	89.88		x	Upstream		x	
A3 BreedeWorkTributaries		H10H	Niv8	Jan du Toit		D	D	55.72			FEPA	x	x	
A3 BreedeWorkTributaries		H10H	Nvii6	Hartbees		D	D	50.84			Upstream			
A3 BreedeWorkTributaries		H10H	Niv9	Hartbees		D	D	53.80			Upstream		x	
A3 BreedeWorkTributaries		H10K	Niv12	Holsloot		C	C	60.41			Rehab			
A3 BreedeWorkTributaries		H10H	Nv3	Breede		C	C	53.25			Fish		x	
A3 BreedeWorkTributaries		H10L		Holsloot		C					Rehab			
A3 BreedeWorkTributaries		H20A		Hex		D					Rehab			
A3 BreedeWorkTributaries		H20B		Hex		D					Rehab			
A3 BreedeWorkTributaries		H20C		Spek		B					FEPA			
A3 BreedeWorkTributaries		H20D		Spek		B					FEPA			
A3 BreedeWorkTributaries		H20E		Amandel		B					FEPA	x		
A3 BreedeWorkTributaries		H20F	Nv18	Hex		D	D/E	41.16			Rehab		x	
A3 BreedeWorkTributaries		H20G	Nvii7	Hex	C	C	C	79.43		x	Fish	x	x	
A3 BreedeWorkTributaries		H20H	Niv10	Hex		D	D	46.46			Fish		x	
A3 BreedeWorkTributaries		H40A		Die Brak		D					Fish			
A3 BreedeWorkTributaries		H40C	Nii1	Breede		C	C	52.51			Fish		x	
A3 BreedeWorkTributaries		H40B	Nvii5	Koo		D	D	56.23			Upstream		x	
A3 BreedeWorkTributaries		H40C	Niv11	Nuy		E	E	22.46					x	
A3 BreedeWorkTributaries		H30A		Groot		D					FEPA			
A3 BreedeWorkTributaries		H30B	Niv18	Kingna		D	D	53.25			Rehab			x
A3 BreedeWorkTributaries		H30C	Niv20	Pietersfontein		D	D	78.85		x				
A3 BreedeWorkTributaries		H30D	Nvii9	Keisie		D	D	80.05		x				
B4 Riviersonderend-Theewaterskloof		H60A		Riviersonderend		C					FEPA	x		
B4 Riviersonderend-Theewaterskloof		H60B	Nvii10	Du Toits		B	B	90.12	x	x	FEPA	x		
B4 Riviersonderend-Theewaterskloof		H60C		Elands		D								
B4 Riviersonderend-Theewaterskloof		H60D	Nv7	Riviersonderend		D	C	53.58					x	
B4 Riviersonderend-Theewaterskloof		H60E	Niv28	Baviaans	B	B	B	84.98	x	x	FEPA	x	x	
B4 Riviersonderend-Theewaterskloof		H60E	Niv29	Sersants		D	D	84.99		x	Rehab			
B4 Riviersonderend-Theewaterskloof		H60F	Niv30	Gobos		C	C	80.19		x	FEPA	x	x	
B4 Riviersonderend-Theewaterskloof		H60F	Nv9	Riviersonderend	D	D	D	56.66					x	

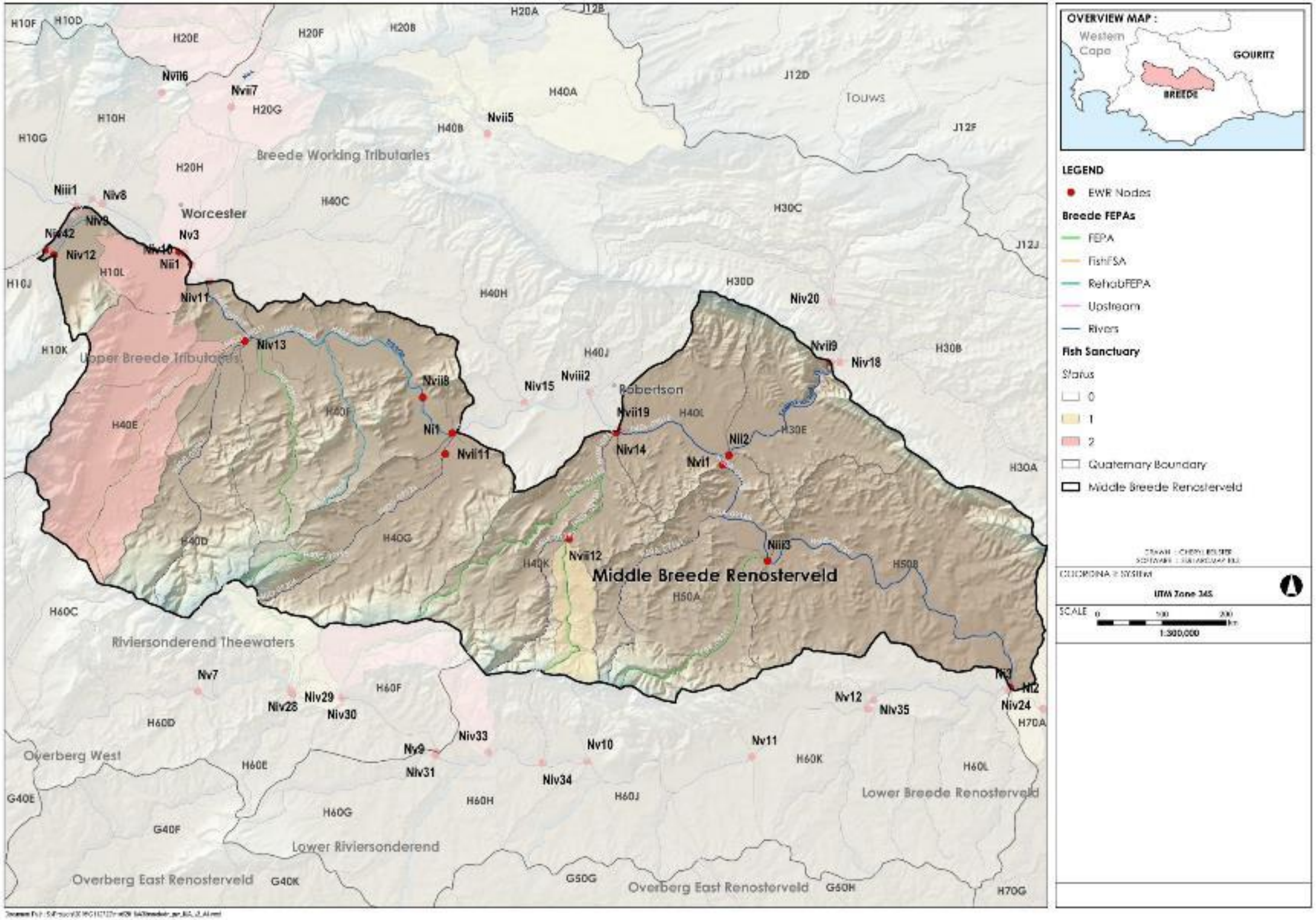
IUA	RU	Quat	Node	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
F9 LowerRiviersonderend		H60G	Niv31	Kwartel		D	D	87.22		x			x	
F9 LowerRiviersonderend		H60H	Niv33	Soetmelksvlei		D	D	59.50					x	
F9 LowerRiviersonderend		H60H	Niv34	Slang		D	D	59.52					x	
F9 LowerRiviersonderend		H60H	Nv10	Riviersonderend		D	D	55.93					x	
F9 LowerRiviersonderend		H60J	Nv11	Riviersonderend		D	D	56.74					x	
F9 LowerRiviersonderend		H60K	Niv35	Kwassadie		E	E	77.38		x			x	
F9 LowerRiviersonderend		H60K	Nv12	Riviersonderend		D	D	56.41					x	
F9 LowerRiviersonderend		H60L	Ni3	Riviersonderend		D	D	52.67					x	
F11 LowerBreede-Renosterveld		H70A	Niv24	Leeu		E	E	79.97		x	Fish	x	x	
F11 LowerBreede-Renosterveld		H70B	Niv24a	Klip		E	E	90.52		x	Upstream	x		
F11 LowerBreede-Renosterveld		H70B	Nv2	Breede		C	C	51.87					x	
F11 LowerBreede-Renosterveld		H70C	Nvii14	Huis		C	C	71.49		x	Rehab	x	x	
F11 LowerBreede-Renosterveld		H70C	Nii3	Tradouw		B	B	71.86	x	x	Rehab	x		
F11 LowerBreede-Renosterveld		H70D		Grootvadersbos		D					Rehab			
F11 LowerBreede-Renosterveld		H70E		Uilshoek		D					Rehab			
F11 LowerBreede-Renosterveld		H70F	Niv25	Buffeljags		E	E	70.14		x	Upstream		x	
F11 LowerBreede-Renosterveld		H70G	Niii4	Breede	B/C	C	C	53.40					x	
F11 LowerBreede-Renosterveld		H70H	Nviii3	Breede		B	B/C	53.57	x		FEPA		x	
F11 LowerBreede-Renosterveld		H70J	Niv26	Slang		E	E	84.51		x	Upstream		x	
B5 OvergbergWest		G40C	Piii1	Palmiet	B	C	C	87.40		x	Rehab		x	
B5 OvergbergWest		G40C	Piv10	Witklippieskloof		D	D	40.31						
B5 OvergbergWest		G40C	Piv9	Palmiet		D	D	33.17			Rehab		x	
B5 OvergbergWest		G40C	Pvi1	Palmiet		D	D	45.50			Rehab		x	
B5 OvergbergWest		G40C	Piv8	Klipdrif		D	D	93.23					x	
B5 OvergbergWest		G40D	Piv4	Klein-Palmiet		D	D	72.24						
B5 OvergbergWest		G40D	Piv7	Krom/Ribbok		D	D	22.21						
B5 OvergbergWest		G40D	Piii2	Palmiet	B/C	B/C	B/C	49.11			FEPA			
B5 OvergbergWest		G40D	Piv12	Dwars/Louws		C	C	98.85		x		x		
B5 OvergbergWest		G40D	Piii3	Palmiet	B	B	B	57.99	x		FEPA		x	
H16 OverbergWestCoastal		G40F	Niv43	Swart		E	E	78.55		x			x	
H16 OverbergWestCoastal		G40G		Bot		C								

IUA	RU	Quat	Node	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
H16 OverbergWestCoastal		G40B		Rooiels		B					FEPA			
H16 OverbergWestCoastal		G40E	Niii5	Bot		C	C	77.83		x			x	
F10 OverbergEast-Renosterveld		G40J	Nii4	Hartbees		D	D	79.12		x			x	
F10 OverbergEast-Renosterveld		G40K	Niv45	Steenbok		E	E	91.31		x			x	
F10 OverbergEast-Renosterveld		G40K	Nv23	Klein	C	C/D	C/D	84.71		x		x		
F10 OverbergEast-Renosterveld		G50G	Nii6	Sout		D	D	70.61		x			x	
F10 OverbergEast-Renosterveld		G50H	Nii7	DeHoopVlei		B	B	89.04	x	x	FEPA		x	
H17 OverbergEast-Fynbos		G40H		Onrus		E					Fish	x		
H17 OverbergEast-Fynbos		G40L		Klein		C						x		
H17 OverbergEast-Fynbos		G40M	Nx8	Uilkraal		C	C	58.37			Rehab	x	x	
H17 OverbergEast-Fynbos		G50A		Ratel/Haelkraal		C					Fish	x		
H17 OverbergEast-Fynbos		G50B	Ni4	Nuwejaar	D	D	D	45.46			Fish		x	
H17 OverbergEast-Fynbos		G50C	Nvii15	Heuningnes		D	D	46.12			Fish			
H17 OverbergEast-Fynbos		G50C	Niv44	Heuningnes		D	D	46.21			Fish	x	x	
H17 OverbergEast-Fynbos		G50D	Nv24	Kars	B	B/C	B/C	89.16	x	x	FEPA			
H17 OverbergEast-Fynbos		G50E	Nii5	Kars		E	E	84.73		x	FEPA			
H17 OverbergEast-Fynbos		G50K		Klipdrifsfontein		B	A				FEPA			



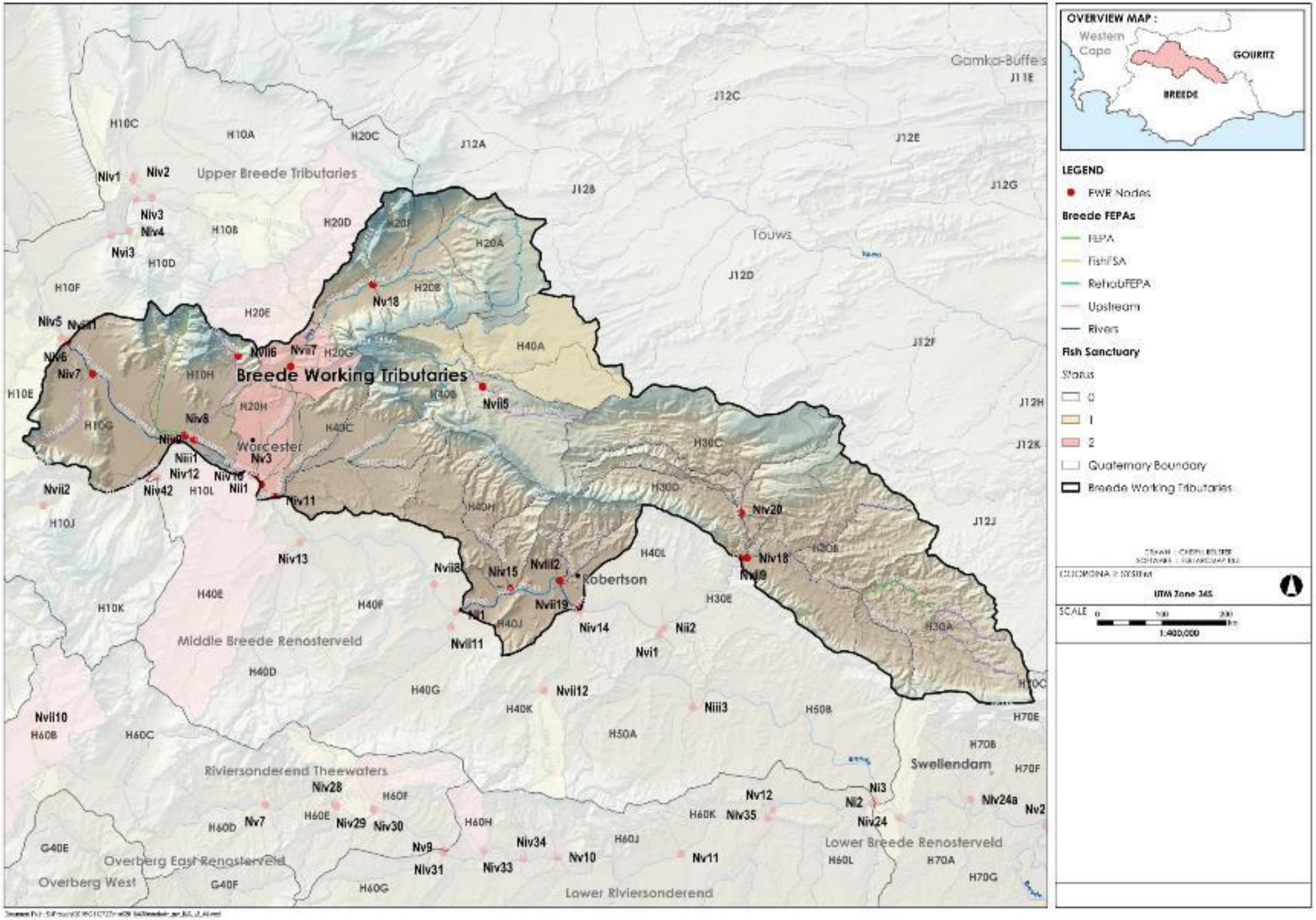
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-1 A1 Upper Breede Tributaries – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale) and Fish sanctuary areas (at quaternary scale)



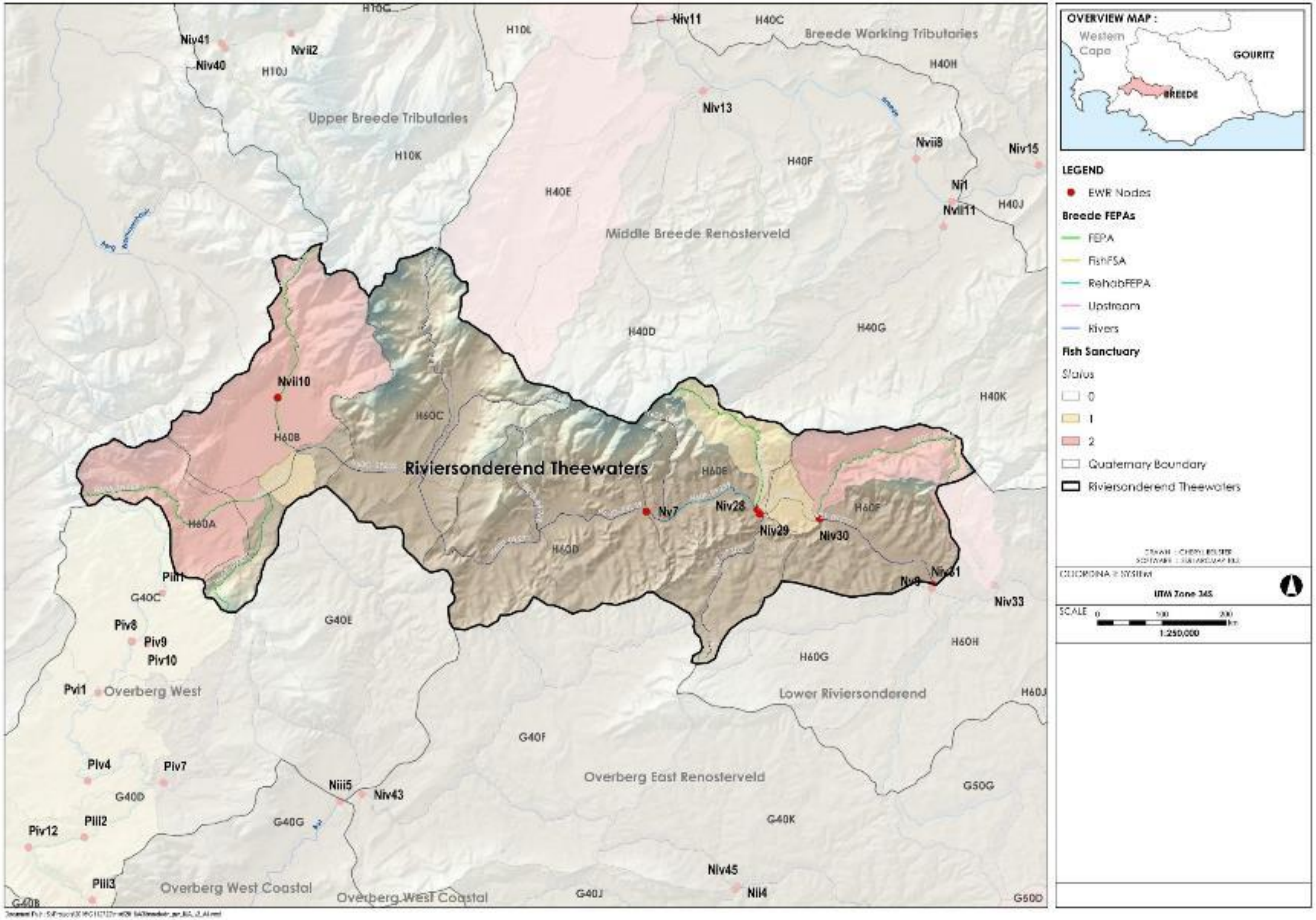
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-2 A2 Middle Breede Renosterveld – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



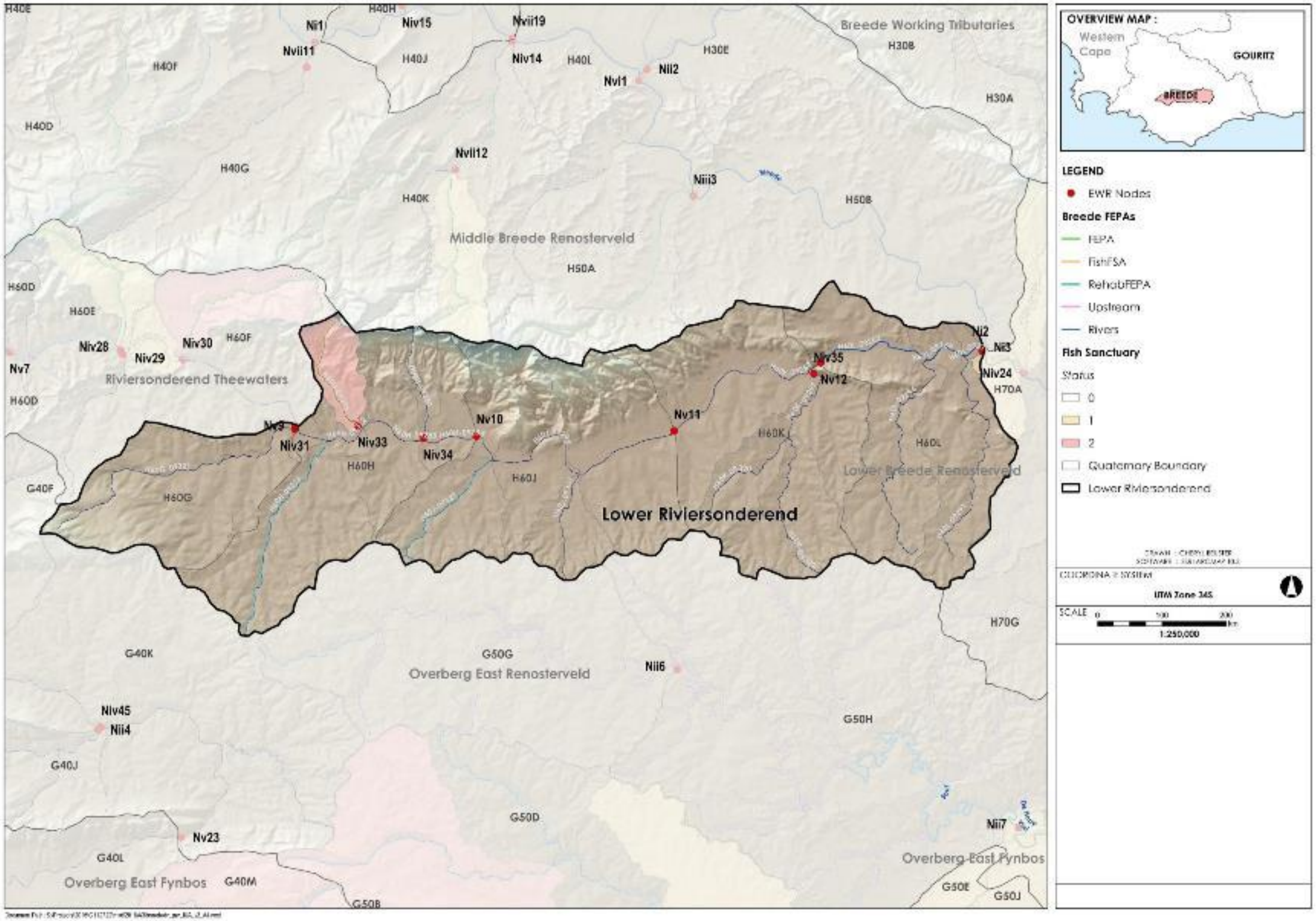
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-3 A3 Breede Working Tributaries – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



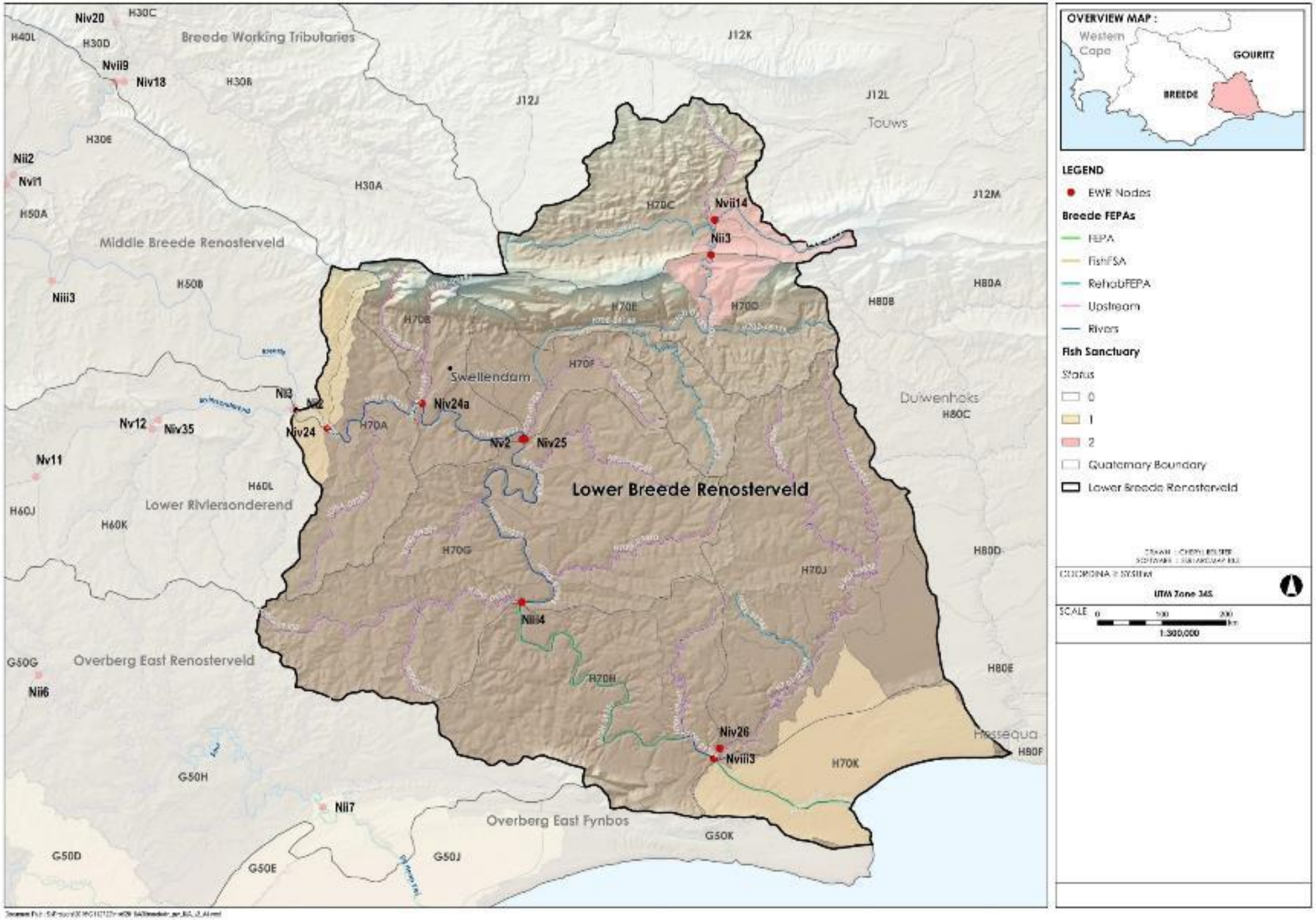
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-4 B4 Riviersonderend Theewaters – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



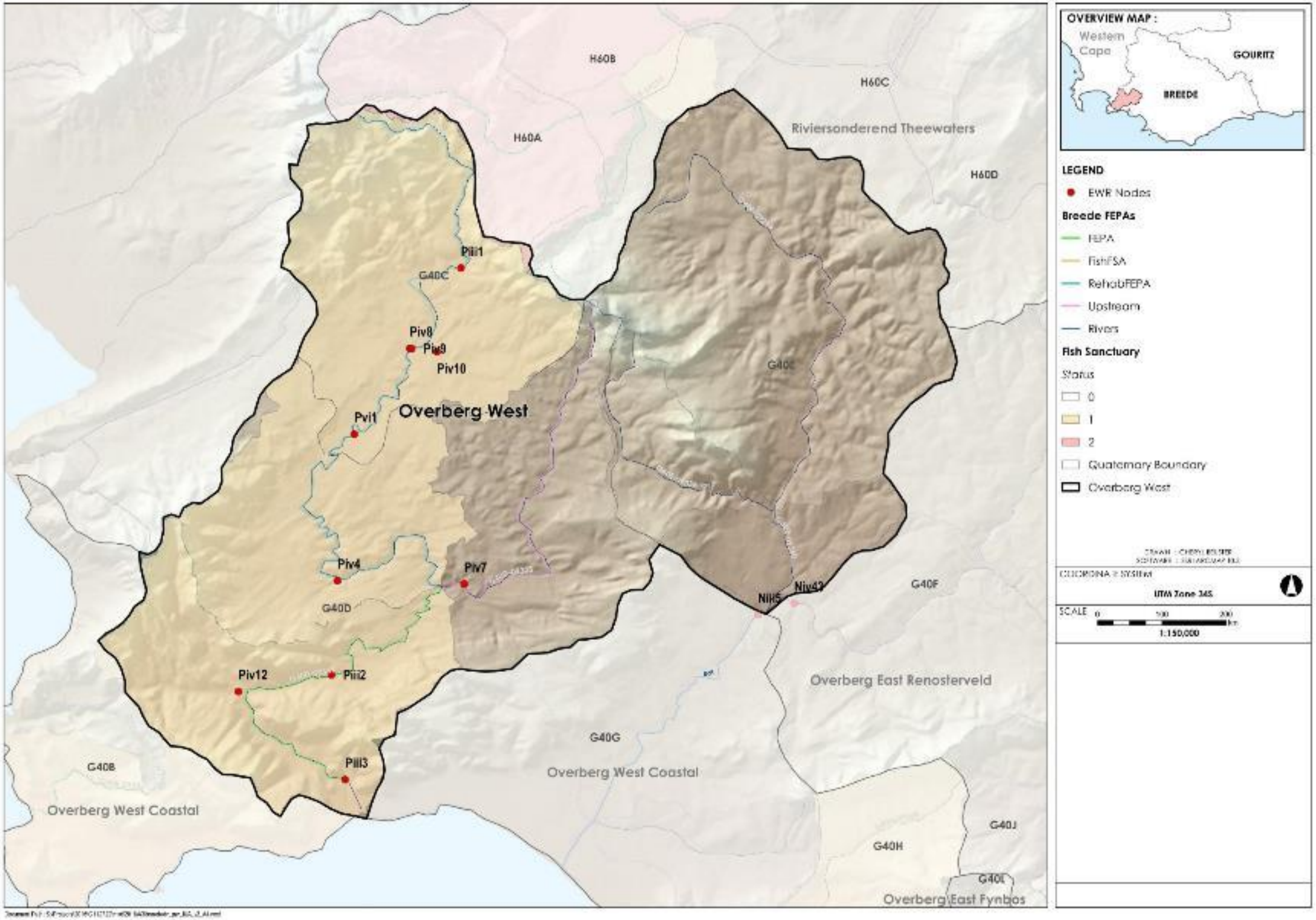
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-5 F9 Lower Riviersonderend – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



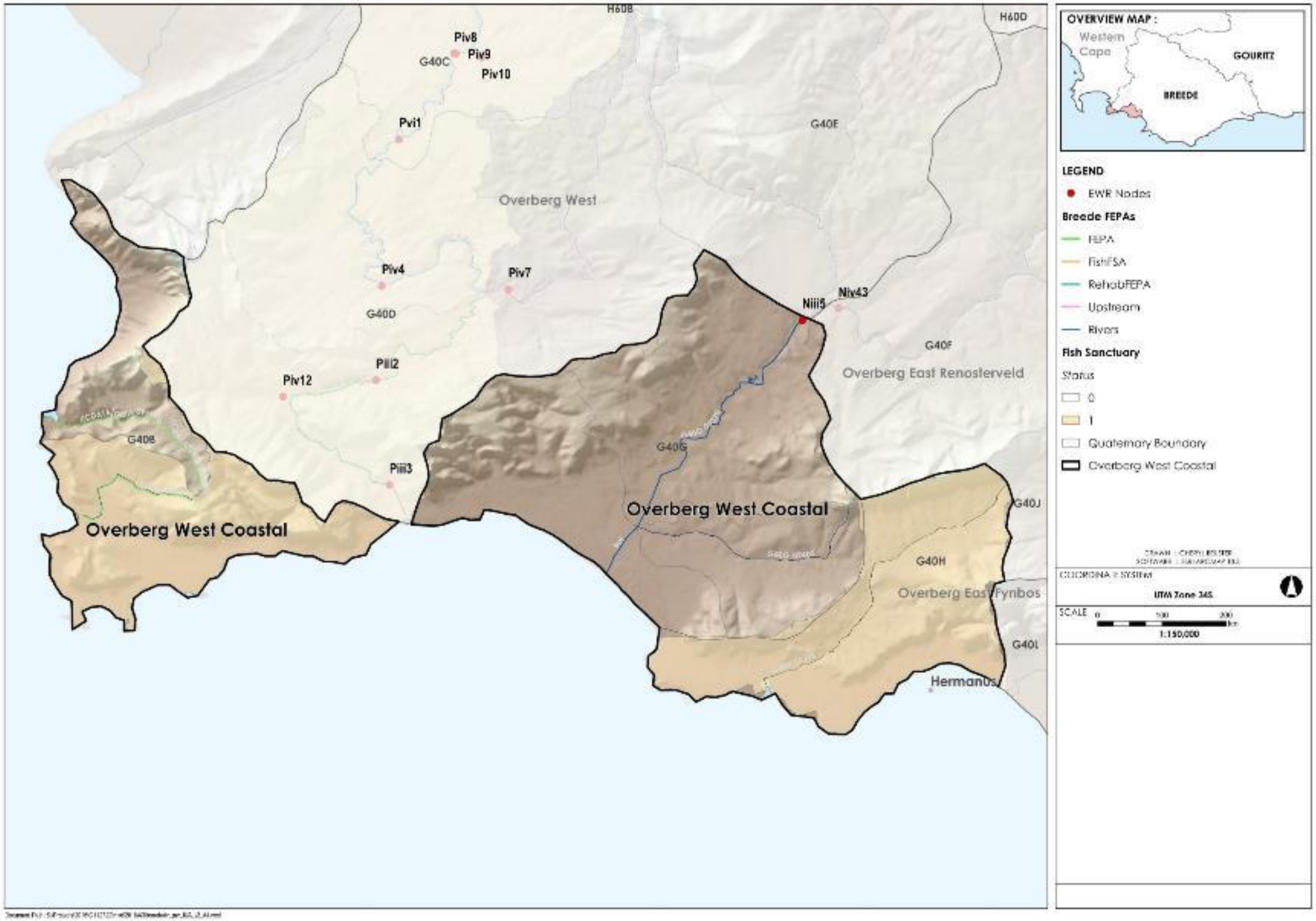
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-6 F11 Lower Breede-Renosterveld – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



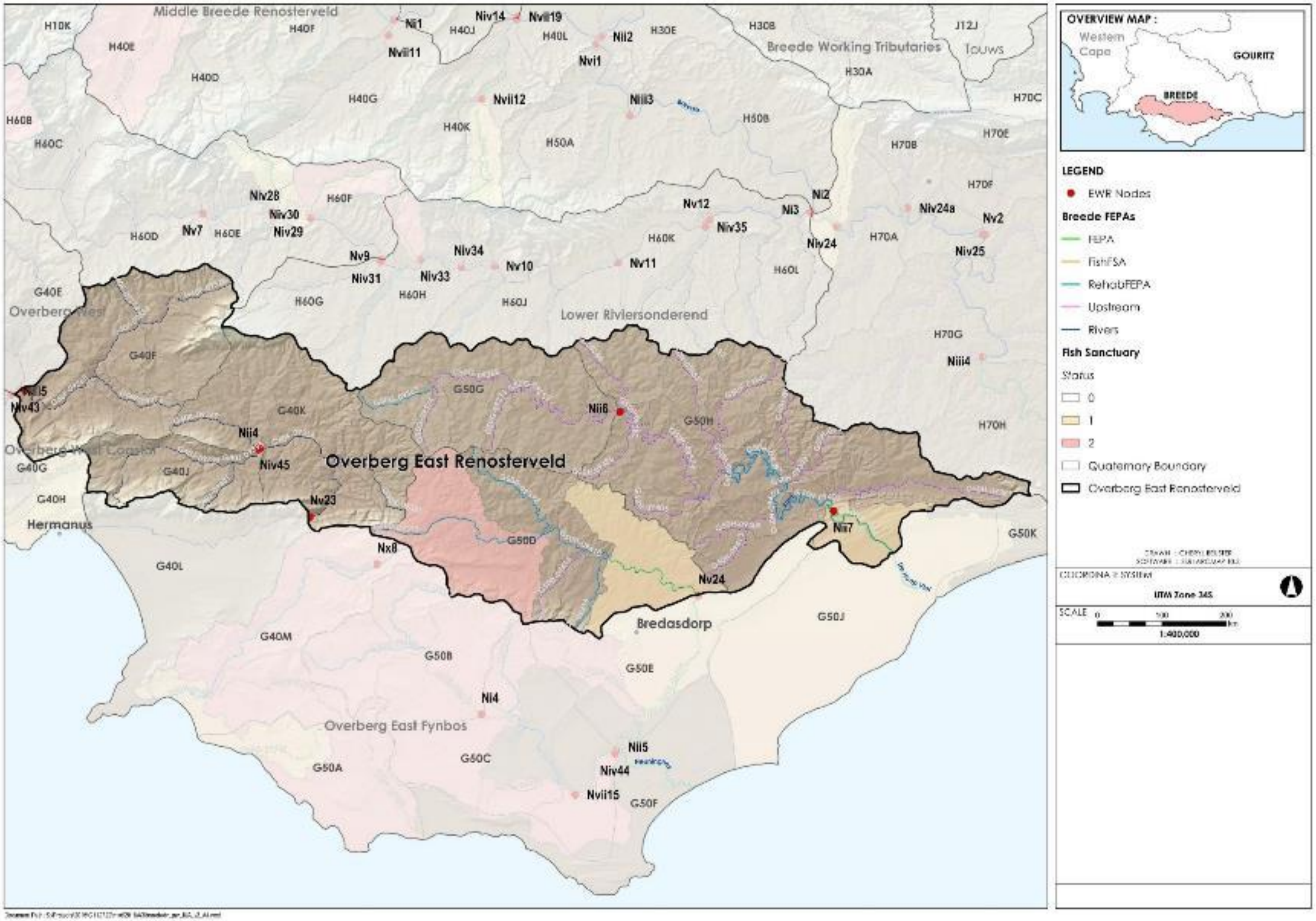
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-7 B5 Overberg West **– Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)**



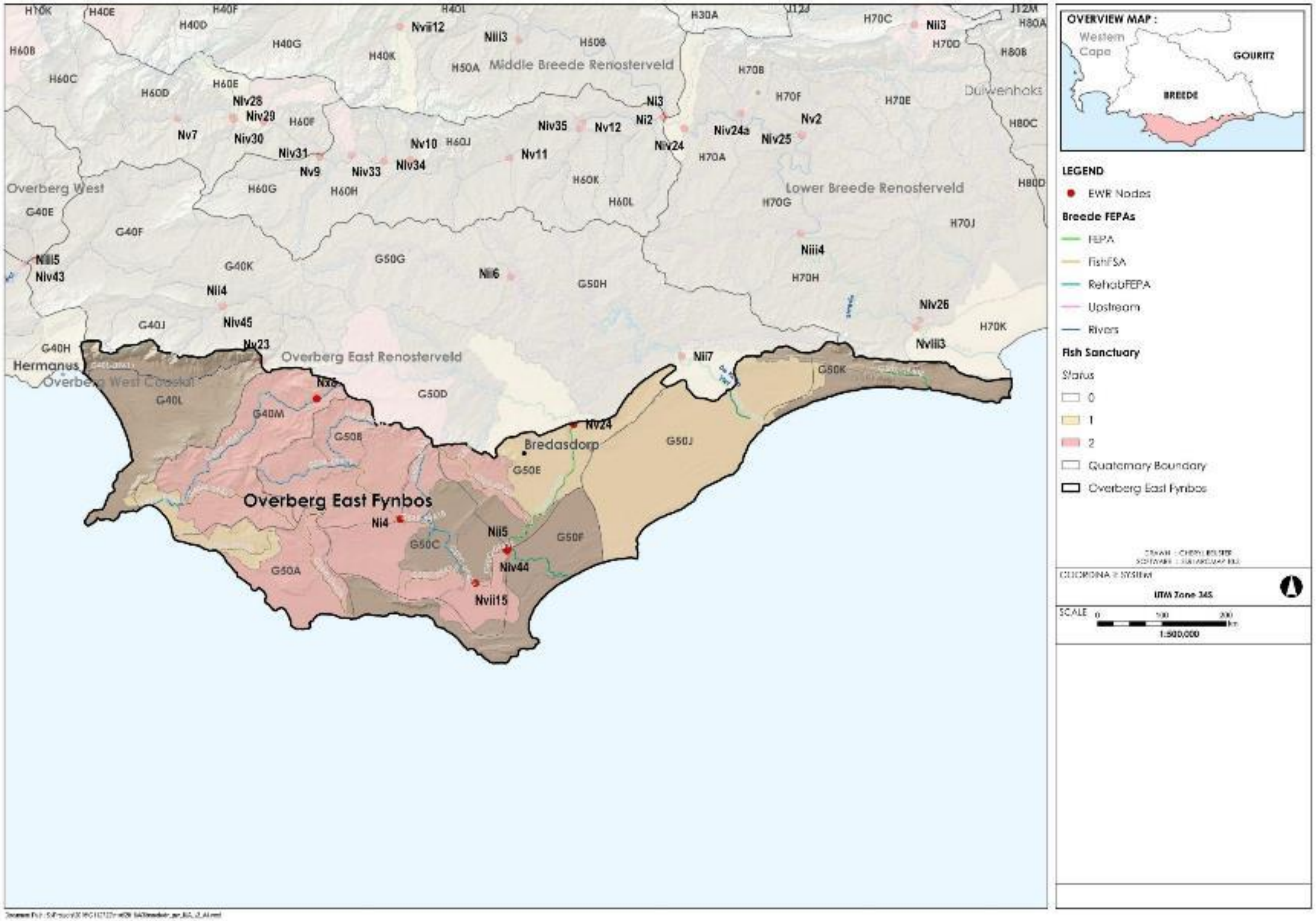
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-8 H16 Overberg West Coastal – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-9 F10 Overberg East Renosterveld – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-10 H17 Overberg East Fynbos Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)

Table 3-2 Ecological infrastructure in the Gouritz River basin and the Coastal region

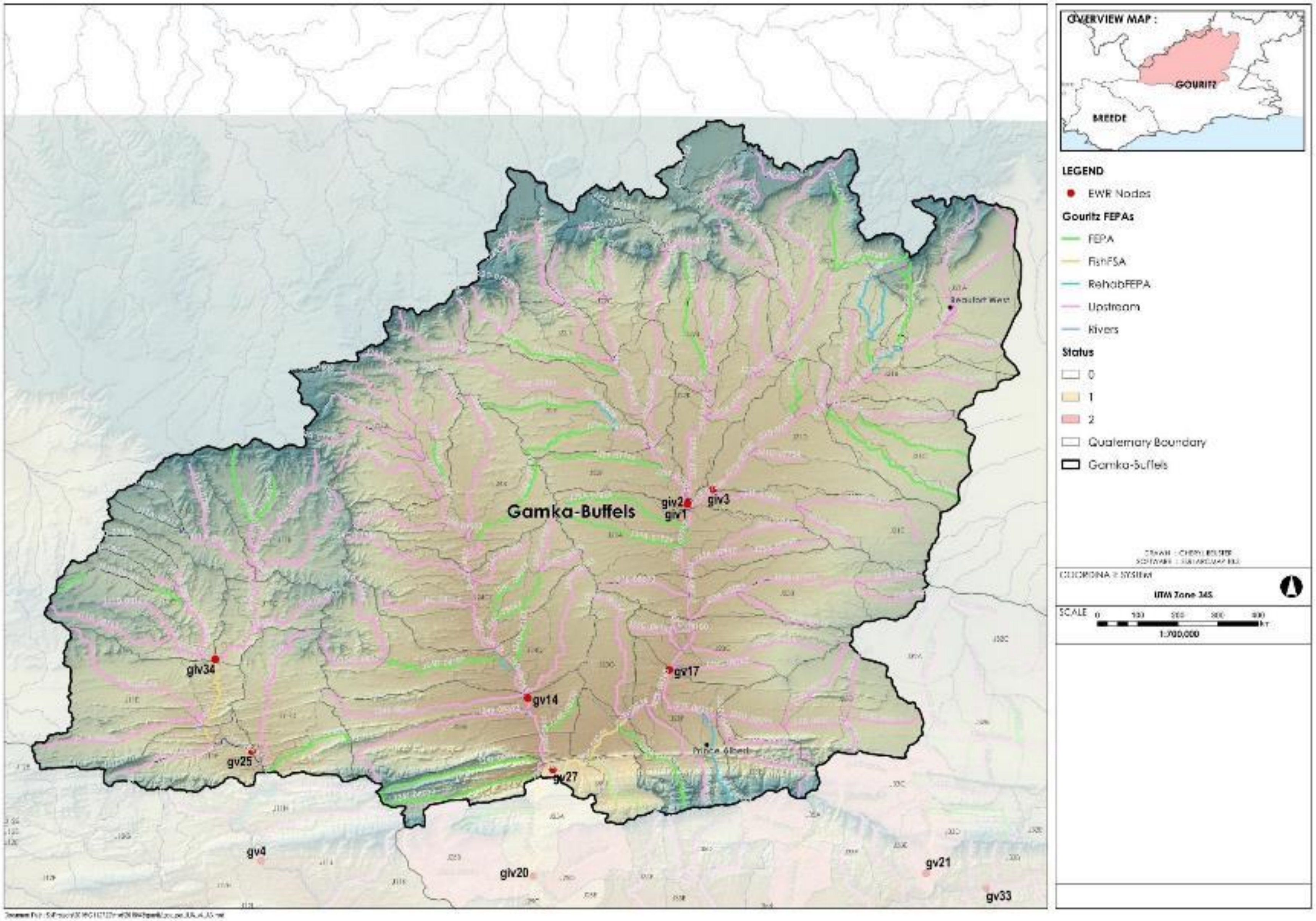
IUA	Quat #	Node code	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
C6 Gamka-Buffels	J11A		Buffels		A					Fish			
C6 Gamka-Buffels	J11B		Koringplaas		B					FEPA			
C6 Gamka-Buffels	J11C	giv34	Buffels		A	A	97.20	x	x	Upstream		x	
C6 Gamka-Buffels	J11D		Roggeveld		C					FEPA			
C6 Gamka-Buffels	J11E		Wilgehout/Baviaans		B					Upstream			
C6 Gamka-Buffels	J11F	gv25	Buffels		C	C	92.34		x	Upstream	x		
C6 Gamka-Buffels	J11G		Geelbek/Hartbeespruit		B					FEPA			
C6 Gamka-Buffels	J21A	gv18	Gamka		B	B	78.30	x	x	Upstream			
C6 Gamka-Buffels	J21B		Gamka		B					Upstream			
C6 Gamka-Buffels	J21C		Put/Plaatjites		B					FEPA			
C6 Gamka-Buffels	J21D	giv3	Gamka		B	B	76.29	x	x	Upstream		x	
C6 Gamka-Buffels	J21E		Veldmans		B					Upstream			
C6 Gamka-Buffels	J22A		Koekemoers		B					Upstream			
C6 Gamka-Buffels	J22B		Teekloof		B					Upstream			
C6 Gamka-Buffels	J22C		Waaikraal		B					Upstream			
C6 Gamka-Buffels	J22D		Viskuil		B					FEPA			
C6 Gamka-Buffels	J22E		Puts/Rietpoort		B					FEPA			
C6 Gamka-Buffels	J22F	giv1	Koekemoers		C	C	85.87		x	Upstream		x	
C6 Gamka-Buffels	J22G		Leeu/Paalhuis		A					Upstream			
C6 Gamka-Buffels	J22H		Sand/Doringhoek		A					FEPA			
C6 Gamka-Buffels	J22J		Hottentots		A					FEPA			
C6 Gamka-Buffels	J22K	giv2	Leeu		C	C	35.94			Upstream		x	
C6 Gamka-Buffels	J23A		Saai/Klip		B					FEPA			
C6 Gamka-Buffels	J23B		Groot		A					Upstream			
C6 Gamka-Buffels	J23C	gv17	Gamka		B	B	66.18	x				x	
C6 Gamka-Buffels	J23D		Sand		A					Upstream			
C6 Gamka-Buffels	J23E		Cordiers/Gang se Leegte		A					Upstream			
C6 Gamka-Buffels	J23F	giv21	Gamka		B	B	59.66	x					
C6 Gamka-Buffels	J23G		Kat		B					Upstream			
C6 Gamka-Buffels	J23H		Dewits		B					FEPA			

IUA	Quat #	Node code	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
C6 Gamka-Buffels	J23J	gv27	Gamka		C	C	59.52			Fish			
C6 Gamka-Buffels	J24A		Dwyka		A					Upstream			
C6 Gamka-Buffels	J24B		Wolwefontein		A					FEPA			
C6 Gamka-Buffels	J24C		Perdelaagte		A					FEPA			
C6 Gamka-Buffels	J24D	gv14	Dwyka		A	A	84.38	x	x	Upstream			
C6 Gamka-Buffels	J24E		Kerks/Jakkals		A					Upstream		x	
C6 Gamka-Buffels	J24F		Elandskloof/Bosluiskloof		A					FEPA			x
E8 Touws	J12A		Smalblaar		C								
E8 Touws	J12C	giv30	Ysterdams		D	D	40.77			Rehab			
E8 Touws	J12B	giv31	Donkies		D	D	47.30						
E8 Touws	J12D	giv28	Touws		D	D	44.15						x
E8 Touws	J12E		Kragga		C								
E8 Touws	J12F		Kruis		C					FEPA			
E8 Touws	J12G		Elandskloof		B								
E8 Touws	J12H	giv27	Touws		B	B	44.95	x			x	x	
E8 Touws	J12J		Gatkraal se		C								
E8 Touws	J12K	giv26	Brak		C	C	13.77						x
E8 Touws	J12L	gviii1	Doring	C/D	C/D	C/D	43.79			Upstream			
E8 Touws	J12L	gv5	Touws	B/C	B/C	B/C	43.01	x		Rehab			
E8 Touws	J12M		Brandwag		D					FEPA		x	
E8 Touws	J11H	gv4	Buffels	C	C	C	66.36			Upstream			
E8 Touws	J11J	gv6	Groot		D	D	44.48			Rehab			
E8 Touws	J11K	giv32	Groot		D	D	38.91					x	
E8 Touws	J13A	gv7	Groot		C	C	39.80			Rehab	x		
E8 Touws	J13B		Derde/Bos		B					FEPA			
E8 Touws	J13C	gii3	Groot		B	B	42.01	x		Rehab		x	
D7 Gouritz-Olifants	J25A	giv20	Gamka	C	C/D	C	51.49			Fish	x	x	
D7 Gouritz-Olifants	J25B		Kobus		D					Fish			
D7 Gouritz-Olifants	J25C		Taais		A					Upstream			
D7 Gouritz-Olifants	J25D	giv18	Nels		D	E	57.78			Fish	x		
D7 Gouritz-Olifants	J25E	gii2	Gamka		C	C	49.33					x	

IUA	Quat #	Node code	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
D7 Gouritz-Olifants	J31A		Olifants		B					Upstream			
D7 Gouritz-Olifants	J31B		Hartbees/Nouga		B					Upstream			
D7 Gouritz-Olifants	J31C	giii2	Olifants	C	C	C	84.08		x	Upstream		x	
D7 Gouritz-Olifants	J31D		Olifants		C					Upstream			
D7 Gouritz-Olifants	J32A		Traka		B					Upstream			
D7 Gouritz-Olifants	J32B		Traka		B					Upstream			
D7 Gouritz-Olifants	J32C		Kouka		B					Upstream			
D7 Gouritz-Olifants	J32D		Soetendalsvlei		B								
D7 Gouritz-Olifants	J32E	giv15	Traka		C	C/D	79.53		x	Upstream			
D7 Gouritz-Olifants	J33A		Wilge		A					FEPA	x		
D7 Gouritz-Olifants	J33B	gv33	Olifants		D	D	79.33		x	Upstream	x		
D7 Gouritz-Olifants	J33C		Aaps		A					FEPA	x		
D7 Gouritz-Olifants	J33D	gv21	Meirings		C	C	90.44		x	Fish	x	x	
D7 Gouritz-Olifants	J33E		Nels		D					Upstream			
D7 Gouritz-Olifants	J33F	giv11	Olifants		E	E	48.43						
D7 Gouritz-Olifants	J34A		Holdrif		C					Fish			
D7 Gouritz-Olifants	J34B		Kammanassie		D					Upstream			
D7 Gouritz-Olifants	J34C	gv36	Kammanassie	C/D	C/D	C/D	71.93		x	Upstream			
D7 Gouritz-Olifants	J34D		Kammanassie		C					Upstream		x	
D7 Gouritz-Olifants	J34E		Brak		D					Upstream			
D7 Gouritz-Olifants	J34F	giv10	Kammanassie		E	D	38.62			Upstream		x	
D7 Gouritz-Olifants	J35A	gvii2	Grobbelaars		C	C	83.23		x	FEPA			
D7 Gouritz-Olifants	J35A	giv9	Grobbelaars		E	E	66.81			Fish	x		
D7 Gouritz-Olifants	J35B		Kandelaars		C					FEPA			
D7 Gouritz-Olifants	J35C		Moeras		D					Fish			
D7 Gouritz-Olifants	J35D	gv19	Olifants		E	E	50.89			Upstream	x		
D7 Gouritz-Olifants	J35E		Olifants		E								
D7 Gouritz-Olifants	J35F	giv17	Olifants		D	D	52.78			Fish		x	
D7 Gouritz-Olifants	J40A	giv16	Gouritz		C	C	56.25			Fish			
F13 Lower Gouritz	J40B	gi4	Gouritz	C	C	C	54.89			Rehab	x	x	
F13 Lower Gouritz	J40C	gv28	Gouritz		D	D	56.71			Fish	x		

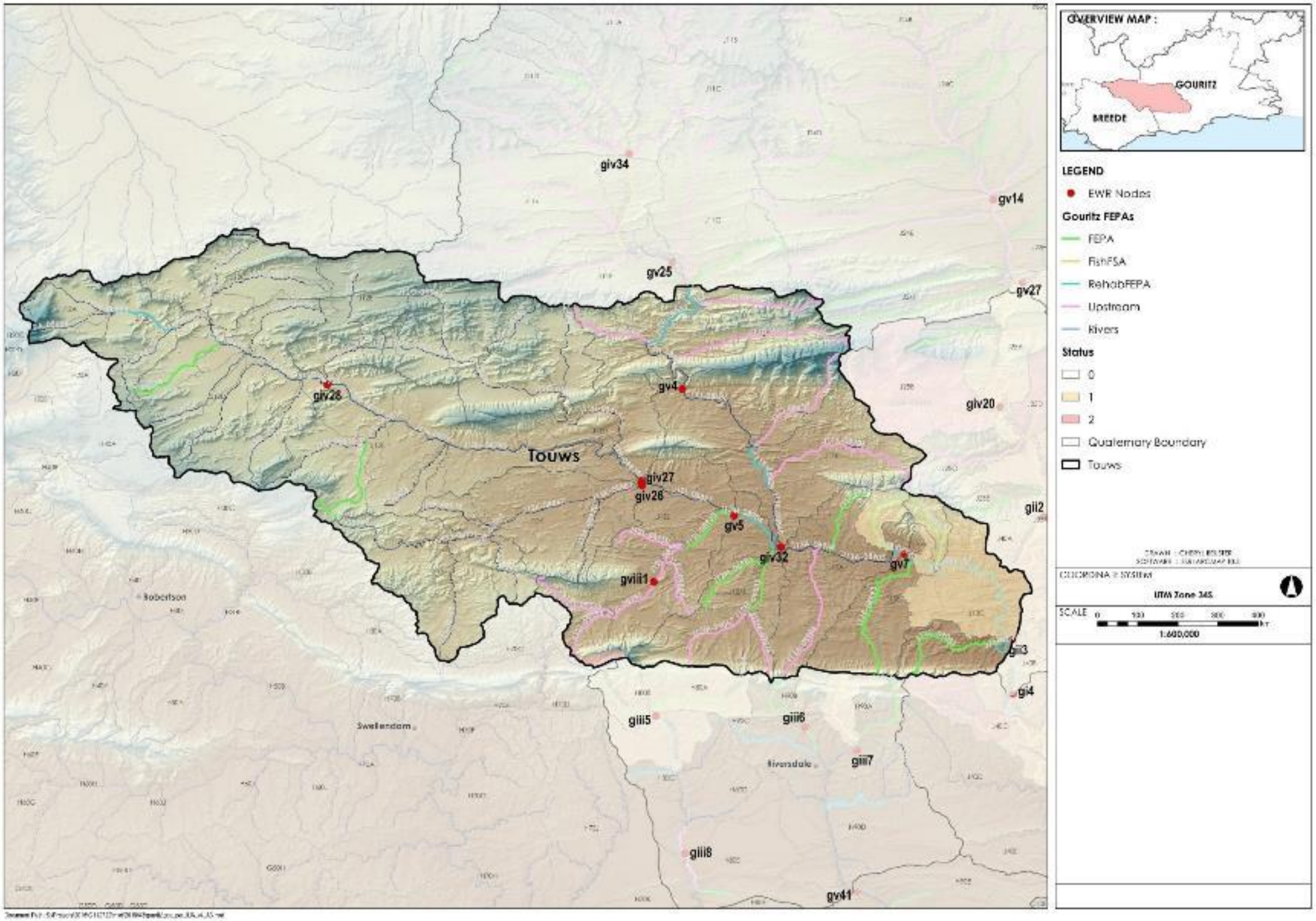
IUA	Quat #	Node code	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
F13 Lower Gouritz	J40D	gv9	Gouritz		C	C	60.11					x	
F13 Lower Gouritz	J40E		Gouritz		B					FEPA			
F12 Duiwenhoks	H80A		Duiwenhoks		C					FEPA			
F12 Duiwenhoks	H80B	giii5	Duiwenhoks		E	E	93.35		x	FEPA		x	
F12 Duiwenhoks	H80C	gv11	Duiwenhoks		D	D	93.23		x				
F12 Duiwenhoks	H80D	giii8	Duiwenhoks	D	D	D	93.51		x	Upstream		x	
F12 Duiwenhoks	H80E		Duiwenhoks		B					Upstream			
F12 Duiwenhoks	H80F		*Coastal none*										
F12 Duiwenhoks	H90B	giii6	Korinte		D	D	88.15		x	FEPA	x	x	
F12 Duiwenhoks	H90A	giii7	Goukou	C/D	C/D	C/D	87.04		x			x	
F12 Duiwenhoks	H90C	gv10	Goukou		D	D	83.85		x				
I18 Hessequa	H90D	gv41	Goukou		C	C	82.48		x			x	
I18 Hessequa	H90E		9364		D					FEPA			
G14 Groot Brak	K10A		*Coastal none*										
G14 Groot Brak	K10B		Hartenbos		D					Rehab			
G14 Groot Brak	K10C		Kouma		D					Fish	x		
G14 Groot Brak	K10D	giv25	Brandwag		D	D	94.89		x			x	
G14 Groot Brak	K10E	gv39	Moordkuil	B/C	D	D	54.97			FEPA			
G14 Groot Brak	K10F		Moordkuil		D					Rehab			
G14 Groot Brak	K20A	gviii2	Groot-Brak	B/C	B/C	B/C	93.62	x	x	Fish		x	
G14 Groot Brak	K20A	gviii12	Varing	C/D	C/D	C/D	97.11		x			x	
G14 Groot Brak	K20A	gviii3	Varing	C/D	D	D	74.59		x			x	
G14 Groot Brak	K20A	gvii7	Groot-Brak		B/C	B/C	43.07	x		Fish		x	
G15 Coastal	K30A	gviii4	Maalgate		D	D	95.12		x				
G15 Coastal	K30A	gvii8	Maalgate	D	D	D	95.12		x				
G15 Coastal	K30B	gvii9	Malgas	C	C	C	95.29		x	Fish	x		
G15 Coastal	K30B	gviii6	Gwaing	D	E	E	95.29		x	Fish		x	
G15 Coastal	K30C	gviii7	Swart		D	D	24.06						
G15 Coastal	K30C	gvii11	Kaaimans	B	B	B	94.03	x	x	Fish	x	x	
G15 Coastal	K30C	gviii8	Silver		B	B	94.03	x	x			x	
G15 Coastal	K30D	gvii12	Touws		B	B	93.64	x	x	FEPA		x	

IUA	Quat #	Node code	River	REC	PES (2014)	TEC	%nMAR	EC > C	WSA	FEPA	FishCons	CBA	ESA
G15 Coastal	K30D	gx8	Klein		D	D	93.63		x	Upstream		x	
G15 Coastal	K40A	giii10	Diep	A/B	B	B	96.64	x	x	Upstream	x		
G15 Coastal	K40B	giii13	Hoekraal		B	B	92.43	x	x	FEPA	x	x	
G15 Coastal	K40C	gvii13	Karatara	A/B	B	B	94.21	x	x				
G15 Coastal	K40C	giii11	Karatara		B	B	94.21	x	x	FEPA	x		
G15 Coastal	K40D		*Swartvlei*										
G15 Coastal	K40E	gviii9	Goukamma	B/C	B/C	B/C	87.31	x	x	FEPA	x	x	
G15 Coastal	K50A	gvii14	Knysna	B	B	B	95.54	x	x	Upstream			
G15 Coastal	K50A	giii12	Knysna		B	B	94.25	x	x	FEPA		x	
G15 Coastal	K50B	gviii11	Gouna	A/B	A/B	A/B	92.12	x	x	FEPA	x	x	
G15 Coastal	K60G	gviii10	Noetzie	A/B	B	B/C	91.72	x	x			x	
G15 Coastal	K60G	gx3	Piesang		E	E	91.71		x				
G15 Coastal	K60A		Keurbooms		D					FEPA			
G15 Coastal	K60B		Kwaai		B					FEPA	x		
G15 Coastal	K60C	giv6	Keurbooms	B/C	C	C	84.09		x	FEPA	x	x	
G15 Coastal	K60D	giv5	Palmiet		A	A	79.47	x	x	FEPA			
G15 Coastal	K60E	gx9	Keurbooms		B	B	81.51	x	x	FEPA			
G15 Coastal	K60F	giv4	Bitou		C	D	96.93		x	FEPA	x	x	
G15 Coastal	K70A	gx4	Buffels		B	C	91.11	x	x			x	
G15 Coastal	K70A	gx5	Sout		B	B	91.12	x	x	FEPA	x		
G15 Coastal	K70B	gvii15	Bloukrans		B	B	77.49	x	x	FEPA	x		



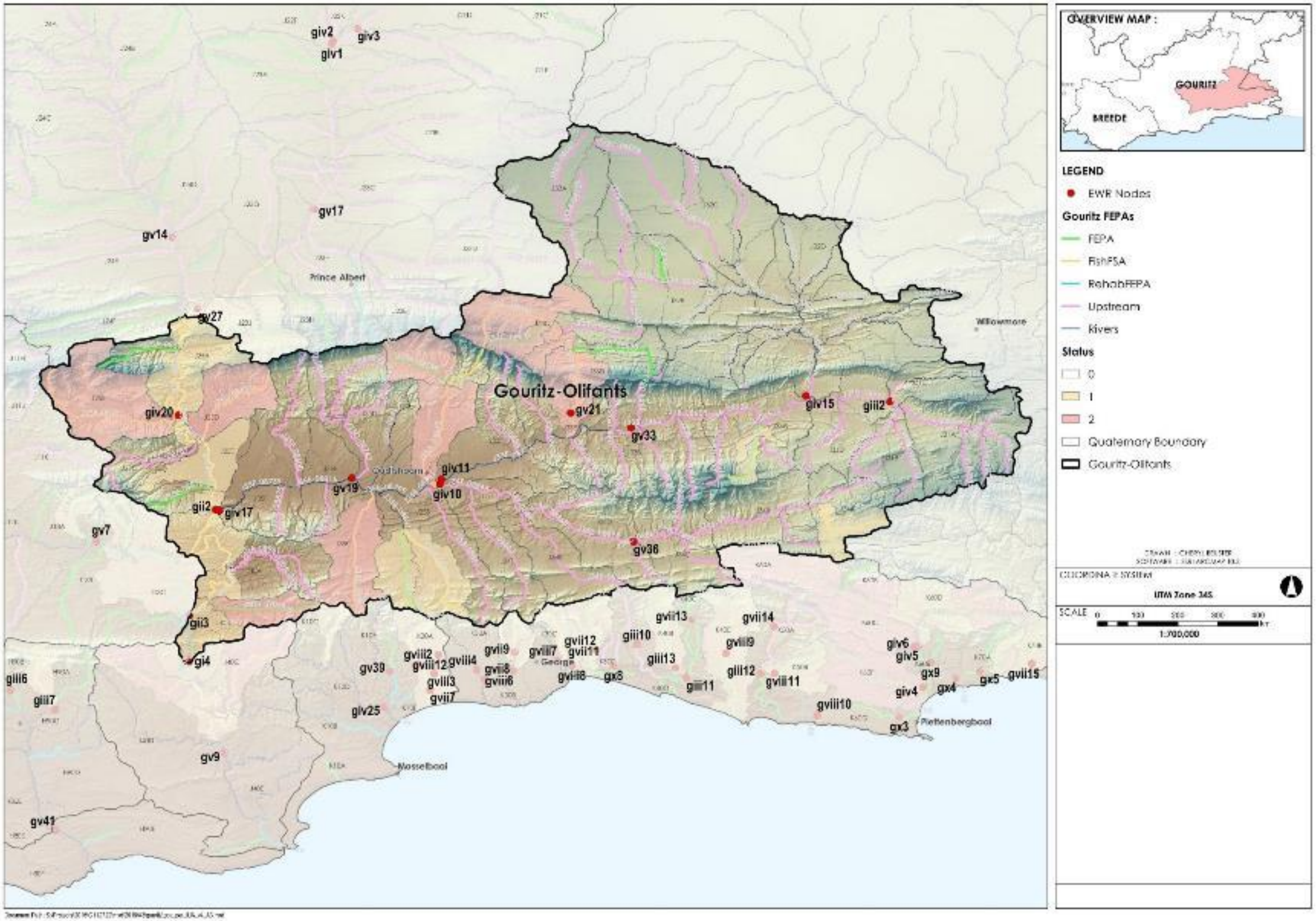
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-11 C6 Gamka Buffels – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



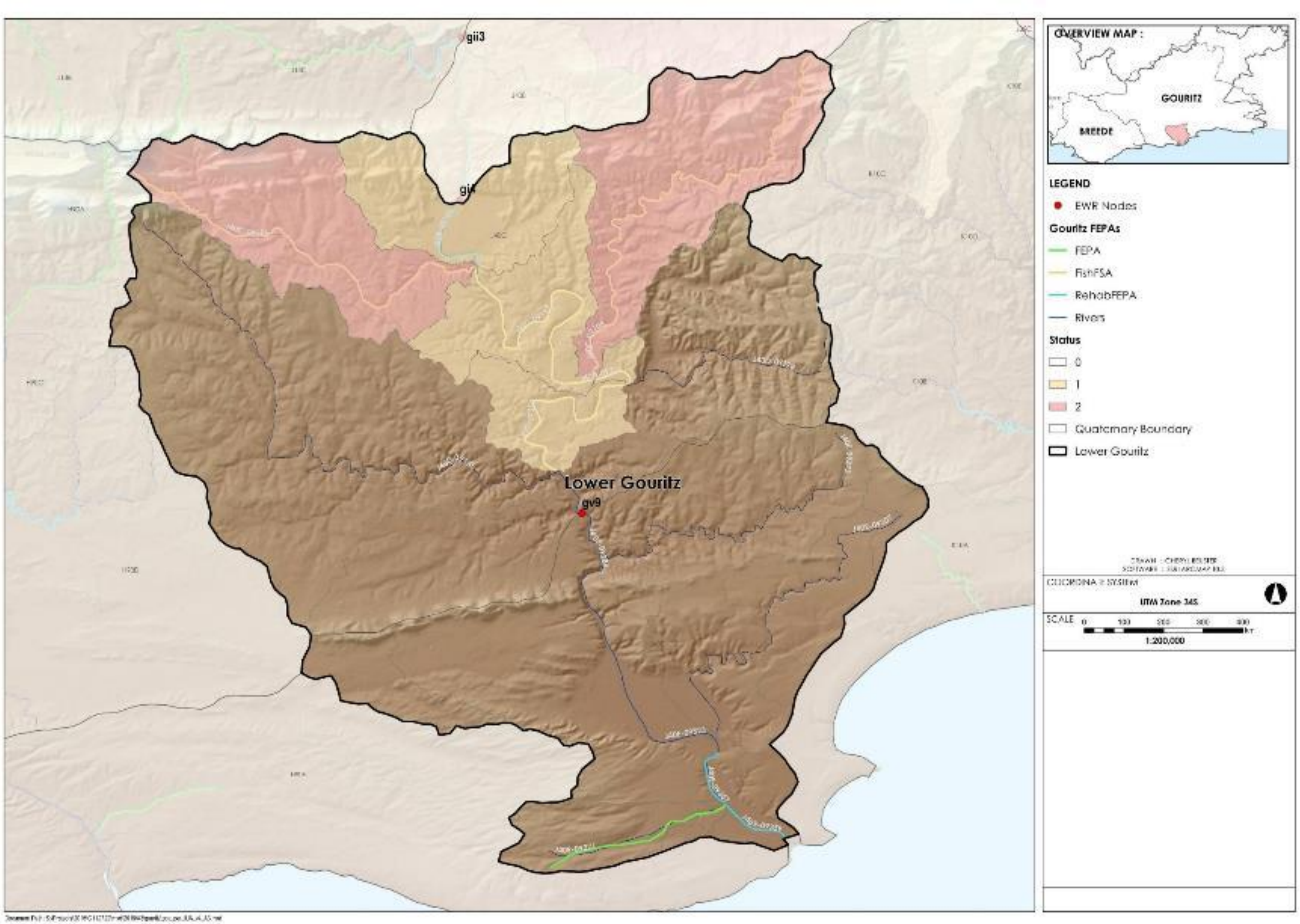
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-12 E8 Touws – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



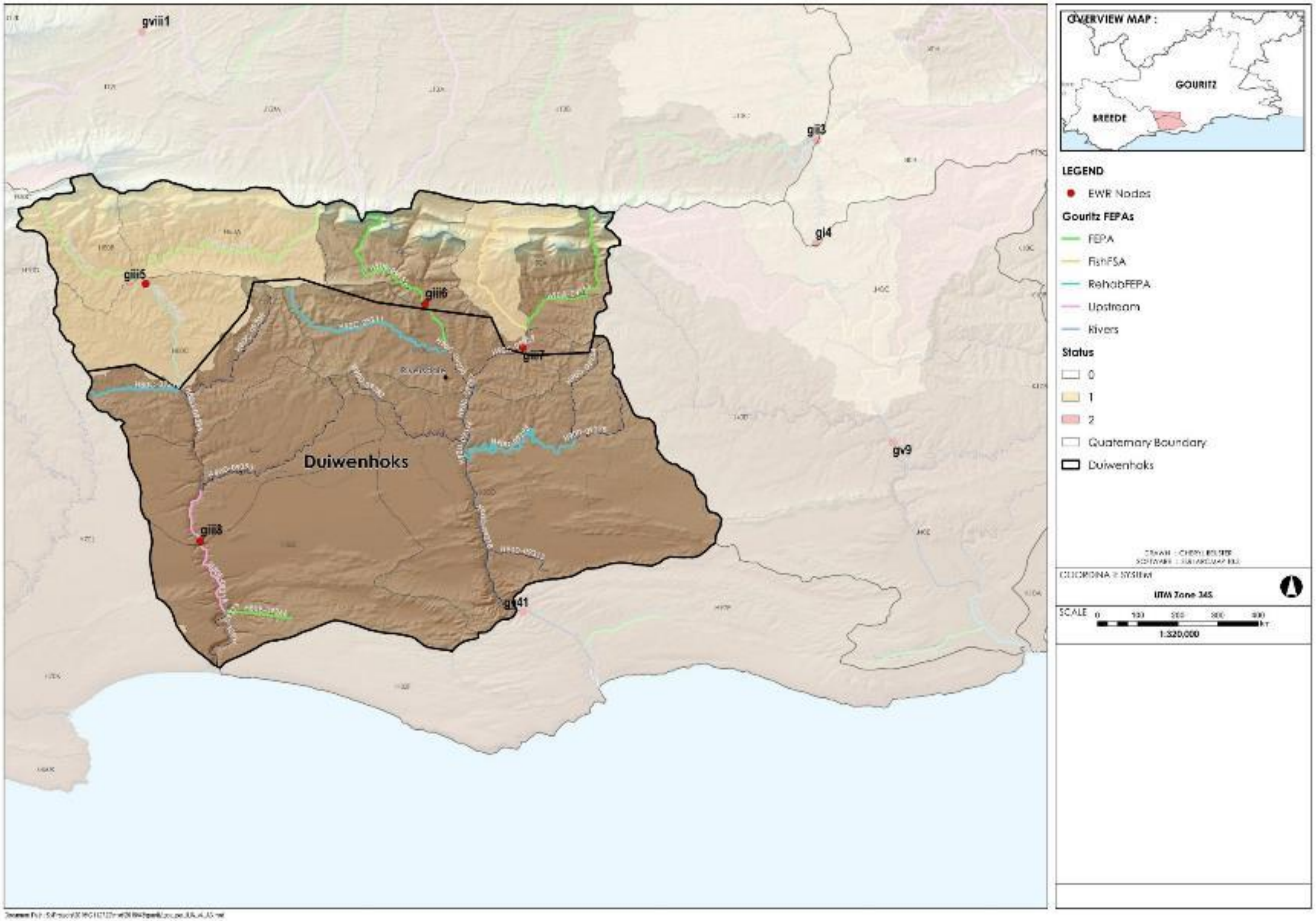
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-13 D7 Gouritz-Olifants – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



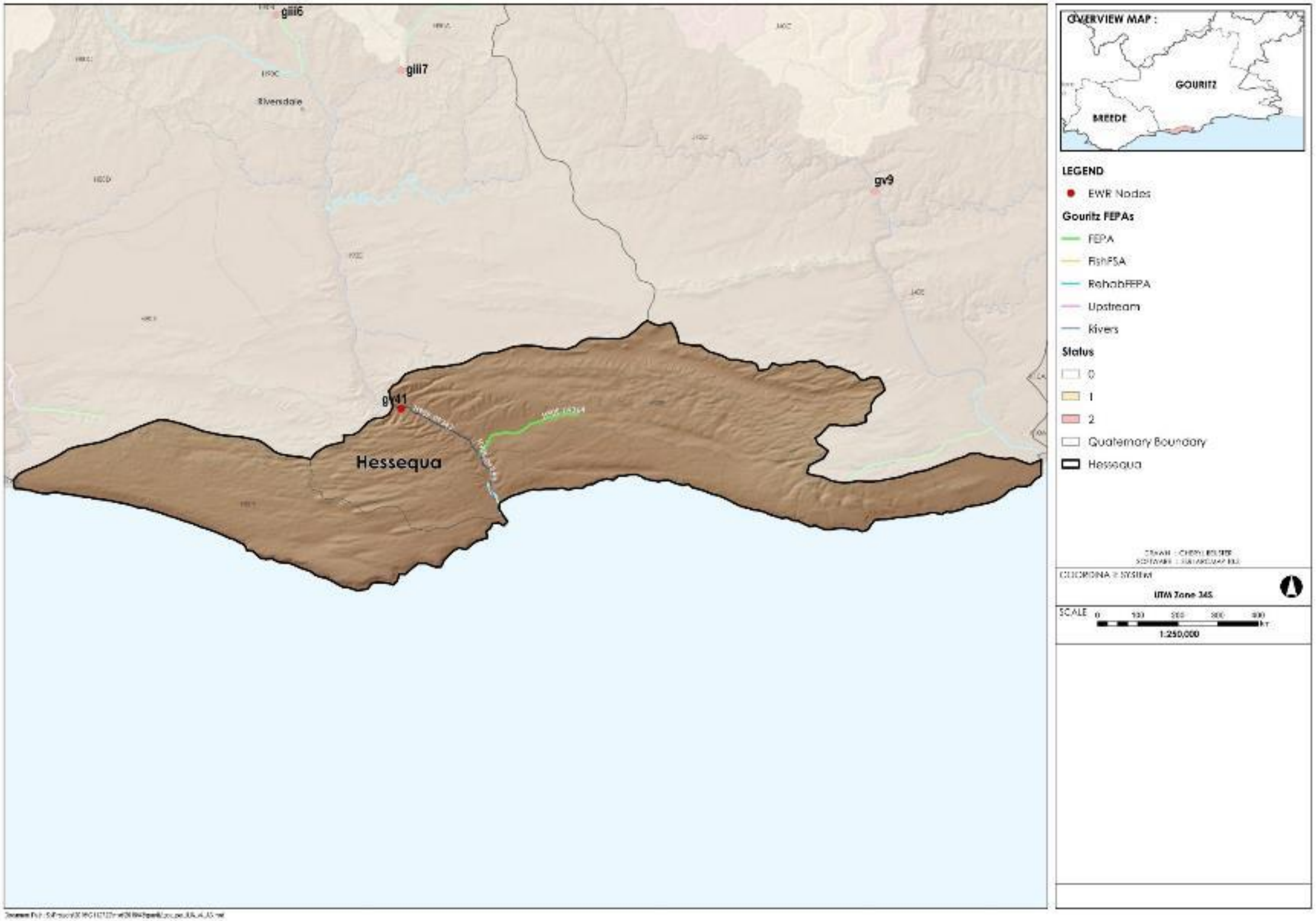
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-14 **F13 Lower Gouritz – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)**



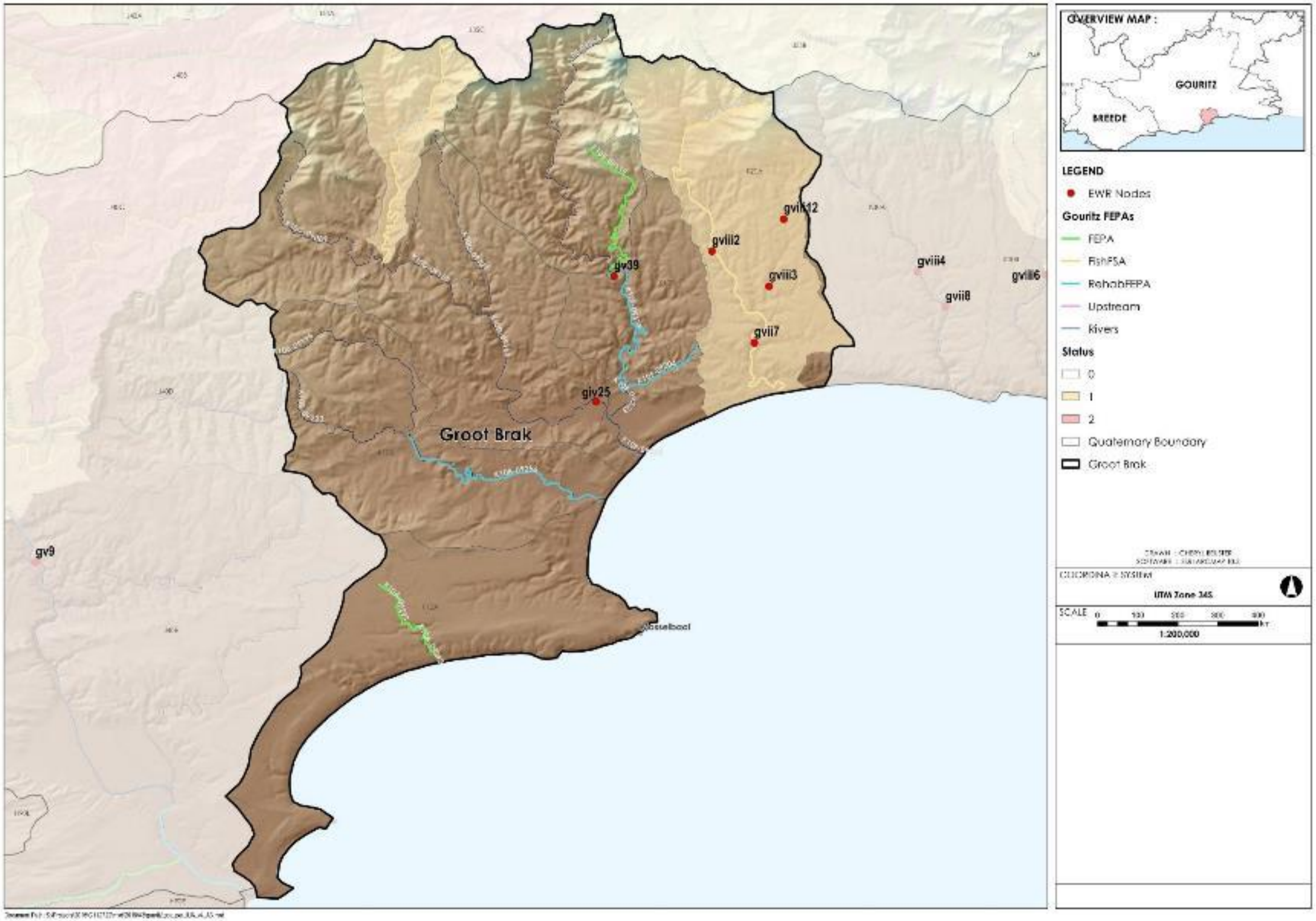
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-15 F12 Duiwenhoks – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



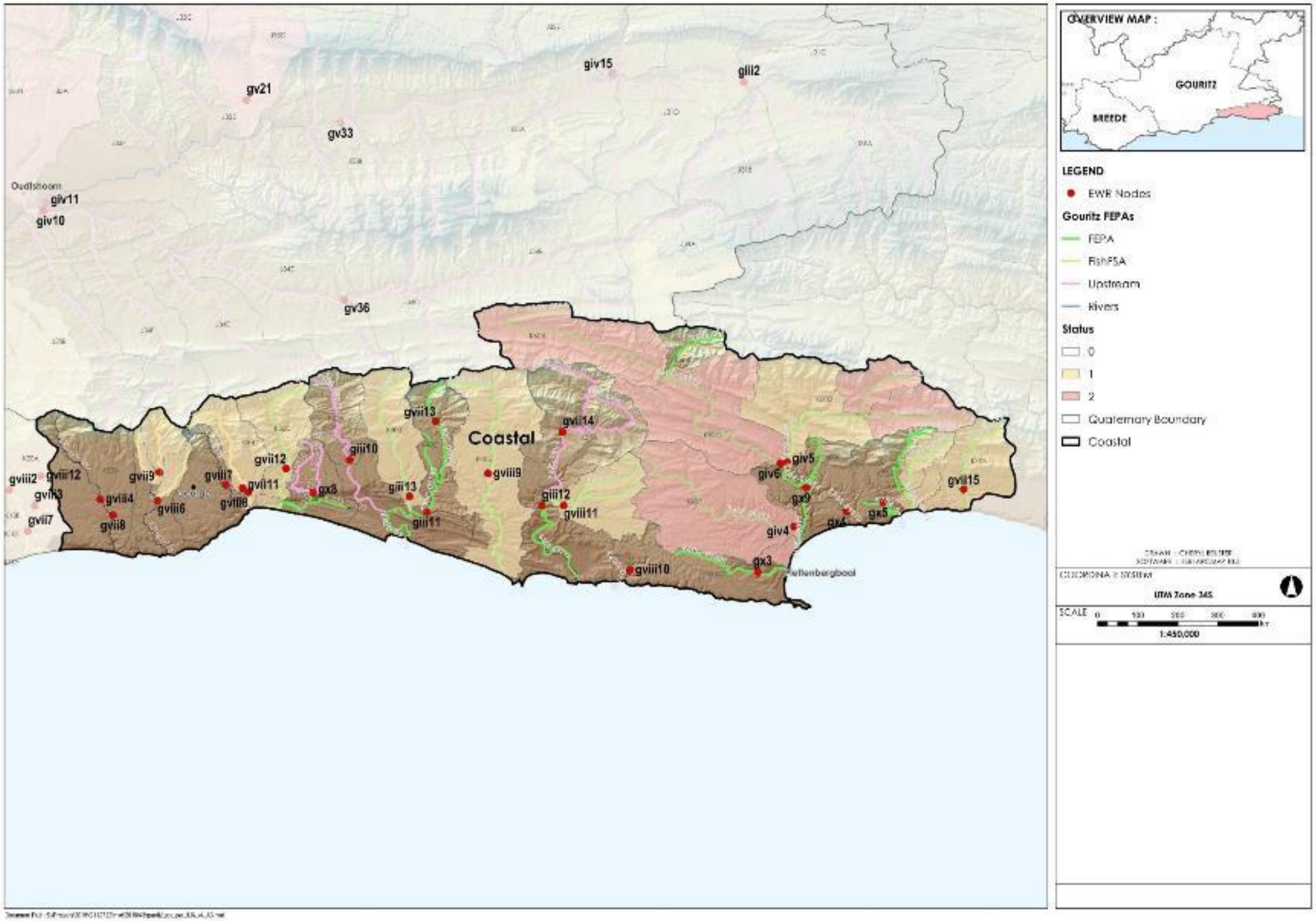
Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-16 I18 Hessequa – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-17 G14 Groot Brak **– Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)**



Rivers are named using the sub-quaternary code from the PES/EIS database (DWS 2014)

Figure 3-18 G15 Coastal – Location of nodes and EWR sites in relation to the NFEPAs (at a sub-quaternary scale and Fish sanctuary areas (at quaternary scale)

3.1.2 Prioritised nodes on the Breede River Basin

This section presents RQOs and TPCs for the 11 high-priority nodes on the Breede River Basin denoted with the pre-fix BREE_: River's priority RUs in Upper Breede Tributaries IUA

3.1.2.1 River's priority RUs in Upper Breede Tributaries IUA

Table 3-3 RQOs and Numerical Limits for river's priority RUs in Upper Breede Tributaries IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
A1 Upper Breede Tributaries	Breede	nviii1	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Breede River in a condition equal to or better than a D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-5.	
			Quality	Nutrients	Phosphate (PO4-P)	River nutrient levels must be maintained in a mesotrophic or better condition.	≤ 0.075 milligrams per litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams per litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 55 milliSiemens/metre EC (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		DO ≥ 6 milligrams per litre (5th percentile)	7.2 mg/l DO
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	
					Atrazine		≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within D category (42-57%).	D category (42-57%)	< 42%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a D category (42-57%).	D category (42-57%)	< 42%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species > 50%	Exotic species > 5%, terrestrial woody species < 40%
			Biota	Fish	FRAI score	FRAI should be within a D category (42-57%).	D category (42-57%)	< 42%
					Indigenous species richness		2 species, *Barbus andrewi, Anguila mossambica*	< 2 species
					Barbus andrewi		FROC = 5	Absent after 2 annual surveys OR

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
								FROC < 2 OR absence of juvenile fish
					Exotic fish species		No increase in FROC; *Micropterus salmoides (2), M dolomieu (5)*	Presence of new exotic fish or increase in FROC of *M salmoides (>2), M dolomieu (>5)*
				Invertebrates	MIRAI score	MIRAI score to be within D category (42-57%)	D category (42-57%)	< 42%
					Invertebrate diversity		SASS score > 70, ASPT > 5.0	SASS score < 65, ASPT < 4.9
					Number of families		> 15 families at abundances A - C	< 13 families at abundance < A
	Molenaars	nvii2	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Molenaars River in a condition equal to or better than a B category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-6.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.5 ≥ pH ≤ 7.5 (5th and 95th percentiles)	5 ≥ pH ≤ 7
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	7.2 mg/l DO
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within B category (42-57%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a B category (82-87%)	B category (82-87%)	< 82%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
			Biota	Fish	FRAI score	FRAI should be within a E category (22-37%).	E category (22-37%)	
					Exotic fish species		No increase in FROC; *Oncorhyncus mykiss (5), M. dolomieu (5)*	Presence of new exotic fish or increase in FROC of *O. mykiss (>5), M dolomieu (>5)*

Table 3-4 Supplementary information for River RQOs in Upper Breede Tributaries IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
A1 Upper Breede Tributaries	II	Breede	nviii1 Breede River @ BREE_BREE_H10F	-33.53985 19.20730	D	BREE_BREE_H10F is at EWR site IFR 1 (Figure 3-19), on the farm Mooiplaas, which is dominated by irrigated agriculture for orchards and vineyards in both up and downstream directions. There is a gauging weir upstream at witbrug. The river is perennial with low flows being impacted on due to abstraction.	Breede River	Breede River Basin study (DWAF 2002a). No SASS samples were taken at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.
		Molenaars	nvii2 Molenaars River @ BREE_MOLE_H10J	-33.72392 19.17090	B	BREE_BREE_H10J is at EWR site IFR 2 (Figure 3-20), at the gauge downstream of the Du Toitskloof trout lodge, which is situated in a natural vegetated valley in Du Toitskloof. There are some trout farms upstream and the N1 road runs alongside the river through the valley. The river is perennial and flows naturally as there is no abstraction.	Molenaars River	Breede River Basin study (DWAF 2002a). No SASS samples were taken at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.

Figure 3-19 Downstream view of BREE_BREE_H10F

Table 3-5 BREE_BREE_H10F: Hydrology RQOs

Source: DWAF (2002a)

Model: DRM (Hughes and Hannart 2003).

Monitor at: H1H001.

```
Desktop Version 2, Generated on 14/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :           nviii1
Annual Flows (Mill. cu. m or index values):
MAR                 =  434.929
S.Dev.              =  159.175
CV                  =    0.366
Q75                 =    4.989
Q75/MMF             =    0.138
BFI Index           =    0.360
CV(JJA+JFM) Index =    2.159
Ecological Category = D
Total IFR           =  110.333 (25.37 %MAR)
Maint. Lowflow      =   56.125 (12.90 %MAR)
Drought Lowflow     =   24.654 ( 5.67 %MAR)
Maint. Highflow     =   54.209 (12.46 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	32.201	16.253	0.505	6.667	2.912	1.651	8.317
Nov	19.013	14.189	0.746	4.007	1.698	0.000	4.007
Dec	8.044	6.061	0.753	2.105	0.947	1.651	3.756
Jan	4.565	6.002	1.315	1.930	0.912	0.000	1.930
Feb	4.953	7.660	1.547	1.268	0.602	0.000	1.268
Mar	5.294	7.745	1.463	1.754	0.737	0.000	1.754
Apr	15.751	17.494	1.111	2.343	1.053	0.000	2.343
May	49.239	49.410	1.003	3.544	1.509	0.000	3.544
Jun	82.797	74.621	0.901	6.452	2.818	5.502	11.954
Jul	81.620	53.995	0.662	7.719	3.368	0.000	7.719
Aug	79.603	46.967	0.590	10.526	4.702	32.397	42.923
Sep	51.850	28.807	0.556	7.810	3.396	13.009	20.818

Figure 3-20 **Downstream view of BREE_MOLE_H10J**

Table 3-6 BREE_BREE_H10J: Hydrology RQOs

Source: DWAF (2002a)

Model: DRM (Hughes and Hannart 2003).

Monitor at: H1H018.

```
Desktop Version 2, Generated on 16/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          nvii2
Annual Flows (Mill. cu. m or index values):
MAR                =  105.527
S.Dev.             =   29.771
CV                 =    0.282
Q75                =    1.629
Q75/MMF            =    0.185
BFI Index          =    0.374
CV(JJA+JFM) Index =    1.581
Ecological Category = B
Total IFR          =   53.560 (50.75 %MAR)
Maint. Lowflow     =   30.215 (28.63 %MAR)
Drought Lowflow    =   10.889 (10.32 %MAR)
Maint. Highflow    =   23.344 (22.12 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	6.640	3.489	0.525	3.381	1.376	0.887	4.268
Nov	4.100	2.965	0.723	2.503	0.668	0.294	2.797
Dec	2.173	1.685	0.775	1.581	0.431	0.000	1.581
Jan	1.383	1.515	1.095	1.023	0.198	0.000	1.023
Feb	1.462	1.622	1.110	0.870	0.192	0.000	0.870
Mar	1.958	2.131	1.089	0.905	0.226	0.000	0.905
Apr	5.399	4.619	0.855	1.356	0.425	0.000	1.356
May	13.406	8.553	0.638	2.480	1.025	4.314	6.795
Jun	19.496	10.310	0.529	3.584	1.286	6.215	9.799
Jul	19.984	9.605	0.481	4.147	1.675	7.737	11.883
Aug	17.969	7.883	0.439	4.388	1.769	1.299	5.687
Sep	11.557	5.687	0.492	3.997	1.617	2.599	6.596

3.1.2.2 River's priority RUs in Breede Working Tributaries IUA

Table 3-7 RQOs and Numerical Limits for river's priority RUs in Breede Working Tributaries IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
A2 Breede Working Tributaries	Hex	nvii7	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Hex River in a condition equal to or better than a C category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-9.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	7.2 mg/l DO
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	
					Atrazine		≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within a C/D category (57-62%).	C/D category (57-62%)	< 57%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a D category (42-57%).	D category (42-57%)	< 42%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
			Biota	Fish	FRAI score	FRAI should be within a D category (42-57%).	D category (42-57%)	< 42%
					Indigenous species richness		4 species; *Barbus andrewi, Galaxius zebratus, Pseudobarbus burchelli and Sandelia capensis.*	< 2 species

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Barbus andrewi		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Galaxius zebratus		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Pseudobarbus burchelli		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Sandelia capensis		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Exotic fish species		No increase in FROC *O. mykiss (1)*	Presence of new exotic fish or increase in FROC of *O. mykiss (>1)*
				Invertebrates	MIRAI score	MIRAI score to be within C category (62-77%).	C category (62-77%)	< 62%
					Invertebrate diversity		SASS score > 100, ASPT > 6.3	SASS score < 98, ASPT < 6.1

Table 3-8 Supplementary information for River RQOs in Breede Working Tributaries IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
A2 Breede Working Tributaries	III	Hex	nvii7 Hex River @ BREE_HEX_H20G	–33.57849 19.50330	C	BREE_HEX_H20G is at EWR site IFR 3 (Figure 3-21), upstream of gauge H1H006, which is dominated by irrigated agriculture for orchards and vineyards in both up and downstream directions. The river is perennial with low flows being impacted on due to abstraction.	Hex River	Intermediate Reserve study for the Hex River (DWAF 2002b). No SASS samples were taken at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.

Figure 3-21 Views of BREE_HEX_H20G

Table 3-9 BREE_HEX_H40G: Hydrology RQOs

Source: DWAF (2002b)

Model: DRM (Hughes and Hannart 2003).

Monitor at: H2H006.

Desktop Version 2, Generated on 16/02/2017

Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:

Total Runoff : nvii7

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

MAR	=	102.770
S.Dev.	=	69.784
CV	=	0.679
Q75	=	1.328
Q75/MMF	=	0.155
BFI Index	=	0.388
CV(JJA+JFM) Index	=	3.263

Ecological Category = C

Total IFR	=	41.135 (40.03 %MAR)
Maint. Lowflow	=	25.718 (25.02 %MAR)
Drought Lowflow	=	6.100 (5.94 %MAR)
Maint. Highflow	=	15.417 (15.00 %MAR)

Monthly Distributions (Mill. cu. m.)

Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	9.062	5.743	0.634	2.998	0.755	0.387	3.385
Nov	6.808	9.721	1.428	2.649	0.685	0.395	3.044
Dec	2.773	1.911	0.689	1.888	0.425	0.000	1.888
Jan	2.275	6.146	2.701	1.180	0.236	0.000	1.180
Feb	1.659	3.264	1.968	1.066	0.171	0.000	1.066
Mar	1.294	1.480	1.144	0.943	0.142	0.000	0.943
Apr	3.660	8.263	2.258	1.142	0.148	0.000	1.142
May	6.670	10.281	1.541	1.652	0.354	1.137	2.789
Jun	15.462	24.859	1.608	2.260	0.571	1.098	3.358
Jul	19.447	23.702	1.219	3.067	0.779	6.801	9.868
Aug	21.005	24.131	1.149	3.540	0.943	2.797	6.337
Sep	12.655	8.886	0.702	3.333	0.891	2.803	6.137

3.1.2.3 River's priority RUs in Middle Breede Renosterveld IUA

Table 3-10 RQOs and Numerical Limits for river's priority RUs in Middle Breede Renosterveld IUA

IUA	River	node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
A3 Middle Breede Renosterveld	Breede	nvii8	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Breede River in a condition equal to or better than a C/D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-12.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	
					Atrazine		≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within C category (52-67%).	C category (62-77%)	< 62%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a C category (52-67%).	C category (62-77%)	< 62%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species > 30%	Exotic species > 5%, terrestrial woody species < 20%
			Biota	Fish	FRAI score	FRAI should be within a D category (42-57%).	D category (42-57%)	< 42%
					Indigenous species richness		2 species, *Barbus andrewi, Gilchrestella aestuaria*	< 2 species

IUA	River	node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Barbus andrewi		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Gilchrestella aestuaria		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Exotic fish species		No increase in FROC *Cyprinus carpio (5), Micropterus dolomieu (5)*	Presence of new exotic fish or increase in FROC of *C. carpio* and *M. dolomieu*.
				Invertebrates	MIRAI score	MIRAI score to be within D category (42-57%).	D category (42-57%)	< 42%
					Invertebrate diversity		SASS score < 45, ASPT > 4.3	SASS score < 41, ASPT < 4.2
					Number of families		> 14 families at A - C abundance	< 12 families at A abundance
	Breede	ni2	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Breede River in a condition equal to or better than a D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-13.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present state levels.	95%tile ≤ 220 milliSiemens/metre EC	176 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
					Water temperature		No more than 2°C change in natural monthly range (minimum and maximum)	1.6 °C difference from ambient
				Toxins		Toxicity levels must not pose a threat to aquatic ecosystems.		
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	95%tile ≤ 165 cfu/100ml Escherichia coli	132 cfu/100ml E coli / Faecal coliforms

Table 3-11 Supplementary information for River RQOs in Middle Breede Renosterveld IUA

IUA	Class	River	Node	TEC	Coordinates	Description	Applicable to	References
A3 Middle Breede Renosterveld	III	Breede	nvii8 Breede River @ BREE_BREE_H40F	C/D	-33.81871 19.69470	BREE_BREE_H40F is at EWR site IFR 3 (Figure 3-22), downstream of Brandvlei Dam at Le Chassuer. The river flowed through a wide, well-vegetated floodplain with mid-channel bars and the	Breede River	Breede River Basin study (DWAF 2002a). No SASS samples were taken

IUA	Class	River	Node	TEC	Coordinates	Description	Applicable to	References
						riparian vegetation was intact on both banks. Though the river flows through farmland, cultivation of the floodplain was not intensive. The river is perennial with low flows being sustained by irrigation releases from Brandvlei Dam.		at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.
		Breede	ni2 Breede River @ BREE_BREE_H50B	D	-34.06867 20.28660	BREE_BREE_H50B is at the outlet of the Breede Working Tributaries IUA and is not a EWR site (Figure 3-23). It is situated upstream of the confluence with the Riviersonderend River. There is no gauge in the vicinity of the river. The river is perennial with low flows being supplied by releases made from Brandvlei Dam. Irrigated agriculture lines the banks and there is dense cover of exotic woody trees.	Breede River	None

Figure 3-22 **Upstream view of BREE_BREE_H40F**

Table 3-12 **BREE_BREE_H40F: Hydrology RQOs**

Source: DWAF (2002a)

Model: DRM (Hughes and Hannart 2003).

Monitor at: H4H017.

```
Desktop Version 2, Generated on 16/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :           nvii8
Annual Flows (Mill. cu. m or index values):
MAR                = 1042.745
S.Dev.             =  408.708
CV                 =    0.392
Q75                =   14.892
Q75/MMF            =    0.171
BFI Index          =    0.380
CV(JJA+JFM) Index =    2.072
Ecological Category = C/D
Total IFR          =  351.554 (33.71 %MAR)
Maint. Lowflow     =  171.107 (16.41 %MAR)
Drought Lowflow    =   64.714 ( 6.21 %MAR)
Maint. Highflow    =  180.447 (17.31 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean     SD       CV      Maint.  Drought    Maint.    Maint.
 Oct   81.334  36.697   0.451   14.575   5.013     3.704    18.279
 Nov   51.218  36.376   0.710    8.743   3.032     0.000     8.743
 Dec   23.804  16.535   0.695    3.449   1.232     0.000     3.449
 Jan   14.727  23.601   1.603    4.796   1.691     0.000     4.796
 Feb   13.886  18.485   1.331    1.461   0.558     0.000     1.461
 Mar   14.204  15.353   1.081    3.181   1.142     0.000     3.181
 Apr   38.954  47.153   1.210    4.262   1.509     0.000     4.262
 May  105.490  99.570   0.944   11.161   3.853    16.107    27.268
 Jun  181.752 158.485   0.872   22.326   6.557    32.902    55.228
 Jul  194.509 132.995   0.684   36.912  14.608    76.916   113.828
 Aug  193.320 124.837   0.646   33.451  12.778    31.869    65.320
 Sep  129.548  65.541   0.506   26.791  12.741    18.949    45.740
```

Figure 3-23 **Aerial view of BREE_BREE_H50B**

Table 3-13 **BREE_BREE_H50B: Hydrology RQOs**

Source: DWAF (2002a)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No gauge.

Desktop Version 2, Generated on 27/12/2016
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff: ni2
Annual Flows (Mill. cu. m or index values):
MAR = 1170.110
S.Dev. = 464.528
CV = 0.397
Q75 = 16.846
Q75/MMF = 0.173
BFI Index = 0.384
CV(JJA+JFM) Index = 2.525
Ecological Category = D
Total IFR = 202.193 (17.28 %MAR)
Maint. Lowflow = 100.984 (8.63 %MAR)
Drought Lowflow = 100.984 (8.63 %MAR)
Maint. Highflow = 101.209 (8.65 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	91.909	46.504	0.506	13.406	13.406	0.000	13.406
Nov	60.718	53.199	0.876	8.861	8.861	3.227	12.089
Dec	29.816	29.967	1.005	3.095	3.095	0.000	3.095
Jan	18.289	33.582	1.836	2.454	2.454	0.000	2.454
Feb	17.479	29.057	1.662	2.911	2.911	0.000	2.911
Mar	19.140	34.794	1.818	1.301	1.301	0.000	1.301
Apr	53.995	82.647	1.531	3.367	3.367	0.000	3.367
May	119.563	113.118	0.946	4.395	4.395	37.538	41.933
Jun	194.417	170.583	0.877	9.942	9.942	7.323	17.265
Jul	209.857	143.884	0.686	13.992	13.992	36.389	50.381
Aug	214.084	149.228	0.697	19.944	19.944	16.731	36.675
Sep	140.843	70.905	0.503	17.315	17.315	0.000	17.315

3.1.2.4 River's priority RUs in Riviersonderend Theewaterskloof IUA

Table 3-14 RQOs and Numerical Limits for river's priority RUs in Riviersonderend Theewaterskloof IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
B4 Riviersonderend Theewaterskloof	Du Toits	nvii10	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Du Toits River in a condition equal to or better than a B category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-16.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river in an oligotrophic condition	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations must be maintained in an Ideal category	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
	Riviersonderend	nv7	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Riviersonderend River in a condition equal to or better than a D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-17.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
	Baviaans	niv28	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Baviaans River in a condition equal to or better than a B category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-18.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre PO4-P	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre TIN	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystems	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.5 ≥ pH ≤ 7.0 (5th and 95th percentiles)	5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within B category (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a B category (82-87%).	B category (82-87%)	< 82%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species > 20%	Exotic species > 5%, terrestrial woody species < 10%
			Biota	Fish	FRAI score	FRAI should be within an A/B category (87-92%).	A/B category (87-92%)	< 87%
					Indigenous species richness		3 indigenous species; *Galaxias zebratus, Pseudobarbus burchelli, Sandelia capensis*	< 2 species
					Galaxius zebratus		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Pseudobarbus burchelli		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Sandelia capensis		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Exotic fish species		None	Presence of exotic fish.
				Invertebrates	MIRAI score	MIRAI score to be within A/B category (87-92%).	A/B category (87-92%)	< 87%
					Invertebrate diversity		SASS score > 160, ASPT > 7.5	SASS score < 157, ASPT < 7.2
					Number of families		> 15 families at abundances A - C	< 13 families at abundance < A
	Riviersonderend	nv9	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Riviersonderend River in a condition equal to or better than a D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-19.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.5 ≥ pH ≤ 7.5 (5th and 95th percentiles)	5 ≥ pH ≤ 7
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within D category (42-57%).	D category (42-57%)	< 42%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a D category (42-57%).	D category (42-57%)	< 42%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species > 30%	Exotic species > 5%, terrestrial woody species < 20%
			Biota	Fish	FRAI score	FRAI should be within a D category (42-57%).	D category (42-57%)	< 42%

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Indigenous species richness		1 species, *Galaxias zebtraus*	No indigenous species
					Galaxius zebratus		FROC = 5	Absent after 2 annual surveys OR FROC < 5
					Exotic fish species		No increase in FROC for *Micropterus salmoides (1), M. dolomieu (5), Lepomis macrochiris (5)*	Presence of new exotic fish or increase in FROC of *C. carpio* and *M. dolomieu*.
				Invertebrates	MIRAI score	MIRAI score to be within C/D category (57-62%).	C/D category (57-62%)	< 57%
					Invertebrate diversity		SASS score > 40, ASPT score > 4.3	SASS score < 36, ASPT < 4.2
					Number of families		> 25 families at abundance A - C	< 23 families at abundance A

Table 3-15 Supplementary information for River RQOs in Riviersonderend Theewaterskloof IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
B4 Riviersonderend Theewaterskloof	III	Du Toits	nvii10 Du Toits River @ BREE_DUTO_H60B	– 34.06867 20.28660	B	BREE_DUTO_H60B is situated on the Du Toits River upstream of Theewaterskloof Dam alongside Franschhoek Pass at gauge H6H007. It is not a EWR site (Figure 3-24). The river is perennial and situated in a nature reserve so is naturally vegetated. There is some abstraction higher up in the catchment Stellenbosch Municipality and the town of Franschhoek.	Du Toits River	None
		Riviersonderend	nv7 Riviersonderend River @ BREE_RIVI_H60D	-34.06361 19.46330	C	BREE_RIVI_H60D is downstream of Theewaterskloof Dam and upstream of the town of Genadendal and is not a EWR site (Figure 3-25). There is no nearby gauge. The river is perennial with low flows being supplied by releases made from Theewaterskloof Dam. Irrigated agriculture lines the banks and there is dense cover of exotic woody trees.	Riviersonderend River	None
		Baviaans	niv28 Baviaans River @ BREE_BAVI_H60E	-34.06331 19.55670	B	BREE_BAVI_H60E is at EWR site IFR 6 (Figure 3-26) in a naturally vegetated nature reserve upstream of the town of Genadendal, upstream of gauge H6H004. The river is perennial upstream of the gauge but low flows being are impacted downstream due to abstraction.	Baviaans River	Breede River Basin study (DWAF 2002a). No SASS samples were taken at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.
		Riviersonderend	nv9 Riviersonderend River @ BREE_RIVI_H60F	-34.11756 19.70490	D	BREE_RIVI_H60F is at EWR site IFR 5 (Figure 3-27) downstream of the town of Genadendal. There is no gauge. Irrigated agriculture takes place on the banks and there is a dense cover of woody exotic plants present. The river is perennial with low flows being impacted on due to abstraction.	Riviersonderend River	Breede River Basin study (DWAF 2002a). No SASS samples were taken at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.

Figure 3-24 **Aerial view of BREE_DUTO_H60B**

Table 3-16 **BREE_DUTO_H60G: Hydrology RQOs**

Source: DWAF (2002a)
Model: DRM (Hughes and Hannart 2003).
Monitor at: No gauge.

```
Desktop Version 2, Generated on 16/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff:            nvii1
Annual Flows (Mill. cu. m or index values):
MAR                  =   43.892
S.Dev.             =   13.382
CV                   =    0.305
Q75                  =    0.707
Q75/MMF              =    0.193
BFI Index            =    0.389
CV(JJA+JFM) Index =    2.193
Ecological Category = B
Total IFR            =   22.277 (50.75 %MAR)
Maint. Lowflow       =   12.567 (28.63 %MAR)
Drought Lowflow      =    4.529 (10.32 %MAR)
Maint. Highflow      =    9.710 (22.12 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type: W.Cape(wet)
Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean     SD       CV     Maint. Drought    Maint.   Maint.
 Oct   3.371   1.893   0.562    1.406   0.572      0.369     1.775
 Nov   2.385   2.286   0.959    1.041   0.278      0.122     1.163
 Dec   1.060   1.001   0.945    0.658   0.179      0.000     0.658
 Jan   0.706   1.039   1.471    0.425   0.082      0.000     0.425
 Feb   0.703   1.367   1.944    0.362   0.080      0.000     0.362
 Mar   0.750   0.861   1.147    0.376   0.094      0.000     0.376
 Apr   2.203   2.858   1.297    0.564   0.177      0.000     0.564
 May   4.617   4.171   0.904    1.032   0.426      1.794     2.826
 Jun   7.397   5.480   0.741    1.491   0.535      2.585     4.076
 Jul   7.852   5.167   0.658    1.725   0.697      3.218     4.943
 Aug   8.199   5.073   0.619    1.825   0.736      0.540     2.365
 Sep   4.648   2.558   0.550    1.663   0.673      1.081     2.743
```

Figure 3-25 Aerial view of BREE_RIVI_H60D

Table 3-17 BREE_RIVI_H60D: Hydrology RQOs

Source: DWAF (2002a)
Model: DRM (Hughes and Hannart 2003).
Monitor at: H6H009.

```
Desktop Version 2, Generated on 16/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff:            nv7
Annual Flows (Mill. cu. m or index values):
MAR                  =  370.164
S.Dev.             =  123.116
CV                   =    0.333
Q75                  =    6.089
Q75/MMF              =    0.197
BFI Index            =    0.389
CV(JJA+JFM) Index =    2.231
Ecological Category = D
Total IFR            =   90.764 (24.52 %MAR)
Maint. Lowflow       =   52.916 (14.30 %MAR)
Drought Lowflow      =   22.958 ( 6.20 %MAR)
Maint. Highflow      =   37.847 (10.22 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type: W.Cape(wet)
Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD       CV     Maint. Drought    Maint.   Maint.
 Oct  29.415  16.369   0.556    3.596   2.654     0.000     3.596
 Nov  21.419  20.820   0.972    2.762   2.348     0.650     3.412
 Dec  10.060   9.760   0.970    0.942   0.999     0.000     0.942
 Jan   6.257   9.240   1.477    0.799   0.999     0.437     1.236
 Feb   6.090  12.087   1.985    0.593   0.902     0.000     0.593
 Mar   6.240   7.396   1.185    0.542   0.856     0.000     0.542
 Apr  17.907  24.016   1.341    2.320   1.105     0.000     2.320
 May  36.681  33.493   0.913    2.854   2.283     3.079     5.933
 Jun  59.826  45.570   0.762    6.905   2.486     2.984     9.888
 Jul  65.627  43.026   0.656    9.989   2.740     7.928    17.916
 Aug  69.315  43.552   0.628   10.845   2.825    19.787    30.631
 Sep  41.326  22.169   0.536   10.771   2.762     2.983    13.754
```

Figure 3-26 **Upstream view of BREE_BAVI_H60E**

Table 3-18 **BREE_BAVI_H60E: Hydrology RQOs**

Source: DWAF (2002a)
Model: DRM (Hughes and Hannart 2003).
Monitor at: H6H004.

```
Desktop Version 2, Generated on 29/12/2016
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          niv28
Annual Flows (Mill. cu. m or index values):
MAR                 =    7.851
S.Dev.              =    3.550
CV                  =    0.452
Q75                 =    0.103
Q75/MMF             =    0.157
BFI Index           =    0.388
CV(JJA+JFM) Index =    3.090
Ecological Category = B
Total IFR           =    5.566 (70.90 %MAR)
Maint. Lowflow      =    3.776 (48.09 %MAR)
Drought Lowflow     =    0.370 ( 4.71 %MAR)
Maint. Highflow     =    1.790 (22.81 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.632	0.569	0.900	0.682	0.051	0.062	0.744
Nov	0.578	1.002	1.733	0.561	0.045	0.000	0.561
Dec	0.306	0.564	1.843	0.256	0.027	0.000	0.256
Jan	0.194	0.401	2.071	0.273	0.029	0.000	0.273
Feb	0.183	0.490	2.677	0.139	0.020	0.062	0.201
Mar	0.162	0.306	1.880	0.068	0.017	0.000	0.068
Apr	0.438	0.840	1.919	0.115	0.020	0.062	0.177
May	0.749	0.843	1.126	0.068	0.017	0.159	0.227
Jun	1.188	1.165	0.981	0.215	0.025	0.159	0.373
Jul	1.259	0.990	0.786	0.358	0.033	0.297	0.655
Aug	1.330	1.164	0.876	0.461	0.040	0.694	1.154
Sep	0.832	0.568	0.683	0.578	0.047	0.297	0.875

Figure 3-27 **Upstream view of BREE_RIVI_H60F**

Table 3-19 **BREE_RIVI_H60F: Hydrology RQOs**

Source: DWAF (2002a)
Model: DRM (Hughes and Hannart 2003).
Monitor at: No gauge.

```
Desktop Version 2, Generated on 16/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff:            nv9
Annual Flows (Mill. cu. m or index values):
MAR                 =  413.701
S.Dev.             =  141.618
CV                  =    0.342
Q75                 =    6.711
Q75/MMF             =    0.195
BFI Index           =    0.350
CV(JJA+JFM) Index =    2.314
Ecological Category = D
Total IFR           =  101.439 (24.52 %MAR)
Maint. Lowflow      =   59.140 (14.30 %MAR)
Drought Lowflow     =   25.658 ( 6.20 %MAR)
Maint. Highflow     =   42.299 (10.22 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type: N.Natal
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	32.934	19.213	0.583	4.019	2.966	0.000	4.019
Nov	24.657	26.249	1.065	3.087	2.624	0.726	3.813
Dec	11.779	12.713	1.079	1.053	1.116	0.000	1.053
Jan	7.344	11.355	1.546	0.893	1.116	0.488	1.381
Feb	7.120	14.776	2.075	0.663	1.008	0.000	0.663
Mar	7.149	8.782	1.228	0.606	0.957	0.000	0.606
Apr	20.328	28.479	1.401	2.593	1.235	0.000	2.593
May	40.798	37.846	0.928	3.190	2.552	3.442	6.631
Jun	66.393	51.686	0.778	7.717	2.778	3.334	11.051
Jul	72.588	48.151	0.663	11.163	3.062	8.860	20.023
Aug	76.664	49.832	0.650	12.120	3.158	22.114	34.234
Sep	45.948	24.717	0.538	12.038	3.087	3.334	15.372

3.1.2.5 River's priority RUs in Lower Riviersonderend IUA

Table 3-20 RQOs and Numerical Limits for river's priority RUs in Lower Riviersonderend IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
F9 Lower Riviersonderend	Riviersonderend	ni3	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Riviersonderend River in a condition equal to or better than a D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-22.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	95th %tile ≤ 85 milliSiemens/metre EC	68 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms

Table 3-21 Supplementary information for River RQOs in Lower Riviersonderend IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
F9 Lower Riviersonderend	III	Riviersonderend	ni3 Riviersonderend River @ BREE_RIVI_H60L	-34.07071 20.28510	D	BREE_RIVI_H60L is at the outlet of the Lower Riviersonderend IUA and is not a EWR site (Figure 3-28). It is situated upstream of the confluence with the Breede River and downstream of gauge H6H009. The river is perennial with low flows being supplied by releases made from Theewaterskloof Dam. Irrigated agriculture lines the banks and there is dense cover of exotic woody trees.	Riviersonderend River	None

Figure 3-28 **Aerial view of BREE_RIVI_H60L**

Table 3-22 **BREE_RIVI_H60L: Hydrology RQOs**

Source: DWAF (2002a)
Model: DRM (Hughes and Hannart 2003).
Monitor at: H6H009.

Desktop Version 2, Generated on 16/02/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff: ni3
Annual Flows (Mill. cu. m or index values):
MAR = 483.759
S.Dev. = 169.491
CV = 0.350
Q75 = 8.120
Q75/MMF = 0.201
BFI Index = 0.397
CV(JJA+JFM) Index = 2.507
Ecological Category = D
Total IFR = 118.617 (24.52 %MAR)
Maint. Lowflow = 69.155 (14.30 %MAR)
Drought Lowflow = 30.003 (6.20 %MAR)
Maint. Highflow = 49.462 (10.22 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type: W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	39.452	25.748	0.653	4.699	3.469	0.000	4.699
Nov	30.939	35.675	1.153	3.609	3.068	0.849	4.459
Dec	15.290	19.579	1.281	1.231	1.305	0.000	1.231
Jan	9.306	14.221	1.528	1.044	1.305	0.571	1.615
Feb	9.059	19.043	2.102	0.775	1.179	0.000	0.775
Mar	9.661	16.941	1.754	0.709	1.119	0.000	0.709
Apr	26.645	41.068	1.541	3.032	1.444	0.000	3.032
May	47.811	44.622	0.933	3.730	2.984	4.024	7.754
Jun	74.113	58.570	0.790	9.023	3.248	3.899	12.923
Jul	81.258	53.333	0.656	13.054	3.580	10.360	23.414
Aug	87.446	60.443	0.691	14.173	3.692	25.859	40.031
Sep	52.781	27.809	0.527	14.076	3.609	3.899	17.975

3.1.2.6 River's priority RUs in Lower Breede Renosterveld IUA

Table 3-23 RQOs and Numerical Limits for river's priority RUs in Lower Breede Renosterveld IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
F11 Lower Breede Renosterveld	Breede	niii4	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Breede River in a condition equal to or better than a B/C category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-25.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in a Tolerable category for Irrigation water supply.	≤ 270 milliSiemens/metre (95th percentile)	216 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
					Water temperature		No more thatn2°C change in natural monthly range (minimum and maximum)	1.6 °C difference from ambient
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	
					Atrazine		≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within B category (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a C category (62-77%).	C category (62-77%)	< 62%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species > 30%	Exotic species > 5%, terrestrial woody species < 20%
			Biota	Fish	FRAI score	FRAI should be within a C category (62-77%).	C category (62-77%)	< 62%
					Indigenous species richness		5 species, *Myxus capensis, Mugil cephalus, Monodactylus falciformis, Gilchristella*	

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
							aestuaria, Anguila marmorata	
					Myxus capensis		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Mugil cephalus		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Monodactylus falciformis		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Gilchrestella aestuaria		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Anguila marmorata		FROC = 4	Absent after 2 annual surveys OR FROC < 4 OR absence of juvenile fish
				Invertebrates	Exotic fish species	MIRAI score to be within D category (42-57%).	No increase in FROC for *Cyprinus carpio (5), Oreochromis mossambicus (5)*	Presence of new exotic fish or increase in FROC of *C. carpio* and *O. mossambicus*
					MIRAI score	MIRAI score to be within D category (42-57%).	D category (42-57%)	< 42%
					Invertebrate diversity		SASS score > 40, ASPT score > 4.3	SASS score < 36, ASPT < 4.2

Table 3-24 Supplementary information for River RQOs in Lower Breede Renosterveld IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
F11 Lower Breede Renosterveld	II	Breede	niii4 Breede River @ BREE_BREE_H70G	-34.23372 20.51460		BREE_BREE_H10F is at EWR site IFR 4 (Figure 3-29) downstream of the N2 at Swellendam which is dominated by dryland agriculture and animal husbandry. There is no gauging weir near the site. The river is perennial with low flows being impacted on due to abstraction.	Breede River	Breede River Basin study (DWAF 2002a). No SASS samples were taken at the time so reference conditions from Dallas (2007) were used for the SASS and ASPT score.

Figure 3-29 Google Earth view of BREE_BREE_H70G

Table 3-25 BREE_BREE_H70G: Hydrology RQOs

Source: DWAF (2002)
Model: DRM (Hughes and Hannart 2003).
Monitor at: H1H001.

```
Desktop Version 2, Generated on 27/12/2016
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff:           niii4
Annual Flows (Mill. cu. m or index values):
MAR                 = 1832.734
S.Dev.            =  648.041
CV                  =    0.354
Q75                 =   34.126
Q75/MMF             =    0.223
BFI Index           =    0.401
CV(JJA+JFM) Index =    2.263
Ecological Category = B/C
Total IFR           =  735.472 (40.13 %MAR)
Maint. Lowflow      =  547.261 (29.86 %MAR)
Drought Lowflow     =  158.170 ( 8.63 %MAR)
Maint. Highflow     =  188.211 (10.27 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint. Drought    Maint.   Maint.
 Oct 151.106  85.229   0.564   72.457  20.997     5.055    77.512
 Nov 110.558 106.623   0.964   47.746  13.880     5.055    52.801
 Dec  54.829  57.424   1.047   16.933   4.848     0.000    16.933
 Jan  35.593  56.403   1.585   13.321   3.844     0.000    13.321
 Feb  35.786  55.372   1.547   15.320   4.560     5.055    20.375
 Mar  43.243  65.894   1.524    7.343   2.037     0.000     7.343
 Apr  98.158 141.360   1.440   18.046   5.274     5.055    23.101
 May 182.054 160.811   0.883   24.023   6.884    58.796    82.819
 Jun 279.686 227.535   0.814   53.756  15.573    25.992    79.748
 Jul 305.800 194.993   0.638   75.977  21.915    56.997   132.973
 Aug 325.201 222.062   0.683  108.462  31.238    26.206   134.669
 Sep 210.720  98.040   0.465   93.876  27.121     0.000    93.876
```

3.1.3 Prioritised nodes on the Overberg area Basin

This section presents RQOs and TPCs for the 6 high-priority nodes on the Overberg area Basin denoted with the pre-fix OVER_.

3.1.3.1 River's priority RUs in Overberg West IUA

Table 3-26 RQOs and Numerical Limits for river's priority RUs in Overberg West IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
B5 Overberg West	Palmiet	piii1	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Palmiet River in a condition equal to or better than a B category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-28.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river in an oligotrophic condition.	≤ 0.025 milligrams per litre PO4-P	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre TIN	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.5 ≥ pH ≤ 7.0 (5th and 95th percentiles)	5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within D category (42-57%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a B/C category (77-82%).	B/C category (77-82%)	< 77%
			Biota	Fish	FRAI score	FRAI should be within an E category (22-37%).	E category (22-37%)	< 22%
				Invertebrates	MIRAI score	MIRAI score to be within B/C category (77-82%).	B/C category (77-82%)	< 77%
					Invertebrate diversity		SASS score > 110, ASPT > 6.5	SASS scores < 100, ASPT < 6.0
					Number of families		Five families, Corydalidae, Elmidae, Hydropsychidae, Cordulidae, Chlorocyphidae	< 3 of these families present
	Palmiet	piii2	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Palmiet River in a condition equal to or better than a B/C category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-29.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
					Iron (Mn)		≤ 0.1 milligrams per litre (95th percentile)	
					Manganese (Mn)		≤ 0.15 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within B category (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	FRAI should be within an E category (23-37%).	B/C category (77-82%)	< 77%
			Biota	Fish	FRAI score	VEGRAI level 3 should be within a B/C category (77-82%).	E category (22-37%)	< 22%
				Invertebrates	MIRAI score	MIRAI score to be within B/C category (77-82%).	B/C category (77-82%)	< 77%
					Invertebrate diversity		SASS score > 110, ASPT > 6.5	SASS scores < 100, ASPT < 6.0
					Number of families		Five families, Corydalidae, Elmidae, Hydropsychidae, Cordulidae, Chlorocyphidae	< 3 of these families present
	Palmiet	piii3	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Palmiet River in a condition equal to or better than a B category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-30.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5.0 ≥ pH ≤ 7.5 (5th and 95th percentiles)	5.5 ≥ pH ≤ 7
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli /

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
						maintained in an Acceptable category for full contact recreation.		Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within a B category (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a B category (82-87%).	B category (82-87%)	< 82%
			Biota	Fish	FRAI score	FRAI should be within a D category (42-57%).	A category (92-100%)	< 92%
					Indigenous species richness		3 species, *Anguila mossambica, Monodactylus falciformis, Myxus capensis*	< 2 species
					Anguila mossambica		FROC = 1	*Anguila mossambica* absent for 2 annual surveys
					Exotic fish species		None	Exotic fish present
				Invertebrates	MIRAI score	MIRAI score to be within a B category (82-87%).	B category (82-87%)	< 82%
					Invertebrate diversity		SASS score > 110, ASPT > 7.0	SASS score < 100, ASPT < 6.5
					Number of families		9 families, Ephemerellidae, Leptophlebidae, Heptageniidae, Tricorythidae, Elmidae, Corydalidae, Trichoptera cased caddis 2 or > types, Pyraustidae, Athericidae	< 6 of these families present

Table 3-27 Supplementary information for River RQOs in Overberg West IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
B5 Overberg West	II	Palmiet	piii1 Palmiet River @ OVER_PALM_G40C	-34.11436 19.05545	C	OVER_PALM_G40C is at EWR site IFR 1 (Figure 3-30), between Nuweberg and Eikenhof Dams, which is dominated by irrigated agriculture for orchards downstream. There is no gauge. The river is perennial with low flows being impacted on due to abstraction.	Palmiet River	Palmiet River Reserve determination at the Comprehensive level (DWAF 2002c).
		Palmiet	piii2 Palmiet River @ OVER_PALM_G40D_1	-34.28571 18.98457	B/C	OVER_PALM_G40D_1 is at EWR site IFR 3 (Figure 3-31), downstream of gauge G4H030, in the Kogelberg Biosphere Reserve that is naturally vegetated. The river is perennial with low flows being impacted on due to abstraction and flow regulation upstream.	Palmiet River	Palmiet River Reserve determination at the Comprehensive level (DWAF 2002c).
		Palmiet	piii3 Palmiet River @ OVER_PALM_G40D_2	-34.33053 18.99073	B	OVER_PALM_G40D_2 is at EWR site IFR 4 (Figure 3-32) just upstream of the Palmiet estuary, which is dominated by naturally vegetated slopes of the Kogelberg Biosphere Reserve. There is a gauging weir G4H007 at the bridge downstream. The river is perennial and flows naturally due to inflow from the Louws and Dwars River tributaries upstream.	Palmiet River	Palmiet River Reserve determination at the Comprehensive level (DWAF 2002c)

Figure 3-30 **Aerial view of OVER_PALM_G40C**

Table 3-28 **OVER_PALM_G40C: Hydrology RQOs**

Source: DWAF (2002c)
Model: DRM (Hughes and Hannart 2003).
Monitor at: No gauge.

Desktop Version 2, Generated on 03/01/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff : piii1
Annual Flows (Mill. cu. m or index values):

MAR	=	39.856
S.Dev.	=	11.313
CV	=	0.284
Q75	=	0.331
Q75/MMF	=	0.100
BFI Index	=	0.340
CV(JJA+JFM) Index	=	2.109

Ecological Category = B

Total IFR	=	18.582 (46.62 %MAR)
Maint. Lowflow	=	12.669 (31.79 %MAR)
Drought Lowflow	=	2.200 (5.52 %MAR)
Maint. Highflow	=	5.913 (14.84 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.357	1.647	0.491	1.742	0.305	0.400	2.142
Nov	1.757	1.078	0.613	1.267	0.225	0.090	1.356
Dec	0.819	0.908	1.109	0.654	0.121	0.000	0.654
Jan	0.346	0.538	1.553	0.291	0.051	0.000	0.291
Feb	0.277	0.488	1.761	0.182	0.028	0.000	0.182
Mar	0.341	0.568	1.665	0.170	0.020	0.000	0.170
Apr	1.030	1.266	1.229	0.290	0.032	0.000	0.290
May	3.342	2.687	0.804	0.709	0.131	0.699	1.407
Jun	6.521	3.306	0.507	1.357	0.240	1.366	2.723
Jul	8.066	3.684	0.457	1.847	0.323	2.097	3.945
Aug	7.931	3.038	0.383	2.104	0.366	0.421	2.525
Sep	6.069	2.310	0.381	2.055	0.358	0.842	2.896

Figure 3-31 **Aerial view of OVER_PALM_G40D_1**

Table 3-29 **OVER_PALM_G40D_1: Hydrology RQOs**

Source: DWAF (2002c)
Model: DRM (Hughes and Hannart 2003).
Monitor at: G4H030.

Desktop Version 2, Generated on 03/01/2017
Summary of Desktop (Version2) estimate for Quaternary Catchment Area:
Total Runoff: piii2
Annual Flows (Mill. cu. m or index values):
MAR = 206.630
S.Dev. = 59.975
CV = 0.290
Q75 = 1.841
Q75/MMF = 0.107
BFI Index = 0.345
CV(JJA+JFM) Index = 2.060
Ecological Category = B/C
Total IFR = 81.799 (39.59 %MAR)
Maint. Lowflow = 54.260 (26.26 %MAR)
Drought Lowflow = 11.696 (5.66 %MAR)
Maint. Highflow = 27.539 (13.33 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type: W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	16.412	7.805	0.476	7.254	1.575	1.660	8.914
Nov	8.737	5.482	0.627	5.224	1.150	0.378	5.602
Dec	3.958	3.934	0.994	2.746	0.631	0.000	2.746
Jan	1.846	2.887	1.564	1.271	0.322	0.000	1.271
Feb	1.544	2.499	1.618	0.860	0.179	0.000	0.860
Mar	1.913	3.063	1.601	0.818	0.126	0.000	0.818
Apr	6.118	7.843	1.282	1.403	0.171	0.000	1.403
May	19.151	15.588	0.814	3.318	0.750	3.620	6.939
Jun	35.374	19.390	0.548	6.051	1.323	6.681	12.732
Jul	41.546	19.069	0.459	7.898	1.710	9.595	17.493
Aug	40.656	15.893	0.391	8.932	1.927	1.868	10.801
Sep	29.374	11.414	0.389	8.485	1.833	3.736	12.221

Figure 3-32 Aerial view of OVER_PALM_G40D_2

Table 3-30 OVER_PALM_G40D_2: Hydrology RQOs

Source: DWAF (2002c)
Model: DRM (Hughes and Hannart 2003).
Monitor at: G4H007.

```
Desktop Version 2, Generated on 14/02/2017
Summary of Desktop (Version2) estimate for Quaternary Catchment Area:
Total Runoff:           piii3
Annual Flows (Mill. cu. m or index values):
MAR                 =  250.416
S.Dev.              =   72.969
CV                  =    0.291
Q75                 =    2.274
Q75/MMF             =    0.109
BFI Index           =    0.345
CV(JJA+JFM) Index =    2.063
Ecological Category = B
Total IFR           =  116.556 (46.55 %MAR)
Maint. Lowflow      =   77.111 (30.79 %MAR)
Drought Lowflow     =   19.604 ( 7.83 %MAR)
Maint. Highflow     =   39.446 (15.75 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type: W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	19.689	9.360	0.475	10.026	2.502	0.049	10.074
Nov	10.513	6.673	0.635	4.710	2.238	0.097	4.807
Dec	4.738	4.624	0.976	2.463	0.925	1.907	4.371
Jan	2.248	3.530	1.570	1.955	0.915	0.954	2.909
Feb	1.893	3.042	1.607	1.118	0.612	0.954	2.072
Mar	2.348	3.751	1.597	1.488	0.808	0.954	2.442
Apr	7.572	9.782	1.292	2.142	0.865	0.954	3.095
May	23.580	19.267	0.817	3.016	0.925	8.623	11.639
Jun	43.188	24.074	0.557	11.085	2.384	2.385	13.469
Jul	50.294	23.232	0.462	12.838	2.502	8.302	21.140
Aug	49.177	19.389	0.394	13.490	2.502	14.219	27.709
Sep	35.174	13.797	0.392	12.780	2.424	0.049	12.828

3.1.3.2 River's priority RUs in Overberg East Renosterveld IUA

Table 3-31 RQOs and Numerical Limits for river's priority RUs in Overberg East Renosterveld IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
F10 Overberg East Renosterveld	Klein	nv23	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Klein River in a condition equal to or better than a C/D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-33.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 180 milliSiemens/metre (95th percentile)	144 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within C category (62-77%).	C category (62-77%)	< 62%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a D category (42-57%).	D category (42-57%)	< 42%
			Biota	Fish	FRAI score	FRAI should be within a E category (22-37%).	E category (22-37%)	< 22%
				Invertebrates	MIRAI score	MIRAI score to be within C category (62-77%).	C category (62-77%)	< 62%

Table 3-32 Supplementary information for River RQOs in Overberg East Renosterveld IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
F10 Overberg East Renosterveld	II	Klein	nv23 Klein River @ OVER_KLEI_G40K	-34.405857 19.602286	C/D	OVERF_KLEI_G40K is at EWR site Kle1 (Figure 3-33) downstream of the farm Raka at the gauge G4H006. There are vineyards and a diary upstream and livestock farms and residential estates downstream. The river is perennial with low flows being impacted on due to abstraction.	Klein River	Breede-Gouritz Ecological Water Requirements and EGSA Report (DWS 2017)

Figure 3-33 **Downstream view of OVER_KLEI_G40K**

Table 3-33 **OVER_KLEI_G40K: Hydrology RQOs**

Source: DWAF (2002)
Model: DRM (Hughes and Hannart 2003).
Monitor at: G4H006.

```
Desktop Version 2, Generated on 30/12/2016
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :           nv23
Annual Flows (Mill. cu. m or index values):
MAR                =   43.010
S.Dev.             =   34.553
CV                 =    0.803
Q75                =    0.234
Q75/MMF            =    0.065
BFI Index          =    0.327
CV(JJA+JFM) Index =    4.986
Ecological Category = C
Total IFR          =    8.291 (19.28 %MAR)
Maint. Lowflow     =    3.414 ( 7.94 %MAR)
Drought Lowflow    =    1.259 ( 2.93 %MAR)
Maint. Highflow    =    4.877 (11.34 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.931	3.795	0.965	0.465	0.175	0.398	0.863
Nov	2.555	3.147	1.232	0.358	0.136	0.179	0.537
Dec	1.161	2.407	2.073	0.199	0.077	0.000	0.199
Jan	0.464	1.150	2.480	0.091	0.037	0.000	0.091
Feb	0.485	1.986	4.096	0.065	0.027	0.000	0.065
Mar	0.616	2.765	4.489	0.064	0.027	0.000	0.064
Apr	2.078	6.573	3.163	0.126	0.030	0.000	0.126
May	3.335	6.540	1.961	0.196	0.051	0.516	0.712
Jun	5.004	7.316	1.462	0.293	0.112	0.767	1.060
Jul	6.866	8.695	1.266	0.413	0.156	0.502	0.915
Aug	10.040	11.699	1.165	0.603	0.227	2.013	2.616
Sep	6.476	7.199	1.112	0.541	0.204	0.502	1.043

3.1.3.3 River's priority RUs in Overberg East Fynbos IUA

Table 3-34 RQOs and Numerical Limits for river's priority RUs in Overberg East Fynbos IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
H17 Overberg East Fynbos	Nuwejaar	ni4	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Nuwejaars River in a condition equal to or better than a C/D category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-36.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 170 milliSiemens/metre (95th percentile)	136 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within a D category (42-57%).	D category (42-57%)	< 42%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within an E category (22-37%).	E category (22-37%)	< 22%
			Biota	Fish	FRAI score	FRAI should be within a E category (22-37%).	E category (22-37%)	< 22%
				Invertebrates	MIRAI score	MIRAI score to be within D category (42-57%).	D category (42-57%)	< 42%
	Kars	nv24	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Kars River in a condition equal to or better than a B/C category.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-37.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 310 milliSiemens/metre (95th percentile)	248 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Atrazine		≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should be within B category (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 3 should be within a B category (82-87%).	B category (82-87%)	< 82%
			Biota	Fish	FRAI score	FRAI should be within a E category (22-37%).	E category (22-37%)	< 22%
				Invertebrates	MIRAI score	MIRAI score to be within B category (82-87%).	B category (82-87%)	< 82%

Table 3-35 Supplementary information for River RQOs in Overberg East Fynbos IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
H17 Overberg East Fynbos	II	Nuwejaar	ni4 Nuwejaar River @ OVER_NUWE_G50B	-33.630191 19.831742	C/D	OVER_NUWE_G50B is at EWR site Nuw1 between the towns of Bredasdorp and Elim, and flows into Soetendalsvlei, before flowing out into the Heuningness River (Figure 3-34). There are dairy farms along the river and although the river flows perennially the low flows are severely impacted by abstraction. There is no gauge near the site.	Nuwejaars River	Breede-Gouritz Ecological Water Requirements and EGSA Report (DWS 2017)
		Kars	nv24 Kars River @ OVER_KARS_G50D	-34.490244 20.103678	B/C	OVER_KARS_G50D is situated at EWR site Kar1 (Figure 3-35) upstream of gauge G5H003 and downstream of Bredasdorp. There are dryland crops and some livestock farms along the river, which flows perennially but at low discharge in the dry season due to abstraction.	Kars River	Breede-Gouritz Ecological Water Requirements and EGSA Report (DWS 2017)

Figure 3-34 **Upstream view of OVER_NUWE_G50B**

Table 3-36 **OVER_NUWE_G50B: Hydrology RQOs**

Source: DWS (2018)
Model: DRM (Hughes and Hannart 2003).
Monitor at: No gauge.

```
Desktop Version 2, Generated on 17/01/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :             ni4
Annual Flows (Mill. cu. m or index values):
MAR                =   12.473
S.Dev.             =   14.086
CV                 =    1.129
Q75                =    0.160
Q75/MMF            =    0.154
BFI Index          =    0.381
CV(JJA+JFM) Index =     4.150
Ecological Category = D
Total IFR          =    1.626 (13.03 %MAR)
Maint. Lowflow     =    0.490 ( 3.93 %MAR)
Drought Lowflow    =    0.210 ( 1.68 %MAR)
Maint. Highflow    =    1.136 ( 9.11 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.216	2.168	1.783	0.055	0.020	0.115	0.170
Nov	0.812	1.132	1.394	0.046	0.010	0.052	0.098
Dec	0.319	0.355	1.112	0.030	0.010	0.000	0.030
Jan	0.262	0.489	1.863	0.022	0.010	0.000	0.022
Feb	0.349	1.058	3.030	0.022	0.010	0.000	0.022
Mar	0.275	0.475	1.727	0.020	0.010	0.000	0.020
Apr	0.952	3.536	3.713	0.030	0.020	0.000	0.030
May	1.053	1.880	1.786	0.035	0.030	0.129	0.163
Jun	1.810	3.792	2.095	0.049	0.030	0.232	0.281
Jul	1.901	3.664	1.927	0.056	0.020	0.108	0.164
Aug	2.170	3.924	1.809	0.065	0.020	0.393	0.459
Sep	1.354	1.769	1.307	0.059	0.020	0.108	0.167

Figure 3-35 Upstream view of OVER-KARS_G50D

Table 3-37 OVER_KARS_G50D: Hydrology RQOs

Source: DWAF (2002)
Model: DRM (Hughes and Hannart 2003).
Monitor at: G5H003.

Desktop Version 2, Generated on 30/12/2016
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff : nv24
Annual Flows (Mill. cu. m or index values):

MAR	=	15.433
S.Dev.	=	12.430
CV	=	0.805
Q75	=	0.240
Q75/MMF	=	0.187
BFI Index	=	0.403
CV(JJA+JFM) Index	=	3.846

Ecological Category = B

Total IFR	=	4.674	(30.29 %MAR)
Maint. Lowflow	=	2.607	(16.89 %MAR)
Drought Lowflow	=	0.644	(4.17 %MAR)
Maint. Highflow	=	2.067	(13.40 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.911	4.130	2.161	0.322	0.079	0.301	0.623
Nov	1.390	1.950	1.403	0.282	0.070	0.157	0.440
Dec	0.558	0.696	1.245	0.168	0.044	0.000	0.168
Jan	0.373	0.528	1.414	0.121	0.034	0.000	0.121
Feb	0.406	0.916	2.256	0.109	0.031	0.000	0.109
Mar	0.609	1.946	3.195	0.119	0.033	0.000	0.119
Apr	1.588	4.472	2.816	0.191	0.030	0.000	0.191
May	1.479	2.508	1.696	0.204	0.050	0.268	0.472
Jun	1.902	4.129	2.171	0.250	0.063	0.349	0.600
Jul	1.667	1.898	1.139	0.255	0.064	0.170	0.425
Aug	2.113	2.878	1.362	0.304	0.075	0.651	0.956
Sep	1.437	1.338	0.931	0.283	0.070	0.170	0.453

3.1.4 Prioritised nodes on the Gouritz Basin

This section presents RQOs and TPCs for the 10 high-priority nodes on the Gouritz Basin (denoted with the prefix GOUR_).

3.1.4.1 River's priority RUs in Tows IUA

Table 3-38 RQOs and Numerical Limits for river's priority RUs in Touws IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
E8 Touws	Doring	gviii1	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Doring River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C/D).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-40.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 1500 milliSiemens/metre (95th percentile)	1200 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a C/D.	C/D category (57-62%)	< 57%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at ~58% for the riparian zone.	C/D category (57-62%)	< 57%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 10%	Exotic species > 15%, terrestrial woody species > 15%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 15%	Exotic species > 20%, terrestrial woody species > 20%
			Biota	Fish	FRAI score	FRAI shall yield a C/D (58.3%).	C/D category (57-62%)	< 57%
					Indigenous species richness		4 species, *Labeo umbratus, Pseudobarbus asper, Sandelia capensis, Barbus anoplus*	
					Labeo umbratus		FROC = 0.5	Absent after 2 annual surveys OR FROC < 0.5 OR absence of juvenile fish
					Pseudobarbus asper		FROC = 0.5	Absent after 2 annual surveys OR FROC < 0.5 OR absence of juvenile fish

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Sandelia capensis		FROC = 0.5	Absent after 2 annual surveys OR FROC < 0.5
					Barbus anoplus		FROC = 0.5	Absent after 2 annual surveys OR FROC < 0.5 OR absence of juvenile fish
					Exotic fish species		No increase in CPUE *Tilapia sparmanii (0.6 ind./min.*	Presence of new exotic fish or increase in CPUE of *T. sparmannii*
				Invertebrates	MIRAI score	MIRAI score to be within D (40-59%) Category	D category (42-57%)	< 42%
					Invertebrate diversity		SASS score > 90, ASPT score > 4.5	SASS score < 90, ASPT < 4.5
					Number of families		> 15 families at abundances A - C	< 13 families at abundance < A
	Touws	gv5	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Touws River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-41.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 1500 milliSiemens/metre (95th percentile)	1200 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at least 78% % for the riparian zone.	B/C category (77-82%)	< 77%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 15%
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 20%, terrestrial woody species > 10%
			Biota	Fish	FRAI score	FRAI shall yield a C/D (59%).	C/D category (57-62%)	< 57%

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Indigenous species richness		4 of 5 species present, *Labeo umbratus, Pseudobarbus asper, Sandelia capensis, Barbus anoplus, Anguila mossambica*	< 3 species present
					Labeo umbratus		FROC > 0.5	Absent after 2 annual surveys OR FROC < 0.5 OR absence of juvenile fish
					Pseudobarbus asper		FROC = 1	Absent after 2 annual surveys OR FROC < 1 OR absence of juvenile fish
					Sandelia capensis		FROC =5	Absent after 2 annual surveys OR FROC < 5
					Barbus anoplus		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Anguila mossambica		FROC = 3	Absent after 2 annual surveys OR FROC < 3
					Exotic fish species		No increase in CPUE, *Tilapia sparmanii (1.36 ind./min.), Labeobarbus aeneus (0.03 ind./min.)*	Presence of new exotic fish or increase in CPUE of *T. sparmannii, L. aeuneus*
				Invertebrates	MIRAI score	MIRAI score to be within B/C (78 - 82%) Category	B/C category (77-82%)	< 77%
					Invertebrate diversity		SASS score > 45, ASPT?> 4.0	SASS score < 45, ASPT < 4.0
					Number of families		> 10 families, 5 with SASS score > 5, abundance A - C	< 10 families
	Buffels	gv4	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Buffels River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-42.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 320 milliSiemens/metre (95th percentile)	256 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
						category for full contact recreation.		
			Habitat	Geomorphology	GAI score	GAI score should equate to a D **(42-57%).**	D category (42-57%)	< 42%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at ~57% for the riparian zone.	D category (42-57%)	< 42%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 20%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 30%	Exotic species > 20%, terrestrial woody species > 30%
			Biota	Fish	FRAI score	FRAI shall yield a B/C (79%).	B/C category (77-82%)	< 77%
					Indigenous species richness		4 of 5 species present, *Labeo umbratus, Pseudobarbus asper, Sandelia capensis, Barbus anoplus, Anguila mossambica*	< 4 species present
					Labeo umbratus		FROC > 2.5	Absent after 2 annual surveys OR FROC < 2.5 OR absence of juvenile fish
					Pseudobarbus asper		FROC = 4.5	Absent after 2 annual surveys OR FROC < 4.5 OR absence of juvenile fish
					Sandelia capensis		FROC = 4	Absent after 2 annual surveys OR FROC < 4
					Barbus anoplus		FROC = 4	Absent after 2 annual surveys OR FROC < 4
					Anguila mossambica		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Exotic fish species		No increase in CPUE, *Tilapia sparmanii (1. ind./min.), Labeobarbus aeneus (0.32 ind./min.)*	Presence of new exotic fish or increase in CPUE of *T. sparmannii, L. aeuneus*
				Invertebrates	MIRAI score	MIRAI score to be within C (60-79%) Category	C category (62-77%)	< 62%
					Invertebrate diversity		SASS score > 90, ASPT > 5.0	SASS score < 85, ASPT < 5.0
					Number of families		> 15 families, 7 with SASS score > 6, abundances A - C	< 14 families, < 7 with SASS score < 6, abundances < A
	Groot River	gv6	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Groot River an ecological condition that is equal to or	Months | Maintenance low flows (million cubic metres) | Maintenance high flows (million cubic metres)	

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric			TPC
						better than the ecological condition in summer 2014 (Category D).	Oct	0.016	0.559	
							Nov	0.018	1.719	
							Dec	0.019	0.559	
							Jan	0.016	1.719	
							Feb	0.015	0	
							Mar	0.022	0	
							Apr	0.024	0	
							May	0.027	0	
							Jun	0.029	0	
							Jul	0.027	0	
							Aug	0.027	0	
							Sep	0.018	0	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)			
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)			
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 320 milliSiemens/metre (95th percentile)			
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)			
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)			
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)			
	Groot River	gii3	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Groot River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category D).	Months	Maintenance low flows (million cubic metres)	Maintenance high flows (million cubic metres)	
							Oct	0.583	0.603	
							Nov	0.746	1.092	
							Dec	0.752	1.123	
							Jan	0.732	1.121	
							Feb	0.637	1.178	
							Mar	0.593	0.589	
							Apr	0.852	3.765	
							May	0.803	1.208	
							Jun	0.903	0	
							Jul	0.791	0	

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric			TPC
							Aug	0.808	1.118	
							Sep	0.587	0.532	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)			
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)			
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 620 milliSiemens/metre (95th percentile)			
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)			
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)			

Table 3-39 Supplementary information for River RQOs in Touws IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
E8 Touws	III	Doring	gviii1 Doring River @ GOUR_DORI_J12L	-33.79137 20.92699	C/D	GOUR_DORI_J12L is at the EWR site J1DORI-EWR7. This site was included in the EWR study in reaction to a current/future development in the Lemoenshoek Stream, a tributary of the Doring River. The EWR site was therefore selected in the Doring River as close as possible to and downstream of the confluence of the Lemoenshoek confluence with the Doring River. The major issues that have caused the change from reference condition were mainly flow and some non-flow related issues. Abstraction and upstream dams as well as flow diversions have resulted in decreased base flows and zero flows at times. Deterioration in water quality is mainly due to agricultural return flows. Exotic invasive vegetation occurs in the lower and upper zones. Exotic fish species also occur in the reach. Clearing and overgrazing as well as catchment erosion have also contributed to bank and bed modification.	Doring River	Reserve Determination Studies for Gouritz WMA (DWS 2015)
		Touws	gv5 Touws River @ GOUR_TOUW_J12L	-33.72707 21.16507	B/C	GOUR_TOUW_J12L is located at the Touws EWR site J1TOUW-EWR3, which is situated just upstream of the confluence with the Buffels River and located downstream of JH018. Three irrigation dams are situated in tertiary catchment J12. The upstream area is in a poor to moderate state due to small farm dams in areas, and irrigation which is extensive in some areas. Non-flow related impacts are mainly agricultural encroachment or clearing of riparian zones and/or floodplains, overgrazing in some areas and physical disturbance (manipulation) of morphological features (localised). The downstream area in which the site is located is mostly in moderate condition which is an improvement due to the decreased irrigation in this area. Direct impacts in the downstream zone are mostly non-flow related. Grazing with some dryland agriculture and minimal irrigation occur. Figure 3-36 shows photographs of GOUR_TOUW_J12L.	Touws River	Reserve Determination Studies for Gouritz WMA (DWS 2015)
		Buffels	gv4 Buffels River @ GOUR_BUFF_J11H	-33.38452 20.94169	C	The main dam in the Buffels River is the Floriskraal Dam (50 MCM) in the Buffels River at the outlet of J11G. The catchment area upstream of this dam is typical Karoo with very little development. Some irrigation (9 million m^3/a) is practised downstream of this dam. The catchment is stressed as a result of irrigation demands exceeding supply. GOUR_BUFF_J11H is located at the EWR site J1BUFF-EWR5, which is situated about 20 km downstream of Floriskraal Dam on a private reserve at Wagendrift Lodge. There is extensive irrigation downstream of Floriskraal Dam. Flood releases (not pulsed) are made irregularly based on requirements to supply downstream users (Figure 3-37). The EWR site is situated within Management Resource Unit (MRU) B (DWA, 2014a) which has irrigation as landuse where the relief allows. The EWR site is nested in a Reserve Assessment Unit which is in better condition (being protected in the poort) than the rest of the MRU.	Buffels River	Reserve Determination Studies for Gouritz WMA (DWS 2015)

Table 3-40 GOUR_DORI_J12L: Hydrology RQOs

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 10/03/2017
Summary of Desktop (Version2) estimate for Quaternary Catchment Area:
Total Runoff :           gviii
Annual Flows (Mill. cu. m or index values):
MAR               =    2.868
S.Dev.           =    3.492
CV                =    1.218
Q75               =    0.013
Q75/MMF           =    0.054
BFI Index         =    0.207
CV(JJA+JFM) Index =    6.371
Ecological Category = C/D
Total IFR         =    0.345 (12.02 %MAR)
Maint. Lowflow    =    0.174 ( 6.06 %MAR)
Drought Lowflow   =    0.002 ( 0.06 %MAR)
Maint. Highflow   =    0.171 ( 5.96 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : E.Karoo
Month    Natural Flows          Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint. Drought    Maint.   Maint.
 Oct   0.247   0.538   2.176    0.017   0.000     0.031     0.048
 Nov   0.302   0.569   1.883    0.021   0.000     0.031     0.052
 Dec   0.322   0.797   2.474    0.019   0.000     0.000     0.019
 Jan   0.280   1.232   4.402    0.012   0.000     0.031     0.043
 Feb   0.271   1.214   4.483    0.009   0.000     0.000     0.009
 Mar   0.195   0.565   2.890    0.015   0.000     0.000     0.015
 Apr   0.392   1.064   2.713    0.016   0.000     0.079     0.095
 May   0.259   0.465   1.793    0.017   0.000     0.000     0.017
 Jun   0.082   0.121   1.466    0.013   0.000     0.000     0.013
 Jul   0.106   0.333   3.146    0.010   0.000     0.000     0.010
 Aug   0.226   0.617   2.725    0.012   0.002     0.000     0.012
 Sep   0.184   0.591   3.209    0.012   0.000     0.000     0.012
```

Figure 3-36 Downstream view of GOUR_TOUW_ J12L

Table 3-41 GOUR_TOUW_J12L: Hydrology RQOs

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: JH018.

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Desktop Version 2, Generated on 15/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :              gv5
Annual Flows (Mill. cu. m or index values):
MAR                =   33.497
S.Dev.            =   36.711
CV                 =    1.096
Q75                =    0.140
Q75/MMF            =    0.050
BFI Index          =    0.183
CV(JJA+JFM) Index =    6.240
Ecological Category = C
Total IFR          =    5.972 (17.83 %MAR)
Maint. Lowflow     =    1.879 ( 5.61 %MAR)
Drought Lowflow    =    0.150 ( 0.45 %MAR)
Maint. Highflow    =    4.093 (12.22 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : E.Karoo
Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean     SD       CV     Maint. Drought    Maint.   Maint.
 Oct   1.614   4.112   2.548    0.125   0.020     0.183     0.308
 Nov   2.904   9.620   3.313    0.164   0.010     0.354     0.518
 Dec   2.280   5.731   2.514    0.139   0.010     0.274     0.414
 Jan   2.034  10.196   5.013    0.124   0.010     0.246     0.370
 Feb   2.047   7.568   3.697    0.119   0.000     0.407     0.526
 Mar   1.661   3.849   2.318    0.108   0.010     0.204     0.311
 Apr   3.293   7.142   2.169    0.163   0.000     1.370     1.533
 May   3.574   6.352   1.777    0.178   0.020     0.446     0.624
 Jun   5.116  15.744   3.077    0.235   0.010     0.000     0.235
 Jul   3.841   8.378   2.181    0.201   0.020     0.000     0.201
 Aug   3.551   8.644   2.434    0.195   0.010     0.433     0.628
 Sep   1.583   3.797   2.399    0.129   0.030     0.175     0.305
```

Figure 3-37 **Downstream view of GOUR_BUFF_J11H**

Table 3-42 **GOUR_BUFF_J11H: Hydrology RQOs**

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: J1H028.

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Desktop Version 2, Generated on 10/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :             gv4
Annual Flows (Mill. cu. m or index values):
MAR                 =   27.384
S.Dev.            =   37.490
CV                  =    1.369
Q75                 =    0.100
Q75/MMF             =    0.044
BFI Index           =    0.177
CV(JJA+JFM) Index =    5.963
Ecological Category = C
Total IFR           =    4.887 (17.85 %MAR)
Maint. Lowflow      =    1.544 ( 5.64 %MAR)
Drought Lowflow     =    0.128 ( 0.47 %MAR)
Maint. Highflow     =    3.343 (12.21 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : E.Karoo
Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean    SD      CV     Maint. Drought    Maint.   Maint.
 Oct   0.894   2.488   2.784    0.075   0.018      0.101      0.175
 Nov   1.794   4.556   2.539    0.105   0.010      0.218      0.324
 Dec   2.522   6.846   2.715    0.132   0.000      0.313      0.444
 Jan   3.295  19.552   5.934    0.159   0.000      0.413      0.572
 Feb   2.127   7.570   3.559    0.120   0.000      0.343      0.462
 Mar   1.929   3.454   1.790    0.115   0.000      0.171      0.286
 Apr   3.395   8.084   2.381    0.170   0.000      1.087      1.257
 May   2.647   6.034   2.280    0.143   0.010      0.325      0.468
 Jun   3.293   8.152   2.476    0.169   0.030      0.000      0.169
 Jul   2.316   3.935   1.699    0.139   0.030      0.000      0.139
 Aug   2.182   5.306   2.431    0.131   0.020      0.263      0.393
 Sep   0.991   2.147   2.167    0.087   0.010      0.109      0.196
```

3.1.4.2 River's priority RUs in Gouritz-Olifants IUA

Table 3-43 RQOs and Numerical Limits for river's priority RUs in Gouritz-Olifants IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
D7 Gouritz-Olifants	Gamka	giv20	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Gamka River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-45.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 90 milliSiemens/metre (95th percentile)	72 mS/m EC
				System variables	pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a C (62-77%).	C category (62-77%)	< 62%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at least 61% for the riparian zone.	C category (62-77%)	< 62%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 10%, terrestrial woody species < 5%	Exotic species > 20%, terrestrial woody species > 10%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 15%	Exotic species > 15%, terrestrial woody species > 10%
			Biota	Fish	FRAI score	FRAI shall yield a C (71.6%).	C category (62-77%)	< 62%
					Indigenous species richness		5 species present, *Labeo umbratus, Sandelia capensis, Barbus anoplus, Anguila mossambica, A. marmorata*	< 4 species present
					Labeo umbratus		FROC > 1	Absent after 2 annual surveys OR FROC < 1 OR absence of juvenile fish
					Anguila marmorata		FROC > 0.5	Absent after 2 annual surveys OR FROC < 1 OR absence of juvenile fish

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Sandelia capensis		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Barbus anoplus		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Anguila mossambica		FROC > 0.5	Absent after 2 annual surveys OR FROC < 1 OR absence of juvenile fish
				Invertebrates	Exotic fish species	MIRAI score to be within B/C (78 - 82%) Category	> 5 exotic species	< exotic species
					MIRAI score		B/C category (77-82%)	< 77%
					Invertebrate diversity	MIRAI score to be within B/C (78 - 82%) Category	SASS score > 100, ASPT > 5.5	SASS score < 90, ASPT < 5
	Olifants	giii2	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Olifants River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C/D).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-46.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	Phosphate (PO4-P)
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	Total inorganic nitrogen (TIN)
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 680 milliSiemens/metre (95th percentile)	Electrical conductivity (EC)
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	pH range
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	Dissolved oxygen
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	Escherichia coli
			Habitat	Geomorphology	GAI score	GAI score should equate to a C/D (57-62%).	C/D category (57-62%)	< 57%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at ~70% for the riparian zone.	C category (62-77%)	< 62%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
			Biota	Invertebrates	MIRAI score	MIRAI score should equate to a C (62-77%)).	C category (62-77%)	< 62%

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
	Kammanassie	gv36	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Kammanassie River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C/D).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-47.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in a D class for aquatic ecosystems.	≤ 85 milliSiemens/metre (95th percentile)	68 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Riparian vegetation	VEGRAI score	VEGRAI level 4 of at ~58% for the riparian zone.	C/D category (57-62%)	< 57%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 10%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 20%	Exotic species > 20%, terrestrial woody species > 30%
			Biota	Fish	FRAI score	FRAI shall yield a D (46.9%).	D category (42-57%)	< 42%
					Indigenous species richness		2 species, *Pseudobarbus asper, Sandelia capensis*	< 2 species
					Pseudobarbus asper		FROC = 0.5	Absent after 2 annual surveys OR FROC < 0.5 OR absence of juvenile fish
					Sandelia capensis		FROC = 0.5	Absent after 2 annual surveys OR FROC < 0.5
					Exotic fish species		No increase in CPUE for *M. salmanoides (0.5 ind./min.)*	Presence of new exotic fish or increase in CPUE of *M. salmanoides*
				Invertebrates	MIRAI score	MIRAI score to be within C/D (58-62%) Category	C/D category (57-62%)	< 57%
					Invertebrate diversity		SASS score > 90, ASPT > 4.5	SASS score < 90, ASPT < 4.5
					Number of families		> 17 families, 2 or more baetids, abundance A - C	< 17 families, < 2 baetids, abundance < A

Table 3-44 Supplementary information for River RQOs in Gouritz-Olifants IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
D7 Gouritz-Olifants	III	Gamka	giv20 Gamka River @ GOUR-GAMK_J25A	-33.36472 21.63051	C	GOUR_GAMK_J25A is at the EWR site J2GAMK-EWR4, which is situated in the Gamkaskloof and Die Hel in the Swartberg Nature Reserve, a World Heritage Site. The site is situated in Gamka River poort downstream of the bridge. There are three upstream dams; two of which supply Beaufort West with domestic water and Gamkapoort Dam upstream of the site which supports domestic water requirements and irrigation downstream. The river is therefore used as a conduit to supply downstream users. The manner of operation is pulsed flow releases with no other releases from the dam apart from a constant leak and spills (Figure 3-38).	Gamka River	Reserve Determination Studies for Gouritz WMA (DWS 2015)
		Olifants	giii2 Olifants River @ GOUR_OLIF_J31C	-33.43813 23.20587	C		Olifants River	Reserve Determination Studies for Gouritz WMA (DWS 2015)
		Kammanassie	gv36 Kammanassie River @ GOUR_KAMM_J34C	-33.73286 22.69740	C/D	GOUR_KAMM_J34C is located at EWR site J3KAMM-EWR10. The Kammanassie Dam. located in the lower reaches of the river, is the only large dam that can be used to operate the system. Upstream of the dam, flow operation can only be managed through restrictions and removal of exotic vegetation. The Kammanassie River downstream of the Kammanassie Dam has degraded to an E and D/E PES due to the significant flow modification in the sub quaternary reaches, agricultural fields, return flows as well as extensive reed growth. The land use is dominated by irrigation which is extensive downstream of the Kammanassie Dam. Upstream of the dam irrigation occurs wherever the relief allows even in the source zone. Extensive exotic vegetation occurs. The major issues that have caused the change from reference condition were mainly flow and some non-flow related issues. Irrigation return flows, abstraction and farm dams have resulted in decreased base flows with zero flows at times. Intensive farming result in impacts on water quality due to irrigation return flows. Elevated sediment input reduces pool depth and degrades the substrate for biota. Exotic vegetation occurs in the upper riparian zone whereas the indigenous *C. textillis* (Flat Sedge) has encroached significantly in area. This is possibly due to nutrient enrichment and more consistent flows or seepage from return flows during dry times. Exotic fish species also occur in the reach. Figure 3-39 shows the EWR site.	Kammanassie River	Reserve Determination Studies for Gouritz WMA (DWS 2015)

Figure 3-38 **Downstream view of GOUR_GAMK_J25A**

Table 3-45 **GOUR_GAMK_J25A: Hydrology RQOs**

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: J2H016.

```
Desktop Version 2, Generated on 18/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :           giv20
Annual Flows (Mill. cu. m or index values):
MAR               =   79.778
S.Dev.          =   89.659
CV                =    1.124
Q75               =    0.440
Q75/MMF           =    0.066
BFI Index         =    0.200
CV(JJA+JFM) Index =    4.746
Ecological Category = C
Total IFR         =   15.174 (19.02 %MAR)
Maint. Lowflow    =    4.335 ( 5.43 %MAR)
Drought Lowflow   =    0.420 ( 0.53 %MAR)
Maint. Highflow   =   10.839 (13.59 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : E.Karoo
Month    Natural Flows          Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD       CV     Maint. Drought    Maint.   Maint.
 Oct   3.192   6.437   2.017    0.282   0.035     0.833     1.115
 Nov   8.303  23.215   2.796    0.348   0.034     0.940     1.288
 Dec   8.759  18.641   2.128    0.395   0.032     2.707     3.102
 Jan   6.241  13.859   2.221    0.347   0.027     0.940     1.287
 Feb  11.342  27.851   2.456    0.366   0.025     0.940     1.305
 Mar  17.013  41.262   2.425    0.739   0.060     2.707     3.447
 Apr   9.739  19.655   2.018    0.578   0.041     0.940     1.517
 May   4.408   9.837   2.231    0.327   0.045     0.000     0.327
 Jun   1.631   3.113   1.909    0.234   0.036     0.000     0.234
 Jul   1.723   3.916   2.274    0.237   0.025     0.000     0.237
 Aug   4.257  12.578   2.955    0.235   0.030     0.000     0.235
 Sep   3.171   7.391   2.331    0.247   0.029     0.833     1.079
```

Table 3-46 GOUR_OLIF_J31C: Hydrology RQOs

Source: DWA (2014b); DWS (2014a).
Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).
Monitor at: No gauge.

```
Desktop Version 2, Generated on 15/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          giii2
Annual Flows (Mill. cu. m or index values):
MAR                 =   11.796
S.Dev.            =   15.202
CV                  =    1.289
Q75                 =    0.050
Q75/MMF             =    0.051
BFI Index           =    0.192
CV(JJA+JFM) Index =    6.571
Ecological Category = C
Total IFR           =    2.102 (17.82 %MAR)
Maint. Lowflow      =    0.661 ( 5.60 %MAR)
Drought Lowflow     =    0.000 ( 0.00 %MAR)
Maint. Highflow     =    1.442 (12.22 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : E.Karoo
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.418	1.040	2.488	0.035	0.000	0.046	0.081
Nov	1.044	3.613	3.462	0.055	0.000	0.130	0.184
Dec	1.103	4.131	3.744	0.057	0.000	0.137	0.194
Jan	0.878	2.310	2.631	0.050	0.000	0.107	0.157
Feb	1.793	4.505	2.512	0.079	0.000	0.127	0.205
Mar	2.650	7.069	2.667	0.109	0.000	0.548	0.657
Apr	1.291	2.627	2.035	0.068	0.000	0.127	0.195
May	0.823	2.152	2.614	0.053	0.000	0.097	0.150
Jun	0.320	0.729	2.274	0.036	0.000	0.000	0.036
Jul	0.396	1.832	4.626	0.037	0.000	0.000	0.037
Aug	0.703	3.516	5.003	0.046	0.000	0.083	0.129
Sep	0.376	1.183	3.150	0.035	0.000	0.040	0.075

Figure 3-39 **Downstream view of GOUR_KAMM_J34C**

Table 3-47 **GOUR_KAMM_J34C: Hydrology RQOs**

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: No gauge.

```
Desktop Version 2, Generated on 09/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :            gv36

Annual Flows (Mill. cu. m or index values):
MAR               =   41.216
S.Dev.           =   48.110
CV                =    1.167
Q75               =    0.500
Q75/MMF           =    0.146
BFI Index         =    0.249
CV(JJA+JFM) Index =    5.452

Ecological Category = C/D

Total IFR         =    6.324 (15.34 %MAR)
Maint. Lowflow    =    3.488 ( 8.46 %MAR)
Drought Lowflow   =    0.398 ( 0.97 %MAR)
Maint. Highflow   =    2.836 ( 6.88 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Karoo
```

Month	Natural Flows Mean	Natural Flows SD	Natural Flows CV	Modified Flows (IFR) Low flows Maint.	Low flows Drought	High Flows Maint.	Total Flows Maint.
Oct	3.177	5.086	1.601	0.435	0.048	0.218	0.653
Nov	4.269	10.513	2.463	0.431	0.047	0.218	0.649
Dec	3.188	8.794	2.758	0.327	0.070	0.000	0.327
Jan	1.479	3.502	2.368	0.252	0.016	1.091	1.343
Feb	1.657	6.797	4.101	0.179	0.000	0.218	0.397
Mar	2.575	8.056	3.129	0.182	0.011	0.000	0.182
Apr	3.511	10.572	3.011	0.182	0.000	0.000	0.182
May	4.238	9.687	2.286	0.215	0.011	0.000	0.215
Jun	2.659	5.079	1.910	0.239	0.016	0.000	0.239
Jul	2.783	4.810	1.728	0.311	0.038	1.091	1.402
Aug	6.832	21.300	3.118	0.381	0.064	0.000	0.381
Sep	4.849	10.520	2.169	0.353	0.078	0.000	0.353

3.1.4.3 River's priority RUs in Lower Gouritz IUA

Table 3-48 RQOs and Numerical Limits for river's priority RUs in Lower Gouritz IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
F13 Lower Gouritz	Gouritz	gi4	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Gouritz River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-50.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	Phosphate (PO4-P)
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	Total inorganic nitrogen (TIN)
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained at present day levels.	≤ 600 milliSiemens/metre (95th percentile)	Electrical conductivity (EC)
				System Variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	pH range
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	Dissolved oxygen
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	Escherichia coli
			Habitat	Geomorphology	GAI score	GAI score should equate to a B (82-87%).	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at ~57% for the riparian zone.	B/C category (77-82%)	< 77%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Upper zone cover abundance		Exotic species < 15%, terrestrial woody species < 40%	Exotic species > 20%, terrestrial woody species > 50%
			Biota	Fish	FRAI score	FRAI shall yield a D (50.1%).	D category (42-57%)	< 42%
					Indigenous species richness		4 species present, *Labeo umbratus, Barbus anoplus, Anguila mossambica, Pseudobarbus anoplus*	< 4 species present
					Labeo umbratus		FROC > 2	Absent after 2 annual surveys OR FROC < 2 OR absence of juvenile fish
					Anguila mossambica		FROC > 1	Absent after 2 annual surveys OR

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
								FROC < 1
					Pseudobarbus asper		FROC = 0.5	Absent after 2 annual surveys OR FROC < 1 OR absence of juvenile fish
					Barbus anoplus		FROC = 1	Absent after 2 annual surveys OR FROC < 1 OR absence of juvenile fish
					Exotic fish species		No increase in CPUE for *Lepomis macrochirus (0.04 ind/min.), Micropterus dolomieu (0.02 ind/min); Micropterus salmoides (0.02 ind/min); Cyprinus carpio (0.02 ind/min); Labeobarbus aeneus (0.7 ind/min); Tilapia sparmanii (0.4 ind/min)*	Presence of new exotic fish or increase in CPUE of Lepomis macrochirus, Micropterus dolomieu, Micropterus salmoides, Cyprinus carpio, Labeobarbus aeneus, Tilapia sparmanii
				Invertebrates	MIRAI score	MIRAI score to be within C (60-79%) Category	C category (62-77%)	< 62%
					Invertebrate diversity		SASS score > 90, ASPT > 5.0	SASS score < 85, ASPT < 5.0
					Number of families		> 19 families, 7 with SASS score > 7, abundance A - C	< 17 families, < 6 with SASS score < 6, abundance < A

Table 3-49 Supplementary information for River RQOs in Lower Gouritz IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
F13 Lower Gouritz	II	Gouritz	gi4 Gouritz River @ GOUR_GOUR_J40B	-33.90982 21.65233	C	GOUR_GOUR_J40B is at the EWR site J4GOUR-EWR6, which is downstream of the confluence of the Buffels (Groot) River. It is situated just upstream of a gorge in the Langeberg Mountains. The site is situated quite far upstream from J2H002 which is a rated section. Although extremely inaccurate for low flows, the flow regime (Figure 3-40) shows that this area is prone to very low flows in the dry season and very large floods in the wet season. The Gouritz River is short compared to the extensive upstream catchments with the Olifants, Gamka, Buffalo and Touws rivers. J2 and J3 are extensively impacted by flow related activities. Localised impacts in the Gouritz River consist of irrigation of mainly lucerne and pastures on the banks of the Gouritz River. Various farm dams are found in the Lower Gouritz River.	Gouritz River	Reserve Determination Studies for Gouritz WMA (DWS 2015)

Figure 3-40 **Downstream view of GOUR_GOUR_J40B**

Table 3-50 **GOUR_GOUR_J40B: Hydrology RQOs**

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: J1H028.

```
Desktop Version 2, Generated on 10/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :              gi4

Annual Flows (Mill. cu. m or index values):
MAR                 =  489.079
S.Dev.             =  392.103
CV                  =    0.802
Q75                 =    7.613
Q75/MMF             =    0.187
BFI Index           =    0.262
CV(JJA+JFM) Index =    3.564

Ecological Category = C

Total IFR           =   72.515 (14.83 %MAR)
Maint. Lowflow      =   25.905 ( 5.30 %MAR)
Drought Lowflow     =   10.461 ( 2.14 %MAR)
Maint. Highflow     =   46.610 ( 9.53 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : E.Karoo

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD       CV     Maint. Drought    Maint.   Maint.
 Oct  33.750  46.479   1.377    2.752   0.946      4.818     7.571
 Nov  54.056 110.632   2.047    2.474   0.773      2.398     4.872
 Dec  48.600  87.261   1.796    2.267   0.799      4.818     7.085
 Jan  33.661  76.728   2.279    1.804   0.716      2.398     4.202
 Feb  38.801  83.206   2.144    1.627   0.611      2.398     4.025
 Mar  52.709  89.147   1.691    2.223   0.779      9.926    12.149
 Apr  51.747  87.585   1.693    2.134   0.479      9.926    12.061
 May  40.697  59.005   1.450    2.041   0.801      9.926    11.968
 Jun  28.091  32.977   1.174    2.021   0.792      0.000     2.021
 Jul  27.944  36.036   1.290    2.137   0.806      0.000     2.137
 Aug  44.774  94.556   2.112    2.213   1.578      0.000     2.213
 Sep  34.249  50.730   1.481    2.213   1.380      0.000     2.213
```

3.1.5 Prioritised nodes on the Coastal region

This section presents RQOs and TPCs for the 10 high-priority nodes on the Coastal (denoted with the prefix OUTE_).

3.1.5.1 River's priority RUs in Duiwenhoks IUA

Table 3-51 RQOs and Numerical Limits for river's priority RUs in Duiwenhoks IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
F12 Duiwenhoks	Duiwenhoks	gii8	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Duiwenhoks River an ecological condition that is equal to or better than the ecological condition in summer 2014.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-53.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in a Tolerable category for irrigation.	≤ 270 milliSiemens/metre (95th percentile)	216 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a D (42-57%).	D category (42-57%)	< 42%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at least 61% for the riparian zone.	C/D category (57-62%)	< 57%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 15%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 20%	Exotic species > 20%, terrestrial woody species > 30%
			Biota	Fish	FRAI score	FRAI shall yield a D in the Duiwenhoks River	D category (42-57%)	< 42%
					Indigenous species richness		3 species present, *Myxus capensis, Mugil cephalus, Redigobius dewaali*	< 3 species present
					Myxus capensis		CPUE = 0.07 ind/min, FROC = 2	Absent after 2 annual surveys OR FROC < 2 OR absence of juvenile fish
					Mugil cephalus		CPUE = 0.08 ind/min, FROC = 2	Absent after 2 annual surveys OR FROC < 2
					Redigobius dewaali		CPUE = 0.05 ind/min, FROC = 2	Absent after 2 annual surveys OR FROC < 2 OR absence of juvenile

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
								fish
					Exotic fish species		No increase in CPUE for *T. sparmanii (0.15 ind./min.)*	Presence of new exotic fish or increase in CPUE of *T. sparmanii*
				Invertebrates	MIRAI score	MIRAI (40 - 59%) shall yield a D in the Duiwenhoks River.	D category (42-57%)	< 42%
					Invertebrate diversity		SASS score > 60, ASPT score > 5	SASS score < 60, ASPT < 5
					Number of families		> 10 families, abundance A - C, presence of Emlidae, Simulidae, Ancylidae	< 10 families, abundance < A, absence of Elmidae, Simulidae, Ancylidae

Table 3-52 Supplementary information for River RQOs in Duiwenhoks IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
F12 Duiwenhoks	III	Duiwenhoks	giii8 Duiwenhoks River @ OUTE_DUIW_H80D	-34.25167 20.99194	D	OUTE_DUIW_H80D (Figure 3-41) is situated in the lower reaches of the Duiwenhoks River downstream of Heidelberg and downstream of H8H001. It is the location of the EWR Site H8DUIW-EWR1. Duiwenhoks River Dam supports irrigation activities (Duiwenhoks Government Scheme) and domestic supply to Heidelberg and the Duiwenhoks Rural Water Supply Scheme. Many farm dams are also found in the catchment. At the time of the EWR study in 2014/16, water requirements exceeded supply and the catchment was regarded as stressed. The upper reaches of the Duiwenhoks River are subjected primarily to non-flow related impacts (agriculture), with the Duiwenhoks Dam situated in the lower reaches of H80A-09154. The ecological condition of the Duiwenhoks River improves slightly in its lower reaches (H80D-9286, H80D-9314) but is still impacted by flow modification and farming activities. Abstraction has resulted in decreased base flows and possibly zero flows at times. Irrigation return flows have resulted in elevated nutrients and salinity and an overall deterioration in water quality. Exotic invasive vegetation and agricultural practices in the riparian zones have led to bank modification and instability and exotic fish species also occur in the reach.	Duiwenhoks River	Reserve Determination Studies for Gouritz WMA (DWS 2015)

Figure 3-41 **Downstream view of OUTE_DUIW_H80D**

Table 3-53 **OUTE_DUIW_H80D: Hydrology RQOs**

Source: DWA (2014b); DWS (2014a).

Model: Revised Desktop Reserve Model (RDRM) (Hughes et al., 2011), Water Resource Yield Model (WRYM - DWAF, 2008c).

Applicable to: Duiwenhoks River.

Monitor at: H8H001.

```
Desktop Version 2, Generated on 09/03/2017
        Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
        Total Runoff :            giii8
        Annual Flows (Mill. cu. m or index values):
        MAR              =   83.249
        S.Dev.          =   37.178
        CV               =    0.447
        Q75              =    2.400
        Q75/MMF          =    0.346
        BFI Index        =    0.417
        CV(JJA+JFM) Index =    2.133
        Ecological Category = D
        Total IFR        =   17.432 (20.94 %MAR)
        Maint. Lowflow   =   13.530 (16.25 %MAR)
        Drought Lowflow  =    5.281 ( 6.34 %MAR)
        Maint. Highflow  =    3.902 ( 4.69 %MAR)
        Monthly Distributions (Mill. cu. m.)
        Distribution Type : S.Cape(wet)
        Month    Natural Flows          Modified Flows (IFR)
                                        Low flows     High Flows Total Flows
               Mean     SD       CV     Maint. Drought    Maint.   Maint.
         Oct   9.348   7.479   0.800    1.775   1.042      0.418     2.193
         Nov  10.198  14.594   1.431    1.676   0.877      0.000     1.676
         Dec   5.750   9.079   1.579    1.151   0.381      0.000     1.151
         Jan   3.537   5.235   1.480    0.648   0.043      0.000     0.648
         Feb   3.576   5.022   1.404    0.489   0.022      0.000     0.489
         Mar   5.810   7.339   1.263    0.781   0.099      0.418     1.199
         Apr   7.231   9.208   1.273    0.861   0.134      0.000     0.861
         May   6.484   5.768   0.890    0.981   0.251      0.000     0.981
         Jun   5.543   3.319   0.599    1.014   0.309      0.418     1.431
         Jul   6.662   4.018   0.603    1.207   0.464      0.000     1.207
         Aug  10.099  10.584   1.048    1.426   0.791      2.649     4.074
         Sep   9.013   6.974   0.774    1.522   0.869      0.000     1.522
```

3.1.5.2 River's priority RUs in Hessequa IUA

Table 3-54 RQOs and Numerical Limits for river's priority RUs in Hessequa IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
I18 Hessequa	Goukou	giii7	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Duiwenhoks River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category C/D).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-56	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained an Acceptable category for ecosystem health.	≤ 130 milliSiemens/metre (95th percentile)	104 mS/m EC
				System variables	pH	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Atrazine	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a D (42-57%).	D category (42-57%)	< 42%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at least 71% for the riparian zone.	C category (62-77%)	< 62%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 15%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 10%	Exotic species > 20%, terrestrial woody species > 20%
			Biota	Fish	FRAI score	FRAI shall yield a D (50.8%).	D category (42-57%)	< 42%
					Indigenous species richness		3 of 4 species, *Sandelia capensis, Pseudobarbus burchelli, Anguilla mossambica, Galaxias zebratus*	< 3 species present

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Sandelia capensis		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Pseudobarbus burchelli		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Anguilla mosssambica		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Galaxius zebratus		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Exotic fish species		No increase in CPUE for *M. salmanoides (0.02 ind./min.)*	Presence of other exotic species OR increase in CPUE of *M. salmanoides*
				Invertebrates	MIRAI score	MIRAI score to be within the D EC (40 - 59%) Category	D category (42-57%)	< 42%
					Invertebrate diversity		SASS score > 90, ASPT score > 5.8	SASS score < 90, ASPT < 5.8
					Number of families		> 12 families, 5 with SASS score > 8, abundance A - C	< 12 families, abundance < A

Table 3-55 Supplementary information for River RQOs in Hessequa IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
I18 Hessequa	III	Goukou	giii7 Goukou River @ OUTE_GOUK_H90C	-34.09324 21.29300	C/D	The Goukou River originates in the Spioenkop Nature Reserve and later flows through the Broomvlei (Kruis River) Nature Reserve. OUTE_GOUK_H90C is the location of the EWR Site H9GOUK-EWR2. The Korente-Vet Dam in the Korentepoort River (8 million m³) together with farm dams support irrigation for vineyards, fruit, pastures and vegetables as well as domestic use in Riversdale (H90C/E). Some forestry is found in the upper reaches (H90A). Irrigation farming is therefore the dominant land use. OUTE_GOUK_H90C is located in a hotspot section in SQ H90C-09229 which lies immediately upstream of Riversdal impacts as well as the impacts of the Vet Tributary of this area downstream of H9H005. Direct impacts on the EWR site are abstraction and upstream farm dams have resulted in decreased base flows and zero flows at times. The cumulative effects of agriculture and return flows e.g. elevated nutrients, salts and some toxicity has resulted in deteriorated water quality. Exotic invasive vegetation and agriculture in the riparian zones have led to bank modification and instability in the reach. Exotic fish species also occur in the reach. Wood removal in the riparian zones occurs. Figure 3-42 provides a photograph of OUTE_GOUK_H90C.	Goukou River	Reserve Determination Studies for Gouritz WMA (DWS 2015)

Figure 3-42 Downstream view of OUTE_GOUK_H90C

Table 3-56 OUTE_GOUK_H90C: Hydrology RQOs

Source: DWA (2014b); DWS (2014a).

Model: RDRM (Hughes et al. 2011), WRYM (DWAF 2008c).

Monitor at: H9H005.

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Desktop Version 2, Generated on 09/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :            giii7
Annual Flows (Mill. cu. m or index values):
MAR                 =   50.914
S.Dev.             =   18.425
CV                  =    0.362
Q75                 =    1.420
Q75/MMF             =    0.335
BFI Index           =    0.382
CV(JJA+JFM) Index =      1.935

Ecological Category = C/D

Total IFR           =   12.304 (24.17 %MAR)
Maint. Lowflow      =    6.406 (12.58 %MAR)
Drought Lowflow     =    0.929 ( 1.82 %MAR)
Maint. Highflow     =    5.898 (11.58 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	5.185	4.655	0.898	0.794	0.000	1.734	2.528
Nov	6.002	7.102	1.183	0.764	0.000	1.734	2.498
Dec	3.683	4.700	1.276	0.171	0.000	0.000	0.171
Jan	2.939	3.506	1.193	0.000	0.000	1.025	1.025
Feb	3.250	3.580	1.101	0.139	0.000	0.381	0.519
Mar	4.963	4.625	0.932	0.688	0.000	0.000	0.688
Apr	5.260	5.142	0.978	0.688	0.132	0.000	0.688
May	4.369	3.628	0.830	0.653	0.146	0.000	0.653
Jun	2.962	2.149	0.726	0.598	0.105	0.000	0.598
Jul	3.261	2.664	0.817	0.567	0.169	0.000	0.567
Aug	4.916	5.095	1.036	0.691	0.189	0.000	0.691
Sep	4.124	3.457	0.838	0.654	0.188	1.025	1.678

3.1.5.3 River's priority RUs in Groot Brak IUA

Table 3-57 RQOs and Numerical Limits for river's priority RUs in Groot Brak IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
G14 Groot Brak	Groot Brak	gviii2	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Groot Brak River in an ecological condition that is equal to or better than Category B/C.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-59.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in a B class for aquatic ecosystem health.	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	6.5 ≥ pH ≤ 8.5 (5th and 95th percentiles)	7 ≥ pH ≤ 8
					Dissolved oxygen		≥ 8 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation in the downstream Wolwedans Dam.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B (82-87%)	B category (82-87%)	< 82%
					Sediment particle size		D16 = 1mm, D50 = 32mm, D84 = 128 mm	D16 < 1mm, D50 < 32mm, D84 < 128 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category B.	B category (82-87%)	< 82%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species <5%, terrestrial woody species < 15%	Exotic species > 10%, terrestrial woody species > 20%
					Upper zone cover abundance		Exotic species < 30%, terrestrial woody species > 40%	Exotic species > 40%, terrestrial woody species < 30%
			Biota	Fish	FRAI score	FRAI shall yield a B (82-87%).	B category (82-87%)	< 82%
					Indigenous species richness		3 species, *Galaxias zebratus, Sandelia capensis, Pseudobarbus afer*	< 3 species present
					Galaxius zebratus		> 20 seine net haul, > 20 visual per 100m	< 10 for either seine or visual

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Sandelia capensis		> 10 seine net haul, > 10 visual per 100m	< 5 for either seine or visual
					Pseudobarbus afer		> 50 seine net haul, > 50 visual per 100m	< 20 for either seine or visual
					Exotic fish species		< 2 seine net haul, < 2 visual per 100m for BOTH *M. dolomieu, M. salmanoides*	Presence of additional exotics or increase in CPUE for *M. dolomieu, M. salmanoides*
				Invertebrates	MIRAI score	MIRAI score to be within A (92-100%).	A category (92-100%)	< 92%
					Invertebrate diversity		SASS score > 170, ASPT > 7.9	SASS score < 150, ASPT < 7

Table 3-58 Supplementary information for River RQOs in Groot Brak IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
G14 Groot Brak	III	Groot Brak	gviii2 Groot Brak River @ OUTE_GROO_K10E	-33.97718 22.19183	B/C	OUTE_GROO_K10E is at EWR Site GB 1, which is representative of the Groot Brak River between Ernest Robertson Dam and Wolwedans Dam (Figure 3-43). The major factors contributing to the ecological condition at OUTE_GROO_K10E were: • localised manipulation of the river channel (non-flow related); • constant low flows as evidenced by reduction of riparian vegetation band and some bank slumping; • a poor fish fauna, possibly related to the flushing effect of a large (c. 1:50 year flood that came through the system c. 1 year before the assessments where undertaken).	Groot Brak River	Reserve Determination Studies for Outeniqua WMA (DWAF 2008)

Figure 3-43 **Upstream view of OUTE_GROO_K10E**

Table 3-59 **OUTE_GROO_K10E: Hydrology RQOs (excludes inter-annual floods)**

Source: DWAF (2008)
Model: DRM (Hughes and Hannart 2003).
Monitor at: K2R002.

```
Desktop Version 2, Generated on 15/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          gviii2
Annual Flows (Mill. cu. m or index values):
MAR                 =   15.312
S.Dev.              =    8.630
CV                  =    0.564
Q75                 =    0.505
Q75/MMF             =    0.396
BFI Index           =    0.503
CV(JJA+JFM) Index =    2.257
Ecological Category = B/C
Total IFR           =    4.052 (26.46 %MAR)
Maint. Lowflow      =    1.980 (12.93 %MAR)
Drought Lowflow     =    1.099 ( 7.17 %MAR)
Maint. Highflow     =    2.072 (13.53 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   1.698   1.612   0.949    0.112   0.110      1.171     1.283
 Nov   2.080   3.724   1.790    0.299   0.107      0.073     0.372
 Dec   1.280   2.369   1.851    0.287   0.088      0.147     0.435
 Jan   1.017   1.276   1.255    0.199   0.066      0.000     0.199
 Feb   0.970   1.176   1.213    0.141   0.060      0.147     0.288
 Mar   1.473   1.866   1.267    0.134   0.043      0.533     0.666
 Apr   1.076   1.183   1.099    0.257   0.085      0.000     0.257
 May   1.128   1.649   1.462    0.068   0.066      0.000     0.068
 Jun   0.750   0.436   0.581    0.087   0.085      0.000     0.087
 Jul   0.857   0.610   0.712    0.112   0.110      0.000     0.112
 Aug   1.502   2.620   1.745    0.134   0.131      0.000     0.134
 Sep   1.483   1.924   1.298    0.151   0.148      0.000     0.151
```

3.1.5.4 River's priority RUs in Coastal IUA

Table 3-60 RQOs and Numerical Limits for river's priority RUs in Coastal IUA

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
G15 Coastal	Malgas	gvii9	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Malgas in an ecological condition that is equal to or better than Category C.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-62	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in B class for aquatic ecosystems.	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5.0 ≥ pH ≤ 7.5 (5th and 95th percentiles)	5.5 ≥ pH ≤ 7.0
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Toxins	Ammonia	Toxicity levels must not pose a threat to aquatic ecosystems.	≤ 0.073 milligrams per litre (95th percentile)	
					Atrazine		≤ 0.079 milligrams per litre (95th percentile)	
					Endosulfan		≤ 0.0013 milligrams per litre (95th percentile)	
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B/C (77-82%).	B/C category (77-82%)	< 77 %
					Sediment particle size		D16 = 2mm, D50 = 4 mm, D84 = 32mm	D16 < 2mm, D50 < 4 mm, D84 < 32mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category D (42-57%)	D category (42-57%)	< 42%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 15%	Exotic species > 10%, terrestrial woody species > 20%
					Upper zone cover abundance		Exotic species < 30%, terrestrial woody species > 50%	Exotic species > 40%, terrestrial woody species < 40%
			Biota	Fish	FRAI score	FRAI shall yield a C/D (57-62%).	C/D category (57-62%)	< 57%
					Indigenous species richness		3 species, *Galaxias zebratus, Sandelia capensis, Pseudobarbus afer*	< 3 species present
					Galaxius zebratus		> 10 seine net haul, > 10 visual per 100m	< 5 for either seine or visual
					Sandelia capensis		> 20 seine net haul, > 20 visual per 100m	< 10 for either seine or visual

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Pseudobarbus afer		> 20 seine net haul, > 20 visual per 100m	< 10 for either seine or visual
					Exotic fish species		< 1 seine net haul, < 1 visual per 100m for BOTH *M. dolomieu, M. salmanoides*	Presence of additional exotics or increase in CPUE for *M. dolomieu, M. salmanoides*
				Invertebrates	MIRAI score	MIRAI score to be within A (92-100%).	A category (92-100%)	< 92%
					Invertebrate diversity		SASS score > 160, ASPT > 8	SASS score < 150, ASPT < 7
	Kaaimans	gvii11	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Kaaimans River in an ecological condition that is equal to or better than Category B.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-63.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystems.	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.5 ≥ pH ≤ 7.5 (5th and 95th percentiles)	5 ≥ pH ≤ 7
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B/C (77-82%).	B/C category (77-82%)	< 72%
					Sediment particle size		D16 = 2mm, D50 = 16 mm, D84 = 64 mm	D16 < 2mm, D50 < 16 mm, D84 < 64 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category A.	A category (92-100%)	< 92%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 15%	Exotic species > 10%, terrestrial woody species > 25%
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 10%, terrestrial woody species > 10%
			Biota	Fish	FRAI score	FRAI shall yield a B.	B category (82-87%)	< 82%
					Indigenous species richness		3 species, *Galaxias zebratus, Sandelia capensis, Pseudobarbus afer*	< 3 species present
					Galaxius zebratus		> 1 seine net haul, > 1 visual per 100m	< 1 for either seine or visual
					Sandelia capensis		> 1 seine net haul, > 1 visual per 100m	< 1 for either seine or visual

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Pseudobarbus afer		> 200 seine net haul, > 200 visual per 100m	< 100 for either seine or visual
					Exotic fish species		< 1 seine net haul, < 1 visual per 100m for BOTH *M. dolomieu, M. salmanoides*	Presence of additional exotics or increase in CPUE for *M. dolomieu, M. salmanoides*
				Invertebrates	MIRAI score	MIRAI score to be within A Category.	A category (92-100%)	< 92%
					Invertebrate diversity		SASS score > 160, ASPT > 8	SASS score < 150, ASPT < 7
	Diep	giii10	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Upper Diep River in an ecological condition that is equal to or better than Category B.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-64.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystems.	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5 ≥ pH ≤ 7 (5th and 95th percentiles)	5.5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B.	B category (82-87%)	< 82%
					Sediment particle size		D16 = 10mm, D50 = 100 mm, D84 = 300 mm	D16 < 10mm, D50 < 100 mm, D84 < 300 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category A/B.	A/B category (87-92%)	< 87%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 20%, terrestrial woody species < 5%	Exotic species > 30%, terrestrial woody species > 10%
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 20%, terrestrial woody species > 10%
			Biota	Fish	FRAI score	FRAI shall yield a B.	B category (82-87%)	< 82%
					Indigenous species richness		3 species, *Psuedobarbus afer, Anguilla mossambica, Sandelia capensis*	< 3 species present
					Pseudobarbus afer		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Anguilla mosssambica		FROC = 2	Absent after 2 annual surveys OR FROC < 2
					Sandelia capensis		FROC =3	Absent after 2 annual surveys OR FROC < 2
					Exotic fish species		None	Exotic fish present
				Invertebrates	MIRAI score	MIRAI score to be within B Category (80-90%).	B category (82-87%)	< 82%
					Invertebrate diversity		SASS score > 190, ASPT > 7	SASS score < 190, ASPT < 7
	Karatara	gvii13	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Gouna River in an ecological condition that is equal to or better than Category A/B.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-65.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystems.	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.0 ≥ pH ≤ 7.0 (5th and 95th percentiles)	4.5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a A.	A category (92-100%)	< 92%
					Sediment particle size		D16 = 30mm, D50 = 80 mm, D84 = 200 mm	D16 < 30mm, D50 < 80 mm, D84 < 200 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category A/B.	A/B category (87-92%)	< 87%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 10%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 10%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 10%
			Biota	Fish	FRAI score	FRAI shall yield a B.	B category (82-87%)	< 82%
					Indigenous species richness		3 species, *Psuedobarbus afer, Anguilla mossambica, Sandelia capensis*	< 3 species present
					Pseudobarbus afer		FROC = 2	Absent after 2 annual surveys

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
								OR FROC < 2 OR absence of juvenile fish
					Anguilla mosssambica		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Sandelia capensis		FROC = 3	Absent after 2 annual surveys OR FROC < 2
					Exotic fish species		None	Exotic fish present
				Invertebrates	MIRAI score	MIRAI score to be within A.	A category (92-100%)	< 92%
					Invertebrate diversity		SASS score > 120, ASPT > 7	SASS score < 120, ASPT < 7
	Goukamma	gviii9	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Goukamma River in an ecological condition that is equal to or better than Category B/C.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-66.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at a mesotrophic or better condition.	≤ 0.075 milligrams/litre (50th percentile)	0.060 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 1.75 milligrams/litre (50th percentile)	1.40 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Acceptable category for aquatic ecosystems.	≤ 55 milliSiemens/metre (95th percentile)	44 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4 ≥ pH ≤ 7 (5th and 95th percentiles)	4.5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 6 milligrams litre (5th percentile)	7.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation.	≤ 165 counts/100ml (95th percentile)	132 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B.	B category (82-87%)	< 82%
					Sediment particle size		D16 = 2mm, D50 = 24 mm, D84 = 128 mm	D16 < 2mm, D50 < 24 mm, D84 < 128 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category B.	B category (82-87%)	< 82%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 15%	Exotic species > 10%, terrestrial woody species > 20%
					Upper zone cover abundance		Exotic species < 5%, terrestrial woody species < 5%	Exotic species > 10%, terrestrial woody species > 10%
			Biota	Fish	FRAI score	FRAI shall yield a C.	C category (62-77%)	< 62%
					Indigenous species richness		3 species, *Galaxias zebratus, Sandelia*	< 3 species present

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
							capensis, Pseudobarbus afer	
					Galaxius zebratus		> 5 seine net haul, > 5 visual per 100m	< 2 for either seine or visual
					Sandelia capensis		> 5 seine net haul, > 10 visual per 100m	< 5 for either seine or visual
					Pseudobarbus afer		> 5 seine net haul, > 30 visual per 100m	< 5 for either seine or visual
					Exotic fish species		< 1 seine net haul, < 1 visual per 100m for BOTH *M. dolomieu, M. salmanoides*	Presence of additional exotics or increase in CPUE for *M. dolomieu, M. salmanoides*
				Invertebrates	MIRAI score	MIRAI score to be within A.	A category (92-100%)	< 92%
					Invertebrate diversity		SASS score > 100, ASPT > 7.4	SASS score < 100, ASPT < 7
	Knysna	gvii14	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Knysna River in an ecological condition that is equal to or better than Category B.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-67.	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystem health.	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.5 ≥ pH ≤ 7.0 (5th and 95th percentiles)	5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a A/B.	A/B category (87-92%)	< 87%
					Sediment particle size		D16 = 30mm, D50 = 120 mm, D84 = 300 mm	D16 < 30mm, D50 < 120 mm, D84 < 300 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category A/B.	A/B category (87-92%)	< 87%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 20%, terrestrial woody species < 5%	Exotic species > 30%, terrestrial woody species > 10%
					Upper zone cover abundance		Exotic species < 40%, terrestrial woody species < 5%	Exotic species > 50%, terrestrial woody species > 10%
			Biota	Fish	Indigenous species richness	FRAI shall yield a B.	3 species, *Psuedobarbus afer, Anguilla mossambica, Sandelia capensis*	< 3 species present

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Pseudobarbus afer		FROC = 5	Absent after 2 annual surveys OR FROC < 5 OR absence of juvenile fish
					Anguilla mosssambica		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Sandelia capensis		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Exotic fish species		None	Exotic fish present
				Invertebrates	MIRAI score	MIRAI score to be within B Category.	B category (82-87%)	< 82%
					Invertebrate diversity		SASS score > 150, ASPT > 6.7	SASS score < 155, ASPT < 6.7
	Gouna	gviii11	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Gouna River in an ecological condition that is equal to or better than Category A/B.	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-68	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystem health.	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	4.0 ≥ pH ≤ 7.0 (5th and 95th percentiles)	4.5 ≥ pH ≤ 6.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a A/B.	A/B category (87-92%)	< 87%
					Sediment particle size		D16 = 10mm, D50 = 50 mm, D84 = 200 mm	D16 < 10mm, D50 < 50 mm, D84 < 200 mm
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of Category A/B.	A/B category (87-92%)	< 87%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 10%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 10%
					Upper zone cover abundance		Exotic species < 10%, terrestrial woody species < 5%	Exotic species > 15%, terrestrial woody species > 10%

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
			Biota	Fish	Indigenous species richness	FRAI shall yield a B.	3 species, *Psuedobarbus afer, Anguilla mossambica, Sandelia capensis*	< 3 species present
					Pseudobarbus afer		FROC = 2	Absent after 2 annual surveys OR FROC < 2 OR absence of juvenile fish
					Anguilla mosssambica		FROC = 1	Absent after 2 annual surveys OR FROC < 1
					Sandelia capensis		FROC = 5	Absent after 2 annual surveys OR FROC < 5
					Exotic fish species		None	Exotic fish present
				Invertebrates	MIRAI score	MIRAI score to be within B	B category (82-87%)	< 82%
					Invertebrate diversity	FRAI shall yield a B.	SASS score > 120, ASPT > 7.5	SASS scores < 125, ASPT < 7
	Keurbooms	giv6	Quantity	Low flows High flows	Maintenance low flows Maintenance high flows	Flows shall be sufficient to maintain the Keurbooms River an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category B).	The suggested numerical limits for river flows to achieve the above narrative RQOs are given in Table 3-69	
			Quality	Nutrients	Phosphate (PO4-P)	Nutrient levels must be maintained in the river at an oligotrophic condition.	≤ 0.025 milligrams per litre (50th percentile)	0.020 mg/l PO_4-P
					Total inorganic nitrogen (TIN)		≤ 0.70 milligrams per litre (50th percentile)	0.56 mg/l TIN
				Salts	Electrical conductivity (EC)	Salt concentrations need to be maintained in an Ideal category for aquatic ecosystem health.	≤ 30 milliSiemens/metre (95th percentile)	24 mS/m EC
				System variables	pH range	pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	5.5 ≥ pH ≤ 8.0 (5th and 95th percentiles)	6 ≥ pH ≤ 7.5
					Dissolved oxygen		≥ 8 milligrams per litre (5th percentile)	9.2 mg/l DO
				Pathogens	Escherichia coli	Concentrations of waterborne pathogens should be maintained in an Ideal category for full contact recreation.	≤ 130 counts/100ml (95th percentile)	104 cfu/100ml E coli / Faecal coliforms
			Habitat	Geomorphology	GAI score	GAI score should equate to a B.	B category (82-87%)	< 82%
				Riparian vegetation	VEGRAI score	VEGRAI level 4 of at ~58% for the riparian zone.	B/C category (77-82%)	< 77%
					Marginal zone cover abundance		No exotic species, no terrestrial woody species	Exotic and terrestrial species present
					Lower zone cover abundance		Exotic species < 5%, terrestrial woody species < 15%	Exotic species > 10%, terrestrial woody species > 25%

IUA	River	Node	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric	TPC
					Upper zone cover abundance		Exotic species < 30%, terrestrial woody species < 20%	Exotic species > 40%, terrestrial woody species > 30%
			Biota	Fish	FRAI score	FRAI shall yield a B	B category (82-87%)	< 82%
					Indigenous species richness		3 species, *Psuedobarbus afer, Anguilla mossambica, Sandelia capensis*	< 3 species present
					Pseudobarbus afer		FROC = 3	Absent after 2 annual surveys OR FROC < 3 OR absence of juvenile fish
					Anguilla mosssambica		FROC = 2	Absent after 2 annual surveys OR FROC < 2
					Sandelia capensis		FROC = 2	Absent after 2 annual surveys OR FROC < 2
					Exotic fish species		None	Exotic fish present
				Invertebrates	MIRAI score	MIRAI score to be within B	B category (82-87%)	< 82%
					Invertebrate diversity		SASS score > 180, ASPT > 6.5	SASS score < 150, ASPT < 6.5
					Number of families		> 15 families, 2 with SASS scores > 12, abundance A - C	< 15 families, < 2 with score < 12, any abundance < A or > D

Table 3-61 Supplementary information for River RQOs in Coastal IUA

IUA	Class	River	Node	Coordinates	TEC	Description	Applicable to	References
G15 Coastal	II	Malgas	gvii9 Malgas River @ OUTE_MALG_K30B	-33.93751 22.42130	C	OUTE_MALG_K30B is at EWR Site Mal 1, which is Malgas River at Ou Brug (Figure 3-44).	Malgas River	Reserve Determination Studies for Outeniqua WMA (DWAF 2008)
		Kaaimans	gvii11 Kaaimans River @ OUTE_KAAI_K30C	-33.97105 22.54773	B	OUTE_KAAI_K30C is at EWR Site Ka 1, which is Kaaimans at Old George-Knysna Road (Figure 3-45).	Kaaimans River	Reserve Determination Studies for Outeniqua WMA (DWAF 2008)
		Diep	giii10 Diep River @ OUTE_DIEP_K40A	-33.91358 22.70805	B	OUTE_DIEP_K40A is at EWR 3 Diep, which is the Upper Diep River in a steep, deeply incised and forested valley downstream of gauge K4H003 (Figure 3-46).	Upper Diep River	Reserve Determination Studies for Outeniqua WMA (DWA 2010)
		Karatara	gvii13 Karatara River @ OUTE_KARA_K40C	-33.88236 22.83833	B	OUTE_KARA_K40C is at EWR 4 Karatara, situated in a steep, deeply incised valley in a forested catchment upstream of gauge K4H002 (Figure 3-47).	Karatara River	Reserve Determination Studies for Outeniqua WMA (DWA 2010)
		Goukamma	gviii9 Goukamma River @ OUTE_GOUK_K40E	-33.94741 22.91933	B/C	OUTE_GOUK_K40E is at EWR Site Gou 1, which is Goukamma at Old George-Knysna Road (Figure 3-48).	Goukamma River	Reserve Determination Studies for Outeniqua WMA (DWAF 2008)
		Knysna	gvii14 Knysna River @ OUTE_KYNS_K50A	-33.89105 23.03450	B	OUTE_KNYS_K50A is at EWR 1 Knysna, which is the Knysna River downstream of a low flow road crossing, downstream of the gauging weir K5H002 (Figure 3-49)	Knysna River	Reserve Determination Studies for Outeniqua WMA (DWA 2010)
		Gouna	gviii11 Gouna River @ OUTE_GOUN_K50B	-33.99691 23.04138	A/B	OUTE_GOUN_K50B is at EWR 2 Gouna, which is situated in a forested catchment in a steep deeply incised valley (Figure 3-50). The site is downstream of gauge K5H001.	Gouna River	Reserve Determination Studies for Outeniqua WMA (DWA 2010)
		Keurbooms	giv6 Keurbooms River @ OUTE_KEUR_K60C	-33.88955 23.24392	C	OUTE_KEUR_K60C is at EWR site K6KEUR-EWR8 (Figure 3-51), which is dominated by forestry. Upstream there is some forestry, agriculture and irrigation. There are no gauging weirs near the EWR site. The river is perennial with low flows being impacted on due to forestry and upstream abstraction.	Keurbooms River	Reserve Determination Studies for Gouritz WMA (DWS 2015)

Figure 3-44 **Downstream view of OUTE_MALG_K30B**

Table 3-62 **OUTE_MALG_K30B: Hydrology RQOs**

Source: DWAF (2008)

Model: DRM (Hughes and Hannart 2003).

Monitor at: K3H004.

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Desktop Version 2, Generated on 14/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :           gvii9
Annual Flows (Mill. cu. m or index values):
MAR              =   17.342
S.Dev.           =    7.005
CV               =    0.404
Q75              =    0.387
Q75/MMF          =    0.268
BFI Index        =    0.376
CV(JJA+JFM) Index =    1.988
Ecological Category = C
Total IFR        =    5.474 (31.57 %MAR)
Maint. Lowflow   =    1.744 (10.06 %MAR)
Drought Lowflow  =    0.660 ( 3.80 %MAR)
Maint. Highflow  =    3.730 (21.51 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV      Maint.  Drought    Maint.    Maint.
 Oct   1.864   1.609   0.863    0.296   0.085     1.218     1.513
 Nov   2.122   2.736   1.289    0.081   0.081     1.044     1.125
 Dec   1.527   1.868   1.223    0.042   0.042     0.219     0.261
 Jan   1.483   1.321   0.890    0.042   0.042     0.219     0.261
 Feb   1.437   1.268   0.883    0.077   0.038     0.219     0.296
 Mar   1.985   1.662   0.837    0.085   0.042     0.812     0.896
 Apr   1.297   1.284   0.989    0.123   0.041     0.000     0.123
 May   1.113   1.499   1.347    0.211   0.042     0.000     0.211
 Jun   0.661   0.625   0.946    0.204   0.041     0.000     0.204
 Jul   0.895   0.926   1.035    0.169   0.042     0.000     0.169
 Aug   1.477   2.031   1.375    0.211   0.085     0.000     0.211
 Sep   1.480   1.696   1.146    0.204   0.081     0.000     0.204
```

Figure 3-45 Downstream view of OUTE_KAAI_K30C

Table 3-63 OUTE_KAAI_K30C: Hydrology RQOs

Source: DWAF (2008)

Model: DRM (Hughes and Hannart 2003).

Monitor at: K3H001.

Desktop Version 2, Generated on 14/03/2017

Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:

Total Runoff : gvii1

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

MAR	=	18.634
S.Dev.	=	9.163
CV	=	0.492
Q75	=	0.520
Q75/MMF	=	0.335
BFI Index	=	0.428
CV(JJA+JFM) Index	=	2.022
Ecological Category	=	B
Total IFR	=	9.362 (50.24 %MAR)
Maint. Lowflow	=	5.209 (27.96 %MAR)
Drought Lowflow	=	2.402 (12.89 %MAR)
Maint. Highflow	=	4.152 (22.28 %MAR)

Monthly Distributions (Mill. cu. m.)

Distribution Type : S.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.977	1.598	0.808	0.592	0.185	0.249	0.841
Nov	2.317	2.972	1.283	0.538	0.179	1.052	1.590
Dec	1.751	2.228	1.273	0.445	0.185	0.775	1.220
Jan	1.447	1.468	1.015	0.371	0.111	0.000	0.371
Feb	1.397	1.291	0.924	0.335	0.167	0.000	0.335
Mar	1.922	1.716	0.893	0.445	0.371	1.828	2.273
Apr	1.551	1.325	0.854	0.538	0.252	0.249	0.787
May	1.287	1.608	1.250	0.483	0.223	0.000	0.483
Jun	0.849	0.762	0.897	0.359	0.179	0.000	0.359
Jul	0.898	0.821	0.914	0.371	0.185	0.000	0.371
Aug	1.531	2.179	1.423	0.371	0.185	0.000	0.371
Sep	1.707	1.846	1.081	0.359	0.179	0.000	0.359

Figure 3-46 Upstream view of OUTE_DIEP_K40A

Table 3-64 OUTE_DIEP_K40A: Hydrology RQOs

Source: DWA (2010)

Model: DRM (Hughes and Hannary 2003).

Monitor at: K4H003.

```
Desktop Version 2, Generated on 14/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          gvii1
Annual Flows (Mill. cu. m or index values):
MAR                =    4.778
S.Dev.             =    2.747
CV                 =    0.575
Q75                =    0.163
Q75/MMF            =    0.409
BFI Index          =    0.495
CV(JJA+JFM) Index =    2.019
Ecological Category = B
Total IFR          =    2.606 (54.53 %MAR)
Maint. Lowflow     =    1.504 (31.48 %MAR)
Drought Lowflow    =    0.360 ( 7.53 %MAR)
Maint. Highflow    =    1.101 (23.05 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.585	0.425	0.727	0.159	0.067	0.562	0.721
Nov	0.599	0.853	1.423	0.177	0.056	0.129	0.306
Dec	0.423	0.579	1.367	0.130	0.029	0.129	0.259
Jan	0.252	0.252	0.999	0.101	0.024	0.070	0.171
Feb	0.198	0.174	0.879	0.087	0.022	0.070	0.157
Mar	0.244	0.257	1.053	0.120	0.024	0.070	0.190
Apr	0.278	0.348	1.249	0.149	0.023	0.070	0.219
May	0.395	0.730	1.846	0.111	0.024	0.000	0.111
Jun	0.323	0.329	1.018	0.112	0.023	0.000	0.112
Jul	0.334	0.233	0.696	0.106	0.024	0.000	0.106
Aug	0.555	0.785	1.414	0.130	0.039	0.000	0.130
Sep	0.591	0.558	0.944	0.122	0.005	0.000	0.122

Figure 3-47 Upstream view of OUTE_KARA_K40C

Table 3-65 OUTE_KARA_K40C: Hydrology RQOs

Source: DWA (2010)

Model: DRM (Hughes and Hannart 2003).

Monitor at: K4H002.

```
Desktop Version 2, Generated on 19/01/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          gvii1
Annual Flows (Mill. cu. m or index values):
MAR                 =   11.166
S.Dev.              =    5.169
CV                  =    0.463
Q75                 =    0.353
Q75/MMF             =    0.379
BFI Index           =    0.452
CV(JJA+JFM) Index =    2.008
Ecological Category = A/B
Total IFR           =    4.494 (40.24 %MAR)
Maint. Lowflow      =    3.115 (27.90 %MAR)
Drought Lowflow     =    0.523 ( 4.68 %MAR)
Maint. Highflow     =    1.379 (12.35 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   1.179   0.835   0.708    0.357   0.055      0.471     0.829
 Nov   1.330   1.590   1.196    0.346   0.053      0.283     0.628
 Dec   1.010   1.124   1.113    0.273   0.036      0.000     0.273
 Jan   0.848   0.813   0.959    0.237   0.036      0.029     0.266
 Feb   0.801   0.687   0.857    0.232   0.035      0.000     0.232
 Mar   1.037   0.959   0.925    0.270   0.052      0.283     0.552
 Apr   0.870   0.761   0.875    0.255   0.050      0.029     0.284
 May   0.823   1.074   1.305    0.244   0.049      0.000     0.244
 Jun   0.622   0.704   1.131    0.204   0.025      0.000     0.204
 Jul   0.633   0.585   0.924    0.192   0.045      0.000     0.192
 Aug   0.970   1.191   1.227    0.237   0.036      0.000     0.237
 Sep   1.041   0.974   0.936    0.270   0.050      0.283     0.553
```

Figure 3-48 Downstream view of OUTE_GOUK_K40E

Table 3-66 OUTE_GOUK_K40E: Hydrology RQOs

Source: DWAF (2008)

Model: DRM (Hughes and Hannart 2003).

Monitor at: No Gauge.

```
Desktop Version 2, Generated on 18/04/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          gviii
Annual Flows (Mill. cu. m or index values):
MAR                 =   30.355
S.Dev.              =   18.229
CV                  =    0.601
Q75                 =    0.695
Q75/MMF             =    0.275
BFI Index           =    0.392
CV(JJA+JFM) Index =    2.652
Ecological Category = BC
Total IFR           =   11.676 (38.47 %MAR)
Maint. Lowflow      =    7.807 (25.72 %MAR)
Drought Lowflow     =    2.553 ( 8.41 %MAR)
Maint. Highflow     =    3.869 (12.75 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
Month    Natural Flows          Modified Flows (IFR)
                                Low flows    High Flows Total Flows
       Mean     SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   3.208   2.933   0.914    0.645   0.428      0.445     1.090
 Nov   3.869   6.125   1.583    1.124   0.355      0.821     1.946
 Dec   2.856   4.168   1.459    0.825   0.183      0.821     1.646
 Jan   2.287   2.797   1.223    0.642   0.153      0.445     1.087
 Feb   2.112   2.337   1.107    0.552   0.138      0.445     0.997
 Mar   2.857   3.520   1.232    0.764   0.153      0.445     1.210
 Apr   2.308   2.589   1.122    0.947   0.148      0.445     1.392
 May   2.228   3.908   1.754    0.401   0.153      0.000     0.401
 Jun   1.554   2.410   1.551    0.387   0.148      0.000     0.387
 Jul   1.537   1.856   1.208    0.431   0.153      0.000     0.431
 Aug   2.678   4.384   1.637    0.554   0.245      0.000     0.554
 Sep   2.859   3.489   1.220    0.536   0.296      0.000     0.536
```

Figure 3-49 Downstream view of OUTE_KNYS_K50A

Table 3-67 OUTE_KNYS_K50A: Hydrology RQOs

Source: DWA (2010)

Model: DRM (Hughes and Hannary 2003).

Monitor at: K5H002.

```
Desktop Version 2, Generated on 11/01/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :          gvii14
Annual Flows (Mill. cu. m or index values):
MAR                 =   26.544
S.Dev.              =   12.925
CV                  =    0.487
Q75                 =    0.775
Q75/MMF             =    0.350
BFI Index           =    0.437
CV(JJA+JFM) Index =    2.075
Ecological Category = B
Total IFR           =    8.516 (32.08 %MAR)
Maint. Lowflow      =    6.243 (23.52 %MAR)
Drought Lowflow     =    2.139 ( 8.06 %MAR)
Maint. Highflow     =    2.272 ( 8.56 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.175	2.504	0.789	0.686	0.260	0.478	1.164
Nov	3.098	3.924	1.267	0.664	0.249	0.837	1.501
Dec	2.061	2.803	1.360	0.546	0.196	0.000	0.546
Jan	1.383	1.582	1.144	0.437	0.146	0.000	0.437
Feb	1.225	1.335	1.090	0.411	0.136	0.239	0.650
Mar	1.649	1.807	1.096	0.441	0.148	0.239	0.680
Apr	1.786	2.119	1.187	0.441	0.148	0.478	0.919
May	2.265	3.338	1.474	0.476	0.165	0.000	0.476
Jun	1.806	1.698	0.940	0.447	0.124	0.000	0.447
Jul	1.919	1.653	0.861	0.474	0.130	0.000	0.474
Aug	2.995	3.275	1.094	0.579	0.200	0.000	0.579
Sep	3.183	2.945	0.925	0.644	0.239	0.000	0.644

Figure 3-50 **Downstream view of OUTE_GOUN_K50B**

Table 3-68 **OUTE_GOUN_K50B: Hydrology RQOs**

Source: DWA (2010)
Model: DRM (Hughes and Hannary 2003).
Monitor at: K5H001.

```
Desktop Version 2, Generated on 14/03/2017
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff :           gvii1
Annual Flows (Mill. cu. m or index values):
MAR                =   27.592
S.Dev.             =   12.637
CV                 =    0.458
Q75                =    0.818
Q75/MMF            =    0.356
BFI Index          =    0.436
CV(JJA+JFM) Index =     1.982
Ecological Category = A/B
Total IFR          =   14.735 (53.40 %MAR)
Maint. Lowflow     =   12.103 (43.87 %MAR)
Drought Lowflow    =    1.425 ( 5.16 %MAR)
Maint. Highflow    =    2.632 ( 9.54 %MAR)
Monthly Distributions (Mill. cu. m.)
Distribution Type : S.Cape(wet)
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	3.234	2.465	0.762	1.440	0.212	0.342	1.782
Nov	3.122	3.782	1.212	1.328	0.200	1.197	2.525
Dec	2.092	2.701	1.291	1.019	0.133	0.000	1.019
Jan	1.463	1.600	1.094	0.778	0.059	0.000	0.778
Feb	1.319	1.374	1.042	0.692	0.053	0.000	0.692
Mar	1.775	1.819	1.025	0.760	0.118	0.684	1.444
Apr	1.911	2.122	1.110	0.781	0.128	0.342	1.123
May	2.368	3.256	1.375	0.898	0.118	0.000	0.898
Jun	1.904	1.725	0.906	0.875	0.057	0.000	0.875
Jul	2.033	1.721	0.847	0.954	0.059	0.000	0.954
Aug	3.110	3.211	1.033	1.202	0.118	0.000	1.202
Sep	3.261	2.887	0.885	1.377	0.171	0.067	1.443

Figure 3-51 **Downstream view of OUTE_KEUR_K60C**

Table 3-69 **OUTE_KEUR_K60C: Hydrology RQOs**

Source: DWA (2014b); DWS (2014a).

Model: DRM (Hughes and Hannary 2003).

Monitor at: K6H001.

```
Desktop Version 2, Generated on 16/01/2017
        Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
        Total Runoff :   giv6

        Annual Flows (Mill. cu. m or index values):
        MAR                 =   46.085
        S.Dev.              =   28.923
        CV                  =    0.628
        Q75                 =    1.500
        Q75/MMF             =    0.391
        BFI Index           =    0.507
        CV(JJA+JFM) Index =    2.322

        Ecological Category = C

        Total IFR           =   16.103 (34.94 %MAR)
        Maint. Lowflow      =    9.683 (21.01 %MAR)
        Drought Lowflow     =    4.173 ( 9.05 %MAR)
        Maint. Highflow     =    6.421 (13.93 %MAR)

        Monthly Distributions (Mill. cu. m.)
        Distribution Type : W.Cape(wet)

        Month    Natural Flows          Modified Flows (IFR)
                                        Low flows    High Flows Total Flows
               Mean     SD      CV     Maint.  Drought     Maint.    Maint.
         Oct   5.274   4.169   0.791    1.289   0.624      0.758     2.046
         Nov   5.931  10.341   1.744    1.101   0.614      0.000     1.101
         Dec   4.318   7.527   1.743    0.880   0.362      0.758     1.638
         Jan   2.729   3.466   1.270    0.595   0.223      0.000     0.595
         Feb   2.361   2.684   1.137    0.381   0.166      0.000     0.381
         Mar   2.745   2.582   0.941    0.471   0.206      0.000     0.471
         Apr   2.899   4.001   1.380    0.504   0.218      0.000     0.504
         May   3.934   8.055   2.047    0.629   0.258      0.758     1.387
         Jun   2.981   3.702   1.242    0.662   0.266      0.000     0.662
         Jul   2.980   2.752   0.923    0.855   0.357      0.000     0.855
         Aug   4.940   7.180   1.453    1.071   0.424      0.758     1.828
         Sep   4.992   4.818   0.965    1.247   0.456      3.389     4.636
```

3.1.6 Hydrological RQOs: all nodes

The TECs and hydrological RQOs for all the nodes in the Breede-Gouritz WMA are provided in Appendix A.

3.2 Estuary RQOs and numerical limits

3.2.1 Prioritised estuaries in the Breede and Overberg region

3.2.1.1 Estuary's priority RUs in Overberg West IUA

Table 3-70 RQOs and Numerical Limits for Palmiet estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="16">B5 Overberg West</td><td rowspan="16">G40D</td><td rowspan="16">Palmiet Estuary</td><td rowspan="16">pxi1</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality.</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>76.6</td><td>49.2</td><td>39.1</td><td>48.2</td><td>43.6</td><td>43.0</td><td>41.1</td><td>46.4</td><td>57.3</td><td>74.4</td><td>86.6</td><td>90.5</td><td>70.1</td></tr>
<tr><td rowspan="11">Quality</td><td rowspan="4">Nutrients</td><td rowspan="2">DIN</td><td rowspan="4">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow: Average DIN concentration >100 µg/l (dry season) or >500 µg/l (wet season)</td></tr>
<tr><td colspan="14">Estuary: Average DIN concentrations in freshwater section >100 µg/l (dry season) (marine waters may have higher concentrations linked to upwelling) and >500 µg/l (wet season)</td></tr>
<tr><td rowspan="2">DIP</td><td colspan="14">River inflow: Average DIP concentration >10 µg/l (dry season) and >50 µg/l (wet season)</td></tr>
<tr><td colspan="14">Estuary: Average DIP concentrations >10 µg/l (dry season) (marine waters may have higher concentrations linked to upwelling) and >50 µg/l (wet season).</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Salinity must not drop below 10 for longer than three months in a year</td></tr>
<tr><td rowspan="4">System variables</td><td>Temperature</td><td rowspan="4">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">River inflow: Summer temperature <20 °C</td></tr>
<tr><td>pH</td><td colspan="14"><8</td></tr>
<tr><td>Dissolved oxygen</td><td colspan="14">>4 mg/</td></tr>
<tr><td>Secchi depth</td><td colspan="14">>2 m</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td rowspan="2">Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td colspan="14">Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.</td></tr>
<tr><td>Sediments</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low phytoplankton biomass; maintain microalgal group diversity as measured for the baseline survey; phytoplankton biomass should not increase by more than 20% above baseline concentrations; phytoplankton group diversity should not change by more 20% from baseline conditions
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Area covered by different plant community types should not change by more than 20% from baseline open and closed mouth conditions, no invasive species should be present, prevent excessive filamentous macroalgal growth, area covered should be less than 50 % of the open water surface area, macroalgae cover should not exceed 50% in 1 m^2 quadrats or occupy more than 50% of the open water surface area in the eastern channel and above sand bank in the lower reaches of the estuary, macroalgal wet biomass should remain below 500 g m^{-2}
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Density of sandprawn burrow openings should exceed 75 per m^2 in the highest density areas in the lower estuary; amphipods should numerically dominate the benthic fauna (*Grandidierella* sp.and *Corophium triaenonyx*) living on the sediment surface in the middle and upper estuarine reaches respectively; in the zooplankton, the density of *Pseudodiaptomus hessei* should range between 100 and 5000 m^3 in the summer in the mid-estuary region
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Retain the following fish assemblages in the estuary (based on abundance): estuarine species (10-20%); estuarine associated marine species (80-90%); and indigenous freshwater species (~1%); all numerically dominant species should be represented by 0+ juveniles.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Retain regular representation of waders, gulls, and terns, and overall waterbird species richness of seven or more species; estuary should not be regularly used by waterfowl species such as Redknobbed Coot; waders or terns should not be absent from the estuary for >5 consecutive counts

Table 3-71 Supplementary information for Palmiet estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
B5- Overberg West	II	Palmiet	pxi1	G40D	B	PES: C %nMAR: 70.13	EC: C %nMAR: 70.13	Additional (non-flow related) interventions to achieve the TEC: • Manage anthropogenic nutrient and organic matter inputs to the estuary through improved agricultural and urban landscape management; • Improve the compliance monitoring of fishing and bait collection activities on the estuary. This will assist in controlling illegal harvesting of the estuarine living resources. At present recreational angling (and the occasional gillnetting) accounts for approximately 0.2 tonne annually. This includes the requirement for improved control of the harvesting of eels from the catchment. • Restrict bait collection when the mouth is closed since recruitment cannot occur during extended periods of mouth closure as it leads to the depletion of important food resources in the estuary. • Install a fish ladder at the gauging weir and an eelway at the dams to facilitate migration of fishes into the lower river reaches.	DWAF (2009) Rapid Ecological Water Requirements Study – Palmiet Assessment

3.2.1.2 Estuary's priority RUs in Overberg West Coastal IUA

Table 3-72 RQOs and Numerical Limits for Buffels (Oos) estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
H16 Overberg West Coastal	G40B	Buffels (Oos) Estuary	bxi1	Quantity	Flow	MMR/MAR (% Nat)	Maintain at least present-day base flows	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	84.4	69.5	28.7	11.2	8.9	13.4	35.3	64.3	87.8	91.2	91.7	89.8	81.9
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	<100µg/ℓ													
						DIP		<10 µg/ℓ													
					System variables	Dissolved oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	>6 mg/l													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediments	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	<20 µg l-1													
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Area occupied by different macrophyte groups should no change by >20 % change in the area covered by habitats, submerged macrophytes such as pondweed *(Potamogeton pectinatus)* should be present during low flow conditions													
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Estuary should have viable populations of *Callianassa kraussi* in sandy zones and *Upogebia africana* in muddy zones.													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V). Estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.

Table 3-73 Supplementary information for Buffels (Oos) estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H16-Overberg West Coastal	II	Buffels (Oos)	bxi1	G40B	B	PES: B %nMAR: 81.86	EC: B %nMAR: 81.86	Additional (non-flow related) interventions to achieve the TEC: • The catchment is contained within the Kogelberg Biosphere Reserve and limited development is expected in this area in future. However, strict control must be maintained over development around the estuary and stormwater runoff to the estuary in future.	RQOs for the Buffels (Oos) estuary are based on those developed for the Rooiels estuary (DWS 2017)

Table 3-74 RQOs and Numerical Limits for **Rooiels** estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="11">H16 Overberg West Coastal</td><td rowspan="11">G40B</td><td rowspan="11">Rooiels Estuary</td><td rowspan="11">bxi2</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain at least present-day base flows</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>99.0</td><td>98.9</td><td>98.4</td><td>98.0</td><td>98.3</td><td>98.0</td><td>98.1</td><td>98.3</td><td>98.5</td><td>98.6</td><td>98.6</td><td>98.8</td><td>98.6</td></tr>
<tr><td rowspan="4">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14"><100µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14"><10 µg/ℓ</td></tr>
<tr><td>System variables</td><td>Dissolved oxygen</td><td>System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">>6 mg/l</td></tr>
<tr><td>Pathogens</td><td>Escherichia coli</td><td>Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤ 130 counts/100ml (95th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediments</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14"><20 µg l^{-1}</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Area occupied by different macrophyte groups should no change by >20 % change in the area covered by habitats, submerged macrophytes such as pondweed (Potamogeton pectinatus) should be present during low flow conditions</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Estuary should have viable populations of Callianassa kraussi in sandy zones and Upogebia africana in muddy zones.</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V). Estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.

Table 3-75 Supplementary information for Rooiels estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H16-Overberg West Coastal	II	Rooiels	bxi2	G40B	B	PES: B %nMAR: 98.63	EC: B %nMAR: 98.63	Additional (non-flow related) interventions to achieve the REC: • The TEC for the Rooiels estuary is the same as the PES.	DWS (2017) Reserve determination study for the Rooiels estuary. The catchment is contained within the Kogelberg Biosphere Reserve and limited development is expected in this area in future. However, strict control must be maintained over development around the estuary and stormwater runoff to the estuary in future.

Table 3-76 RQOs and Numerical Limits for Bot/Kleinmond estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="12">H16 Overberg West Coastal</td><td rowspan="12">G40G</td><td rowspan="12">Bot/Kleinmond Estuary</td><td rowspan="12">nxi6</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>80.2</td><td>75.7</td><td>63.9</td><td>58.2</td><td>60.3</td><td>63.7</td><td>75.5</td><td>80.9</td><td>83.8</td><td>85.8</td><td>87.7</td><td>85.0</td><td>81.8</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow (low flows): DIN <100 µg/l; River inflow high flows): DIN <300 µg/l; Estuary (low flows): DIN <100 µg/l (except during upwelling events); Estuary (high flows): DIN <300 µg/l in Zones A & B (upper reaches) and <100 µg/l in Zones C & D (lower reaches) (except during upwelling events)</td></tr>
<tr><td>DIP</td><td colspan="14">River inflow (low flows): DRP <50 µg/l; River inflow high flows): DRP <80 µg/l; Estuary (low flows): DRP <50 µg/l (except during upwelling events); Estuary (high flows): DRP <80 µg/l in Zones A & B (upper reaches) and <50 µg/l in Zones C & D (lower reaches) (except during upwelling events)</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Summer: 8<Salinity<40</td></tr>
<tr><td rowspan="2">System variables</td><td>pH</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">6 < pH < 8.5</td></tr>
<tr><td>Dissolved oxygen</td><td colspan="14">>4 mg/l</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediments</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td>Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low phytoplankton biomass (< 6 ug l^{-1}); phytoplankton biomass should not rise above 10 ug l^{-1} for greater than 6 months; maintain microalgal group diversity as measured for the baseline survey (an increase in Cyanophytes (blue greens) would be a cause for concern); phytoplankton group diversity should not decrease below 20% of that found for baseline conditions; maintain present benthic microalgal biomass (< 4 ug g^{-1}); benthic microalgal biomass should not rise above 10 ug g^{-1} for greater than 6 months</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the present area (2011) covered by the macrophyte habitats: submerged macrophytes (476 ha); reeds and sedges (60 ha); salt marsh (69 ha); and macroalgae (238 ha); prevent excessive filamentous macroalgal growth; the present ratio of macroalgae to submerged macrophytes must be maintained (i.e. 50%).
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Zooplankton: Density of *Pseudodiaptomus hessei* should range between 100 and 5000 m^3 in the summer in the mid-estuary region; Benthic macrofauna: density of sandprawn *Callianassa kraussi* burrow openings should exceed 75 per m^2 in the highest density areas in the lower estuary, burrow density in the lower estuary should not drop below 50 counts per m^2 in the highest density areas, all size classes of sand prawn should be present in the population
					Fish	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish community composition, abundance and richness	Juvenile estuary dependant marine fish should not be absent from the estuary for more than two years in a row; % contribution by juvenile estuary dependant marine fish to assemblage by number should not drop to <60% of residents; Alien species abundance should remain below 5 % of biomass in main body of estuary; % contribution of adult & sub-adult estuary-dependent fish to assemblage by number should not drop below 15%
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Number of non-passerine waterbird species recorded in counts should not decrease by more than 10% over a five-year period; overall numbers of waders, wading birds or gulls & terns, or numbers of any of the species in these groups should not decrease relative to the baseline average by more than 10% over a five-year period, after correcting for regional/global population changes; total summer numbers of waterfowl should not exceed 15 000 for more than 4 years.

Table 3-77 Supplementary information for Bot/Kleinmond estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
B5-Overberg West	II	Bot / Kleinmond	nxi6	G40G	EC: B %nMAR: 81.78	PES: C %nMAR: 81.78	EC: C %nMAR: 81.78	Motivation for achieving REC/TEC • The Bot/Kleinmond estuary system is ranked as the 8th most important estuary in South Africa (Turpie et al. 2011) and forms part of a core set of estuaries that needs to be protected to meet biodiversity targets in South Africa (Turpie et al 2010, Turpie and Clarke 2007). The RDM study completed for this system (CSIR 2011) identified that the REC for the system, should be a B category but that restoration of flow alone was not sufficient to achieve this REC. Major pressures contributing to the degraded health of the system include little or no river inflow in summer, poor water quality, artificial breaching and over exploitation of fish. These issues all need to be addressed through joint effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) in accordance with the Ecological Specifications included below. Clearing of alien vegetation from the catchment will also assist in restoring flow to the system. Additional (non-flow related) interventions to achieve the TEC: • Agricultural and urban landscape management – this is especially relevant in the case of Arabella Country Estate which show increase macrophyte growth in the estuary near its fairways; • Improve the compliance monitoring of fishing and bait collection activities on the estuary. This will assist in controlling illegal harvesting of the estuarine living resources. At present, illegal gillnetting and recreational angling accounts for approximately 16 tons annually. • Review the artificial breaching guidelines for the Bot Estuary to ensure it can follow natural hydrological cycles (long term wet-dry) and not short-term inflexible rules that forces it to breach only in specific seasons or under specific conditions. • Prevent artificial breaching of the Kleinmond Estuary	DWAF (2011): Rapid assessment of the Ecological Water Requirements for the Bot Estuary

Table 3-78 RQOs and Numerical Limits for Onrus estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
H16 Overberg West Coastal	G40H	Onrus Estuary	nxi8	Quantity	Flow	MMR/MAR (% Nat)	Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	55.6	54.2	53.8	52.9	51.2	50.2	49.7	49.0	50.0	49.8	51.7	54.8	51.8
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <300µg/ℓ													
						DIP		Entire estuary and river inflow: DIP < 25 µg/ℓ													
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	10 < Salinity <40													
					System variables	Dissolved oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Entire estuary and river inflow: DO >5 mg/ℓ													
						Turbidity		Turbidity <5 NTU													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediments	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Control nutrient input from sewage spills to prevent microalgal blooms (> 20 µg l^{-1}) and the occurrence of harmful algal bloom species; maintain the distribution of different phytoplankton groups (diverse community composition) and prevent dominance of Cyanophytes (blue-green algae) that occur under nutrient rich, freshwater conditions													
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the present area (2014) covered by the macrophyte habitats: open surface water area: 2.59, sand and mudflats: 1.86, reeds and sedges: 6.57, prevent further spread of reeds by reducing nutrient input and occurrence of aquatic invasive such as water fern *Azolla*.; prevent further disturbance and development in the riparian zone; remove alien plants from the riparian zone and control the spread of garden invasive													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	The estuary should have viable populations of *Callianassa kraussi* in sandy zones and *Upogebia africana* in muddy zones. Breeding in both species ceases at salinities lower than 17 ppt during prolonged mouth phase. In *U. africana* and export of larvae into marine and postlarvae back to estuary ceases; prolonged mouth closure should be avoided as this will result in a loss of marine species (e.g. *Pseudodiaptomus* sp.) from the zooplankton community
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 2 estuary dependent marine species (Category II), 1 indigenous catadromous species (Category V) and two freshwater indigenous species (Category IV). Estuarine residents should dominate numerically (>50%), but estuary dependent marine species, indigenous catadromous and freshwater species should be present

Table 3-79 Supplementary information for Onrus estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H16 Overberg West Coastal	II	Onrus	nxi8	G40H	EC: D %nMAR: 51.8	PES: D %nMAR: 51.77	EC: D %nMAR: 51.77	Motivation for achieving REC/TEC • The Onrus estuary is considered to be of “low to average importance” from a biodiversity conservation perspective (ranked 94 out of 273 estuaries in South Africa) and has not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is the same as PES – i.e. D category. The system is nonetheless important from a socio-economic perspective – it is an important node for recreation, tourisms and contributes significantly to property value. It is important to maintain the system in a reasonable state of health and in state that is safe for contact recreation. The most important threats to the Onrus estuary include freshwater deprivation (due to abstractions from the De Bos Dam, located 9 km upstream for the estuary mouth, for agricultural and domestic use), sedimentation (due to reduced flow and concomitant changes in mouth dynamics) and impaired water quality (due to sewage spills and the poor quality of stormwater inputs from informal settlements). Clearing of alien vegetation from the catchment (above and below the De Bos Dam) will also assist in restoring flow to the system, however, concerted effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) is required to address other threats to the estuary in accordance with the Ecological Specifications included below Additional (non-flow related) interventions to achieve the REC: • It is critically important to reduce nutrient inputs to the Onrus estuary by upgrading sewage infrastructure and diverting or treating stormwater runoff from informal settlements in the catchment. Restoration of freshwater inflows (by making appropriate releases from the De Bos Dam and clearing of alien vegetation from the catchment - above and below the De Bos Dam) will also increase the frequency and duration of the open mouth state and will serve to increase salinity in the estuary and reduce macrophyte cover	DWS (2017) Reserve determination study for the Onrus estuary

3.2.1.3 Estuary's priority RUs in Overberg East Fynbos IUA

Table 3-80 RQOs and Numerical Limits for Klein estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
H17 Overberg East Fynbos	G40L	Klein Estuary	nxi7	Quantity	Flow	MMR/MAR (% Nat)	Flood and breaching regimes to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	84.2	83.1	85.5	73.7	69.4	78.8	78.0	83.9	82.3	86.9	89.7	90.3	85.6
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <300µg/ℓ													
						DIP		Entire estuary and river inflow: DIP <25 µg/ℓ													
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	5 < Salinity <40													
					System variables	Dissolved oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Entire estuary and river inflow: DO >5mg/ℓ, turbidity < 5 NTU													
						Turbidity		Turbidity <5 NTU													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediments	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Phytoplankton biomass, measured as water column chlorophyll-a should not exceed 10 µg l^{-1}; maintain high subtidal benthic microalgae biomass during the closed mouth phase and high intertidal benthic microalgae biomass during the open phase; phytoplankton biomass should not exceed 10 µg l^{-1}; benthic microalgae biomass should not deviate more than 20 % compared with Present State concentrations; no brackish epipelic diatoms should be found during the closed phase													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the present area (2014) covered by the macrophyte habitats: open surface water area: 741.6 ha; sand and mud banks: 79 ha; submerged macrophytes: 92 ha; salt marsh: 170 ha; reeds and sedges: 127 ha; floodplain: 280 ha (mostly intact) and 110 ha (disturbed); maintain the distribution of plant community types i.e. submerged macrophyte, *Ruppia cirrhosa* beds during closed mouth brackish conditions, salt marsh, *Salicornia meyeriana* marsh during open mouth conditions, *Phragmites australis* stands in the middle / upper reaches and salt marsh grasses indicative of brackish conditions
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Benthic invertebrates: The estuary should have viable populations of *Callianassa kraussi* in sandy zones and *U. Africana* in muddy zones. Breeding in both species ceases at salinities lower than 17 ppt during prolonged mouth phase. In *U. africana* and export of larvae into marine and postlarvae back to estuary ceases; abundance of *C. kraussi* and *U. africana* should not drop below 50% of recorded total abundances in each season; recruits should be recorded in population (Identify zones where these are abundant from the baseline study and these would be where the above would be assessed); Zooplankton: Prolonged close mouth would result in a loss of marine species (e.g. *Pseudodiaptomus sp.)* from the zooplankton community; abundance of indicator marine species (e.g. *Pseudodiaptomus sp.)* should not change by more than 50% of current levels.
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Retain the following fish assemblages in the estuary (based on abundance): estuarine species (20-30%), estuarine associated marine species (60-70%) and indigenous freshwater species (<1%). All numerically dominant species are represented by 0+ juveniles. abundance of estuary associated marine species should not drop below 50% of total abundance; abundance of estuarine species should not increase above 50% of total abundance.; alien freshwater species should not be present in the estuary; 0+ juveniles of all of the dominant fish species should be present
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a rich avifaunal community that includes representatives of all the original groups, significant numbers of migratory waders and terns, as well as a healthy breeding population of resident waders; the estuary should support thousands of birds in summer and hundreds in winter; numbers of waterfowl should not drop below 600, waders below 100 in summer, and terns below 250; overall numbers of bird species should not drop below 1000 for 3 consecutive counts

Table 3-81 Supplementary information for Klein estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H17-Overberg East Fynbos	II	Klein	nxi7	G40L	EC: B %nMAR: 98.05	PES: C %nMAR: 80.33	EC: C %nMAR: 85.58	Motivation for achieving REC/TEC • The Klein estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 24th out of 273 estuaries in South Africa), and has been designated as a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment (Turpie et al. 2012). The REC for the estuary is an A category or "Best Attainable State", however, the BAS for this system is estimated to be a B category. This system is extremely sensitive to reductions in flow and %MAR has been reduced significantly from natural (80.3%). It is not possible to achieve a B category for this system through restoration in flow alone (TEC = C category). Major pressures on the system include artificial breaching at low berm height levels, impaired water quality (resulting from poor quality agricultural return flows and stormwater runoff from informal settlements in the catchment), loss of estuarine habitat from development around the estuary margins, and illegal fishing. These issues all need to be addressed through joint effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) in accordance with the Ecological Specifications included below. Restoration of flow can be achieved largely through clearance of alien vegetation from the catchment. Additional (non-flow related) interventions to achieve the TEC: • Removing AIPs from the catchment • Conduct an audit of all water use in the Klein catchment to identify and all legal and illegal uses of water in the catchment, to quantify their level of use. Thereafter, steps need to be taken to eliminate all illegal abstractions and to ensure legal users do not exceed their allowable limits • Reduce levels of inorganic nutrients in inflowing water from the catchment • Reduction in fertilizer use in the catchment • Educate landowners/farmers on impacts of excessive fertilizer use on the Klein estuary • Improve quality of effluent from Standford WWTW • Reduce direct inputs of inorganic nutrient into the estuary • Eliminate septic and conservancy tanks from properties on the banks of the Klein estuary through provision of sewage reticulation infrastructure • Implement a mouth management plan that satisfies ecological requirements of the estuary (increased breaching water level, improved nursery function, improved water quality, increase connectivity with the Botvlei Estuary through aligning open periods where possible) • Institute and enforce appropriate development set-back line around the estuary that provide adequate protection for estuarine fauna and flora • Management of recreational activities on the estuary through zonation to reduce impacts of kite boarding and sailing on bird populations • Improved compliance in respect of use of living marine and estuarine resources (legal and illegal fishing)	Anchor Environmental Consultants (2015) Determination of the Ecological Reserve for the Klein Estuary

Table 3-82 RQOs and Numerical Limits for Uilkraals estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
H17 Overberg East Fynbos	G40M	Uilkraals Estuary	nxi5	Quantity	Flow	MMR/MAR (% Nat)	Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8, 58.8
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <300µg/ℓ
						DIP		Entire estuary and river inflow: DIP <25 µg/ℓ
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	10 < Salinity <40
					System variables	Dissolved oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Entire estuary and river inflow: DO > 6 mg/ℓ
						Turbidity		Turbidity < 5 NTU
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline
					Sediments	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Phytoplankton biomass, measured as water column chlorophyll-a should not exceed 10 ug l^{-1}; maintain high subtidal benthic microalgal biomass during the closed mouth phase and high intertidal benthic microalgal biomass during the open phase
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the distribution of plant community types i.e. submerged macrophyte, *Ruppia cirrhosa* beds during closed mouth brackish conditions, salt marsh, *Salicornia meyeriana* marsh during open mouth conditions, *Phragmites australis* stands in the middle / upper reaches and salt marsh grasses indicative of brackish conditions.
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	The estuary should have viable populations of *Callianassa kraussi* in sandy zones and U. Africana in muddy zones

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Retain the following fish assemblages in the estuary (based on abundance): estuarine species (30-40%), estuarine associated marine species (60-70%) and indigenous freshwater species (<1%). All numerically dominant species are represented by 0+ juveniles
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a rich avifaunal community that includes representatives of all the original groups, significant numbers of migratory waders and terns, as well as a healthy breeding population of resident waders; the estuary should support thousands of birds in summer and hundreds in winter

Table 3-83 Supplementary information for Uilkraals estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H17-Overberg East Fynbos	II	Uilkraals	nxi5	G40M	C	PES: E %nMAR: 43.93	EC: C/D %nMAR: 58.79	Additional (non-flow related) interventions to achieve the REC: • Non-flow impacts have played a major role in the degradation of the Uilkraals estuary to a D, but flow-related impacts are the main cause of its degradation. Thus, the highest priority is to address the quantity and quality of influent water. Clearing of alien vegetation from the catchment will go a long way towards addressing the flow deficits in this system. Of the non-flow-related impacts, water quality problem as a result of sewage pollution in the estuary was found to be the most important factor that influenced the health of the system.	Anchor Environmental Consultants (2012) Reserve Determination Study for the Uilkraals Estuary

Table 3-84 RQOs and Numerical Limits for **Ratel** estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
H17 Overberg East Fynbos	G50A	Ratel Estuary	nxi3	Quantity	Flow	MMR/MAR (% Nat)	Maintain at least present-day base flows	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	90.0	90.0	90.1	90.3	90.2	90.2	90.0	90.0	90.0	90.0	90.0	90.0	90.0
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <300µg/ℓ													
						DIP		Entire estuary and river inflow: DIP <25 µg/ℓ													
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	10 < Salinity <40													
					System variables	Dissolved oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Entire estuary and river inflow: DO > 6 mg/ℓ													
						Turbidity		Turbidity < 5 NTU													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediments	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain the distribution of different phytoplankton groups and low biomass (< 20 µg l-1)													
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the distribution of current macrophyte habitats, <20 % change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries); submerged macrophytes such as pondweed (*Potamogeton pectinatus*) should be present during low flow conditions													
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	The estuary should have viable populations of *Callianassa kraussi* in sandy zones and *Upogebia africana* in muddy zones													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.

Table 3-85 Supplementary information for Ratel estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H17-Overberg East Fynbos	II	Ratel	nxi3	G50A	C	PES: C %nMAR: 90.02	EC: C/D %nMAR: 72.99		RQOs for the Ratel estuary are based on those developed for the Rooiels estuary (DWS 2017)

Table 3-86 RQOs and Numerical Limits for **Heuningnes** estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="13">H17 Overberg East Fynbos</td><td rowspan="13">G50F</td><td rowspan="13">Heuningnes Estuary</td><td rowspan="13">nxi1</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Flood and breaching regimes to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>79.6</td><td>77.5</td><td>73.1</td><td>71.5</td><td>72.5</td><td>76.2</td><td>79.1</td><td>79.2</td><td>79.0</td><td>78.4</td><td>78.7</td><td>78.2</td><td>78.2</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">Entire estuary and river inflow: DIN <300µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">Entire estuary and river inflow: DIP <25 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Average salinity in the estuary is artificially elevated at present due to reduced freshwater inflow, target levels for the various zones are as follows: Zone A: 30, Zone B: 14, Zone C: 6, Zone D: 2</td></tr>
<tr><td rowspan="2">System variables</td><td>Dissolved oxygen</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td>pH</td><td colspan="14">8< pH <9</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediments</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="2">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Phytoplankton biomass, measured as water column chlorophyll-a should not exceed 10 µg l^{-1} in both the estuary and Soetendalsvlei (Zone D); maintain diversity of phytoplankton groups i.e. diatoms abundant during marine phase.</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Area covered by different macrophyte habitats particularly intertidal and supratidal salt marsh should be allowed to revert to a more natural state through restoration of a more natural flow regime (particularly summer base flows) and by allowing mouth operate normally as far as possible (minimum height for artificial breaching to be increased to 2.5 m) breaching which will increase backflooding and soil salinity; present area (2014) covered by the macrophyte habitats is as follows: Open surface water area :907.92, Sand and mudflats :43.35, Submerged macrophytes :10.17, Reeds and sedges:1154.98, Intertidal salt marsh :16.18 , Supratidal salt marsh:942.4</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Benthic invertebrates: Abundance of *C. kraussi* and *U. Africana* should not drop below 50% of recorded total abundances in each season, recruits should be recorded in population (Identify zones where these are abundant from the baseline study and these would be where the above would be assessed; Zooplankton: Prolonged close mouth would result in a loss of marine species (e.g. *Pseudodiaptomus sp.)* from the zooplankton community, abundance of indicator marine species (e.g. *Pseudodiaptomus sp.)* should not change by more than 50% of current levels
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Retain the following fish assemblages in the estuary (based on abundance): estuarine species (20-30%), estuarine associated marine species (60-70%) and indigenous freshwater species (<1%); all numerically dominant species are represented by 0+ juveniles; abundance of estuary associated marine species should not drop below 50% of total abundance; abundance of estuarine species should not increase above 50% of total abundance; alien freshwater species should not be present in the estuary; 0+ juveniles of all of the dominant fish species should be present
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a rich avifaunal community that includes representatives of all the original groups, significant numbers of migratory waders and terns, as well as a healthy breeding population of resident waders. The estuary should support thousands of birds in summer and hundreds in winter; numbers of waterfowl should not drop below 600, waders below 100 in summer, and terns below 250; overall numbers of bird species should not drop below 1000 for 3 consecutive counts

Table 3-87 Supplementary information for Heuningnes estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H17-Overberg East Fynbos	II	Heuningnes	niv44	G50C	EC: A %nMAR: 78.0	PES: C %nMAR: 68.78	EC: A/B %nMAR: 78.17	Motivation for achieving REC/TEC • The Heuningnes estuary is rated as "highly important" from a biodiversity conservation perspective, and is located in a Provincial Nature Reserve (De Mond Nature Reserve). The REC for the estuary is an A category or "Best Attainable State", however, the BAS for this system is estimated to be a C category. This system is extremely sensitive to reductions in flow and %MAR has been reduced significantly from natural (78.0%). It is not possible to achieve a B category for this system through restoration in flow alone (TEC = A/B category). Major pressures on the system include mouth stabilisation and artificial breaching at low berm height levels, impaired water quality (resulting from poor quality agricultural return flows), loss of estuarine habitat as a result of reclamation of land for agriculture, and illegal fishing. These issues all need to be addressed through joint effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) in accordance with the Ecological Specifications included below. Restoration of flow can be achieved largely through clearance of alien vegetation from the catchment. Additional (non-flow related) interventions to achieve the REC: • Restoration of freshwater inflow (which can largely be accomplished to a large extent by removal of alien invasive vegetation from the catchment) will improve the health of the estuary to a B category but restoring this system to an A category will also require reclamation of a significant portion of the historic floodplain area of the estuary (currently under agriculture or use as grazing land, this land would need to be bought up by Cape Nature), reducing nutrient inputs (mostly die to application of agricultural fertilizers but also the Bredasdorp WWTW), eliminating illegal fishing on the system, minimising interference with natural mouth dynamics (increase breaching height to 2.5 m amsl), limiting numbers of visitors to the estuary (will limit disturbance to birds and fishing pressure), and removal of the remnants of the causeway below Soetendalsvlei.	Anchor Environmental Consultants (2018) Reserve Determination Study for the Heuningnes estuary

Table 3-88 RQOs and Numerical Limits for **Klipdriftsfontein** estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
H17 Overberg East Fynbos	G50K	Klipdriftsfontein Estuary	bxi3	Quantity	Flow	MMR/MAR (% Nat)	Maintain at least present-day base flows	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	62.5	68.0	63.3	58.4	58.3	65.7	68.6	64.4	60.2	61.2	66.8	64.3	64.8
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <300µg/ℓ													
						DIP		Entire estuary and river inflow: DIP <25 µg/ℓ													
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	10 < Salinity <40													
					System variables	Dissolved oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Entire estuary and river inflow: DO > 6 mg/ℓ													
						Turbidity		Turbidity < 5 NTU													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediments	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain the distribution of different phytoplankton groups and low biomass (< 20 µg l-1)													
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the distribution of current macrophyte habitats, <20 % change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries); submerged macrophytes such as pondweed (*Potamogeton pectinatus*) should be present during low flow conditions													
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	The estuary should have viable populations of *Callianassa kraussi* in sandy zones and *Upogebia africana* in muddy zones													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.

Table 3-89 Supplementary information for Klipdriftsfontein estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
H17-Overberg East Fynbos	II	Klipdriftsfontein	bxi3	G50K	A	PES: A %nMAR: 64.77	EC: A %nMAR: 64.77		RQOs for the Klipdrifsfontein estuary are based on those developed for the Rooiels estuary (DWS 2017)

3.2.1.4 Estuary’s priority RUs in Lower Breede Renosterveld IUA

Table 3-90 RQOs and Numerical Limits for Breede estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="13">F11 Lower Breede Renosterveld</td><td rowspan="13">H70K</td><td rowspan="13">Breede Estuary</td><td rowspan="13">nxi2</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as per recommended ecological flow</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>57.6</td><td>50.1</td><td>34.0</td><td>33.0</td><td>34.6</td><td>41.7</td><td>59.7</td><td>56.6</td><td>61.2</td><td>47.6</td><td>51.3</td><td>27.3</td><td>47.2</td></tr>
<tr><td rowspan="6">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">Entire estuary and river inflow: DIN <300µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">Entire estuary and river inflow: DIP <25 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Zone A (0-15 km upstream of mouth): 40> Salinity >20, Zone B (15-30 km): 30> Salinity >10, Zone C (30-40 km): 20> Salinity >5, Zone D (40-50 km): <10</td></tr>
<tr><td>System variables</td><td>Dissolved oxygen</td><td>System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td rowspan="2">Maintain connectivity with marine environment</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td colspan="14">Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.</td></tr>
<tr><td>Sediments</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime to maintain natural bathymetry and the sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="2">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Median phytoplankton chlorophyll a (minimum 5 sites) not to exceed 3.5 µg/ℓ; prevent formation of localised phytoplankton blooms; maintain a high median intertidal benthic microalgal biomass; median intertidal benthic chlorophyll a (minimum 5 sites) not to exceed 42 mg/m$^{2;}$ site specific chlorophyll a concentration not to exceed 20 µg/ℓ and cell density not to exceed 10 000 cells/ℓ.</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain the present area (2014) covered by the macrophyte habitats: intertidal salt marsh: 20.5 ha, supratidal salt marsh: 29.55 ha, submerged macrophytes: 6 ha, reeds & sedges: 4.8 ha, sand/mud banks: 136 ha; maintain the integrity of the remaining supratidal salt marsh; maintain the reed and sedge stands in the upper reaches of the estuary; rehabilitate 20% of the floodplain habitat by removing any agricultural berms and invasive plants; maintain the integrity of the riparian zone.; invasive plants (e.g. Eucalyptus, prickly pear, Tamarix) cover not to exceed 5% of total floodplain area</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zone B); maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); mudprawn density should not deviate from average baseline levels by more than 25% in each season; dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (G. aestuaria, Hyporamphus capensis, Omobranchus woodii); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus, P. commersonii, Lichia amia); REI species dominated by both Myxus capensis and G. aestuaria
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a diverse avifaunal community that includes representatives of all the original taxonomic groups (see 2015 EWR report).; tern roosts should be seen at the estuary on a regular basis; apart from gulls, terns and regionally increasing species such as Egyptian Goose, the estuary should generally support more than 200 birds; numbers of birds other than gulls, terns and regionally increasing species should not fall below 120 for three consecutive counts; numbers of waterbird species drop should not below 15 for 3 consecutive counts

Table 3-91 Supplementary information for Breede estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
F11 Lower Breede Renosterveld	II	Breede	nxi2	H70K	EC: B %nMAR: 50.2	PES: B %nMAR: 49.5	EC: B %nMAR: 47.2	Motivation for achieving REC/TEC • The Breede estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 19th out of 273 estuaries in South Africa), and has been designated as a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment (Turpie *et al*. 2012). The REC for the estuary is a B category. The Present MAR is estimated at 49.5% of natural. However, future water demands for freshwater in the Breede catchment (mainly for domestic and industrial use by the City of Cape Town and agriculture in the catchment) mean that this will drop slightly in future (to 47.2% of natural). It is likely that this system will remain in a B category under this condition, however, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in a B category. Key threats to the system include reduction in freshwater runoff, sedimentation, and impaired water quality (because of agricultural return flows). Additional (non-flow related) interventions to achieve the REC: • Actively encourage stewardship programmes that promote alternative farming practices (i.e. using less water); • Future planning and construction of hard structures should be prohibited as a result of the high dynamic/erodable of the estuary bank; • Appropriate dune management and setback along coast adjacent to mouth should be implemented as it affects mouth dynamics; and • Control/reduce fishing effort through improve compliance monitoring of fishing activities and banning of night fishing.	DWAF (2003) Intermediate Determination of Resource Directed Measures for the Breede River Estuary

3.2.2 Prioritised estuaries in the Gouritz and Coastal region

3.2.2.1 Estuary's priority RUs in Lower Gouritz IUA

Table 3-92 RQOs and Numerical Limits for Gouritz estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="12">F13 Lower Gouritz</td><td rowspan="12">J40E</td><td rowspan="12">Gouritz Estuary</td><td rowspan="12">gxi1</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as per recommended ecological flow</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>53.2</td><td>59.8</td><td>53.5</td><td>46.4</td><td>53.3</td><td>59.7</td><td>61.8</td><td>66.7</td><td>62.2</td><td>62.8</td><td>74.1</td><td>57.8</td><td>59.7</td></tr>
<tr><td rowspan="6">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow: NOx-N not to exceed 100 µg/ℓ over 2 consecutive months, NH_3-N not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average NOx-N not to exceed 100 µg/ℓ, no single measurement to exceed 150 µg/ℓ, average NH_3-N not to exceed 20 µg/ℓ during survey, no single measurement to exceed 100 µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">River inflow: PO_4-P not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average PO_4-P not to exceed 20 µg/ℓ during survey, no single measurement to exceed 50 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Salinity should not exceed 0 at head of estuary, average salinity in Zone C < 20, Average salinity 11 km upstream from mouth > 20 for no more than 3 months of the year, salinity <40 in saltmarsh sediments</td></tr>
<tr><td>System variables</td><td>Dissolved oxygen</td><td>System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td rowspan="2">Maintain connectivity with marine environment</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td colspan="14">Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.</td></tr>
<tr><td>Sediments</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime to maintain natural bathymetry and the sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td>Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Median phytoplankton chlorophyll a (minimum 5 sites) should not exceed 3.5 µg/ℓ; prevent formation of localised phytoplankton blooms; site specific chlorophyll a concentration exceeds 20 µg/ℓ and cell density exceeds 10 000 cells/ mℓ; Median intertidal benthic chlorophyll a (minimum 5 sites) exceeds 42 mg/m2</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the present area (2013) covered by the macrophyte habitats: surface water area: 298.04 ha, sand and mud banks : 81.02 ha, reeds and sedges 6.72 ha, floodplain (supratidal salt marsh): 137.77 ha; Maintain the integrity of the remaining supratidal salt marsh; maintain the reed and sedge stands in the upper reaches of the estuary; rehabilitate 20% of the floodplain habitat by removing any agricultural berms and invasive plants; maintain the integrity of the riparian zone; change in the area covered by salt marsh, reeds and sedges not to exceed 20% from baseline; invasive plants (e.g. Eucalyptus, prickly pear, Tamarix) cover not to exceed 5% of total floodplain area
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zones A and B); mudprawn density should not deviate from average baseline levels by more than 25% in each season; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); the dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (G. aestuaria, Hyporamphus capensis, Omobranchus woodii); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus, P. commersonii, Lichia amia); REI species dominated by both Myxus capensis and G. aestuaria
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a diverse avifaunal community that includes representatives of all the original taxonomic groups (see 2015 EWR report).; tern roosts should be seen at the estuary on a regular basis; apart from gulls, terns and regionally increasing species such as Egyptian Goose, the estuary should generally support more than 200 birds; numbers of birds other than gulls, terns and regionally increasing species should not fall below 120 for three consecutive counts; numbers of waterbird species drop should not below 15 for 3 consecutive counts

Table 3-93 Supplementary information for Gouritz estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
F13 Lower Gouritz	II	Gouritz	gxi1	J40E	EC: B %nMAR: 71.5	PES: C %nMAR: 62.01	EC: C %nMAR: 47.4	Motivation for achieving REC/TEC • The Gouritz estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 49th out of 273 estuaries in South Africa), and has been designated as a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment (Turpie *et al*. 2012). The Duiwenhoks estuary is also an important nursery area for exploited fish stocks (e.g. collapsed stock: dusky kob, white Steenbras), as well as catchment flows to the marine environment (sediment and detritus) and coastal connectivity (e.g. way point for fish. The REC for the estuary is a B category, but future demands for freshwater in the Gouritz catchment (mainly for agriculture) mean that this is likely to drop dramatically in future (to 47.4% of natural) and that thus there is a very real threat that the health of this system may decline in future (TEC has been set as the same as the PES but this may not be realistic). Thus, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in a B category. Key threats to the system include reduction in freshwater runoff, sedimentation, habitat modification (loss and degradation of floodplain habitats), illegal fishing, and impaired water quality (as a result of agricultural return flows). Additional (non-flow related) interventions to achieve the TEC: • Actively encourage stewardship programmes that promote alternative farming practices (i.e. using less water); • Rehabilitate 20% of the flood plain by removing the agriculture levees and invasive plants; • The abutment on the eastern side of the bridge across river will fail under flood which require the construction of appropriate open spans/culverts; • Water supply pipe (along western bank in the middle reaches of the estuary) should be protected by hard infrastructure (e.g. stone gabions have short life span in salty conditions) but preferably an alternative location should be investigated; • Future planning and construction of hard structures should be prohibited as a result of the high dynamic/erodable of the estuary bank; • Appropriate dune management and setback along coast adjacent to mouth should be implemented as it affects mouth dynamics; and • Control/reduce fishing effort through improve compliance monitoring of fishing activities and banning of night fishing.	DWS (2015) Intermediate level EWR assessment for the Gouritz Estuary.

3.2.2.2 Estuary's priority RUs in Duiwenhoks IUA

Table 3-94 RQOs and Numerical Limits for Duiwenhoks estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="13">F12 Duiwenhoks</td><td rowspan="13">H80E</td><td rowspan="13">Duiwenhoks Estuary</td><td rowspan="13">gxi2</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as per TEC</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>92.2</td><td>92.0</td><td>87.7</td><td>84.0</td><td>84.7</td><td>90.7</td><td>92.9</td><td>93.5</td><td>93.5</td><td>93.8</td><td>94.4</td><td>93.5</td><td>91.9</td></tr>
<tr><td rowspan="6">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow: NOx-N not to exceed 100 µg/ℓ over 2 consecutive months, NH_3-N not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average NOx-N not to exceed 100 µg/ℓ, no single measurement to exceed 150 µg/ℓ, average NH_3-N not to exceed 20 µg/ℓ during survey, no single measurement to exceed 100 µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">River inflow: PO_4-P not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average PO_4-P not to exceed 20 µg/ℓ during survey, no single measurement to exceed 50 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Salinity should not exceed 0 at head of estuary, average salinity in Zone C < 20, Average salinity 11 km upstream from mouth > 20 for no more than 3 months of the year</td></tr>
<tr><td>System variables</td><td>Dissolved oxygen</td><td>System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td rowspan="2">Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td colspan="14">Average tidal amplitude near the mouth does not change more than 30% from present during low flows (summer).</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >10% from established baseline</td></tr>
<tr><td>Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Median phytoplankton chlorophyll *a* (minimum 5 sites) not to exceed 3.5 µg/ℓ; prevent formation of localised phytoplankton blooms; maintain a high median intertidal benthic microalgal biomass; median intertidal benthic chlorophyll a (minimum 5 sites) not to exceed 42 mg/m^2; site specific chlorophyll a concentration not to exceed 20 µg/ℓ and cell density not to exceed 10 000 cells/ℓ.</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the present area (2013) covered by the macrophyte habitats: surface water area: 40 ha, Sand and mud banks : 29 ha, Salt marsh: 26 ha, Reeds and sedges 3 ha, Floodplain: 6 ha; Invasive plants (e.g. black wattle, prickly pear, Tamarix) cover must remain < 5% of total floodplain area; maintain the integrity of the salt marsh; maintain the reed and sedge stands in the middle and upper reaches of the estuary; rehabilitate 10% of the floodplain habitat by removing any agricultural berms and invasive plants; maintain the integrity of the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zones A and B); mudprawn density should not deviate from average baseline levels by more than 25% in each season; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); the dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (G. aestuaria, Hyporamphus capensis, Omobranchus woodii); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus, P. commersonii, Lichia amia); REI species dominated by both Myxus capensis and G. aestuaria
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a diverse avifaunal community that includes representatives of all the original taxonomic groups (see 2015 EWR report).; tern roosts should be seen at the estuary on a regular basis; apart from gulls, terns and regionally increasing species such as Egyptian Goose, the estuary should generally support more than 200 birds; numbers of birds other than gulls, terns and regionally increasing species should not fall below 120 for three consecutive counts; numbers of waterbird species drop should not below 15 for 3 consecutive counts

Table 3-95 Supplementary information for Duiwenhoks estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
F12-Duiwenhoks	III	Duiwenhoks	Gxi2	H80E	EC: A %nMAR: 91.1	PES: B %nMAR: 91.1	EC: B %nMAR: 82.41	Motivation for achieving REC/TEC • The Duiwenhoks estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 23rd out of 273 estuaries in South Africa), and has been designated as a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment (Turpie *et al*. 2012). The Duiwenhoks estuary has also been identified as an important nursery area for red data species and exploited fish stocks, and a very important conduit for eels which are listed species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The REC for the estuary is an A category, but the BAS for this system is estimated to be a B category, mostly due to non-flow related influences (flow at present meets the specifications for the REC). Future demands for freshwater in the Duiwenhoks catchment (mainly for agriculture) mean that this is likely to drop in future (to 82.4% of natural) and that thus there is a very real threat that the health of this system may decline in future (this is not reflected in a reduction in the TEC, though). Thus, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in a B category. Key threats to the system include reduction in freshwater runoff, sedimentation, habitat modification (loss and degradation of floodplain habitats) and impaired water quality (as a result of agricultural return flows). Additional (non-flow related) interventions to achieve the REC: • *Peat* land upstream of the estuary is rehabilitated to improve the regulation of river inflow to the estuary so as to maintain the river-estuary-interface (REI) zone for longer periods; • At least 10% of degraded estuarine habitat in the riparian zones is rehabilitated, including the removal of alien vegetation; • Control/reduce fishing effort through improved compliance monitoring of fishing activities; • Implement an alien fish control programme; and • Institute a control programme to reduce the number of Egyptian geese in the surrounding habitat.	DWS (2014) Intermediate level RDM study for the Duiwenhoks estuary.

3.2.2.3 Estuary's priority RUs in Hessequa IUA

Table 3-96 RQOs and Numerical Limits for Goukou estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="12">I18 Hessequa</td><td rowspan="12">H90E</td><td rowspan="12">Goukou Estuary</td><td rowspan="12">gxi3</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as per recommended ecological flow
Ensure the persistence of freshwater seepage sites in the lower and middle reaches of the estuary.
River inflow should not drop
Maintain water levels in fountains (determine trough baseline study)</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>81.7</td><td>81.4</td><td>72.8</td><td>70.0</td><td>71.2</td><td>81.9</td><td>85.0</td><td>85.0</td><td>84.1</td><td>84.5</td><td>85.7</td><td>83.8</td><td>81.4</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow: NOx-N not to exceed 100 µg/ℓ over 2 consecutive months, NH_3-N not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average NOx-N not to exceed 100 µg/ℓ, no single measurement to exceed 150 µg/ℓ, average NH_3-N not to exceed 20 µg/ℓ during survey, no single measurement to exceed 100 µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">River inflow: PO_4-P not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average PO_4-P not to exceed 20 µg/ℓ during survey, no single measurement to exceed 50 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Salinity should not exceed 0 at head of estuary, average salinity in Zone C < 20, Average salinity 11 km upstream from mouth > 20 for no more than 3 months of the year, salinity <40 in saltmarsh sediments</td></tr>
<tr><td rowspan="2">System variables</td><td>Dissolved oxygen</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td>pH</td><td colspan="14">6.0 < pH > 8.0 (black water system)</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td rowspan="2">Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td colspan="14">Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Median phytoplankton chlorophyll *a* (minimum 5 sites) not to exceed 3.5 µg/ℓ; prevent formation of localised phytoplankton blooms; maintain a high median intertidal benthic microalgal biomass; median intertidal benthic chlorophyll a (minimum 5 sites) not to exceed 42 mg/m$^{2;}$ ^{s}ite specific chlorophyll a concentration not to exceed 20 µg/ℓ and cell density not to exceed 10 000 cells/ℓ.
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain the present area (2014) covered by the macrophyte habitats: Open surface water area: 206, Sand and mud banks: 35, Submerged macrophytes: 5, Salt marsh: 57, Reeds and sedges: 21; maintain pockets of reeds in lower and middle reaches (linked to freshwater seepage sites); maintain the reed and sedge stands in the upper reaches of the estuary; rehabilitate 20% of the floodplain habitat by removing agriculture and invasive plants; maintain the integrity of the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zones A and B); mudprawn density should not deviate from average baseline levels by more than 25% in each season; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); the dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (G. aestuaria, Hyporamphus capensis, Omobranchus woodii); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus, P. commersonii, Lichia amia); REI species dominated by both Myxus capensis and G. aestuaria
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuary should contain a diverse avifaunal community that includes representatives of all the original taxonomic groups (see 2015 EWR report).; tern roosts should be seen at the estuary on a regular basis; apart from gulls, terns and regionally increasing species such as Egyptian Goose, the estuary should generally support more than 200 birds; numbers of birds other than gulls, terns and regionally increasing species should not fall below 120 for three consecutive counts; numbers of waterbird species drop should not below 15 for 3 consecutive counts

Table 3-97 Supplementary information for Goukou estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
I18--Hessequa	III	Goukou	gxi3	H90E	EC: B %nMAR: 80.6	PES: C %nMAR: 80.58	EC: C %nMAR: 78.94	Motivation for achieving REC/TEC • The Goukou estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 31st out of 273 estuaries in South Africa), is part of the Stilbaai MPA, is an important nursery area for red data species and exploited fish stocks, and is very important conduit for eels which are CITES listed species. The REC for the estuary is an B category, but the BAS for this system is estimated to be a C category, mostly due to non-flow related influences (flow at present meets the specifications for the REC, while the TEC flow is only marginally lower than this). Future demands for freshwater in the Duiwenhoks catchment (mainly for agriculture) mean that flows are likely to drop slightly in future (from 80.6 to 78.9% of natural) and that thus there is a very real threat that the health of this system may decline in future. Thus, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in a B category. Key threats to the system include reduction in freshwater runoff, sedimentation, loss and degradation of floodplain habitats, overfishing, impaired water quality (as a result of agricultural return flows) and disturbance caused by recreational activities. Additional (non-flow related) interventions to achieve the TEC: • Restore 50% of the flood plain and riparian habitat along length of estuary; • Identify all fountains, spring and seeps and ensure adequate freshwater supply to riparian zone and estuary to facilitate connectivity between estuary and terrestrial environment (critical factor for the protection of eels); • Control/reduce fishing effort through improve compliance monitoring of fishing activities and banning of night fishing; • Prepare and implement guidelines on appropriate bank stabilisation along the estuary; • Control boating activities on the estuary towards mitigating bank erosion (e.g. through proper zonation and establishment and enforcement of boating carrying capacity limits); • Institute proper stormwater management in future development planning (e.g. management of runoff from hardened surfaces and associated pollution); • Upgrade and maintain sewage infrastructure (e.g. restore broken pipes and install back-up pumps for pump station in close proximity of the estuary); • Ensure that the water quality and volumes discharged through the Riversdal WWTW meet permit requirements as issued under the National Water Act; • Prepare and implement guidelines on appropriate (nature-friendly) structures to secure access to the estuary.	DWS (2015): Intermediate level EWR assessment for the Goukou estuary

3.2.2.4 Estuary's priority RUs in Groot Brak IUA

Table 3-98 RQOs and Numerical Limits for Klein Brak estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="13">G14 Groot-Brak</td><td rowspan="13">K10F</td><td rowspan="13">Klein-Brak Estuary</td><td rowspan="13">gxi4</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>77.4</td><td>77.4</td><td>75.1</td><td>71.7</td><td>70.2</td><td>75.8</td><td>77.9</td><td>78.5</td><td>78.0</td><td>78.1</td><td>79.5</td><td>78.8</td><td>77.0</td></tr>
<tr><td rowspan="8">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow: NOx-N not to exceed 100 µg/ℓ over 2 consecutive months, NH_3-N not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average NOx-N not to exceed 100 µg/ℓ, no single measurement to exceed 150 µg/ℓ, average NH_3-N not to exceed 20 µg/ℓ during survey, no single measurement to exceed 100 µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">River inflow: PO_4-P not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average PO_4-P not to exceed 20 µg/ℓ during survey, no single measurement to exceed 50 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">A salinity gradient should always be present in the upper reaches of the estuary (Zone D and F), an REI zone should always be present in the upper reaches of the estuary (Zone D and F), salinity should not exceed 35</td></tr>
<tr><td rowspan="3">System variables</td><td>Dissolved oxygen</td><td rowspan="3">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td>TSS</td><td colspan="14">TSS <5 mg/ ℓ (low flow)</td></tr>
<tr><td>pH</td><td colspan="14">7.0 < pH > 8.5</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td>Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. *Acacia* spp.) in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zones A and B); mudprawn density should not deviate from average baseline levels by more than 25% in each season; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); the dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species ; Category IIa obligate dependents should be well represented by large exploited species
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Estuary should contain a diverse avifaunal community that includes representatives of all the original groups. Saltmarsh/wetlands in the floodplain should be rich in birdlife. Intertidal areas should have a good density and diversity of both larger and smaller waders; numbers of waterbirds on the entire system should not drop below 30 species or below 250 birds for three consecutive counts; numbers of waterbirds in the lower estuary should not drop below 10 species or 50 birds (excluding terns and gulls) for three consecutive counts
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: Phytoplankton not to exceed 8 µg/ℓ (median), Phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); Benthic microalgae not to exceed 42 mg/m^2 (median), Dinoflagellates, chlorophytes and/or cyanobacteria > 10% of relative abundance
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. *Acacia* spp.) in the riparian zone

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-99 Supplementary information for Klein Brak estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G14-Groot Brak	III	Klein Brak	gxi4	K10F	EC: C %nMAR: 89.9	PES: C %nMAR: 89.9	EC: C %nMAR: 76.5	Motivation for achieving REC/TEC • The Klein Brak estuary is rated as being of "average importance" from a biodiversity conservation perspective (ranked 58 out of 273 estuaries in South Africa), but is considered to play a very important role as a fish nursery for exploited and endangered fish species and provides an open estuary along a coast where a significant number of systems are seasonally closed. The PES, REC and TEC for this estuary are all a C category, but the %MAR for the TEC has been reduced from 89.9% of natural (for the PES and REC) to 76.5% of natural due to increasing demands for water in the region. Other threats to this important estuary include barriers (roads/bridges/weirs) to upstream penetration of salt water, development in the EFZ, alien plants and fishing. It is imperative therefore that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing these pressures on this system to ensure that this highly important system remains in a C category in spite of it receiving less water in future. Additional (non-flow related) interventions to achieve the TEC: • *On both the Brandwag (34◦03'43.51" S; 22◦06'47.95" E) and Moordkuil arms (34◦03'15.32" S; 22◦ 07'55.24" E) there are* obstructions across the estuary (i.e. roads) that prevent saline intrusion/tidal variation extending further upstream. To improve tidal connectivity these obstructions should either be removed or proper bridges should be constructed. In doing so, the river-estuary-interface (REI) (roughly defined as the reach where salinity ranges between 10 and 0) will be introduced more readily, enhancing nursery function in the upper estuaries and thus contributing to the recovery of collapsed and endangered fish species, e.g. dusky cob and white Steenbras. • Further upstream in the Moordkuil arm there is also a DWS weir (34◦03'11.14" S; 22◦08'02.85" E). As this weir fulfils an important gauging function it may not have to be removed, but fish ladders should be installed on both sides of the weir to allow migrating species (e.g. eels) to move upstream. • Rehabilitate degraded areas in the estuary functional zone, e.g. consolidate present access routes so as not to have a web of small roads on the salt marshes. • Removal of invasive alien plant species in the estuary functional zone, focussing especially in supratidal areas. • Reduce fishing pressures and (illegal) bait collecting through increased compliance (existing DAFF initiative). Institute a ban on night fishing to reduce the pressure on breeding stock of collapsed and endangered fish species, e.g. dusky cob (*proposed DAFF initiative).*	DWS (2014) Rapid level EWR assessment for the Klein Brak Estuary

Table 3-100 RQOs and Numerical Limits for Groot Brak estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="12">G14 Groot-Brak</td><td rowspan="12">K20A</td><td rowspan="12">Groot-Brak Estuary</td><td rowspan="12">gxi5</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality.</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>62.2</td><td>67.3</td><td>55.3</td><td>48.2</td><td>43.4</td><td>55.7</td><td>49.2</td><td>54.9</td><td>38.3</td><td>43.7</td><td>63.4</td><td>63.8</td><td>56.2</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">River inflow: NOx-N not to exceed 100 µg/ℓ over 2 consecutive months, NH_3-N not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average NOx-N not to exceed 100 µg/ℓ, no single measurement to exceed 150 µg/ℓ, average NH_3-N not to exceed 20 µg/ℓ during survey, no single measurement to exceed 100 µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">River inflow: PO_4-P not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average PO_4-P not to exceed 20 µg/ℓ during survey, no single measurement to exceed 50 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">A salinity gradient should always be present in the upper reaches of the estuary (Zone D and F), an REI zone should always be present in the upper reaches of the estuary (Zone D and F), salinity should not exceed 35</td></tr>
<tr><td rowspan="2">System variables</td><td>Oxygen</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Entire estuary and river inflow: DO >5 mg/ℓ</td></tr>
<tr><td>pH</td><td colspan="14">6 < pH > 8.5 in estuary</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td>Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low phytoplankton biomass. Maintain microalgal group diversity as measured for the baseline survey; phytoplankton biomass should not increase by more than 20% above baseline concentrations; phytoplankton group diversity to should not change more than 20% from baseline conditions; maintain high subtidal benthic microalgal biomass during the closed mouth phase and low intertidal benthic microalgal biomass during the open phase; Epipelic diatoms indicative of brackish conditions should be found during the closed phase.</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats as for present (2013): Submerged macrophyte, *Ruppia cirrhosa* beds: ~5 ha, *Zostera capensis* present during open mouth conditions, intertidal salt marsh: ~13 ha, supratidal and floodplain salt marsh: ~26.6 ha), Reed (*Phragmites australis)* and sedge stands in the middle / upper reaches: ~2.5 ha); prevent excessive filamentous macroalgal growth. Area covered should be half that covered by submerged macrophytes and less than 50 % of the open water surface area; maintain the zonation of salt marsh and distribution of different species along an elevation gradient. Ensure the long-term persistence of intertidal salt marsh species such as *Triglochin* spp. and *Cotula coronopifolia*; prevent hypersaline sediment and groundwater conditions in the salt marsh. Sediment electrical conductivity should be approximately 30 mS and similar to groundwater values.
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Density of mudprawns should exceed 100 – 150 burrow counts per m2 in the highest density areas; in the zooplankton, the density of Pseudodiaptomus hessei should exceed levels of about 5000-10000 m3 in the upper estuary in spring. Salinity variation in the estuary is highly variable and the mouth remains closed for extended periods - this may also lead to the temporary absence of some invertebrate species that might be expected to occur here.
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the five estuarine association categories in similar proportions (diversity and abundance) to that under the reference. Numerically, assemblage should comprise: Estuarine species (40-60%), Estuarine associated marine species (30-50%), Indigenous freshwater fish (1-5%); Category Ia species should contain viable populations of at least two species (e.g. *G. aestuaria*, & *Hyporamphus capensis*); Category IIa obligate dependents should be well represented by at least two large exploited species (i.e. *L. lithognathus, Lichia amia*); REI (River Estuary Interface) species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Retain species richness, abundance and density of bird counts of resident and migrant waders, gulls, terns, wading birds and waterfowl within 15 % of present state (2006).

Table 3-101 Supplementary information for Groot Brak estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G14-Groot Brak	III	Groot Brak	gxi5	K20A	EC: C %nMAR: 58.5	PES: D %nMAR: 53.79	EC: D %nMAR: 53.79	Motivation for achieving REC/TEC • The Groot Brak estuary is considered to be of "moderately" from a biodiversity conservation perspective (ranked 46 out of 273 estuaries in South Africa) but it has not been included on the list of existing or desired protected areas (Turpie et al. 2012). The system is nonetheless important both for biodiversity conservation and also from a socio-economic perspective – it is an important node for recreation, tourisms and contributes significantly to property value. It is important to maintain the system in a reasonable state of health and in state that is safe for contact recreation. The REC for the estuary is thus a C, two categories higher than present category (PES = E). At present, the system receives approximately 58.5% of its natural runoff, and it has been determined that water abstraction from this system cannot be reduced in future without compromising requirements for other users in this region (through use of alternative sources). The MAR for the Target Ecological Condition remains at 53.8% of natural for the TEC. The most important threats to the Groot Brak estuary include river flow reduction (due to the Wolwedans Dam), artificial breaching; deteriorating water quality; structures in the intertidal area, development on, and disturbance of, the saltmarshes; over-exploitation of fish and bait organism; disturbance of birds; obstruction of the estuary and river by causeways, weirs and the Wolwedans Dam. Since restoring flow to the system is not feasible, a concerted effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) will be required to address other threats to the estuary and to restore the health of the system to a reasonable state as required by the NWA. Additional (non-flow related) interventions to achieve the REC: • Remove or increase the width and height of the Charles Searle Bridge spans, and remove the causeway at the top of the estuary to permit increased tidal action, which would assist in maintaining open mouth conditions for longer periods. • Increase the breaching levels from 2.0 m to 2.2 m MSL as this would increase the maximum outflow by 20 - 30 % and assist in keeping the mouth open for longer periods. Higher breaching levels would also assist in flushing out more macroalgae and salt from the supratidal marshes. • Manage anthropogenic nutrient and organic matter inputs to the estuary. Inorganic nutrients (e.g. ammonia) can be introduced to the estuary directly from urban developments (e.g. malfunctioning septic tanks and runoff from golf courses) as well as inappropriate agricultural practices (e.g. effluents dairy farming). These nutrients can also be generated in situ through remineralisation (associated with increased accumulation of organic matter as a result of the marked reduction in flooding or "resetting" events). Sub-surface releases from the Wolwedans Dam can also contribute to elevated ammonia levels. Nutrient inputs can be managed by: ○ Improved agricultural practices that will reduce both inorganic nutrient and organic matter inputs to the system (e.g. artificial wetlands to trap nutrients before they reach the river); ○ improved urban development practices that will reduce both inorganic nutrient and organic matter inputs to the system, e.g. ensuring that septic tanks along the estuary function properly; ○ investigating the use of artificial wetlands to reduce nutrient loads entering the estuary from diffuse sources, e.g. golf courses; and ○ using only surface releases from the Wolwedans Dam (monitoring of nutrient profiles at 10 m intervals close to the dam wall can be used to establish appropriate release levels (i.e. to determine water depths at which ammonia levels are acceptable for release into the estuary). • Establish the present levels of toxic substances in the estuary, as well as the associated sources and if necessary, mitigate by employing improved urban development and agricultural practices. • Improving the health of the saltmarshes by limiting further development in the supratidal marsh, removing litter and preventing vehicles from driving on the saltmarshes.	DWAF (2008) Groot Brak RDM study

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
								• Restore/rehabilitate approximately nine ha of wetland area on the floodplain; rehabilitate the intertidal habitat in the upper reaches of the estuary and in the area between the upper causeway and the DWAF flow gauging weir. • Remove the recently established invasive alien plant Spartina alterniflora from the Groot Brak saltmarshes. This is the first record of this species in South Africa and it is a very aggressive invader that poses a serious threat to the biodiversity of all South African estuaries as it can spread very easily to adjacent systems. The removal of the invasive alien vegetation and rehabilitation of the upper reaches will provide important additional habitat for invertebrates and fish by increasing intertidal and refuge areas. • Improving the compliance monitoring of fishing and bait collection activities on the estuary. This will assist in controlling illegal harvesting of the estuarine living resources. At present recreational angling accounts for about 1 tonne and illegal gillnetting for an additional 1 tonne of fish annually. • Restrict bait collection when the mouth is closed since recruitment cannot occur during extended periods of mouth closure, which can lead to the depletion of important food resources in the estuary. • Install a fish ladder at the gauging weir and an eelway at the Wolwedans Dam to facilitate migration of fishes into the lower river reaches	

Table 3-102 RQOs and Numerical Limits for Blinde estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="14">G14 Groot-Brak</td><td rowspan="14">K10A</td><td rowspan="14">Blinde Estuary</td><td rowspan="14">gxi19</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as close to present as possible (small system needs most flows)</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>69.6</td><td>69.9</td><td>67.8</td><td>65.6</td><td>64.8</td><td>68.7</td><td>69.3</td><td>70.1</td><td>69.0</td><td>69.9</td><td>70.7</td><td>70.3</td><td>69.2</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">DIN not to exceed 100 µg/ℓ (average)</td></tr>
<tr><td>DIP</td><td colspan="14">DIP not to exceed 20 µg/ℓ (average)</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14"><20 (expected range 5-15)</td></tr>
<tr><td rowspan="2">System variables</td><td>Oxygen</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">>5 mg/l</td></tr>
<tr><td>Turbidity</td><td colspan="14">Turbidity not to exceed 10 NTU in low flow season</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass; phytoplankton not to exceed 3.5 µg/ℓ (median); phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain distribution of macrophyte habitats: Reeds & sedges: 0.04 ha, Sand/mud banks: 0.05 ha, Open water: 1.66 ha; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. Acacia spp.) in the riparian zone</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary; establish presence/absence of the copepod Pseudodiaptomus hessei or estuarine congeneric in the zooplankton of the estuary; populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-103 Supplementary information for Blinde estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G14-Groot Brak	III	Blinde	gxi19	K10A	B	PES: B %nMAR: 98.0	EC: C %nMAR: 68.8	Motivation for achieving REC/TEC • The Blinde estuary is considered to be of “low importance” from a biodiversity conservation perspective (ranked 216 out of 273 estuaries in South Africa) and has not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is the same as PES – i.e. B category. Demands for freshwater in the Mossel Bay area require that the MAR for this system be dropped to 68.8 which is expected to reduce the health of the system to a C category. The most important threats to the Blinde estuary is naturally freshwater deprivation which is likely to cause serious changes in mouth condition (the mouth is likely to close much more frequently than it does at present and will remain closed for much longer periods). Water quality in the system is also likely to deteriorate, especially oxygen and micro- and macro-algae are likely to proliferate in the system. Concerted effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) is required to minimise future reductions in freshwater flow to this estuary and to mitigate the negative consequences of this reduction. Additional (non-flow related) interventions to achieve the REC: • Reduced water quality as a result of industrial activities in the catchment; • Flow modification (high and low flows reduced), with a related shift in the onset of the high flow period and increase in the duration of the low flow period; and • Limited bait collection and fishing.	DWS (2015) Desktop Assessment of Estuaries in the Gouritz WMA

Table 3-104 RQOs and Numerical Limits for Tweekuilen estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G14 Groot-Brak	K10A	Tweekuilen Estuary	gxi20	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime as close to present as possible (small system needs most flows)	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3, 72.3
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not to exceed 100 µg/ℓ (average)
						DIP		DIP not to exceed 20 µg/ℓ (average)
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	<20 (expected range 5-15)
					System variables	Oxygen	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	>5 mg/l
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats: Reeds & sedges: 0.04 ha, Sand/mud banks: 0.05 ha, Open water: 1.66 ha; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. *Acacia* spp.) in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn *Callichirus kraussi* on sand banks in lower estuary; establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary; populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-105 Supplementary information for Tweekuilen estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G14-Groot Brak	III	Tweekuilen	gxi20	K10A	EC: C %nMAR: 65.3	PES: D %nMAR: 96.1	EC: C %nMAR: 72.3	Motivation for achieving REC/TEC • The Tweekuilen estuary is considered to be of "low importance" from a biodiversity conservation perspective (not formally ranked) and is not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is one level higher than the PES – i.e. C category. Present day flows are considerably higher than those required to maintain the estuary in a C category (96.1 vs. 65.3% nMAR), thus provision has been made for use of a greater amount for water from this system (TEC = 72.3% nMAR). The most important threats to the Tweenkuilen estuary include freshwater deprivation and impaired water quality (due to stormwater inputs). These issues need to be address in order to improve the health of this system to a C category. Additional (non-flow related) interventions to achieve the REC: • Clear alien vegetation from the catchment	No RDM study has been completed for the Tweekuilen estuary, thus Ecospecs for this system were derived from those for the Blinde and Hartenbos systems.

Table 3-106 RQOs and Numerical Limits for Gericke estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="13">G14 Groot-Brak</td><td rowspan="13">K10A</td><td rowspan="13">Gericke Estuary</td><td rowspan="13">gxi21</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as close to present as possible (small system needs most flows)</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td><td>72.3</td></tr>
<tr><td rowspan="6">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">DIN not to exceed 100 µg/ℓ (average)</td></tr>
<tr><td>DIP</td><td colspan="14">DIP not to exceed 20 µg/ℓ (average)</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14"><20 (expected range 5-15)</td></tr>
<tr><td>System variables</td><td>Oxygen</td><td>System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">>5 mg/l</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain distribution of macrophyte habitats: Reeds & sedges: 0.04 ha, Sand/mud banks: 0.05 ha, Open water: 1.66 ha; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. Acacia spp.) in the riparian zone</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary; establish presence/absence of the copepod Pseudodiaptomus hessei or estuarine congeneric in the zooplankton of the estuary; populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-107 Supplementary information for Gericke estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G14-Groot Brak	III	Gericke	gxi21	K10A	EC: C %nMAR: 65.3	PES: D %nMAR: 96.1	EC: C %nMAR: 72.3	Motivation for achieving REC/TEC • The Gericke estuary is considered to be of “low importance” from a biodiversity conservation perspective (not formally ranked) and is not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is one level higher than the PES – i.e. C category. Present day flows are higher than those required to maintain the estuary in a C category (96.2 vs. 65.3% nMAR), thus provision has been made for use of a greater amount for water from this system (TEC = 72.3% nMAR). The most important threats to the Tweenkuilen estuary include freshwater deprivation and impaired water quality (due to stormwater inputs). These issues need to be address in order to improve the health of this system to a C category Additional (non-flow related) interventions to achieve the REC: • Clear alien vegetation from the catchment	No RDM study has been completed for the Gericke estuary, thus Ecospecs for this system were derived from those for the Blinde and Hartenbos systems.

Table 3-108 RQOs and Numerical Limits for Hartenbos estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="15">G14 Groot-Brak</td><td rowspan="15">K10B</td><td rowspan="15">Hartenbos Estuary</td><td rowspan="15">gxi22</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain at least present-day base flows</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>59.7</td><td>64.0</td><td>68.7</td><td>71.1</td><td>67.4</td><td>60.3</td><td>64.2</td><td>64.7</td><td>65.9</td><td>60.8</td><td>66.1</td><td>66.9</td><td>65.0</td></tr>
<tr><td rowspan="8">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">Entire estuary and river inflow: DIN <200µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">Entire estuary and river inflow: DIP <50 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Average salinity along the estuary should not drop more than 5 below baseline average</td></tr>
<tr><td rowspan="3">System variables</td><td>Turbidity</td><td rowspan="3">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Turbidity <20 NTU in low flow season</td></tr>
<tr><td>Secchi depth</td><td colspan="14">Secchi depth should >0.5 m in the fresher part of the estuary</td></tr>
<tr><td>Oxygen</td><td colspan="14">>5 mg/l</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: Phytoplankton not to exceed 8 µg/ℓ (median), Phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); Benthic microalgae not to exceed 42 mg/m² (median), Dinoflagellates, chlorophytes and/or cyanobacteria > 10% of relative abundance</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain distribution of macrophyte habitats; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. Acacia spp.) in the riparian zone</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod Pseudodiaptomus hessei or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-109 Supplementary information for Hartenbos estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G14-Groot Brak	III	Hartenbos	gxi22	K10B	EC: C %nMAR: 64.3	PES: D %nMAR: 65.0	EC: C %nMAR: 80.7	Motivation for achieving REC/TEC • The Hartenbos estuary is considered to be of "average importance" from a biodiversity conservation perspective (ranked 75 out of 273 estuaries in South Africa) and has not been included on the list of existing or desired protected areas (Turpie et al. 2012). The system is nonetheless important from a socio-economic perspective – it is an important node for recreation, tourisms and contributes significantly to property value. It is important to maintain the system in a reasonable state of health and in state that is safe for contact recreation. The REC for the estuary is thus a C, one category higher than present category. It has been determined that water abstraction from this system can be greatly reduced in future without compromising requirements for other users in this region (through use of alternative sources). The MAR for the Target Ecological Condition is thus 80.7% of natural. The most important threats to the Hartenbos estuary include freshwater deprivation (due to abstractions from the Hartbeeskuil Dam, for agricultural and domestic use), sedimentation (due to reduced flow and concomitant changes in mouth dynamics) and impaired water quality (due to agricultural return flows and poor quality of stormwater from informal settlements). Restoration of flow will go a long way towards improving the health of this system, however, concerted effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) is still required to address other threats to the estuary in accordance with the Ecological Specifications included in the table above. Additional (non-flow related) interventions to achieve the REC: • Dam construction has resulted in a reduction in base flow and floods to the system, with a shift in the onset of the high flow period and an increase in the duration of the low flow period; • Artificial breaching; • Loss of tidal flows and habitat as result of bridge construction (e.g. old N2, railway bridge); • Infilling of estuary channel and mouth area as a result of loss of floods and artificial breaching; • A significant reduction in water quality as a result of the Mossel Bay WWTW discharge and urban runoff; • Development in the EFZ; • Alien vegetation; • Limited bait collection and fishing effort; and • Human disturbance (which influences bird abundance).	DWS (2015) Desktop Assessment of Estuaries in the Gouritz WMA

3.2.2.5 Estuary's priority RUs in Coastal IUA

Table 3-110 RQOs and Numerical Limits for Maalgate estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="15">G15 Coastal</td><td rowspan="15">K30A</td><td rowspan="15">Maalgate Estuary</td><td rowspan="15">gxi6</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime (small system needs most flows)</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>80.3</td><td>79.1</td><td>74.5</td><td>73.4</td><td>71.3</td><td>80.5</td><td>82.1</td><td>82.7</td><td>85.9</td><td>84.3</td><td>83.7</td><td>81.9</td><td>79.3</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">Entire estuary and river inflow: DIN <100µg/ℓ</td></tr>
<tr><td>DIP</td><td colspan="14">Entire estuary and river inflow: DIP <20 µg/ℓ</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Average salinity >10</td></tr>
<tr><td rowspan="2">System variables</td><td>Turbidity</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14"><10 NTU in low flow season</td></tr>
<tr><td>Oxygen</td><td colspan="14">>5 mg/l</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain distribution of macrophyte habitats; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. Acacia spp.) in the riparian zone</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod Pseudodiaptomus hessei or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-111 Supplementary information for Maalgate estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Maalgate	Gxi6	K30A	EC: B %nMAR: 96.3	PES: B %nMAR: 96.3	EC: B %nMAR: 80.0	Motivation for achieving REC/TEC • The Maalgate estuary is considered to be of “low to average importance” from a biodiversity conservation perspective (ranked 172 out of 273 estuaries in South Africa) and is not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is one level higher than the PES – i.e. C category. Present day flows are higher than those required to maintain the estuary in a C category (96.2 vs. 65.3% nMAR), thus provision has been made for use of a greater amount for water from this system (TEC = 72.3% nMAR). The most important threats to the Tweenkuilen estuary include freshwater deprivation and impaired water quality (due to stormwater inputs). These issues need to be address in order to improve the health of this system to a C category.	

Table 3-112 RQOs and Numerical Limits for Gwaing estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K30B	Gwaing Estuary	gxi7	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime (small system needs most flows)	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 84.9, 84.3, 82.8, 83.0, 81.6, 84.8, 86.3, 87.0, 89.1, 87.8, 86.8, 86.1, 85.0
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <100µg/ℓ
						DIP		Entire estuary and river inflow: DIP <20 µg/ℓ
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Average salinity >10
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	<10 NTU in low flow season
						Oxygen		>5 mg/l
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment	Closed mouth state should not increase by >10% from established baseline
					Sediment	Sediment characteristics, Channel shape/size	Flood regime to maintain natural bathymetry and the sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. *Acacia* spp.) in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-113 Supplementary information for Gwaing estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Gwaing	Gxi7	K30B	EC: B %nMAR: 98.7	PES: B %nMAR: 98.7	EC: B %nMAR: 85.4	Motivation for achieving REC/TEC • The Gwaing estuary is considered to be of "low importance" from a biodiversity conservation perspective (ranked 254 out of 273 estuaries in South Africa) and is not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is the same as the PES – i.e. B category. Present day flows are higher than those required to maintain the estuary in a B category (98.7 vs. 85.4% nMAR), thus provision has been made for use of a greater amount for water from this system (TEC = 85.4% nMAR). The most important threats to the Gwaing estuary include freshwater deprivation, impaired water quality and disturbance from recreational use. These issues need to be addressed in order to maintain the current health status of the system in the face of reduced freshwater inflow. Additional (non-flow related) interventions to achieve the TEC: • Eliminate wastewater discharges to the estuary • Clear alien vegetation from the catchment	DWA (2008) Desktop assessment of estuaries in the Tsitsikamma region

Table 3-114 RQOs and Numerical Limits for Kaaimans estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K30C	Kaaimans Estuary	gxi8	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime (small system needs most flows)	Months / MMR/MAR (% Nat): Oct 70.9 Nov 74.5 Dec 74.7 Jan 70.7 Feb 70.4 Mar 72.8 Apr 72.3 May 73.7 Jun 69.5 Jul 67.3 Aug 74.1 Sep 73.8 Annual 72.5
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Entire estuary and river inflow: DIN <100µg/ℓ
						DIP		Entire estuary and river inflow: DIP <20 µg/ℓ
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Average salinity >10
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	<10 NTU in low flow season
						Oxygen		>5 mg/l
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Estuary mouth permanently open
						Tidal variation		Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats; prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. *Acacia* spp.) in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-115 Supplementary information for Kaaimans estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Kaaimans	gvii11	K30C	EC: B %nMAR: 72.3	PES: B %nMAR: 72.3	EC: B %nMAR: 72.1	Motivation for achieving REC/TEC • The Kaaimans estuary is considered to be of “low to average importance” from a biodiversity conservation perspective (ranked 210 out of 273 estuaries in South Africa) and is not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC and TEC for the estuary is the same as the PES – i.e. B category. Flows will remain the same as for present. The most important threats to the Tweenkuilen estuary include freshwater deprivation and impaired water quality (due to stormwater inputs). These issues need to be addressed in order to maintain the health of this system in a B category.	DWA (2008) Desktop assessment of estuaries in the Tsitsikamma region

Table 3-116 RQOs and Numerical Limits for Wilderness (Touw) estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
G15 Coastal	K30D	Wilderness Estuary	gxi9	Quantity	Flow	MMR/MAR (% Nat)	Maintain a flow regime to maintain water quality and the required habitat for birds, fish, macrophyes and macrophytes. Abstraction should not result in flow differing more than 5% from the present day (2017) keeping in mind the percentage nMAR to be maintained in the system (88.6%) to keep it in its ecological category.	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	89.7	90.9	87.2	84.5	83.5	85.5	86.9	90.8	88.7	88.1	93.1	92.8	88.6
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	River inflow, NOx-N not to exceed 50 µg/ℓ over two consecutive months, NH3-N not to exceed 10 µg/ℓ over two consecutive months; Estuary: Average NOx-N <50 µg/ℓ, no single measure >100 µg/ℓ, average NH3-N <10 µg/ℓ, no single measure >100 µg/ℓ; Lakes: average NOx-N <50 µg/ℓ, no single measure >100 µg/ℓ, average NH3-N <20 µg/ℓ													
						DIP		River inflow, PO4-P not to exceed 10 µg/ℓ over two consecutive months; Estuary: average PO4-P <10 µg/ℓ, no single sample >50 µg/ℓ; Lakes: average PO4-P <20 µg/ℓ													
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Estuary in the closed state: average salinity in Zone A < 12, average salinity in Zone B: < 10, average salinity in Zone C < 5; Lakes average salinity +2 from baseline (2013) and variability should not increase as below: Serpentine: 12 ± 10, Eilandvlei: 8 ± 5, Langvlei: 10 ±4, Rondevlei: 11 ± 6													
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Average <5 NTU (low flow) throughout													
						Oxygen		>5 mg/l throughout													
						pH		River inflow: 6.0 < pH < 7.0 (Touw), 7.0 < pH < 8.0 (Duiwe), Estuary: 7.0 < pH < 8.5, Lakes: 7.5 < pH < 9													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m^2 (median); prevent formation of phytoplankton blooms caused by anthropogenic eutrophication
					Macrophytes	Extent, distribution and richness of macrophytes	Have no further loss to extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Have no further loss to the present area (2014) covered by the macrophyte habitats; have no further loss to the distribution of sensitive macrophyte habitats (e.g. salt marsh, submerged macrophytes); control/eliminate invasive plants; prevent the spread of reeds into open water that results in loss of sandbank areas and has a negative impact on biota and hydrological processes
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain presence of sand prawn Callichirus kraussi on sand banks in lower Touw Estuary; maintain rich populations of the benthic amphipod *Grandidierella lignorum* throughout the lakes and estuary
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuarine lake system should contain a diverse avifaunal community that includes representatives of all the original groups, and that sustains the populations that meet RAMSAR requirements; numbers of waterbirds on the entire system, other than those that have or are increasing regionally such as Egyptian Goose, should not drop below 40 species or below 3000 birds for three consecutive counts

Table 3-117 Supplementary information for Wilderness estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Wilderness	gxi9	K30D	EC: A %nMAR: 88.5	PES: B %nMAR: 88.5	EC: B %nMAR: 88.5	Motivation for achieving REC/TEC • The Wilderness estuary is "highly important" from a biodiversity conservation perspective (ranked 27 out of 273 estuaries in South Africa) and has been included on the list of existing or desired protected areas (Turpie et al. 2012). This estuary is also very important nursery for collapsed and endangered fish species plays an important role as a waypoint/refuge area for fish along a coast that is known for extreme upwelling events that can cause fish kills. Further, the Wilderness Estuarine System is part of the Garden Route National Park and contributes significantly towards South Africa's overall estuarine biodiversity targets. The system is also very important from a socio-economic perspective – it is an important node for recreation, tourisms and contributes significantly to property value. It is important to maintain the system in a good state of health and in state that is safe for contact recreation. The REC for the estuary is thus an A, one category higher than present. It has been determined that restoration of flow alone cannot restore the health of the estuary to an A category and that other non-flow related issues need to be addressed to achieve this. Thus, the % nMAR for the TEC has been retained at 88.35%. The most important non-flow related threats to the Wilderness estuary include artificial manipulation of the mouth, barriers to movement of water and fauna between the different parts of the system and the presence of alien fish species in the system. Concerted effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) is thus required to address these threats to the estuary in accordance with the Ecological Specifications included below. Additional (non-flow related) interventions to achieve the REC: • Increase breaching level, at least to +2.9 m MSL (currently the system is breached between 2.1-2.4 m MSL). These higher levels match levels experienced during the 2007 and 2011 floods. If the system can be breached at these higher water levels, more sediment will be removed and the system will remain open to the sea for longer periods. • Interim management measures should be considered to improved connectivity (interlinking channels) between the estuary and lakes, e.g. harvesting excessive macrophyte growth • Terminate ad hoc riparian protection practices along the banks of the estuary and the lakes and consider developing strategic guidelines for bank protection that will be more appropriate for this system.	DWS (2015) Rapid RDM assessment of the Wilderness system

Table 3-118 RQOs and Numerical Limits for Swartvlei estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
G15 Coastal	K40D	Swartvlei Estuary	gxi10	Quantity	Flow	MMR/MAR (% Nat)	Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
								MMR/MAR (% Nat)	89.5	87.6	80.9	78.7	81.3	86.8	86.8	88.5	85.9	88.4	90.9	90.2	86.6
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	River inflow, NOx-N not to exceed 50 µg/ℓ over two consecutive months, NH_3-N not to exceed 10 µg/ℓ over two consecutive months; Estuary: Average NOx-N <50 µg/ℓ, no single measure >100 µg/ℓ, average NH_3-N <10 µg/ℓ, no single measure >100 µg/ℓ; Lake: average NO_x-N <50 µg/ℓ, no single measure >100 µg/ℓ, average NH_3-N <20 µg/ℓ													
						DIP		River inflow, PO_4-P not to exceed 10 µg/ℓ over two consecutive months; Estuary: average PO_4-P <10 µg/ℓ, no single sample >50 µg/ℓ; Lakes: average PO_4-P <20 µg/ℓ													
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Estuary in the closed state: average salinity <12; Lake average salinity +2 from baseline (2013)													
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Average <5 NTU (low flow) throughout													
						Oxygen		>5 mg/l throughout													
						pH		River inflow: 6.0 < pH < 7.0, Estuary: 6.0 < pH < 8.5, Lake: 7.0 < pH < 8.5													
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)													
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)													
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline													
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms													

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Macrophytes	Extent, distribution and richness of macrophytes	No further loss to extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	No further loss to the present area (2014) covered by the macrophyte habitats; no further loss to the distribution of sensitive macrophyte habitats (e.g. salt marsh, submerged macrophytes); control/eliminate invasive plants; prevent the spread of reeds into open water that results in loss of sandbank areas and has a negative impact on biota and hydrological processes
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain presence of sand prawn *Callichirus kraussi* on sand banks in lower Touw Estuary; maintain rich populations of the benthic amphipod *Grandidierella lignorum* throughout the lakes and estuary
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	The estuarine lake system should contain a diverse avifaunal community that includes representatives of all the original groups, and that sustains the populations for which the system has acquired Ramsar status; numbers of waterbirds on the entire system, other than those that have or are increasing regionally such as Egyptian Goose, should not drop below 40 species or below 1500 birds for three consecutive counts

Table 3-119 Supplementary information for Swartvlei estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Swartvlei	gxi10	K40D	EC: B %nMAR: 90.9	PES: B %nMAR: 90.9	EC: B %nMAR: 77.8	Motivation for achieving REC/TEC • The Swartvlei estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 7th out of 273 estuaries in South Africa), and is included in the Garden Route National Park MPA. The REC, PES and TEC for the system are all the same (B category), however future demands for freshwater in the Swartvlei catchment mean that flows are likely to drop slightly in future (from 90.9 to 77.8% of natural) and that thus there is a very real threat that the health of this system may decline in future. Thus, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in a B category. Key threats to the system include reduction in freshwater runoff (due to afforestation and alien invasive plants), loss of connectivity in the system, sedimentation, loss and degradation of floodplain habitats, overfishing, impaired water quality and disturbance caused by recreational activities. Additional (non-flow related) interventions to achieve the REC: • To achieve and maintain the REC, the mouth must be allowed to remain closed up 3.5 m above MSL. This is difficult due to housing developments at elevations lower than 3.5 m MSL, thus a compromise as close to 3.5 m MLS must be agreed with all stakeholders. • In addition, barriers to flow and movement of fauna in the system should be eliminated as far as possible. This includes eliminating or at least reducing blockages caused by the N2 and railway line that extend right cross the estuary • Strict control should be maintained over recreational activities on the estuary to ensure that these do not impact negatively on sensitive fauna such as water fowl.	DWA (2009) RDM report for the Swartvlei estuary

Table 3-120 RQOs and Numerical Limits for Goukamma estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K40E	Goukamma Estuary	gxi11	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 87.5, 88.8, 87.5, 85.7, 85.5, 87.1, 86.9, 88.2, 87.2, 86.5, 88.5, 88.3, 87.5
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not >100 µg/L once-off.
						DIP		DIP not > 20 µg/L once-off.
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	Turbidity >10 NTU in low flow
						Oxygen		>5 mg/L in estuary.
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Estuary mouth permanently open
						Tidal variation		Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain median phytoplankton/benthic microalgae biomass: phytoplankton not > 1.0 µg/L (median)., benthic microalgae not > 11 mg/m² (median); Phytoplankton not > 20 µg/L and/or cell density not >10 000 cells/ml (once-off); Prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats; prevent the spread of invasive trees (e.g. *Acacia* spp.) in the riparian zone.
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-121 Supplementary information for Goukamma estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Goukamma	gxi11	K40E	EC: A %nMAR: 92.8	PES: B %nMAR: 87.4	EC: B %nMAR: 87.3	Motivation for achieving REC/TEC • The Goukamma estuary is "highly important" from a biodiversity conservation perspective (ranked 59 out of 273 estuaries in South Africa), is located in a Provincial Nature Reserve (Goukamma Nature Reserve) and thus makes an important contribution to conservation of estuarine biodiversity in South Africa (Turpie et al. 2012). This estuary is also very important nursery for collapsed and endangered fish species, e.g. dusky cob and white Steenbras and plays an important role as a waypoint/refuge area for fish along a coast that is known for extreme upwelling events that can cause fish kills. The estuary is also an important node for recreation and tourisms. It is important to maintain the system in a good state of health and in state that is safe for contact recreation. The REC for the estuary is thus an A, one category higher than present (B). It has been determined that restoration of flow alone cannot restore the health of the estuary to an A category and that other non-flow related issues need to be addressed to achieve this. Thus, the % nMAR for the TEC has been retained at 87.3%. The most important non-flow related threats to the Goukamma estuary include freshwater deprivation and impaired water quality caused by nutrient rich agricultural return flows. Concerted effort on the part of DWS and other stakeholders (SANParks in particular but also other local, provincial and other national government agencies) is thus required to address these threats to the estuary in accordance with the Ecological Specifications included below. Additional (non-flow related) interventions to achieve the REC: • reduction in nutrient input; • removal of the upstream weirs; and • relocation of Buffelsbaai road	DWAF (2008) RDM report for the Goukamma estuary

Table 3-122 RQOs and Numerical Limits for Knysna estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="14">G15 Coastal</td><td rowspan="14">K50B</td><td rowspan="14">Knysna Estuary</td><td rowspan="14">gxi12</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as close to natural as possible</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>87.5</td><td>87.6</td><td>82.7</td><td>83.9</td><td>86.1</td><td>82.5</td><td>84.7</td><td>87.1</td><td>87.5</td><td>86.8</td><td>88.3</td><td>90.5</td><td>86.8</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">DIN not >100 µg/L once-off.</td></tr>
<tr><td>DIP</td><td colspan="14">DIP not > 20 µg/L once-off.</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14"></td></tr>
<tr><td rowspan="2">System variables</td><td>Turbidity</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">Turbidity >10 NTU in low flow</td></tr>
<tr><td>Oxygen</td><td colspan="14">>5 mg/L in estuary.</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td rowspan="2">Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td colspan="14">Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="2">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m^2 (median); prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>No further loss to extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">No further loss to the present area (2014) covered by the macrophyte habitats; no further loss to the distribution of sensitive macrophyte habitats (e.g. salt marsh, submerged macrophytes); control/eliminate invasive plants</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zones A and B); mudprawn density should not deviate from average baseline levels by more than 25% in each season; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); the dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (*A.japonicus, L. lithognathus, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Estuary should contain a diverse avifaunal community that includes representatives of all the original groups. Saltmarsh/wetlands in the floodplain should be rich in birdlife. Intertidal areas should have a good density and diversity of both larger and smaller waders; numbers of waterbirds on the entire system should not drop below 35 species or below 2000 birds for three consecutive counts;

Table 3-123 Supplementary information for Knysna estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Knysna	gxi12	K50B	EC: B %nMAR: 95.0	PES: B %nMAR: 95.0	EC: B/C %nMAR: 76.3	Motivation for achieving REC/TEC • The Knysna estuary is rated as "highly important" from a biodiversity conservation perspective (ranked 1st out of 273 estuaries in South Africa), and is located within the Garden Route National Park (Turpie *et al*. 2012). The Knysna estuary is an extremely important nursery area for exploited fish stocks (e.g. white Steenbras), as well as catchment flows to the marine environment (sediment and detritus) and coastal connectivity (e.g. way point for fish. The REC for the estuary is a B category, but future demands for freshwater in the Knysna catchment (mainly for domestic use) mean that this is likely to drop significantly in future (from 95.0 to 76.3% of natural) and that thus there is a very real threat that the health of this system may decline in future (TEC has been set at a B/C category but this may not be realistic). Thus, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in a B category. Key threats to the system include reduction in freshwater runoff, sedimentation, habitat modification (loss and degradation of floodplain habitats), illegal fishing, impaired water quality (as a result of stormwater and WWTW inflow), barriers to flow and movement of fauna in the system and disturbance form recreational activities. Additional (non-flow related) interventions to achieve the REC: • Fishing and bait collecting: Fishing and bait collecting have a significant impact on the trophic functioning of the estuary. As a protected environment it is recommended that stringent policies be developed and implemented to reduce the impact of these extractive activities. • Boating and Disturbance: Boating and other activities have a significant impact on the bird populations on the estuary. A rigorously enforced disturbance and boating plan needs to be implemented. • Water quality: Water quality in the estuary needs to be improved and all point and diffuse sources identified and managed. The lower reaches around the Ashmead channel need specific attention. WWTP needs to function within relevant parameters, which is not currently the case. Undesirable catchment management activities result in negative impacts downstream and need to be responsibly managed. • Urban encroachment: Policies around urban encroachment and the impact that this has on supratidal and salt marsh vegetation need to be rigorously enforced. • Red data species: The Estuary Management plan needs to take special cognisance of species such as the Knysna Sea horse. • REI: The further abstraction of freshwater from the Knysna catchment will mainly impact on the upper reaches of the estuary above the N2 bridge. The most significant impacts will be felt in the River Estuary Interface (REI) Zone above the Red Bridge. It is imperative that this area be given priority to reduce any non-flow drivers of change. It is recommended that above the Red Bridge all extractive activities be excluded, no power boating of any sort be allowed, no dogs be allowed, strict setback lines for development are enforced, septic tanks and any point or diffuse water sources be monitored, and all alien vegetation be removed.	DWAF (2009) Ecological Water Requirements Study: Knysna Estuary

Table 3-124 RQOs and Numerical Limits for Noetsie estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="17">G15 Coastal</td><td rowspan="17">K60G</td><td rowspan="17">Noetsie Estuary</td><td rowspan="17">gxi13</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime (small system needs most flows)</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>93.5</td><td>93.4</td><td>90.7</td><td>87.1</td><td>85.5</td><td>89.8</td><td>92.1</td><td>94.0</td><td>93.0</td><td>92.8</td><td>94.3</td><td>94.3</td><td>92.5</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">DIN not >100 µg/L once-off.</td></tr>
<tr><td>DIP</td><td colspan="14">DIP not > 20 µg/L once-off.</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">10 < Salinity <40</td></tr>
<tr><td rowspan="2">System variables</td><td>Turbidity</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">>10 NTU in low flow</td></tr>
<tr><td>Oxygen</td><td colspan="14">>5 mg/L in estuary.</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain median phytoplankton/benthic microalgae biomass: phytoplankton not > 1.0 µg/L (median)., benthic microalgae not > 11 mg/m² (median); Phytoplankton not > 20 µg/L and/or cell density not >10 000 cells/ml (once-off); Prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain distribution of macrophyte habitats; prevent an increase in nutrient input leading to macroalgal blooms; control the spread of invasive plants in the riparian zone</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod Pseudodiaptomus hessei or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-125 Supplementary information for Noetsie estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	TEC	Context of the RQO	References
G15-Coastal	II	Noetsie	gxi13	K60G	EC: A %nMAR: 91.7	PES: B %nMAR: 91.7	EC: C %nMAR: 65.1	Motivation for achieving REC/TEC • The Noetsie estuary is considered to be of “low to average importance” from a biodiversity conservation perspective (ranked 209 out of 273 estuaries in South Africa) but it is located in the Garden Route National Park. The REC for the estuary (A category) is one level higher than the PES (B category). However, flows that have been allocated to the estuary are only sufficient to maintain this system in a C category. The most important threats to the Noetsie estuary include freshwater deprivation and disruption of natural mouth dynamics (access to properties at Noetsie is via the beach and across the mouth of the estuary). These issues need to be address in order to improve the health of this system to the REC. Additional (non-flow related) interventions to achieve the TEC • access to properties at Noetsie is via the beach and across the mouth of the estuary which is negatively impacting on mouth dynamics	DWA (2008) Desktop assessment of estuaries in the Tsitsikamma region

Table 3-126 RQOs and Numerical Limits for Piesang estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="14">G15 Coastal</td><td rowspan="14">K60G</td><td rowspan="14">Piesang Estuary</td><td rowspan="14">gxi14</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain at least present-day base flows</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>71.4</td><td>77.2</td><td>69.5</td><td>68.8</td><td>63.6</td><td>69.2</td><td>70.9</td><td>81.5</td><td>68.1</td><td>66.8</td><td>74.7</td><td>86.1</td><td>73.8</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">DIN not >100 µg/L once-off.</td></tr>
<tr><td>DIP</td><td colspan="14">DIP not > 20 µg/L once-off.</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">5 < Salinity <40</td></tr>
<tr><td rowspan="2">System variables</td><td>Turbidity</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">>10 NTU in low flow</td></tr>
<tr><td>Oxygen</td><td colspan="14">>5 mg/L in estuary.</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="2">Habitat</td><td>Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Closed mouth state should not increase by >10% from established baseline</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="3">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain distribution of macrophyte habitats (reeds and sedges currently cover 3.14 ha, submerged macrophytes and salt marsh present); prevent the spread of reeds into open water; prevent an increase in nutrients and macroalgal blooms; prevent the spread of invasive trees (e.g. Acacia spp.) in the riparian zone</td></tr>
<tr><td>Invertebrates</td><td>Macrofauna community composition, abundance and richness</td><td>Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton</td><td colspan="14">Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod Pseudodiaptomus hessei or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-127 Supplementary information for Piesang estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Piesang	gxi14	K60G	EC: B %nMAR: 91.7	PES: C %nMAR: 72.5	EC: C %nMAR: 72.3	Motivation for achieving REC/TEC • The Piesang estuary is rated as "moderate important" from a biodiversity conservation perspective (ranked 62nd out of 273 estuaries in South Africa), and has been designated as a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment (Turpie *et al*. 2012). The estuary also supports a high diversity of fish and is considered to be an important nursery area for marine fish species in spite of its small size. The REC for the estuary is an B, however, water required to achieve this state (91.7% of natural) is simply not available and thus TEC has been set as a C. Major pressures on the system include freshwater deprivation, artificial breaching at low berm height levels, impaired water quality (resulting from industrial and stormwater runoff), loss of estuarine habitat from development around the estuary margins, and a desalination plant that is abstracting water from boreholes in the estuary. These issues all need to be addressed through joint effort on the part of DWS and other stakeholders (local, provincial and other national government agencies) in accordance with the Ecological Specifications included below. Some improvements in flow can be achieved through elimination of illegal abstractions in the lower catchment. Additional (non-flow related) interventions to achieve the REC: • restored base flows to the system; • Elimination of direct abstraction of water from the mouth region for the reverse osmosis plant causing increased mouth closure and low water levels; • Improvement in water quality (impacted by urban runoff); • Controlling fishing effort; and • Minimising human disturbance (which influences bird abundance).	DWS (2015) Desktop Assessment of Estuaries in the Gouritz WMA

Table 3-128 RQOs and Numerical Limits for Keurbooms estuary

<table>
<tr><th>IUA</th><th>Quat #</th><th>Estuary</th><th>Node</th><th>Component</th><th>Sub-component</th><th>Indicator</th><th>RQO Narrative</th><th colspan="14">RQO Numeric</th></tr>
<tr><td rowspan="14">G15 Coastal</td><td rowspan="14">K60G</td><td rowspan="14">Keurbooms Estuary</td><td rowspan="14">gxi15</td><td rowspan="2">Quantity</td><td rowspan="2">Flow</td><td rowspan="2">MMR/MAR (% Nat)</td><td rowspan="2">Maintain flow regime as close to natural as possible</td><td>Months</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Annual</td></tr>
<tr><td>MMR/MAR (% Nat)</td><td>90.6</td><td>90.5</td><td>88.8</td><td>85.3</td><td>83.0</td><td>85.5</td><td>89.3</td><td>92.0</td><td>92.3</td><td>91.8</td><td>92.8</td><td>91.8</td><td>90.0</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td>DIN</td><td rowspan="2">Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae</td><td colspan="14">DIN not >100 µg/L once-off.</td></tr>
<tr><td>DIP</td><td colspan="14">DIP not >20 µg/L once-off.</td></tr>
<tr><td>Salinity</td><td>Salinity</td><td>Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae</td><td colspan="14">Average salinity >10 at the top of the estuary in the Keurbooms and/or Bitou Arm, average salinity >20 along the length of the system</td></tr>
<tr><td rowspan="2">System variables</td><td>Turbidity</td><td rowspan="2">System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota</td><td colspan="14">>10 NTU in low flow</td></tr>
<tr><td>Oxygen</td><td colspan="14">>5 mg/L in estuary.</td></tr>
<tr><td rowspan="2">Pathogens</td><td>Enterococci</td><td rowspan="2">Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation</td><td colspan="14">≤185 Enterococci/100 ml) (90th percentile)</td></tr>
<tr><td>Escherichia coli</td><td colspan="14">≤500 E. coli/100 ml (90th percentile)</td></tr>
<tr><td rowspan="3">Habitat</td><td rowspan="2">Hydrodynamics</td><td>Mouth state</td><td>Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary</td><td colspan="14">Estuary mouth permanently open</td></tr>
<tr><td>Tidal variation</td><td>Flood regime is sufficient to maintain natural bathymetry and sediment characteristics</td><td colspan="14">Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.</td></tr>
<tr><td>Sediment</td><td>Sediment characteristics, Channel shape/size</td><td>Flood regime to maintain natural bathymetry and the sediment characteristics</td><td colspan="14">Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline</td></tr>
<tr><td rowspan="2">Biota</td><td>Microalgae</td><td>Biomass and community composition of phytoplankton and benthic microalgae community</td><td>Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass</td><td colspan="14">Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms</td></tr>
<tr><td>Macrophytes</td><td>Extent, distribution and richness of macrophytes</td><td>Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species</td><td colspan="14">Maintain the distribution of sensitive macrophyte habitats (e.g. salt marsh, submerged macrophytes, reeds and sedges) (of special importance are the submerged macrophytes in the Bitou Arms as habitat for the endangered seahorses H. capensis); rehabilitate the Bitou wetlands by removing weirs, berms, old bridges; limit the spread of invasive plants; maintain the integrity of the riparian zone</td></tr>
</table>

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain high biomass and diversity of benthic invertebrates in the lagoon area in the lower estuary; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos).
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-129 Supplementary information for Keurbooms estuary RQOs

<table>
<tr><th>IUA</th><th>Class</th><th>Estuary</th><th>Node</th><th>Quat.</th><th>REC</th><th>Current</th><th>Target</th><th>Context of the RQO</th><th>References</th></tr>
<tr><td>G15-Coastal</td><td>II</td><td>Keurbooms</td><td>gxi15</td><td>K60G</td><td>EC: A
%nMAR: 87.3</td><td>PES: A
%nMAR: 87.3</td><td>EC: A/B
%nMAR: 77.32</td><td>Motivation for achieving REC/TEC
• The Keurbooms estuary is rated as “highly important” from a biodiversity conservation perspective (ranked 18 out of 273 estuaries in South Africa), and has been designated as a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment (Turpie et al. 2012). The PES, REC and TEC for the estuary are all A/B category, but future demands for freshwater in the Keurbooms catchment (mainly for domestic use) mean that the flow to the estuary is set to drop slightly in future (from 87.3 to 77.3) which will make it extremely difficult for this estuary to retain its health as an A/B. Thus, it is imperative that DWS and other stakeholders (local, provincial and other national government agencies) assist in addressing other pressures on this system to ensure that this highly important system remains in an A/B category. Key threats to the system include barriers to flow and movement of fauna within the system, alien invasive vegetation in the catchment, habitat loss and modification (loss and degradation of floodplain habitats), reduction in freshwater runoff, and disturbance caused by recreational activities.
Additional (non-flow related) interventions to achieve the REC:
• Bitou Drift:
o The drift through the Bitou River should be removed in total including all foreign rock material.
• Northern floodplain of the lower Bitou Estuary:
o Remove all exotic invasive trees from the flood plain.
o No further development should be allowed on the floodplain to prevent further loss of floodplain functionality. Remove the old gravel road to the south of the R340.
• Southern floodplain of the lower Bitou Estuary:
o Remove all exotic invasive plant species from the floodplain, remove the infilling, create a buffer zone (~ 10 m wide separating the wetland from the agricultural activities on the floodplain).
• Road Bridge across the lower Bitou Estuary:
o Remove concrete piers of the old road bridge to facilitate flow and tidal exchange in the Bitou Estuary and investigate establishing connection with old Bitou channel.
• Middle reaches of the Keurbooms Estuary:
o Remove all alien trees from the banks and The Island.
o Establish a buffer adjacent to the estuary and restrict new development on the banks of the estuary.
• Upper reaches of the Ganse Spruit:
o Remove all exotic vegetation from the stream bed.
• The Ganse Spruit Wetlands:
o Install a sufficient number of large culverts in the roads bisecting the wetlands to allow the free flow of surface water through the wetlands and remove all exotic invasive tree species.
• Earthen barricades across tidal channels in the Bitou Arm:
o Completely remove all earthen barricades to restore connectivity on the supratidal marsh. Maintain freshwater flow from the northern sections into the supratidal marsh south of the R340.
• Middle reaches of the Bitou Estuary:
o Remove all exotic tree species from this area, allow the artificial canal to naturally silt up, allow salt marsh to naturally re-colonise the extensive Stenotaphrum grasslands, insert culverts below the road bisecting the floodplain to link up the old channels</td><td>DWAF (2008) RDM study for the Keurbooms estuary
DWS (2015) Re-evaluation of the 2008 EWR study of the Keurbooms estuary</td></tr>
</table>

Table 3-130 RQOs and Numerical Limits for Matjies estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K70A	Matjies Estuary	gxi16	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime (small system needs most flows)	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 73.9, 73.8, 69.1, 68.0, 65.0, 67.9, 67.9, 68.4, 65.8, 66.8, 71.6, 74.1, 70.5
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not >100 µg/L once-off.
						DIP		DIP not >20 µg/L once-off.
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Average Salinity > 20 for more than 20% of the time (indicative of flow reduction), average Salinity < 5 for more than 20% of the time (indicative of extended closure).
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	>10 NTU in low flow
						Oxygen		>5 mg/L in estuary.
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m2 (median); prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats, prevent an increase in nutrient input leading to macroalgal blooms, control the spread of invasive plants in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-131 Supplementary information for Matjies estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Matjies	Gxi16	K70A	EC: B %nMAR: 91.1	PES: B %nMAR: 91.1	EC: C %nMAR: 63.5	Motivation for achieving REC/TEC • The Matjies estuary is considered to be of “low importance” from a biodiversity conservation perspective (ranked 220 out of 273 estuaries in South Africa) and is not been included on the list of existing or desired protected areas (Turpie et al. 2012). The REC for the estuary is the same as the PES – i.e. B category, however, there is not sufficient water available to maintain the system in this category and TEC has been set at a C category (NMAR = 63.5 vs. 91.1 at present). The most important threats to the Matjies estuary include freshwater deprivation and altered mouth dynamics). These issues need to be address in order to improve the health of this system to a B category at least.	Turpie et al. (2011) National Biodiversity Assessment – Estuaries component

Table 3-132 RQOs and Numerical Limits for Sout (Oos)estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K70A	Sout (Oos) Estuary	gxi17	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime (small system needs most flows)	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 86.7, 86.8, 86.0, 83.2, 81.7, 83.1, 84.2, 86.1, 85.6, 84.6, 85.8, 86.8, 85.6
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not >100 µg/L once-off.
						DIP		DIP not >20 µg/L once-off.
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Average salinity <10 at the head of the estuary (expected average range 5 - 10 for most of the system)
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	>10 NTU in low flow
						Oxygen		>5 mg/L in estuary.
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Mouth must remain permanently open
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m^2 (median); prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats, prevent an increase in nutrient input leading to macroalgal blooms, control the spread of invasive plants in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-133 Supplementary information for Sout (Oos) estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Sout (Oos)	Gxi17	K70A	EC: A %nMAR: 91.1	PES: A %nMAR: 91.1	EC: A %nMAR: 85.0	Motivation for achieving REC/TEC • The Sout (Oos) estuary is considered to be of "average importance" from a biodiversity conservation perspective (ranked 91 out of 273 estuaries in South Africa) but it is located in the De Vasselot Section of the Tsitsikamma National Park. The REC for the estuary is the same as the PES – i.e. an A category. Present day flows are higher than those required to maintain the estuary in an A category, thus provision has been made for use of a greater amount for water from this system (TEC = 85.0% nMAR). The most important threats to the Sout (Oos) estuary include freshwater deprivation.	DWAF (2008) RDM report for the Sout estuary

Table 3-134 RQOs and Numerical Limits for Groot (Wes) estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K70A	Groot (Wes) Estuary	gxi23	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime (small system needs most flows)	See monthly values below
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not >100 µg/L once-off.
						DIP		DIP not >20 µg/L once-off.
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Average salinity <10 at the head of the estuary (expected average range 5 - 10 for most of the system)
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	>10 NTU in low flow
						Oxygen		>5 mg/L in estuary.
					Pathogens	*Enterococci*	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 *Enterococci*/100 ml) (90th percentile)
						Escherichia coli		≤500 *E. coli*/100 ml (90th percentile)

Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
MMR/MAR (% Nat)	87.9	88.0	87.2	84.3	82.7	84.1	85.3	87.3	86.7	85.7	86.9	87.9	86.7

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m^2 (median); prevent formation of phytoplankton blooms
					Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats, prevent an increase in nutrient input leading to macroalgal blooms, control the spread of invasive plants in the riparian zone
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine-dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1-5%); Category Ia species should contain viable populations of at least 4 species (*G. aestuaria, Hyporamphus capensis*, *Omobranchus woodii*); Category IIa obligate dependents should be well represented by large exploited species (A.japonicus, L. lithognathus*, P. commersonii, Lichia amia*); REI species dominated by both *Myxus capensis* and *G. aestuaria*
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-135 Supplementary information for Groot (Wes) estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	Target	Context of the RQO	References
G15-Coastal	II	Groot (Wes)	Gxi23	K70A	EC: B %nMAR: 91.1	PES: B %nMAR: 91.1	EC: B %nMAR: 86.2	Motivation for achieving REC/TEC • The Groot (Wes) estuary is rated as being of "low to average importance" from a biodiversity conservation perspective (ranked 84th out of 273 estuaries in South Africa), but it is situated in the Tsitsikamma National Park and is thus one of a core set of priority estuaries in need of protection to achieve biodiversity targets in the National Estuaries Biodiversity Plan for the National Biodiversity Assessment (Turpie et al. 2012). The REC for the estuary is a B (= BAS), and the TEC has been set at the same level, albeit with a slight reduction in inflow (86.2 vs. 91.1% of natural). The system is largely pristine, but pressures include freshwater deprivation, development in the EFZ and disturbance from recreational activities. These issues will need to be closely monitored in future through joint effort on the part of DWS and other stakeholders (particularly SANParks and provincial and local government) Additional (non-flow related) interventions to achieve the REC: • Some reduction in base flow and floods to the system as a result of forestry in the catchment and abstraction by the adjacent town (Natures Valley), with a shift in the onset of the high flow period; • Loss of tidal flows and habitat as a result of bridge construction; • Some development in the EFZ and related loss of habitat; and • Limited bait collection and fishing	DWS (2015) Desktop Assessment of Estuaries in the Gouritz WMA

Table 3-136 RQOs and Numerical Limits for Bloukrans estuary

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	K70B	Bloukrans Estuary	gxi18	Quantity	Flow	MMR/MAR (% Nat)	Maintain flow regime (small system needs most flows)	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 98.7, 99.0, 98.3, 96.7, 96.8, 97.1, 97.2, 98.1, 97.6, 97.7, 98.2, 98.9, 98.0
				Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not >100 µg/L once-off.
						DIP		DIP not >20 µg/L once-off.
					Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Average salinity <10 at the head of the estuary (expected average range 5 - 10 for most of the system)
					System variables	Turbidity	System variables (temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to exceed TPCs for biota	>10 NTU in low flow
						Oxygen		>5 mg/L in estuary.
					Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
						Escherichia coli		≤500 E. coli/100 ml (90th percentile)
				Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Estuary mouth permanently open
						Tidal variation		Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline.
					Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline
				Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 1 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 11 mg/m2 (median); prevent formation of phytoplankton blooms
					Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Establish presence/absence of sand prawn Callichirus kraussi on sand banks in lower estuary, establish presence/absence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary, populations of these species should not deviate from average baselines (as determined in first three visits) by more 30%
					Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Maintain fish assemblage that includes at least 2 estuarine breeding species (Category I), 3 estuary dependent marine species (Category IIa & IIb) and 1 indigenous catadromous species (Category V); estuarine residents should dominate numerically, but the proportion of estuary dependent marine species (based on abundance) should not fall below 2%.

IUA	Quat #	Estuary	Node	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
					Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Maintain population of original groups of birds present on the estuary; number of birds in any group, other than species that are increasing regionally such as Egyptian geese, should not drop below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts

Table 3-137 Supplementary information for Bloukrans estuary RQOs

IUA	Class	Estuary	Node	Quat.	REC	Current	TEC	Context of the RQO	References
G15-Coastal	II	Bloukrans	Gxi18	K70B	EC: A %nMAR: 91.8	PES: A %nMAR: 91.8	EC: A %nMAR: 97.9	Motivation for achieving REC/TEC • The Bloukrans estuary is rated as being of “low importance” from a biodiversity conservation perspective (ranked 120 out of 273 estuaries in South Africa), but it is situated in the Tsitsikamma National Park and is thus one of a core set of priority estuaries in need of protection to achieve biodiversity targets in the National Estuaries Biodiversity Plan for the National Biodiversity Assessment (Turpie et al. 2012). The REC for the estuary is an A (= PES), and the TEC has been set at the same level. The system is largely pristine, but pressures include freshwater deprivation (due to afforestation) and some limited disturbance from recreational activities. These issues will need to be closely monitored in future through joint effort on the part of DWS and other stakeholders (particularly SANParks and provincial and local government)	DWS (2015) Desktop Assessment of Estuaries in the Gouritz WMA

3.3 Dam RQOs and numerical limits

The prioritised dams are shown in Figure 3-52.

The outcomes of the RQO and Numerical Limits determination for dams are described in the tables following the map, as follows:

- RQOs for the Breede-Overberg area are presented in Table 3-138 to Table 3-142.
- RQOs for the Gouritz-Coastal area are presented in Table 3-143 to Table 3-144
- Supplementary information for the dams in the Breede-Overberg area is presented in Table 3-145 to Table 3-150.
- Supplementary information for the dams in the Gouritz-Coastal area is presented in Table 3-151 to Table 3-152.

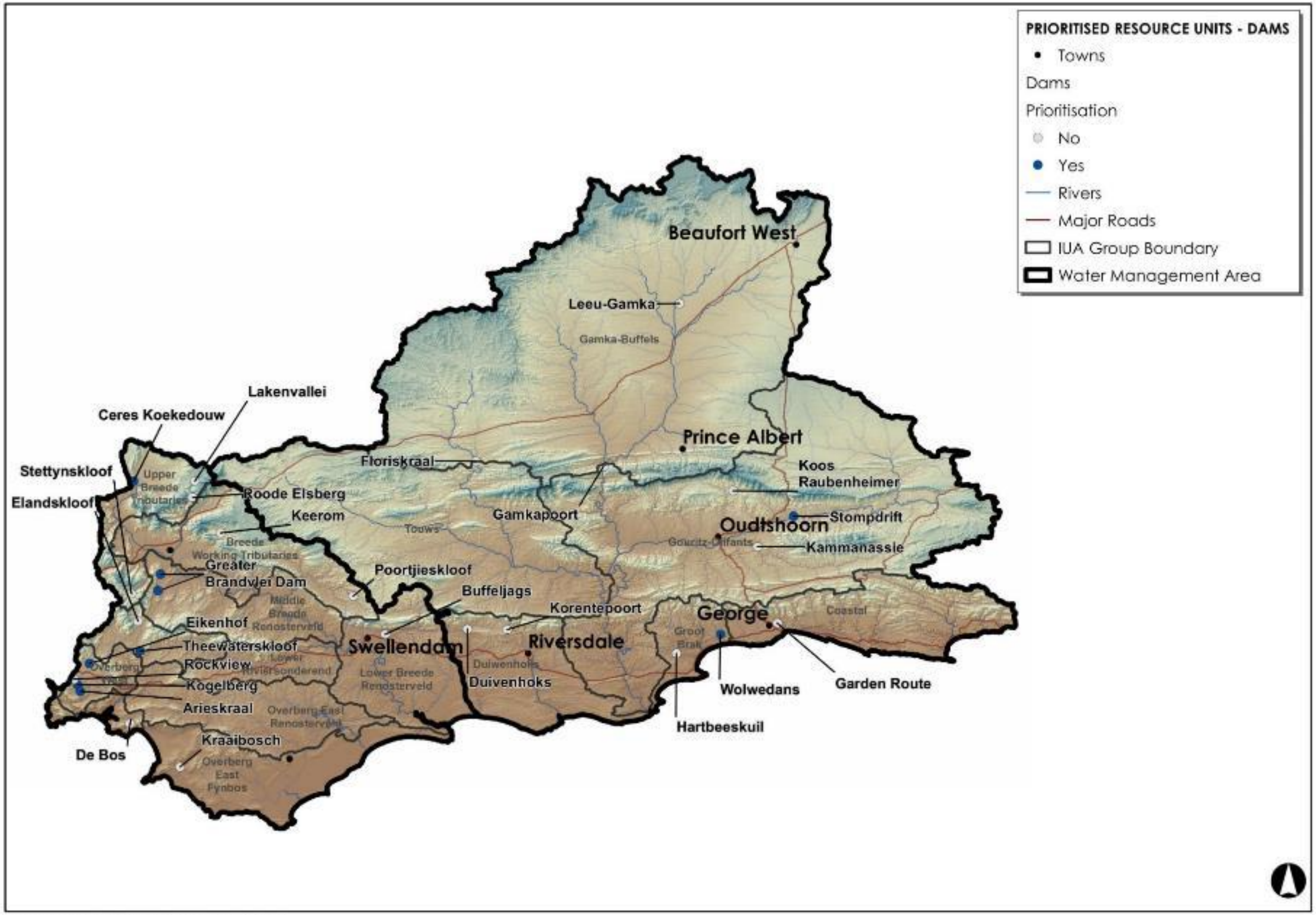

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Figure 3-52 Priority dams considered in the WMA

Table 3-138 RQOs for Theewaterskloof Dam in the Riviersonderend Theewaters IUA

IUA	Name of dam	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
B4 Riviersonderend Theewaters	Theewaterskloof	Quantity	Low flows	Dam levels Flow releases: Breede EWR5 in H60F nMAR = 347.41 million m^3/a pMAR: 93.50 million m^3/a REC = D category	Dam levels must be sufficient for releases for irrigation and human use and protection of ecosystem function downstream, whilst considering the need for unseasonal flow releases for irrigation.	% of live storage
			High flows		During the wet season dam levels must be maintained such that they support ecosystem function and human use, within the constraint of dam outlet structures.	
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in a mesotrophic state or better.	Median ≤ 0.025 mg/ ℓ P
				Total inorganic nitrogen (TIN)[1]		Median ≤ 1.00 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply.	95th percentile ≤ 70 mS/m
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to, or not impact negatively on regional biodiversity and to support the local recreational angling industry. The re-infestation of alien species upstream from the dam should be prevented. Consumption of fish must not pose a health risk.	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.
			Phytoplankton	Chlorophyll *a*	The system must be maintained in a mesotrophic state or better.	Median ≤ 20 µg/ℓ Chl *a*

EWR SITE 5: RIVIERSONDEREND RIVER ASSURANCE OF MAINTENANCE LOW FLOWS: 60% (summer) and 70% (winter) nMAR: 347.41 pMAR: 93.50										
MONTH	MAINTENANCE LOW FLOWS			HIGH FLOWS				DROUGHT LOW FLOWS		
	DEPTH[4]	FLOW ($m^3 s^{-1}$)	VOLUME ($10^6 m^3$)	DEPTH[4]	FLOW ($m^3 s^{-1}$) Daily average	DURATION	VOLUME[1] ($10^6 m^3$)	DEPTH[4]	FLOW ($m^3 s^{-1}$)	VOLUME ($10^6 m^3$)
Oct	0.47	2.7	7.23					0.34	0.93	2.5
Nov	0.46	2.5	6.48	0.65	7.5	2	0.61	0.33	0.85	2.2
Dec	0.31	0.7	1.88	0.53	4	2	0.40	0.24	0.35	0.94
Jan 2	0.29	0.6	1.61	0.53	4	2	0.41	0.24	0.35	0.94
Feb	0.28	0.5	1.21	0.53	4	2	0.423	0.24	0.35	0.85
Mar	0.26	0.4	1.07					0.23	0.3	0.80
Apr	0.41	1.8	4.67					0.24	0.4	1.04
May	0.43	2.0	5.36	0.90	20.6	3	2.89	0.32	0.8	2.1
Jun	0.49	3.0	7.78	1.10	21	3	2.80	0.33	0.9	2.3
Jul3	0.51	3.5	9.37	1.15	44.5	4	7.44	0.34	0.96	2.6
Aug	0.53	3.8	10.18	1.40	84.9	6	18.57	0.34	0.99	2.7
Sep	0.53	4.0	10.37	1.16	45	4	7.44	0.34	1	2.6
TOTAL			67.19				40.98			21.55
% OF nMAR			19.34				11.80			6.20
Long term % OF nMAR				38.65 (134.27 $10^6 m^3$)						
1	The volume represents the daily average less the low flows									
2	December was the month identified by the specialists to determine the dry season flows. Due to the unnatural high flows occurring presently in the system - the flow was set near natural.									
3	July was the month identified by the specialists to determine the wet season flows. The other months are extrapolated using hydrological regional parameters for the Western Cape.									
4	As per cross-section 2.									

[1] Total inorganic nitrogen (TIN) (mg/l) = NO_2+NO_3-N (mg/l) + NH_4-N (mg/l)

Table 3-139 RQOs for Greater Brandvlei Dam in the Breede Working Tributaries IUA

IUA	Name of dam	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
A2 Breede Working Tributaries	Greater Brandvlei	Quantity	Low flows	Dam levels	Dam levels must be sufficient for releases for irrigation and human use.	% of live storage
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in an oligotrophic state or better.	Median ≤ 0.015 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are acceptable for rural use, and in an Ideal category for irrigation water use.	95^{th} percentile ≤ 40 mS/m
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support the local recreational angling industry. Consumption of fish must not pose a health risk.	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.

Table 3-140 RQOs for Ceres Koekedouw Dam in the Upper Breede Tributaries IUA

IUA	Name of dam	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
A1 Upper Breede Tributaries	Ceres Koekedouw	Quantity	Low flows	Dam levels No EWR Current: PES (2014) = D %nMAR = 96.32	Dam levels must be sufficient for releases for human and irrigation use and protection of ecosystem function downstream, within the constraint of limited-capacity outlet works.	% of live storage Agreed ecological release flow pattern and rate (condition of dam raising).
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in an oligotrophic state or better.	Median ≤ 0.015 mg/ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/ℓ N
			Salts	Electrical conductivity	Salt concentrations are low, in an Ideal category, and should must be maintained at concentrations where they do not impact negatively on the ecosystem, are acceptable for municipal treatment and rural use, and Ideal for irrigation use.	95^{th} percentile ≤ 40 mS/m
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.	Habitat suitability and fish wellbeing in a state which is equivalent to a C or better ecological category.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.

IUA	Name of dam	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
B5 Overberg West	Eikenhof	Quantity	Low flows	Dam levels No EWR below dam. nMAR =60 million m^3/a and MAR = 27 million m^3/a.	Dam levels must be sufficient for releases for irrigation, urban and industrial use and releases to contribute to the protection of ecosystem function in the lower Palmiet River below Arieskraal Dam.	% of live storage EWR flows released at Nuweberg Dam must pass through Eikenhof Dam and associated flow downstream must remain unabstracted, in line with the Palmiet CMP. EWR further recommended upper wet season lowflow discharge value of 0.49 m^3/s and an upper dry season lowflow discharge of 0.17 m^3/s, which are the upper lowflow levels above which flows should be abstracted for use. Rule curve for implementation of this recommendation has not yet developed.
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in an oligotrophic state or better.	Median ≤ 0.015 mg/ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 0.70 mg/ℓ N
			Salts	Electrical conductivity	Salt concentrations are low, in an Ideal category, and should must be maintained at concentrations where they do not impact negatively on the ecosystem, are acceptable for municipal treatment and rural use, and Ideal for irrigation use.	95^{th} percentile ≤ 40 mS/m
		Biota	Fish	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.	Habitat suitability and fish wellbeing in a state which is equivalent to a B or better ecological category.
				Populations of indigenous fish		Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.

Table 3-141 RQOs for Kogelberg Dam in the Overberg West IUA

<table>
<tr><th>IUA</th><th>Dam</th><th>Component</th><th>Sub-component</th><th>Indicator/ measure</th><th>RQO Narrative</th><th>RQO Numeric</th></tr>
<tr><td rowspan="7">B5 Overberg West</td><td rowspan="7">Kogelberg</td><td>Quantity</td><td>Low flows</td><td>Dam levels
Releases to ensure spills from Arieskraal Dam.
Flow releases:
Palmiet EWR3 in G40D below Arieskraal Dam
nMAR = 207 million m^3/a
pMAR: 135 million m^3/a
REC = B/C category</td><td>Dam levels must be sufficient for energy generation, transfers for urban and industrial use and protection of ecosystem function downstream of Arieskraal Dam.</td><td>% of live storage
<table>
<tr><th colspan="7">Annual Flows: (million m^3/a)</th></tr>
<tr><td colspan="7">Summary of flows required for ecological Reserve (million m^3/a)</td></tr>
<tr><td></td><td colspan="6">Total Maintenance EWR = 70.6 million m^3/a (excl. > 1:2 year floods) = 34% nMAR</td></tr>
<tr><td></td><td colspan="6">Maintenance Lowflow = 57.36 million m^3/a</td></tr>
<tr><td></td><td colspan="6">Drought Lowflow = 12.80 million m^3/a</td></tr>
<tr><td></td><td colspan="6">Maintenance Highflow = 27.74 million m^3/a (excl. > 1:2 year flood events)</td></tr>
<tr><th colspan="7">Required month distribution (million m^3/a)</th></tr>
<tr><th colspan="7">Distribution type:</th></tr>
<tr><th rowspan="3">Month</th><th colspan="2" rowspan="2">Natural Flows</th><th colspan="4">Required flows (ecological Reserve)</th></tr>
<tr><th colspan="2">Lowflows</th><th rowspan="2">High flows</th><th rowspan="2">Total flows</th></tr>
<tr><th>Mean</th><th>SD</th><th>Maintenance</th><th>Drought</th></tr>
<tr><td>Oct</td><td>16.63</td><td>9.9</td><td>7.78</td><td>1.43</td><td>0.35</td><td>8.13</td></tr>
<tr><td>Nov</td><td>8.56</td><td>5.2</td><td>3.56</td><td>1.53</td><td>0.70</td><td>4.27</td></tr>
<tr><td>Dec</td><td>4.08</td><td>2.1</td><td>1.94</td><td>1.59</td><td>1.06</td><td>3.00</td></tr>
<tr><td>Jan</td><td>2.54</td><td>2.5</td><td>1.63</td><td>1.50</td><td>0.53</td><td>2.16</td></tr>
<tr><td>Feb</td><td>2.07</td><td>3.3</td><td>0.86</td><td>1.55</td><td>0.53</td><td>1.39</td></tr>
<tr><td>Mar</td><td>2.67</td><td>3.2</td><td>1.18</td><td>1.35</td><td>0.53</td><td>1.88</td></tr>
<tr><td>Apr</td><td>8.87</td><td>10.3</td><td>1.41</td><td>0.69</td><td>0.53</td><td>1.22</td></tr>
<tr><td>May</td><td>21.37</td><td>18.5</td><td>1.96</td><td>0.68</td><td>6.06</td><td>8.02</td></tr>
<tr><td>Jun</td><td>36.65</td><td>24.6</td><td>7.69</td><td>0.47</td><td>1.35</td><td>9.04</td></tr>
<tr><td>Jul</td><td>39.29</td><td>19.1</td><td>9.35</td><td>0.58</td><td>5.7</td><td>15.05</td></tr>
<tr><td>Aug</td><td>39.88</td><td>17.8</td><td>10.08</td><td>0.60</td><td>10.05</td><td>20.13</td></tr>
<tr><td>Sep</td><td>25.22</td><td>10.7</td><td>9.92</td><td>0.63</td><td>0.35</td><td>10.37</td></tr>
</table></td></tr>
<tr><td rowspan="4">Quality</td><td rowspan="2">Nutrients</td><td>Ortho-phosphate (PO_4-P)</td><td rowspan="2">The system must be maintained in a mesotrophic state or better.</td><td>Median ≤ 0.025 mg/ℓ P</td></tr>
<tr><td>Total inorganic nitrogen (TIN)</td><td>Median ≤ 1.00 mg/ℓ N</td></tr>
<tr><td rowspan="2">Pathogens</td><td>E. coli</td><td rowspan="2">The system must be maintained in a state that is safe for municipal use and contact recreation.</td><td>≤ 130 counts/100 ml</td></tr>
<tr><td>Faecal coliforms</td><td>≤ 130 counts/100 ml</td></tr>
<tr><td rowspan="2">Biota</td><td rowspan="2">Fish</td><td>Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)</td><td rowspan="2">The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.</td><td>Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category.</td></tr>
<tr><td>Populations of indigenous fish</td><td>Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.</td></tr>
</table>

Table 3-142 RQOs for Arieskraal Dam in the Overberg West IUA

<table>
<tr><th>IUA</th><th>Name of dam</th><th>Component</th><th>Sub-component</th><th>Indicator/ measure</th><th>RQO Narrative</th><th>RQO Numeric</th></tr>
<tr><td rowspan="7">B5 Overberg West</td><td rowspan="7">Arieskraal</td><td>Quantity</td><td>Low flows</td><td>Dam levels
Spills from dam.
Flow releases:
Palmiet EWR3 in G40D below Arieskraal Dam
nMAR = 207 million m^3/a
pMAR: 135 million m^3/a
REC = B/C category</td><td>Dam levels must be sufficient for releases for human use by Kleinmond and protection of ecosystem functions downstream, through spills.</td><td>% of live storage
<table>
<tr><td colspan="7">Annual Flows: (million m^3/a)</td></tr>
<tr><td colspan="7">Summary of flows required for ecological Reserve (million m^3/a)</td></tr>
<tr><td></td><td colspan="6">Total Maintenance EWR = 70.6 million m^3/a (excl. ≥ 1:2 year floods) = 34% nMAR</td></tr>
<tr><td></td><td colspan="6">Maintenance Lowflow = 57.36 million m^3/a</td></tr>
<tr><td></td><td colspan="6">Drought Lowflow = 12.60 million m^3/a</td></tr>
<tr><td></td><td colspan="6">Maintenance Highflow = 27.74 million m^3/a (excl. ≥ 1:2 year flood events)</td></tr>
<tr><td colspan="7">Required month distribution (million m^3/a)</td></tr>
<tr><td colspan="7">Distribution type:</td></tr>
<tr><th rowspan="3">Month</th><th colspan="2" rowspan="2">Natural Flows</th><th colspan="4">Required flows (ecological Reserve)</th></tr>
<tr><th colspan="2">Lowflows</th><th rowspan="2">High flows</th><th rowspan="2">Total flows</th></tr>
<tr><th>Mean</th><th>SD</th><th>Maintenance</th><th>Drought</th></tr>
<tr><td>Oct</td><td>16.63</td><td>9.9</td><td>7.78</td><td>1.43</td><td>0.35</td><td>8.13</td></tr>
<tr><td>Nov</td><td>8.56</td><td>5.2</td><td>3.56</td><td>1.53</td><td>0.70</td><td>4.27</td></tr>
<tr><td>Dec</td><td>4.06</td><td>2.1</td><td>1.94</td><td>1.59</td><td>1.06</td><td>3.00</td></tr>
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<tr><td>Feb</td><td>2.07</td><td>3.3</td><td>0.86</td><td>1.55</td><td>0.53</td><td>1.39</td></tr>
<tr><td>Mar</td><td>2.67</td><td>3.2</td><td>1.18</td><td>1.35</td><td>0.53</td><td>1.88</td></tr>
<tr><td>Apr</td><td>8.87</td><td>10.3</td><td>1.41</td><td>0.69</td><td>0.53</td><td>1.22</td></tr>
<tr><td>May</td><td>21.37</td><td>18.5</td><td>1.96</td><td>0.68</td><td>6.06</td><td>8.02</td></tr>
<tr><td>Jun</td><td>36.65</td><td>24.6</td><td>7.69</td><td>0.47</td><td>1.35</td><td>9.04</td></tr>
<tr><td>Jul</td><td>39.29</td><td>19.1</td><td>9.35</td><td>0.58</td><td>5.7</td><td>15.05</td></tr>
<tr><td>Aug</td><td>39.88</td><td>17.8</td><td>10.08</td><td>0.60</td><td>10.05</td><td>20.13</td></tr>
<tr><td>Sep</td><td>25.22</td><td>10.7</td><td>9.92</td><td>0.63</td><td>0.35</td><td>10.37</td></tr>
</table>
</td></tr>
<tr><td rowspan="4">Quality</td><td rowspan="2">Nutrients</td><td>Ortho-phosphate (PO_4-P)</td><td rowspan="2">The system must be maintained in a mesotrophic state or better.</td><td>Median ≤ 0.025 mg/ ℓ P</td></tr>
<tr><td>Total inorganic nitrogen (TIN)</td><td>Median ≤ 1.00 mg/ℓ N</td></tr>
<tr><td rowspan="2">Pathogens</td><td>E. coli</td><td rowspan="2">The system must be maintained in a state that is safe for contact recreation.</td><td>95th percentile ≤ 130 counts/100 ml</td></tr>
<tr><td>Faecal coliforms</td><td>95th percentile ≤ 130 counts/100 ml</td></tr>
<tr><td rowspan="2">Biota</td><td rowspan="2">Fish</td><td>Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)</td><td rowspan="2">The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.</td><td>Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category.</td></tr>
<tr><td>Populations of indigenous fish</td><td>Fish demographics and species assemblage of indigenous fish should be the same or better than the baseline status.</td></tr>
</table>

Table 3-143 RQOs for Stompdrift Dam in the Gouritz-Olifants IUA

IUA	Name of dam	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
D7 Gouritz-Olifants	Stompdrift	Quantity	Low flows	Dam levels	Dam levels must be sufficient for releases for irrigation and human use.	% of live storage
		Quality	Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Acceptable category for municipal treatment and rural use.	95th percentile ≤ 150 mS/m -

Table 3-144 RQOs for Wolwedans Dam in the Coastal IUA

IUA	Name of dam	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
G15 Coastal	Wolwedans	Quantity	Low flows	Dam levels Flow releases: Groot Brak Estuary EWR in K20A nMAR = 27.0 million m^3/a pMAR: 0.92 million m^3/a REC = C category	Dam levels must be sufficient for releases for industrial and urban use and protection of ecosystem function downstream.	% of live storage Ecological flow distribution in the Groot Brak estuary: (see table below)
			High flows		During the wet season dam levels must be maintained such that they support ecosystem function and human use, mainly through spills, within the constraints of the existing outlet works.	
		Quality	Nutrients	Ortho-phosphate (PO_4-P)	The system must be maintained in a mesotrophic state or better.	Median ≤ 0.025 mg/ ℓ P
				Total inorganic nitrogen (TIN)		Median ≤ 1.00 mg/ℓ N
			Salts	Electrical conductivity	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are acceptable for industrial and urban use.	95th percentile ≤ 85 mS/m

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99%ile	8.22	15.91	11.83	11.28	9.00	9.91	10.44	14.07	4.20	4.17	15.77	11.12
90%ile	4.34	5.83	2.56	1.74	1.79	4.20	3.97	2.44	1.19	0.96	2.38	4.97
80%ile	2.47	2.95	1.34	0.77	0.81	2.59	1.58	1.03	0.26	0.49	1.29	2.94
70%ile	1.30	1.52	0.79	0.75	0.75	1.15	0.60	0.16	0.05	0.05	0.65	1.25
60%ile	0.69	0.80	0.76	0.73	0.72	0.56	0.54	0.04	0.03	0.04	0.64	0.64
50%ile	0.66	0.76	0.75	0.72	0.71	0.54	0.53	0.03	0.02	0.03	0.63	0.63
40%ile	0.65	0.75	0.72	0.71	0.71	0.51	0.52	0.02	0.02	0.02	0.62	0.63
30%ile	0.64	0.73	0.71	0.70	0.70	0.51	0.51	0.01	0.01	0.02	0.62	0.62
20%ile	0.62	0.72	0.70	0.70	0.70	0.50	0.51	0.01	0.01	0.01	0.61	0.62
10%ile	0.61	0.71	0.70	0.70	0.70	0.50	0.50	0.01	0.01	0.01	0.61	0.61
1%ile	0.61	0.70	0.70	0.50	0.47	0.30	0.03	0.00	0.00	0.01	0.02	0.60

Table 3-145　Supplementary information for Theewaterskloof Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
B4 Riviersonderend Theewaters	Theewaterskloof	Quantity	Low flows	Largest dam in the Western Cape Province and main supply dam to the Western Cape Water Supply System, with significant transfers and supply for irrigation, urban and industrial use. There are small upstream farm dams. Releases are currently made for irrigation, urban, industrial and urban use from the dam into the river.	Not applicable		DWS, 2017.
			High flows				
		Quality	Nutrients	There is irrigation located upstream, as well as the town of Villiersdorp, but in-lake phosphate concentrations are low. Nutrients must be maintained at mesotrophic levels to retain the recreational value of the dam and to provide water to people via the transfer scheme to Berg River Dam.	Ortho-phosphate (PO_4-P)	0.020 mg/ ℓ P	DWAF, 2002
					Total inorganic nitrogen (TIN)	0.08 mg/ℓ N	
			Salts	Salt concentrations are low, in an Ideal category for all users. There is a very slight increasing trend over time. Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for municipal treatment and rural use.	Electrical conductivity	60 mS/m	DWA, 2006
		Biota	Fish	Portions of the dam falls within a fish sanctuary. Alien invasive fish species has impacted negatively on indigenous populations, although there are still pockets of some indigenous communities left, such as Burchell's redfin. Alien fish form the mainstay of the recreational angling industry. The sharptooth catfish is a significant problem, with their bottom feeding causing turbidity problems. A barrier weir needs to be built above Theewaterskloof Dam to prevent re-infestation of alien species from the dam.	Habitat suitability and fish wellbeing (FRAI) in a state worse than a D ecological category Dam storage < 5% for rescue of drought-threatened indigenous fish species		DWS, 2017, NFEPA, 2011 CapeNature, 2007 Breede State of Water Resources, 2011
			Phytoplankton	There are algal blooms in the dam, as well as taste and odour problems in the drinking water when the blooms occur. Chlorophyll data indicate oligotrophic conditions; probably due to elevated turbidity that inhibits algal growth.	Chlorophyll a	≤ 15 µg/ℓ	DWAF, 2002

Table 3-146 Supplementary information for Greater Brandvlei Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
A2 Breede Working Tributaries	Greater Brandvlei	Quantity	Low flows	This is largely an off-channel dam (impounds the small lower Brandvlei River) with limited natural inflow, and with limited farm dams located upstream. During the dry season significant irrigation releases are made. The important Papenkuils floodplain wetland is located just upstream of the dam, below the canal off-takes from the Smalblaar and Holsloot rivers. Water in the dam is mainly used for irrigation along the Breede River and for urban and rural use. Irrigation water is distributed by a system of canals receiving water directly from the dam as well as pumps and canals abstracting released water downstream. The significant recreational activities include abseiling, sailing, kayaking and fishing, among others.	Not applicable		DWS, 2017
		Quality	Nutrients	Nutrient concentrations are low, in the oligotrophic range and the dam should be maintained in an oligotrophic range.	Ortho-phosphate (PO_4)	0.020 mg/ ℓ P	DWAF 2002
					Nitrate (NO_3) Nitrite (NO_2) Total inorganic nitrogen (TIN)	0.80 mg/ℓ N	
			Salts	Salt concentrations are low, well within the Ideal range for all uses. No significant trend over time. Concentrations should be maintained in an Ideal category.	Electrical conductivity	35 mS/m	DWA 2006
		Biota	Fish	The dam falls within a fish sanctuary. The indigenous Berg-Breede whitefish and Burchell's redfin is found in the dam. Fish in the dam include smallmouth bass, carp and whitefish. It is reputedly the best smallmouth bass fishing area in the country. Alien fish form the mainstay of a significant recreational angling industry, with provincial and national competitions being held.	Habitat suitability and fish wellbeing in a state worse than a D ecological category. Dam storage < 5% for rescue of drought-threatened indigenous fish species		NFEPA, 2011 Breede State of Water Resources, 2011

Table 3-147 Supplementary information for Ceres Koekedouw Dam on ecosystem scale

<table>
<tr><th>IUA</th><th>Name of dam</th><th>Component</th><th>Sub-component</th><th>Context of the RQO</th><th colspan="2">Threshold of Probable Concern</th><th>Reference</th></tr>
<tr><td rowspan="5">A1 Upper Breede Tributaries</td><td rowspan="5">Ceres Koekedouw</td><td>Quantity</td><td>Low flows</td><td>The dam supplies water for irrigation (Ceres-Koekedouw WUA), and to the town of Ceres for urban and industrial water use. The dam is located in a mountainous area. A number of small dams are located in the upstream irrigation areas which will impound low flows. No change is expected for future impacts. While there is no EWR site located downstream, the construction of the dam was approved subject to the release of environmental water requirements which are being implemented and monitored to some extent.</td><td colspan="2">Not applicable</td><td>Breede State of Rivers, 2011.</td></tr>
<tr><td rowspan="3">Quality</td><td rowspan="2">Nutrients</td><td rowspan="2">The reservoir should be maintained in an oligotrophic state or better.</td><td>Ortho-phosphate (PO_4)</td><td>0.010 mg/ ℓ P</td><td rowspan="2">DWAF, 2002</td></tr>
<tr><td>Nitrate (NO_3)
Nitrite (NO_2)</td><td>0.60 mg/ℓ N</td></tr>
<tr><td>Salts</td><td>Salt concentrations are low, in an Ideal category for all uses. There is a slight increasing trend but it is well within the Ideal range. Salt concentrations should be kept constant.</td><td>Electrical conductivity</td><td>35 mS/m</td><td>DWA, 2006</td></tr>
<tr><td>Biota</td><td>Fish</td><td>The dam is located within a fish sanctuary for indigenous threatened fish species. Very limited indigenous fish communities remain.</td><td colspan="2">Dam storage < 5% for rescue of drought-threatened indigenous fish species</td><td>NFEPA, 2011</td></tr>
</table>

Table 3-148 Supplementary information for Eikenhof Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
B5 Overberg West	Palmiet	Quantity	Low flows	The Eikenhof Dam is located 4.5 km downstream of the 4 million m^3 Nuweberg Dam. It is a 35m concrete bottom release dam for irrigation supply. The dam supplies irrigation water to 6 400 ha of agricultural land, and domestic water to Grabouw and industries (e.g. Appletiser). There are four gauging weirs in irrigation canals downstream of Eikenhof Dam. The Nuweberg WWTW package plant at the Forestry Station is the only point-source effluent. There are some impacts from farming, forestry, forestry clearing, and invasion by exotic vegetation.	Not applicable		Palmiet River CMP Update and Review, 2010. Groenland WUA, 2017
		Quality	Nutrients	Nuweberg WWTW and forestry clearing causes limited elevated orthophosphate levels, increased suspended solids, and pH changes. The reservoir should be maintained in an oligotrophic state or better.	Ortho-phosphate (PO_4)	0.010 mg/ ℓ P	DWAF, 2002
					Nitrate (NO_3) Nitrite (NO_2)	0.60 mg/ℓ N	
			Salts	Salt concentrations are low, in an Ideal category for all uses. There is a slight increasing trend but it is well within the Ideal range. Salt concentrations should be kept constant.	Electrical conductivity	35 mS/m	DWA, 2006
		Biota	Fish	The dam is located within a fish sanctuary for indigenous threatened fish species. Indigenous fish populations represent possibly the most downstream distribution of indigenous fish in the mainstem river. This, together with their uncertain taxonomic status (potentially new species) highlights their conservation worthiness. Potential invasion routes for exotic fish species and secure habitat for existing indigenous fish populations should be identified.	Dam storage < 5% for rescue of drought-threatened indigenous fish species		NFEPA, 2011 (pers. comm. Ernst Swartz, South African Institute for Aquatic Biodiversity, Grahamstown).

Table 3-149 Supplementary information for Kogelberg Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
B5 Overberg West	Kogelberg	Quantity	Low flows	Applethwaite Dam is located directly upstream and Arieskraal Dam a short river stretch downstream. Flow conditions are significantly modified. The low-flows are reduced by Eikenhof Dam and the significant upstream irrigation development and farm dams and the town of Grabouw located directly upstream of the series of 3 dams. Together with the off-channel Rockview Dam on the watershed dividing the Palmiet from the Steenbras River catchments, the dam comprises part of the Palmiet Pumped Storage Scheme that generates 400 MW of power for distribution to the Cape Metropolitan Area over peak periods (weekdays). During winter, once flows measured at the Campanula weir (G4H030) reach or exceed 4.33 m^3/s (the wet season low flow capping discharge), water is transferred to Rockview Dam and stored there for allocating water to the Cape Metropolitan Area via the Steenbras Dam (22.5 million m^3/a). Managed high-flow releases from the combined Kogelberg and Arieskraal dams are restricted by the capacities of the existing outlet works at these dams. Kogelberg Dam can release a maximum of 15 m^3/s whilst Arieskraal Dam has no release mechanism and any flood flows in the Palmiet River downstream are only achieved through spillage. DWS operates the dam and pumped storage scheme.	Not applicable		Palmiet River CMP Update and Review, 2010. DWS, 2017.
		Quality	Nutrients	There is elevated nutrient and conductivity levels at Applethwaite Dam, just upstream, illustrating the combined effects of farming and urban and industrial (including informal settlement) runoff on the river. Treatment plants at Molteno Brothers, Elgin Orchards and Elgin Fruitpackers, and the Grabouw Waste Water Treatment Works all discharge effluent with high concentrations of phosphates, nitrates and ammonia, as well as high dissolved solids. Although it is not considered feasible to restore river ecosystem functions, mitigating water quality impairment upstream of the Applethwaite Dam and reducing nutrient loading in the dams and lower river is considered a high priority. Upgrading the Grabouw WWTW would alleviate part of the problem. Special effluent standards should be both stipulated and adhered to in future expansion of the WWTW. Sanitation should be improved in the informal settlement. Median phosphate concentrations at the dam wall fall just within the mesotrophic range (moderately enriched).	Ortho-phosphate (PO_4)	0.020 mg/ ℓ P	Palmiet River CMP Update and Review, 2010. DWS NCMP data
					Total Inorganic Nitrogen (TIN)	0.90 mg/ℓ N	
			Pathogens	There are some concerns about pathogens from the informal settlements and WWTWs upstream of the series of dams, although there is currently no data to support the concern.	E. coli	100 counts/100 ml	DWA, 2006
					Faecal coliforms	100 counts/100 ml	
		Biota	Fish	The dam is located within a fish sanctuary for indigenous threatened fish species. Very limited indigenous fish communities remain.	Habitat suitability and fish wellbeing in a state worse than a D ecological category. Dam storage < 5% for rescue of drought-threatened indigenous fish species		NFEPA, 2011 Palmiet River CMP Update and Review, 2010.

Table 3-150 Supplementary information for Arieskraal Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
B5 Overberg West	Arieskraal	Quantity	Low flows	Arieskraal Dam is located a very short river stretch upstream. Flow conditions are significantly modified. The low-flows are reduced by Eikenhof Dam and the significant upstream irrigation development and farm dams and the town of Grabouw located directly upstream of the series of 3 dams. Most of the catchment below the dam is located in the Kogelberg Nature Reserve, which is also managed as a biosphere reserve (Kogelberg Biosphere Reserve). Implementation of the EWR is thus of the highest priority. The Biosphere Reserve is marked by an extraordinarily high level of floral diversity and a wide diversity of terrestrial and freshwater habitats. Managed high-flow releases from the combined Kogelberg and Arieskraal dams are restricted by the capacities of the existing outlet works at these dams. Flood flows in the Palmiet River downstream are currently only achieved through spillage. Arieskraal Dam's outlet pipe can release up to 2 m^3/s but an orifice plate has been bolted onto the outlet pipe which prevents any variation in releases from the dam. Changes to this outlet structure is recommended, which would firstly allow for the EWR entering the Kogelberg/Arieskraal dams to be released downstream and secondly allow for greater variation in flow to be provided, albeit within the constraint of a maximum discharge of 2 m^3/s. Groenland WUA operates the system in accordance with the Palmiet River CMP. The town of Kleinmond is fully dependent on the flow in the Palmiet River for its bulk raw water supply, and they have no existing bulk water storage capacity.	Not applicable		Palmiet River CMP Update and Review, 2010. DWS, 2017.
		Quality	Nutrients	There is elevated nutrient and conductivity levels at Applethwaite Dam, just upstream, illustrating the combined effects of farming and urban (informal settlement) runoff on the river. Treatment plants at Molteno Brothers, Elgin Orchards and Elgin Fruitpackers, and the Grabouw Waste Water Treatment Works all discharge effluent with high concentrations of phosphates, nitrates and ammonia, as well as high dissolved solids. Inflowing phosphate concentrations fall within in the mesotrophic range (moderately enriched). However, cage aquaculture in the dam would increase nutrient levels in the dam. There is no in-lake nutrient data available from DWS.	Ortho-phosphate (PO_4)	0.020 mg/ ℓ P	Palmiet River CMP Update and Review, 2010.
					Total Inorganic Nitrogen (TIN)	0.90 mg/ℓ N	
			Pathogens	There are some concerns about pathogens from the informal settlements and WWTWs upstream of the series of dams, although there is currently no data to support the concern.	E. coli	100 counts/100 ml	DWA, 2006
					Faecal coliforms	100 counts/100 ml	
		Biota	Fish	The fish species in the dam is mainly Bass. The dam falls within a fish sanctuary (rehabilitation). At EWR 3 site downstream all fish species are introduced.	Habitat suitability and fish wellbeing in a state worse than a D ecological category.		NFEPA, 2011 Palmiet River CMP Update and Review, 2010.

Table 3-151 Supplementary information for Stompdrift Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
D7 Gouritz-Olifants	Stompdrift	Quantity	Low flows	There are limited economic activities upstream of the dam and the impacts on the dam are largely non-flow related. The main use of the dam is for irrigation purposes. The Stompdrift and Kammanassie dams are the main sources of water for irrigation in the Klein Karoo, providing water to farms through a system of canals extending more than 75 km along the Olifants River valley downstream of the dams (Stompdrift-Kammanassie WUA). The water from the two dams and from other sources has been significantly over-allocated. As a result, water can only be supplied erratically, and in some years only at a fraction of the full allocation, making irrigated agriculture very difficult to manage and sustain. There is no EWR site in the Olifants River downstream. The river deteriorates significantly below the dam, relating to the minimal flow in the river, extensive reed growth in the channel, irrigation return flows and irrigation fields in the riparian zone. Recreational activities include kayaking, cruises, angling, swimming, etc.	Not applicable		Oudtshoorn Agricultural Study, 2007.
		Quality	Nutrients	In-lake phosphate concentrations are in the meso to eutrophic range (moderately to enriched range).	Ortho-phosphate (PO_4)	0.020 mg/ ℓ P	DWS NCMP data
					Total inorganic nitrogen	0.90 mg/ℓ N	
		Quality	Salts	Salt concentrations are high and in an Acceptable category.	Electrical conductivity	140 mS/m	DWS NCMP data

Table 3-152 Supplementary information for Wolwedans Dam on ecosystem scale

IUA	Name of dam	Component	Sub-component	Context of the RQO	Threshold of Probable Concern		Reference
G15 Coastal	Wolwedans	Quantity	Low flows	There are dryland and irrigated agriculture upstream of the dam, as well as some small farms dams, which impedes low flow. The dam is the main source of water for the municipality of Mossel Bay (Mossel Bay, Kleinbrak, Grootbrak) as well as the gas-to-liquids refinery PetroSA, i.e. municipal and industrial water supply. The dam has a significant impact on the downstream flow regime, and releases to the Groot Brak estuary is essential to meet the estuarine EWR requirements and to ensure estuarine health.	Not applicable		DWS, 2017 Groot Brak Estuary Management Plan, 2013.
			High flows				
		Quality	Nutrients	Phosphate concentrations are in the mesotrophic to eutrophic range (moderately to enriched range).	Ortho-phosphate (PO_4)	0.1005 mg/ ℓ P	DWAF, 2002
					Total inorganic nitrogen (TIN)	4.0 mg/ℓ N	
			Salts	Salt concentrations are moderately low, in the Ideal range but with excursions into the Acceptable range for domestic water use.	Electrical conductivity	≤ 75 mS/m	DWA, 2006

3.4 Wetland RQOs and numerical limits

The outcomes of the RQO and Numerical Limits determination for wetlands is shown as follows:

- RQOs for the wetland water per IUA are presented in Table 3-153.
- Supplementary information for Wetland RQOs on ecosystem scale is presented in Table 3-154.

Table 3-153 RQOs for Wetlands per IUA

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
A1 Upper Breede Tributaries	II	A1-W01	Strategic Water Source Wetlands	WR1 Western Folded	Quantity	Hydroperiod	Wetland extent	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
A2 Breede Working Tributaries	II	A2-W02	East Coast Shale Renosterveld FLOODPLAIN (Papenkuils)	WR1 Western Folded	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
A3 Middle Breede Tributaries	III	A3-W03	East Coast Shale Renosterveld FLOODPLAIN (Breede)	WR8 Southern Folded	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
F11 Lower Breede Renosterveld	II	F11-W04	East Coast Shale Renosterveld FLOODPLAIN (Breede)	WR3 Southern Coastal	Quantity	Hydroperiod	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
B4 Riviersonderend Theewaters	III	B4-W05	East Coast Shale Renosterveld FLOODPLAIN (Breede)	WR8 Southern Folded	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
B5 Overberg West	II	B5-W06	Strategic Water Source Wetlands	WR1 Western Folded and WR3 Southern Coastal	Quantity	Hydroperiod	Wetland extent	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
F10 Overberg East Renosterveld	II	F10-W07	Southwest Ferricrete Fynbos FLOODPLAIN (Kars)	WR8 Southern Coastal	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Geomorphology	Sediment accumulation	Floodplain acting as a deposition zone for sediment during high flow events.	Geomorphological assessment and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Amphibians & reptiles	Frog presence	Populations of frog must be maintained at least at current levels to meet NFEPA frog conservation targets.	N/A
H16 Overberg West Coastal	II	H16-W08	Southwest Sand Fynbos CHANNELLED VALLEY BOTTOM (Kleinmond)	WR2 Coastal Southern Folded	Quantity	Hydroperiod	Wetland extent	Channelled valley-bottom wetlands require retention of water with limited flow concentration.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the wetland vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Birds	Bird abundance*	Populations of Bank Comorant (*Phalacrocorax neglectus*), African Marsh Harrier (*Circus ranivorus*) and Blue Crane (*Anthropoides paradiseus)* must be maintained at least at current levels to meet conservation targets.	N/A
		H16-W09	Strategic Water Source Wetlands	WR2 Coastal Southern Folded	Quantity	Hydroperiod	Wetland extent	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
H17 Overberg East Fynbos	II	H17-W10	Southwest Ferricrete Fynbos FLOODPLAIN (Agulhas)	WR2 Coastal Southern Folded and WR4 Coastal Sediments	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
			Southwest Ferricrete Fynbos FLAT (Agulhas)	WR2 Coastal Southern Folded and WR4 Coastal Sediments	Quantity	Hydroperiod	Wetland extent	Flat wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	Define wetland extent and monitor every 5 years.

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
					Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Maintain or improve nutrient level.	Define nutrient level and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the wetland vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Amphibians & reptiles	Frog presence	Populations of frog must be maintained at least at current levels to meet NFEPA frog conservation targets.	N/A
					Biota	Invertebrates	Invertebrate presence	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	Invertebrate assessment and monitor every 5 years.
			Southwest Ferricrete Fynbos DEPRESSION (Agulhas)	WR4 Coastal Sediments	Quantity	Hydroperiod	Wetland extent	Depression wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	Define wetland extent and monitor every 5 years.
					Quality	Nutrients	Phosphate (PO4-P), Total Inorganic Nitrogen (TIN-N)	Maintain or improve nutrient level.	Define nutrient level and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Amphibians & reptiles	Frog presence	Populations of frog must be maintained at least at current levels to meet NFEPA frog conservation targets.	N/A
					Biota	Invertebrates	Invertebrate presence	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	Invertebrate assessment and monitor every 5 years.
		H17-W11	East Coast Shale Renosterveld FLOODPLAIN (De Hoop Vlei)	WR3 Southern Coastal and WR4 Coastal Sediments	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Birds	Bird abundance*	Populations of *Pelecanus onocrotalus, Ixobrychus minutus, Ciconia ngra, Phoenicopterus ruber, Phonicopterus minor, Hydroprogne caspia, Charadrius pallidrus* must be maintained at least at current levels to meet conservation targets.	N/A
		H17-W12	South Strandveld Western	WR4 Coastal Sediments	Quantity	Hydroperiod	Wetland extent	Flat and seep wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting	Define wetland extent and monitor every 5 years.

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
			Strandveld FLAT/SEEP (Heuningnes)					wetland vegetation.	
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the wetland vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Birds	Bird abundance*	Populations of Damara Tern (*Sterna balaenarum*) must be maintained at least at current levels to meet conservation targets.	N/A
C6 Gamka Buffels	II	C6-W13	Upper Nama Karoo DEPRESSION	WR5 Nama Karoo	Quantity	Hydroperiod	Wetland extent	Depression wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Wetland vegetation must be maintained or where necessary improved in order to protect the wetland vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Diatoms	Diatom presence	Diatom presence indicative of water quality.	Diatom assessment and monitor every 5 years.
					Biota	Invertebrates	Invertebrate presence	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	Invertebrate assessment and monitor every 5 years.
		C6-W14	Lower Nama Karoo DEPRESSION	WR6 Great Karoo	Quantity	Hydroperiod	Wetland extent	Depression wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Wetland vegetation must be maintained or where necessary improved in order to provide NFEPA cluster connectivity.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
					Biota	Diatoms	Diatom presence	Diatom presence indicative of water quality.	Diatom assessment and monitor every 5 years.
					Biota	Invertebrates	Invertebrate presence	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	Invertebrate assessment and monitor every 5 years.
E8 Touws	III	E8-W15	Strategic Water Source Wetlands	WR7 Cape Fold Swartberg	Quantity	Hydroperiod	Wetland extent	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
F13 Lower Gouritz	II	F13-W16	Albany Thicket FLOODPLAIN (Gouritz)	WR3 Southern Coastal	Quantity	Flow	High flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	High flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation must be maintained or where necessary improved in order to protect the floodplain vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
F12 Duiwenhoks	III	F12-W17	East Coast Shale Renosterveld CHANNELLED VALLEY BOTTOM (Goukou)	WR3 Southern Coastal	Quantity	Hydroperiod	Flow concentration and wetland extent	Flows should be such that they do not pose a threat to the nature of the wetland.	Define wetland extent and monitor every 5 years.
					Habitat	Geomorphology	Headcut and bank erosion	Current geomorphology of wetland to be maintained.	Define erosion extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Alien invasive plants, particularly *Acacia mearnsii*, affect the water distribution and cause bank erosion. The density of alien invasive plants need to be managed, especially in the vicinity of active erosion areas.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
		F12-W18	East Coast Shale Renosterveld CHANNELLED VALLEY BOTTOM (Duiwenhoks)	WR3 Southern Coastal	Quantity	Hydroperiod	Flow concentration and wetland extent	Flows should be such that they do not pose a threat to the nature of the wetland.	Define wetland extent and monitor every 5 years.
					Habitat	Geomorphology	Headcut and bank erosion	Current geomorphology of wetland to be maintained.	Define erosion extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Alien invasive plants, particularly Acacia mearnsii, affect the water distribution and cause bank erosion. The density of alien invasive plants need to be managed, especially in the vicinity of active erosion areas.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
G15 Coastal	II	G15-W19	Freshwater LAKE (Groenvlei)	WR11 Sedimentary Coastal Lakes	Quantity	Hydroperiod	Groundwater level, particularly eastern side of wetland	Water level of the Lake to be maintained through maintenance of groundwater levels.	Define wetland extent and monitor every 5 years. Groundwater levels to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Wetland vegetation must be maintained in order to provide habitat.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.
		G15-W20	Freshwater LAKE (Wilderness)	WR10 South East Coastal	Quantity	Flow	Flow	Water level of the lake to be maintained through maintaining freshwater inputs from surrounding rivers.	Flow at upstream river nodes to be maintained.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Critically endangered wetland vegetation and geomorphology must be maintained or where necessary improved in order to protect the vegetation surrounding the Ramsar site.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Indicator/ measure	RQO Narrative	RQO Numeric
					Biota	Birds	Bird abundance*	Populations of Little bittern (*Ixobrychus minutus payesii*) and Caspian tern (*Hydroprogne caspia*) must be maintained at least at current levels to meet conservation targets.	N/A
		G15-W21	Strategic Water Source Wetlands	WR10 South East Coastal	Quantity	Hydroperiod	Wetland extent	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent.	Define wetland extent and monitor every 5 years.
					Habitat	Vegetation	Natural vegetation versus alien invasive vegetation	Seeps to be maintained as Strategic Water Source Areas. Ability to provide water to downstream rivers require maintenance of wetland extent through maintenance of natural vegetation.	Define natural vegetation versus alien invasive vegetation and monitor every 5 years.

*Data obtained from bird clubs and conservation authorities. Measured as per methods prescribed by Avian Demography Unit, Department of Statistical Sciences University of Cape Town or Birdlife SA.

Table 3-154 Supplementary information for Wetland RQOs on ecosystem scale

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Context of RQO	Threshold of potential concern	Reference
A1 Upper Breede Tributaries	II	A1-W01	Strategic Water Source Wetlands	WR1 Western Folded	Quantity	Hydroperiod	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
					Habitat	Vegetation			
A2 Breede Working Tributaries	II	A2-W02	East Coast Shale Renosterveld FLOODPLAIN (Papenkuils)	WR1 Western Folded	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	Papenkuils Reserve
					Habitat	Vegetation	The Papenkuils floodplain has endangered vegetation (Breede Alluvium Fynbos). Floodplain vegetation is important as refuge for fauna as well as in the provision of important ecosystem services, particularly flood attenuation.	N/A	SANBI, 2017
A3 Middle Breede Tributaries	III	A3-W03	East Coast Shale Renosterveld FLOODPLAIN (Breede)	WR8 Southern Folded	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A
					Habitat	Vegetation	The portion of the Breede River floodplain has critically endangered vegetation (Muscadel Riviere, Cape Lowland Alluvial and Eastern Shale Renosterveld). Floodplain vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017
F11 Lower Breede Renosterveld	II	F11-W04	East Coast Shale Renosterveld FLOODPLAIN (Breede)	WR3 Southern Coastal	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A
B4 Riviersonderend Theewaters	III	B4-W05	East Coast Shale Renosterveld FLOODPLAIN (Breede)	WR1 Western Folded	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A
					Habitat	Vegetation	The floodplain has critically endangered vegetation (Central Roens Shale Renosterveld). Floodplain vegetation is important as refuge for fauna as well as in the provision of important ecosystem services, particularly sediment retention for Theewaterskloof dam.	N/A	SANBI, 2017
B5 Overberg West	II	B5-W06	Strategic Water Source Wetlands	WR2 Coastal Southern Folded	Quantity	Hydroperiod	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
					Habitat	Vegetation			
F10 Overberg East	II	F10-W08	Southwest Ferricrete	WR8 Southern Coastal	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Context of RQO	Threshold of potential concern	Reference
Renosterveld			Fynbos FLOODPLAIN (Kars)		Habitat	Geomorphology	Floodplain acting as a deposition zone for sediment during high flow events.	N/A	N/A
					Habitat	Vegetation	The floodplain has critically endangered vegetation (Central Roens Shale Renosterveld). Floodplain vegetation is important as refuge for fauna as well as in the provision of important ecosystem services, particularly sediment retention.	N/A	SANBI, 2017
					Biota	Amphibians & reptiles	NFEPA frog priority area.	N/A	Nel et al., 2011
H16 Overberg West Coastal	II	H16-W09	Southwest Sand Fynbos CHANNELLED VALLEY BOTTOM (Kleinmond)	WR2 Coastal Southern Folded	Quantity	Hydroperiod	Channelled valley-bottom wetlands require retention of water with limited flow concentration.	N/A	N/A
					Habitat	Vegetation	The wetland has critically endangered vegetation (Kogelberg Sandstone Fynbos). Vegetation is important as refuge for fauna as well as in the provision of important ecosystem services associated with maintenance of the Ramsar wetland.	N/A	SANBI, 2017
					Biota	Birds	Bird species as per Ramsar conditions.	N/A	Kleinmond Ramsar data sheet
		H16-W10	Strategic Water Source Wetlands	WR2 Coastal Southern Folded	Quantity	Hydroperiod	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
					Habitat	Vegetation			
H17 Overberg East Fynbos	II	H17-W11	Southwest Ferricrete Fynbos FLOODPLAIN (Agulhas)	WR2 Coastal Southern Folded and WR4 Coastal Sediments	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A
					Habitat	Vegetation	The floodplain has critically endangered vegetation (Elim Ferricrete Fynbos). Floodplain vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017
			Southwest Ferricrete Fynbos FLAT (Agulhas)	WR2 Coastal Southern Folded and WR4 Coastal Sediments	Quantity	Hydroperiod	Flat wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	N/A	N/A
					Habitat	Vegetation	The wetland has critically endangered vegetation (Elim Ferricrete Fynbos). Wetland vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017
					Biota	Amphibians & reptiles	NFEPA frog priority area.	N/A	Nel et al., 2011
					Biota	Invertebrates	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	N/A	Wilkinson et al., 2016

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Context of RQO	Threshold of potential concern	Reference
			Southwest Ferricrete Fynbos DEPRESSION (Agulhas)	WR4 Coastal Sediments	Quantity	Hydroperiod	Depression wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	N/A	N/A
					Quality	Nutrients	Large depression wetlands vulnerable to pollution.	N/A	Malan et al., 2015
					Habitat	Vegetation	The wetland has critically endangered vegetation (Elim Ferricrete Fynbos). Wetland vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017
					Biota	Amphibians & reptiles	NFEPA frog priority area.	N/A	Nel et al., 2011
					Biota	Invertebrates	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	N/A	Wilkinson et al., 2016
		H17-W12	East Coast Shale Renosterveld FLOODPLAIN (De Hoop Vlei)	WR3 Southern Coastal and WR4 Coastal Sediments	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A
					Habitat	Vegetation	Upper floodplain wetland has critically endangered vegetation (Central Roens Shale Renosterveld). Wetland vegetation is important as refuge for fauna as well as in the provision of important ecosystem services for the downstream Ramsar wetland.	N/A	SANBI, 2017
					Biota	Birds	Bird species as per Ramsar conditions.	N/A	De Hoop Vlei Ramsar data sheet
		H17-W13	South Strandveld Western Strandveld FLAT/SEEP (Heuningnes)	WR4 Coastal Sediments	Quantity	Hydroperiod	Flat and seep wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	N/A	N/A
					Biota	Birds	Bird species as per Ramsar conditions.	N/A	Heuningnes Ramsar data sheet
C6 Gamka Buffels	II	C6-W14	Upper Nama Karoo DEPRESSION	WR5 Nama Karoo	Quantity	Hydroperiod	Depression wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	N/A	N/A
					Habitat	Vegetation	Wetland vegetation must be maintained or where necessary improved in order to protect the wetland vegetation.	N/A	N/A

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Context of RQO	Threshold of potential concern	Reference
					Biota	Diatoms	Diatom presence indicative of water quality.	N/A	Wilkinson et al., 2016
					Biota	Invertebrates	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	N/A	Wilkinson et al., 2016
		C6-W15	Lower Nama Karoo DEPRESSION	WR6 Great Karoo	Quantity	Hydroperiod	Depression wetlands require inputs from surrounding runoff, and interflow, in order to provide wetting regime required for supporting wetland vegetation.	N/A	N/A
					Habitat	Vegetation	Wetland vegetation must be maintained or where necessary improved in order to provide NFEPA cluster connectivity.	N/A	Nel et al., 2011
					Biota	Diatoms	Diatom presence indicative of water quality.	N/A	Wilkinson et al., 2016
					Biota	Invertebrates	Presence of certain invertebrate taxa indicative of salinity, hydroperiod and acidity.	N/A	Wilkinson et al., 2016
E8 Touws	III	E8-W16	Strategic Water Source Wetlands	WR7 Cape Fold Swartberg	Quantity	Hydroperiod	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
					Habitat	Vegetation			
F13 Lower Gouritz	II	F13-W17	Albany Thicket F FLOODPLAIN (Gouritz)	WR3 Southern Coastal	Quantity	Flow	High flows need to be maintained in order to overtop banks and inundate floodplain vegetation.	N/A	N/A
					Habitat	Vegetation	Floodplain has critically endangered vegetation (Cape Lowland Alluvial). Wetland vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017
F12 Duiwenhoks	III	F12-W18	East Coast Shale Renosterveld CHANNELLED VALLEY BOTTOM (Goukou)	WR3 Sout Vegetation hern Coastal	Quantity	Hydroperiod	Flows should be such that they do not pose a threat to the nature of the wetland.	N/A	Working for Wetlands, 2015
					Habitat	Geomorphology	Current geomorphology of wetland to be maintained.	N/A	Working for Wetlands, 2015
					Habitat	Vegetation	The Goukou wetland system has critically endangered wetland vegetation (Eastern Roens Shale Renosterveld, East Coast Shale Renosterveld, Southern Siltcrete Fynbos) as well as peat with palmiet in the Grootbosberg and Lower Tierkloof wetlands. These wetlands have had rehabilitation efforts by the Working for Wetlands project focused on erosion mitigation. Wetland vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017 and Working for Wetlands, 2015

IUA	Class	RU	Wetland Name	Wetland Region	Component	Sub-component	Context of RQO	Threshold of potential concern	Reference
		F12-W19	East Coast Shale Renosterveld CHANNELLED VALLEY BOTTOM (Duiwenhoks)	WR3 Southern Coastal	Quantity	Hydroperiod	Flows should be such that they do not pose a threat to the nature of the wetland.	N/A	Working for Wetlands, 2015
					Habitat	Geomorphology	Current geomorphology of wetland to be maintained.	N/A	Working for Wetlands, 2015
					Habitat	Vegetation	The Duiwenhoks wetland system has critically endangered wetland vegetation (Eastern Roens Shale Renosterveld). The upper wetlands have had rehabilitation efforts by the Working for Wetlands project focused on erosion mitigation. Wetland vegetation is important as refuge for fauna as well as in the provision of important ecosystem services.	N/A	SANBI, 2017 and Working for Wetlands, 2015
G15 Coastal	II	G15-W20	Freshwater LAKE (Groenvlei)	WR11 Sedimentary Coastal Lakes	Quantity	Hydroperiod	Water level of the Lake to be maintained through maintenance of groundwater levels.	N/A	Rountree, 2009
					Habitat	Vegetation	Wetland vegetation must be maintained in order to provide habitat.	N/A	Rountree, 2009
		G15-W21	Freshwater LAKE (Wilderness)	WR10 South East Coastal	Quantity	Flow	Water level of the lake to be maintained through maintaining freshwater inputs from surrounding rivers.	N/A	Rountree, 2009
					Habitat	Vegetation	Critically endangered wetland vegetation and geomorphology must be maintained or where necessary improved in order to protect the vegetation surrounding the Ramsar site. The Wilderness Lake system occurs within the Garden Route National Park therefore the vegetation is considered to be protected	N/A	SANBI, 2017 and Rountree, 2009
					Biota	Birds	Bird species as per Ramsar conditions.	N/A	Wilderness Lakes Ramsar data sheet
		G15-W22	Strategic Water Source Wetlands	WR10 South East Coastal	Quantity	Hydroperiod	Important hillslope seeps contribute to water supply of downstream rivers.	N/A	CSIR, 2017
					Habitat	Vegetation			

*Data obtained from bird clubs and conservation authorities. Measured as per methods prescribed by Avian Demography Unit, Department of Statistical Sciences University of Cape Town or Birdlife SA.

3.5 Groundwater RQOs and numerical limits

3.5.1 Introduction

Whilst groundwater resource units have been defined, the preferred scale for application of RQOs is at quaternary catchment scale. Therefore, prioritisation was completed at quaternary catchment level, with the aim of at least one quaternary catchment being prioritise per Groundwater Resource Unit (GRU) – although not always necessary where an entire GRU does not met any criteria for prioritisation. The prioritised groundwater resource units, for which draft RQOs are developed, are shown in Table 3-155.

The selected components, sub-components and indicators are listed in Table 3-156 (as per resource evaluation stage). In addition, Table 3-156 provides the narrative RQOs applied, and shows the numerical limits applied for each RQO (where applicable, and where standardised between resource units). The supporting information column provides a motivation for the selection of this indicator, and its value. The items listed in Table 3-156 were considered for applicability in each prioritised area. Water quantity related RQOs (i.e. abstraction, water level and baseflow) are aimed at ensuring sufficient yield for all users, and to maintain groundwater discharge to support low flow river requirements. The setting of water quality related RQOs is aimed at maintaining the groundwater quality in relation to its background/present level.

In all cases the setting of RQO's has considered the aquifer-specific conditions such as interaction with surface water, and differing water quality. An RQO that is applicable to all aquifers in the prioritised area will be listed as "all", alternatively a specific aquifer grouping will be listed. The setting of RQOs is therefore based on an understanding of the behaviour of the various aquifers within each GRU. This is outlined in the Status Quo report and that information should be referred to in order to support the understanding of the RQOs established (specifically the detailed status quo assessment in appendix B, along with the geological map per GRU).

3.5.2 Results

The outcomes of the RQO determination for prioritised groundwater resource units is shown in Table 3-157 to Table 3-177.

Table 3-155 Groundwater resource units prioritised for development of RQOs

IUA	GRU	Quaternary
A1 Upper Breede Tributaries	BB-1	H10A
A1 Upper Breede Tributaries	BB-1	H10B
A1 Upper Breede Tributaries	BB-1	H10C
A1 Upper Breede Tributaries	BB-2	H20C
A3 Breede Working Tributaries	BB-2	H20A
A3 Breede Working Tributaries	BB-2	H20B
A3 Breede Working Tributaries	BB-2	H20F
A1 Upper Breede Tributaries	BB-3	H10F
A1 Upper Breede Tributaries	BB-3	H10J
A3 Breede Working Tributaries	BB-3	H10G
A3 Breede Working Tributaries	BB-3	H10H
A3 Breede Working Tributaries	BB-3	H10L
A3 Breede Working Tributaries	BB-4	H40B
A3 Breede Working Tributaries	BB-5	H20H
A3 Breede Working Tributaries	BB-5	H40C
A3 Breede Working Tributaries	BB-6	H30B
A3 Breede Working Tributaries	BB-7	H40J
A2 Middle Breede Renosterveld	BB-7	H40K
B4 Riviersonderend Theewaters	BR-1	H60A
Ba Riviersonderend Theewaters	BR-1	H60B
B4 Riviersonderend Theewaters	BR-1	H60C
*[Berg]**	*BO-1*	*G40A*
B5 Overberg West	BO-1	G40C
B5 Overberg West	BO-1	G40D
H16 Overberg West Coastal	BO-2	G40H
F10 Overberg East Renosterveld	BO-3	G50D
H17 Overberg East Fynbos	BO-3	G50B
H17 Overberg East Fynbos	BO-3	G50E
C6 Gamka-Buffels	GGr-3	J11E
C6 Gamka-Buffels	GGa-2a, 2b and 2c	J21A
C6 Gamka-Buffels	GGa-2a, 2b and 2c	J21B
C6 Gamka-Buffels	GGa-2a, 2b and 2c	J23A
C6 Gamka-Buffels	GGa-1	J24B
E8 Touws	GGr-1	J12C
D7 Gouritz-Olifants	GO-4	J35B
F13 Lower Gouritz	GGo-1	J40C
F13 Lower Gouritz	GGo-1	J40D
I18 Hessequa	GGo-2a and 2b	H90E
G14 Groot Brak	GC-1	K20A
G15 Coastal	GC-1	K20A
G15 Coastal	GC-2	K40D
G15 Coastal	GC-3	K70A

* *Although G40A is not part of the Brede-Gouritz WMA, it sits within the GRU BO-1 and was included in this table because the RQOs are presented per GRU*

Table 3-156 Outcome of Resource Evaluation stage for groundwater showing sub-components, indicators, and RQOs considered for each prioritised GRU

Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric	Supporting information
Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a	Whilst exploiting groundwater storage is acceptable for managing drought, and could be acceptable for short periods to bridge the transition to other bulk water supplies (i.e. 5-10 years desalination/ re-use), over the long-term, groundwater use should be sustainable for all users and the environment. The RQO essentially implies that groundwater mining is considered unacceptable in the long-term. Implementation of this RQO requires the authority to isolate the cause of groundwater level decline, and identify over-abstraction (unacceptable) from transition to new dynamic equilibrium (unavoidable), drought and climate change (unavoidable).
	Groundwater level (saline intrusion)	Groundwater level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	<1 mamsl	Saline intrusion is a risk in coastal aquifers, and maintaining groundwater levels above sea level prevents saline intrusion via upcoming and direct intrusion.
	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a	Groundwater use should be sustainable for all users and the environment. In areas where groundwater and surface water are hydraulically connected, it is assumed that the reversal of the natural gradient with surface water would have unacceptable impacts. Where groundwater discharges to surface water, groundwater abstraction close to surface water (distance dependent on aquifer diffusivity), or groundwater abstraction rates that reduce aquifer water levels beneath that of the river, would reverse the gradient towards the river, and surface water would be 'lost' to groundwater (indirect recharge). The setting of this RQO assumes that this would be unacceptable (for surface water resources / ecology).
	Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m	Whilst all abstraction reduces natural discharge to some extent and at some point, in time, the timing of surface water depletion (the response time) is related to the distance to surface water, and the hydraulic diffusivity. It is therefore aquifer- and abstraction location- specific. Abstraction far from surface water, and in an aquifer with lower diffusivity, may for all practical purposes not impact on surface water (for millennia). Given the variability in hydraulic diffusivity even at different locations within the same aquifer, the data is not available in order to determine area-specific numerical values. The numerical value listed is in alignment with best-practice guidelines.
	Low flow in river	Compliance with the lowflow requirements in the river	Maintain (groundwater component of) the low flow requirements in the river	(Case specific)	It is assumed that (a portion of) the maintenance low flow is derived from groundwater. Whilst all abstraction reduces natural discharge to some extent and at some point, in time, it would be unacceptable for abstraction to cause groundwater discharge to reduce below the maintenance low flow value, at locations that have been identified as having higher dependence on groundwater.

Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric	Supporting information
Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not deteriorate from natural background	(Case specific)	Groundwater management measures must ensure groundwater quality is protected. The parameters selected will support identification of a variety of pollution sources (captured in increase in salts), agricultural pollution (fertilisers), and saline intrusion. The numerical values generally represent the 90 or the 95 percentiles for the listed aquifer within the catchment or GRU depending on the statistics for the region. This is taken as a limit of acceptable deviation from natural background. Where insufficient data exists to establish robust statistics for an aquifer within an area, numerical values are either taken from the same aquifer in neighbouring areas or from data for the same aquifer across the wider region.
	Salts	SO_4		(Case specific)	
		EC		(Case specific)	
	Pathogens	E-coli		0 counts / 100 ml	Groundwater management measures must ensure groundwater quality is protected. The parameters selected will support identification of pollution from waste water (pathogens) and other bacteriological sources. The numerical value is based on drinking water quality standards.
	Pathogens	Total Coliform		10 counts / 100ml	

Table 3-157 RQOs for groundwater quality and quantity in priority catchments of BB-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A1 Upper Breede Tributaries	BB-1	H10A, H10B, H10C	Bokkeveld Group, Nardouw Group, Cenozoic coastal deposits	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Cenozoic coastal deposits - alluvium	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<6.8 mg/l
					Salts	EC		<311 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<2.4 mg/l
					Salts	EC		<236 mS/m
			Nardouw Group		Nutrients	NO_3 (as N)		<4.4 mg/l
					Salts	EC		<119 mS/m
			Bokkeveld Group, Nardouw Group, Cenozoic coastal deposits		Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		<10 counts / 100ml

Table 3-158 RQOs for groundwater quality and quantity in priority catchments of BB-3

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A1 Upper Breede Tributaries	BB-3	H10F, H10G, H10J, H10L	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			All		Low flow in river	Compliance with the low flow requirements in the river (as per riverine RQO)	Maintain (groundwater component of) the low flow requirements in the river	Maintenance low flow requirements: 56.125 Mm^3/a (12.90 %MAR) at H1H001; 30.215 Mm^3/a (28.63 %MAR) at H1H018
			Coastal cenozoic deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<9.6 mg/l
					Salts	EC		<73 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<1.8 mg/l
					Salts	EC		<109 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		<10 counts / 100ml

Table 3-159 RQOs for groundwater quality and quantity in priority catchments of BB-7

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A2 Middle Breede Renosterveld / A3 Breede Working Tributaries	BB-7	H40J, H40K	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Superficial aquifers		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<10 mg/l
					Salts	EC		<280 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<741 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.8 mg/l
					Salts	EC		<117 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-160 RQOs for groundwater quality and quantity in priority catchments of BB-2

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A3 Breede Working Tributaries	BB-2	H20A, H20B, H20C, H20F	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<11.0 mg/l
					Salts	EC		<168 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<1.8 mg/l
					Salts	EC		<329 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.7 mg/l
					Salts	EC		<63 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		<10 counts / 100ml

Table 3-161 RQOs for groundwater quality and quantity in priority catchments of BB-4

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A3 Breede Working Tributaries	BB-4	H40B	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<10 mg/l
					Salts	EC		<280 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<741 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.8 mg/l
					Salts	EC		<117 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-162 RQOs for groundwater quality and quantity in priority catchments of BB-5

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A3 Breede Working Tributaries	BB-5	H10H, H20H, H40C	Coastal cenozoic deposits	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
					Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
					Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
				Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<3.1 mg/l
					Salts	EC		<591 mS/m
					Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		<10 counts / 100ml

Table 3-163 RQOs for groundwater quality and quantity in priority catchments of BB-6

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
A3 Breede Working Tributaries	BB-6	H30B	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Coastal cenozoic deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<9.8 mg/l
					Salts	EC		<170 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<589 mS/m
			Nardouw Sub-Group		Nutrients	NO_3 (as N)		<4.4 mg/l
					Salts	EC		<119 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-164 RQOs for groundwater quality and quantity in priority catchments of BR-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Description (narrative)	Numerical Value
B4 Riviersonderend Theewaters	BR-1	H60A, H60B, H60C	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Superficial aquifers		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			All		Low flow in river	Compliance with the low flow requirements in the river (as per riverine RQO)	Maintain (groundwater component of) the low flow requirements in the river	Maintenance low flow requirements: 12.567 Mm^3/a (28.63 %MAR) at Nvii10
			Coastal cenozoic deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<10 mg/l
					Salts	EC		<280 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<741 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.8 mg/l
					Salts	EC		<70 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-165 RQOs for groundwater quality and quantity in priority catchments of BO-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
B5 Overberg West	BO-1	G40A, G40C, G40D	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Superficial aquifers		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			All		Low flow in river	Compliance with the low flow requirements in the river (as per riverine RQO)	Maintain (groundwater component of) the low flow requirements in the river	Maintenance low flow requirements: 12.669 Mm^3/a (31.79 %MAR) at Piii1; 54.260 Mm3/a (26.26 %MAR) at G4H030; 77.111 Mm3/a (30.79 %MAR) at G4H007
			Bokkeveld Group	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<3.6 mg/l
					Salts	EC		<589 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.8 mg/l
					Salts	EC		<117 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-166 RQOs for groundwater quality and quantity in priority catchments of BO-2

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
H16 Overberg West Coastal	BO-2	G40H	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			All		Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	>1 mamsl
			Superficial aquifers		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<9.8 mg/l
					Salts	EC		<280 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<589 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.8 mg/l
					Salts	EC		<117 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		<10 counts / 100ml

Table 3-167 RQOs for groundwater quality and quantity in priority catchments of BO-3

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
F10 Overberg East Renosterveld / H17 Overberg East Fynbos	BO-3	G50B, G50D, G50E	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			All		Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	>1 mamsl
			Superficial aquifers		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			All		Low flow in river	Compliance with the low flow requirements in the river (as per riverine RQO)	Maintain (groundwater component of) the low flow requirements in the river	Maintenance low flow requirements: 0.490 Mm^3/a (3.93 %MAR) at Ni4; 2.067 Mm^3/a (13.40 %MAR) at G5H003.
			Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<10 mg/l
					Salts	EC		<280 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<741 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<3.8 mg/l
					Salts	EC		<117 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		<10 counts / 100ml

Table 3-168 RQOs for groundwater quality and quantity in priority catchments of GGr-3

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
C6 Gamka-Buffels	GGr-3	J11E	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			Karoo Supergroup	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<11.7 mg/l
					Salts	SO_4		< 600 mg/l
						EC		<231 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-169 RQOs for groundwater quality and quantity in priority catchments of GGa-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
C6 Gamka-Buffels	GGa-1	J24B	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Beaufort Group, Karoo Supergroup	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<12.0 mg/l
					Salts	SO_4		< 237 mg/l
						EC		<226 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-170 RQOs for groundwater quality and quantity in priority catchments of GGa-2

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
C6 Gamka-Buffels	GGa-2a, 2b and 2c	J21A, J21B, J23A	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			Beaufort Group, Karoo Supergroup	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<15.8 mg/l
					Salts	SO_4		<525 mg/l
						EC		<310 mS/m
			Coastal cenozoic deposits		Nutrients	NO_3 (as N)		<15.9 mg/l
					Salts	SO_4		<634 mg/l
						EC		<367 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-171 RQOs for groundwater quality and quantity in priority catchments of GGr-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
E8 Touws	GGr-1	J12C, J12D	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Cenozoic coastal deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<9.8 mg/l
					Salts	EC		<170 mS/m
			Witteberg Group		Nutrients	NO_3 (as N)		<11.0 mg/l
					Salts	EC		<420 mS/m
			Bokkeveld Group		Nutrients	NO_3 (as N)		<3.6 mg/l
					Salts	EC		<589 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-172 RQOs for groundwater quality and quantity in priority catchments of GO-4

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
D7 Gouritz-Olifants	GO-4	J35B	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Bokkeveld Group	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<11.0 mg/l
					Salts	EC		<589 mS/m
			Table Mountain Group		Nutrients	NO_3 (as N)		<11.0 mg/l
					Salts	EC		<170 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-173 RQOs for groundwater quality and quantity in priority catchments of GGo-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
F13 Lower Gouritz	GGo-1	J40C, J40D	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			All		Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
			All		Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
			Coastal cenozoic deposits	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<3.3 mg/l
					Salts	EC		<170 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-174 RQOs for groundwater quality and quantity in priority catchments of GGo-2

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
I18 Hessequa	GGo-2a and 2b	H90E	All	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
			Coastal Cenozoic Sand	Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<4.5 mg/l
					Salts	EC		<316 mS/m
			All		Pathogens	E-coli		0 counts / 100 ml
			All		Pathogens	Total Coliform		<10 counts / 100ml

Table 3-175 RQOs for groundwater quality and quantity in priority catchments of GC-1

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
G14 Groot Brak / G15 Coastal	GC-1	K20A	All	Quantity	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
					Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m

Table 3-176 RQOs for groundwater quality and quantity in priority catchments of GC-2

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	GC-2	K40D	Cenozoic coastal deposits	Quantity	Abstraction	Seasonal abstraction: water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles. Permanent abstraction: water level decline stabilises under consideration of aquifer response time.	Groundwater use should be sustainable for all users and the environment	n/a
					Groundwater level	Water level	Minimum water level in abstraction boreholes within 2.5km from the ocean to avoid saline intrusion	>0.5 mamsl
					Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
					Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m
				Quality	Nutrients	NO_3 (as N)	Groundwater should be fit for domestic use after treatment; and groundwater quality shall not show a deteriorating trend from natural background	<11.0 mg/l
					Salts	EC		<170 mS/m
					Pathogens	E-coli		0 counts / 100 ml
					Pathogens	Total Coliform		10 counts / 100ml

Table 3-177 RQOs for groundwater quality and quantity in priority catchments of GC-3

IUA	GRU	Quat(s)	Aquifer	Component	Sub-Component	Indicator	RQO Narrative	RQO Numeric
G15 Coastal	GC-3	K70A	Cenozoic coastal deposits	Quantity	Discharge	Relative water levels between groundwater and surface water (in mamsl)	The natural gradient between groundwater and surface water should be maintained	n/a
					Discharge	Buffer zones	No groundwater abstraction around wetland and river FEPAs in accordance with the implementation manual for FEPAs.	250m

4 Addressing uncertainties

Since the submission of the first draft of this Outline of Resource Quality Objectives Report, on March 2018, until its final submission, July 2018, several stakeholder meetings have been held, as follows:

- Technical Task Group Meeting 2, from 12 to 16 March 2018
- Sector Meeting 1: Estuaries, on 17 April 2018
- Sector Meeting 2: Agriculture, on 24 May 2018
- Project Steering Committee Meeting 3, on 12 June 2018
- Sector Meeting 3: Municipalities (and Agriculture), on 13 June 2018.

At the stakeholder workshop sessions, the proposed RUs, sub-components and indicators were presented and discussed with stakeholders and the final RUs, sub-components and indicators were reviewed, updated and refined. Furthermore, all the comments received have been addressed and incorporated in the relevant sections of this report.

Some of the key limitation and uncertainties which may influence the confidence of the outcomes of the RQOs and numerical limits process which should be considered when implementing the RQOs are described below.

4.1.1 Dams

There is some uncertainty regarding data availability, which slightly limits the confidence of certain indicators and numerical limits. The limitation with respect to the outlet structures of almost all dams, may imply that it will remain unlikely that larger floods can be released from almost all dams, unless there is a commitment for significant investment into upgrading the outlet infrastructure – this should be confirmed. The conflict between high release flows from dams for agriculture vs. low flow EWR requirements in downstream river reaches makes it uncertain whether the seasonality of EWR low flows regimes can be attained, unless irrigation release patterns can be changed, which seems unlikely.

4.1.2 Wetlands

Detailed information available about wetlands is either through the Reserve Determination studies, or through specific rehabilitation projects such as the Working for Wetlands project. In other systems which have not been prioritised as part of larger studies this level of data is not available. The level of detail required for RQO determination for wetlands is not comparable to the level of detail that has gone into the longer term and detailed river or estuarine systems. The spatial scale of wetland systems also needs to be considered as implementation of the RQOs may require monitoring over large spatial scales.

4.1.3 Groundwater

Given the nature of groundwater it is not possible or meaningful to assign numerical limits for several indicators. Some relate to long term trends, or to maintaining relative rather than absolute values. This has become accepted in RQO development for groundwater (for example DWA, 2013), however then requires the regulator to undertake the necessary analysis to determine compliance. RQOs must be implementable, and the non-numeric RQOs and the analysis required to enforce them will specifically be discussed with stakeholders.

The amount of water quality data varies considerably across the area with some quaternary catchments having >100 datasets on which to base a numerical value, and others having less than 5. Where water quality data is sparse, a balance must be struck between setting a limit which may be too stringent for the natural background of that area, and a limit that is too high and provides ineffective aquifer protection. The setting of aquifer-specific values, and the use of the regional aquifer-specific values where local information was not available, have minimised the uncertainties. Nevertheless, where a decision was required, the limits set were generally conservative. A conservative limit is implementable by the Department: the onus would be on a groundwater user to demonstrate that the groundwater quality at their borehole is naturally beyond the limit.

4.2 Way forward

The next step of the RQO determination process, Sub-step 5.8, involves the confidence assessment in both the RQOs and in the process followed in determining the narrative statements. The confidence in the RQOs is dependent on the accuracy of information used in the process. The assessment of confidence was undertaken for the processes applied and associated outputs at both the catchment and Resource Unit scale and is included in the Determination of Water Resources Classes and Resource Quality Objectives in the Breede-Gouritz Water Management Area: Confidence Assessment of Resource Quality Objectives report.

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Appendix A

Hydrological RQOs: all nodes

The TECs and hydrological RQOs for all the nodes in the Breede Basin are provided in Table A-1.

Table A-1 TECs, monthly flow volumes (Mm^3), annual volume, and % annual nMAR for nodes in the Breede Basin (includes inter-annual floods)

Node	Quat	River	REC	TEC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
Niv3	H10B	Titus		C	1.39	0.14	0.00	0.00	0.00	0.00	0.40	2.53	4.76	4.24	4.66	3.32	21.45	82.03
Niv1	H10C	Koekedou		D	1.39	0.19	0.03	0.02	0.01	0.01	0.18	1.16	2.51	3.72	3.74	2.63	15.59	96.32
Niv2	H10C	Dwars		C	4.07	1.88	0.86	0.47	0.37	0.36	0.73	3.29	7.45	8.66	10.23	7.83	46.20	52.94
nvi4	H10C	Breede		C	7.19	2.19	0.57	0.41	0.41	0.43	1.67	7.43	15.29	17.88	19.72	14.44	87.61	64.81
Niv4	H10D	Witels		A	4.91	3.00	1.09	0.82	1.28	1.26	4.26	11.08	17.60	16.26	14.83	7.94	84.33	100.00
Nvi3	H10D	Breede		C	11.85	4.11	0.67	0.58	1.10	0.98	5.32	21.24	30.46	31.17	30.25	14.91	152.64	72.88
Nvii16	H10E	Witte		A	2.42	1.45	0.65	0.35	0.37	0.50	1.77	4.93	7.45	7.87	7.06	4.32	39.13	92.04
Niv5	H10F	Witte		A	8.23	4.68	1.95	0.96	1.01	1.37	4.97	15.05	23.90	25.38	23.23	14.52	125.27	88.40
Niv6	H10F	Waboomś		D	0.13	0.02	0.00	0.00	0.00	0.00	0.03	0.36	1.08	1.22	1.28	0.62	4.74	37.75
Nviii1	H10F	Breede (**IFR1-priority**)	D	D/E	20.73	6.86	1.00	0.73	1.26	1.29	9.16	38.34	60.56	63.54	60.90	34.14	298.52	75.82
Niv40	H10J	Elands		B	3.26	1.97	1.04	0.66	0.70	0.94	2.63	6.78	10.08	10.37	9.27	5.88	53.59	92.20
Niv41	H10J	Krom		B	0.50	0.30	0.16	0.10	0.11	0.15	0.41	1.05	1.56	1.60	1.43	0.91	8.28	92.21
Nvii2	H10J	Molenaars (**IFR2-priority**)	B	B	5.92	3.58	1.89	1.20	1.27	1.70	4.77	12.32	18.31	18.84	16.83	10.68	97.30	92.20
Niv7	H10G	Slanghoek		D	2.50	0.95	0.06	0.02	0.02	0.02	0.33	1.48	3.73	4.78	5.22	4.03	23.13	47.73
Niii1	H10G	Breede		D	25.94	8.88	1.02	0.66	1.19	1.22	9.68	41.18	64.29	68.32	66.12	38.17	326.67	74.99
Niv42	H10J	Smalblaar		E	10.71	6.46	3.41	2.15	2.28	3.07	8.62	22.30	33.15	34.10	30.47	19.32	176.03	92.20
Niv8	H10H	Jan du Toit		D	1.65	0.80	0.11	0.04	0.02	0.03	0.08	0.78	2.39	2.95	3.23	2.52	14.59	47.53
Nvii6	H10H	Hartbees		D	0.37	0.17	0.02	0.00	0.00	0.00	0.01	0.17	0.51	0.63	0.70	0.56	3.15	77.96
Niv9	H10H	Hartbees		D	0.94	0.45	0.06	0.02	0.01	0.01	0.04	0.44	1.34	1.66	1.82	1.43	8.21	58.41
Niv12	H10K	Holsloot		C	7.52	3.89	1.10	0.18	0.15	0.24	1.93	8.00	14.87	18.44	18.53	12.96	87.81	81.68
Nv3	H10H	Breede		C	47.37	20.26	5.56	2.59	3.17	4.15	20.67	52.71	85.31	84.14	83.15	51.73	460.81	59.83
Nv18	H20F	Hex		D/E	0.22	0.17	0.05	0.05	0.02	0.01	0.06	0.17	0.65	1.18	1.42	0.83	4.83	50.77
Nvii7	H20G	Hex (Hex-**IFR3-priority**)	C	C	6.08	4.83	2.34	2.39	1.24	0.69	2.69	5.29	12.17	16.94	17.87	9.76	82.30	80.73
Niv10	H20H	Hex		D	3.30	2.86	0.49	0.93	0.44	0.15	2.12	3.76	9.84	14.41	16.46	7.42	62.18	58.69
Nii1	H40C	Breede		C	38.47	17.65	5.67	3.20	3.49	4.29	17.71	51.40	88.65	98.38	99.06	55.08	483.06	59.70

Node	Quat	River	REC	TEC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
Nvii5	H40B	Koo		D	0.04	0.03	0.01	0.01	0.01	0.00	0.03	0.04	0.09	0.10	0.18	0.09	0.62	41.86
Niv11	H40C	Nuy		E	0.49	0.40	0.08	0.10	0.14	0.04	0.17	0.54	0.77	1.50	2.76	1.72	8.72	38.24
Niv18	H30B	Kingna		D	1.06	0.79	0.62	0.25	0.26	0.45	1.97	1.93	1.62	2.05	3.22	1.56	15.79	42.98
Niv20	H30C	Pietersfontein		D	1.03	0.86	0.59	0.29	0.30	0.47	2.14	2.11	1.52	1.76	2.49	0.92	14.47	83.82
Nvii9	H30D	Keisie		D	1.24	1.04	0.73	0.36	0.38	0.60	2.62	2.43	1.76	2.08	3.06	1.11	17.42	73.21
Niv13	H40D	Doring ((**IFR3-priority**)		E	1.95	1.37	0.66	0.62	0.62	0.37	1.95	3.14	5.53	7.97	8.14	4.56	36.88	77.78
Nvii8	H40F	Breede	C/D	D	40.91	19.42	6.42	3.91	4.25	4.71	19.83	55.08	94.95	107.85	109.96	61.37	528.66	59.76
Ni1	H40F	Breede		B	40.88	18.80	5.31	3.17	3.53	3.84	19.79	55.21	95.24	108.29	110.52	61.57	526.15	59.45
Nvii11	H40G	Poesjenels		D	0.69	0.67	0.45	0.11	0.18	0.24	1.04	0.89	0.75	1.04	1.45	0.64	8.17	43.90
Niv15	H40H	Vink		D	0.51	0.49	0.20	0.31	0.25	0.13	0.97	1.21	2.54	2.76	2.68	1.08	13.13	45.45
Nviii2	H40J	Willem Nels		D	0.35	0.36	0.24	0.12	0.14	0.19	0.57	0.51	0.43	0.50	0.68	0.33	4.43	44.77
Nvii19	H40J	Breede		B	41.88	19.75	5.48	3.92	4.25	4.38	22.38	57.82	98.97	112.60	115.33	63.61	550.38	58.97
Nvii12	H40K	Keisers		D	0.24	0.26	0.17	0.04	0.07	0.12	0.46	0.32	0.25	0.61	0.94	0.39	3.86	56.39
Niv14	H40K	Keisers		D	0.41	0.41	0.27	0.07	0.12	0.22	0.82	0.62	0.51	0.95	1.52	0.73	6.65	53.97
Nvi1	H40L	Breede		D	43.00	20.92	6.46	4.55	4.88	5.12	24.64	59.89	100.88	115.25	119.26	65.71	570.56	58.82
Nii2	H30E	Kogmanskloof		D	2.57	1.99	1.46	0.73	0.78	1.27	5.11	4.74	3.68	4.48	6.79	2.94	36.53	53.92
Niii3	H50A	Breede		D	44.76	21.61	6.31	3.82	4.29	5.22	29.60	64.74	104.64	119.85	126.26	68.45	599.55	58.26
Ni2	H50B	Breede (**priority**)		D	45.63	22.34	6.53	3.87	4.28	5.55	30.85	65.96	105.54	120.92	128.10	69.37	608.95	58.23
Nvii10	H60B	Du Toits (**priority**)		B	3.11	2.18	0.95	0.62	0.62	0.66	1.96	4.15	6.72	7.14	7.50	4.27	39.88	90.87
Nv7	H60D	Riviersonderend (**priority**)		C	13.53	9.15	5.88	4.80	3.73	5.22	7.37	4.65	15.10	37.16	48.01	28.60	183.19	52.12
Niv28	H60E	Baviaans (**IFR6-priority**)	B	B	0.56	0.50	0.24	0.14	0.14	0.12	0.39	0.68	1.09	1.15	1.21	0.75	6.97	88.72
Niv29	H60E	Sersants		D	0.32	0.29	0.14	0.08	0.08	0.07	0.22	0.39	0.63	0.66	0.70	0.43	4.02	54.44
Niv30	H60F	Gobos		C	0.86	0.75	0.32	0.16	0.16	0.14	0.59	1.04	1.70	1.81	1.92	1.19	10.65	62.36
Nv9	H60F	Riviersonderend (**IFR5-priority**)	D	D	16.60	11.89	7.14	5.47	4.37	5.83	9.50	8.37	21.11	43.54	54.75	32.79	221.36	52.44
Niv31	H60G	Kwartel		D	0.84	0.78	0.40	0.21	0.23	0.27	0.87	1.02	1.21	1.34	1.56	0.96	9.69	53.38
Niv33	H60H	Soetmelksvlei		D	0.20	0.18	0.07	0.04	0.04	0.03	0.17	0.29	0.40	0.47	0.54	0.32	2.73	47.90
Niv34	H60H	Slang		D	0.11	0.09	0.04	0.02	0.02	0.01	0.09	0.15	0.21	0.24	0.28	0.16	1.42	47.90

Node	Quat	River	REC	TEC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
Nv10	H60H	Riviersonderend		D	18.57	13.43	7.47	5.29	4.20	6.02	11.60	10.96	24.28	47.18	59.06	35.33	243.39	51.95
Nv11	H60J	Riviersonderend		D	20.06	14.73	8.00	5.46	4.39	6.37	13.19	12.85	26.53	49.67	61.97	37.11	260.33	53.42
Niv35	H60K	Kwassadie		E	0.52	0.47	0.21	0.07	0.06	0.20	0.57	0.56	0.45	0.54	0.84	0.50	4.98	84.68
Nv12	H60K	Riviersonderend		D	21.05	15.59	8.22	5.31	4.20	6.61	14.28	13.92	27.39	50.71	63.59	38.08	268.97	53.96
Ni3	H60L	Riviersonderend (**priority**)		D	21.44	15.58	7.37	4.09	2.94	6.12	15.06	14.82	28.14	51.61	64.97	38.72	270.87	53.31
Niv24	H70A	Leeu		E	0.51	0.51	0.24	0.08	0.07	0.19	0.57	0.58	0.42	0.50	0.83	0.44	4.92	85.44
Niv24a	H70B	Klip		E	2.80	2.44	1.03	0.93	1.09	2.05	2.40	1.95	1.50	2.09	3.42	2.47	24.18	92.40
Nv2	H70B	Breede		C	71.78	42.08	15.43	8.90	8.49	14.48	50.16	84.50	136.49	176.31	199.32	108.94	916.87	57.48
Nvii14	H70C	Huis		C	0.23	0.25	0.11	0.06	0.06	0.09	0.24	0.24	0.16	0.19	0.34	0.18	2.18	75.01
Nii3	H70C	Tradouw		B	1.44	1.61	0.73	0.38	0.40	0.61	1.57	1.60	1.14	1.31	2.23	1.22	14.25	75.21
Niv25	H70F	Buffeljags		E	10.79	9.13	3.54	2.57	3.27	6.27	8.42	6.97	5.64	8.38	13.81	8.30	87.07	73.18
Niii4	H70G	Breede (**IFR4-priority**	B/C	C	83.60	51.99	18.66	10.80	11.31	20.73	59.48	92.32	142.97	185.77	214.80	118.66	1011.09	58.52
Nviii3	H70H	Breede		B/C	83.60	51.99	18.80	10.66	11.11	20.67	59.48	92.32	142.97	185.77	214.80	118.66	1010.83	58.41
Niv26	H70J	Slang		E	1.09	1.13	0.46	0.18	0.19	0.42	0.79	0.68	0.64	0.83	1.32	1.22	8.95	51.86
Nxi2	H70K	Bree estuary	B	B	85.03	53.50	19.43	10.91	11.37	21.24	60.54	93.21	143.78	186.82	216.52	120.23	1022.56	47.19

The TECs and hydrological RQOs for all the nodes in the Overberg Basins are provided in Table A-2.

Table A-2 TECs, monthly flow volumes (Mm^3), annual volume, and % annual nMAR for nodes in the Overberg Basins (includes inter-annual floods)

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
Piii1	G40C	Palmiet (IFR1-**priority**)	B	C	3.27	1.54	0.67	0.26	0.21	0.26	0.80	2.83	6.23	7.97	7.87	6.02	37.94	95.19
Piv10	G40C	Witklippieskloof		D	0.83	0.18	0.06	0.02	0.01	0.02	0.10	0.46	1.33	1.93	2.19	1.75	8.88	58.93
Piv9	G40C	Palmiet		D	3.44	0.84	0.33	0.16	0.12	0.12	0.27	1.24	3.72	6.33	8.66	7.35	32.58	42.96
Pvi1	G40C	Palmiet		D	5.51	1.20	0.39	0.14	0.07	0.15	0.67	3.06	8.87	12.90	14.59	11.65	59.20	60.68
Piv8	G40C	Klipdrif		D	1.08	0.58	0.27	0.11	0.09	0.10	0.32	1.05	2.07	2.56	2.51	1.93	12.66	93.39
Piv4	G40D	Klein-Palmiet		D	0.77	0.36	0.15	0.08	0.07	0.09	0.29	0.92	1.75	2.38	2.51	1.73	11.08	80.71
Piv7	G40D	Krom/Ribbok		D	1.05	0.26	0.01	0.03	0.00	0.00	0.00	0.03	0.32	1.91	3.25	2.72	9.57	34.85
Piii2	G40D	Palmiet (IFR3-**priority**)	B/C	B/C	11.63	3.31	0.99	0.59	0.38	0.48	1.59	6.49	16.89	28.41	33.45	25.70	129.89	63.71
Piv12	G40D	Dwars/Louws		C	1.86	1.01	0.45	0.23	0.20	0.25	0.82	2.52	4.44	4.97	4.84	3.29	24.87	98.81
Piii3	G40D	Palmiet (IFR4-**priority**)	B	B	14.61	4.82	1.51	0.82	0.57	0.72	2.77	10.61	24.35	36.79	41.62	31.16	170.37	69.83
Pxi1	G40D	Palmiet estuary	B	C	14.83	4.86	1.52	0.82	0.58	0.73	2.80	10.73	24.68	37.51	42.63	31.75	173.44	70.13
Bxi1	G40B	Buffels	B	B	0.91	0.42	0.08	0.01	0.01	0.01	0.08	0.50	1.43	1.86	1.98	1.49	8.80	81.86
Bxi2	G40B	Rooiels	B	B	0.95	0.53	0.23	0.11	0.07	0.07	0.21	0.69	1.43	1.79	1.90	1.46	9.44	98.63
Niv43	G40F	Swart		E	2.82	1.93	0.76	0.35	0.46	0.61	2.17	3.70	5.35	6.31	8.12	4.84	37.41	88.83
Niii5	G40E	Bot		C	5.25	3.54	1.42	0.83	0.93	0.95	3.07	4.86	8.00	10.66	14.49	8.36	62.35	84.20
Nxi6	G40G	Bot estuary	B	C	6.54	4.33	1.70	1.03	1.19	1.14	3.75	5.91	9.97	13.25	18.20	10.68	77.67	81.78
Nxi8	G40H	Onrus estuary	D	E/F	0.22	0.15	0.07	0.05	0.06	0.05	0.12	0.18	0.30	0.40	0.55	0.36	2.49	51.77
Nii4	G40J	Hartbees		D	1.32	0.71	0.27	0.12	0.15	0.19	0.69	1.15	1.87	2.76	4.22	2.56	15.99	55.69
Niv45	G40K	Steenbok		E	0.93	0.59	0.27	0.10	0.11	0.14	0.50	0.80	1.20	1.60	2.31	1.53	10.06	93.40
Nv23	G40K	Klein (Kle1-**priority**)	C	C/D	3.38	2.02	0.86	0.35	0.39	0.50	1.79	2.92	4.53	6.32	9.36	5.97	38.38	79.11
Nxi7	G40L	Klein estuary	B	C	4.57	2.63	1.01	0.50	0.64	0.65	2.70	3.94	6.42	8.44	12.12	7.59	51.21	85.58
Nx8	G40M	Uilkraal		C	0.16	0.09	0.03	0.02	0.03	0.02	0.11	0.12	0.22	0.24	0.29	0.18	1.50	92.00
Nxi5	G40M	Uilkraal estuary	C	E/F	0.60	0.29	0.05	0.04	0.10	0.06	0.50	0.50	0.92	1.12	1.31	0.80	6.28	58.79
Nxi3	G50A	Ratel estuary	C	C	0.33	0.22	0.09	0.07	0.09	0.07	0.26	0.29	0.50	0.52	0.61	0.37	3.42	72.99
Ni4	G50B	Nuwejaar (Nuw1-**priority**)	D	D	0.63	0.35	0.11	0.09	0.14	0.10	0.47	0.47	0.90	1.01	1.18	0.74	6.19	71.67

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
Nvii15	G50C	Heuningnes		D	0.91	0.51	0.17	0.14	0.20	0.14	0.71	0.68	1.31	1.42	1.66	1.05	8.90	71.67
Niv44	G50C	Heuningnes		D	0.97	0.55	0.18	0.14	0.21	0.15	0.76	0.72	1.39	1.50	1.76	1.11	9.43	71.67
Nv24	G50D	Kars (Kar1-**priority**)	B	B/C	1.76	1.25	0.48	0.32	0.35	0.53	1.42	1.32	1.73	1.50	1.92	1.30	13.89	89.99
Nii5	G50E	Kars		E	2.40	1.76	0.74	0.52	0.56	0.80	2.03	1.88	2.38	2.06	2.63	1.81	19.56	85.84
Nxi1	G50F	Heuningnes estuary	A	C	3.53	2.38	0.92	0.66	0.77	0.96	2.93	2.74	4.04	3.82	4.70	3.12	30.56	78.17
Nii6	G50G	Sout		D	0.42	0.26	0.09	0.06	0.08	0.14	0.45	0.34	0.47	0.28	0.35	0.16	3.09	73.69
Nii7	G50H	DeHoopVlei		B	3.09	2.12	0.78	0.52	0.60	0.95	2.68	2.44	3.23	2.74	3.49	2.23	24.88	91.96
Bxi3	G50K	Klipdrifsfontein estuary	A	A	0.08	0.12	0.05	0.02	0.02	0.05	0.09	0.06	0.04	0.04	0.10	0.08	0.75	64.77

The TECs and hydrological RQOs for all the nodes in the Gouritz Basin are provided in Table A-3.

Table A-3 TECs, monthly flow volumes (Mm³), annual volume, and % annual nMAR for nodes in the Gouritz Basin (includes inter-annual floods)

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
giv30	J12C	Ysterdams		D	0.03	0.11	0.02	0.05	0.01	0.01	0.06	0.11	0.41	0.32	0.25	0.06	1.44	40.77
giv31	J12B	Donkies		D	0.09	0.27	0.10	0.16	0.06	0.02	0.16	0.38	0.88	0.82	0.72	0.17	3.83	47.30
giv28	J12D	Touws		D	0.18	0.67	0.18	0.36	0.10	0.04	0.34	0.81	2.39	1.95	1.60	0.33	8.95	44.15
giv27	J12H	Touws		B	0.38	1.07	0.45	0.69	0.53	0.24	0.66	1.22	3.06	2.42	2.02	0.52	13.25	44.95
giv26	J12K	Brak		C	0.01	0.14	0.07	0.02	0.04	0.03	0.03	0.03	0.01	0.01	0.02	0.01	0.41	13.77
gviii1	J12L	Doring (EWR7-**priority**)	C/D	C/D	0.10	0.11	0.12	0.13	0.15	0.10	0.17	0.12	0.04	0.05	0.09	0.07	1.24	43.79
gv5	J12L	Touws (EWR3-**priority**)	B/C	B/C	0.55	1.38	0.70	0.90	0.80	0.41	0.93	1.42	3.13	2.50	2.17	0.63	15.53	43.01
gv4	J11H	Buffels (EWR5-**priority**)	C	C	1.01	1.02	1.45	2.89	1.17	0.89	1.52	1.26	1.64	1.28	1.07	1.33	16.52	66.36
gv6	J11J	Groot		D	0.56	0.44	0.51	1.98	0.79	0.31	1.45	1.32	1.72	1.35	1.15	1.10	12.66	44.48
giv32	J11K	Groot		D	0.35	0.35	0.32	1.86	0.76	0.22	1.39	1.34	1.73	1.35	1.15	0.95	11.76	38.91
gv7	J13A	Groot		C	1.13	1.98	1.29	2.98	1.76	0.72	2.72	3.10	4.94	3.90	3.66	1.66	29.84	39.80
gii3	J13C	Groot		B	1.45	2.52	1.85	3.34	1.98	0.93	3.04	3.35	5.03	4.03	4.00	1.90	33.42	42.01
giv34	J11C	Buffels		A	0.31	0.82	1.04	1.57	0.89	0.81	1.15	1.23	1.88	1.25	1.23	0.52	12.70	97.20
gv25	J11F	Buffels		C	0.63	1.40	2.00	2.79	1.67	1.51	2.74	2.24	2.88	2.01	1.92	0.81	22.60	92.34
gv18	J21A	Gamka		B	0.82	2.17	1.78	1.45	3.30	4.47	2.44	1.08	0.38	0.45	1.39	0.93	20.68	78.30
giv3	J21D	Gamka		B	0.87	2.57	2.29	1.73	3.99	5.84	2.97	1.20	0.39	0.45	1.51	0.98	24.80	76.29
giv1	J22F	Koekemoers		C	0.12	0.35	0.91	0.53	0.80	1.72	0.87	0.28	0.10	0.10	0.46	0.24	6.47	85.87
giv2	J22K	Leeu		C	0.09	0.80	0.48	0.43	1.64	2.41	0.87	0.23	0.10	0.03	0.32	0.14	7.54	35.94
gv17	J23C	Gamka		B	1.10	3.79	3.88	2.78	6.53	10.46	4.93	1.75	0.61	0.59	2.34	1.39	40.14	66.18
giv21	J23F	Gamka		B	1.04	4.14	4.03	2.68	6.57	10.83	5.47	2.23	0.84	0.70	2.50	1.39	42.43	59.66
gv27	J23J	Gamka		C	1.07	4.23	4.08	2.69	6.57	10.84	5.63	2.33	0.88	0.74	2.58	1.43	43.04	59.52
gv14	J24D	Dwyka		A	0.08	0.22	0.42	0.35	0.35	0.69	0.49	0.21	0.08	0.07	0.25	0.15	3.37	84.38
giv20	J25A	Gamka (EWR5-**priority**)	C	C	1.59	5.22	5.22	3.57	7.46	12.15	7.03	3.03	1.18	1.07	3.20	1.95	52.67	64.91
giv18	J25D	Nels		E	0.30	0.51	0.64	0.41	0.40	0.42	0.99	0.27	0.05	0.09	0.29	0.29	4.64	38.70
gii2	J25E	Gamka		C	2.15	6.74	7.34	4.65	9.51	14.59	9.13	3.79	1.28	1.28	4.01	2.59	67.06	55.19

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
giii2	J31C	Olifants (EWR9-**priority**)	C	C	0.18	0.68	0.50	0.50	1.12	1.63	0.55	0.53	0.19	0.18	0.38	0.04	6.46	50.50
giv15	J32E	Traka		C/D	0.03	0.11	0.20	0.07	0.19	0.41	0.14	0.09	0.01	0.01	0.05	0.01	1.31	40.41
gv33	J33B	Olifants		D	0.53	1.37	1.29	0.85	2.10	3.38	1.29	1.18	0.47	0.46	1.07	0.33	14.32	53.95
gv21	J33D	Meirings		C	1.06	2.14	1.82	1.30	1.74	2.57	2.20	1.85	1.15	1.13	1.38	1.05	19.40	90.44
giv11	J33F	Olifants		E	1.51	3.59	3.15	0.78	1.80	3.16	3.73	3.90	2.53	2.53	3.49	1.85	32.02	41.46
gv36	J34C	Kammanassie (EWR10-**priority**)	C/D	C/D	1.93	2.87	1.89	0.76	0.82	1.74	2.68	3.61	2.32	2.39	6.21	3.97	31.19	71.93
giv10	J34F	Kammanassie		D	2.16	3.38	2.33	0.86	0.96	2.01	3.07	4.26	2.58	2.55	7.30	4.36	35.81	57.64
gvii2	J35A	Grobbelaars		C	1.09	1.83	1.33	0.62	0.81	1.29	1.70	1.41	0.78	0.90	1.21	0.98	13.94	83.23
giv9	J35A	Grobbelaars		E	1.52	2.48	1.86	0.92	1.14	1.77	2.43	2.18	1.23	1.34	1.83	1.45	20.14	66.81
gv19	J35D	Olifants		E	5.94	12.28	9.33	3.29	5.08	8.86	11.50	12.51	7.08	7.23	16.25	8.50	107.86	46.75
giv17	J35F	Olifants		D	6.42	13.80	10.45	3.69	5.70	9.85	12.63	13.52	7.39	7.66	18.12	8.99	118.22	45.39
giv16	J40A	Gouritz		C	8.82	21.61	18.89	8.84	16.06	25.92	22.92	18.27	8.74	9.11	23.15	12.09	194.42	48.06
gi4	J40B	Gouritz (EWR6-**priority**)	C	C	10.40	24.54	21.39	12.46	18.51	27.57	26.63	22.13	13.86	13.23	27.73	14.27	232.73	46.95
gv28	J40C	Gouritz		D	10.67	25.57	22.55	13.00	19.36	28.99	27.98	23.16	14.04	13.41	28.89	14.70	242.33	45.77
gv9	J40D	Gouritz		C	11.11	27.25	24.24	13.87	20.71	31.26	30.15	24.82	14.32	13.70	30.75	15.58	257.76	44.21
Gxi1	J40E	Gouritz estuary	B	C	15.01	31.97	26.66	15.41	22.15	33.67	33.82	28.54	16.71	16.45	35.28	19.01	294.69	47.36

The TECs and hydrological RQOs for all nodes in the Coastal / Outeniqua Basins are provided in Table A-4.

Table A-4 TECs, monthly flow volumes (Mm³), annual volume, and % annual nMAR for nodes in the Coastal / Outeniqua Basins (includes inter-annual floods)

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
giii5	H80B	Duiwenhoks		E	6.54	7.07	3.92	2.49	2.60	4.42	5.37	4.80	3.93	4.64	6.90	6.06	58.74	93.35
gv11	H80C	Duiwenhoks		D	7.08	7.56	4.18	2.62	2.68	4.65	5.68	5.03	4.18	4.90	7.68	6.43	62.68	83.03
giii8	H80D	Duiwenhoks (H8DUIW-EWR1-**priority**)	D	D	8.05	8.52	4.61	2.83	2.87	4.95	6.24	5.62	4.77	5.68	8.89	7.54	70.58	84.29
Gxi2	H80E	Duiwenhoks estuary	A	B	8.41	8.89	4.75	2.86	2.90	5.07	6.49	5.86	5.00	5.99	9.41	8.02	73.65	82.41
giii6	H90B	Korinte		D	3.24	3.60	1.93	1.40	1.58	2.76	3.16	2.73	1.93	2.14	3.21	2.69	30.37	88.15
giii7	H90A	Goukou (H9GOUK-EWR2-**priority**)	C/D	C/D	4.61	5.26	2.86	2.22	2.46	4.34	4.84	4.02	2.73	3.01	4.56	3.74	44.63	87.04
gv10	H90C	Goukou		D	8.26	9.44	4.94	3.55	3.91	7.25	8.43	7.15	5.01	5.53	8.38	6.91	78.77	83.85
gv41	H90D	Goukou		C	9.32	10.66	5.45	3.76	4.10	7.60	9.19	7.92	5.67	6.29	9.63	8.06	87.64	82.48
Gxi3	H90E	Goukou estuary	B	C	9.53	11.05	5.76	3.96	4.32	7.72	9.31	8.01	5.73	6.38	9.85	8.32	89.94	80.58
giv25	K10D	Brandwag		D	1.71	2.25	1.80	0.95	0.78	1.31	1.63	1.33	0.98	0.87	1.64	1.85	17.08	73.56
gv39	K10E	Moordkuil	D	D	0.91	1.20	0.61	0.45	0.38	0.74	0.71	0.70	0.47	0.51	0.95	0.83	8.44	42.61
Gxi4	K10F	Klein-Brak estuary	C	C	4.14	5.25	3.16	1.93	1.58	3.22	3.24	3.13	2.19	2.48	4.58	4.18	39.10	76.54
gviii2	K20A	Groot-Brak (GB 1-**priority**)	B/C	B/C	1.60	1.96	1.16	0.91	0.86	1.39	1.02	1.08	0.72	0.82	1.44	1.41	14.36	93.62
gviii12	K20A	Varing	C/D	C/D	0.65	0.80	0.47	0.37	0.35	0.56	0.42	0.44	0.29	0.33	0.59	0.57	5.84	97.11
gviii3	K20A	Varing	C/D	D	0.55	0.67	0.40	0.31	0.29	0.48	0.35	0.37	0.25	0.28	0.50	0.49	4.94	74.59
gvii7	K20A	Groot-Brak		B/C	1.58	2.17	1.07	0.70	0.58	1.17	0.69	0.86	0.30	0.45	1.40	1.41	12.40	43.07
Gxi5	K20A	Groot-Brak estuary	C	E	2.06	2.73	1.38	0.96	0.82	1.60	1.03	1.21	0.56	0.73	1.86	1.84	16.77	53.79
Gxi19	K10A	Blinde estuary	B	B	0.09	0.13	0.07	0.04	0.03	0.08	0.07	0.07	0.04	0.05	0.12	0.10	0.90	68.80
Gxi20	K10A	Tweekuilen estuary	D	D	0.09	0.14	0.08	0.05	0.04	0.08	0.07	0.07	0.04	0.05	0.12	0.10	0.94	72.31
Gxi21	K10A	Gericke estuary	D	D	0.03	0.04	0.02	0.01	0.01	0.03	0.02	0.02	0.01	0.02	0.04	0.03	0.29	72.31
Gxi22	K10B	Hartenbos estuary	C	C	0.38	0.58	0.50	0.22	0.16	0.30	0.38	0.30	0.21	0.17	0.45	0.51	4.15	80.74
gviii4	K30A	Maalgate		D	1.30	1.64	1.01	0.92	0.84	1.44	0.83	0.74	0.33	0.50	1.04	1.00	11.58	76.10
gvii8	K30A	Maalgate	D	D	2.57	3.23	1.98	1.82	1.66	2.83	1.64	1.46	0.64	0.99	2.06	1.96	22.84	76.10
Gxi6	K30A	Maalgate estuary	B	B	3.34	4.21	2.62	2.41	2.22	3.68	2.12	1.89	0.83	1.28	2.66	2.55	29.81	79.98
gvii9	K30B	Malgas (Mal 1-**priority**)	C	C	0.88	1.00	0.69	0.68	0.65	0.94	0.62	0.53	0.32	0.43	0.71	0.71	8.16	95.13

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
gviii6	K30B	Gwaing	D	E	1.51	1.71	1.18	1.15	1.11	1.61	1.06	0.91	0.54	0.73	1.21	1.21	13.92	82.41
Gxi7	K30B	Gwaing estuary	B	B	2.43	2.75	1.94	1.89	1.80	2.59	1.72	1.49	0.90	1.21	1.97	1.96	22.64	85.37
gviii7	K30C	Swart		D	0.33	0.61	0.50	0.27	0.25	0.45	0.34	0.32	0.11	0.06	0.39	0.42	4.06	24.06
gvii11	K30C	Kaaimans (Ka 1-**priority**)	B	B	1.86	2.19	1.65	1.35	1.30	1.80	1.45	1.21	0.80	0.84	1.45	1.61	17.53	94.03
gviii8	K30C	Silver		B	1.49	1.75	1.32	1.08	1.04	1.44	1.16	0.97	0.64	0.67	1.16	1.29	14.02	94.03
Gxi8	K30C	Kaaimans estuary	B	B	3.66	4.51	3.45	2.70	2.58	3.65	2.93	2.47	1.55	1.58	2.95	3.28	35.32	72.06
gvii12	K30D	Touws		B	1.72	2.22	1.40	1.27	1.20	1.86	1.07	0.99	0.44	0.65	1.42	1.34	15.59	93.64
gx8	K30D	Klein		D	0.26	0.33	0.21	0.19	0.18	0.28	0.16	0.15	0.07	0.10	0.21	0.20	2.34	93.63
Gxi9	K30D	Wilderness estuary	A	B	3.25	4.21	2.56	2.27	2.12	3.35	1.97	1.88	0.82	1.22	2.75	2.61	29.01	88.48
giii10	K40A	Diep (EWR 3 Diep-**priority**)	B	B	1.34	1.62	0.91	0.74	0.69	1.11	0.79	0.97	0.62	0.70	1.28	1.20	11.97	96.64
giii13	K40B	Hoekraal		B	2.90	3.34	2.01	1.80	1.64	2.57	1.79	1.99	1.25	1.50	2.59	2.45	25.84	92.43
gvii13	K40C	Karatara (EWR 4-**priority**)	A/B	B	1.12	1.26	0.94	0.78	0.74	0.98	0.82	0.78	0.59	0.60	0.92	0.99	10.52	94.21
giii11	K40C	Karatara		B	3.38	3.83	2.86	2.37	2.23	2.96	2.49	2.37	1.79	1.81	2.80	3.00	31.89	94.21
Gxi10	K40D	Swartvlei estuary	B	B	8.52	9.71	6.16	4.99	4.79	7.10	5.48	5.88	4.05	4.47	7.51	7.53	76.19	86.29
gviii9	K40E	Goukamma (Gou 1-**priority**)	B/C	B/C	2.81	3.44	2.50	1.96	1.81	2.49	2.01	1.96	1.35	1.33	2.37	2.52	26.55	87.31
Gxi11	K40E	Goukamma estuary	A	B	4.89	5.99	4.35	3.41	3.15	4.34	3.49	3.42	2.36	2.32	4.13	4.40	46.25	87.31
gvii14	K50A	Knysna (EWR 1-**priority**)	B	B	3.05	2.98	1.98	1.32	1.16	1.57	1.70	2.16	1.72	1.83	2.86	3.05	25.38	95.54
giii12	K50A	Knysna		B	3.74	3.70	2.42	1.80	1.45	1.87	1.97	2.81	1.97	2.08	3.56	3.58	30.95	66.49
gviii11	K50B	Gouna (EWR 2-priority)	A/B	A/B	2.99	2.90	1.94	1.34	1.21	1.63	1.75	2.19	1.75	1.86	2.87	3.01	25.44	92.12
Gxi12	K50B	Knysna estuary	B	B/C	8.12	7.96	5.37	3.89	3.31	4.31	4.60	6.05	4.59	4.86	7.77	8.00	68.83	76.29
gviii10	K60G	Noetzie	A/B	B	0.44	0.47	0.34	0.19	0.13	0.17	0.21	0.28	0.17	0.15	0.33	0.26	3.14	65.76
Gxi13	K60G	Noetsie estuary	A	C	0.50	0.53	0.38	0.21	0.15	0.19	0.23	0.32	0.20	0.18	0.38	0.31	3.59	65.09
gx3	K60G	Piesang		E	0.30	0.35	0.20	0.12	0.08	0.11	0.14	0.26	0.15	0.15	0.31	0.42	2.58	61.61
Gxi14	K60G	Piesang estuary	B	C	0.61	0.67	0.43	0.25	0.18	0.24	0.29	0.47	0.32	0.32	0.60	0.74	5.12	72.31
giv6	K60C	Keurbooms (EWR8-**priority**)	B/C	C	4.96	5.61	3.96	2.38	2.01	2.41	2.66	3.78	2.83	2.82	4.77	4.78	42.96	92.50
giv5	K60D	Palmiet		A	6.32	7.10	5.13	3.22	2.76	3.16	3.38	4.63	3.54	3.59	5.85	5.87	54.55	92.62
gx9	K60E	Keurbooms		B	13.60	15.24	10.78	6.55	5.53	6.60	7.27	10.16	7.72	7.75	12.87	12.95	117.02	91.48

Node	Quat	River	REC	EC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	%nMAR
giv4	K60F	Bitou		D	1.43	1.71	1.01	0.51	0.28	0.47	0.62	1.39	0.63	0.61	1.53	1.85	12.03	31.99
Gxi15	K60G	Keurbooms estuary	A	A/B	15.22	17.08	12.05	7.37	6.03	7.26	8.08	11.71	8.58	8.60	14.57	15.05	131.60	77.32
gx4	K70A	Buffels		C	0.14	0.13	0.10	0.06	0.04	0.06	0.06	0.08	0.07	0.09	0.14	0.15	1.12	43.82
Gxi16	K70A	Matjies estuary	B	C	0.41	0.39	0.28	0.16	0.12	0.16	0.17	0.24	0.21	0.25	0.41	0.45	3.25	63.50
gx5	K70A	Sout		B	0.59	0.56	0.41	0.23	0.17	0.23	0.24	0.35	0.31	0.36	0.59	0.65	4.68	85.04
Gxi17	K70A	Sout(Oos) estuary	A	A	0.76	0.72	0.52	0.29	0.22	0.29	0.30	0.45	0.39	0.46	0.75	0.83	5.99	85.03
Gxi23	K70A	Groot(Wes) estuary	B	B	1.40	1.34	0.97	0.54	0.41	0.54	0.56	0.83	0.73	0.85	1.40	1.53	11.10	86.17

Appendix B

Spatially Targeted Classification Scenario, Recommended ECs and Proposed Water Resource Classes

Spatially Targeted Classification Scenario

Guiding considerations

In order to give appropriate recognition to spatial variations of priority objectives inside individual IUAs, a spatially-targeted scenario needs to be formulated, resulting in a blend of targeted ECs for all nodes ranging between REC and ESBC. The following considerations guide the derivation of this scenario:

- There is a need to seek a balance of competing ecological requirements, conservation priorities, projected future demands and development opportunities inside individual IUAs.
- REC water requirements at all the nodes are the logical starting points for the derivation of the scenario.
- In search of the abovementioned balance of priorities, REC water requirements would need to be "relaxed" to the ESBC level for certain individual nodes or clusters of nodes.
- EC downgrades to the ESBC level will not be considered for nodes or clusters of nodes associated with special conservation areas, such as Strategic Water Source Areas, NFEPAs and Fish conservation areas, as well as for estuaries.
- The logical focus points across the WMA for such potential EC downgrades relative to REC are those IUAs with the highest total infrastructure costs to meet the environmental water requirements of the RECs of the nodes inside those IUAs.
- Stakeholder inputs are a prerequisite for the appropriate selection of nodes for potential EC downgrades below the REC level in each IUA.

A "pilot" spatially-targeted scenario

In order to demonstrate that the above approach towards derivation of a spatially-targeted scenario would be practicable, a "pilot" exercise was implemented. The process and outcome of this pilot exercise is described in the paragraphs below.

The IUAs with the highest infrastructure costs to implement the REC under 2040 water demands are, for the Breede - H16, H17, A1, A2+A3, B4 - and for the Gouritz - D7, G15 (Table B-5 and Figure B-1). For every node in each of these eight IUAs the water requirements for the ESBC replaced the relatively higher water requirements for the REC, unless that node was associated with special conservation areas, in which case the REC water requirement values were retained.

Table B-5 The estimated total infrastructure costs to meet future demands and EWR requirements under the ESBC and REC scenarios

IUA Name	IUA	Estimated total infrastructure costs to meet future demands and EWR requirements	
		ESBC	REC
Overberg West Coastal	H16	R 306 million	R 300 million
Overberg East Fynbos	H17	R 103 million	R 308 million
Upper Breede Tributaries	A1	R 75 million	R 303 million
Breede Working Tributaries & Middle Breede	A2 + A3	R 296 million	R 550 million
Riviersonderend Theewaters	B4	R 3 million	R 197 million
Gouritz-Olifants	D7	R 383 million	R 771 million
Coastal	G15	R 394 million	R 672 million

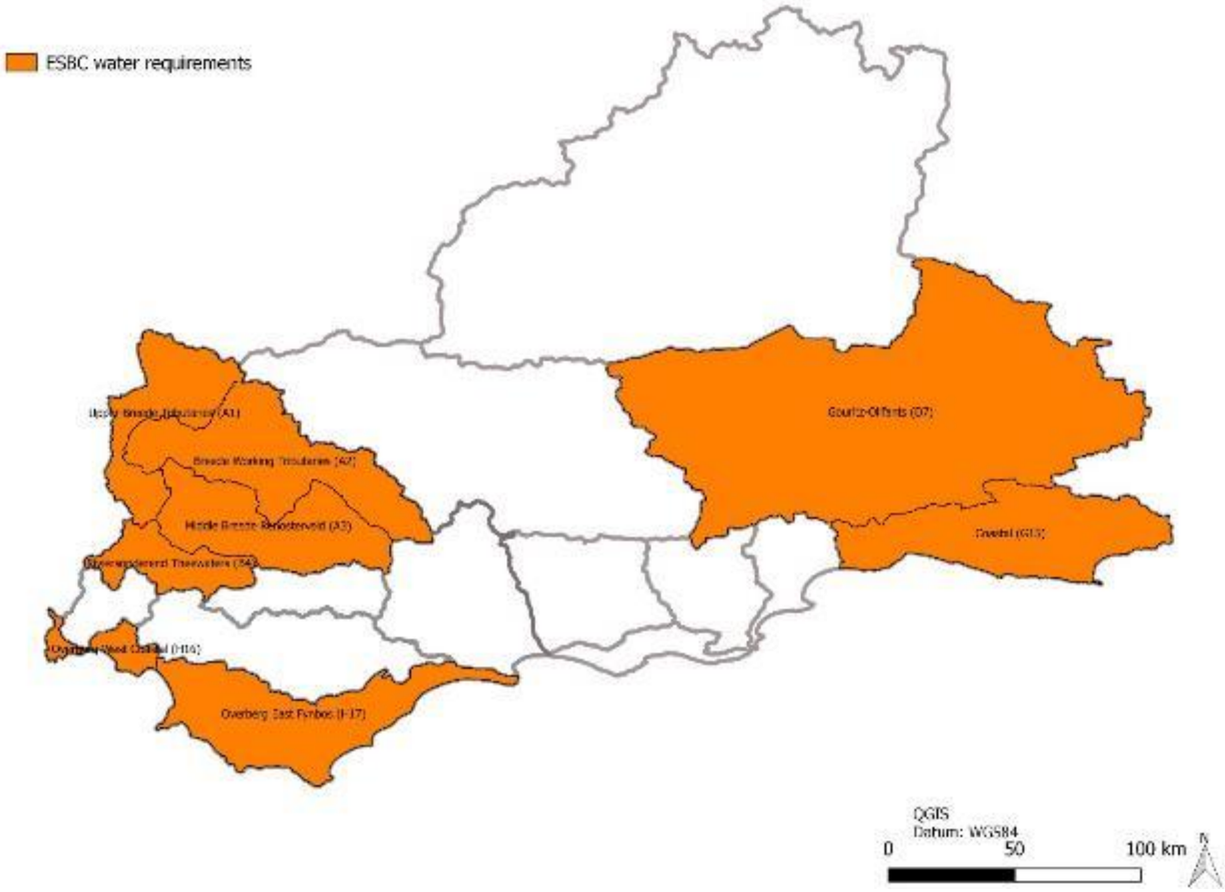


Figure B-1 The eight IUAs identified where the water requirements for the ESBC scenario replaced the water requirements for the REC in the study area

In addition to this it was noted that there is variation within an IUA, in terms of ecological conditions, which may not be represented effectively given the large spatial scale of the IUA. In certain cases where important conservation areas (i.e. Strategic Water Source Areas or protected areas) “split” an IUA these were considered to be important to represent as separate areas in the classification summary (“management considerations”). These areas may be considered to be the more “pristine” tributaries which should be maintained at a higher class than “working rivers” which are more degraded. The IUAs considered for this “split are indicated in Table B-6 and Figure B-2.

Table B-6 The IUAs considered which have important conservation areas in the study area

IUA Name	IUA	Conservation priority
Upper Breede Tributaries	A1	SWSA, Protected area
Breede Working Tributaries	A2	SWSA, Protected area
Middle Breede Renosterveld	A3	SWSA, Protected area
Riviersonderend Theewaters	B4	SWSA, Protected area
Overberg West	B5	SWSA, Protected area
Lower Breede Renosterveld	F11	SWSA, Protected area
Duiwenhoks	F12	SWSA, Protected area
Gouritz Olifants	D7	SWSA, Protected area
Gamka-Buffels	C6	Groundwater use
Coastal	G15	SWSA, Protected area

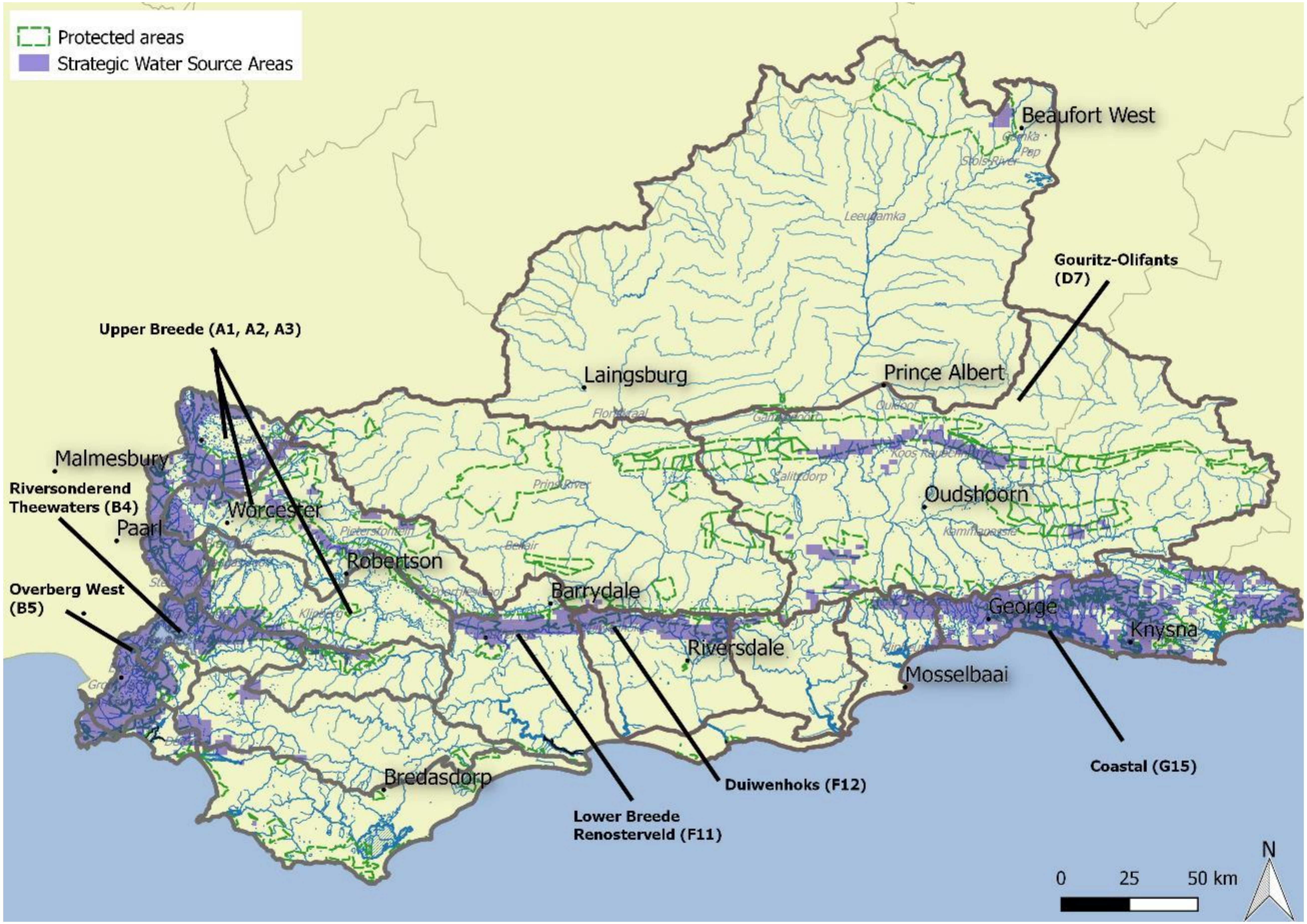


Figure B-2 **The IUAs in the study area which are considered to be "split" to allow for variation in working rivers versus pristine tributaries**

Final Recommended Targeted Ecological Categories

The final recommended target ECs for all river and estuary nodes are presented in Table B-7 and Figure B-3 for the Breede-Overberg region and In the Gouritz-Coastal region, both the PES and the STS meet 32 of the 47 RECs (rivers and estuaries). Of the 23 estuaries, 13 RECs are met by the STS. With a few exceptions (Gouritz, Groot-Brak, and Hartenbos), the estuaries have flows at more than 70% of natural, and increasing flows alone will not improve their conditions. Of the 22 river nodes, only five do not meet the REC under the STS scenario, *viz*.: the Varing at gviii3, the Gwaing at gviii6, the Karatara at gvii13, the Noetzie at gviii10, and Keurbooms at giv6,

Table B-8 and Figure B-4 for the Gouritz-Coastal region. Also presented are whether the Spatially Targeted Scenario (STS) improves on conditions relative to PES both in terms of resulting Ecological Category and in terms of flow as a percentage of nMAR.

In the Breede-Overberg region, the PES meets 14 of the 24 RECs (rivers and estuaries), while the STS meets or exceeds at 15 of the 24. Of these, five are estuaries. An additional two estuaries (Uilkraal and Heuningnes) improve on the PES, although the REC is not met.

Table B-7 Annual flow as % nMAR, and river condition (A to F) at each node for the Breede-Overberg IUAs for the Present Ecological Status (PES) and Spatially Targeted Scenario (STS)

IUA	Node	Quat	River	ER-REC	PES		STS		PES Meets REC?	STS Meets REC?	STS	
					EC	%nMAR	EC	%nMAR			EC Ch from PES	%nMAR Ch from PES
B5-OverbergWest	**Piii1**	**G40C**	**Palmiet**	**B**	C	95.19	C	95.19	Not met	Not met		
	Piv10	G40C	Witklippieskloof		D	58.93	D	58.93				
	Piv9	G40C	Palmiet		D	42.96	D	42.96				
	Pvi1	G40C	Palmiet		D	60.68	D	60.68				
	Piv8	G40C	Klipdrif		D	93.39	D	93.39				
	Piv4	G40D	Klein-Palmiet		D	80.71	D	80.71				
	Piv7	G40D	Krom/Ribbok		D	34.85	D	34.85				
	Piii2	**G40D**	**Palmiet**	**B/C**	B/C	63.71	B/C	63.71	Met	Met		
	Piv12	G40D	Dwars/Louws		C	98.81	C	98.81				
	Piii3	**G40D**	**Palmiet**	**B**	B	69.83	B	69.83	Met	Met		
	Pxi1	**G40D**	**Palmiet estuary**	**B**	C	70.13	C	70.13	Not met	Not met		
H16- Overberg West Coastal	**Bxi1**	**G40B**	**Buffels**	**B**	B	81.86	B	81.86	Met	Met		
	Bxi2	**G40B**	**Rooiels**	**B**	B	98.63	B	98.63	Met	Met		
	Niv43	G40F	Swart		E	88.83	E	88.83				
	Niii5	G40E	Bot		C	84.20	C	84.20				
	Nxi6	**G40G**	**Bot**	**B**	C	81.78	C	81.78	Not met	Not met		
	Nxi8	**G40H**	**Onrus**	**D**	D	51.77	D	51.77	Met	Met		
F10-Overberg East Renosterveld	Nii4	G40J	Hartbees		D	87.08	D	55.69				Down
	Niv45	G40K	Steenbok		E	93.40	E	93.40				
	Nv23	**G40K**	**Klein**	**C**	C/D	89.23	C/D	79.11	Not met	Not met		Down
H17-Overberg East Fynbos	**Nxi7**	**G40L**	**Klein**	**B**	C	80.33	C	85.58	Not met	Not met		Up
	Nx8	G40M	Uilkraal		C	62.95	C	92.00				Up
	Nxi5	G40M	Uilkraal	C	E	43.93	C/D	58.79	Not met	Not met	Up	Up
	Nxi3	G50A	Ratel	C	C	90.02	C	90.02	Met	Met		
	Ni4	G50B	Nuwejaar	D	D	49.65	C/D	71.67	Met	Exceeds	Up	Up
	Nvii15	G50C	Heuningnes		D	50.14	C/D	71.67			Up	Up
	Niv44	G50C	Heuningnes		D	50.20	C/D	71.67			Up	Up
F10-Overberg East Renosterveld	Nv24	G50D	Kars	B	B/C	89.99	B/C	89.99	Not met	Not met		
H17-Overberg East Fynbos	Nii5	G50E	Kars		E	85.84	E	85.84				
	Nxi1	G50F	Heuningnes	A	C	68.78	A/B	78.17	Not met	Not met	Up	Up
F10-Overberg East Renosterveld	Nii6	G50G	Sout		D	73.69	D	73.69				
	Nii7	G50H	DeHoopVlei		B	91.96	B	91.96				
H17-Overberg East Fynbos	Bxi3	G50K	Klipdrifsfontein	A	A	64.77	A	64.77	Met	Met		
A1-UppBreedeTribs	Niv3	H10B	Titus		C	82.03	C	82.03				
	Niv1	H10C	Koekedou		D	96.32	D	96.32				
	Niv2	H10C	Dwars		C	62.47	C	52.94				Down
	nvi4	H10C	Breede		C	70.43	C	64.81				Down
	Niv4	H10D	Witels		A	100.00	A	100.00				
	Nvi3	H10D	Breede		C	75.09	C	72.88				Down

IUA	Node	Quat	River	ER-REC	PES		STS		PES Meets REC?	STS Meets REC?	STS	
					EC	%nMAR	EC	%nMAR			EC Ch from PES	%nMAR Ch from PES
	Nvii16	H10E	Witte		A	92.04	A	92.04				
	Niv5	H10F	Witte		A	88.40	A	88.40				
	Niv6	H10F	Wabooms		D	64.05	D	37.75				Down
	Nviii1	H10F	Breede	D	D/E	77.18	D	75.82	Not met	Met	Up	Down
	Niv40	H10J	Elands		B	92.20	B	92.20				
	Niv41	H10J	Krom		B	92.21	B	92.21				
	Nvii2	H10J	Molenaars	B	B	92.20	B	92.20	Met	Met		
	Niv7	H10G	Slanghoek		D	70.95	D	47.73				Down
	Niii1	H10G	Breede		D	77.70	D	74.99				Down
	Niv42	H10J	Smalblaar		E	92.20	E	92.20				
	Niv8	H10H	Jan du Toit		D	81.32	D	47.53				Down
	Nvii6	H10H	Hartbees		D	77.96	D	77.96				
	Niv9	H10H	Hartbees		D	80.09	D	58.41				Down
	Niv12	H10K	Holsloot		C	81.68	C	81.68				
	Nv3	H10H	Breede		C	62.39	C	59.83				Down
A2-BreedeWorkTribs	Nv18	H20F	Hex		D	50.77	D	50.77				
	Nvii7	H20G	Hex	C	C	80.73	C	80.73	Met	Met		
	Niv10	H20H	Hex		D	58.69	D	58.69				
	Nii1	H40C	Breede		C	61.98	C	59.70				Down
	Nvii5	H40B	Koo		D	69.20	D	41.86				Down
	Niv11	H40C	Nuy		E	29.69	D/E	38.24			Up	Up
	Niv18	H30B	Kingna		D	58.05	D	42.98				Down
	Niv20	H30C	Pietersfontein		D	83.82	D	83.82				
	Nvii9	H30D	Keisie		D	84.80	D	73.21				Down
	Niv13	H40D	Doring		E	77.78	E	77.78				
	Nvii8	H40F	Breede	C/D	C/D	61.10	C/D	59.76	Met	Met		Down
	Ni1	H40F	Breede		B	60.78	A/B	59.45			Up	Down
	Nvii11	H40G	Poesjenels		D	50.90	D	43.90				Down
	Niv15	H40H	Vink		D	83.93	D/E	45.45			Down	Down
	Nviii2	H40J	Willem Nels		D	84.78	D/E	44.77			Down	Down
A3-MidBreede-Renosterveld	Nvii19	H40J	Breede		B	61.12	A/B	58.97			Up	Down
	Nvii12	H40K	Keisers		D	56.39	D	56.39				
	Niv14	H40K	Keisers		D	53.97	D	53.97				
	Nvi1	H40L	Breede		D	61.04	D	58.82				Down
	Nii2	H30E	Kogmanskloof		D	69.40	D	53.92				Down
	Niii3	H50A	Breede		D	61.08	D	58.26				Down
	Ni2	H50B	Breede		D	61.01	D	58.23				Down
	Nvii10	H60B	Du Toits		B	90.87	B	90.87				
	Nv7	H60D	Riviersonderend		C	49.49	C	52.12				Up
B4-UpperRiviersonderend	Niv28	H60E	Baviaans	B	B	88.72	B	88.72	Met	Met		
	Niv29	H60E	Sersants		D	88.72	D	54.44				Down
	Niv30	H60F	Gobos		C	87.77	C	62.36				Down
	Nv9	H60F	Riviersonderend	D	D	53.57	D	52.44	Met	Met		Down
	Niv31	H60G	Kwartel		D	90.70	D	53.38				Down
	Niv33	H60H	Soetmelksvlei		D	67.84	D	47.90				Down
	Niv34	H60H	Slang		D	67.89	D	47.90				Down
F9-LowerRiviersonderend	Nv10	H60H	Riviersonderend		D	55.01	D	51.95				Down
	Nv11	H60J	Riviersonderend		D	56.34	D	53.42				Down
	Niv35	H60K	Kwassadie		E	84.68	E	84.68				
	Nv12	H60K	Riviersonderend		D	56.82	D	53.96				Down
	Ni3	H60L	Riviersonderend		D	56.12	D	53.31				Down
	Niv24	H70A	Leeu		E	85.44	E	85.44				
	Niv24a	H70B	Klip		E	92.40	E	92.40				
	Nv2	H70B	Breede		C	60.15	C	57.48				Down
	Nvii14	H70C	Huis		C	75.01	C	75.01				
F11-LowBreede-Renoster	Nii3	H70C	Tradouw		B	75.21	B	75.21				
	Niv25	H70F	Buffeljags		E	73.18	E	73.18				
	Niii4	H70G	Breede	B/C	C	60.99	C	58.52	Not met	Not met		Down
	Nviii3	H70H	Breede		B	61.13	B	58.41				Down
	Niv26	H70J	Slang		E	89.07	E	51.86				Down
	Nxi2	H70K	Bree	B	B	49.53	B	47.19	Met	Met		Down

ER = Ecological Reserve. EWR sites are in **bold** with RECs from ER studies in column 5.

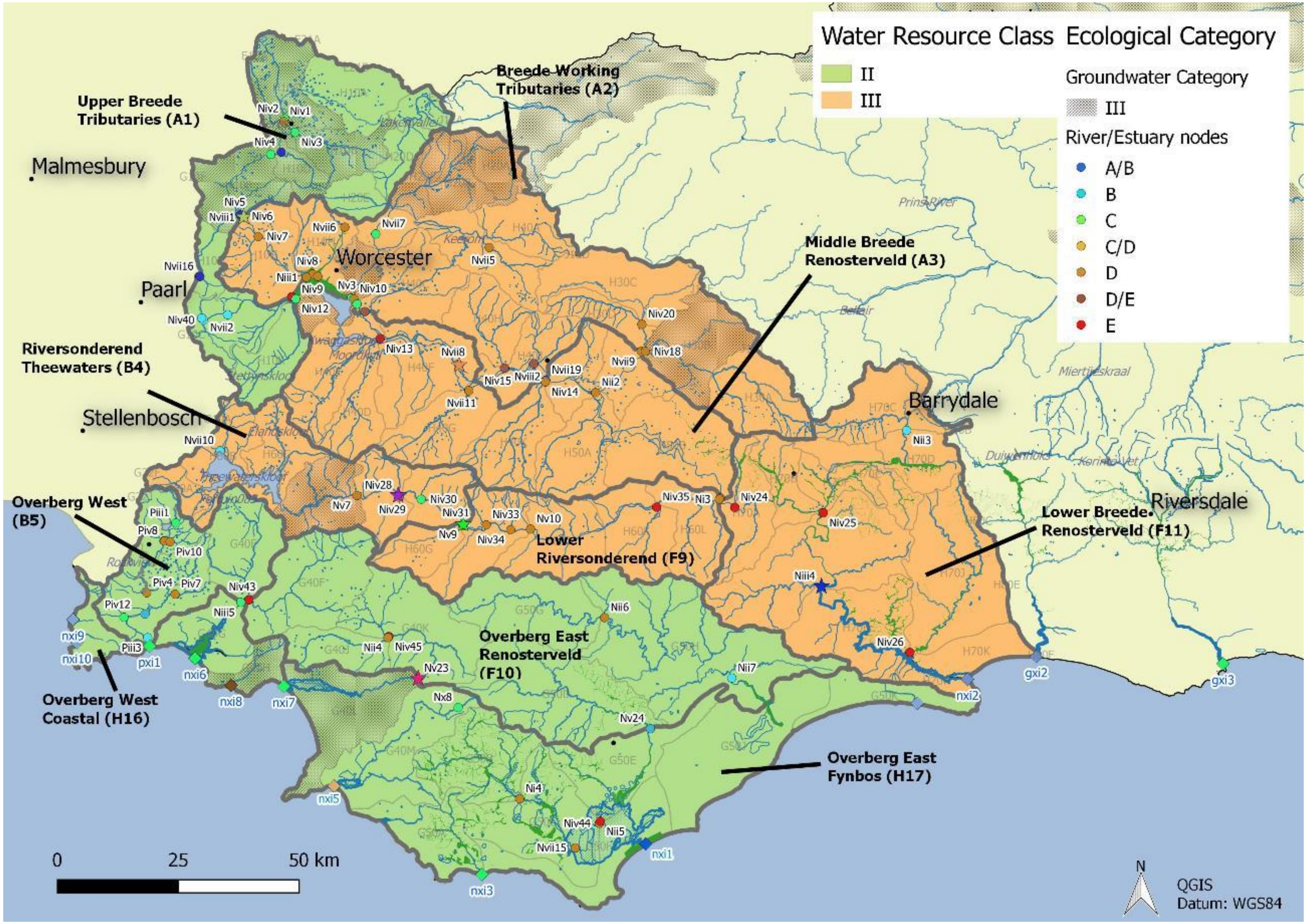


Figure B-3 **The water resource class and ecological category for the IUAs under the Spatially Targeted Scenario in the Breede-Overberg region of the study area**

In the Gouritz-Coastal region, both the PES and the STS meet 32 of the 47 RECs (rivers and estuaries). Of the 23 estuaries, 13 RECs are met by the STS. With a few exceptions (Gouritz, Groot-Brak, and Hartenbos), the estuaries have flows at more than 70% of natural, and increasing flows alone will not improve their conditions. Of the 22 river nodes, only five do not meet the REC under the STS scenario, *viz*.: the Varing at gviii3, the Gwaing at gviii6, the Karatara at gvii13, the Noetzie at gviii10, and Keurbooms at giv6,

Table B-8 Average monthly flows as % nMAR, and river condition (A to F) for the Gouritz-Coastal IUAs at each node for the Present Ecological Status (PES) and Spatially Targeted Scenario (STS)

IUA	Node	Quat	River	ER-REC	PES		STS		PES Meets REC?	STS Meets REC?	STS	
					EC	%nMAR	EC	%nMAR			EC Ch from PES	%nMAR Ch from PES
E8-Touws	giv30	J12C	Ysterdams		D	50.87	D	50.87				
	giv31	J12B	Donkies		D	55.52	D	55.52				
	giv28	J12D	Touws		D	54.57	D	54.57				
	giv27	J12H	Touws		B	50.24	B	50.24				
	giv26	J12K	Brak		C	14.46	C	14.46				
	gviii1	**J12L**	**Doring**	**C/D**	C/D	43.39	C/D	43.39	Met	Met		
	gv5	**J12L**	**Touws**	**B/C**	B/C	46.37	B/C	46.37	Met	Met		
	gv4	**J11H**	**Buffels**	**C**	C	60.32	C	60.32	Met	Met		
	gv6	J11J	Groot		D	42.70	D	42.70				
	giv32	J11K	Groot		D	38.59	D	38.59				
	gv7	J13A	Groot		C	41.06	C	41.06				
	gii3	J13C	Groot		B	42.79	B	42.79				
C6-Gamka-Buffels	giv34	J11C	Buffels		A	97.25	A	97.25				
	gv25	J11F	Buffels		C	93.27	C	93.27				
	gv18	J21A	Gamka		B	77.34	B	77.34				
	giv3	J21D	Gamka		B	77.81	B	77.81				
	giv1	J22F	Koekemoers		C	87.87	C	87.87				
	giv2	J22K	Leeu		C	44.14	C	44.14				
	gv17	J23C	Gamka		B	68.99	B	68.99				
	giv21	J23F	Gamka		B	62.35	B	62.35				
	gv27	J23J	Gamka		C	61.87	C	61.87				
	gv14	J24D	Dwyka		A	85.15	A	85.15				
D7-Gouritz-Olifants; Lower Gouritz	**giv20**	**J25A**	**Gamka**	**C**	C/D	55.79	C	66.02	Not met	Met	Up	Up
	giv18	J25D	Nels		D	55.82	E	42.22			Down	Down
	gii2	J25E	Gamka		C	48.82	C	59.98				Up
	giii2	**J31C**	**Olifants**	**C**	C	85.27	C	54.74	Met	Met		Down
	giv15	J32E	Traka		C	81.11	C/D	47.89			Down	Down
	gv33	J33B	Olifants		D	79.46	D	57.22				Down
	gv21	J33D	Meirings		C	90.58	C	90.58				
	giv11	J33F	Olifants		E	47.00	E	40.04				Down
	gv36	**J34C**	**Kammanassie**	**C/D**	C/D	75.67	C/D	75.67	Met	Met		
	giv10	J34F	Kammanassie		E	41.26	D	60.46			Up	Up
	gvii2	J35A	Grobbelaars		C	82.76	C	82.76				
	giv9	J35A	Grobbelaars		E	65.75	E	65.75				
	gv19	J35D	Olifants		E	51.60	E	50.63				Down
	giv17	J35F	Olifants		D	53.21	D	50.15				Down
	giv16	J40A	Gouritz		C	55.30	C	51.97				Down
	gi4	**J40B**	**Gouritz**	**C**	C	54.34	C	51.65	Met	Met		Down
	gv28	J40C	Gouritz		D	56.22	D	53.69				Down
	gv9	J40D	Gouritz		C	59.81	C	57.51				Down
	Gxi1	**J40E**	**Gouritz estuary**	**B**	C	61.88	C	59.73	Not met	Not met		Down
F12-Duiwenhoks-Hessequa	giii5	H80B	Duiwenhoks		E	94.05	E	94.05				
	gv11	H80C	Duiwenhoks		D	94.05	D	94.05				
	giii8	**H80D**	**Duiwenhoks**	**D**	D	94.35	D	94.35	Met	Met		
	Gxi2	**H80E**	**Duiwenhoks estuary**	**A**	B	91.89	B	91.89	Not met	Not met		
I18-Duiwenhoks-Hessequa	giii6	H90B	Korinte		D	89.02	D	89.02				
	giii7	**H90A**	**Goukou**	**C/D**	C/D	87.67	C/D	87.67	Met	Met		
	gv10	H90C	Goukou		D	84.73	D	84.73				
	gv41	H90D	Goukou		C	83.50	C	83.50				
	Gxi3	**H90E**	**Goukou estuary**	**B**	C	81.41	C	81.41	Not met	Not met		

IUA	Node	Quat	River	ER-REC	PES		STS		PES Meets REC?	STS Meets REC?	STS	
					EC	%nMAR	EC	%nMAR			EC Ch from PES	%nMAR Ch from PES
G14-Groot Brak	giv25	K10D	Brandwag		D	73.80	D	73.80				
	gv39	**K10E**	**Moordkuil**	**D**	D	41.78	D	41.78	Met	Met		
	Gxi4	**K10F**	**Klein-Brak estuary**	**C**	C	77.05	C	77.05	Met	Met		
	gviii2	**K20A**	**Groot-Brak**	**B/C**	B/C	93.79	B/C	93.79	Met	Met		
	gviii12	**K20A**	**Varing**	**C/D**	C/D	97.27	C/D	97.27	Met	Met		
	gviii3	**K20A**	**Varing**	**C/D**	D	74.73	D	74.73	Not met	Not met		
	gvii7	K20A	Groot-Brak		B/C	45.89	B/C	45.89				
	Gxi5	**K20A**	**Groot-Brak estuary**	**C**	E	56.20	E	56.20	Not met	Not met		
	Gxi19	**K10A**	**Blinde estuary**	**B**	B	69.23	B	69.23	Met	Met		
	Gxi20	**K10A**	**Tweekuilen estuary**	**D**	D	96.73	D	72.31	Met	Met		Down
	Gxi21	**K10A**	**Gericke estuary**	**D**	D	96.80	D	72.31	Met	Met		Down
	Gxi22	**K10B**	**Hartenbos estuary**	**C**	D	65.01	D	65.01	Not met	Not met		
G15-Coastal	gviii4	K30A	Maalgate		D	75.80	D	75.80				
	gvii8	**K30A**	**Maalgate**	**D**	D	75.80	D	75.80	Met	Met		
	Gxi6	**K30A**	**Maalgate estuary**	**B**	B	79.32	B	79.32	Met	Met		
	gvii9	**K30B**	**Malgas**	**C**	C	95.00	C	95.00	Met	Met		
	gviii6	**K30B**	**Gwaing**	**D**	E	82.30	E	82.30	Not met	Not met		
	Gxi7	**K30B**	**Gwaing estuary**	**B**	B	85.00	B	85.00	Met	Met		
	gviii7	K30C	Swart		D	25.28	D	25.28				
	gvii11	**K30C**	**Kaaimans**	**B**	B	94.07	B	94.07	Met	Met		
	gviii8	K30C	Silver		B	94.07	B	94.07				
	Gxi8	**K30C**	**Kaaimans estuary**	**B**	B	72.45	B	72.45	Met	Met		
	gvii12	K30D	Touws		B	93.75	B	93.75				
	gx8	K30D	Klein		D	93.75	D	93.75				
	Gxi9	**K30D**	**Wilderness estuary**	**A**	B	88.59	B	88.59	Not met	Not met		
	giii10	**K40A**	**Diep**	**B**	B	96.53	B	96.53	Met	Met		
	giii13	K40B	Hoekraal		B	92.49	B	92.49				
	gvii13	**K40C**	**Karatara**	**A/B**	B	92.99	B	92.99	Not met	Not met		
	giii11	K40C	Karatara		B	92.99	B	92.99				
	Gxi10	**K40D**	**Swartvlei estuary**	**B**	B	86.61	B	86.61	Met	Met		
	gviii9	**K40E**	**Goukamma**	**B/C**	B/C	87.46	B/C	87.46	Met	Met		
	Gxi11	**K40E**	**Goukamma estuary**	**A**	B	87.46	B	87.46	Not met	Not met		
	gvii14	**K50A**	**Knysna**	**B**	B	95.63	B	95.63	Met	Met		
	giii12	K50A	Knysna		B	94.74	B	87.20				Down
	gviii11	**K50B**	**Gouna**	**A/B**	A/B	92.21	A/B	92.21	Met	Met		
	Gxi12	**K50B**	**Knysna estuary**	**B**	B	90.63	B	86.75	Met	Met		Down
	gviii10	**K60G**	**Noetzie**	**A/B**	B	92.46	B	92.46	Not met	Not met		
	Gxi13	**K60G**	**Noetsie estuary**	**A**	B	92.45	B	92.45	Not met	Not met		
	gx3	K60G	Piesang		E	92.45	E	64.25				Down
	Gxi14	**K60G**	**Piesang estuary**	**B**	C	73.04	C	73.84	Not met	Not met		Up
	giv6	**K60C**	**Keurbooms**	**B/C**	C	93.22	C	93.22	Not met	Not met		
	giv5	K60D	Palmiet		A	93.24	A	93.24				
	gx9	K60E	Keurbooms		B	92.25	B	92.25				
	giv4	K60F	Bitou		C	97.47	C	92.10				Down
	Gxi15	**K60G**	**Keurbooms estuary**	**A**	A	91.17	A	90.04	Met	Met		Down
	gx4	K70A	Buffels		B	83.72	B/C	57.23			Down	Down
	Gxi16	**K70A**	**Matjies estuary**	**B**	B	83.73	C	70.47	Met	Not met	Down	Down
	gx5	K70A	Sout		B	85.58	B	85.58				
	Gxi17	**K70A**	**Sout(Oos) estuary**	**A**	A	85.58	A	85.58	Met	Met		
	Gxi23	**K70A**	**Groot(Wes) estuary**	**B**	B	86.73	B	86.73	Met	Met		
	gvii15	K70B	Bloukrans		B	82.69	B	82.69				
	Gxi18	**K70B**	**Bloukrans estuary**	**A**	A	98.00	A	98.00	Met	Met		

ER = Ecological Reserve. EWR sites are in **bold** with RECs from ER studies in column 5.

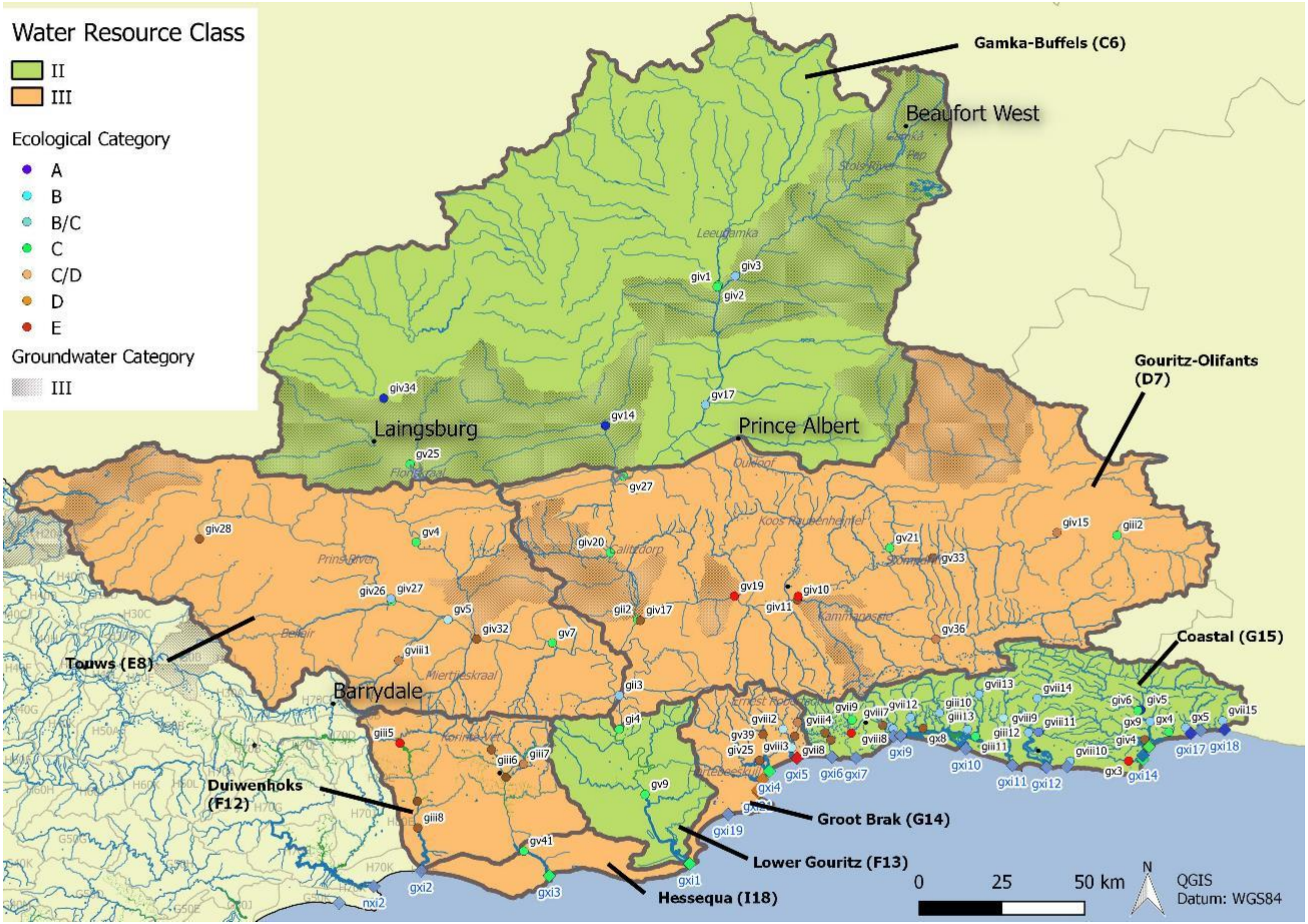


Figure B-4 **The final water resource class and ecological category for the IUAs under the Spatially Targeted Scenario in the Gouritz-Coastal region of the study area**

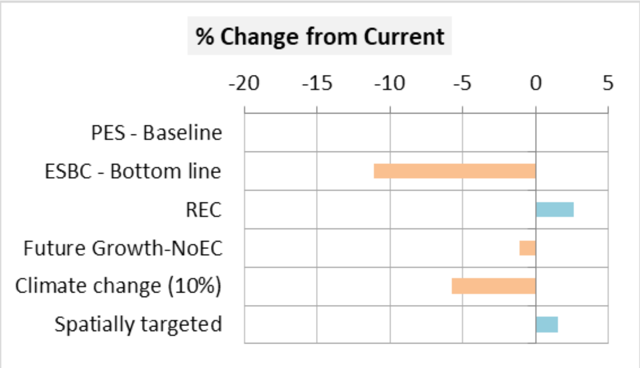
Summary of results

Rivers and Estuaries

In the spatially-targeted scenario the IUAs with the highest infrastructure costs to implement the REC under 2040 water demands are Overberg West Coastal (H16), Overberg East Fynbos (H17), Upper Breede Tributaries (A1), Breede Working Tributaries (A2), Middle Breede Renosterveld (A3), Riviersonderend Theewaters (B4), Gouritz-Olifants (D7) and Coastal (G15) IUAs. The results in this regard were that in these IUAs a surplus of water is made available for development needs (unless a node is associated with a conservation site) by reducing the conditions of rivers. In all other IUAs the REC water requirements were retained.

This resulted in 76% of river EWR sites meeting or exceeding the EC required. At sites which did not meet the required EC additional interventions are often required, which are not related to flow. Of all the nodes most did not change from the current state (PES) with ~15% improving and ~8% declining from the current EC. In particular this decline is related to additional development needs in the Gouritz-Olifants IUA (D7) which pushes the Nels and Traka Rivers to below current, while the Kammanassie River improves from an E to a D category. In the Coastal IUA (G15) a decline from current EC is seen in the Buffels River, and the Matjies Estuary nodes. Developments in the Breede-Overberg reduce the ECs of the Vink (Niv15) and Willem Nels (Nviii2) rivers.

The overall changes in ecological condition for all scenarios are summarised in Figure B-5, showing the compromise achieved between protection in the form of the REC scenario, and development, where in the Breede-Overberg, there is still some improvement relative to the PES scenario, and in the Gouritz-Coastal, there is a very slight reduction.



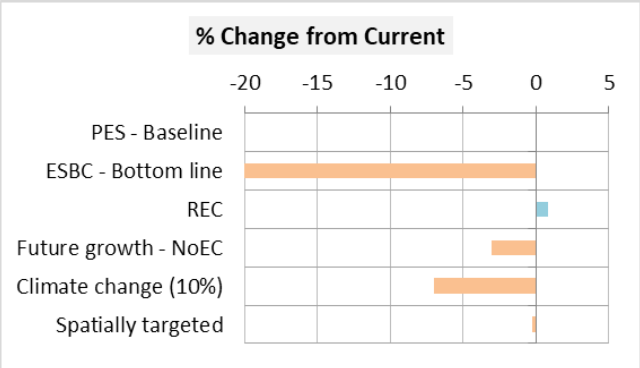


Figure B-5 Breede-Overberg (left) and Gouritz-Coastal (right): Percentage change in ecosystem health / integrity from the current scenario (PES) for all scenarios

A note on the achievement of REC through flow for estuaries:

Ecological water requirements for estuaries are described in terms of the quantity and quality of flows required to meet defined health thresholds. Estuary Health or the Ecological condition of an estuary is therefore described through the Estuary Health Index (EHI) via assessment of abiotic (hydrology, hydrodynamics, physical habitat) and biotic (microalgae, invertebrates, fish, birds) health. This study assessed the relationship between freshwater inflows as a percentage of natural Mean Annual Runoff (%MAR) and estuary health. As the EHI is also influenced by anthropogenic factors other than changes in flow volumes (i.e. change in nutrient inputs, habitat reclamation, fishing), restoring flows to 100% of natural is often not sufficient to restore estuary condition to natural. Setting environmental flows requires consideration of both quantity and quality of flows, therefore if anthropogenic impacts on water quality were reduced, then EHI goes up.

The Ecological Water Requirements (EWRs) for estuaries (as defined in the EWR report) are determined using scenarios, representing future planning options. The threshold flow requirements for each Ecological Category (EC) for each estuary, based on current and improved water quality, were determined and assessed in terms of the likelihood of pollution problems being reduced in the future. In this way the future REC scenario provided a threshold flow requirement for the REC based on whether or not pollution impacts are likely to be reduced. This is the case for the following estuaries:

Table B-9 Estuaries where additional non-flow related interventions are required in order to meet REC

IUA	Node	Quat	River	ER-REC	Current		Spatially targeted	
					EC	%nMAR	EC	%nMAR
B5	Pxi1	G40D	Palmiet	**B**	C	70.13	C	70.13
H16	Nxi6	G40G	Bot	**B**	**C**	**81.78**	**C**	**81.78**
H17	Nxi7	G40L	Klein	**B**	C	80.33	C	85.58
	Nxi5	G40M	Uilkraal	**C**	E	43.93	C/D	58.79
	Nxi1	G50F	Heuningnes	**A**	C	68.78	A/B	78.17
D7	Gxi1	J40E	Gouritz	**B**	C	61.88	C	59.73
I18	Gxi2	H80E	Duiwenhoks	**A**	B	91.89	B	91.89
	Gxi3	H90E	Goukou	**B**	C	81.41	C	81.41
G14	Gxi5	K20A	Groot-Brak	**C**	E	56.20	E	56.20
G15	Gxi9	K30D	Wilderness	**A**	B	88.59	B	88.59
	Gxi13	K60G	Noetzie	**A**	B	92.45	B	92.45
	Gxi14	K60G	Piesang	**B**	C	73.04	C	73.84
	Gxi16	K70A	Matjies	**B**	B	83.73	C	70.47

Wetlands

The assessment for wetlands focused on the impacts of surface and groundwater use as well as the indirect impacts of future development scenarios. As the spatially-targeted scenario presents a balance between the development driven scenario (ESBC) and ecology driven scenario (REC), this means that indirect impacts of future development can be focused to particular IUAs considered above. Although wetlands occur throughout the study area, wetlands of particular ecological importance which supply important ecosystem services are considered most at risk to future development.

Under the PES and REC scenario most wetlands are in a good condition (i.e. AB or C), and the associated river nodes are similar. There are certain river nodes that are very poor in comparison to the condition of the associated wetlands, mainly due to the surrounding agricultural activities and transformation of the riverbanks. Most of the wetlands in the high-lying areas are within high yield Strategic Water Source Area (Breede), and within protected areas, where REC flows were maintained. Papenkuils floodplain wetland has a REC of C. Although the Smalblaar River node (Niv42) has a low ecological category (E), the Breede River nodes (Niii1 and Nv3) are in better condition (D and C, respectively), and are thus better able to support the preliminary Reserve determined for the Papenkuils (at an ecological condition of C). The node associated with De Hoop Vlei (Nii7) is maintained as a category B with near natural flows.

The Duiwenhoks wetland has a PES of D which needs to be maintained, although the PES of the associated river node is E. The Grootbosberg, Lower Tierkloof and Upper Gaffie wetlands on Goukou River are also at risk from erosion. The associated river node for these wetlands has a PES of C/D. The upper reaches of Donkies River in Touws IUA have FEPA channelled valley-bottom wetlands in a good condition, which are within the Bokkeriviere Nature Reserve and the Gouritz High Yield Strategic Water Source Area. This region requires natural flow and may be considered for conservation purposes. Channelled valley wetlands on the Brak and Touws tributaries are associated with nodes in a better condition, and this should be maintained. The poor condition of the Gouritz, Brandwag and Moordkuil Rivers impacts associated FEPA floodplain wetlands and valley bottom wetlands, which have a good condition.

The Wilderness Lakes is a Ramsar site and needs to be managed accordingly. Although currently the rivers in this area are in a good condition and the rivers flow is close to natural, future development means that in some cases flow has been reduced,

Water Quality

Water quality in the Upper Breede Tributaries will probably remain in the same state as present. With increased development the water quality in the Upper Breede Tributaries will probably remain ideal. Water quality in the Breede River downstream of Ceres would probably deteriorate more due to less dilution of irrigation return flows and WWTW discharges, and more poor quality (unacceptable category) irrigation return flows if the surplus water generated in this scenario is used locally to support expanded irrigation activities. Under this scenario wet season flows would probably decrease and the dry season flows would increase. The impacts on water quality is that the increase in flow during the dry season would dilute the poor quality in the lower reaches of the river impacted by large irrigation return flows. The reduction in flow during the wet season may not result in a major change in the water quality. Under this scenario lower volume freshening releases will probably be made from Brandvlei Dam during the summer months (dry season) which may result in elevated salinity in the river reach up to Sanddrift Canal. This may impact negatively on the irrigation farmers. The impacts of WWTW discharges on elevating nutrient concentrations and elevated bacterial counts from urban runoff in the middle Breede River will probably reduce during the dry season due to higher dilution as a result of the elevated flows. The poor quality in the Breede River at Swellendam could be slightly alleviated by the increase in dry season flows in the main stem river. Flow in the Klip River at Swellendam would be largely unchanged and it is therefore important that WWTW discharges from the Swellendam be controlled. The Overberg West IUA will probably remain in a good state provided point sources of pollution and urban runoff are controlled effectively. Water quality in the Overberg East Renosterveld IUA will continue to exhibit high salt concentrations which was largely ascribed to the geology of the region. In the Riviersonderend Theewaters IUA will probably remain in a good state provided the effluent discharges from WWTW and other pollution sources being controlled effectively. Water quality in the Lower Riviersonderend IUA will probably continue to exhibit elevated salt concentrations as a result of agricultural return flows and it might be higher due to reduced dry season flows in the main stem Riviersonderend River.

Water quality in the Gouritz-Olifants IUA will probably continue to exhibit elevated salt and nutrient concentrations, especially in river reaches receiving large volumes of treated wastewater effluents and/or irrigation return flows. High salinities that occur throughout the Touws IUA will probably continue. Water quality in the upper and middle reaches of the Duiwenhoks IUA will remain poor quality. Water quality in the Korentepoort Dam will probably remain ideal. The elevated salinities in the Groot Brak IUA, especially in the Hartebeestkuil Dam and the downstream Hartenbos River will remain. The same would probably apply to the moderately elevated salinities in Wolwedans Dam. The generally good water quality in the rivers of the Coastal IUA would probably be maintained or it might deteriorate slightly under this scenario.

Groundwater

The present groundwater status has a groundwater use of 215 million m^3/a. This increases in the spatially targeted scenario to 429 million m^3/a. This increase in groundwater use is 99% current, which is lower than the expected groundwater use for the REC scenario (124%). In the Upper Breede Tributaries IUA (A1) there is an increase in status of 4 quaternaries, 2 of which have a significant increase although none are high GWB/EWR. There is a moderate increase in status at 4 quaternaries in the Overberg West/Coastal IUAs, with one quaternary having a high GWBF/EWR (to be managed with RQOs). In the Gouritz-Olifants IUA (D7) there is a moderate increase in status at 7 quaternaries (4 of which change from status I to status III). None are high GWBF/EWR.

Ecosystem Goods, Services and Attributes

As described in Section 5, the assessment of the changes to Ecosystem Goods, Services and Attributes (ecosystem services) were modelled according to different flow scenarios for estuaries. The resulting changes that would be expected under the spatially targeted scenario are outlined below for the tourism, property value, subsistence fishing value and nursery value. The results of this analysis show that changes in ecosystem services are very specific to the location of any change in water flow. Some rivers and estuaries have much higher value than others due to the location of towns, amenities and infrastructure.

Under the spatially targeted (ST) scenario there is an overall gain of R15.4 million per year in the value of ecosystem goods and services compared to the current (PES). While this gain is not as high as the gains seen under the REC scenario, it is the second-best scenario and higher than current EGSA values.

Table B-10 Summary of changes to the aquatic ecosystem services under the different scenarios relative to PES for the Breede-Gouritz WMA, in Millions of Rand per year. ST= spatially targeted.

Estuary Ecosystem Service	Scenario				
	ESBC	REC	No EC	CC	ST
Subsistence Fisheries Value	-1.15	+0.11	-0.41	-0.85	+0.10
Nursery Value	-105.68	+23.05	-3.71	-51.64	+11.79
Property Value	-39.15	+3.88	-14.51	-31.01	+3.28
Tourism Value	-455.18	+32.69	-13.07	-69.71	+0.21
Total (Rm/yr.)	**-601.16**	**+59.73**	**-31.70**	**-153.21**	**+15.38**

Water Supply Consequences

The average annual volume of surface water supplied to all user categories to meet current water requirements in the Breede-Overberg and Gouritz-Coastal regions of the WMA are 627.7 and 275.1 million m^3/a, respectively. The net surplus/deficit in supplying the current day water requirements under the spatially targeted scenario considers the ESBC water requirements in certain IUAs, and the REC requirements in all others. Under the ESBC scenario, in which less surface water is reserved for environmental flows, IUAs are in net surplus relative to the Ecological Reserve requirements. Under the REC scenario, in which more surface water is reserved for environmental flows, several IUAs are in net deficit relative to current-day flows.

For each node with a deficit, the availability of local groundwater to cover such a deficit was determined from the quaternary catchment groundwater availability information. In cases of inadequate local groundwater availability, additional sources of water indicated in Golder (2016) were accepted as suitable for the purposes of this exercise. Nodal deficits are indicated in only two IUAs, namely D7, which includes the town of Oudtshoorn, and for which adequate groundwater is available, and in the Middle Breede (IUA A2 and A3). In IUA A2 and A3 there is insufficient groundwater available and a new surface water scheme is needed. For the other IUAs nodal deficits are indicated in nine IUAs, of which six require additional water sources beyond groundwater: For H16 a new surface water scheme could serve the Greater Hermanus area, while for H17 a groundwater scheme targeting the TMG could serve the Greater Gansbaai area. Local groundwater as well as the TMG aquifer could also potentially supply the shortfall in D7.

Socio-Economic Consequences

Water supply infrastructure costs

Applying the ESBC water requirements for certain IUAs requires additional infrastructure, whilst implementing the REC across the rest of the IUAs would mean allocating more water to the ecological Reserve, making the provision of water more expensive in these IUAs. However, the results indicate that while the water supply infrastructure costs are higher for the spatially targeted scenario than the costs under the ESBC, No EC and CC scenarios, they are significantly lower than the costs needed to meet demands under the REC scenario.

Table B-11 Infrastructure construction costs required to cover water supply deficits relative to current-day water requirements for different scenarios with current-day water supply infrastructure (R million)

WMA portion	IUA	Costs of planned infrastructure costs (R million)	Total infrastructure costs to meet both demands and EWR requirements under each scenario.					
			Maintain PES	ESBC	REC	No EC Constraints	No EC (CC)	Spatially-targeted
Breede	B5	29.6	52.1	30.5	52.1	30.5	30.5	52.1
	H16	189.2	253.1	306.5	299.4	306.5	306.5	299.4
	H17	100	102.7	102.7	308	102.7	102.7	250.8
	F10	11.2	11.2	11.2	26.6	11.2	11.2	11.2
	A1	42.7	283.8	75.2	303.4	75.2	75.2	268.3
	A2 + A3	172	526.5	296	550.5	296	296	393.3
	B4	2.7	3.9	2.7	197.3	2.7	2.7	2.7
	F9	2.8	4.8	2.8	4.8	2.8	2.8	2.8
	F11	8	98.8	9.2	98.8	9.2	9.2	8.0
	Total	**558.2**	**1336.9**	**836.8**	**1840.8**	**836.8**	**836.8**	**1288.6**
Gouritz	E8	19.1	24.4	21.9	24.4	21.9	21.9	24.4
	C6	27.8	51.1	27.8	51.1	27.8	27.8	51.1
	D7	335.8	469.9	383.3	771.1	383.3	383.3	367.3
	F13	0	3.9	0	3.9	0	0	3.9

WMA portion	IUA	Costs of planned infrastructure costs (R million)	Total infrastructure costs to meet both demands and EWR requirements under each scenario.					
			Maintain PES	ESBC	REC	No EC Constraints	No EC (CC)	Spatially-targeted
	F12	0	18.5	0	18.5	0	0	18.5
	I18	0	0	0	0	0	0	0.0
	G14	0	60.3	10.5	60.2	10.5	10.5	53.7
	G15	394	636.9	394	671.9	394	394	627.7
	Total	**776.6**	**1264.7**	**837.3**	**1601.1**	**837.3**	**837.3**	**1146.6**
Total for WMA		**1334.8**	**2601.6**	**1674.1**	**3441.9**	**1674.1**	**1674.1**	**2435.2**

Comparison of costs and benefits

The same approach, as described in section above, for comparing costs and benefits was used here to compare the results from the spatially targeted scenario. The overall economic impact of each scenario was expressed in terms of the direct gains and losses of ecosystem services and water supply costs, expressed in present value terms. The gain and losses for the spatially targeted scenario compared to the EC scenarios is given in Table B-14 and shown graphically in Figure B-6. The results show that there is an overall economic gain under the spatially targeted scenario. The overall gain is only slightly less than the overall gain under the REC scenario and while the REC results in a larger change in EGSA value from present, the infrastructure costs required to meet demands under the spatially targeted are significantly lower than under the REC scenario. Therefore, the best outcome from an economic perspective appears to still be the allocation of the ecological REC. However, the overall economic impact of the spatially targeted scenario is not much different and does result in a positive outcome when compared to the current PES scenario, with lower infrastructure costs.

Table B-12 Estimated differences in value of EGSA and in the costs of water supply infrastructure over the period 2017 to 2040 relative to maintain PES under the different scenarios, including the spatially targeted (ST) scenario.

	Change in EGSA value (R millions) relative to maintaining PES		Change in water supply infrastructure costs (R millions) relative to maintaining PES		Overall gain/loss (R millions, NPV @ 6%)
	Annual change in current terms	Overall change (PV)	Difference in value of infrastructure requirements	Difference in PV costs over 20 years relative to Maintain PES	
ESBC	-601	-8214	-928	532	-7682
REC	60	816	840	-482	334
NoEC	-32	-433	-928	532	99
No EC (CC)	-153	-2093	-928	532	-1561
ST	15.4	210	-166.4	95	306

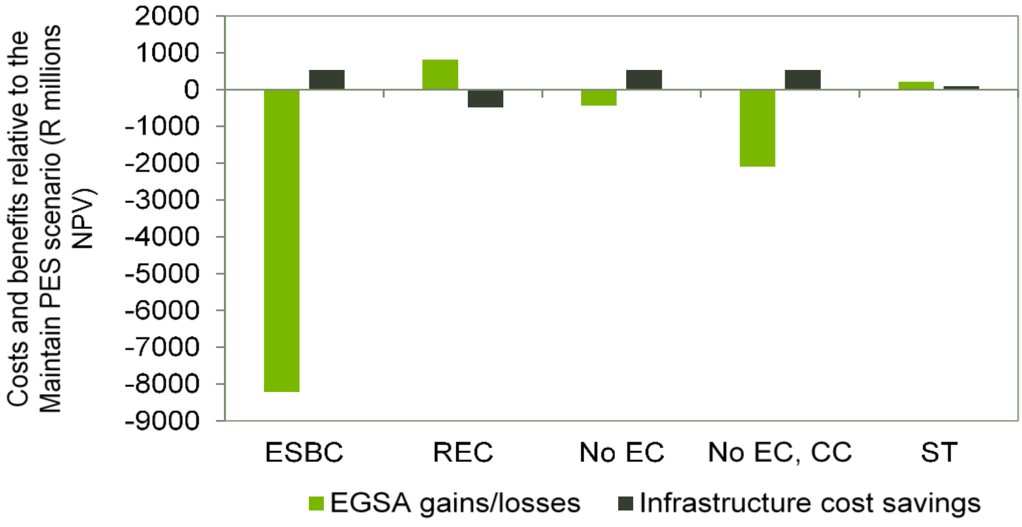


Figure B-6 **Changes in the present value of EGSAs and water infrastructure under alternative scenarios (including the spatially targeted scenario), relative to the Maintain PES scenario, using a discount rate of 6%.**

Social impacts and Implications

The main social impacts of the scenarios are likely to be in the form of changes in the recreational usage and spiritual values of aquatic ecosystems to households. These values are very difficult to quantify, but can make a major difference to household wellbeing. The relative impacts of the different scenarios on these types of values is likely to follow the same pattern as for the tourism values. Thus, social values are maximised where the condition of ecosystems is closest to natural.

Final Proposed Water Resources Classes

The results of the final recommend classification scenario are used to determine the final proposed water resources class for each IUA based on the number of nodes of different EC in each IUA. The final proposed water resource class for each IUA in the Breede-Gouritz WMA are given in Table B-13. In some cases, IUAs have been split to provide a clearer distinction between different water resources classes.

Table B-13 **Final proposed water resources classes for IUAs**

Region	IUA		Spatially targeted	PES
Breede Overberg	Upper Breede Tributaries	A1	II	III
	Middle Breede Renosterveld	A2	III	III
	Breede Working Tributaries	A3	III	III
	Riviersonderend Theewaters	B4	III	III
	Lower Riviersonderend	F9	III	III
	Overberg West	B5	II	III
	Overberg West Coastal	H16	II	III
	Overberg East Renosterveld	F10	II	III
	Overberg East Fynbos	H17	II	III
	Lower Breede Renosterveld	F11	II	III
Gouritz Coastal	Gamka Buffels	C6	II	II
	Touws	E8	III	III
	Gouritz-Olifants	D7	III	III
	Lower Gouritz	F13	II	III
	Duiwenhoks	F12	III	III
	Hessequa	I18	III	III
	Groot Brak	G14	III	III
	Coastal	G15	II	II

Management considerations

A summary of the overall consequences of implementation of the proposed classification scenario for each IUA are given in Table B-14 and Table B-15.

Table B-14 Summary of implications of the spatially targeted classification scenario for each IUA in the Breede-Overberg region of the WMA

IUA	Class	Description	Consequences of Implementation	Groundwater
A1	II	Upper Breede Tributaries (a)	• Upper Breede tributaries within the strategic water source area and Ceres Mountain Fynbos Nature Reserve/Hawequas Nature Reserve need to be maintained in a good condition.	To achieve this scenario into the future, the groundwater status increases compared to PES in four quaternary catchments (i.e. increases from category I to II or I to III). These four catchments are all in the H10 catchments of the Upper Breede Tributaries IUA. The increase in groundwater stress in two of the four is moderate, and the increase is fairly significant in the remaining two. This increase in stress relates to a change in groundwater category from I to II in two catchments; I to III in one catchment, and II to III in one catchment. None of the quaternary catchments impacted by a change in category have been identified as having a high GWBF/EWR ratio.
		Upper Breede Tributaries (b)	• High infrastructure costs to implement REC therefore water requirements for the ESBC used. • Upper Breede tributaries outside of important conservation areas will be in a less natural state.	
A2	III	Breede Working Tributaries (a)	• Tributaries within Matroosberg MCA/Fonteintjiesberg Nature Reserve/Langeberg-Wes MCA/Dassieshoek Local NR need to be maintained in a good condition.	
		Breede Working Tributaries (b)	• High infrastructure costs to implement REC therefore water requirements for the ESBC used. • Although some river nodes are within strategic water source areas, these are not in a natural state and most will have a fair to poor condition. • Nuy River improves to a better condition, but is still in a poor condition.	
A3	III	Middle Breede Renosterveld (a)	• Tributaries within Brandvlei NR/Riviersonderend MCA/Vrolijkheid NR/Langberg Wes MCA/Marloth NR need to be maintained in a good condition.	
		Middle Breede Renosterveld (b)	• High infrastructure costs to implement REC therefore water requirements for the ESBC used. • Rivers are not in a natural state and most will have a poor condition.	
B4	III	Riviersonderend Theewaters (a)	• Upper tributaries within the strategic water source area and Hottentots-Holland NR/Theewaters NR//Hawequas NR/Riviersonderend NR need to be maintained in a good condition.	To achieve REC into the future, the groundwater status increases compared to PES in three quaternary catchments (i.e. increases from category I to II or I to III). These three catchments are all in the H60 catchments of the Riviersonderend Theewaters IUA. The increase in groundwater stress in these three catchments is moderate at two catchments, and significant at one catchment with an increase in the use/ recharge ratio ('stress') is from 0 to 66% at the H60D quaternary catchment. None of the quaternary catchments impacted by a change in category have been identified as having a high GWBF/EWR ratio.
		Riviersonderend Theewaters (b)	• High infrastructure costs to implement REC therefore water requirements for the ESBC used. • Most river nodes will be in a poor condition.	
F9	III	Lower Riviersonderend (a)	• Upper tributaries in the Riviersonderend NR should be maintained in a good condition.	
		Lower Riviersonderend (b)	• Most river nodes will be in a poor condition.	
F11	II	Lower Breede Renosterveld (a)	• River nodes in the upper tributaries will be in a good condition (i.e. A to B Ecological Category).	Although there is an increase in total groundwater use for this scenario, the groundwater status does not change in any quaternary catchment.
		Lower Breede Renosterveld (b)	• Certain river nodes (Leeu, Klip, Buffeljags and Slang) will be in an unacceptable condition.	

<table>
<tr><th>IUA</th><th>Class</th><th>Description</th><th>Consequences of Implementation</th><th>Groundwater</th></tr>
<tr><td>H16</td><td>II</td><td>Overberg West Coastal</td><td>• High infrastructure costs to implement REC therefore water requirements for the ESBC used.
• Swart river node will be in an unacceptable condition, and Onrus river node improved from baseline but will still be in a poor condition (i.e. C to below D Ecological Category).
• Buffels and Rooiels will be in a good condition.</td><td rowspan="3">To achieve this scenario into the future, the groundwater status increases compared to PES in four (of six) quaternary catchments. These four catchments include all those of the Overberg West Coastal, plus G40C of the Overberg West IUA. The increase in groundwater stress in these four catchments is moderate, with each catchment increasing its status by one equivalent category (i.e. increases from category I to II or II to III).
One of the quaternary catchments impacted by a change in category (G40H) has been identified as having a high GWBF/EWR ratio, indicating groundwater contribution to baseflow has the potential to sustain the EWR. Abstraction would need to be carefully managed to ensure impacts on GWBF do not impact on the flow required for the associated EC.</td></tr>
<tr><td rowspan="2">B5</td><td rowspan="2">II</td><td>Overberg West (a)</td><td>• The nodes at the bottom of the catchment should be maintained in a good condition (i.e. B to C Ecological Category).</td></tr>
<tr><td>Overberg West (b)</td><td>• Although there are regions within the Overberg West IUA that are of conservation importance, the surrounding land use in most cases has led to degraded systems.</td></tr>
<tr><td>F10</td><td>II</td><td>Overberg East Renosterveld</td><td>• Hartbees and Steenbok will be in a poor condition.</td><td rowspan="3">To achieve this scenario, the groundwater status increases compared to PES in one quaternary catchment (G40L, located in Overberg East Fynbos IUA). The increase in groundwater stress in this catchment is fairly significant, with the catchment increasing its use/ recharge ratio (‘stress’) from 19 to 88%.
The quaternary catchment impacted by a change in category has not been identified as having a high GWBF/EWR ratio.</td></tr>
<tr><td rowspan="2">H17</td><td rowspan="2">II</td><td>Overberg East Fynbos (a)</td><td>• Kleinmond/Heuningnes/De Hoopvlei Ramsar wetlands need to be maintained in a good condition.
• Upper tributaries in Walker Bay NR/Salmonsdam NR/Uitkraalsmond NR/Pearly beach NR/Agulhas NP/Quion Point NR/Agulhas NP/Soetendalsvlei NR/Heuningberg NR/Waenhuiskrans NR/De Hoop NR are to be maintained in a good condition.</td></tr>
<tr><td>Overberg East Fynbos (b)</td><td>• High infrastructure costs to implement REC therefore water requirements for the ESBC used.
• Limited change from baseline condition. Conditions of river nodes are fair to poor.
• De Hoop Vlei and Klipdrifsfontein will be maintained in a good condition.</td></tr>
</table>

Table B-15 Summary of implications of the spatially targeted classification scenario for each IUA in the Breede-Coastal region of the WMA

IUA	Class	Description	Consequences of Implementation	Groundwater
F12	III	Duiwenhoks (a)	• Upper tributaries in the Langeberg-Oos MCA/Boosmansbos/Garcia NR should be maintained in a good condition.	Although there is an increase in total groundwater use for this scenario, the groundwater status does not change in any quaternary catchment.
		Duiwenhoks (b)	• This flow regime meets the REC of D for giii8 (Duiwenhoks River). • The river node associated with Duiwenhoks wetland remains in an unacceptable condition. • Despite flowing relatively naturally, a range of agricultural impacts such as clearing of riparian vegetation for cultivation and infilling in cultivated areas have meant that the rivers of the Duiwenhoks and Hessequa are in moderate to poor condition. • Flow requirements are met for the REC of C/D at giii7 (Goukou River) with 80% of natural flows.	
I18	III	Hessequa	• The ecological condition of the Duiwenhoks and the Goukou estuaries will be B and C, respectively, which is lower than the Recommended Ecological Condition of A and B, respectively.	
E8	III	Touws (a)	• Tributaries within Bokkeriviere NR/Touw Local Authority NR/Anysberg NR/Warmwaterberg NR/Klein Swartberg MCA/Towerkop NR/Ladismith Klein Karoo/Rooiberg MCA/Wolwekop NR/Langeberg East MCA are to be maintained in a good condition.	To achieve this scenario into the future, the groundwater status increases compared to PES in two quaternary catchments. These two catchments are J12B and J13C; located at the northwest (upstream) and southeast (downstream) extremities of the catchment respectively. The increase in groundwater stress in J12B is significant, with an increase in its use/ recharge ratio ('stress') from 2 to 100%, corresponding for a change in status category from I to III. The change at J13C is moderate. None of the quaternary catchments impacted by a change in category have been identified as having a high GWBF/EWR ratio.
		Touws (b)	• Ysterdams, Donkies and upper Touws rivers at the upper reaches of this region and the upper Groot River will remain in poorer condition.	
C6	II	Gamka-Buffels (a)	• Most river nodes will be in a good condition.	No increase in groundwater use.
		Gamka-Buffels (b)		There is a minor increase in groundwater use in this scenario (compared to PES), however there is no change in groundwater status category for any quaternary catchments within the IUA.
D7	III	Gouritz-Olifants (a)	• Tributaries within Klein Swartberg MCA/Grootswartberg MCA/Swartberg East NR/Kammanassie MCA/Rooiberg MCA/Gamkaberg NR/Doringrivier Wilderness area are to be maintained in a good condition.	To maintain PES into the future, the groundwater status increases compared to PES in seven quaternary catchments. These catchments are in the J25 (west of the IUA, west of Gamka River) and J33 and J35 catchments (centre of IUA) of the Gouritz-Olifants IUA. The increase in groundwater stress in these catchments is moderate to significant, and the increase in the use/ recharge ratio ('stress') ranges
		Gouritz-Olifants (b)	• High infrastructure costs to implement REC therefore water requirements for the ESBC used. • Olifants, Grobbelaars and Kammanassie river nodes will be in a very poor condition. Other nodes are in a fair to poor condition.	

IUA	Class	Description	Consequences of Implementation	Groundwater
F13	II	Lower Gouritz	• The river and estuary nodes will remain in a baseline condition.	from 0 to 20% under current PES, to 26 to 97% at the quaternary catchments. Four of the seven change from a groundwater status of I to III. None of the quaternary catchments impacted by a change in category have been identified as having a high GWBF/EWR ratio.
G14	III	Groot Brak	• Groot Brak estuary will remain in an unacceptable condition.	To achieve this scenario, the groundwater status increases compared to PES in one quaternary catchment (K20A in the east of the IUA). The increase in groundwater stress in these catchments is low, with the catchment increasing in use/recharge ratio ('stress') from 1% to 24%, corresponding to a change in category from I to II. The catchment K20A has a high GWBF/EWR ratio, and abstraction would need to be carefully managed to ensure impacts on GWBF do not impact on the flow required for the associated EC.
G15	II	Coastal (a)	• Rivers and estuaries need to be maintained in a good condition.	To maintain PES into the future, the groundwater status increases compared to PES in two quaternary catchments. These catchments are K30C and K30B around George. The increase in groundwater stress is moderate, with an increase in its use/ recharge ratio ('stress') from between 2 and 5% under current PES, to between 39 and 40% in future respectively, corresponding for a change in status category from I to II. None of the quaternary catchments impacted by a change in category have been identified as having a high GWBF/EWR ratio.
		Coastal (b)	• High infrastructure costs to implement REC therefore water requirements for the ESBC used. • Most river and estuary nodes will be maintained in a good condition.	