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

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RESOURCE UNITS AND INTEGRATED UNITS OF ANALYSIS DELINEATION REPORT

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Bold type indicates this Report.

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- Technical Task Group meeting minutes and updated stakeholder issues and response register
- Project Steering Committee meeting minutes and updated stakeholder issues and response register.
- Training and Capacity Building Report
- Project Management Committee meeting minutes and Progress Reports

List of Abbreviations

BGCMA	Breede-Gouritz Catchment Management Agency
BGCMS	Breede-Gouritz Catchment Management Strategy
CD: WE	Chief Directorate: Water Ecosystems
DWA	(Previous) Department of Water Affairs
DWS	Department of Water and Sanitation
DM	District Municipality
EC	Ecological Category
EIS	Ecological importance and sensitivity
EWR	Ecological water requirements
FSP	Fine Scale Planning
GEF	Global Environmental Fund
GDP	Gross Domestic Product
IUA	Integrated Unit of Analysis
IWRM	Integrated Water Resource Management
IWRMP	Integrated Water Resources Management Plan
LM	Local Municipality
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological Sate
RQOs	Resource Quality Objectives
RDM	Resource Directed Measures
RUs	Resource Units
SEZ	Socio-Economic Zones
WCWSS	Western Cape Water Supply System
WMA	Water Management Area
WRC	Water Resource Class
WRCS	Water Resource Classification System

Executive Summary

INTRODUCTION

It has been recognised that some water resources, by virtue of their ecological importance, do require a high level of protection, whereas other water resources may serve the country's developmental and economic growth needs. In response to Chapter 3 of the National Water Act (NWA) (Act 36 of 1998), the Department of Water and Sanitation (DWS) has established a Water Resources Classification System (WRCS) and Resource Quality Objectives (RQOs) process to achieve these goals.

Against this background DWS has commissioned this Study to determine the Classification and associated RQOs for the water resources of the Breede-Gouritz Water Management Area (WMA). This Report deals with the first component of the first step of the Classification procedure, which is to delineate the integrated units of analysis (IUAs). The second component of the first step of the Classification procedure is to describe the status quo of the water resources. The IUAs represent the spatial units that are defined as significant water resources. Each IUA represents a relatively homogeneous area which requires its own specification of the Water Resources Class. The objective of defining IUAs is to establish broader-scale units for assessing the socio-economic implications of different catchment configuration scenarios and to report on ecological conditions at a sub-catchment scale. Delineation of IUAs is required as it would not be appropriate to set the same Water Resource Class for all water resources in a catchment. This Report outlines the process of delineating and determining the IUAs for the water resources in the Breede-Gouritz WMA.

IUA DELINEATION APPROACH

This Study followed the delineation approach defined in the WRCS Guidelines, Volumes 1 and 2 (DWAF, 2007f). The following was considered for the delineation of IUAs within catchments of the Breede-Gouritz WMA:

- Socio-economic zone, including similar characteristics of land-use and economic activities
- Ecoregion
- Geomorphic zone
- Hydrological characteristics
- Present ecological status
- Vegetation bioregion
- Catchment boundaries

PROVISIONAL DELINEATION OF IUAs

The composition of the individual provisional IUAs is outlined in Table ES1, where it can be seen that both individual Socio-Economic Zones and individual River Resource Units may incorporate more than one provisional IUA. The locations of the individual provisional IUAs for the Gouritz and the Breede-Overberg components of the WMA are indicated in Figure ES1 and Figure ES2, respectively.

NB: It should be noted that the compositions and/or the boundaries of the individual IUAs should be treated as provisional, as more detailed evaluations undertaken during the Status Quo component of the first step of the Classification procedure, may lead to changes in IUA compositions and/or boundaries.

Table ES1: Composition of individual provisional IUAs delineated for the Breede-Gouritz WMA

Socio-economic Zone	Zone Code	River Resource Units	IUA Name	IUA Code	Quaternary Catchments
Breede wine & fruit region	A	Upper Breede Tributaries	Upper Breede Tributaries	A1	H10C H10A H20C H10B H20D H10D H10F H20E H10E H10J H10K
		Breede Working	Breede Working Tributaries	A2	H20A H20F H20B H40A H10H H10G H20G H40B H40C H20H H30C H40H H10L H30D H30B H40J H30A H70C
		Middle Breede Renosterveld	Middle Breede Renosterveld	A3	H40E H40F H40L H30E H40D H40G H40K H50A H50B
Theewaterskloof fruit region	B	Riviersonderend Upper	Riviersonderend Theewaters	B4	H60B H60C H60E H60D H60A H60F
		Overberg West (part 1 of 3)	Overberg West	B5	G40E G40C G40D
Great Karoo	C	Groot/Touws (part 1 of 2) Gamka (part 1 of 2)	Gamka-Buffels	C6	J22G J22H J22B J22A J21A J22C J22J J22K J21B J22D J22E J24A J21D J24B J21C J22F J11B J11A J21E J23A J24C J11D J23B J24D J11C J32A J32C J23G J23C J11G J11E J32B J23D J32D J24E J11F J23F** J23H**
Swartberg	D	Lower Gouritz (part 1 of 2) Olifants	Gouritz-Olifants	D7	J23F** J23H** J23E J32E J33C J24F J23J J25A J33D J35A J25B J35D J31C J33F J35F J33E J31D J25D J33A J33B J31A J31B J25E J35E J25C J35B J34A J34B J34F J34D J34C J35C J34E J40A J40B
Little Karoo	E	Groot/Touws (part 2 of 2)	Touws	E8	J12C J12E J12A J12B J12G J11H J12D J11J J12F J11K J12H J12L J12K J13A J12M J13B J13C J12J
Wheat belt	F	Riviersonderend Lower	Lower Riviersonderend	F9	H60L H60K H60H H60J H60G
		Overberg West (part 2 of 3)	Overberg East Renosterveld	F10	G40F G40K G50H G50G G40J G50D
		Overberg East Renosterveld (part 1 of 2)			

Socio-economic Zone	Zone Code	River Resource Units	IUA Name	IUA Code	Quaternary Catchments
		Lower Breede Renosterveld	Lower Breede Renosterveld	F11	H70D H70B H70A H70E H70F H70J H70G H70H H70K
		Duiwenhoks (1 of 2)	Duiwenhoks	F12	H80B H80A H90B H90A H80C H90C H90D H80D H80E
		Lower Gouritz (2 of 2)	Lower Gouritz	F13	J40C J40D J40E
Garden route coast	G	Coastal Rivers (1 of 2)	Groot Brak	G14	K10E K10C K20A K10D K10F K10B K10A
		Coastal Rivers (2 of 2)	Coastal	G15	K60A K60B K60D K50A K40E K40B K40A K60C K40C K30D K30C K70B K30B K30A K70A K60E K60F K40D K50B K60G
Overberg coast	H	Overberg West (3 of 3)	Overberg West Coastal	H16	G40B G40H G40G
		Overberg East (Fynbos)	Overberg East Fynbos	H17	G40L G50K G50J G40M G50E G50B G50C G50F G50A
Hessequa coast	I	Duiwenhoks (2 of 2)	Hessequa	I18	H90E H80F

***: J23F and J23H shared between Gamka-Buffels and Gouritz-Olifants provisional IUAs*

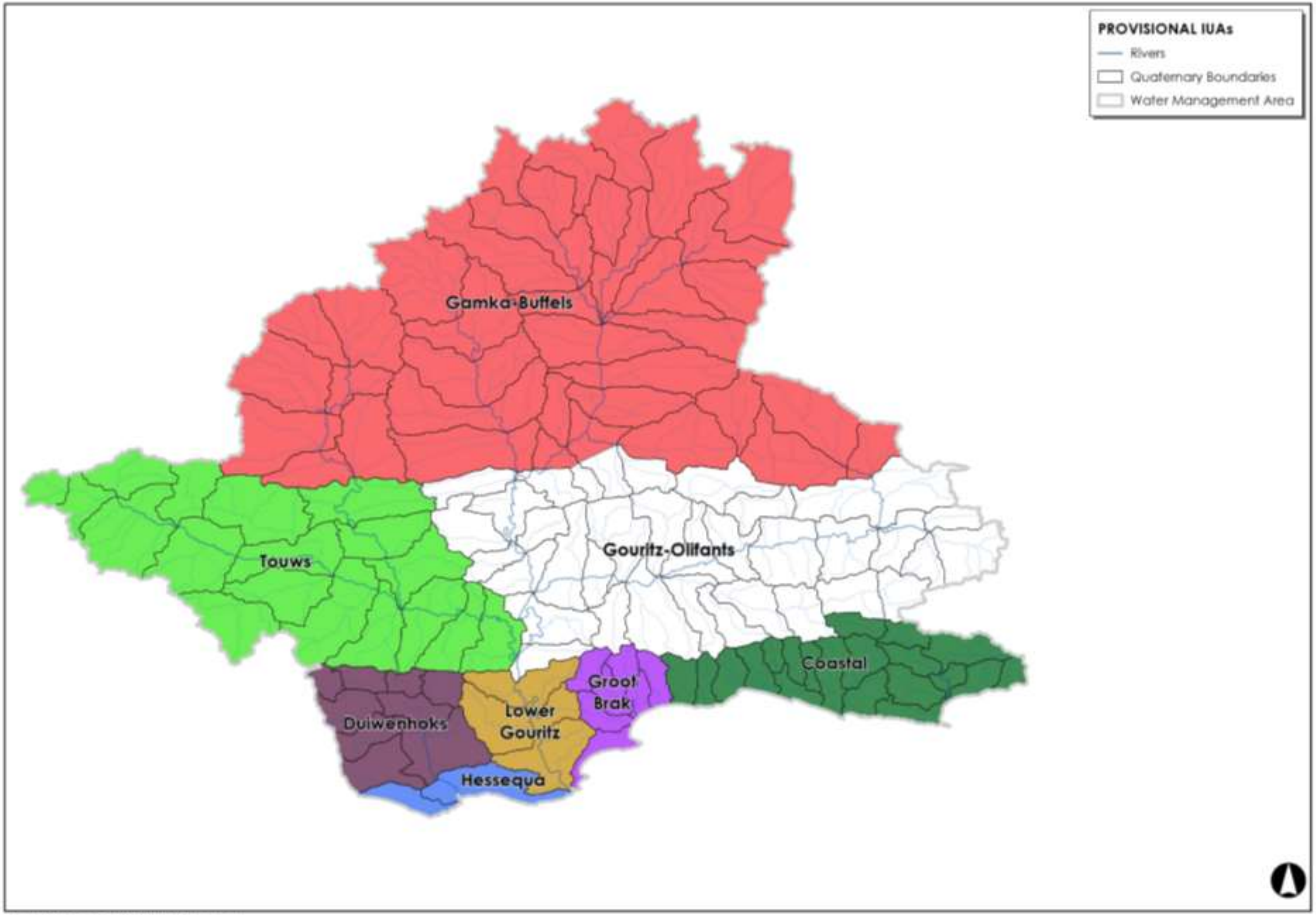

Figure ES1: Locations of the provisional IUAs delineated for the Gouritz component of the WMA

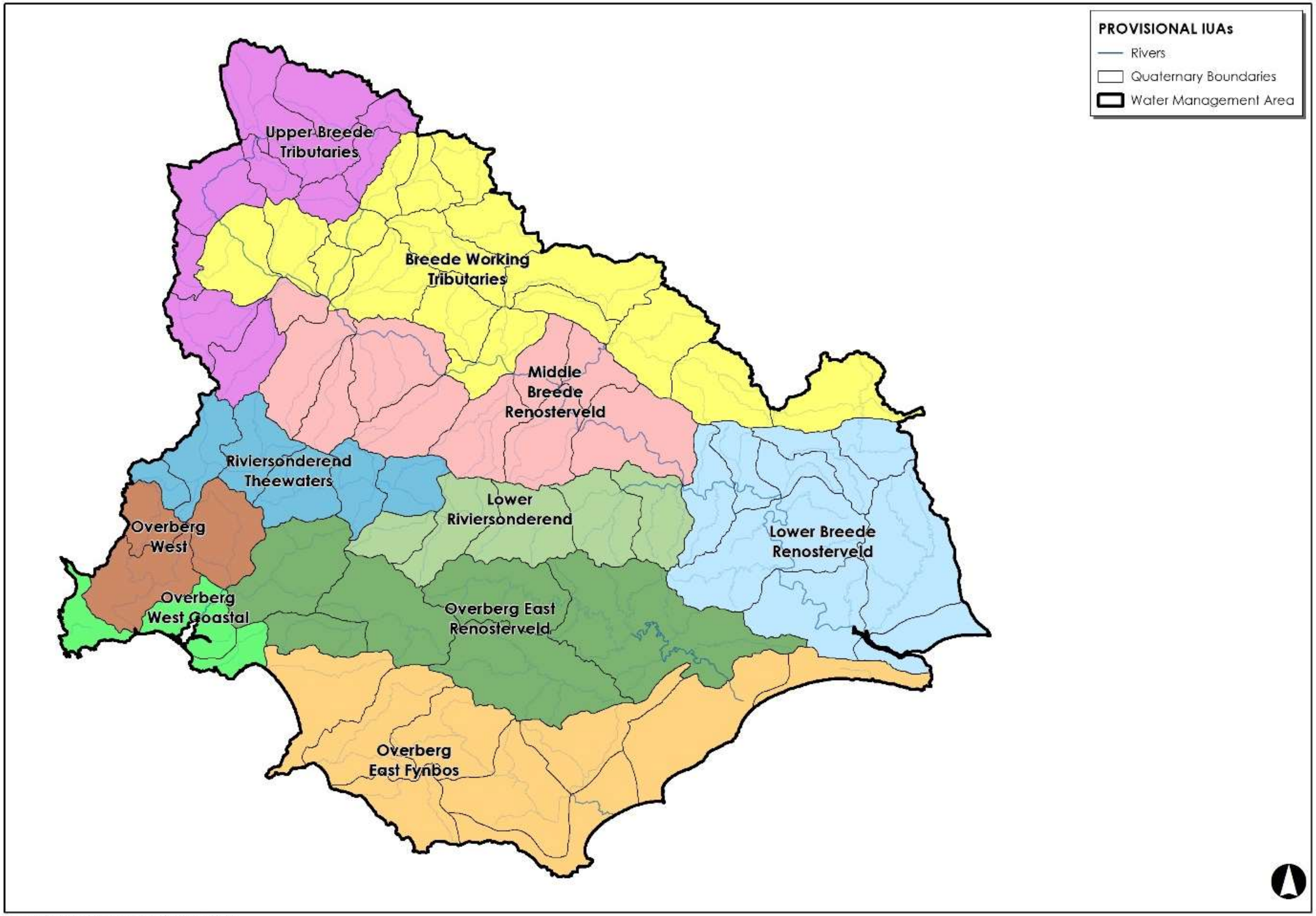

Figure ES2: Locations of the provisional IUAs delineated for the Breede-Overberg component of the WMA

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1 INTRODUCTION

1.1 Background

Chapter 3 of the National Water Act (NWA) lays down a series of measures which are together intended to ensure protection of the water resources. In accordance with these measures, the Department of Water and Sanitation (DWS) in line with Section 12 of the NWA, established a Water Resources Classification System (WRCS) that is formally prescribed by Regulations 810 dated 17 September 2010. The WRCS provides guidelines and procedures for determining Water Resource Classes, Reserve and Resource Quality Objectives.

Section 13 of the NWA states that "as soon as reasonable 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)."

The Chief Directorate: Water Ecosystems has therefore commissioned a study to determine Water Resource Classes (WRC) and associated Resource Quality Objectives (RQO) for all significant water resources in the Breede-Gouritz Water Management Area (WMA).

The Gouritz Catchment consists of the Gouritz River, as well as other rivers such as the Buffels, Touws, Groot, Gamka, Olifants, Kammanassie, and catchments of smaller coastal rivers. The Breede Catchment area consists of the Breede River, its main tributary, the Rivieronderend River and the Overberg River, as well as other smaller coastal rivers.

The 7-step WRCS procedure is prescribed in the WRCS Overview Report (DWAF, 2007f) leading to the recommendation of the Class of a water resource (the outcome of the Classification Process). The determination of the Integrated Unit of Analysis (IUAs) represents one component of Step 1 in the 7-step procedure. The other component of the Step 1 is the description of the status quo of the identified significant water resources in the WMA.

1.2 Objectives of the Study

The main objectives of the Study are to undertake the following:

- Co-ordinate the implementation of the WRCS, as required in Regulation 810 in Government Gazette 33541, by classifying all significant water resources as part of the Breede-Gouritz Water Management Area (WMA).
- Determine RQOs using the DWS Procedures to Determine and Implement RQOs for all significant water resources in the Breede-Gouritz WMA.

In addition the project will require extensive stakeholder engagement and capacity building of DWS and Breede-Gouritz Catchment Management Agency (BGCMA) staff.

The final outcome from the study will be the recommended Water Resources Classes and associated RQOs presented to DWS for gazetting.

1.3 Extent of the Study Area

The Study Area covers all significant water resources of the Breede-Gouritz WMA (see Figure 1.1 overleaf). The Breede and Gouritz Catchments and their primary tributaries, Riviersonderend, Groot, Gamka and Olifants rivers, dominate the Study Area, but it also includes numerous smaller coastal catchments. The Breede-Overberg region is characterised by mountain ranges in the north and west, the wide Breede River valley, and the rolling hills of the Overberg in the south. The Gouritz region is characterised by mountain ranges in the south-west, south and south-east and the vast flat landscape of the Karoo in the north. The smaller coastal rivers include the Palmiet, Rooi-Els, Onrus, Klein, Bot, Stanford, Uilenkraals, Ratel, Heuningnes, Klipdriftsfontein, Duiwenhoks, Hartenbos, De Hoop, Goukou, Klein-Brak, Groot-Brak, Kaaimans, Touws, Karatara, Goukamma, Swart, Maalgate, Gwaiing, Malgas, Noetsie, Knysna, Piesang and Keurbooms rivers.

1.4 Purpose of this Report

The first step of the classification procedure to recommend the Water Resource Class (WRC) of a resource is to delineate the IUAs and describe the status quo of the water resources. The IUAs represent the spatial units that will be defined as significant water resources. Each IUA represents a homogenous area which requires its own specification of the WRC. This report outlines the process for delineating and determining the IUAs for the water resources in the Breede-Gouritz WMA.

The purpose of this report is therefore:

- To provide the information used to delineate the IUAs,
- To detail a network of significant sources and establish biophysical and allocation nodes, i.e. the resource units,
- To detail the defined set of delineated IUAs within the Breede-Gouritz WMA.

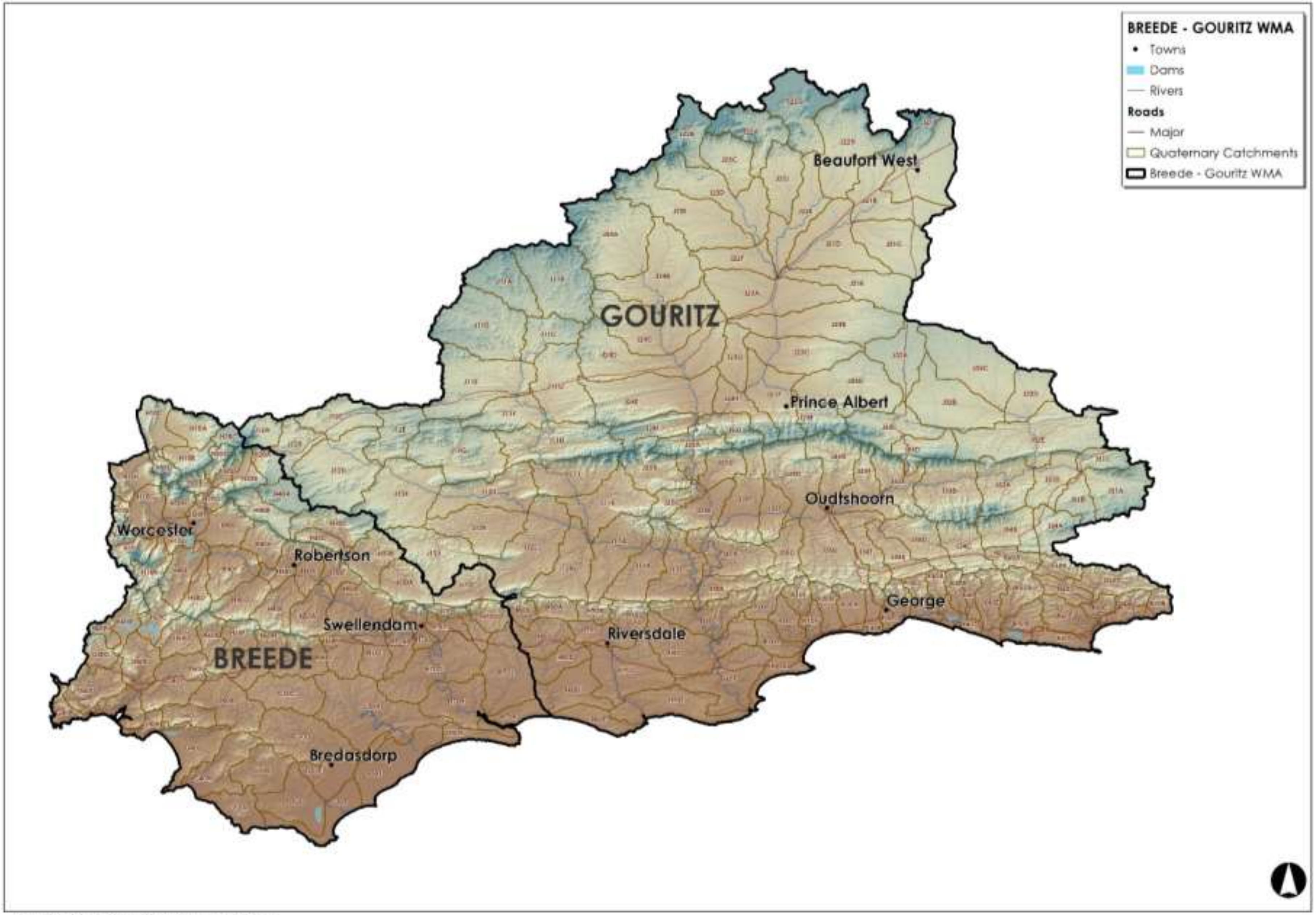

Figure 1.1: Map of the Study Area

2 OUTLINE OF PROCEDURE TO DETERMINE IUAs

2.1 Generic WRCS outline

The WRCS provides for a structured process to identify the agreed trade-off point between resource protection and development of river basins, through an assessment of the economic, social and ecological implications alternative future conditions for a given water resource (DWAF, 2007f). It is designed for use in Classification Processes for every WMA in the country, the outcome of which is the setting, by the Minister or delegated authority, of the Water Resource Class, Reserve and Resource Quality Objectives (RQOs) for significant water resources (river, estuary, dams, wetland and aquifer) in each WMA.

A Water Resource Class, which describes the desired condition of the resource, and concomitantly, the degree to which it can be utilised, is determined for an entire catchment or sub-catchment (DWAF, 2007f). The Class can range from Minimally to Heavily used as defined in Table 2.1, and sets the boundaries for the volume, distribution and quality of the Ecological Reserve and RQOs, and thus the potential allocable portion of a water resource for off-stream use. This has considerable economic, social and ecological implications.

Table 2.1: Definition of Water Resource Classes (DWAF, 2007f)

Class I: Minimally used The configuration of 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 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 water resources within a catchment results in an overall water resource condition that is significantly altered from its pre-development condition.

Many of the steps or procedures of the WRCS are similar to those undertaken as part of Resource Directed Measures (RDM) processes during which, among other things, EWRs are specified. Once gazetted, the WRCS is used in place of the Preliminary Reserves that have been determined to date. For those catchments where Intermediate or Comprehensive Reserve determination studies have already been completed, the WRCS extends the information generated by those studies for use in the Classification Process.

The 7-step procedure prescribed in the WRCS Overview Report (DWAF, 2007f) leading to the recommendation of the Class of a water resource (the outcome of the Classification Process) is summarised in Figure 2.1. It can be seen that the determination of the IUAs represents one component of Step 1 in the 7-step procedure. The other component of the Step 1 is the description of the status quo of the identified significant water resources in the WMA.

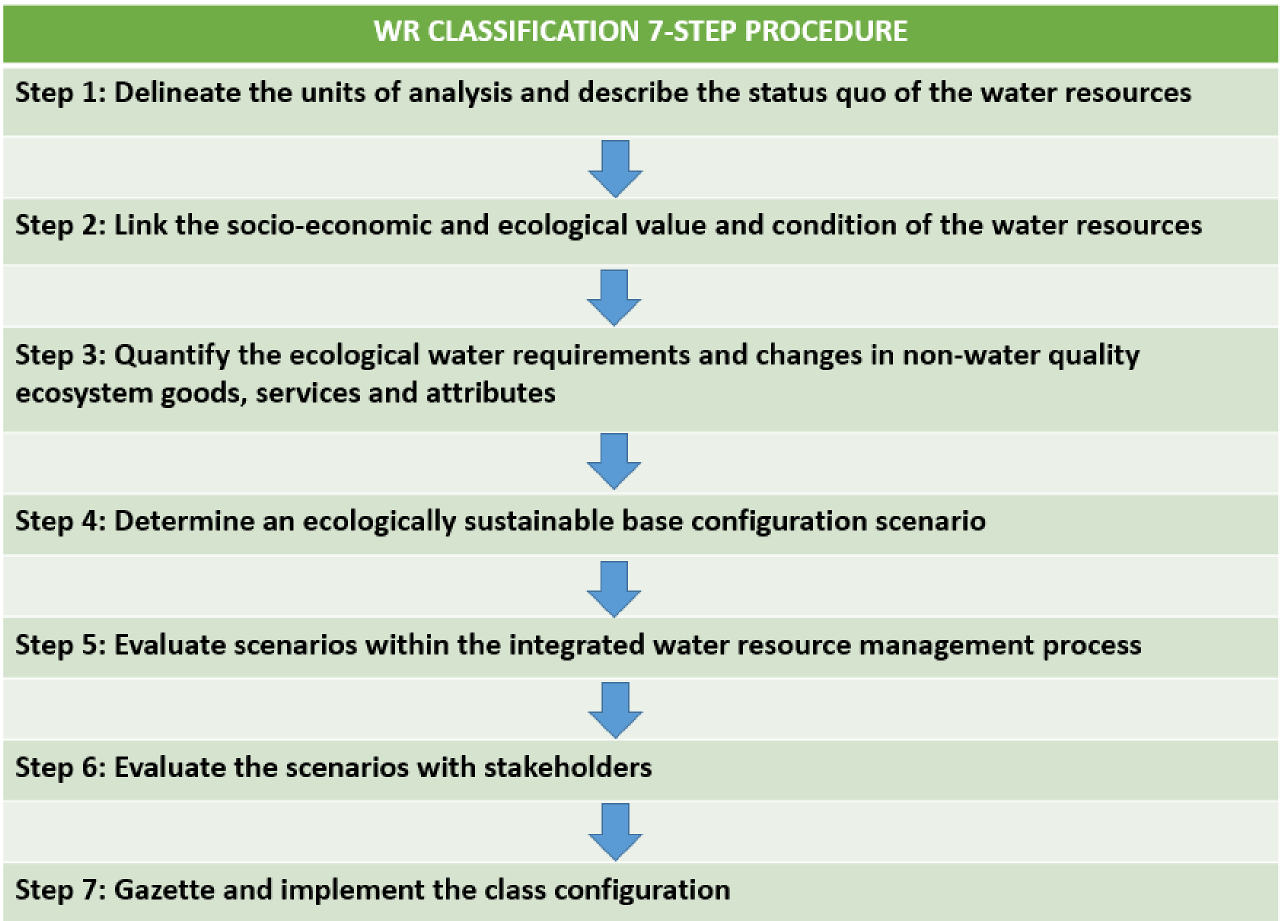

Figure 2.1: WR Classification 7-step procedure (DWAF 2007f)

2.2 Generic outline of IUA determination sub-steps

Figure 2.2, extracted from DWAF (2007f), presents a flow diagram that outlines the sub-steps that need to be undertaken to arrive at final IUA delineations. It is important to note that, although the sub-steps are portrayed sequentially, in reality, various sub-steps are undertaken simultaneously.

(d) Define a network of significant resources and establish bio-physical and allocation nodes

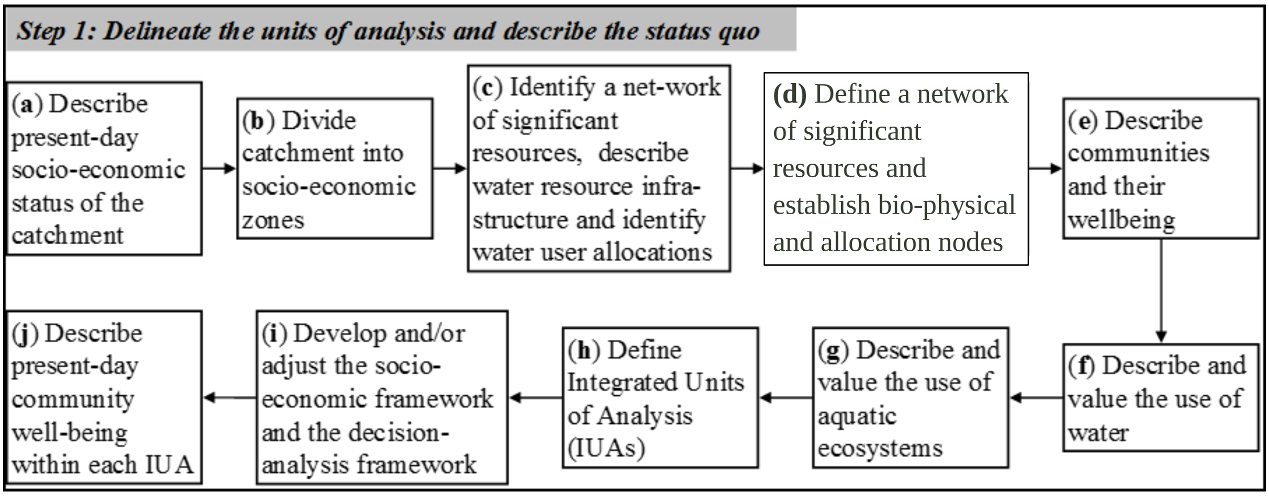

Figure 2.2: Sub-steps of the IUA delineation process (DWAF, 2007f)

2.2.1 Sub-steps 1a and 1b

The purpose of these two sub-steps is to *logically consolidate spatial information on the socio-economic characteristics and aquatic ecosystem services of the study area into socio-economic zones* in order to predict and report the implications of different catchment configuration scenarios on social wellbeing, economic prosperity and ecosystem health at an appropriate spatial scale. This includes the following tasks:

- An overview of land use, population and the use of water in the study area.
- Descriptions of the water user groups and their economic outputs.
- A preliminary description of the value of aquatic ecosystems in terms of the ecosystem services they provide.
- Delineation of socio-economic zones and descriptions of their activities and population characteristics.

2.2.2 Sub-step 1c

The purpose of *identifying a network of significant resources* is to delineate the resources that will be utilised for the Classification Process. Significant water resources are defined as those that are significant from a use perspective and/or for which sufficient data exist to enable an evaluation of changes in their ecological condition in response to changes in water quality and quantity. Significant resources may include main-stem rivers in each quaternary catchment; estuaries, wetlands, dams, aquifers and any other resources considered significant.

The purpose of *describing the water resource infrastructure* is to ensure that the selection of biophysical and allocation nodes (sub-step 1d) takes account of existing water resource infrastructure for (later) modelling and allocation purposes. The description of water resource infrastructure may include major dams, minor dams, farm dam clusters, abstraction infrastructure, canals, and any other water resource infrastructure considered significant.

2.2.3 Sub-step 1d

The purpose of *defining biophysical nodes is to delineate a network of significant resources* that will form the basis of the classification process in the study area. This sub-step comprises the following tasks:

- The determination of ecosystem-specific units (i.e. rivers, estuaries, wetlands, dams and aquifers).
- The identification of areas of interaction between ecosystems (i.e. river-estuary interactions, river-wetlands interactions, river-groundwater interactions, estuary-wetland interactions, estuary-groundwater interactions and groundwater-wetlands).
- The identification of nodes that will account for the interactions between ecosystems.
- The establishment of allocation nodes.

The nodes are used to assess the response of the upstream resources to changes in water quality, quantity and timing. DWAF (2007f) indicates that the biophysical nodes should be located at the end-points of ecosystem reaches that will allow for meaningful trade-offs between different parts of the catchment in terms of the quantity (volume and distribution) and quality of water that remains in the resource, and thus the quantity and quality of water available for off-stream use. The allocation nodes should account for "existing lawful use" and for potential future use.

2.2.4 Sub-step 1e

The objective of *describing communities and their wellbeing* within each socio-economic zone (identified in sub-step 1b) is to provide the baseline from which changes in social wellbeing can be estimated for each of the catchment configuration scenarios evaluated in Steps 5 and 6 of the Classification Procedure. This requires describing the levels of financial, physical, human, social and natural capital available to each community, as well as constructing a measure or index of social wellbeing from the data collected in Steps 1a and 1b.

2.2.5 Sub-step 1f

The objective of *describing and valuing the use of water* is to determine the way in which water is currently being used in each socio-economic zone and to estimate the value generated by that use. This will provide the baseline from which the socio-economic implications of different catchment configuration scenarios can be assessed.

2.2.6 Sub-step 1g

The objective of *describing and valuing the use of aquatic ecosystems* is to determine the way in which aquatic ecosystems are currently being used in each socio-economic zone, and to estimate the value generated by that use. This will provide the baseline against which the socio-economic and ecological implications of different catchment configuration scenarios can be compared.

2.2.7 Sub-step 1h

The objective of *defining IUAs* is to establish broader-scale units for assessing the socio-economic implications of different catchment configuration scenarios and to report on ecological conditions at a sub-catchment scale. IUAs are therefore a combination of the socio-economic zones defined in Step 1b and catchment boundaries, within which ecological information is provided at a finer scale. This requires that the nodes established in Step 1d of the Classification Procedure be nested within the IUAs.

2.2.8 Sub-step 1i

The objective of this sub-step is to *develop and/or adjust the socio-economic framework and the decision-analysis framework* proposed in DWAF (2007f) for a specific application of the Classification Process. For the socioeconomic component of the Classification Procedure, this requires developing and/or adjusting the socio-economic framework that links changes in yield and ecosystem characteristics to socio-economic values to meet the specific requirements of the catchment.

2.2.9 Sub-step 1j

The objective of this sub-step is to *describe the present-day community wellbeing within each IUA* using the index developed in Step 1e. This is to ensure that the ecological and socio-economic implications of different catchment configuration scenarios are reported at the same scale.

2.3 Step 1 outcomes reported in this document

Our appointment brief specifies that the details and outcomes of Step 1 of the Classification Procedure for this study must be reported in two separate documents, namely a *Resource Unit Delineation and Integrated Units of Analysis* Report and a *Status Quo* Report.

In accordance with this specification, this document reports only on the outcomes of Sub-step 1b (divide catchment into socio-economic zones), Sub-step 1d (define a network of significant resources and establish the biophysical nodes and allocation nodes) and Sub-step 1h (define the IUAs).

The details, methodologies and outcomes of the tasks falling under the other Sub-steps of Step 1 are fully documented in our *Status Quo* Report.

3 SUB-STEP 1b: DEFINE SOCIO-ECONOMIC ZONES

3.1 General approach

The purpose of delineating socio-economic zones is to make it easier to provide descriptions of the socio-economic implications of different classification scenarios that can be readily understood by stakeholders who can relate to the various areas that they depend upon. The rationale for the zonation process was that zones should be relatively homogenous in terms of the relationships of the economic activities in the zones with water. For example, some zones are heavily dependent on irrigation, with associated pressures on water resources, others may be dominated by dryland crops, others by use of natural areas for which ecosystem health is of greatest importance, and others by urban and industrial activities which have a high impact on water resources. In reality the study area contains a high diversity of activities and zones cannot be quite so neatly defined.

3.2 Delineation of Socio-Economic Zones

Socio-economic zones were delineated after detailed inspection of a range of spatial information on geography, climate, drainage, vegetation and land use. The zones were demarcated primarily on the basis of agricultural land use. Layers that were the most important in this process included:

- Land Cover 2014
- Agricultural Census, which shows detailed spatial information on crops planted at the sub-farm level
- Homogenous Farming Areas

Although Homogenous Farming Areas initially seemed to provide a promising guide, there were significant discrepancies between these areas and the census and land cover data; therefore, the latter were taken as the primary determinants of land use zones. Initial boundaries were then compared with river characteristics and catchment boundaries. After input from the rest of the team, some of the socio-economic boundaries were slightly realigned in order to facilitate the summarising of data between the different disciplines. Since many of the socio-economic zones in the Breede-Gouritz catchment are aligned from west to east while catchments largely flow from north to south, these areas tend to intersect one another, as shown in Figure 3.1.

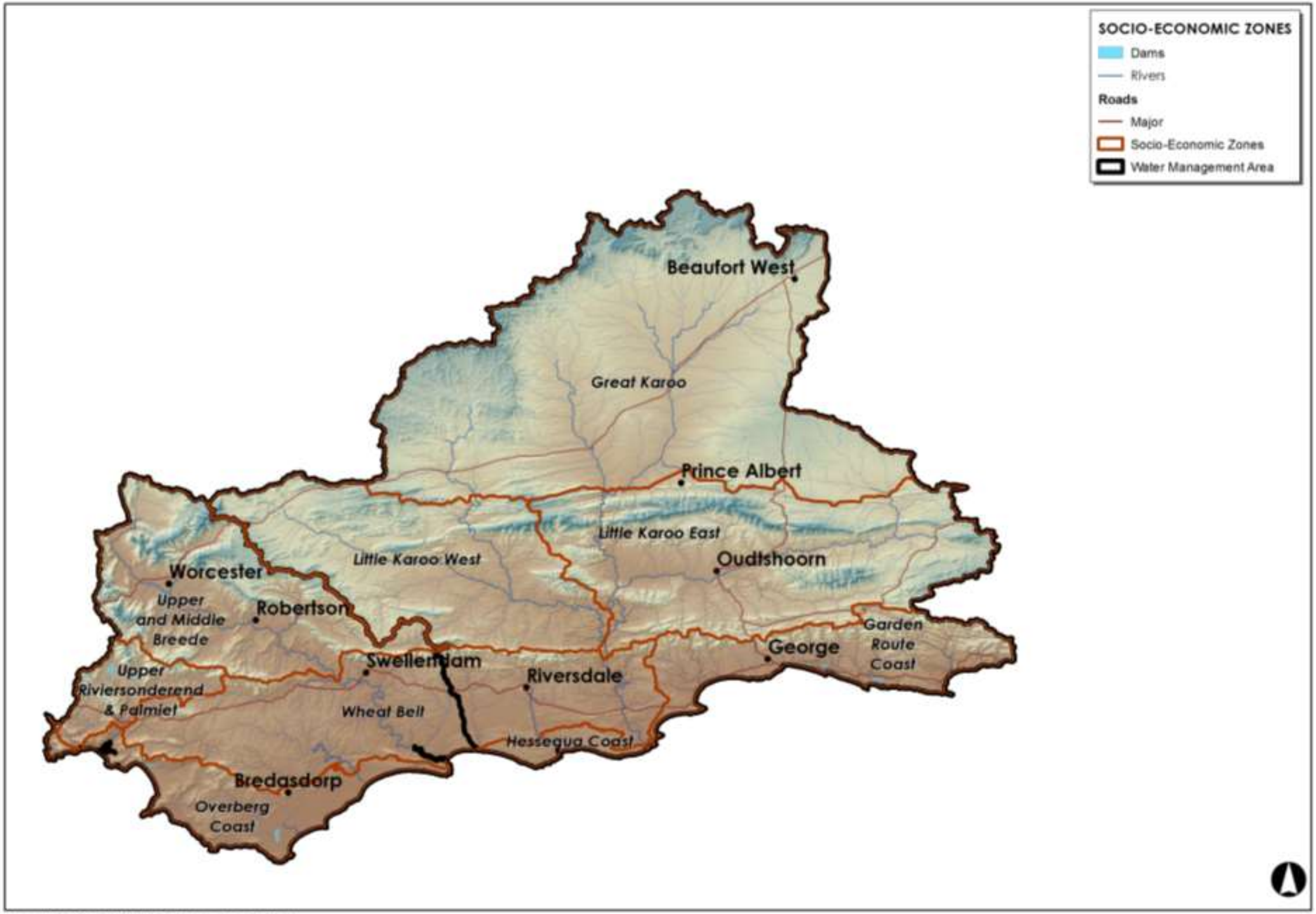

Figure 3.1: Socio-economic zones delineated for the Breede-Gouritz WMA

4 SUB-STEP 1d (i): DEFINE RESOURCE UNITS

4.1 River Resource Units

4.1.1 General approach

The general approach followed to define the boundaries of the significant surface water resources comprising the River Resource Units (River RUs), was to overlay six different sets of spatial data that are ecologically relevant on a base map of major catchment boundaries, infilled with quaternary catchment boundaries. This enabled the derivation of River RUs which, in ecologically-relevant terms, are internally consistent. These six sets of overlaying spatial data were as follows:

- ecoregions
- geomorphic zones
- hydrological index
- present ecological status (PES)
- aquatic vegetation classes
- vegetation bioregions.

The detailed data sets and mapping used for this delineation are reported in full in the Status Quo Report.

4.1.2 Gouritz River RU delineation

The River RU delineation started in the north with the merging of the Gamka and the Dwyka catchments as highly similar Karoo rivers. They join just upstream of the Gouritz, which is rather different in terms of all six the above criteria. Two quaternaries at the north-eastern extreme of the Study Area, which are tributaries of the Olifants River, were also added to the Gamka/Dwyka as they are also typical Karoo rivers. Despite the Olifants and the Groot/Touws being similar in vegetation and geomorphic zones, they were delineated as separate RUs in the light of differences across the other criteria, as well as being physically separated by the Lower Gouritz, which, in turn, differs from both of them. The Duiwenhoks catchment and the coastal catchments are distinctly different to the above four RUs and are, therefore, delineated as separate RUs.

The delineation of the six River RUs is depicted in Figure 4.1 and the quaternaries that fall in each are detailed in Table 4.1.

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Figure 4.1: River Resource Units delineated for the Gouritz

Table 4.1: Quaternary catchments belonging to Gouritz River Resource Units

River Resource Unit	Quaternary Catchments
Gamka	J22G, J22H, J22B, J22A, J21A, J22C, J22J, J22K, J21B, J22D, J22E, J21D, J21C, J22F, J21E, J23A, J23B, J23G, J23C, J23F, J23D, J23H, J23E, J23J, J24E, J24C, J24D, J24F, J24A, J24B, J32A, J32C
Groot/Touws	J11B, J11A, J11D, J11C, J11G, J11E, J11F, J12C, J12E, J12A, J12B, J12G, J11H, J12D, J11J, J12F, J11K, J12H, J12L, J12K, J13A, J12M, J13B, J13C, J12J
Olifants	J32B, J32D, J32E, J33C, J33D, J35A, J35D, J31C, J33F, J35F, J33E, J31D, J33A, J33B, J31A, J31B, J35E, J35B, J34A, J34B, J34F, J34D, J34C, J35C, J34E
Lower Gouritz	J25A, J25B, J25D, J25E, J25C, J40A, J40B, J40C, J40D, J40E
Duiwenhoks	H80B, H80A, H90B, H90A, H80C, H90C, H90D, H80D
Coastal Rivers	K60A, K60B, K60D, K50A, K40E, K40B, K40A, K60C, K40C, K30D, K10E, K30C, K10C, K20A, K30B, K30A, K70A, K60E, K60F, K40D, K10D, K50B, K10F, K60G, K10B

4.1.3 Breede-Overberg River RU delineation

The River RU delineation started in with the separation of the main catchment groupings, namely Breede, Riviersonderend, Overberg East and Overberg West. Next, the Overberg East was divided into two RUs, viz. Renosterveld and Fynbos respectively. The Riviersonderend catchment was also divided into two RUs, viz. upstream and downstream of Theewaterskloof Dam respectively. The upstream catchment is near-pristine and mostly under Fynbos. The downstream catchment is mostly under Renosterveld and the downstream flow regime is highly impacted by the operations of the Dam. The six sets of overlays provided no convincing evidence to separate the individual Overberg West rivers from one another. The Breede was divided into four RUs: an Upper RU with mostly healthy Fynbos tributaries, an RU of hard-working tributaries feeding the Upper and Middle Breede, a Middle Breede RU with drier Renosterveld tributaries and a Lower Breede with Renosterveld tributaries.

The delineation of the nine River RUs is depicted in Figure 4.2 overleaf and the quaternaries that fall in each are detailed in Table 4.2.

Table 4.2: Quaternary catchments belonging to Breede-Overberg River Resource Units

River Resource Unit	Quaternary Catchments
Upper Breede Fynbos	H10C, H10A, H20C, H10B, H20D, H10D, H10F, H20E, H10E, H10J, H10K
Breede Working Tributaries	H20A, H20F, H20B, H40A, H10H, H10G, H20G, H40B, H40C, H20H, H30C, H40H, H10L, H30D, H30B, H40J, H30A, H70C, H70D, H70B, H70E, H70F
Middle Breede Renosterveld	H20A, H20F, H20B, H40A, H10H, H10G, H20G, H40B, H40C, H20H, H30C, H40H, H10L, H30D, H30B, H40E, H40J, H40F, H40L, H30E, H40D, H30A, H70C, H40G, H40K, H50A, H50B, H70D, H70B, H70E, H70F
Lower Breede Renosterveld	H70A, H70J, H70G, H70H
Riviersonderend Upstream	H60B, H60C, H60A, H60E, H60D, H60F
Riviersonderend Downstream	H60L, H60K, H60H, H60J, H60G
Overberg West	G40E, G40C, G40F, G40D, G40K, G40B, G40G, G40J, G40H, G40L
Overberg East Fynbos	G40M, G50E, G50B, G50C
Overberg East Renosterveld	G50H, G50G, G50D

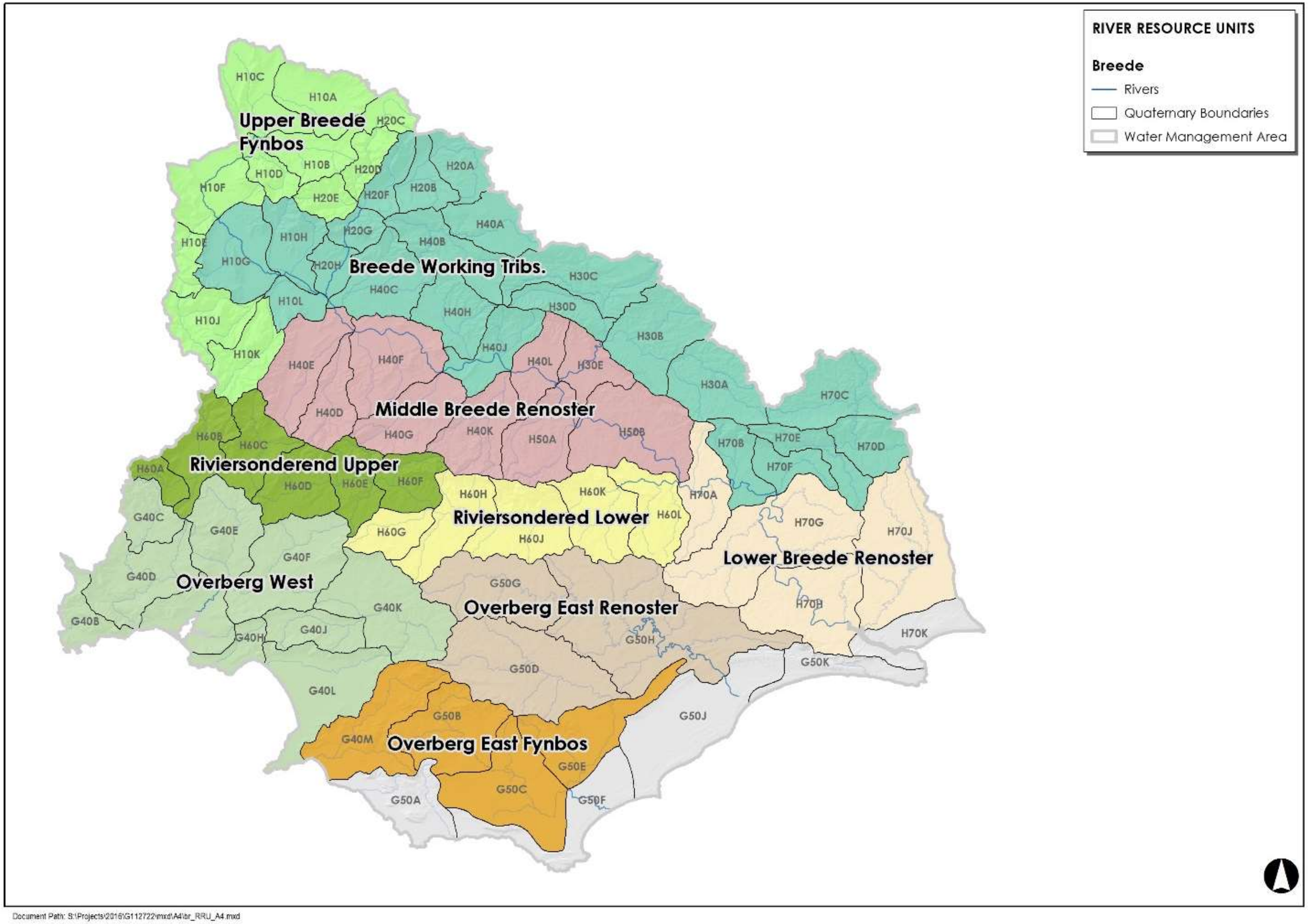

Figure 4.2: River Resource Units delineated for the Breede-Overberg

4.2 Groundwater Resource Units

4.2.1 General approach

The ‘Groundwater Reserve’ is usually determined per quaternary catchment and is used as the primary delineation of water resource units in Resource Directed Measures (RDM) assessments. The delineation of groundwater units relate specifically to hydrogeological criteria and might not necessarily correlate to quaternary surface water catchments or surface water units of analysis. Due to the strongly compartmentalised nature of the TMG, due to faults or fault zones, and the associated deep confined flow paths, the aquifer boundaries mostly do not coincide with surface water catchment boundaries. In these instances subsurface conditions could play an influential role in controlling hydrological and ecological conditions (Umvoto Africa, 2010). The delineation of resource units is complex within the TMG and requires that the recharge zone and the discharge zones of the flow paths are determined. A summary of the previous hydrogeological divisions of the larger TMG area provides some insight into the approach for delineating resource units for the Breede-Gouritz WMA.

Previous hydrogeological delineations

Based on the type of openings – primary or secondary – lithostratigraphy, physiography and climate, Vegter (2001) divided South Africa into 64 groundwater regions, 12 of which are located within the Breede and Gouritz WMA. However, in this delineation the TMG is not significantly distinguished from the adjacent Bokkeveld and Witteberg Groups. In earlier studies, four sections of the entire TMG Super Aquifer were outlined, based on different thickness of geological successions or their positions in the CFB and on associated tectonic regimes present. Regionally, the TMG aquifer system has been previously divided into five sections, namely the Western Section (the CAGE area, Central Section (Agter Witzenberg – Ceres – Hex – Koo Valley and Villiersdorp), Klein Karoo Section, eastern TMG Section and Coastal Belt (from Kleinmond to Mossel Bay).

A more comprehensive delineation was presented by Wu (2005) based on a more detailed identification of hydrogeological boundaries and aquifer systems. Wu (2005) regarded the regional faults as a structural boundary as well as a hydrogeological boundary and assumed that most of the regional faults are impermeable. Based on geological and hydrodynamic characteristics, namely, geomorphology and boundary conditions of groundwater, flow nineteen hydrogeological units were identified. Xu et al. (2009) later adapted the delineation into 15 hydrogeological units (Figure 4.3).

The concept of an integrated water resources management (IWRM) domain was applied by for the Berg Water Availability Assessment Study (DWAF 2008), which was for the main purpose of establishing domains/units to “initiate the planning for the groundwater modelling as well as the Water Resource Yield Model (WRYM) development and to promote the integration of surface water, groundwater and ecological monitoring within a domain that conceivably responds differently in time but has the same boundary conditions” (CMC, 2004). Based on the hydraulic principles of the definition of the IWRM domain several units were delineated by DWAF (2008) in the upper Breede catchment (Figure 6). Boundaries generally follow major watersheds and topographic divides, and/or important lithological boundary changes (aquifer-aquitard contacts). The IWRM domain is defined around a potential water resource development scheme that integrates the local surface-water resource with one or more components of the groundwater system in that area. They generally combine between two and ten quaternary catchments.

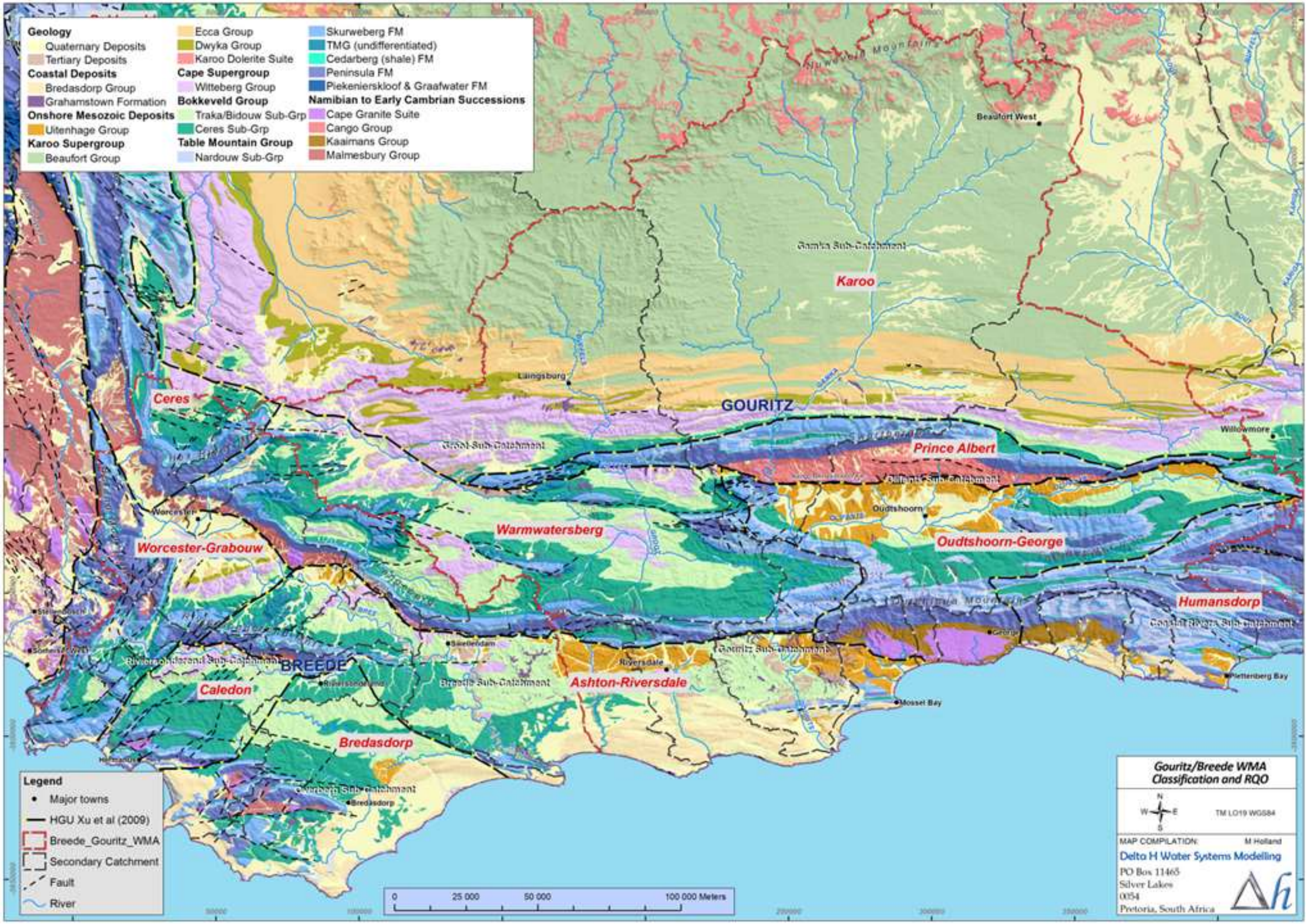

Figure 4.3: Regional delineation of fifteen hydrogeological units (adapted from, Xu et al., 2009)

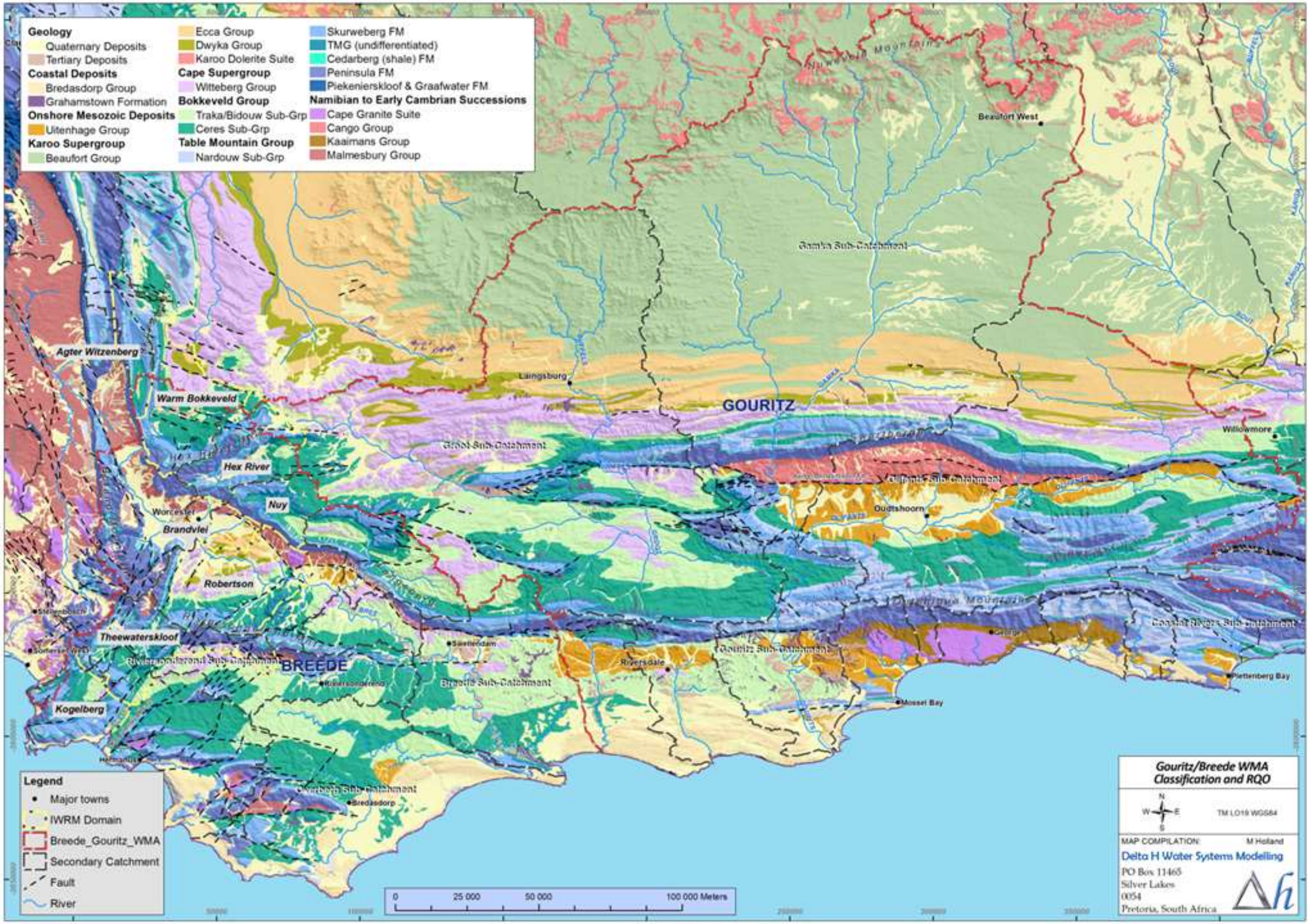

Figure 4.4: **Regional delineation of eight IWRM domains (adapted from DWAF, 2008)**

Surface water catchments

The Breede and Gouritz catchments and their primary tributaries, Riviersonderend, Groot, Gamka and Olifants, dominate the Study Area, but it also includes numerous smaller coastal catchments. The WMAs comprise of 210 quaternary catchments with rivers cutting through various formations and structural units of the area that produce diverse watercourses and slope systems, which lead to both the rugged surface and different relief mountain and hill systems. These influence the groundwater systems in terms of recharge locations, interflow behaviours, and corresponding groundwater circulations.

Approach and results

The geological setting of the TMG leads to a complex delineation of resource units due to the confined and unconfined nature of the Cape Supergroup, which is largely controlled through faults, folding and lithology. The Peninsula Formation forms in most cases surface water catchment divides with the remainder of the Bokkeveld Group the lower lying areas. DWAF (2008) recognised that a water balance based on (surface water) catchment boundaries may lead to erroneous recharge allocated to an adjacent groundwater unit. To overcome this DWAF (2008) differentiated between the Peninsula Formation outcrop area and the confined Peninsula Formation (i.e. Peninsula Formation that is covered by other geological units). This approach was adapted here for the current delineation for classification, but the resulting groundwater unit was not limited to the Peninsula Aquifer alone. The Peninsula Formation often forms the head water of major drainage system (sometimes in the opposite direction of the deep groundwater flow system) and depending on the geological setting can contribute to recharge and groundwater flow on either side of the drainage divide. It's generally observed that the Skurweberg aquifer contributes more directly to river baseflow both via the river bottom and via springs at the Nardouw – Cedarberg contact, while the Peninsula contributes to river flow mainly as surface run-off (WRC, 2003).

For consistency during the delineation process the contact between the Peninsula Formation and the reminder of the TMG and the overlying Cape Supergroup was used in cases where it was deemed necessary (i.e. main recharge/run-off area). An example of the GRU delineation is shown in a section Figure 7. Using standard procedures the groundwater classification can be applied to each resource unit but with scrutiny some links will exist between resource units. This can be quantified by applying different recharge estimates for lithologies and disaggregating the quaternary baseflow estimates into resource units.

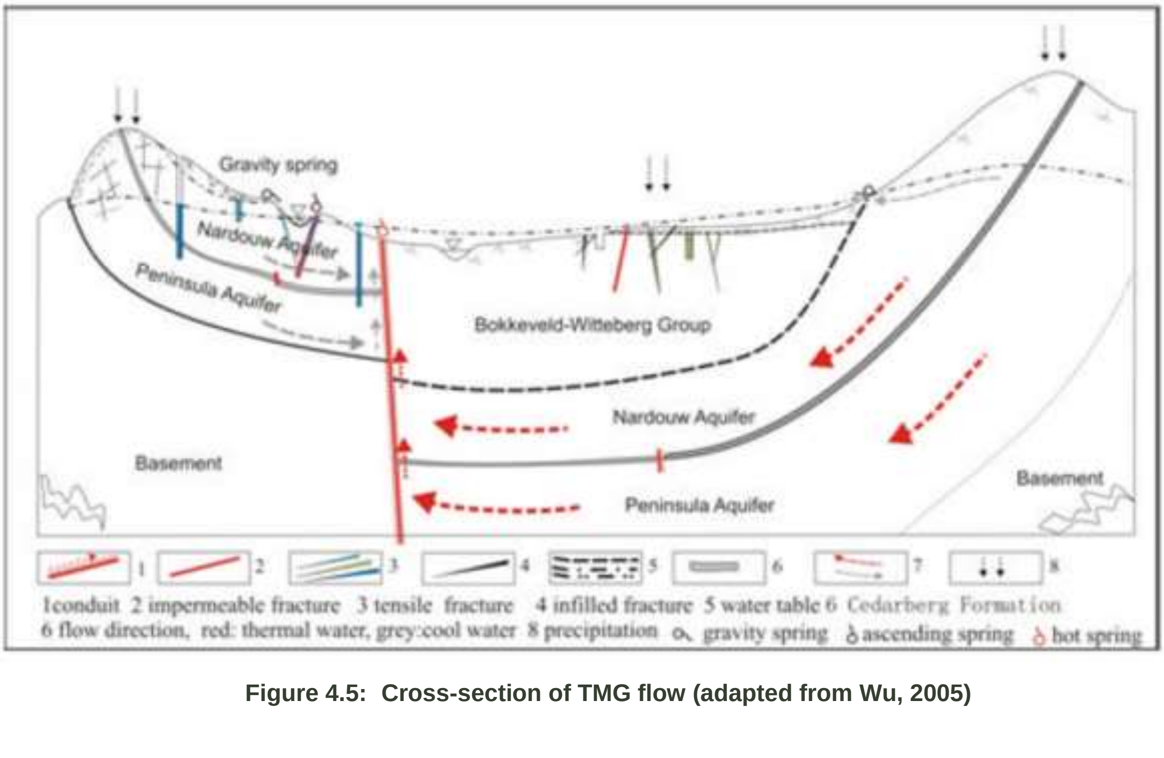

Figure 4.5: Cross-section of TMG flow (adapted from Wu, 2005)

Delineation of Groundwater Resource Units was largely a GIS-based exercise which took the following into consideration:

- Surface water topographical divides on a quaternary and secondary level
- Geological structures (i.e. faults, hydro-stratigraphy, dykes, lithological contact zones)
- Recharge zones
- Discharge zones
- River systems
- Groundwater use
- Groundwater management (size and extent of units)

The resource units were grouped primarily into the different sub-catchments with consideration of the groundwater system in that area. The delineated resource units generally combine a couple of quaternary catchments, but boundaries do not always coincide with surface water divides. However, the integration of surface water and groundwater systems was largely achieved.

4.2.2 Groundwater RU delineation

A summary for each of the thirteen groundwater resource units delineated in the Breede catchment is listed in Table 4.3.

Table 4.3: Summary description of Gouritz Groundwater Resource Units

Catchment	GRU	Quaternary	Summary Description
Groot	GGr-1	J12B to J12E	The Gouritz catchment boundary encloses the unit in the northwest, while the northern boundary deviates along the contact between the Witteberg Group and overlying Karoo Supergroup. The area is dominated mainly by the Bokkeveld Group and Witteberg Group outcrops. Cenozoic cover occurs over much of the area and alluvial materials in river valleys (e.g. Touws River), or screes and other slope materials could results in moderate groundwater resources.
	GGr-2	J12F; J12G	The northern boundary deviates along the contact between the Witteberg Group and overlying Karoo Supergroup. The unit is limited to the J12F and J12H catchment boundaries in the east. The area is dominated mainly by the Bokkeveld Group and Witteberg Group outcrops. The TMG (mainly the Nardouw sub-group) exposed to the east dips north under the rest of the Cape Supergroup and under the Karoo Supergroup. Cenozoic cover occurs over much of the area and alluvial materials in river valleys, or screes and other slope materials could results in moderate groundwater resources.
	GGr-3	J11A to J11F	The Gouritz catchment boundary encloses the unit in the northwest and north, whiles the Dwyka drainage tributaries and associated catchment, bounds the unit in the east. The Dwyka and Ecca Groups of the Karoo Supergroup dominate the unit and groundwater occurrence is associated with the intrusion of dolerite dykes and the degree of weathering and fracturing.
	GGr-4	J11H to J11K;	The unit straddles the Cango-Baviaanskloof Fault and also the Swartberge. This area of very rugged mountains is dominated by the Peninsula Formation, with higher TMG Formations only really occurring on the highest peak. Discharge from the TMG also occurs to surface water systems, mainly to the south. The unit is bounded in the north by the Witteberg Group and the overlying Karoo Supergroup contact zone and to the south by the Rooiberg fault zone. The east and west coincide with J12 and J25 catchment boundaries.
	GGr-5	J12K to J12M; J13A to J13C	The J12K catchment bounds the unit in the north but deviates along the fault zone and in along the contact between the Peninsula Formation outcrop and the remaining rocks of the TMG and the overlying Bokkeveld Group which corresponds closely to the quaternary boundary enclosing J13

Catchment	GRU	Quaternary	Summary Description
			A, J13B, J13C and J40A. The area is dominated by the Bokkeveld Group outcrop. However, deep groundwater in the TMG occurs recharged from the surrounding mountains. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GGo-1, GGo-2a and 2b.
Gamka	GGa-1	J24A to J24E	The Gouritz catchment boundary encloses the unit in the northwest and north, while the Gamka sub-catchment bounds the unit in the east. The Dwyka and Ecca Groups of the Karoo Supergroup dominate the unit and groundwater occurrence is associated with the intrusion of dolerite dykes and the degree of weathering and fracturing.
	GGa-2a, 2b and 2c	J22A to J22F; J21A to J21E; J23A; J23 B	The unit comprises the upper Gamka catchment and is dominated by rocks of the Dwyka and Ecca Groups of the Karoo Supergroup. The J23B catchment bounds the unit in the south.
	GGa-3	J24F; J25A to J25E	The northern boundary deviates along the contact between the Witteberg Group and overlying Karoo Supergroup. The unit forms the western flank of the Klein Karoo Basin. The valley floor surrounding Calitzdorp consists of Tertiary to Quaternary sand deposits of the Uitenhage Group. The Rooiberg Mountain Range was formed by a large anticlinal fault, while the Klein Swartberge and Groot Swartberge mountain range are characterised by folds and overturned beds. These mountain ranges consist predominantly of the Peninsula Formation and Nardouw sub-group. The unit is limited to the Olifants sub-catchment to the east.
	GGa-4	J23C to J23J	The unit comprises the central parts of the Swartberge Mountain range and is bounded to the south by the Peninsula Formation outcrop and the remaining rocks of the TMG (closely associated with the catchment boundary). The lower lying area of rolling hills is towards the north of the TMG outcrop is dominated by Witteberg Group, with minor Bokkeveld Group. The northern parts of the unit comprise the Dwyka and Ecca Groups of the Karoo Supergroup. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GO-4.
	GGa-5	J40A; J40B	The northern boundary coincides with the Rooiberg Mountain Range, while the east and west is associated with J13C and J35C catchment boundaries. The unit is dominated with TMG outcrop in the east and the Bokkeveld Group in the west. The Outeniqua Mountain Range bounds the unit to the south. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GC-1.
Gouritz	GGo-1	J40C to J40E; K10A; K10B	The northern boundary deviates from the quaternary catchment boundary and follows the contact between the TMG and the overlying Bokkeveld Group. Its southern half is bounded by the Atlantic Ocean with Vlees Bay in the west and Hartenbos in the east. The eastern boundary is deviates from the catchment boundary in the north and follows the contact zone of the Cape Granite Suite north of Brak River. Mesozoic Uitenhage Group deposits occur in the north east and overlies the TMG. The TMG outcrops west of Mosselbay and together with the Bokkeveld Group underlie the Bredasgroup Cenozoic cover to the southwest.
	GGo-2a and 2b	H80A to H80F; H90A to H90E	The unit comprises largely of the H80 and H90 catchment. Its southern half is bounded by the Atlantic Ocean with Still Bay in the southeast. The northern boundary deviates from the quaternary catchment boundary and follows the contact between the Peninsula Formation outcrop and the remaining rocks of the TMG and the overlying Bokkeveld Group. Mesozoic Uitenhage Group deposits also occur, in the north of this area. Towards the south, the TMG and mainly the Bokkeveld Group rocks underlie Cenozoic cover. Groundwater discharge to the ocean will occur. Discharge occurs to low lying wetlands adjacent to river systems, which are dependent on groundwater.
Olifants	GO-1	J32A to J32E	The unit comprises the Upper Olifants catchment and is bounded to the north and east by the Gouritz WMA catchment boundary. To the south the Peninsula Formation outcrop and the remaining rocks of the TMG (closely associated with the catchment boundary) forms the unit boundary. The lower lying area of rolling hills is towards the north of the TMG outcrop is dominated by the Bokkeveld and Witteberg Group, with the overlying

Catchment	GRU	Quaternary	Summary Description
			Dwyka and Ecca Groups of the Karoo Supergroup further to the north. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GO-2.
	GO-2	J31A to J31D; J33A; J33B	The unit represents largely the middle Olifants catchment and bounded in the south and north along the contact zone of the Peninsula Formation. The unit is limited to the east and west by catchment boundaries. Towards the southeast the boundary deviates from the catchment boundary follows the northern contact zone of the Peninsula Formation (coinciding with the Kammanassie Mountain Range). Buried TMG may discharge deep groundwater towards the Olifants River Basin. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GO-3.
	GO-3	J34A to J34C; K60A	The unit is dominated by the TMG and Bokkeveld Group and lies west of the Gourtiz WMA catchment boundary. Towards the south the unit is limited to the northern contact zone of the Peninsula Formation. The unit is limited to the east and west by catchment boundaries. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GC-2.
	GO-4	J35A to J35E; J34D to J34F; J33E;J33F; J34D; J34E	The unit is characterized as the Central and Eastern Karoo Basin with deposits of the Uitenhage Group overlying rocks of the Cape Supergroup. The area could probably be subdivided into smaller resource units but it will be difficult to subdivide the Olifants River Basin without compromising the surface water balance. The contact zone between the Peninsula Formation and remaining TMG Formations closely associated with the catchment boundary and the Outeniqua Mountain Range bounds the unit to the south. The catchment divide associated with the Rooiberg Mountain Range limits the unit in the southwest. The northern boundary deviates from the catchment boundary and follows similarly the contact zone between the Peninsula Formation and remaining TMG Formations. The remaining boundaries coincide with catchment boundaries. Deep groundwater flow of the TMG will link the Peninsula Formation within unit GC-1.
Coastal	GC-1	K10C to K10F ; K20A, K30A to K30D	The unit's southern half is bounded by the Atlantic Ocean with Groot Brakrivier in the west and Wilderness in the east. To the north the boundary deviates from the catchment and follows the contact between the Peninsula Formation and the remaining rocks of the TMG. The George batholith outcrops west and south of George, which intruded into the Kaaimans Group. The western boundary deviates from the catchment boundary and follows the contact zone of the Cape Granite Suite north of Brak River. The argillaceous character of the Kaaimans Group renders it less favourable for groundwater development than other aquifer types in the study area. Cape Granite Suite aquifers owe their water-bearing properties to both fracturing and weathering, and typical drilling targets include zones of deep weathering, contact zones with the Kaaimans Group and dyke contacts. The Peninsula Formation outcropping to the north is considered to have the most groundwater potential. Groundwater is expected to flow southwards and toward the nearest surface water bodies.
	GC-2	K40A to K40E; K50A to K50B;K60F; K60G	The unit can be divided for management reasons between the K40 and K50 catchment boundaries. Similar to unit GS-1 the northern boundary is associated with the northern contact of the Peninsula Formation. Its southern half is bounded by the Atlantic Ocean with Rondevlei in the west and Plettenberg Bay in the east.
	GC-3	K60B to K60E; K70A; K70B	The unit is bounded by the coast line to the south and the Gouritz WMA catchment boundary.

The nineteen resource units for the Gouritz catchment are listed in Table 4.4.

Table 4.4: Summary description of Breede-Overberg Groundwater Resource Units

Catchment	GRU	Quaternary	Summary Description
Overberg	BO-1	G40A to G40D; G40G	Its southern half is bounded by the Atlantic Ocean with False Bay in the West. The G40 catchment boundary bounds the north-western part of the KGB, while the Groenlandberg Fault bounds the north-eastern part. The eastern boundary is limited to the TMG outcrop (east of Kleinmond). Groundwater flow occurs in the Peninsula and Nardouw aquifers.
	BO-2	G40E to G40L	Its southern half is bounded by the Atlantic Ocean with Hermanus in the south-west and Gansbaai in the south-east. The G40L and G40K catchment bounds the unit in the east and northeast. Although the Caledon (deep seated) hot spring occurs on the fault bounding the southern side of the Swartberg the unit boundary corresponds to the northern contact between the TMG and Bokkeveld Group. Other than discharge to surface water systems, deep groundwater flow from this area is most likely northwards where the TMG continues beneath the Bokkeveld Group. The unit is bound to the west by the NE-SW fault zone east of Kleinmond. TMG and Bokkeveld Group rocks underlie Cenozoic cover to the south and hydraulic connection probably occurs in places. Discharge occurs to low lying wetlands adjacent to river systems, which are dependent on groundwater.
	BO-3	G40M; G50 to G50J	Its southern half is bounded by the Atlantic Ocean with Pearly Beach in the west, Struis Bay in the south-east and Skipskop in the east. The G40M, G50D and G50G catchment bounds the unit in the east, northeast and north. The TMG outcrops largely to the area west of Bredasdorp while the remainder of the area is underlain by TMG and this could be potentially recharged by the numerous ranges and inselbergs adjacent to the area. Towards the east the area opens up to the Bontehoek fault. Towards the south and east of Bredasdorp, the Bokkeveld Group rocks underlie Cenozoic cover. Groundwater will discharge to the ocean. Discharge occurs to low lying wetlands adjacent to river systems, which are dependent on groundwater.
Riviersonderend	BR-1	H60A to H60D	The overall Berg catchment boundary bounds the unit to the east and the Groenlandberg Fault bounds the south. The northern and eastern boundary follows the quaternary catchment boundaries that enclose the H60 catchment. The peninsula outcrop could be linked to BB-7.
	BR-2	H60E to H60L	The H60E, H60H and H60J catchment bounds the unit in the north associated with the Riviersonderend Mountains with the Overberg sub-catchment bounding the unit to the south. The TMG dips north under the rest of the Cape Supergroup and even under Karoo Supergroup and Uitenhage Group rocks, to depths of several kilometers, until abutting against the Worcester Fault (beyond BR-2). Discharge from the TMG also occurs to surface water systems, both to the north and south. Deep groundwater flow is possible from the Riviersonderend Mountains into these areas and links BR-2 to the BB-7 unit. Towards the east the large, low lying area of rolling hills is dominated by Bokkeveld Group outcrop, with minor Witteberg Group.
Breede	BB-1	H10A to H10C	The overall Berg catchment boundary bounds the unit to the north. To the west the boundary follows the axis of the Hansiesberg Anticline. It was assumed that the major groundwater will flow towards the Berg WMA along the centre of the Agter-Witzenberg Syncline axis. The eastern boundary follows the quaternary catchment boundaries enclosing the H10 catchment.
	BB-2	H20A to H20; J12A	The overall Berg catchment boundary bounds the unit to the north and the Touws river Fault. The eastern boundary follows the quaternary catchment boundaries that enclose the H20 catchment. The boundaries contain the Hex River Valley, bounded by the TMG-dominated Hex River Mountains and the Kwadouwsberge. Groundwater flow from the Peninsula Formation in the south from unit BB-5 is possible.
	BB-3	H10D to H10F; H10J;H10K	The northern boundary follows the northern H10D and H10H quaternary boundary before returning to the contact. The Brandvlei unit consists of rocks of the Table Mountain Group with inliers of Malmesbury and

Catchment	GRU	Quaternary	Summary Description
			Granite basement in the bounding mountains, and quaternary sediments of the Bredasdorp Group in addition to alluvium bounding the Upper Breede River basin. Groundwater flow is possible from the Hex River Mountains into the Ceres valley and link to the BB-2 and BB-1 units. Groundwater flow within the Breede Alluvial aquifer will also flow from BB-3 to BB-5.
	BB -4	H40A; H40B	The Gouritz catchment boundary bounds the unit to the east and northeast. Significant groundwater resources are available at depth in the TMG, which is recharged in the surrounding mountains. Some upwards leakage may occur from the TMG into the Bokkeveld Group. Groundwater flow in the Nardouw Aquifer feeds the Nuy River while flow in the Peninsula Formation (from unit BB-5) enters confinement in the Koo Valley.
	BB -5	H10H; H20G; H20H; H40C	The northern boundary follows the contact between the Peninsula Formation outcrop and the remaining rocks of the TMG and the overlying Bokkeveld Group which corresponds closely to the quaternary boundary enclosing H40H, H40L. The unit Is limited towards the east by the H50 catchment. Sediments overlie these rocks and alluvium borders the Breede River, which is connected to the alluvial aquifer in BB-4. Groundwater flow occurs in the Peninsula and Nardouw Aquifers into deep confinement below the rocks of the Bokkeveld and Witteberg
	BB-6	H30A to H30D; J12J;H70C	The unit straddles the Breede and Gouritz catchment boundary. The area is dominated mainly by the Bokkeveld Group with some Witteberg Group outcropping towards the east. Minor to moderate groundwater resources will occur in the Bokkeveld Group sandstone units, or in alluvial materials in river valleys (e.g. Koo River), or screes and other slope materials. Major groundwater resources are available at depth in the TMG, which is recharged in the surrounding mountains (i.e. Langeberg Mountains to the south). Deep groundwater flow of the TMG will link the Peninsula Formation within unit BB-7 and BB-8.
	BB-7	H40D to H40L; H30E; H50A;H50B	Similar to unit BB-5 the northern boundary follows the contact between the Peninsula Formation outcrop and the remaining rocks of the TMG and the overlying Bokkeveld Group which corresponds closely to the quaternary boundary enclosing the H50 catchment. The unit Is limited towards the south and east by the H60 and H70 catchments, respectively. Deep groundwater flow of the TMG will link the Peninsula Formation within unit BR-2.
	BB-8	H70A to H70K; G50K	The northern boundary of the lower Breede unit follows the contact between the Peninsula Formation outcrop and the remaining rocks of the TMG and the overlying Bokkeveld Group which corresponds closely to the quaternary boundary enclosing the H70 catchment. Its southern half is bounded by the Atlantic Ocean with Witsand in the south and the Bontehoek fault in the west. The overall Gourtiz catchment boundary bounds the unit to the east.

The spatial distribution of the resource units in relation to geology and surface catchments is shown in Figure 4.6.

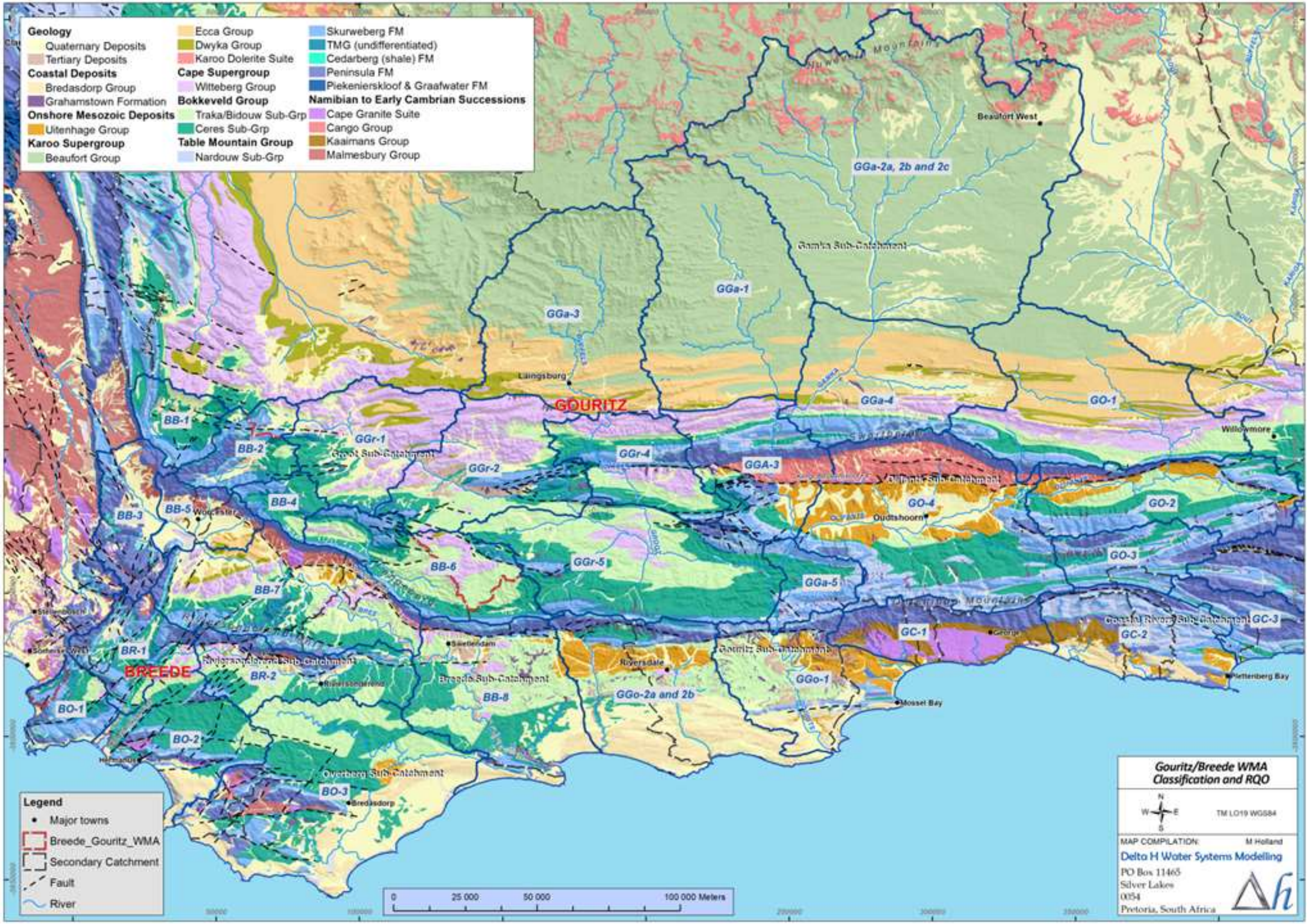

Figure 4.6: Delineated groundwater resource units

4.3 Preliminary Dams Resource Units

4.3.1 General approach

The National List of Registered Dams (DWS, 2016) kept by the Dam Safety Office of DWS, was used as a starting point to identify dams. As the dams that will be prioritised will be the result of a screening process to be undertaken later as part of the RQO activities, what is required at this stage is that a first level of screening be undertaken, to identify the initial list of dams that may potentially be screened / prioritised later in the process, termed the Preliminary Dams RUs.

A conservative approach was followed, whereby a fairly sizeable number of dams were identified for further screening, so as not to miss potential priority dams, although it is expected that the number of prioritised dams may be much less. All the dams located within the study area was subjected to a first high-level screening, as follows:

- The national list was filtered to view dams that are located in the WMA, and 717 dams were identified,
- Large or medium sized dams were selected,
- High or significant hazard potential dams were selected,
- Category 2 or category 3 dams were selected, in terms of dam safety legislation, and
- Dams with a capacity of more than 5 million m^3 were selected. Dams that have a capacity of 5 million m^3 or less are generally not regarded as significant dams.

4.3.2 Dams RU delineation

The locations of the Preliminary Dams RUs for the Study Area are indicated in Figure 4.7 and descriptions of the individual Preliminary Dams RUs are presented in Table 4.5.

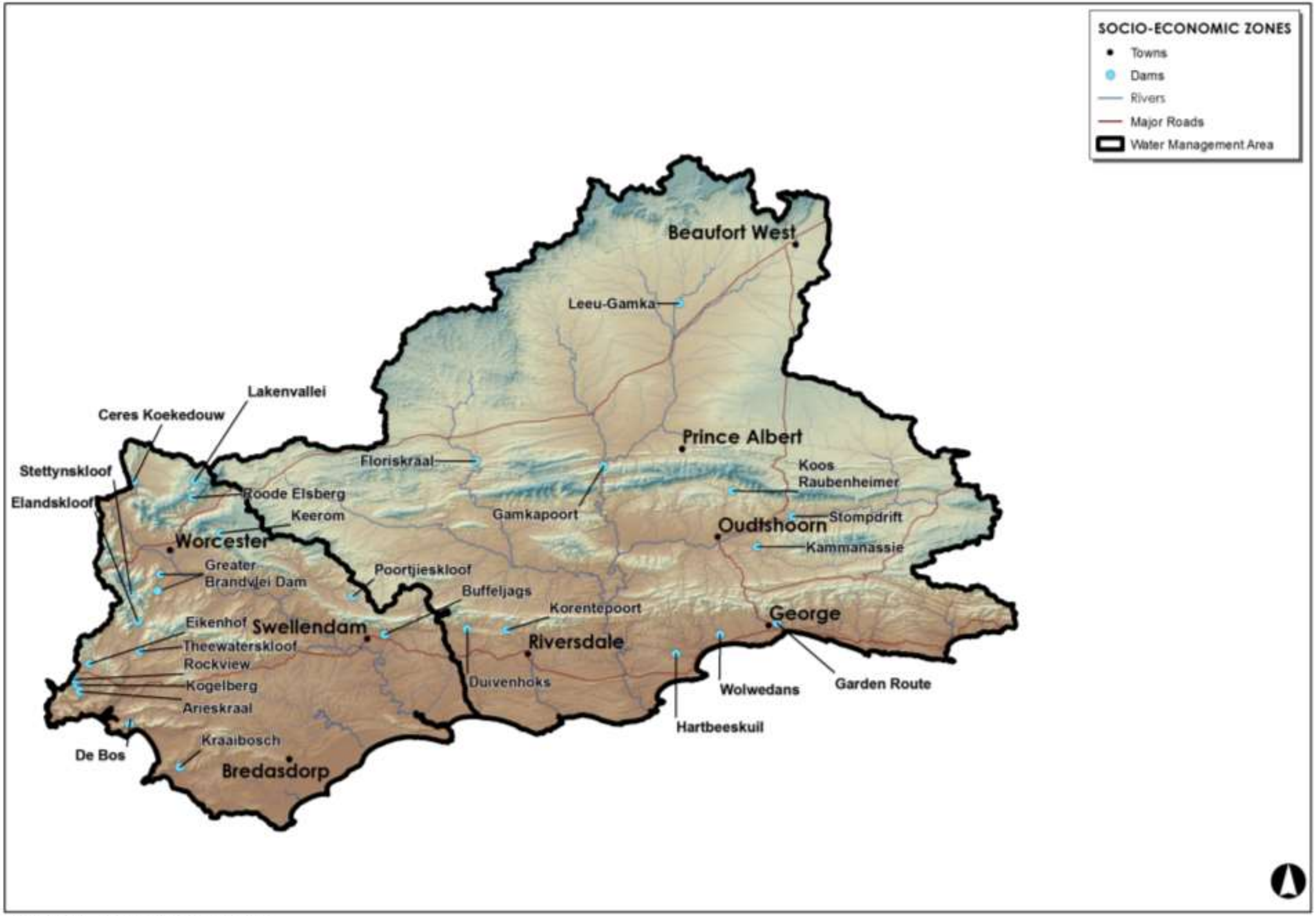

Figure 4.7: Preliminary Dams Resource Units delineated for the Breede-Gouritz WMA

Table 4.5: **Preliminary Dams Resource Units for the Breede-Gouritz WMA**

No of dam	Name of dam	Quaternary Drainage Area	Completion date	Completion date raising	River or Watercourse	Wall type	Capacity (1000 m^3)	Purpose / use	Owner Name
H600/02	Theewaterskloof Dam	H60D	1980		Riviersonderend	Earthfill	480 406	Municipal, industrial and irrigation	DWS
H100/08	Brandvlei Dam & Greater Brandvlei Reservoir	H10L	1983		Breede Tributary	Earthfill	456 000	Irrigation	DWS
J330/01	Stompdrift Dam	J33B	1965	2014	Olifants River	Multi-Arch	55 300	Irrigation	DWS
J110/01	Floriskraal Dam	J11G	1957		Buffels	Buttress & Gravity	50 334	Irrigation	DWS
J250/01	Gamkapoort Dam	J25A	1969		Gamka	Gravity	3 6000	Flood control	DWS
J340/02	Kammanassie Dam	J34E	1923		Kammanassie	Gravity	35 870	Irrigation	DWS
G401/80	Eikenhof Dam	G40C	1977	1998	Palmiet	Earthfill	29 000	Irrigation and domestic supply	Groenland Irrigation Board
K200/02	Wolwedans Dam	K20A	1990		Groot Brak	Gravity Arch	25 530	Municipal and industrial	DWS
G400/05	Kogelberg Dam	G40D	1986		Palmiet	Arch & Earthfill	19 300	Industrial (hydropower)	DWS
H101/BL	Ceres Koekedouw Dam (was Greater Ceres)	H10C	2001		Koekedouw	Rockfill	17 200	Irrigation	Witzenberg Local Municipality
G400/49	Rockview Dam	G40D	1986		Palmiet	Rockfill	16 400	Hydropower and domestic	DWS
H100/18	Stettynskloof Dam	H10K	1981		Stettynskloof	Earthfill & Rockfill	15 000	Municipal and industrial	Breede Valley Local Municipality
J220/01	Leeu-Gamka Dam	J22K	1959		Leeu	Earthfill	14 639	Irrigation	DWS
H600/01	Elandskloof Dam	H60C	1976		Elands	Gravity	11 500	Irrigation and water supply	DWS
H200/06	Lakenvallei Dam	H20D	1974		Sanddrif	Gravity Arch	10 230	Irrigation	DWS
H300/01	Poortjieskloof Dam	H30A	1955	1968	Groot	Arch	9 680	Irrigation	DWS
J350/04	Koos Raubenheimer Dam	J35A	1971		Lit/Kln Le Roux	Earthfill	9 203	Municipal and industrial	Oudtshoorn Local Municipality
H400/02	Keerom Dam	H40B	1954	1989	Nuy	Arch	9 110	Irrigation	Nuy Irrigation Board
H900/03	Korentepoort Dam	H90B	1965		Korinte River	Arch	8 207	Irrigation, domestic and industrial	DWS

No of dam	Name of dam	Quaternary Drainage Area	Completion date	Completion date raising	River or Watercourse	Wall type	Capacity (1000 m^3)	Purpose / use	Owner Name
K300/13	Garden Route Dam	K30C	1980		Swart	Earthfill	8 067	Domestic supply and industrial	George Local Municipality
H200/07	Roode Elsberg Dam	H20D	1969		Sanddriftskloof	Arch	7 733	Irrigation and domestic	DWS
K100/02	Hartbeeskuil Dam	K10B	1969		Hartenbos	Arch	7 152	Limited agricultural use	DWS
H800/03	Duivenhoks Dam	H80A	1965		Duiwenhoks	Arch & Gravity	6 320	Irrigation, domestic and industrial	DWS
G400/03	De Bos Dam	G40H	1977	2003	Onrus	Earthfill	5 940	Municipal and industrial	Overstrand Local Municipality
G401/78	Arieskraal No.2 Dam	G40D	1967		Palmiet River	Arch	5 500	Irrigation	Henderson D.A.
G404/61	Kraaibosch Dam	G40M	1999		Uilenkraals	Earthfill	5 500	Irrigation and municipal (Gansbaai)	Lomond Wine Estate (Pty) Ltd
H700/02	Buffeljags Dam	H70E	1967		Buffeljags	Earthfill & Gravity	5 200	Irrigation	DWS

4.4 Wetland Resource Units

4.4.1 General approach

The National Freshwater Ecosystems Priority Areas (NFEPA) wetlands map (Nel et al., 2011) was used as a starting point to identify wetlands in the Study Area. The NFEPA approach is based on the SANBI classification system for wetlands and other aquatic ecosystems in South Africa (SANBI, 2009 & 2013). This system uses hydrological and geomorphological traits to distinguish the direct factors that influence wetland function. This is presented as a 6-tiered structure with four spatially nested primary levels that are applied in a hierarchical manner between different wetland types on the basis of these direct factors. Level 1 distinguishes between marine, estuarine and inland ecosystems based on the degree of connectivity the systems have with the ocean. Level 2 categorises the regional wetland setting using a combination of biophysical attributes at the landscape level. Level 3 assesses the topographical position of inland wetlands and Level 4 concerns the hydrogeomorphic (HGM) units, defined by landform, hydrological characteristics hydrodynamics. The HGM unit is considered the focal point for the system as the upper levels are meant to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, whilst the lower levels provide more descriptive detail.

For certain areas where the NFEPA maps lacked enough detail the maps developed by Cape Nature (2008) as part of the GEF-funded CAPE Fine-Scale Biodiversity Planning Project, the so-called FSP maps, were also used. As the NFEPA and FSP maps both indicate priority wetlands, these wetlands were identified as priority wetlands for the Study Area.

For the final delineation of the Wetland RUs the approach reported in DWAF (2010), which emphasised that geology was a key factor in the delineation of Wetland RUs was followed. For instance the Cape Folded Mountain EcoRegion is dominated by Table Mountain Sandstones with shale intrusions, which weather to form steep valleys and act as a limiting factor in the development of extensive wetlands. In contrast, the South Eastern Coastal Belt EcoRegion is characterised by a flatter topography, with characteristically flat drainage lines of low energy areas which favour the development of wetlands. The Wetland RUs were further delineated according to the similarity of wetland types and functions located within them. Whilst the Wetland RU defines the regional setting, the HGM unit is used as the defining characteristic for the Wetland RU.

Apart from rivers, the wetland types that occur in the Study Area are the following:

- Floodplain wetlands - occur on mostly flat areas adjacent to and formed by an alluvial river channel.
- Valley-bottom wetlands - occur mostly on flat areas located along the valley floor and can be either channelled or un-channelled.
- Depressions - defined as a wetland or aquatic ecosystem with closed (or near closed) elevation contours within which water accumulates and may be flat-bottomed (often described as pans), or extend over large areas termed “wetland flats” or “floodplain flats”.
- Seeps - a wetland area located on gentle to steeply sloping land, dominated by colluvial, uni-directional movement of water and material down-slope.

4.4.2 Wetland RU delineation

The locations of the Wetland RUs for the Study Area are indicated in Figure 4.8 and Figure 4.9 for the Gouritz and Breede-Overberg, respectively. Descriptions of the individual Wetland RUs are presented in **Table 4.6**, including descriptive names for certain wetlands included from the Western Cape Wetlands Inventory.

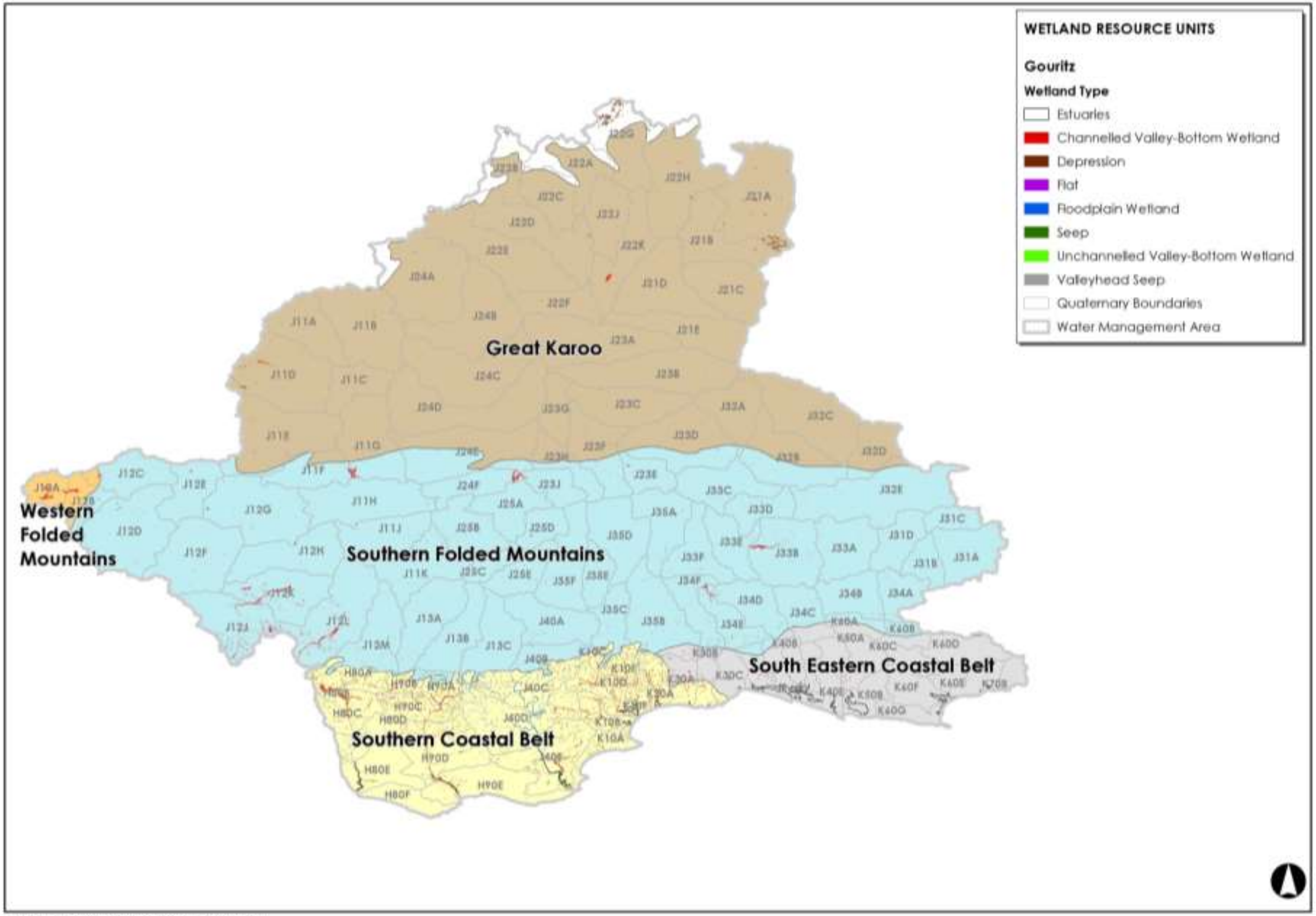

Figure 4.8: Wetland Resource Units delineated for the Gouritz

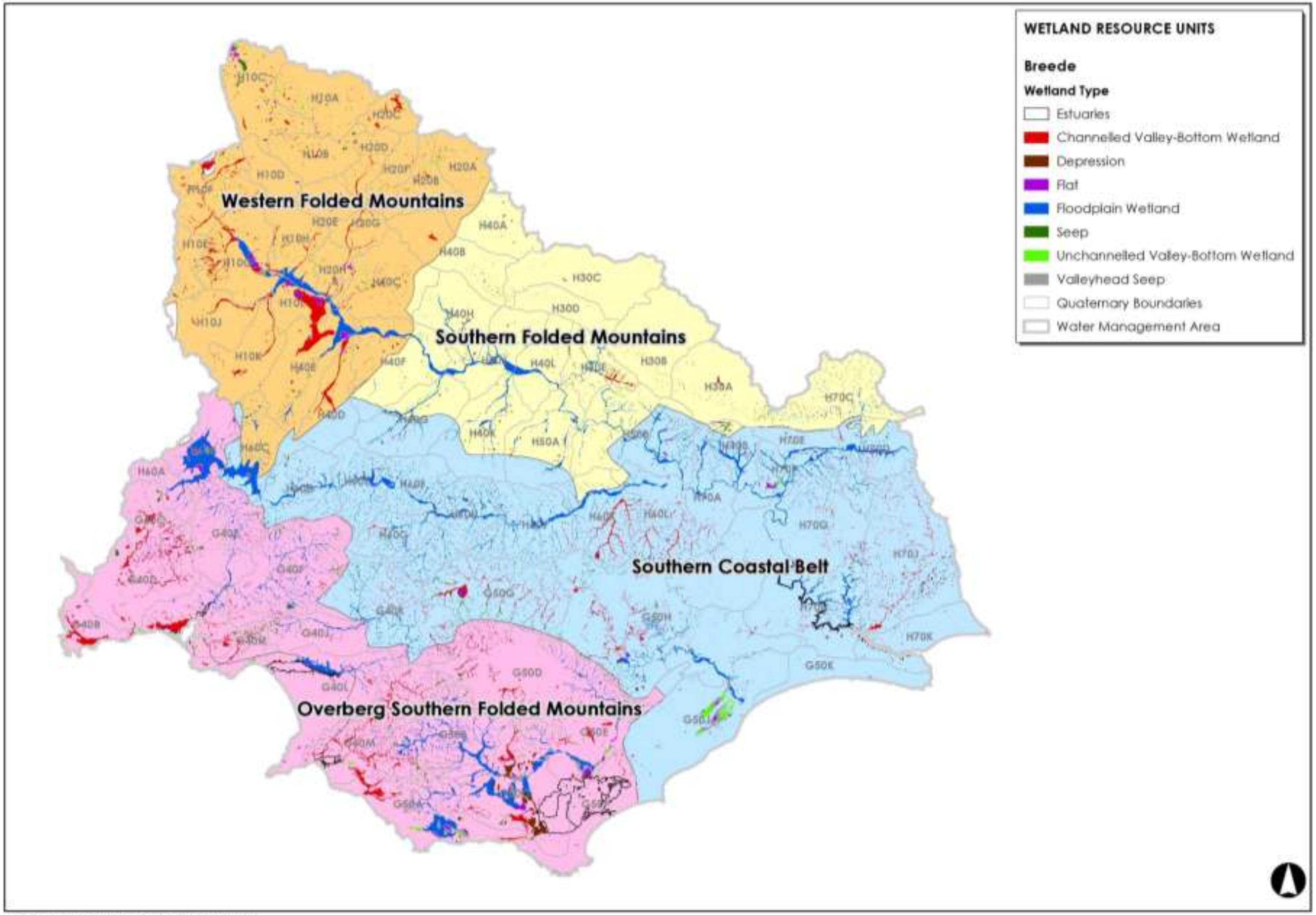

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Figure 4.9: Wetland Resource Units delineated for the Breede-Overberg

Table 4.6: Wetland Resource Units for the complete Breede-Gouritz WMA

Unit	Wetland RU	Information Source	Description	Wetland Names
1	Western Folded Mountains	FSP/NFEPA	Channeled valley-bottom; Depression; Flat; Floodplain wetland; Seep; Un-channeled valley-bottom; Valleyhead seep.	Verkeerdevlei; Moordkuil Vlei; Papenkuils Wetland; Groenvlei-Breede River
2	Southern Folded Mountains	FSP/NFEPA	Channeled valley-bottom; Depression; Flat; Floodplain wetland; Seep; Un-channelled valley-bottom; Valleyhead seep.	Unnamed wetlands
3	Overberg Southern Fold Mountains	NFEPA	Channeled valley-bottom; Depression; Flat; Floodplain wetland; Seep; Un-channelled valley-bottom; Valleyhead seep.	Groot Rondevlei; Malkopsvlei; Pringle Bay Restio Marsh; Skilpadsvlei; Palmiet River; Kleinmond River, Bot River; Belsvlei; De Diepte Gatt; Klein River; Uitkraals River; Hagelkraal; Pearly Beach; Ratel River; Melkbos Pan; Uiltjieskuil riparian wetland; Moddervlei; Voëlvlei; Nuwejaarsriver; Soutpan; Algulhas Soutpan; Rhenosterkop Pan.
4	Southern Coastal Belt	FSP/NFEPA	Channeled valley-bottom; Depression; Flat; Floodplain wetland; Seep; Un-channelled valley-bottom; Valleyhead seep.	Elandskloof Wetlands; Greyton Wetlands; Riversonderend riparian wetlands; Stransvlei; Stormsvlei; Bontebok Floodplain; Potberg Pan; Koenskraal Pan; Duiwenhoks wetland system; Korinte Vet; Goukou River Wetland; Kruisrivier Wetland; Geelbeksvlei; Maalgat riparian wetlands; Gwayang riparian wetlands; Voëlvlei; Soutpan; De Hoop Vlei; Soetendalsvlei; Soutpansvlakte.
5	South Eastern Coastal Belt	FSP/NFEPA	Channelled valley-bottom; Depression; Flat; Floodplain wetland; Seep; Un-channelled valley-bottom; Valleyhead seep.	Wilderness Lakes System; Upper Knysna catchment; Touws River; Elandvlei; Langvlei, Rondevlei; Ruigtevlei;
6	Great Karoo	NFEPA	Channelled valley-bottom; Depression; Flat; Seep; Un-channelled valley-bottom; Valleyhead seep.	Unnamed wetlands

4.5 Estuary Resource Units

4.5.1 General approach

The Estuary Component of the National Biodiversity Assessment (NBA) definition for the estuarine functional zone (EFZ) was used. This extends the lateral boundaries of an estuary up to the 5 m contour, with the downstream boundary taken as the estuary mouth and the upstream boundary taken as the limits of tidal variation or salinity penetration, whichever penetrates furthest. Protection and rehabilitation of the estuarine functional zone are considered essential for protection of estuarine biodiversity and associated ecological processes.

Informal discussions with estuarine scientists as part of this Study has resulted in consensus regarding the fact that to qualify as a significant estuary, an outlet must meet the definition of an estuary in the National Water Act (1998) and the open water area of which, averaged over several years, exceeds 2 ha in extent and is dominated by estuarine (as opposed to freshwater) biota. A detailed re-evaluation of the coastline of the Breede-Gouritz WMA undertaken as part of this Study identified a total of 48 river outlets (three more than the NBA) of which 23 are considered to be significant estuaries in terms of the above definition.

4.5.2 Gouritz estuaries

The estuaries of the Gouritz component of the WMA are indicated in Figure 4.10 and their details are presented in Table 4.7.

Table 4.7: Details of the estuaries of the Gouritz (names in bold are primary estuaries)

Estuary	Area (ha) incl. floodplain	Channel area (ha)	Mouth		Top	
			Longitude	Latitude	Longitude	Latitude
Gouritz	1 049.4[1]	319.0	21°53'09.25"	34°20'43.23"	21°44'37.18"	34°09'27.45"
Duiwenhoks	419.3[3]	108.3	21°00'04.26"	34°21'54.11"	20°59'30.94"	34°15'05.98"
Goukou	372.3[3]	122.4	21°25'24.70"	34°22'42.07"	21°18'29.59"	34°17'31.97"
Blinde	4.1[3]	2.1	22°00'46.61"	34°12'39.06"	22°00'32.00"	34°12'20.37"
Tweekuilen	9.8[2]	1.6	22°06'34.82"	34°09'05.77"	22°06'08.03"	34°09'03.32"
Gericke	3.6[2]	0.9	22°06'40.01"	34°08'38.20"	22°06'19.50"	34°08'27.76"
Hartenbos	236.9[3]	30.5	22°07'32.82"	34°06'54.40"	22°05'02.53"	34°06'42.98"
Klein Brak	976.9[3]	89.4	22°08'54.91"	34°05'34.55"	22°04'12.26"	34°04'26.25"
Groot Brak	205.1[3]	65.6	22°14'21.45"	34°03'26.11"	22°13'15.26"	34°01'32.99"
Rooi	-	<0.1	22°17'03.51"	34°03'03.31"	N/A	N/A
Maalgate	22.2[3]	17.0	22°21'15.98"	34°03'15.80"	22°21'07.69"	34°02'30.07"
Gwaing	10.6[3]	4.2	22°26'02.90"	34°03'23.29"	22°25'43.65"	34°02'48.46"
Skaapkop	1.1[2]	0.2	22°29'56.23"	34°02'11.86"	22°29'52.38"	34°02'8.88"
Meul	1.8[2]	0.3	22°32'34.46"	34°00'47.23"	22°32'25.68"	34°00'43.78"
Kaaimans	20.6[3]	9.0	22°33'25.40"	33°59'52.13"	22°33'33.41"	33°59'13.24"
Wilderness	1 091.7[3]	501.8	22°34'52.06"	33°59'44.73"	22°36'20.05"	33°58'26.54"
Swartvlei	2 037.9[1]	114.5	22°47'46.52"	34°01'53.46"	22°48'02.00"	33°58'10.44"
Goukamma	213.1[3]	45.3	22°56'56.89"	34°04'37.78"	22°55'54.68"	34°00'11.66"
Knysna	2 284.1[1]	1691.7	23°03'41.23"	34°04'57.74"	23°00'11.69"	33°59'53.81"
Noetsie	14.8[3]	8.0	23°07'44.95"	34°04'49.09"	23°08'21.36"	34°04'23.92"
Grooteiland	0.9[2]	0.2	23°12'34.55"	34°05'09.55"	23°12'38.77"	34°05'8.78"
Kranshoek	-	<0.1	23°13'27.76"	34°05'11.68"	N/A	N/A
Crooks	0.6[2]	0.0	23°14'44.74"	34°05'28.92"	23°14'45.52"	34°05'24.01"
Piesang	59.5[3]	4.9	23°22'43.54"	34°03'37.67"	23°21'21.29"	34°03'44.92"
Keurbooms	1 523.4[1]	398.2	23°22'41.47"	34°02'59.46"	23°19'57.04"	33°59'48.75"
Matjies	2.5[3]	0.5	23°28'12.66"	34°00'07.07"	23°28'10.78"	33°59'49.62"
Brak	-	<0.1	23°31'49.54"	33°59'49.05"	23°31'42.38"	33°59'49.53"
Sout (Oos)	13.8[3]	1.7	23°32'11.55"	33°59'22.21"	23°31'47.92"	33°59'07.00"
Groot (Wes)	64.4[3]	30.2	23°34' 09.05"	33°58'54.41"	23°33'24.02"	33°57'50.19"
Helpmekaars	-	<0.1	23°35'57.52"	33°58'48.34"	N/A	N/A
Klip	0.4[2]	<0.1	23°37'01.35"	33°58"42.35"	23°37'01.44"	33°58'41.56"

Estuary	Area (ha) incl. floodplain	Channel area (ha)	Mouth		Top	
			Longitude	Latitude	Longitude	Latitude
Bloukrans	4.2[1]	2.3	23^{0}38'50.89"	33^{0}58'46.72"	23°38'44.82"	33°58'33.14"

[1]Based on combination of NBA national estuary layer (delineated using the 5 m topographical contour obtained from Chief Directorate Surveys and Mapping), 5 m contour from SRTM data (http://eros.usgs.gov/) and satellite imagery

[2]Based on 5 m contour from SRTM data (http://eros.usgs.gov/) and satellite imagery.

[3]Based on NBA national estuary layer

4.5.3 Breede-Overberg estuaries

The estuaries of the Breede-Overberg component of the WMA are indicated in **Figure 4.11** and their details are presented in **Table 4.8**.

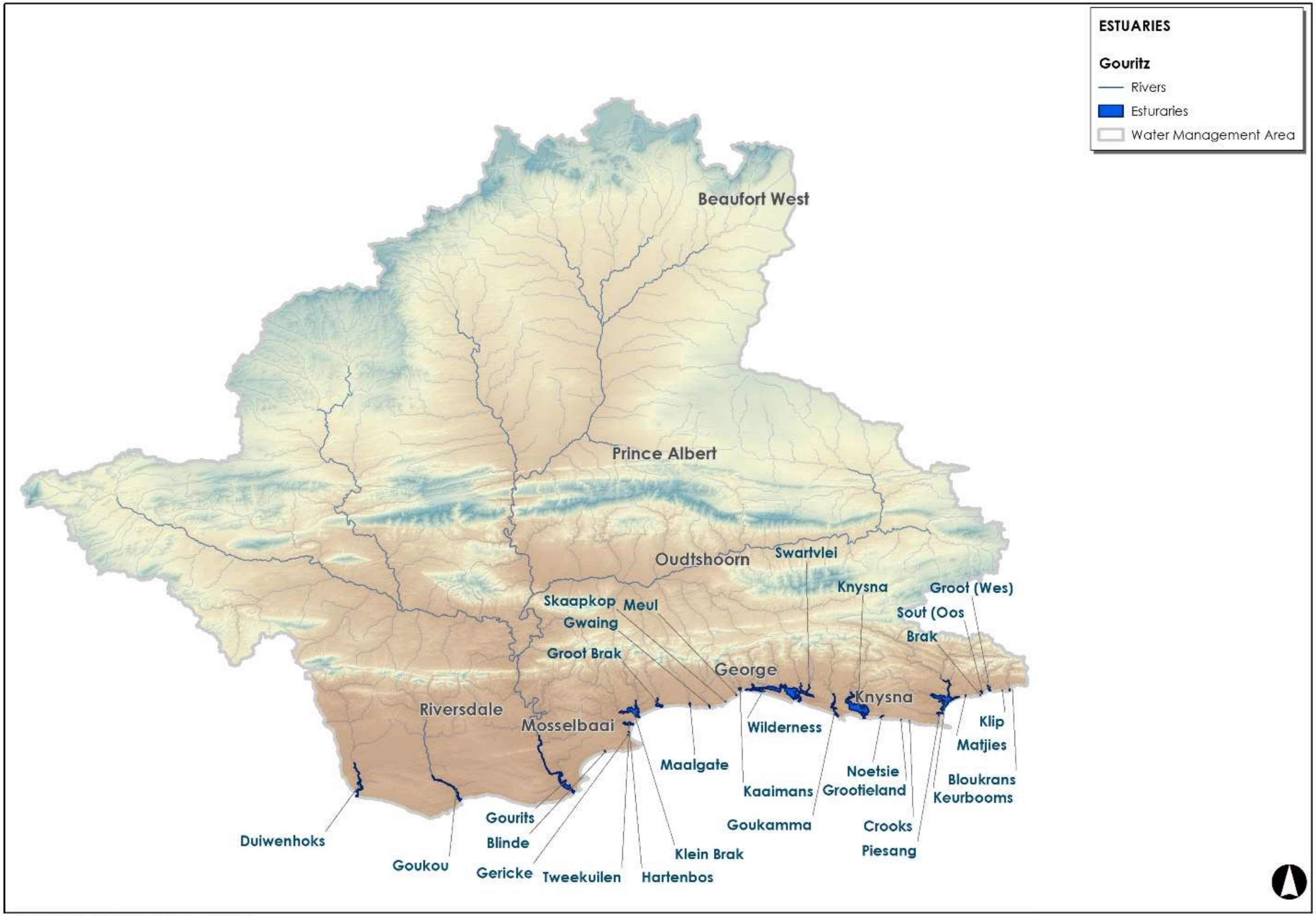

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Figure 4.10: Estuaries of the Gouritz component of the WMA

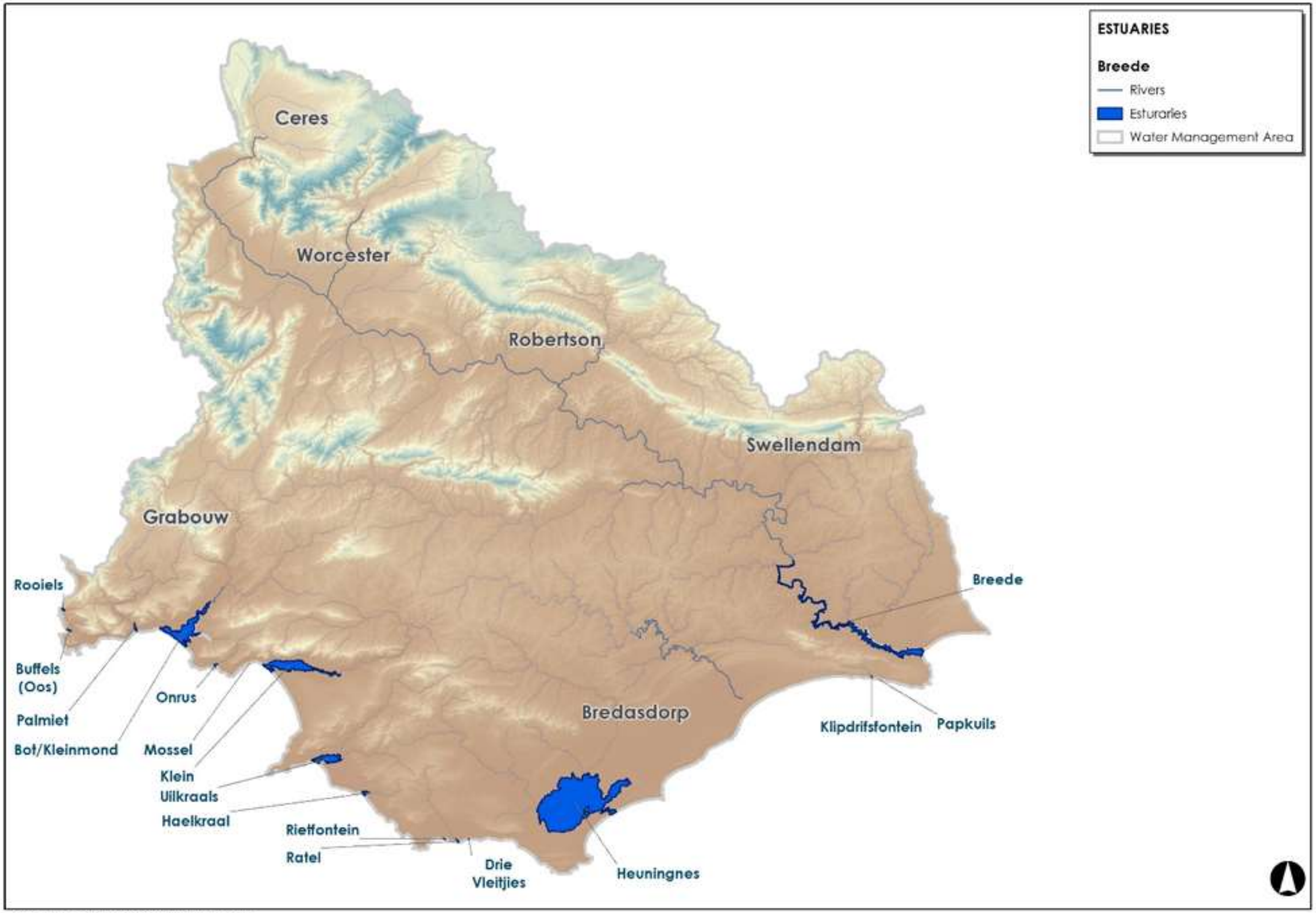

Figure 4.11: Estuaries of the Breede-Overberg component of the WMA

Table 4.8: Details of the estuaries of the Breede-Overberg (names in bold are primary estuaries)

Estuary	Area (ha) incl. floodplain	Channel area (ha)	Mouth		Top	
			Longitude	Latitude	Longitude	Latitude
Rooiels	16.0[3]	1.9	18°49'15.76"	34°17'44.79"	18°49'28.61"	34°18'08.71"
Buffels (Oos)	4.7[3]	1.3	18°49'46.33"	34°20'20.21"	18°50'23.05"	34°20'28.56"
Palmiet	28.5[3]	26.0	18°59'38.91"	34°20'43.58"	18°59'22.60"	34°19'47.80"
Bot/Kleinmond	2 039.0[1]	1229.2	19°50'49.68"	34°22'06.35"	19°10'05.76"	34°17'23.74"
Onrus	15.1[3]	3.5	19°10'43.29"	34°25'07.15"	19°11'03.83"	34°24'45.43"
Mossel	-	<0.1	19°16'21.41"	34°24'31.13"	N/A	N/A
Klein	1 802.3[3]	113.6	19°17'53.37"	34°25'14.35"	19°28'22.70"	34°26'10.28"
Uilkraals	702.3[1]	55.7	19°24'27.49"	34°36'27.18"	19°28'26.18"	34°36'16.48"
Haelkraal	59.0[2]	12	19°31'42.10"	34°40'34.93"	19°32'21.06"	34°40'14.80"
Rietfontein	3.0[2]	0.65	19°42'58.52"	34°45'48.84"	19°42'43.54"	34°45'38.99"
Ratel	8.6[3]	1.5	19°44'47.42"	34°46'15.67"	19°44'32.33"	34°45'48.01"
Drie Vleitjies	1.1[2]	0.2	19°46'23.85"	34°45'49.47"	19°46'23.90"	34°45'45.86"
Heuningnes	13 125.8[1]	1451.5	20°07'09.29"	34°42'53.24"	19°56'09.03"	34°42'33.04"
Klipdrifsfontein	2.2[3]	0.8	20°43'52.80"	34°27'06.86"	20°43'44.78"	34°26'56.43"
Papkuils	-	<0.1	20°45'08.61"	34°27'22.99"	N/A	N/A
Breede	2 079.4[3]	1147.6	20°50'43.20"	34°24'26.76"	20°32'43.95"	34°13'15.77"

[1]Based on combination of NBA national estuary layer (delineated using the 5 m topographical contour obtained from Chief Directorate Surveys and Mapping), 5 m contour from SRTM data (http://eros.usgs.gov/) and satellite imagery

[2]Based on 5 m contour from SRTM data (http://eros.usgs.gov/) and satellite imagery.

[3]Based on NBA national estuary layer

5 SUB-STEP 1d (ii): DEFINE BIOPHYSICAL & ALLOCATION NODES

5.1 General approach

For rivers the biophysical and allocation river nodes for the Study Area were defined according to the procedures described in DWAF (2007f). Eleven "tiers" of information were sequentially assessed, and rules applied, in order to establish nodes for each tier. Nodes were added sequentially for Tiers I to Tier VIII, whereafter rationalisation rules were applied to eliminate nodes for which EWRs were not required, e.g., impoundments (Tier VII). Then additional nodes were added as required for Tiers V-IX, and rationalisation rules were applied again to eliminate nodes for which appropriate hydrological information was not available and/or nodes that were too close to each other (Tier IX). Thereafter, nodes were again added where additional information was likely to be needed at a particular sub-quaternary catchment level for planning or allocation purposes.

For estuaries the National Biodiversity Assessment approach was followed in which the estuarine functional zone (EFZ) was formulated as the lateral boundaries of an estuary up to the 5 m contour, with the downstream node taken as the estuary mouth and the upstream node taken as the limits of tidal variation or salinity penetration, whichever penetrates furthest.

5.2 Gouritz River Nodes

Figure 5.1 and Table 5.1 present details regarding the locations of the biophysical and allocation nodes for the Gouritz component of the WMA.

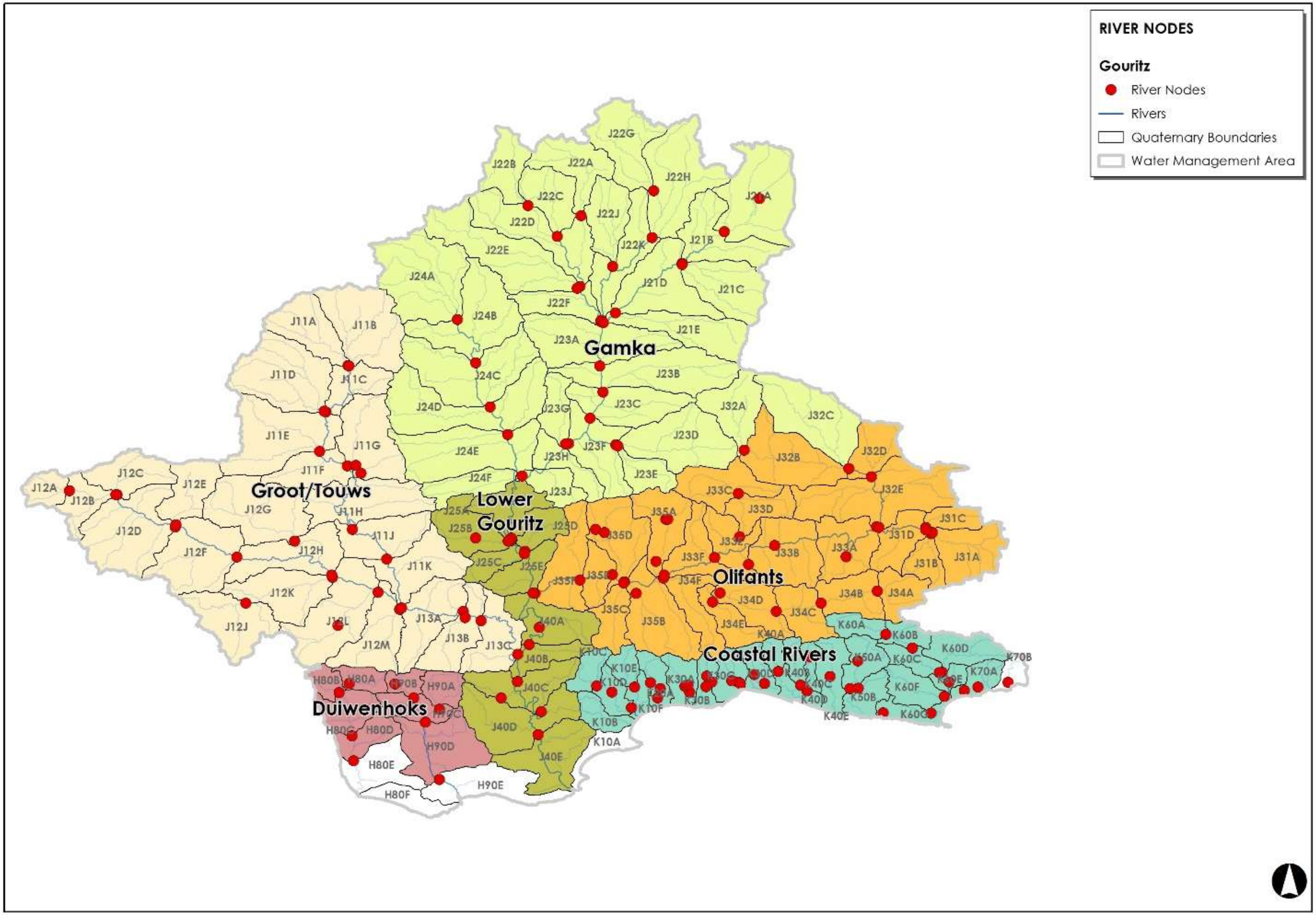

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Figure 5.1: Locations of Gouritz biophysical and allocation nodes

Table 5.1: Gouritz biophysical and allocation nodes

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
gi1	20.854	-33.203	d/s confluence Wilgehout Buffels	Buffels
gi2	22.042	-33.176	d/s confluence Sand Cordiers	Sand
gi3	23.071	-33.272	u/s confluence Traka Maermanskraal	Traka
gi4	21.654	-33.979	quaternary outlet J40B	Gouritz
gii1	23.105	-33.442	u/s confluence Olifants Traka	Olifants
gii2	21.714	-33.678	u/s confluence Gamka Olifants/Gouritz	Gamka
gii3	21.654	-33.886	u/s confluence Groot Gouritz	Groot
gii4	22.051	-33.180	u/s confluence Cordiers Sand	Cordiers
gii5	21.613	-33.504	u/s confluence Kobus Gamka	Kobus
gii6	22.537	-33.336		Groot
giii1	22.179	-32.475	d/s confluence Leeu Sand	Leeu
giii2	23.293	-33.447	d/s confluence NoName Olifants	Olifants
giii3	22.023	-32.575	u/s confluence Hottentots Leeu	Hottentos
giii4	21.801	-32.474	u/s confluence Waaikraal Teekloof	Waaikraal
giii5	20.931	-34.016		Duiwenhoks
giii6	21.233	-34.035		Korinte
giii7	21.339	-34.073	d/s confluence Goukou Kruis	Goukou
giii8	20.990	-34.248		Duiwenhoks
giii9	21.988	-32.764	u/s confluence Gamka Leeu	Gamka
giii10	22.709	-33.934		Diep
giii11	22.827	-33.998		Karatara
giii12	23.002	-33.987		Knysna
giii13	22.801	-33.978		Hoekraal
v1	19.848	-33.331	u/s of Verkeerdevlei, d/s of confluence Smalblaar Bok	Donkies
v2	20.519	-33.558	d/s of confluence Touws Stinkfontein	Touws
v3	20.753	-33.506	u/s of reservoir	Prins
v4	20.985	-33.466		Groot
v5	21.090	-33.678	D/s confluence Touws Doring	Touws
v6	21.123	-33.566	D/s confluence Groot Swartberg	Groot
v7	21.433	-33.742	D/s confluence Groot Huis	Groot
v8	21.505	-33.774	D/s confluence Groot Bos	Groot
v9	21.739	-34.156		Gouritz
v10	21.282	-34.117	D/s confluence Goukou Vet	Goukou
v11	20.983	-34.163		Duiwenhoks
v12	21.479	-32.903	D/s confluence Dwyka Frieshoek	Dwyka
v13	21.538	-33.052	D/s confluence Dwyka Bad	Dwyka
v14	21.608	-33.144	D/s Dwyka Jakkals/Vlakkraal	Dwyka
v15	21.976	-32.910		Gamka
v16	21.989	-32.998	D/s confluence Gamka Groot	Gamka
v17	21.938	-33.087	D/s confluence Gamka Gedenksteen se leegte	Gamka
v18	22.466	-32.452	D/s confluence Gamka Stols	Gamka
v19	22.033	-33.614	D/s confluence Olifants Wynands	Olifants
v20	21.902	-33.634	D/s confluence Olifants Vlei	Olifants
v21	22.545	-33.481		Meirings
v22	22.445	-33.553		Olifants
v23	23.142	-33.802		Keurbooms
v24	20.555	-33.715	Placed u/s of Bellair reservoir	Gatkraal se
v25	20.965	-33.251	Placed u/s of Floriskraal reservoir	Buffels
v26	21.405	-32.756	D/s confluence Dwyka Juk	Dwyka
v27	21.668	-33.284	Placed u/s of Gamkapoort reservoir	Gamka

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
v28	21.751	-34.079	D/s confluence Gouritz Langtou	Gouritz
v29	21.895	-32.404		Koekemoers
v30	22.183	-32.318		Leeu
v31	22.558	-33.190		Traka
v32	22.980	-33.245	D/s confluence Traka Kouka	Traka
v33	22.687	-33.508	Place u/s Stompdrif reservoir	Olifants
v34	23.103	-33.656		Kammanassie
v35	22.877	-33.701		Kammanassie
v36	22.697	-33.732	U/s confluence Kammanassie Gansekraal	Kammanassie
v37	22.469	-33.672	Placed u/s of Kammanassie reservoir	Kammanassie
v38	23.251	-33.846		Keurbooms
v39	22.128	-33.993	D/s confluence Moordkuil Beneke	Moordkuil
v40	21.976	-33.991	D/s confluence Kouma Halekraal	Palmiet
v41	21.340	-34.311		Goukou
V42	21.685	-32.371		Teekloof
vii1	21.481	-33.495	gauge H2H005	Kobus
vii2	22.247	-33.426	gauge J3H014	Grobbelaars
vii3	22.254	-33.426	gauge J3H015	Klein Leroux
vii4	21.964	-33.463	gauge J3H020	Meul
vii5	22.001	-33.473	gauge J3H018	Wynands
vii6	21.588	-34.034	gauge J4H003	Weyers
vii7	22.223	-34.029	gauge K2H002	Groot-Brak
vii8	22.351	-34.008	gauge K3H003	Malgate
vii9	22.421	-33.953	gauge K3H004	Malgas
vii10	22.440	-33.973	gauge K3H007	Rooi
vii11	22.547	-33.971	gauge K3H001	Kaaimans
vii12	22.613	-33.946	gauge K3H005	Touws
vii13	22.838	-33.883	gauge K4G002	Karatara
vii14	23.031	-33.894	gauge K5H002	Knysna
vii15	23.641	-33.955	gauge K7H001	Bloukrans
vii16	22.975	-33.543	gauge J3H016	Wilge
vii17	22.582	-33.575	gauge J3H042	Marnewicks
vii18	21.623	-33.502	gauge J2H010	Gamka
vii19	21.441	-33.764	gauge J1H017	Derde
vii20	22.131	-33.677	gauge J3H017	Kandelaars
vii21	22.604	-32.339	Springfontein reservoir	Kuils
vii22	22.440	-33.702	Kammanassie reservoir	Brak
vii23	20.973	-33.987	IBT	Duiwenhoks
vii24	21.158	-33.988	IBT	Korinte
viii1	20.927	-33.790		Doring
viii2	22.193	-33.978		Groot-Brak
viii3	22.232	-33.997		Varing
viii4	22.332	-33.988		Maalgate
viii5	22.344	-33.984		Moeras
viii6	22.418	-33.989		Gwaing
viii7	22.522	-33.968		Swart
viii8	22.556	-33.977		Silver
viii9	22.919	-33.948		Goukou
viii10	23.138	-34.066		Noetzie
viii11	23.035	-33.986	EWR 2 Outeniqua	Gouna
x1	21.740	-33.795	U/s confluence Slang Gouritz	Slang
x2	22.038	-34.011	U/s confluence Ruiterbos Palmiet, for Witels Reserve	Ruiterbos

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
x3	23.331	-34.065	Piesang River EWR site	Piesang
x4	23.464	-33.986	U/s confluence	Buffels
x5	23.519	-33.973	U/s confluence	Sout
x6	20.999	-33.251	U/s reservoir, inflow J11G	Geelbek
x7	21.020	-33.277	U/s reservoir inflows from J11G	Hartbeesspruit
x8	22.654	-33.976	DWS reserve	Klein Keurbooms
x9	23.402	-33.957	D/s confluence Keurbooms Duiwelsgat	Keurbooms
giv1	21.976	-32.761	U/s confluence Koekemoer Leeu	Koekemoers
giv2	21.980	-32.756	U/s confluence Leeu Koekemoers	Leeu
giv3	22.036	-32.731	U/s confluence Gamka Veldmans	Gamka
giv4	23.385	-34.007	U/s confluence Bitou Keurbooms	Bitou
giv5	23.372	-33.925	U/s confluence Palmiet Keurbooms	Palmiet
giv6	23.362	-33.927	U/s confluence Keurbooms Palmiet	Keurbooms
giv7	22.083	-33.638	U/s confluence Olifants Moeras	Olifants
giv8	22.080	-33.641	U/s confluence Moeras Olifants	Moeras
giv9	22.209	-33.568	U/s confluence Grobbelaars Olifants	Grobbelaars
giv10	22.240	-33.624	U/s confluence Leeu Koekemoer	Leeu
giv11	22.243	-33.615	U/s confluence Olifants Kammanassie	Olifants
giv12	23.294	-33.439	U/s confluence Kammanassie Olifants	Kammanassie
giv13	23.313	-33.459	U/s confluence Hartbees Olifants	Hartbees
giv14	23.321	-33.455	U/s confluence Olifants Hartbees	Olifants
giv15	23.095	-33.439	U/s confluence Traka Olifants	Traka
giv16	21.701	-33.853	U/confluence Gouritz Kamma	Gouritz
giv17	21.723	-33.681	U/s confluence Olifants Gouritz	Olifants
giv18	21.681	-33.538	U/s confluence Nels Gamka	Nels
giv19	21.678	-33.546	U/s confluence Gamka Nels	Gamka
giv20	21.624	-33.494	U/s confluence Gamka Kobus	Gamka
giv21	21.852	-33.173	U/s confluence Gamka Kat	Gamka
giv22	21.841	-33.175	U/s confluence Kat Gamka	Kat
giv23	21.893	-32.643	U/s confluence Koekemoers Wilgerbos	Koekemoers
giv24	21.882	-32.649	U/s confluence Wilgerbos Koekemoers	Wilgerbos
giv25	22.116	-34.063	U/s confluence Brandwag Klein Brak	Brandwag
giv26	20.904	-33.628	U/s confluence Brak Touws	Brak
giv27	20.902	-33.621	U/s confluence Touws Brak	Touws
giv28	20.271	-33.457	U/s confluence Touws Kragga	Touws
giv29	20.275	-33.448	U/s confluence Kragga Touws	Kragga
giv30	20.039	-33.345	U/s confluence Ysterdams Donkies	Ysterdams
giv33	21.176	-33.737	U/s confluence Touws Groot	Touws
giv32	21.184	-33.732	U/s confluence Groot Touws	Groot
giv34	20.878	-33.069	U/s confluence Buffels Meintjiesplaas	Buffels
giv31	20.033	-33.346	U/s confluence Donkies Ysterdams	Donkies
Giv35	20.873	-33.068	U/s confluence Meintjiesplaas Buffels	Meintjiesplaas
Giv36	22.301	-32.562	U/s confluence Gamka Put	Gamka
Giv37	22.300	-32.566	U/s confluence Put Gamka	Put
giv38	20.968	-32.913	U/s confluence Buffels Swaerskraal se	Buffels
giv39	20.971	-32.914	U/s confluence Swaerkraal se Buffels	Swaerkraal

5.3 Breede-Overberg River Nodes

Figure 5.2 and Table 5.2 present details regarding the locations of the biophysical and allocation nodes for the Breede-Overberg River component of the WMA.

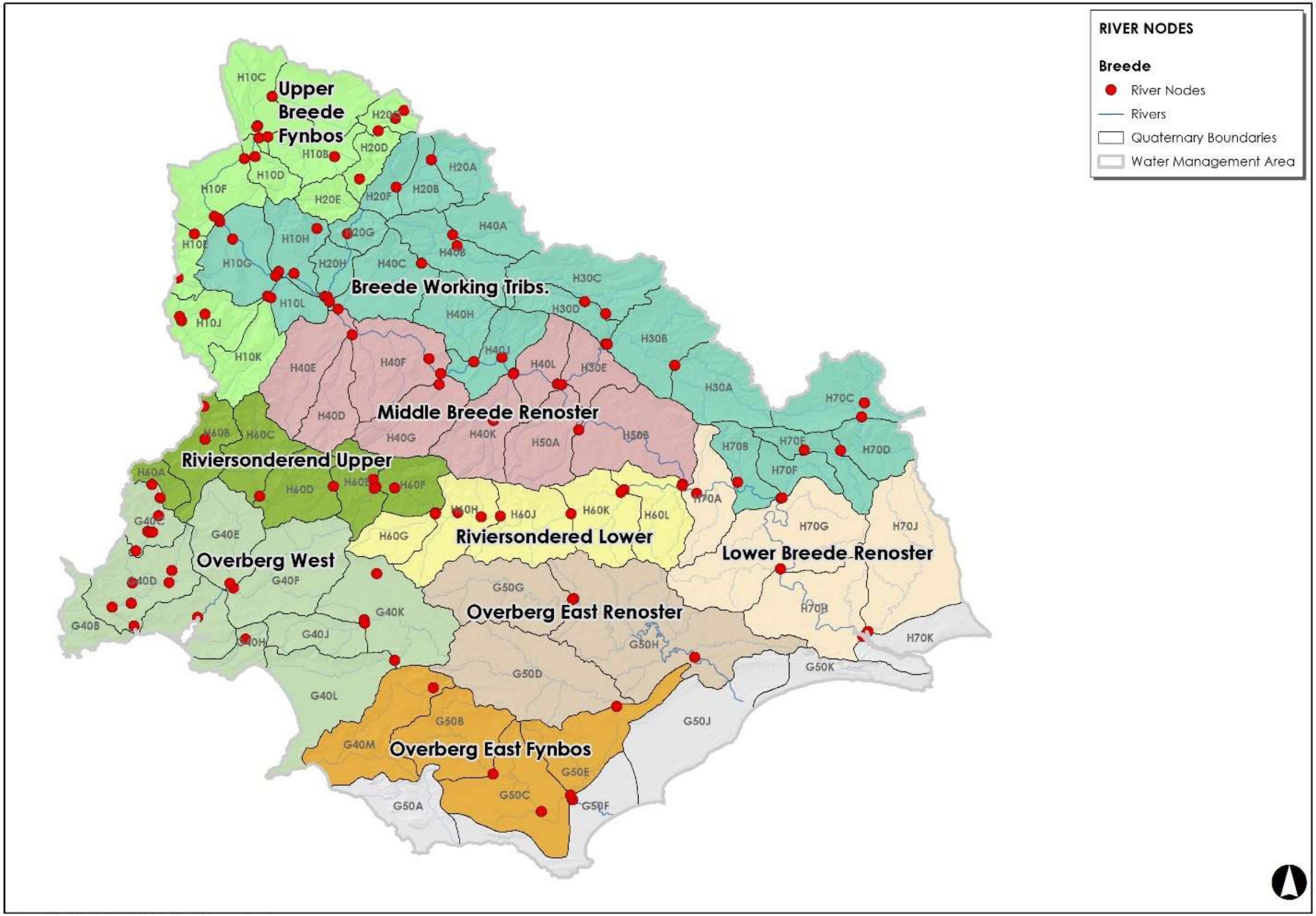

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Figure 5.2: Locations of Breede-Overberg biophysical and allocation nodes

Table 5.2: Breede-Overberg biophysical and allocation nodes

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
Nvii1	-33.544	19.208		Breede
Nviii2	-33.816	19.864		Willem Nels
Nviii3	-34.367	20.708		Breede
Nvii3	-33.420	19.478	U/s of confluence with Titus, at gauge H1H016	Rooikloof
Nvii6	-33.560	19.435	At gauging weir H1H020, 7.5 km North of Worcester	Hartbees
Nvii2	-33.724	19.170	At gauging weir H1H018, EWR 2	Molenaars
Nvii4	-33.464	19.536	At gauging weir H2H005, 7 km West of Hex River Valley	Sanddrif (Spek)
Nvii7	-33.571	19.506	At gauging weir H2H006, North of Worcester on N1, also for offtake to OverHex u/s	Hex
Nvii9	-33.792	20.108	U/s of confluence with Kogmanskloof	Keisie
Nvii5	-33.597	19.761	At gauging weir H4H008, 2.3 km North of Worcester	Koo
Nvii8	-33.817	19.693	At gauging weir H4H017, EWR 3, and pumping scheme Agterkliphoogte	Breede
Nvii10	-33.968	19.165	U/s of Theewaterskloof Dam	Du Toits
Nvii11	-33.868	19.716		Poesjenels
Nvii12	-33.940	19.842		Keisers
Nvii13	-33.709	20.059		Keisie
Nvii14	-33.910	20.713		Huis
Nvii16	-33.652	19.108	u/s Gawie se water	Heuningnes
Nvii17	-33.347	19.622	u/s offtake to E22C, inverdoorn canal	Witte
Nvii18	-33.332	19.642	u/s offtake to E22C, inverdoorn canal	Spek
Nvii19	-33.848	19.891	at outlet H40J, for cogmanskloof et al offtakes	Valsgat
Nvii20	-33.903	19.163	mont rochelle offtake to Franschhoek, at pump station	Breede
Nvi4	-33.381	19.302	2 km d/s of confluence with Dwars/ Titus	Du Toits
Nvi3	-33.421	19.268	U/s of junction of roads R46/ R43	Breede
Nvi2	-33.567	19.148	At Tweede Tol on Bainskloof Pass (R303)	Breede
Nvi1	-33.870	19.993	U/s of confluence with Kogmanskloof	Wit
Pvi1	-34.184	18.997	U/s of Applethwaite reservoir	Breede
Nv3	-33.693	19.451	U/s of confluence with Hex (at Brandvlei reservoir)	Palmiet
Nv7	-34.065	19.464	2.5 km u/s of confluence with Meul	Breede
Nv8	-34.066	19.565	South of Genadendal, d/s of R404 bridge	Riviersonderend
Nv9	-34.118	19.704	At confluence with Kwartel	Riviersonderend
Nv10	-34.126	19.856	D/s of confluence with Slang and Lindeshof town	Riviersonderend
Nv11	-34.124	20.022	9 km u/s of Stormsvlei, alongside N2	Riviersonderend

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
Niv12	-34.077	20.148	Just South of Rawsonville	Riviersonderend
Nv2	-34.096	20.516	U/s of confluence with Buffelsjags	Riviersonderend
Nv13	-34.003	20.657	At Suurbraak	Breede
Nv14	-34.002	20.572	U/s of Buffeljags Dam	Buffeljags
Nv15	-33.300	19.335		Buffeljags
Nv16	-33.371	19.581	also for IBT node d/s as inflow into Roode Elsberg dam	Skaap
Nv17	-33.429	19.704		Spek
Nv18	-33.481	19.621		Hex
Nv19	-33.576	19.752		Hex
Nv20	-33.631	19.678		Die Brak
Nv21	-33.835	20.269		Nuy
Nv22	-34.081	19.290		Groot
Nv23	-34.406	19.602		Riviersonderend
Nv24	-34.500	20.126		Klein
Niv3	-33.379	19.323	U/s of confluence with Breede	Kars
Niv2	-33.357	19.300	U/s of confluence with Koekedou	Titus
Niv1	-33.360	19.298	U/s of confluence with Dwars	Dwars
Niv4	-33.418	19.292	U/s of confluence with Breede	Koekedou
Niv6	-33.538	19.205	U/s of confluence with Breede	Witels
Niv5	-33.533	19.196	U/s of confluence with Breede	Wabooms
Niv7	-33.578	19.237	U/s of confluence with Slanghoek	Wit
Niv8	-33.643	19.344	U/s of confluence with Breede	Slanghoek
Niv9	-33.647	19.379	U/s of confluence with Breede	Bothaspruit/ Witrivier
Niv40	-33.736	19.115	U/s of confluence with Molenaars	Hartbees/ de Wetskloof
Niv41	-33.727	19.110	U/s of confluence with Molenaars	Elands
Niv42	-33.690	19.316	Just South of Rawsonville	Krom
Niv12	-33.693	19.325	Just South of Rawsonville	Molenaars (Smalblaar)
Niv10	-33.694	19.457	U/s of confluence with Breede	Holsloot
Niv18	-33.793	20.111	U/s of confluence with Kogmanskloof	Hex
Niv20	-33.733	20.108	U/s of confluence with Keisie	Kingna
Niv11	-33.718	19.481	U/s of confluence with Breede	Pietersfontein
Niv13	-33.769	19.514	U/s of confluence with Breede, d/s of Hoeks/Doring (Bobbejaans/Keisie)	Nuy
Niv15	-33.824	19.797	U/s of confluence with Breede	Doring
Niv14	-33.849	19.890	U/s of confluence with Breede	Vink
Niv28	-34.052	19.558	U/s of confluence with Riviersonderend, d/s of EWR 6 on Baviaans	Keisers

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
Niv29	-34.069	19.561	U/s of confluence with Riviersonderend	Baviaans
Niv30	-34.069	19.608	U/s of confluence with Riviersonderend	Sersants
Niv31	-34.120	19.703	U/s of confluence with Riviersonderend	Gobos
Niv34	-34.128	19.811	U/s of confluence with Riviersonderend	Kwartel
Niv33	-34.119	19.756	U/s of confluence with Riviersonderend	Slang
Niv35	-34.083	20.140	U/s of confluence with Riviersonderend	Soetmelksvlei
Niv24	-34.086	20.318	U/s of confluence with Riviersonderend	Kwassadie
Niv24 a	-34.064	20.415	U/s of confluence with Riviersonderend	Leeu
Niv25	-34.095	20.520	U/s of confluence with Riviersonderend	Klip
Niv26	-34.357	20.721	U/s of confluence with Breede	Buffeljags
Piv4	-34.246	18.988	U/s of confluence with Palmiet	Slang
Piv7	-34.246	19.074	U/s of confluence with Palmiet	Klein-Palmiet
Piv8	-34.146	19.025	U/s of confluence with Palmiet, 0.5km u/s of R231	Krom/Ribbok
Piv9	-34.148	19.031	U/s of confluence with Klipdrif, 0.5km u/s of R231	Klipdrif
Piv10	-34.147	19.038	U/s of confluence with Palmiet, 0.5km West of R231	Palmiet
Piv12	-34.292	18.938	Below confluence of Dwars and Louws, before Berg. Pristine wilderness=100% MAR	Witklippieskloof
Niv43	-34.260	19.225		Dwars/Louws
Niv45	-34.326	19.532		Swart
Niv46	-34.289	20.027		Heuningnes
Niii1	-33.651	19.337	U/s of confluence with Molenaars (Smalblaar)	Steenbok
Niii3	-33.959	20.042	U/s of confluence with Boesmans	
Niii4	-34.234	20.515	D/s of EWR 4, at Napkei confluence	Breede
Piii1	-34.115	19.052	U/s Eikenhof Dam at EWR 1	Breede
Piii2	-34.286	18.984	At EWR 3	Breede
Piii3	-34.330	18.989	Top of estuary. Just below or at IFR4	Palmiet
Niii5	-34.250	19.217		Palmiet
Nii1	-33.703	19.462	D/s of Hex/Breede confluence	Palmiet
Nii2	-33.870	20.003	At gauging weir H3H011, u/s of confluence with Breede	Bot
Nii3	-33.937	20.707		Breede
Nii4	-34.332	19.533		Kogmanskloof
Nii6	-34.291	20.024		Tradouw
Nii7	-34.406	20.311		Hartbees
Ni1	-33.847	19.719	U/s of confluence with Poesjenels	Kars
Ni2	-34.067	20.286	U/s of confluence with Riviersonderend	Sout
Ni3	-34.070	20.284	U/s of confluence with Breede	DeHoopVlei

River Node	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Comments	River
Ni4	-34.630	19.832		Breede
Px1	-34.081	19.056	Was in reservoir	Breede
Px2	-34.054	19.038		Riviersonderend
Px3	-34.223	19.081		Nuwejaar
Nx4	-34.367	19.100	Bot Estuary	Palmiet
Nx5	-34.315	19.139	U/s of estuary	Palmiet
Nx6	-34.360	19.251	was in reservoir	Krom/Ribbok
Nx7	-34.236	19.563	Steenbok upper	
Nx8	-34.460	19.693		Bot
Nvii15	-34.705	19.945		Onrus
Niv44	-34.682	20.020		Steenbok
Nii5	-34.673	20.015		Uilkraal

5.4 Preliminary Dams Nodes

The locations of the preliminary dams nodes for the WMA are presented in Table 4.5.

5.5 Wetlands Nodes

The locations of the wetlands nodes for the WMA are presented in Table 4.6.

5.6 Gouritz Estuary Nodes

The locations of the estuary nodes for the Gouritz component of the WMA are presented in Table 4.7.

5.7 Breede-Overberg Estuary Nodes

The locations of the estuary nodes for the Breede-Overberg component of the WMA are presented in Table 4.8.

6 SUB-STEP 1h: DEFINE IUAs

6.1 General approach

The IUAs were based on socio-economics zones, River Resource Units and estuaries. Alignment with the groundwater resource units (GRUs) was considered, however GRUs intend to adhere to hydraulic boundaries where possible hence did not align in many areas. Previous WRCS project experience shows that there is not a specific need for the GRUs and IUAs to align. The groundwater assessment will be assessed based on the GRUs, and where required, information can be summarised into IUAs.

Our delineation of the provisional IUAs followed the following approach:

- Tentative socio-economic areas were sketched based on land cover data, homogenous farm areas, vegetation types, topography, etc.
- These were then consolidated into relatively homogenous Socio-Economic Zones.
- The Socio-Economic Zones were overlaid on the River Resource Units that had earlier been delineated.
- Given that the River RUs tend to be oriented North-South whereas Socio-Economic Zones tend to run East-West, the overlaying process resulted in multiple individual overlaps, which provided the first "cut" at the provisional IUAs.
- These prototype IUAs were then rationalised in various ways, followed by aligning individual overlapping sub-zones better, to yield a second version of the provisional IUAs.
- The final step was to refine the selection of quaternaries for each provisional IUA – which yielded the current version of the provision IUAs. In a few cases, the quaternaries had to be cut.

6.2 Provisional delineation of IUAs

The composition of the individual provisional IUAs is outlined in Table 6.1.

It can be seen that both individual Socio-Economic Zones and individual River Resource Units may incorporate more than one provisional IUA. The locations of the individual provisional IUAs for the Gouritz and the Breede-Overberg are indicated in Figure 6.1 and Figure 6.2, respectively.

NB: It should be noted that the compositions and/or the boundaries of the individual IUAs should be treated as provisional, as more detailed evaluations undertaken during the Status Quo component of the first step of the Classification procedure, may lead to changes in IUA compositions and/or boundaries.

Table 6.1: Composition of provisional IUAs delineated for the Breede-Gouritz WMA

Socio-economic Zone	Zone Code	River Resource Units	IUA Name	IUA Code	Quaternary Catchments
Breede wine & fruit region	A	Upper Breede Tributaries	Upper Breede Tributaries	A1	H10C H10A H20C H10B H20D H10D H10F H20E H10E H10J H10K
		Breede Working	Breede Working Tributaries	A2	H20A H20F H20B H40A H10H H10G H20G H40B H40C H20H H30C H40H H10L H30D H30B H40J H30A H70C
		Middle Breede Renosterveld	Middle Breede Renosterveld	A3	H40E H40F H40L H30E H40D H40G H40K H50A H50B
Theewaterskloof fruit region	B	Riviersonderend Upper	Riviersonderend Theewaters	B4	H60B H60C H60E H60D H60A H60F
		Overberg West (part 1 of 3)	Overberg West	B5	G40E G40C G40D
Great Karoo	C	Groot/Touws (part 1 of 2)	Gamka-Buffels	C6	J22G J22H J22B J22A J21A J22C J22J J22K J21B J22D J22E J24A J21D J24B J21C J22F J11B J11A J21E J23A J24C J11D J23B J24D J11C J32A J32C J23G J23C J11G J11E J32B J23D J32D J24E J11F J23F** J23H**
		Gamka (part 1 of 2)			
Swartberg	D	Lower Gouritz (part 1 of 2)	Gouritz-Olifants	D7	J23F** J23H** J23E J32E J33C J24F J23J J25A J33D J35A J25B J35D J31C J33F J35F J33E J31D J25D J33A J33B J31A J31B J25E J35E J25C J35B J34A J34B J34F J34D J34C J35C J34E J40A J40B
		Olifants			
Little Karoo	E	Groot/Touws (part 2 of 2)	Touws	E8	J12C J12E J12A J12B J12G J11H J12D J11J J12F J11K J12H J12L J12K J13A J12M J13B J13C J12J
Wheat belt	F	Riviersonderend Lower	Lower Riviersonderend	F9	H60L H60K H60H H60J H60G
		Overberg West (part 2 of 3)	Overberg East Renosterveld	F10	G40F G40K G50H G50G G40J G50D
		Overberg East Renosterveld (part 1 of 2)			

Socio-economic Zone	Zone Code	River Resource Units	IUA Name	IUA Code	Quaternary Catchments
		Lower Breede Renosterveld	Lower Breede Renosterveld	F11	H70D H70B H70A H70E H70F H70J H70G H70H H70K
		Duiwenhoks (1 of 2)	Duiwenhoks	F12	H80B H80A H90B H90A H80C H90C H90D H80D H80E
		Lower Gouritz (2 of 2)	Lower Gouritz	F13	J40C J40D J40E
Garden route coast	G	Coastal Rivers (1 of 2)	Groot Brak	G14	K10E K10C K20A K10D K10F K10B K10A
		Coastal Rivers (2 of 2)	Coastal	G15	K60A K60B K60D K50A K40E K40B K40A K60C K40C K30D K30C K70B K30B K30A K70A K60E K60F K40D K50B K60G
Overberg coast	H	Overberg West (3 of 3)	Overberg West Coastal	H16	G40B G40H G40G
		Overberg East (Fynbos)	Overberg East Fynbos	H17	G40L G50K G50J G40M G50E G50B G50C G50F G50A
Hessequa coast	I	Duiwenhoks (2 of 2)	Hessequa	I18	H90E H80F

***: J23F and J23H shared between Gamka-Buffels and Gouritz-Olifants provisional IUAs*

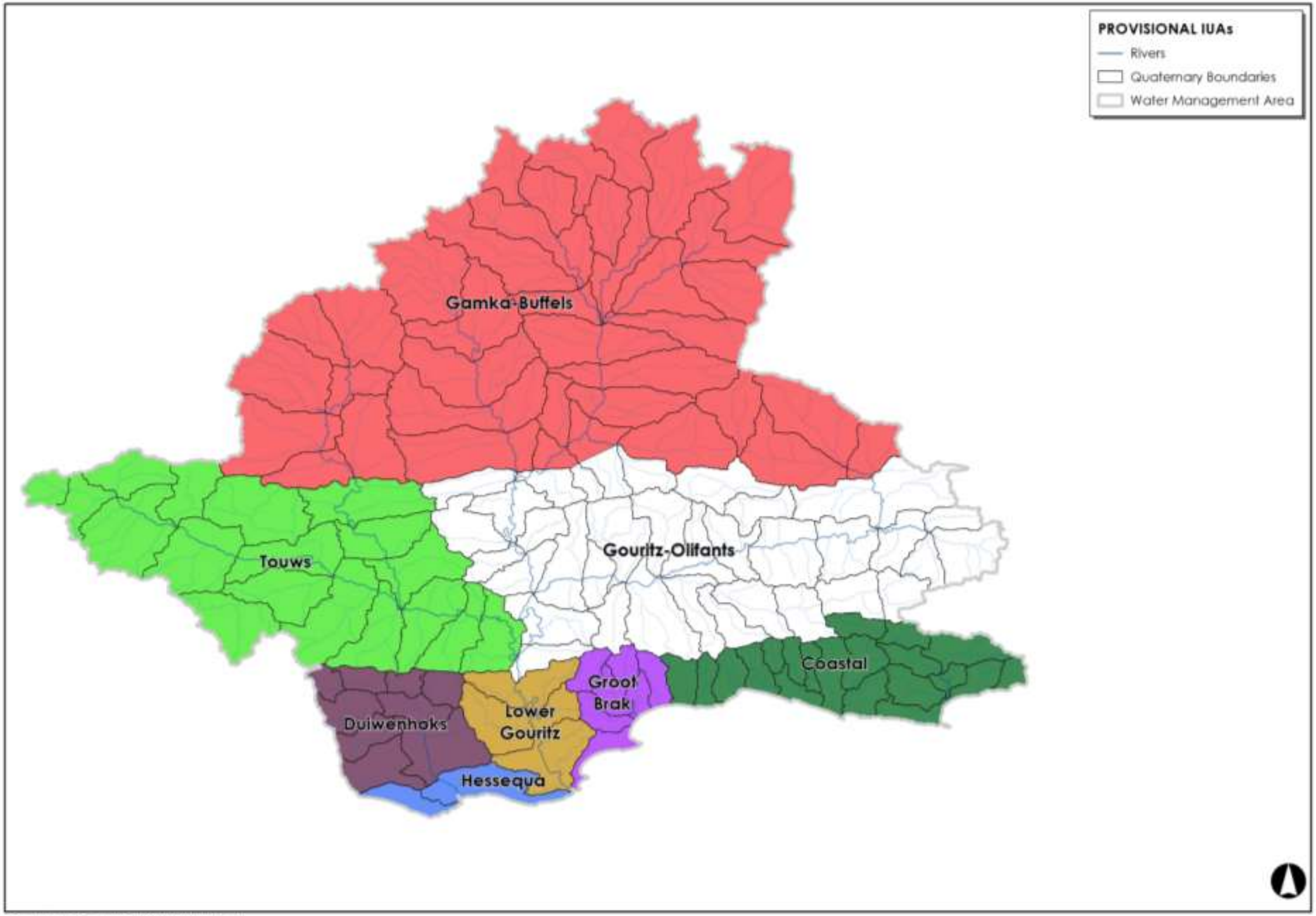

Figure 6.1: Locations of provisional IUAs delineated for the Gouritz component of the WMA

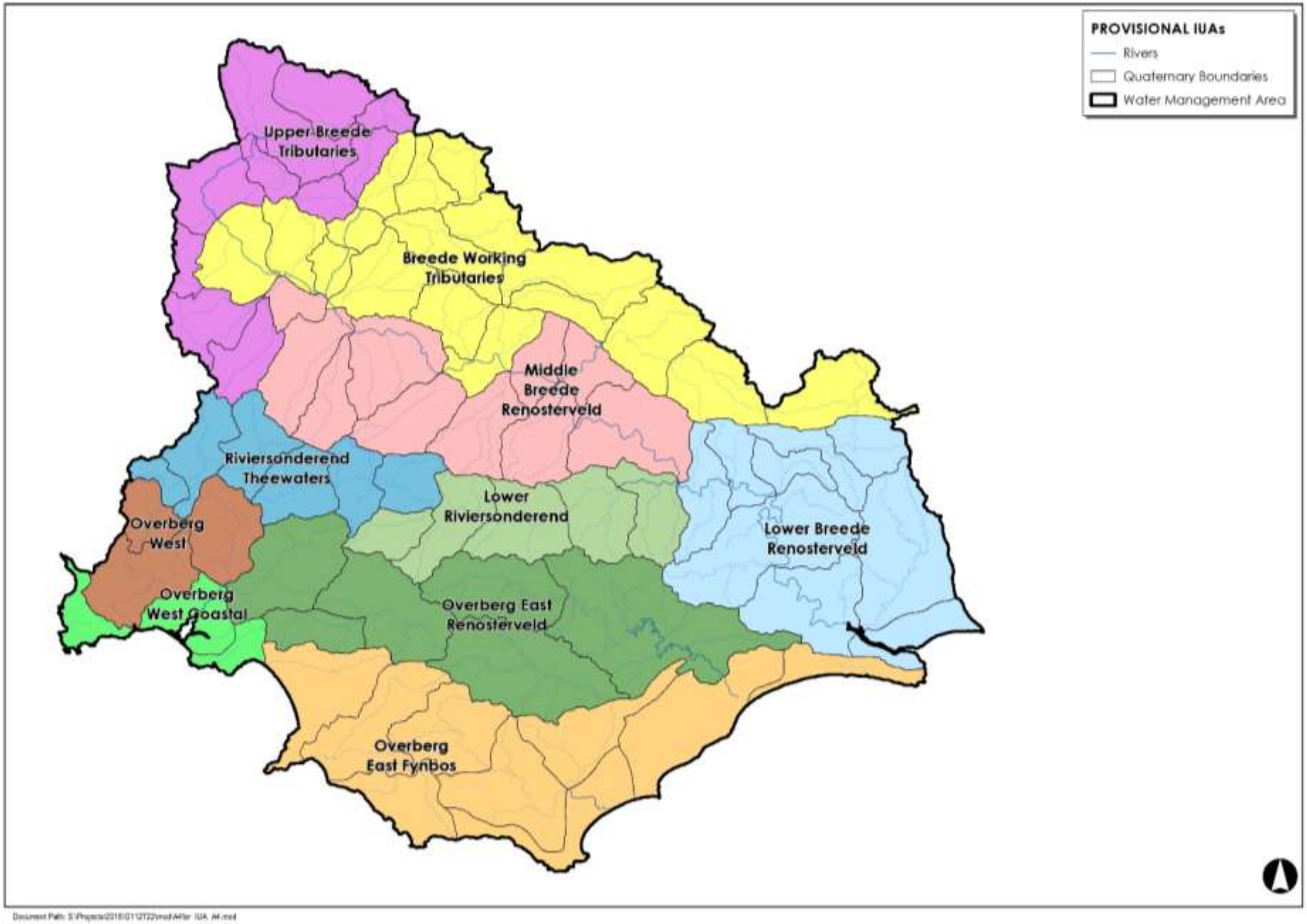

Figure 6.2: Locations of provisional IUAs delineated for the Breede-Overberg component of the WMA

7 WAY FORWARD

This Report is the first of six Deliverables that constitute the outcomes of the Classification component of this Study. These Deliverables are as follows:

- *Resource Units and Integrated Units of Analysis Delineation Report*
- *Status Quo Report*
- *Report on Linking the Value and Condition of the Water Resource*
- *Report on Quantification of the EWR and Changes in EGSAs*
- *Ecological Base Configuration Scenarios Report*
- *Evaluation of Scenarios Report*

The Status Quo Report will more fully document the detailed evaluations that underlie the above delineation of Socio-Economic Zones, Resource Units, Nodes and provisional IUAs. It will also cover the additional work undertaken to complete Sub-step 1a (describe present-day socio-economic status), Sub-step 1e (describe wellbeing of communities), Sub-step 1f (value of water use), Sub-step 1g (value of ecosystem use), Sub-step 1i (socio-economic framework and decision-analysis framework) and Sub-step 1j (describe present-day community wellbeing in IUAs).

The work leading up to the Status Quo Report will also include re-visiting the provisional IUAs proposed in this Report with a view to adjusting their composition or delineation if deemed necessary on the basis of the Status Quo outcomes.

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