WP 10543

REPORT NO. RDM/WMA16/00/CON/0213

RESERVE DETERMINATION STUDIES FOR THE SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE GOURITZ WATER MANAGEMENT AREA

PROJECT TECHNICAL REPORT 2

DESKTOP ECOCLASSIFICATION REPORT

April 2014

Department of Water Affairs
Chief Directorate: Resource Directed Measures

Published by

Department of Water Affairs
Private Bag X313
PRETORIA, 0001
Republic of South Africa

Tel: +27 (12) 336 7500
Fax: +27 (12) 323 0321

Copyright reserved

This report should be cited as:

Department of Water Affairs (DWA), 2014. *Reserve Determination Studies for the Selected Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area:* Desktop EcoClassification Report. Prepared by Scherman Colloty & Associates cc. Report no. RDM/WMA16/00/CON/0213.

Compiled by:
Scherman Colloty & Associates cc
22 Somerset Street
Grahamstown
6139

In association with:
AECOM SA (Pty) Ltd
Waterside Place
South Gate
Tyger Waterfront
Carl Cronje Drive
Bellville
7530

DOCUMENT INDEX

Reports as part of this project:

INDEX NUMBER	REPORT NUMBER	REPORT TITLE
Report Number 01	RDM/WMA16/00/CON/0113	Inception Report
Report Number 02	**RDM/WMA16/00/CON/0213**	**Desktop EcoClassification Report**
Report Number 03, Volume 1	RDM/WMA16/00/CON/0313, Volume 1	Delineation Report, Volume 1 (Groundwater, Estuaries and Wetlands)
Report Number 03, Volume 2	RDM/WMA16/00/CON/0313, Volume 2	Delineation Report, Volume 2 (Rivers)
Report Number 04	RDM/WMA16/02/CON/0413	Groundwater Report
Report Number 05	RDM/WMA16/03/CON/0513	Wetland Report
Report Number 06	RDM/WMA16/04/CON/0613	Estuaries RDM Report – Desktop Assessment
Report Number 07, Volume 1	RDM/WMA16/04/CON/0713, Volume 1	Estuaries RDM Report – Rapid Assessment, Volume 1 (Klein Brak Estuary)
Report Number 07, Volume 2	RDM/WMA16/04/CON/0713, Volume 2	Estuaries RDM Report – Rapid Assessment, Volume 2 (Wilderness System)
Report Number 08, Volume 1	RDM/WMA16/04/CON/0813, Volume 1	Estuaries RDM Report – Intermediate Assessment, Volume 1 (Duiwenhoks Estuary)
Report Number 08, Volume 2	RDM/WMA16/04/CON/0813, Volume 2	Estuaries RDM Report – Intermediate Assessment, Volume 2 (Gouritz Estuary)
Report Number 08, Volume 3	RDM/WMA16/04/CON/0813, Volume 3	Estuaries RDM Report – Intermediate Assessment, Volume 3 (Goukou Estuary)
Report Number 09	RDM/WMA16/00/CON/0913	Scenario Report
Report Number 10	RDM/WMA16/01/CON/1013	Rivers RDM Report – Intermediate Assessment
Report Number 11	RDM/WMA16/01/CON/1113	Rivers RDM Report – Rapid Assessment
Report Number 12	RDM/WMA16/00/CON/1213	Monitoring Report
Report Number 13	RDM/WMA16/00/CON/1313	Main Report

Bold indicates this report.

APPROVAL

TITLE:	Reserve Determination Studies for the Selected Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area: Desktop EcoClassification Report
DATE:	April 2014
AUTHORS:	Louw MD; Kotzé P; Mackenzie J; Scherman P-A; Van Niekerk E; Huggins G; Mallory S
EDITORS:	Koekemoer Aquatic Services: Shael Koekemoer; Scherman Colloty & Associates
REVIEWERS:	Project Management Team
LEAD CONSULTANT:	Scherman Colloty & Associates
REPORT NO:	RDM/WMA16/00/CON/0213
FORMAT:	MSWord and PDF
WEB ADDRESS:	http://www.dwa.gov.za

Approved for Scherman Colloty & Associates cc:

Dr Patsy Scherman
Technical Team Leader

Approved for AECOM SA (Pty) Ltd:

Dr Aldu le Grange
Study Leader

Approved for the Department of Water Affairs by:

Ms Nancy Motebe
Deputy-Director: Groundwater
Reserve Requirements

Ms Barbara Weston
Deputy-Director: Surface Water
Reserve Requirements

Mr Yakeen Atwaru
Director: Reserve Requirements

Ms Ndileka Mohapi
Chief Director: Water Ecosystems

ACKNOWLEDGEMENTS

The following individuals are thanked for their contributions to this project:

Project Co-ordinators

Yakeen Atwaru	Department of Water Affairs	Project Director
Barbara Weston	Department of Water Affairs	Project Manager: Surface Water
Nancy Motebe	Department of Water Affairs	Project Manager: Groundwater
Thapelo Machaba	Department of Water Affairs	Project Co-ordinator

Project Management Team

Aldu le Grange	AECOM SA (Pty) Ltd	Professional Service Provider Study Leader
Patsy Scherman	Scherman, Colloty & Associates	Technical Study Team Leader
Simon von Witt	AECOM SA (Pty) Ltd	Professional Service Provider Study Co-ordinator

Members of Project Steering Committee

Names	Affiliation
Ndileka Mohapi	CD: Water Ecosystems (WE)
Yakeen Atwaru	D: Reserve Requirements (RR)
Barbara Weston	D: Surface Water Reserve Requirements (SWRR)
Nancy Motebe	D: Groundwater Reserve Requirements (GWRR)
Thapelo Machaba	D: SWRR
Vuledzani Muthelo	D: RR-SWRR
Gladys Makhado	D: RR
Happy Maleme	D: RR
Wietsche Roets	D: Water Abstraction and Instream Use
Shane Naidoo	D: Water Resources Classification
Vusi Mema	D: Resource Directed Measures Compliance (RDMC)
Boitumelo Sejamoholo	D: RDMC
Manelisi Ndima	D: GWRR
Isa Thompson	DWA: National Planning
Pieter Viljoen	DWA: Water Quality Planning
Mennard Mugumo	DWA: Options Analysis
Fanus Fourie	DWA: Planning Groundwater
Nadene Slabbert	DWA: Resource Quality Services (RQS)
Neels Kleynhans	DWA: RQS
Gerhard Cilliers/Nolu Jafta	DWA: RQS
Rashid Khan	DWA Western Cape (WC): Regional Director
Wilna Kloppers	DWA WC: Resource Protection
Andrew Gordon	DWA WC: Resource Protection
Bertrand van Zyl	DWA WC: Operations
John Roberts/Hester Lyons	DWA WC: Gouritz Catchment Manager
Frans Mouski	DWA WC: Hydrology
Mike Smart	DWA WC: Geo-Hydrology
André Roux	Department of Agriculture Western Cape (DAWC)
Danie Swanepoel/ Francois Naude	Department of Environmental Affairs and Development Planning (DEADP)

Names	Affiliation
Ian Russell/ Dirk Roux	South African National Parks Board (SANParks)
Greg Palmer/ Andrew Turner/ Pierre de Villiers	CapeNature
Heidi Nieuwoudt	South African National Biodiversity Institute (SANBI)
Jannie van Staden	Breede Overberg Catchment Management Agency (BOCMA)
Vernon Gibbs-Halls	Eden District Municipality
Harold Basson	George Municipality
Alie Killian	Oudtshoorn Municipality
Roy Parry	Knysna Municipality
Johan du Preez	Mossel Bay Municipality
Pikkie Lombard	Bitou Municipality
Reggie Wesso	Hessequa Municipality
Louw Smit/Christopher Wright	Beaufort West Municipality
Richard Fransen/ Heinrich Mettler	Prince Albert Municipality
Jannie Venter	Laingsburg Municipality
Aldu le Grange	AECOM
Simon von Witt	AECOM
Patsy Scherman	SC&A
Cecilia Bester	Agricultural Research Council
Carl Opperman	Agri-Western Cape
Barry Levinrad	Department of Land Affairs
Alwyn Lubbe	Endangered Wildlife Trust
Connie Jonker	Jonkersberg Plantation
Ayanda Matoti	Marine and Coastal Management
Alan Boyd	Marine Protected Area and Estuary Management

AUTHORS

The following persons contributed to this report:

Authors	Company
Huggins, Greg	Nomad Consulting
Koekemoer, Shael	Koekemoer Aquatic Services (editing)
Kotzé, Pieter	Clean Stream Biological Services
Louw, Delana	Rivers for Africa eFlows Consulting (Pty) Ltd
MacFadyan, Sandra	Private (GIS maps and analysis)
Mackenzie, James	Mackenzie Ecological & Development Services cc
Mallory, Stephen	IWR Water Resources (WRUI tables)
Scherman, Patsy	Scherman Colloty & Associates cc
Van Niekerk, Estelle	AECOM SA (Pty) Ltd

REPORT SCHEDULE

Version	Date
First draft	April 2014
Second and final draft	July 2014

EXECUTIVE SUMMARY

INTRODUCTION

This document serves to report on the desktop ecological classification of the study area for rivers and the identification of river hotspots.

RIVER DESKTOP ECOCLASSIFICATION AND HOTSPOT IDENTIFICATION

The objective of this task is to describe and document the status quo which included various components such as water use, river ecology, water quality and Ecosystem Services. This task therefore describes the physical template and information for decision making regarding the different levels of investigation for Reserve determination and guides the selection of rivers for which Ecological Water Requirements (EWRs) should be provided, as well as preferred sections of river in which the EWRs should be placed.

WATER RESOURCES STATUS QUO ASSESSMENT

The Gouritz WMA was divided into water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. The significant resources of the proposed water resource areas are summarised below.

Gouritz catchment water resource zones

Secondary catchment	Quaternary catchment	Description	Water resource areas	Major impoundments	Impoundment at outlet of	River
H8	H80 A to H80F	Duiwenhoks	H80	Duiwenhoks Dam	H80A	Duiwenhoks
H9	H90A to H90E	Goukou	H90	Korintepoort Dam	H90B	Korinte-Vet
J1	J11A to J11K, J12A to J12M, J13A to J13C	Groot (tributary of Gouritz)	J11J	Floriskraal Dam	J11G	Buffels
			J11G	Bellair Dam	J12J	Touws
			J12A	Verlorenvlei	J12A	Touws
			J12B	Verkeerdevlei Dam	J12B	Touws
			J12C	Tierkloof	J12C	Touws
			J12C	Aartappel	J12C	Touws
			J12D			
			J12E	Gant	J12E	Touws
			J12F			
			J12G	Prins River Dam	J12G	Touws
			J12M	Miertjieskraal Dam	J12M	Touws
J2	J21A to J21E, J22A to J22K, J23A to J23J, J24A to J24F, J25A to J25E	Gamka	J21A	Stols River Dam	J21A	Gamka
			J21A	Gamka Dam	J21A	
			J21A	Stols River Dam	J21A	
			J21A	Springfontein Dam	J21A	
			J22G	Doornfontein Dam	J22G	Leeu
			J22K	Ou Leeu-Gamka Dam	J22K	Leeu
			J22K	Leeu-Gamka Dam	J22K	Leeu

Secondary catchment	Quaternary catchment	Description	Water resource areas	Major impoundments	Impoundment at outlet of	River
			J25D	Calitzdorp Dam	J25D	Tributary of Dwyka
			J23E	Oukloof Dam	J23E	Tributary of Swart
			J24F	Gamkapoort Dam	J24F	Tributary of Dwyka
J3	J31A to J31D	Olifants (tributary of Gouritz)				Upper Olifants (to Stompdrift)
	J32A to E					Traka
	J33A and J33B		J33B	Stompdrift Dam	J33B	Middle Olifants
	J33C to J33F					Middle Olifants
	J34A to J34E		J34E	Kammanassie Dam	J34E	Upstream of Kammanassie
			J34E	Ezeljacht Dam	J34E	Tributary of Kammanassie
	J34F					Downstream of Kammanassie tributary
	J35A to J35F		J35A	Koos Raubenheimer Dam	J35A	Tributary of Olifants
J4	J40A to J40E	Gouritz				Gouritz
K1	K10A to K10F	Klein Brak	K10B	Hartbeeskuil Dam	K10B	Klein Brak
			K10F	Klipheuwel Dam	K10F	Klein Brak
K2	K20A	Groot Brak	K20A	Wolwedans Dam	K20A	Groot Brak
K3	K30A to K30D	Kaaimans/ Touws	K30C	Swartrivier Dam	K30C	Swart
			K30C	Garden Route Dam	K30C	Swart
			K30D	Rondevlei	K30D	Touw
			K30D	Bo-Lang Vlei	K30D	Touw
			K30D	Onder-Lang Vlei	K30D	Touw
			K30A	Geelhoutboom Dam	K30A	Maalgate
			K30A	Kruisrivier Dam	K30A	Maalgate
K4	K40A to K40E	Goukamma	K40D	Groenvlei	K40D	Goukamma
K5	K50A to K50B	Knysna	K50B	Knysna Lagoon	K50B	Knysna
K6	K60A to K60G	Keurbooms	K60G	Roodefontein Dam	K60G	Keurbooms
K7	K70A to K70B	Sout/Matjie				Sout/Matjie

WATER QUALITY STATUS QUO ASSESSMENT

The report provides a water quality overview per primary and secondary catchment based on an extensive literature review, including the 2012 DWA Green Drop for the Western Cape regarding the functionality of wastewater treatment works (WWTW). Land uses are identified as these are closely

linked to water quality state. Present water quality state is described as based on literature. This data will be updated when the detailed water quality assessment is undertaken.

ECOSYSTEM SERVICES STATUS QUO ASSESSMENT

The socio-economic profile was established based on the desktop review of existing studies and information for the applicable district and local municipalities. Specifically, this included a review of the latest versions of the district and local municipal Integrated Development Plans. These plans were further supplemented by the analysis of the 2011 Census, Community Survey 2007 data (as provided by Statistics SA) and other applicable sources. Land use was determined via existing GIS coverage and DWA Internal Strategic Perspectives (DWAF, 2004) developed for the WMA.

The study identified areas and communities that are significantly dependent on Ecosystem Services provided by the natural resource. The level of dependence can be determined based on the general principle that vulnerable communities will have limited access to formal resources and thus are more likely to be dependent on local natural resources.

An index or set of criteria was established to determine which areas and communities may be considered vulnerable and dependant on Ecosystem Services and as such constitute "hot spots". For each criterion, a number of variables or thresholds were determined to permit the identification of specific areas/communities via spatial mapping. The criteria were summarised in a single score entitled resource dependence and linked to overall Socio Cultural Importance (SCI) assessment of the sub-quaternary (SQ) catchment. The score used was between 0 (no resource dependence significance) and 5 (extreme dependence of significant communities on riverine Ecosystem Services). The table below sets out the SQs that have high (≥3) scores.

For the most part areas with high resource dependence and associated Ecosystem Services utilisation by communities are in areas that are rural and defined as underdeveloped. Given the nature of the population and the largely formal as opposed to subsistence rural setting there are few communities who are highly dependent on riverine linked Ecosystem Services.

SQ	River	HIGH SCI score (≥3)	Comment
H90E-09383	Goukou	3.2	This river section extends into the Goukou estuarine system. The town of Stilbaai is located along much of the west bank of this river section. The east bank is comprised mostly of open terrain with some development. Likely moderate to high recreational use of the estuary.
J33D-08571	Meirings	3.1	River section extends through a gorge with some aesthetic value. Limited farming noted on upper and middle reaches, but more extensive on the lower reaches. The town of De Rust located to the west of the river. Guest houses and lodges noted.
J34A-08871	Holdrif	3.1	River section extends through a uniform open terrain. Greater presence of agriculture noted in proximity of the river. Grazing likely. The town of Uniondale noted on the extreme upper reaches. Presence of tourism resorts.
J40E-09359	Gouritz	3	Coastal plains with agricutlure. Estuary with Gouritzmond town on West Bank and elevated aesthetic and recreational values.

SQ	River	HIGH SCI score (≥3)	Comment
K50B-09117	*Knysna*	*4*	*The lower reaches of the river extends into the Knysna lagoon/estuarine system. The estuary is flanked on both banks by a number of up-market residential areas. Recreational and ritual use, as well as heritage and aesthetic value is high.*
K60E-09097	*Keurbooms*	*3.3*	*Located in the Keurboomsrivier Nature Reserve. The river extent is comprised of open/natural terrain. The river extends into a lagoon, and a number of resorts are located on both banks of the lagoon. Plettenberg Bay is located near the river mouth. The nature reserve, presence of upscale resorts at the estuary and Plettenberg Bay suggest high levels of tourism and recreational use, as well as elevated heritage and aesthetic value.*
K20A-09083	*Groot Brak*	*3.2*	*River headwaters located in the inland escarpment. The lower reaches of the river extends through the coastal plain and a mosaic of open/natural terrain, indigenous forests and commercial agriculture. The river drains through the Wolwedans Dam therefore recreational, ritual and aesthetic value is likely to be elevated. River extends towards the coast into the river estuary. The small towns of Groot Brakrivier, Bergsig, Southern Cross and The Island (formal, affluent) are located on the west and east banks of the river/estuary. Recreational, ritual and aesthetic value is likely to be elevated along the lower river reaches and the estuary.*
K60F-09092	*Bitou*	*3.2*	*Upper reaches of the river extends through the Knysna Forest, with the presence of plantation forestry on the east bank. Middle and lower reaches of the river comprise of a mosaic of open/natural terrain, small-holdings and commercial agriculture. A number of tourism facilities (lodges, hotels) noted along the river route suggesting elevated recreational use, as well as aesthetic value. The small town of Wittedrift (formal, affluent) is located within 1 km of the river. The river drains into the Keurbooms lagoon, and there are high levels of recreational use in this lagoon.*
K60G-09188	*Keurbooms*	*3.1*	*River section completely contained in the Keurbooms lagoon. A number of resorts are located on north bank of the lagoon. Plettenberg Bay is located near the river mouth. The presence of upscale resorts at the estuary and Plettenberg Bay suggest high levels of tourism and recreational use, as well as elevated heritage and aesthetic value.*
K30D-09173	*Touws*	*3*	*Short river section extends through Wilderness Town into the Touws River estuary. Tourism and recreational facilities and resources noted, therefore recreational, aesthetic, ritual and heritage use is elevated.*
K70B-09055	*Bloukrans*	*3*	*River near exclusively extends through indigenous forest (potentially linked to a nature reserve). Some plantation forestry noted on the banks of the lower reaches of the river. River drains into an estuarine system used for recreation.*

ECOLOGICAL STATUS QUO ASSESSMENT OF THE RIVERS

Determination of the Present Ecological State, which in essence represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process (Kleynhans and Louw, 2007). The EcoClassification process consists of four levels which refer increasing complexity and intensity of work ranging from Level I (Desktop) to Level IV. An additional level, also Desktop, was

developed by Dr Neels Kleynhans (Kotzé et al., 2012) with the specific purpose of building up a country wide database of Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES). This project is referred to as the national PES/EI/ES project and has been finalised. All the spreadsheets for the secondary catchments in South Africa have been completed and the information was used as the baseline for the status quo assessment. The work specifically for this WMA was undertaken by Southern Waters (DWA, 2013). The PES component was reviewed during this study.

K1 (Hartenbos, Klein Brak)

K10A-9292 is in a PES of D, primarily related to water quality alterations (Mossdustria industrial area) and limited non-flow related impacts, such as agriculture. The entire Hartenbos River system (including Melkboom) (K10B) is in a PES of D. The primary impacts are non-flow related associated with agriculture (wheat) and livestock farming activities, while flow related impacts are associated with the Hartebeeskuils Dam and irrigation abstraction. The land use in quaternary catchments K10C and K10D is primarily agriculture (non-flow related), resulting in the PES of this entire area ranging between a C/D and D. The primary land use and impacts in quaternary catchment K10E is related to forestry, with the condition still being good (category B) in the Beneke River (K10E-9119) and moderate (category C) in the upper Moordkuil River (K10E-9064). The lower Moordkuil River (K10F-9139) and unnamed tributary (K10F-9204) are impacted by flow and non-flow related impacts namely forestry and agriculture, as well as the Klipheuwel Dam, resulting in a PES of C/D.

K2 (Groot Brak)

The Groot Brak River (K20A-9083) is impacted by non-flow related (forestry and agriculture) as well as flow related impacts (Wolwedans Dam in lower 20% of reach), resulting in a moderately modified PES of B/C on the river.

K3 (Maalgate, Malgas, Gwaing and Swart)

The Maalgate River (K30A-9087) is primarily impacted by flow related activities namely abstraction for irrigation, while the non-flow related agricultural impacts also contribute to the largely modified PES of a D. The Malgas River (K30B-9082) and especially the upper reaches of this SQ is in a good condition (PES of B), while the lower reaches are impacted by a cement factory and golf estate (irrigation and return flows, as well vegetation removal). The remaining SQs of K30B has a PES of a D due to the non-flow related impacts (forestry and urban development) with some flow related (irrigation) impacts in the Rooi River (K30B-9115) and K30B-9100, while water quality impacts (cement factory and irrigation return flows) are the primary causes for deterioration in the Gwaiing River (K30B-9158 and K30B9151). The Kaaimans River (K30C-9065) is still in a relatively good state with a PES of a B with the primary impacts being related to forestry. The Swart River (K30C9177) is, however, largely impacted by flow modification (George and Garden Route dams), resulting in a PES of a D. The Touws River (K30D-9042) is also still in a relatively good state with a PES of a B and the primary impacts being related to forestry. The remainder of K30D (Klein Keurbooms and Duiwe) is subjected to primarily flow related impacts (dams and irrigation abstraction), while non-flow related agriculture and forestry impacts contribute somewhat to the PES of C/D to D prevailing in this area.

K4 (Sedgefield, Diep, Hoëkraal and Karatara)

Both the Hoëkraal and Karatara are category B rivers and have large portions with indigenous forest. The Huis River, which is a tributary of the Karatara is in a C category and the main impacts are non-flow related, mainly forestry and agriculture. The Diep River is also in a category C, but the upper half of the SQ is likely a B with more impacts in the lower half. Impacts are mainly forestry encroachment into the riparian zone and invasion by alien plant species.

The Homtini River is in a category B/C with the majority of impacts occurring in the lower portions of the SQ. Impacts are mainly agriculture with associated vegetation clearing.

K5 (Knysna)

The Knysna River system runs mostly through mountainous terrain with indigenous forests and has low impacts overall. Consequently the PES is high throughout the system although forestry and invasion by alien plant species does occur especially towards the lower part of the catchment towards the estuary.

K6 (Keurbooms)

Most rivers in the Keurbooms system are in a category B or better, with the impacts that exist being non-flow related vegetation removal or the presence of alien plant species. The Keurbooms River has the high biodiversity important Bietou wetlands in the lower parts of the Keurbooms River adjacent to the Keurbooms estuary. The Bitou (B/C category) also has both flow (small farm dams and irrigation) and non-flow (loss of riparian vegetation to agriculture) related impacts, while the riparian zone of the upper portion of the Keurbooms (K60A-08947) is largely fragmented by agricultural activities. The Piesang River on the other hand is the most impacted system in this secondary catchment with both flow (dams) and non-flow related (loss of riparian vegetation due to agriculture and urban development) impacts.

K7 (Bloukrans)

All the rivers in K7 are near natural (category B) with minimal removal of riparian vegetation in localised areas and some forestry.

J1 (Groot Catchment)

Buffels and tributaries up to Floriskraal Dam:

Most of these streams occur in mountainous areas and have low impacts. Overall, the PES of this area is in a category B or higher, with only four of the 32 SQs in a C category (Roggeveld and Buffels - J11F-08427 and J11F-08460). Impacts are predominantly agriculture, irrigation and small farm dams. Some alien plant species also occur in the area.

Groot and tributaries downstream of Floriskraal Dam to Touws River confluence:

Most of the streams in this portion are in C or D categories with the exception of J11H-08584 and the Buffels (J11H-08647) which are a category A and B respectively. Other than the mainstream Buffels and Groot rivers being impacted by the Floriskraal Dam there is also extensive irrigation in the area and associated agriculture which fragments and deteriorates the riparian zone and associated floodplains. Alien plant species have invaded some areas.

Touws River and tributaries from source to confluence with Prins River:
The rivers in this area are mixed in terms of their PES. About half of the SQs are in a category B/C or better and about half in a category C or D. There are no category A or A/B SQs and only a single E category (J12B-08656). The main impacts in the area are both flow and non-flow related. Flow related impacts include multiple small farm dams in areas, irrigation (extensive in some areas), and a few large dams, e.g. Verkeerdevlei and Gants Dams. Non-flow related impacts are mainly agricultural encroachment or clearing of riparian zones and/or floodplains, overgrazing in areas and physical disturbance (manipulation) of morphological features (localised). Some canals exist for off-take to reservoirs and some artificial levees and river course manipulation is evident. Several of the upper SQs fall within the southern extreme of the Riverine Rabbit distribution (Bunolagus monticularis), which is a critically endangered riparian mammal.

Prins River to the confluence with the Touws River:
Most of the SQs in this area traverse mountainous areas with few impacts and are predominantly B category rivers. Prins Dam (large dam) occurs towards the end of the area on the Prins River, and several small farm dams exist in some places. Where topography allows there is intense but localised agricultural activities with irrigation in places and some off take via canals. In these areas the PES has deteriorated to a category B/C or C.

Brak River and tributaries to the confluence with the Touws River:
Mostly category B/C and C rivers with some of the mountainous tributaries in category A or A/B (Wilgebos).

J2 (Gamka Catchment)
Most of the upper reaches of catchment J2 (J21, J22, J23 and J24) is in a good PES ranging between categories A, A/B and B. These areas are generally seasonal or ephemeral, and impacts are limited to livestock farming, some agriculture and dams as well as towns. The exceptions that are in a more deteriorated state (C to D) due to primarily non-flow related farming impacts (livestock and agriculture) and limited flow modification associated with farm dams include the Kuils (J21A-07211), Kwagga (21A-07499), Boeteka (J21B-07538), Plaatjies (J21C-07669), Koekemoers (J22F-07805) rivers.

The sub-quaternary reaches of the Leeu (F22F) and the Gamka rivers (J23A and J23B) in the vicinity and especially downstream of the town of Leeu-Gamka are also in a deteriorated PES, ranging between a C and D due to flow modification (dams and abstraction for irrigation), water quality deterioration (Leeu-Gamka town and irrigation return flows) as well as non-flow related impacts associated with farming (cultivated lands in riparian zone, over grazing by livestock).

The Cordier, Swart and Dorps rivers in the vicinity of Prince Albert is in a deteriorated PES ranging between C and D due to flow modification (Oukloof and farm dams and irrigation), non-flow related impacts (agriculture, towns developments) and water quality impacts (town and irrigation return flows).

The lower Gamka River (J23J, J25A, J25C, J25E) is also in a deteriorated state due to modified flows (Gamkapoort Dam, abstraction for irrigation and towns), as well as non-flow related impacts (extensive agricultural activities along river) as well as water quality deterioration (irrigation return

flows and town of Calitzdorp). The Kobus River (J25B-08591) is highly cultivated in some section, resulting in a PES of D, while the Nels River (J25D-08626) is impacted by flow modification (Calitzdorp Dam) as well as non-flow related and water quality impacts associated with the extensive agricultural areas.

J3 (Olifants Catchment)

Upper Olifants:

Of the 15 SQs, 11 fall in a B PES Category. Only three of these SQs are in the main Olifants River, the rest are tributaries. The good condition is due to the dry (mostly ephemeral) nature of the rivers (minimising options of use) and the topography (lack of access).

The remaining four SQs consist of three in the Olifants River (PES of a C and B/C and one in the Hartbees River (PES of a C). The impacts are largely non flow-related and consist of overgrazing, erosion, bank disturbance due to agriculture, and removal of the riparian zone to make place for agricultural fields.

Traka:

Of the 34 SQs, 24 fall in a B PES EC or higher. The good state is due to the ephemeral nature of many of the rivers which occur in mountains areas and are inaccessible. Impacts are limited to localised agricultural activities and farm dams. The remaining 10 SQs consist of five in the main Traka River, with the rest in tributaries. Most of the impacts in the Traka River are dominated by non-flow related impacts due to grazing, agricultural practices and placing of agricultural fields within the riparian zone. In the lower Traka River, a railway line is situated in the river and marginal zone as it traverses through a Kloof in the Swartberg mountains. The impacts in the tributaries are similar to the Traka River's impacts with farm dams also resulting in barrier and inundation impacts.

Middle Olifant and Groot rivers:

This catchment consists of 31 SQs. Due to the extensive utilisation of water for irrigation in this dry area, the river states are showing a negative trajectory leading to a progressive degradation in their ecological states. There are only five SQs which are in a B category whilst 15 SQs are in a PES of a C and B/C (few) category. The reasons for this are due to abstraction for irrigation (flow-related impacts) and non-flow related secondary impacts from irrigation activities (irrigation fields in the riparian zones, irrigation return flows, etc.). In the main Olifants River downstream of Stompdrif Dam, the Olifants River deteriorates significantly and range from a D, D/E and E PES categories. These states relate to the minimal flow in the river, extensive reed growth in the channel, irrigation return flows and irrigation fields in the riparian zone.

Kammanassie River:

Of the 17 SQs, only one SC in the Klues River (J34C-08859) falls into a B PES. Three SQs fall into a B/C state (Huis (J34D-08853) and the Kammanassie (J34D-08868 and 08899). Most of the rest of the SQs fall in a C and C/D state. Sections in the Potjies and Diep rivers fall in a D/E due to extensive alien vegetationa and agricultural fields. The Kammanassie River downstream of Kammanassie Dam falls in an E and D/E PES due to the flow modification, agricultural fields and return flows and extensive reed growth. Upstream of Kammanassie Dam the impacts are related to urban impacts, agricultural fields in the riparian zone, alien vegetation. The areas which are in the best condition are due to inaccessibility being in a deep river valley.

Lower Olifants River:

Ten of the 26 SQs fall in the main Olifants River catchment area. All of these SQs apart from the most downstream SQ have a PES of a D/E and E Categories. This is due to flow modifications, the excessive reed growth in the channel due to the irrigation return flows, alien vegetation and changes in the physical channel. Water quality impacts from the return flows will also be severe.

Three SQs lies within the Grobbelaars River and its tributary, the Klein-Leroux River. Some of the mountainous areas are in reasonable condition, but the lower Grobbelaars River is in an E PES due to flow changes (i.e. Koos Raubenheimer Dam) and extensive irrigation as well as the impacts resulting from Oudtshoorn town through which it flows.

Of the remaining 13 SQs in the tributaries, there are four SQs in a PES of a B category namely the Kansa, Droë and two unnamed rivers. The rest are in lower categories and two SQs that have deteriorated to a PES of a D/E (Moeras and Kandelaars rivers). All impacts are associated with alien vegetation and extensive agriculture and irrigation activities.

J4 (Gouritz)

Main Gouritz, Slang and Kamma rivers:

The main stem of the Gouritz River in J40A (8924 and 9020) is primarily impacted by flow related activities in the upper catchment (J2 and J3), with limited non-flow related activities (agriculture) within this reach, resulting in a PES with a C category. The Slang River (J40A-8967, 8997, 8961) is ephemeral and primarily impacted by non-flow related impacts associated with dry land agriculture, resulting in a PES of a C. The Kamma River (J40B-9054) is mostly natural with limited farming activities (non-flow related) contributing to a PES of a B. The Gouritz River in J40B remains primarily impacted by upstream flow and water quality alterations, with J40B-9106 also impacted by the activities in catchment J1, but still remaining in a category C due to minimal localised impacts (agriculture).

Weyers, Langtou, Gouritz, Vals, and Stink rivers:

The Weyers River (J40C-09156) originates in the Paardeberg nature reserve, with the upper reaches therefore being in a close to natural state. The lower reaches of this river is impacted by mixed agriculture, grazing, dairy, irrigated (vineyards and vegetables) and dry land cultivation (wheat), resulting in an overall PES of C. The lower Langtou (J40C) is primarily impacted by agricultural activities while the upper reaches seem to be in a fairly good state with limited impacts. The Gouritz River in J40C remains primarily impacted by upstream flow and water quality alterations, but with the PES deteriorating to a category C/D due to the inclusion of localised agricultural impacts (flow and non-flow related). This PES is also continued downstream into J40D where localised farming impacts increase and contribute to the deterioration. The upper reaches of J40D-9178 is in a relative undisturbed state, while the lower reaches is impacted by agricultural activities, with the overall reach estimated to be in a PES of a C/D. The Vals River (J40D-09185) is largely impacted by agricultural activities (non-flow related) resulting in an overall PES of a C. The Stink River (J40E-9273) is impacted by agricultural (seems to by mostly dry land) activities resulting in a PES of C.

H8 (Duiwenhoks)

The upper reaches of the Duiwenhoks River (H80A-09154 and H80B-09149) is subject to primarily non-flow related impacts (agriculture), with the Duiwenshok Dam situated in the lower reaches of H80A-09154, resulting in an overall PRES of C. The flow modification and water quality impacts of the Duiwenhoks Dam are more significant in the next downstream reach of the Duiwenhoks River (H80C-09208) and, together with the agricultural impacts (including irrigation) and Heidelberg town, result in a deteriorated PES of D/E. The Hooikraal River (H80C-09290) is primarily impacted by non-flow related activities (farming) resulting in a PES of D. The Spieels River (H80C-09209) is also primarily impacted on by non-flow related activities (farming), which were the primary drivers causing the PES of C/D. The Duiwenhoks River improves slightly in the lower reaches (H80D-9286 and H80D-9314) to a category D but is still impacted notably by the flow modification (Duiwenhoks Dam and abstraction for irrigation) as well as non-flow related activities (farming). The Pienaars River (H80D-09293) is primarily impacted by farming activities (crops and livestock) resulting in a PES of D.

H9 (Goukou)

The Kruis River (H90A-09165) is impacted by agricultural activities with the middle section being fairly natural, but overall classified in a PES of a D. The Goukou River originates in the Spioenkop Nature Reserve and later flows through the Broomvlei (Kruis River) Nature Reserve, but impacts related to agricultural activities and alien vegetation result in a PES of C. The primary impact in the Korinte River (H90B-09155) is associated with the Korintepoort Dam, together with agricultural activities resulting in a PES of D. The Naroo River (H90C-09211) is seriously impacted by agricultural activities resulting in a PES of D. After the confluence of these two rivers it becomes the Vet River (H90C-09220) which is in a deteriorated E PES due to the upstream agricultural impacts and Riversdale urban impacts. The lower Goukou (H90D-09287, H90D-09316 and H90D-09318) downstream of Riversdale is impacted by the aggregate impact of the upstream reaches together with localised agriculture, Riversdale urban runoff and WWTW, resulting in PES of D, with an improvement in the lower reach H90E-09343 to a C due to reduced localised impacts. The Soetmelks River (H90D-09254 and H90D-09298) and SQ reaches H90D-09278 and H90E-09364 flows through agricultural areas falling in a category D.

IDENTIFICATION OF HOTSPOTS

A hotspot represents a river reach with a high Integrated Environmental Importance (IEI) which could be under threat due to its importance for water resource use. The hotspots are therefore an indication of areas where detailed investigations would be required if development was being considered. The hotspot identification therefore provides an indication of the level of EWR assessment required at the SQ catchment. In essence, this would be similar to a filtering process where the most detailed assessment is undertaken at hotspots, and less detailed assessments at the other areas. Nodes that are EWR sites represent the areas where most detailed EWR methods will be required.

The purpose of the identification of hotspots for this study was the following:

- *To select rivers where new EWR sites should be selected.*
- *To select river reaches where new EWR sites should be selected.*
- *To provide guidance to levels of Reserve that might be required for licensing purposes within the framework provided by the National Water Resource Classification System (NWRCS).*

- *To provide an indication where scenario development and testing would be important.*

The identified hotspots are illustrated in the table below.

SQ	River	IEI[1] (0 - 5)	WRUI[2] (0 - 4)	Hotspot
K				
K20A-09083	Groot Brak	4	4	4
K30C-09065	Kaaimans	5	3	4
K50A-09069	Knysna	5	3	4
K60C-08992	Keurbooms	5	3	4
K60E-09114	Keurbooms	5	3	4
K60F-09092	Bietou	5	3	4
J1				
J11H-08647	Buffels	5	4	4
J11K-08828	Groot	3	4	4
J11K-08860	Groot	3	4	4
J12K-08960	Brak	5	3	4
J12M-08904	Touws	5	3	4
J12M-08975	Brand	5	3	4
J13A-08905	Groot	5	3	4
J13A-08933	Groot	5	3	4
J13A-08954	Groot	5	3	4
J13B-08923	Groot	4	3	4
J13B-08938	Groot	4	3	4
J13C-08915	Groot	5	3	4
J13C-09099	Groot	4	3	4
J2				
J23A-07922	Gamka	5	3	4
J23A-07962	Gamka	5	3	4
J23A-08007	Gamka	5	3	4
J23B-08017	Gamka	5	3	4
J23B-08123	Gamka	5	3	4
J23C-08155	Gamka	5	3	4
J23C-08176	Gamka	5	3	4
J23C-08212	Gamka	5	3	4
J23C-08217	Gamka	5	3	4
J23E-08400	Cordiers	5	3	4
J23F-08268	Gamka	5	3	4
J23F-08334	Gamka	5	3	4
J23F-08335	Gamka	5	3	4
J23H-08359	Gamka	5	3	4
J23H-08415	Gamka	5	3	4
J23J-08497	Gamka	5	3	4
J25A-08536	Gamka	4	3	4
J25A-08567	Gamka	5	3	4
J25C-08776	Gamka	4	3	4

SQ	River	IEI[1] (0 - 5)	WRUI[2] (0 - 4)	Hotspot
J25C-08795	Gamka	4	3	4
J25E-08769	Gamka	4	3	4
J3				
J33E-08777	Olifants	5	4	4
J34B-08888	Potjies	4	3	4
J34C-08942	Diep	5	3	4
J34D-08956	Gansekraal	4	3	4
J34E-08910	Brak	4	3	4
J34F-08843	Kammanassie	5	4	4
J34F-08848	Kammanassie	4	4	4
J35A-08551	Klein-Leroux	5	3	4
J35A-08653	Grobbelaars	5	3	4
J35B-08799	Olifants	5	4	4
J35B-08820	Olifants	4	4	4
J35B-08841	Olifants	4	4	4
J35B-08881	Kandelaars	5	3	4
J35C-08821	Olifants	4	4	4
J35C-08873	Olifants	4	4	4
J35D-08745	Wynands	4	3	4
J35D-08854	Olifants	4	4	4
J35E-08764	Olifants	4	4	4
J35E-08816	Olifants	4	4	4
J35F-08600	Vlei	5	3	4
J35F-08739	Olifants	4	4	4
J35F-08849	Olifants	4	4	4
J4				
J40A-08924	Gouritz	4	3	4
J40A-09020	Gouritz	5	3	4
J40B-09073	Gouritz	4	3	4
J40B-09106	Gouritz	5	3	4
J40C-09169	Gouritz	5	3	4
J40D-09236	Gouritz	4	3	4
J40D-09250	Gouritz	4	3	4
J40E-09284	Gouritz	5	3	4
J40E-09323	Gouritz	5	3	4
J40E-09357	Gouritz	4	3	4
J40E-09359	Gouritz	5	3	4
J40E-09371		4	3	4

1 Integrated Environmental Importance.

2 Water Resource Use Importance.

The rivers where hotspots dominate are:

- *Keurbooms (forestry).*
- *Buffels/Groot (Floriskraal Dam and irrigation).*
- *Gamka (Various dams, irrigation, nature reserve and World Heritage site).*

- *Olifants (Various dams and irrigation).*
- *Gouritz (Extensive irrigation).*

LEVEL OF EWR ASSESSMENT AND EWR ASSESSMENT

The locality of both the existing and new EWR sites is listed below:

- *Duiwenhoks (2 SQ hotspots)*
- *Goukou and tributaries (4 SQ hotspots)*
- *Buffels/Groot (13 SQ hotspots)*
- *Touws (3 SQ hotspots)*
- *Doring (3 SQ hotspots)*
- *Gamka (20 SQ hotspots)*
- *Olifants (20 SQ hotspots) (upper section only)*
- *Kammanassie (3 SQ hotspots)*
- *Gouritz (11 SQ hotspots)*
- *Keurbooms (2 SQ hotspots)*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

CD: RDM	Chief Directorate: Resource Directed Measures
CMA	Catchment Management Agency
COD	Chemical Oxygen Demand
CISR	Council for Scientific and Industrial Research
DS	Downstream
DSS	Decision Support System
DWA	Department Water Affairs (name change from DWAF applicable after April 2009)
DWAF	Department Water Affairs and Forestry
D:RQS	Directorate: Resource Quality Services
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
F	Flow related impacts
GD	Green Drop
GDP	Gross Domestic Product
GGP	Gross Geographic Product
GIS	Geographic Information System
IDP	Integrated Development Plan
IEI	Integrated Environmental Importance
ISP	Internal Strategic Perspective
IUA	Integrated Unit of Analysis
MAR	Mean Annual Runoff
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act
NWRCS	National Water Resource Classification System
NF	Non-flow related impacts
PES	Present Ecological State
REC	Recommended Ecological Category
RHP	River Health Programme
SCI	Socio-Cultural Importance
SQ	Sub Quaternary
SWAT	Soil and Water Assessment Tool
TDS	Total Dissolved Solids
TMG	Table Mountain Group
US	Upstream
WMA	Water Management Area
WQ	Water Quality
WReMP	Water Resources Modelling Platform
WRMF	Water Resources Modelling Framework
WRUI	Water Resource Use Importance
WWTW	Wastewater Treatment Works

1 INTRODUCTION

1.1 BACKGROUND

The National Water Act (Act No. 36 of 1998) (NWA), Section 3 requires that the Reserve be determined for water resources, i.e. the quantity, quality and reliability of water needed to sustain both human use and aquatic ecosystems, so as to meet the requirements for economic development without seriously impacting on the long-term integrity of ecosystems. The Reserve is one of a range of measures aimed at the ecological protection of water resources and the provision of basic human needs (i.e. in areas where people are not supplied directly from a formal water service delivery system and thus directly dependent on the resource according to Schedule 1 of the NWA). The Chief Directorate: Resources Directed Measures (CD: RDM) within DWA is tasked with the responsibility of ensuring that the Reserve is considered before water allocation and licensing can proceed.

The requirement for detailed Reserve studies in the Gouritz Water Management Area (WMA) became apparent for the following reasons:

- Various licence applications in the area.
- Gaps that have been identified as part of the Outeniqua Reserve determination completed in 2010.
- The conservation status of various priority water resources in the catchment and existing and proposed impacts on them.
- Increasing development pressures and secondary impacts related from the aforementioned and the subsequent impact on the availability of water.

1.2 STUDY AREA OVERVIEW

The Gouritz WMA (WMA16) is situated on the south coast of the Western Cape, largely falling within the Western Cape Province, and with a surface area of approximately 53 000 km^2. It consists of primary drainage region J (approximately 90 quaternary catchments), and part of primary drainage regions K (K1 to K7) and H (H8 to H9). The WMA therefore consists of approximately 100 -105 quaternary catchments. It consists of the large dry inland area that is comprised of the Karoo and Little Karoo, and the smaller humid strip of land along the coastal belt. The main rivers are the Gouritz and its major tributaries, the Buffels, Touws, Groot, Gamka, Olifants and Kammanassie rivers, with smaller coastal rivers draining the coastal belt. All the inland rivers drain via the Gouritz into the Indian Ocean. The mean annual precipitation varies from as high as 865 mm in the coastal areas, which experience all year round rainfall, to as little as 160 mm in the drier areas inland to the north, which experience late summer rainfall.

According to DWAF (2005) regarding setting up a Catchment Management Agency (CMA) for the WMA, the area consists of five sub-areas, i.e. the (1) Groot River (secondary catchment J1), (2) the Gamka River (secondary catchment J2), (3) the Olifants River (secondary catchment J3), (4) the Western Coastal Rivers (secondary catchments H8, H9 and J4) and (5) the Eastern Coastal Rivers (secondary catchments K1, K2, K3, K4, K5, K6 and K7).

The Gouritz River is controlled by several dams in its tributaries, including Kammanassie, Stompdrift, Koos Raubenheimer, Leeu-Gamka, Gamkapoort and Floriskraal dams. Several dams have been constructed on the coastal rivers, the largest of which being the Wolwedans Dam. About 41% of the total surface runoff from the WMA comes from the catchment of the Gouritz River, which covers the bulk of the land in the WMA. A further 46% of the flows originates from the Coastal sub-area, while the remaining 13% is contributed by the rivers west of the Gouritz River (DWAF, 2005).

Forestry and agriculture are the two primary activities in the WMA. Most of the afforestation on the coastal belt, primarily in the Plettenberg Bay / Knysna area (K1 to K7) is indigenous forestry. Most irrigation (as at 2005) is opportunistic and lucerne is predominantly grown. Grapes and apples are also grown in the Langkloof area and there is significant ostrich farming near Oudtshoorn.

The coastal belt boasts extensive eco-tourism, with the WMA also having several areas that are ecologically sensitive and important. These include the upper river reaches of the Dwyka, Leeuw and Gamka rivers in the interior; and the Keurbooms, Knysna and South Cape Coastal River Systems, along the coast. Many of the wetland and estuary systems in the area have not been studied in detail as yet. A map of the study area is provided in **Figure 1.1**.

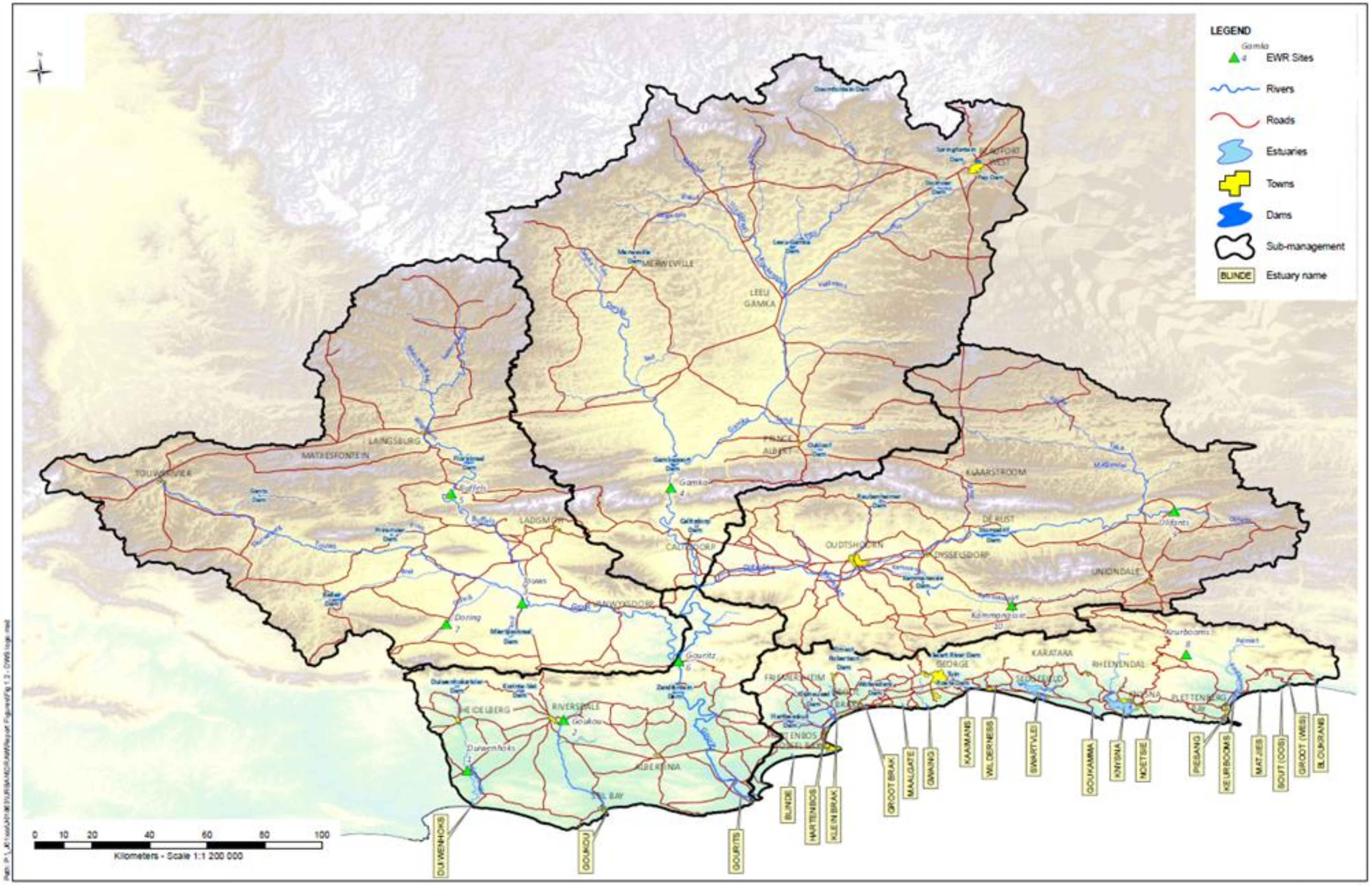
1.3 RIVER DESKTOP ECOCLASSIFICATION AND HOTSPOT IDENTIFICATION

The objective of this task is to describe and document the status quo which included various components such as water use, river ecology, identifying water quality problems and Ecosystem Services. This task therefore describes the physical template and information for decision making regarding the different levels of investigation for Reserve determination and guides the selection of rivers in which Ecological Water Requirements (EWRs) should be selected, as well as preferred sections of river in which the EWRs should be placed.

1.4 OUTLINE OF THIS REPORT

The report outline is as follows:

- **Section 1** provides general background to the study.
- **Section 2** to **5** of the report outlines the various multi-disciplinary methodologies adopted during this task and provides the findings of the various Status Quo assessments for the Gouritz WMA.
- **Section 6** provides the Recommended Ecological Category (REC) for the relevant Sub Quaternary reaches which was derived from revised Present Ecological State (PES) data as well as DWA (2013) data.
- **Section 7** outlines the general approach to identifying hotspots in WMA 11 and the results of this process is provided in **Section 8**.
- **Section 9** outlines the process of selecting final biophysical nodes for which EWRs will be determined and the level at which the EWR will be determined is also discussed.
- References are listed in **Section 10**.



water & sanitation AECOM

Figure 1.1 Study area

2 STATUS QUO ASSESSMENT: WATER RESOURCES

2.1 INTRODUCTION

This section deals with the status quo assessment of both the available Decision Support Systems (DSS) for the Gouritz WMA and the water resources in the study area.

2.2 APPROACH

2.2.1 Decision support system

The status quo of the available DSS (including the hydrological database used by the DSS) from both past and present studies in the study area were assessed, in order to obtain the most appropriate DSS for conducting the water resource analyses required for this study.

2.2.2 Water resources

The Gouritz WMA was divided into water resource areas based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. Each of the water resources zones was assessed

2.3 DESCRIPTION OF WATER RESOURCES

The Gouritz WMA is situated along the southern coast of South Africa and extends inland across the Little Karoo and into the Great Karoo. The WMA has two primary climatic regions that display distinctly different characteristics; the large arid inland Karoo area drained by the Gouritz River, and the smaller humid strip of land along the coastal belt with several small rivers.

Economic activity in the arid areas is centered around sheep and ostrich farming, also with extensive irrigation of lucerne, grapes and deciduous fruit in the Little Karoo; and forestry, tourism and petrochemical industries in the coastal region. Indigenous forests, wetlands and estuaries of high conservation status are found in the humid areas.

Several dams control the Gouritz River and its tributaries, the water in the arid areas being naturally of high salinity as a result of the geology and climate. Dams have also been constructed on some of the coastal rivers, where potential for further regulation remains. A substantial proportion of the yield is from groundwater, with strong interdependence between surface water and groundwater in the Olifants River valley. The potential is being investigated for possible utilisation of deep groundwater from the Table Mountain Group (TMG) aquifers. A small quantity of 0.7 million m^3 per year is transferred to the Breede WMA for rural water supply.

The Gouritz WMA is in deficit (either through over registration and/or calculated crop water demand versa actual water used), which means that effective water conservation and demand management, and reconciliation actions are critical. The inland catchments of the Gouritz WMA do not receive

sufficient rainfall to sustain reliable supplies from surface water resources. Therefore, there is an increasing reliance placed on the groundwater resource, throughout this WMA.

A decline in population is foreseen in the inland areas, with little change in the requirements for water. Strong potential for growth, however, exists in the coastal area, related to tourism and eco-tourism as well as possible further petrochemical developments.

The main rivers are the Gouritz River and its major tributaries, the Buffels, Touws, Groot, Gamka, Olifants and Kammanassie rivers, with smaller coastal rivers draining the coastal belt. All the inland rivers drain via the Gouritz River into the Indian Ocean.

The Great Karoo and Olifants River catchment regions are classified as a very late summer rainfall region, with a large proportion of annual precipitation falling from March to May and in October through storm events. Parts of the Southern Coastal area experience all year round rainfall.

The key areas are as follows:

- **Coastal – west of Gouritz River (H8 and H9), namely:**
  - Duiwenhoks River (H80A to D)
  - Goukou River (H90A to E)
- **Gouritz (primary J), with tributaries:**
  - Groot (J1)
  - Gamka (J2)
  - Olifants (J3)
  - Lower Gouritz (J4)
- **Coastal (K1 to K7), namely:**
  - Hartenbos (K10B)
  - Little Brak (K10C to F)
  - Great Brak (K20A)
  - Maalgate (K30A) and Gwaing (K30B)
  - Kaaimans (K30A to D), with tributary: Swart (K30B and C)
  - Touw (K30D)
  - Diep (K40A), Hoëkraal (K40B), Karatara (K40C) and K40D)
  - Goukamma (K40E)
  - Knysna (K50 A and B)
  - Small coastal rivers and Piesang River (K60G)
  - Bitou (K60F) and Keurbooms (K60A to E)
  - Matjes (K70A) and Sout River (K70A)

2.3.1 Coastal catchments to the west of the Gouritz River Mouth Area (H8 and H9)

- **Duiwenhoks River (H80):** The main storage dam in the H80 secondary catchment (Duiwenhoks River Dam (6 million m³) supports irrigation activities (Duiwenhoks Government Scheme) and domestic supply to the town of Heidelberg and to Duiwenhoks Rural Water Supply Scheme. Many farm dams, which support irrigation are also found in this catchment. Water requirements exceed supply and the catchment can be regarded as stressed.

- **Goukou River (H90):** The Korinte-Vet Dam in the Korintepoort River (8 million m³) together with farm dams support irrigation for vineyards, fruit, pastures and vegetables and domestic use in Riversdale (H90C/E). Some forestry is found in the upper reaches (H90A).

2.3.2 Gouritz Area with four sub-basins

SUB-BASIN 1: GROOT/BUFFELS (J1)

- **Tributary Buffels River (J11):** The main dam in the Buffels River is the Floriskraal Dam (50 million m³) at the outlet of J11G. The catchment area upstream of this dam is typical Karoo with very little development. Some irrigation (9 million m³/a) is practised downstream of this dam. The catchment is stressed as a result of irrigation demands exceeding supply. Some perennial streams in J11H and J11J rising in the Swartberg mountains.
- **Tributary Touws River (J12):** Three irrigation dams are situated in the tertiary J12: Verkeerdevlei, Prins and Belair dams with Belair the largest at 10 million m³ but no longer in use.
- **Buffels/Gouritz confluence (J13):** J13 shows limited irrigation from farm dams.

SUB-BASIN 2: GAMKA (J2)

- **Gamka (J21):** Gamka Dam (1.8 million m³) and Springfontein Dam in the Upper Gamka supplies Beaufort West. Also some groundwater abstraction and limited opportunistic irrigation occurs along the flood plain downstream of the dam. The remainder of J21 is undeveloped. The Upper Gamka is in deficit as a result of irrigation requirements exceeding availability.
- **Koekemoers/Leeu (J22):** No development, i.e. typical Karoo with limited irrigation downstream of the 14.3 million m³ Leeu-Gamka Dam (J22K). Doornboomsfontein Dam (4.4 million m³) is situated in the upper reaches (J22G) is a private dam.
- **Gamka (J23):** Oukloof Dam (4.2 million m³), tributary of Gamka in J23E support irrigation (Cordiers River Scheme). Some irrigation from farm dams occurs in J23B.
- **Dwyka (J24):** This catchment is mostly undeveloped with only some irrigation from Gamkapoort Dam (J24F).
- **Gamka/Dwyka confluence (J25):** Gamkapoort Dam in J25A with a capacity of 44.2 million m³ supports domestic water requirements, livestock and irrigation. Calitzdorp Dam (J25D) supports irrigation (Calitzdorp Irrigation Board) and Calitzdorp town (4.8 million m³) in the Nels River.

SUB-BASIN 3: OLIFANTS (J3)

- Cultivation in the Klein Karoo only takes place in the valleys and the rest of the areas are either mountainous or foothills covered in Karoo shrub. Ostrich farming supported by irrigation (Lucerne (98%) and some high yield crops (2%)) form the main agriculture farming activities. There are no significant commercial timber plantations in the area. Large areas of the Olifants and Grobbelaars River channels contain dense growths of reeds. These reeds are indigenous and play an important role in the functioning of the ecologies of the river channels. Therefore, even though they may reduce streamflow, they are not regarded as water users.
- **Upper Olifants (J31):** Development comprises of farm dams and limited irrigation and stock watering. No urban areas. Alien vegetation is a concern in J31A and D. No afforestation occurs in this catchment.

- **Olifants (J32):** Development comprises of some farm dams in J32B and limited irrigation. No afforestation and no serious invasive alien vegetation problems.
- **Groot/Olifants confluence (J33):** No afforestation occurs in J33. Alien vegetation occurs mainly in the catchments of the Meirings and Kango rivers. Irrigation and stock watering are practised in this catchment with a significant amount of irrigation in J33F. Domestic abstraction for the town of Oudtshoorn occurs from the Kango River (J33F). The Huis River Weir supplies De Rust with domestic water and some borehole abstractions supplies domestic water in J33F.
- **Olifants (J33B):** Stompdrift Dam is located in the upper reaches of the Olifants River (J33B) with a capacity of 55 million m³. The natural Mean Annual Runoff (MAR) of 38 million m³/a was reduced with 42 % to 22 million m^3/a as a result of development (farm dams and irrigation) and supplies irrigation as part of the Olifants River. The main water requirement in the catchment upstream of Stompdrift Dam is for irrigation. There are no urban water requirements in the catchment of Stompdrift Dam, but the farming community require water for domestic use, livestock require drinking water, and there are relatively small areas of commercial timber plantations (afforestation).
- **Kamanassie (J34):** Negligible pine forestry occurs in this catchment. Invasive alien vegetation is predominantly a problem in the catchment of the Kamanassie Dam. Many farm dams are found upstream of Kamanassie Dam.Kamanassie Dam on the Kamanassie River, a tributary of the Olifants River has a capacity of 34 million m^3 and the natural MAR was reduced by 40 % from 70 million m^3/a to the present MAR of 42 million m^3/a. There is only a small domestic water requirement in this catchment. The town of Uniondale is located in this catchment, obtains water from a local mountain stream and from Haarlem Dam, which is outside the catchment of Kamanassie Dam. Some irrigation activities and farm dams are found in the catchment.
- **Olifants River Government Scheme:** The Stompdrift and Kamanassie dams are the main sources of water for irrigation in the Klein Karoo and Olifants River Government Water Scheme. They provide water to farms through a system of canals that extends more than 75 km along the Olifants River valley downstream of the dams (J33E and F, J34F and J35B to F). The canals are unlined over most of their length, with the result that water losses are high. The full allocated quantities of water are supplied erratically, and, in some years, only a fraction of the allocations can be supplied. The area of cultivated land in the Olifants River catchment doubled since 1961. The yields of the dams have been over-allocated and the existing water supply cannot meet the full requirements. Therefore, it is unlikely that it would be economically viable to rehabilitate the river.
- No environmental releases are made from either Stompdrift or Kamanassie Dam. The tributaries are generally in a better ecological state than the main stem rivers, with the result that most of the ecological functions of the river system at present take place in the tributaries.
- **Wynands, Kansa, Vlei (J35):** Invasive alien vegetation in J35F is a cause of concern. Koos Raubenheimer and Melville dams in J35A supply the town of Oudtshoorn and irrigation. There are also some farm dams in catchment. Oudtshoorn and De Rust rely on surface water resources (J33E-Huis Rivier Scheme) for their water supplies and Dysselsdorp on groundwater.

SUB-BASIN 4: LOWER GOURITZ (J4)

Irrigation occurs of mainly lucerne and pastures on the banks of the Gouritz River. Some farm dams are also located in the lower Gouritz River.

2.3.3 Coastal rivers to the east of the Gouritz Area

- **K10A:** PetroSA has it gas-to-oil plant in this catchment. Water is transferred from Wolwedans Dam (K20A) for its operations.
- **Hartenbos (K10B):** Hartbeeskuil Dam (7 million m³) is mainly used for domestic (not drinking water) and stock watering as the water is very salty.
- **Little Brak (K10C to F):** Little Brak supports irrigation and forestry. The Klipheuwel Dam (off-channel) in K10F supports the water requirements of Mossel Bay.
- **Great Brak (K20A):** Wolwedans Dam (24 million m³) supplies PetroSA and the town Mossel Bay. Mossel Bay also receives water from Ernest Robertson Dam (0.4 million m³). Some irrigation occurs upstream of Wolwedans Dam.
- **Maalgate (K30A) and Gwaing (K30B):** Land use constitutes irrigation from farm dams and run-of river as well as forestry. Urban development (George) falls within this catchment.
- **Kaaimans (K30B, D), with tributary the Swart River:** Land use comprises of irrigation, farm dams, large areas of forestry, alien vegetation and domestic abstraction to George. This is a highly ecologically sensitive area. The Swartrivier Dam that is not in use at present and the Garden Route Dam supply water to George. They are both located on the Swart River. Although the Kaaimans River is not dammed, George receives water from an abstraction weir in the Kaaimans River.
- **Swart (K30B and C):** Land use comprises of irrigation, farm dams, forestry, alien vegetation and domestic abstraction to George. This is a highly ecologically sensitive area.
- **Touws (K30D):** Forestry, farm dams and irrigation occur in K30D. The vleis/lakes – Rondevlei, Langevlei and Swartvlei - are also found in this catchment.
- **Diep (K40A), Hoëkraal (K40B), Karatara (K40C) and K40D:** Forestry, irrigation and domestic abstraction for the town Sedgefield occurs in this catchment. This catchment is in a deficit.
- **Goukamma (K40E):** Land use constitutes forestry, irrigation, small dams and domestic abstraction.
- **Knysna (K50 A and B):** Forestry, irrigation, small dams and domestic abstraction occur here.
- **Small coastal rivers and Piesang River (K60G), Bitou (K60F) and Keurbooms (K60A to E):** Roodefontein Dam (2 million m³) in Piesang River supplies irrigation and Plettenberg Bay. Run-of-river transfers from the Keurbooms River to Plettenberg Bay. Water supply problems are experienced during peak season. The Roodefontein Dam on the Piesang River is to supply irrigation and Plettenberg Bay municipality. The central purification works receives water via a pipeline from the Keurbooms River and a pipeline from the Roodefontein Dam.
- **Matjies and Sout River (K70A):** The Matjies River is a small coastal river that drains into the sea at Keurboomstrand. The Sout River enters the sea just west of Nature's Valley, and the Groot River flows into the sea slightly further east at Nature's Valley. All these rivers, together with a few smaller coastal rivers are in the K70A catchment area. This region exhibits neither a summer nor a winter rainfall characteristic. Rain is experienced throughout the year with the highest precipitation during spring (September to November) and again during late summer

(February and March). Kurland and Nature's Valley in K70A receive water from their own dams. Land use consists of irrigation, forestry, urban development and small industries (textiles).

2.4 STATUS QUO ASSESSMENT

2.4.1 Decision support system

A review of the various past and current studies in the study area was conducted in order to confirm the availability and status of both the hydrology and water resource models available. In the case where there are gaps the WR2005 could be considered as a source of information, however, there are several known problems with the WR2005 study data sets for this WMA, such as that no farm dams were taken into account during the calibration process.

The models available for the different catchments in WMA16 as well as the confidence of the models are presented in **Table 2.1**. The higher confidence models were done recently and with recent land use data, while the medium confidence models were based on older analyses and land use data, while still being relatively high resolution models.

Table 2.1 Models available for the different catchments in WMA16

Key area	Rivers	Secondary catchment	Quaternaries	Models	Source of flow data	Confidence of models
Duiwenhoks	Duiwenhoks	H8	H80 A to H80F	WR2000, WRMF[1]	WR2005	Low
Korintepoort	Goukou	H9	H90A to H90E	WR2000, WRMF	WR2005	Low
Buffels	Buffels	J1	J11A to J11K, J12A to J12M, J13A to J13C	WR2000, WRMF	WR2005	Low
Gamka	Gamka	J2	J21A to J21E, J22A to J22K, J23A to J23J, J24A to J24F, J25A to J25E	WR2000, WRMF	WR2005	Low
Upper Olifants (to Stompdrift)	Olifants	J3	J31A to J31D	WR2000, WRMF	WR2005	Low
	Traka		J32A to E	WR2000, WRMF	WR2005	Low
	Olifants		J33A and J33B	WR2000, WRMF	WR2005	Low
	Olifants		J33C to J33F	WR2000, WRMF	WR2005	Low
Upstream of Kammanassie Dam	Kammanassie		J34A to J34E	WR2000, WRMF	WR2005	Low
Downstream of Kammanassie Dam			J34F	WR2000, WRMF	WR2005	Low
			J35A to J35F	WR2000, WRMF	WR2005	Low
Gouritz	Gouritz	J4	J40A to J40E	WR2000, WRMF	WR2005	Low

Key area	Rivers	Secondary catchment	Quaternaries	Models	Source of flow data	Confidence of models
Klein Brak	Klein Brak	K1	K10A to K10F	WR2000, WRMF, WReMP[2]	DWA	Medium
Groot Brak	Groot Brak	K2	K20A	WR2000, WRMF, WReMP	DWA	Medium
Kaaimans	Kaaimans/ Touws	K3	K30A to K30B, K30D	WR2000, WRMF, WReMP	DWA	Medium
Touw	Touw		K30C	WR2000, WRMF, WReMP	WR2005	Low
Goukou	Goukou	K4	K40A to K40E	WR2000, WRMF, WReMP	DWA	Medium
Knysna	Knysna	K5	K50A to K50B	WR2000, WRMF, WReMP	DWA	Medium
Keurbooms	Keurbooms	K6	K60A to K60G	WR2000, WRMF	WR2005	Low
Sout/Matjie	Sout/Matjie	K7	K70A to K70B	WR2000, WRMF	WR2005	Low

1 Water Resources Modelling Framework
2 Water Resources Modelling Platform

2.4.2 Water resources

The Gouritz WMA was divided into water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. The significant resources of the proposed water resource areas are summarised in **Table 2.2**.

Table 2.2 Gouritz catchment water resource areas

Secondary catchment	Quaternary catchment	Description	Water resource areas	Major impoundments	Impoundment at outlet of	River
H8	H80 A to H80F	Duiwenhoks	H80	Duiwenhoks Dam	H80A	Duiwenhoks
H9	H90A to H90E	Goukou	H90	Korintepoort Dam	H90B	Korinte-Vet
J1	J11A to J11K, J12A to J12M, J13A to J13C	Groot (tributary of Gouritz)	J11J	Floriskraal Dam	J11G	Buffels
			J11G	Bellair Dam	J12J	Touws
			J12A	Verlorenvlei	J12A	Touws
			J12B	Verkeerdevlei Dam	J12B	Touws
			J12C	Tierkloof	J12C	Touws
			J12C	Aartappel	J12C	Touws
			J12D			
			J12E	Gant	J12E	Touws

Secondary catchment	Quaternary catchment	Description	Water resource areas	Major impoundments	Impoundment at outlet of	River
			J12F			
			J12G	Prins River Dam	J12G	Touws
			J12M	Miertjieskraal Dam	J12M	Touws
J2	J21A to J21E, J22A to J22K, J23A to J23J, J24A to J24F, J25A to J25E	Gamka	J21A	Stols River Dam	J21A	Gamka
			J21A	Gamka Dam	J21A	
			J21A	Springfontein Dam	J21A	
			J22G	Doornfontein Dam	J22G	Leeu
			J22K	Ou Leeu-Gamka Dam	J22K	Leeu
			J22K	Leeu-Gamka Dam	J22K	Leeu
			J25D	Calitzdorp Dam	J25D	Tributary of Dwyka
			J23E	Oukloof Dam	J23E	Tributary of Swart
			J24F	Gamkapoort Dam	J24F	Tributary of Dwyka
J3	J31A to J31D	Olifants (tributary of Gouritz)				Upper Olifants (to Stompdrift)
	J32A to E					Traka
	J33A and J33B		J33B	Stompdrift Dam	J33B	Middle Olifants
	J33C to J33F					Middle Olifants
	J34A to J34E		J34E	Kammanassie Dam	J34E	Upstream of Kammanassie
			J34E	Ezeljacht Dam	J34E	Tributary of Kammanassie
	J34F					Downstream of Kammanassie tributary
	J35A to J35F		J35A	Koos Raubenheimer Dam	J35A	Tributary of Olifants
J4	J40A to J40E	Gouritz				Gouritz
K1	K10A to K10F	Klein Brak	K10B	Hartbeeskuil Dam	K10B	Klein Brak
			K10F	Klipheuwel Dam	K10F	Klein Brak
K2	K20A	Groot Brak	K20A	Wolwedans Dam	K20A	Groot Brak
K3	K30A to K30D	Kaaimans/ Touws	K30C	Swartrivier Dam	K30C	Swart
			K30C	Garden Route Dam	K30C	Swart
			K30D	Rondevlei	K30D	Touw
			K30D	Bo-Lang Vlei	K30D	Touw
			K30D	Onder-Lang Vlei	K30D	Touw
			K30A	Geelhoutboom Dam	K30A	Maalgate
			K30A	Kruisrivier Dam	K30A	Maalgate
K4	K40A to K40E	Goukamma	K40D	Groenvlei	K40D	Goukamma
K5	K50A to K50B	Knysna	K50B	Knysna Lagoon	K50B	Knysna
K6	K60A to K60G	Keurbooms	K60G	Roodefontein Dam	K60G	Keurbooms

Secondary catchment	Quaternary catchment	Description	Water resource areas	Major impoundments	Impoundment at outlet of	River
K7	K70A to K70B	Sout/Matjie				Sout/Matjie

3 STATUS QUO ASSESSMENT: WATER QUALITY

3.1 APPROACH

This section of the report provides a water quality overview per primary and secondary catchment based on an extensive literature review, including the 2012 DWA Green Drop for the Western Cape regarding the functionality of Wastewater Treatment Works (WWTW) (DWA, 2012a). Land uses are identified as these are closely linked to the water quality state. Present water quality state is described based on the literature, current water users/uses and land-use practices. This data will be updated when the detailed water quality assessment is undertaken. Note that detailed information on water quality of rivers covered during the Outeniqua EWR study can be found in the report series for that study.

3.2 OVERVIEW

The 2011 Planning Level Review of Water Quality in South Africa (DWA, 2011) identified the major water quality issues in the country, as well as the WMAs they are prevalent. The following issues were identified for WMA16:

- Microbial contamination.
- Salinisation and poor quality stormwater run-off; and
- Dry weather flow from dense settlements, i.e. conditions associated with urban rivers. Issues such as eutrophication, metal and toxicant contamination were not considered problematic in WMA16, although high phosphate levels were recorded for large parts of the WMA due to agricultural return flows and discharges from WWTW. **Table 3.1** summarises the water quality issues across WMA16 (DWA, 2011).

Table 3.1 Water quality issues across WMA 16 (DWA, 2011)

WMA	Water Quality Issue	Driver	Effect
WMA 16: Gouritz	Salinisation	Natural geology High evaporation	Water unsuitable for irrigation agriculture. Corrosion of appliances and equipment. Alteration of the taste of domestic water.
	Urban impacts on water quality	Densely populated urban areas on coast, urban runoff, treated wastewater not meeting standards and runoff from informal settlements.	Poor bacterial water quality. Impacts on downstream users. Human health risks. Low dissolved oxygen & ecosystem impacts.
	Microbial and organics contamination	Vandalism of sewage reticulation system and pumping infrastructure. Sewage spills into receiving streams Oudtshoorn for example.	Poor bacterial water quality. Impacts on downstream users. Human health risks and low dissolved oxygen & ecosystem impacts.
	Wood processing waste	Disposal of wood processing waste in the coastal catchment. Some saw mill operators are without permits.	Leachate with high organic acids and COD. Low dissolved oxygen and ecosystem impacts.

Elevated salinities in the Gouritz River and its major tributaries occur naturally over the inland catchments of the Great and Little Karoo due to geology and high natural evaporation rates (DWA, 2011).

A summary of primary land use activities of the management areas in WMA16, which impact on or determine water quality state, are shown below (RHP, 2007):

- Goukou/Duiwenhoks: Irrigated agriculture (lucerne and pasture).
- Gouritz: Irrigated agriculture (lucerne and pasture), livestock (ostriches and sheep).
- Garden Route: Irrigated agriculture, afforestation (pine), urban.

3.3 WATER QUALITY ASSESSMENT PER SECONDARY CATCHMENT

3.3.1 Primary catchment H

Elevated salinities are not found to the same extent in the K and coastal (H8 and H9) catchments as elsewhere in the WMA (DWA, 2011). Main land use and towns in the area are indicated in **Table 3.2,** based on River Health Programme information (RHP, 2007), while the state of WWTW is taken from DWA (2012a), i.e. the Green Drop (GD) Report for the Western Cape.

Table 3.2 Main land use and towns in primary catchment H

Management area	Duiwenhoks	Goukou
Main land use	Dryland and irrigated agriculture (vineyards, lucerne, pasture)	Dryland and irrigated agriculture (vineyards, fruit, vegetables, lucerne, pastures), livestock (sheep), commercial forestry (pine)
Main town	Heidelberg, Vermaaklikheid	Riversdale, Stilbaai
Risk rating of WWTW (high – critical only)	Stilbaai WWTW: High risk rating (no monitoring) Barrydale WWTW: High risk rating – secondary catchment H7 but near the Doring River (flow exceeds capacity, poor effluent quality) Riversdale WWTW: High risk rating (flow exceeds capacity)	

Secondary catchment: H8

The **Duiwenhoks River catchment** has a lower rainfall spread evenly throughout the year (Ogden, 2013). The Fynbos Biome has all-year rainfall with slightly less rain in summer and the highest rainfall in winter, mainly between March and August. The mean annual rainfall is low with 389 mm in the East Coast Renosterveld, and a higher 615mm in the Eastern Fynbos Renosterveld (Mucina and Rutherford 2006; cited in Ogden, 2013). The primary impact on water quality is cultivated land (i.e. privately owned farms), with both crop (primarily citrus in the upper and wheat in the lower catchment) and livestock (dairy) farming. High salinity levels have been recorded due to agricultural return flows and discharges from WWTW (DWA, 2011). Heidelberg is located in the centre of the catchment, with an associated WWTW. Water quality was described as Poor in this area according to the RHP (RHP, 2007). However, a large portion of the catchment area is natural fynbos and non-irrigated grains, with no known anthropogenic pollution sources (Ogden, 2013). Water quality around Doringkloof (upstream Heidelberg) and Vermaaklikheid (downstream Heidelberg) is considered Good (RHP, 2007).

Secondary catchment: H9

Elevated salt and nutrient concentrations have been recorded in the **Goukou River.** Organic loading from dairy farming in this area, especially around Riversdale, is also significant (DWA, 2011). The RHP (2007) describes the water quality of the Gouritz River around Riversdale and Klipfontein as Poor, while that of the Vet River tributary is Natural – Good.

3.3.2 Primary catchment J

Secondary catchment: J1

Salinity levels of the **Buffels River** at Floriskraal Dam are considered Tolerable, but deteriorate to Unacceptable levels further downstream on the **Groot River** at Vanwyksdorp (DWA, 2011). The RHP (2007) describes water quality of the Groot River as Good, suggesting either a hotspot around Vanwyksdorp or a decline in water quality state between 2007 and 2011. Detailed water quality analysis will be undertaken to evaluate the present state.

Water quality state of the **Doring** and **Touws rivers** has been described as Good, while that around Laingsburg on the Buffels River is Fair (RHP, 2007).

Main land use and towns in the area are indicated in **Table 3.3** (RHP, 2007), while state of WWTW is taken from DWA (2012a), i.e. the GD Report for the Western Cape.

Table 3.3 Main land use and towns in secondary catchment J1

Management area	Groot
Main land use	Dryland and irrigated agriculture (vineyards, fruit, lucerne), livestock (sheep), conservation areas
Main town	Touws River, Laingsburg, Matjiesfontein, Ladismith, Vanwyksdorp
Risk rating of WWTW (high – critical only)	Laingsburg WWTW: High risk rating (poor effluent quality)

Secondary catchment: J2

According to the RHP (2007) the water quality of the **Gamka, Dwyka, Huis** and **Nels rivers** is Good.

Main land use and towns in the area are indicated in **Table 3.4** (RHP, 2007), while state of WWTW is taken from DWA (2012a), i.e. the GD Report for the Western Cape.

Table 3.4 Main land use and towns in secondary catchment J2

Management area	Gamka
Main land use	Irrigated agriculture (vineyards, fruit, lucerne, pastures), livestock (ostriches, sheep), conservation areas
Main town	Beaufort West, Merweville, Leeu-Gamka, Prince Albert and Prince Albert Road, Calitzdorp

Risk rating of WWTW (high – critical only)	Leeu-Gamka WWTW: High risk rating (poor effluent quality)

Secondary catchment: J3

Nutrient enrichment and eutrophication is seen in the **Olifants River** downstream of Oudtshoorn. There are also impacts related to a number of tanneries in the Oudtshoorn area. This area also experiences impacts on the microbial quality of receiving rivers due to run-off from informal settlements and poorly-serviced housing areas (DWA, 2011). The water quality of the lower Olifants River is described by the RHP (2007) as Fair, with that of the **Grobbelaars River** tributary being Good.

The **Kammanassie River** is described as having Fair water quality (RHP, 2007).

Main land use and towns in the area are indicated in **Table 3.5** (RHP, 2007), while state of WWTW is taken from DWA (2012a), i.e. the GD Report for the Western Cape.

Table 3.5 Main land use and towns in secondary catchment J3

Management area	Olifants
Main land use	Dryland and irrigated agriculture (lucerne, pastures), livestock (ostriches, sheep), conservation areas
Main town	Oudtshoorn, Uniondale, De Rust, Dysselsdorp, Klaarstroom
Risk rating of WWTW (high – critical only)	Uniondale WWTW: Critical risk rating (no monitoring; potential impact on the Holdrif River just upstream of its confluence with the Kammanassie River) Outeniqua WWTW: Moderate risk rating (effluent quality) Dysselsdorp WWTW: Moderate risk rating (effluent quality)

Secondary catchment: J4

The water quality of the **Gouritz River** is characterized by elevated salt concentrations, with salinity increasing down the system due to geology (natural source), high evaporation rates and agricultural impacts. Increases in ammonia and nitrates were also noted (DWA, 2011).

Main land use and towns in the area are indicated in **Table 3.6** (RHP, 2007), while state of WWTW is taken from DWA (2012a), i.e. the GD Report for the Western Cape.

Table 3.6 Main land use and towns in secondary catchment J4

Management area	Gouritz
Main land use	Dryland and irrigated agriculture (lucerne, pastures), livestock (cattle, sheep)
Main town	Herbertsdale, Albertinia, Gouritzmond
Risk rating of WWTW (high – critical only)	Albertina WWTW: High risk rating (no monitoring)

The upper reaches of the Gouritz River in the Great Karoo are mostly in a Good ecological state, while lower reaches are vulnerable to agricultural and urban development and are therefore in a Fair to Poor ecological condition (RHP, 2007).

3.3.3 Primary catchment K

Elevated salinities are not found to the same extent in the K and coastal (H8 and H9) catchments as elsewhere in the WMA. However, the disposal of wood processing waste, with associated high Chemical Oxygen Demand (COD) concentrations, is an issue in the K primary catchment. Organic loading from dairy farming in this area, especially around George and Riversdale, is also significant (DWA, 2011).

Main land use and towns in the area are indicated in **Table 3.7** (RHP, 2007), while state of WWTW is taken from DWA (2012a), i.e. the GD Report for the Western Cape.

Table 3.7 Main land use and towns in primary catchment K

Management area	Mossel Bay - George	Wilderness	Knysna-Bloukrans
Main land use	Natural forests and conservation areas, afforestation (pine), dryland and irrigated agriculture (lucerne, pastures), urban, livestock (sheep), tourism	Natural forests and conservation areas, afforestation (pine), irrigated agriculture (lucerne, pastures), urban, tourism	Natural forests and conservation areas, afforestation (pine), irrigated agriculture, urban, livestock (sheep), tourism
Main town	Mossel Bay, Hartenbos, George	Wilderness, Karatara, Sedgefield	Knysna, Plettenberg Bay, Nature's Valley
Risk rating of WWTW (high – critical only)			Knysna 2 WWTW: High risk rating (poor effluent quality; flow exceeds capacity)

Secondary catchment: K1

Impacts in K1 are primarily related to water quality alterations (Mossdustria industrial area) and some agriculture. Primary water quality impacts on the **Hartenbos River** system are agriculture (wheat) and livestock farming activities. Land use in K10E is primarily forestry. The **Brandwag** tributary of the **Klein Brak River** has a Good water quality status according to RHP (2007), with that of the **lower Moordkuil River** being Natural.

Secondary catchment: K2

Land use in the upper catchment is natural fynbos – especially around the source (the Perdeberg) and on the high altitude areas, with forestry on the lower slopes. There are several plantations in the Groot River (**Groot Brak River**) catchment, and few to none in the Ruitersbos catchment. More intense land use is found above Wolwedans Dam with dryland agriculture and irrigated pastures, sheep, dairy and crops. There is fairly extensive irrigated agriculture downstream of the Wolwedans

Dam and increasing infrastructure development (mostly housing). Water quality state appears to be Good in the upper reaches to Good – Fair in the lower reaches (Malan, 2008).

Secondary catchment: K3

In April 2012 the Council for Scientific and Industrial Research (CSIR) commenced a three year project aimed at integrating water quality into land use, water resource and estuary management and decision-making processes for the Wilderness area (The Water Wheel, March/April 2014). The **Wilderness area** has been identified as an area at extreme risk of drought, flood events and now also deteriorating water quality. Towards the end of 2012, a farmer in the Karatara area related the death of a dozen livestock, suspecting a toxic cyanobacterial bloom in his farm dam. Cyanobacterial blooms are related to high nutrient levels. Other water quality issues that have been highlighted by concerned stakeholders are sediment loss and microbiological pollution. The Wilderness area is small, almost compact, and has several land uses: forestry, dairy and vegetable farming, some permanent urban settlement and a large seasonal influx of tourists. A team of scientists has mapped out the land uses in the **Touws River** catchment, and linked these to water quality. Water quality data, and runoff and land use information are being used to design a Soil and Water Assessment Tool (SWAT) model for the Touws River system. Water quality has been described as Natural along the length of the Touws and **Kaaimans rivers** (RHP, 2007). The upper catchment of the Kaaimans River has few or no impacts (Malan, 2008), with the forested, foot-hill area starting just north of Saasveld College. The **Silver River** flows into the Kaaimans and has similar land use, thus also similar largely-natural water quality (Malan, 2008).

The Kaaimans is considered to be “a largely pristine river” although there is limited agricultural activity (dairy) in this area and plantations (Malan, 2008). Organic loading from dairy farming in some parts of this area, especially around George, is significant (DWA, 2011).

The catchment of the **Moeras/Maalgate rivers** is comprised of natural vegetation in the source areas and forestry in the foothills draining the mountain slopes. The Witels and Moerass rivers join to become the Maalgate River. There is extensive agriculture in the foothills and on the coastal plain (crops – including vegetables, hops, dairy). Excessive abstraction has been reported to occur in this area. Much of the rivers are heavily invaded by invasive alien vegetation particularly black wattle. Water quality of the **upper Moordkuil River** is a C or Fair category according to Malan (2008).

The upper reaches of the **Swart River** (both above and below the small George Dam) flow through mountainous fynbos areas and thus water quality is expected to be largely natural. In the lower foothill regions there is forestry (both plantations and indigenous forests) and the river flows into the Garden Route Dam. The lower portion of the Swart River is influenced by impacts caused by the Garden Route Dam, specifically reduced flow. There are extensive plantations and farming activity (dairy, vegetables) in this region. Housing density is also increasing. The Swart River joins the Kaaimans River approximately 1km from the sea (at the N2 road-crossing) within the tidal reach (Malan, 2008).

Secondary catchment: K4

The source of the **Goukamma River** is the Outeniqua mountains. The river is called the “Homtini” in these reaches, with a near-natural water quality state. Land use in the upper reaches (Homtini River) is largely conservation areas with indigenous forests and forestry plantations. There may

possibly be localized impacts from the small village of Rheenendal, e.g. sewage inflows from the village. There is also some agricultural activity (dairy, vegetables) around Rheenendal. In the lower reaches (below the N2) there is also intensive dairy farming, which increases the nutrient load going into the estuary. Water quality of the river is therefore near-natural along most of its length (Malan, 2008).

The **Hoëkraal, Karatara, Wolwe** and **Diep rivers** are all located in K4 and are part of the **Swartvlei River system**. The land cover in the Swartvlei catchment comprises mainly bushland, forest and shrubland. Agriculture, which consists primarily of commercial forestry, improved grasslands and temporary commercial irrigation, accounts for about 40 % of the land cover in the catchment, with dairy farming in the Diep River catchment. On the lower Hoëkraal there is some citrus farming, while on the Karatara the land use is dairy farming, timber processing (Geelhoutvlei), sawmill processing and forestry (DWAF, 2004; cited in DWA, 2009). Some of the sawmills have no disposal sites and could potentially have impacts on the lagoon/estuary.

The water quality state of the upper reaches of the Hoëkraal, Diep and Karatara rivers are Natural – Good (DWA, 2009). However, the Wolwe River water quality state is described as Fair by RHP (2007).

Secondary catchment: K5

The predominant land cover on the **Knysna River** catchment is exotic and indigenous vegetation. Agricultural development is confined mainly to the farms of Portland, Charlesford, Westford, Eastford, Simola and the Gouna Commonage. Irrigated food crops are cultivated at Portland, while the predominant agricultural activity is cattle grazing. There are abstractions on the Knysna River (Charlesford farm upstream of the weir) and the Gouna River (Gouna pump station) by the Knysna Municipality for water supply. The new Simola Golf and Country Estate are located on Kaapweg, downstream of the Gouna pump station. The **Gouna River** is a tributary of the Knysna River. The Outeniqua Reserve Determination Study (2008 - 2010) showed the Gouna water quality state to be Natural – Good along the length of the river, with the upper reaches of the Knysna River also in an A category (DWA, 2009).

Secondary catchment: K6

DWA (2011) notes sand mining activities in the K catchment, particularly at Wittedrift near Plettenberg Bay, i.e. on the **Bitou River** system. Water quality of the upper Bitou is described as Good, with conditions deteriorating to Fair in the lower reaches (RHP, 2007).

According to the RHP (2007), water quality state of the upper and middle **Keurbooms River** is Fair, with an improvement toward the lower reaches.

Secondary catchment: K7

The following land use activities are present in the catchment (Scherman *et al.*, 2007):

- Numerous dams in the catchment, some stocked with largemouth bass, smallmouth bass and trout. These result in decreased water input into rivers (reduction in natural runoff) and threat of invasion by alien fish.
- Inter Basin Transfer canal at Kurland, connecting the Sout and Buffels rivers catchments.

- Agriculture, including cattle farming, which results in water abstraction and nutrient loading. There are also vineyards (with associated use of fertilizers, pesticides, etc.) downstream of the Buffels Dam.
- Land-use activities such as the polo fields at Kurland Estates, with associated use of fertilizers etc.
- Urban areas and associated activities, e.g. Kurland Village., including a WWTW and inflow of sewage effluents into the river, resulting in nutrient enrichment, increase in COD, Total Dissolved Solids (TDS) and turbidity.
- Addition of limestone and agricultural lime, which results in increasing pH levels. This will result in changing the habitat template for highly sensitive macroinvertebrate species.
- Industrial developments, such as brickworks (Sout River), saw mills, a quarry and a dairy (Sout River).
- Alien vegetation in the upper catchments of rivers, resulting in decreased runoff yield to rivers, shading out of indigenous vegetation, habitat loss for insect adults, destabilization of river banks, erosion and increased sedimentation into river channels.

The Reserve study showed a Good water quality state for both the **Wit River**, a tributary of the **Sout River**, and the **Bloukrans River**, a tributary of the **Matjies River**. Water quality state of the Sout River was described as Natural – Good by the RHP (2007).

4 STATUS QUO ASSESSMENT: ECOSYSTEM SERVICES

4.1 APPROACH

In terms of generating data for this report the most important step was to provide an integrated assessment of the current population of all three areas. Analysis was undertaken using three primary tools. These were:

- The 2001 Census as adjusted and the 2011 Census data that is available.
- Geographic Information System (GIS) overlays of quaternary catchments and the census "sub-place name" data. "Sub-place name" data fields are the most detailed subsets of data released by Statistic South Africa. This allows for the population for each quaternary to be calculated and a profile of the population for each unit to be analysed. Data was analysed to select areas in which populations likely to be dependent on riverine goods and services were possibly or probably present.
- Cross check of the GIS data sets with available mapping to determine likely livelihood styles and profiles.

A second level of analysis based on the typology of settlements in the area and their likely associated dependence on goods and services for livelihoods was undertaken for this report. This was sourced from information available from Statistics South Africa and cross referenced with an examination of aerial photography, largely that provided by Google Earth™. This allowed for an analysis of land use types associated with the settlement typology.

Further, each sub-quaternary catchment of the Gouritz System has been examined in detail via the analysis of socio-cultural importance. The Socio Cultural Importance (SCI) was determined from (a) a site visit that covered points along the river, (b) extrapolation to sites not visited by reference to available literature as well as to existing mapping. Given the size of the budget and the geographical scope of the work most of the information used to influence the score was derived from direct observation and consideration of the literature available.

In order to generate the SCI model, information was extracted in a "master spreadsheet" that incorporates all the SCI results. Each secondary catchment within the WMA has its own set of spreadsheets. Column descriptions in the SCI sheet in the master spreadsheet are as follows and provided electronically:

- Column A: Sub Quaternary (SQ) number: Individual code provided for each SQ by the Department Water Affairs (DWA) and based on the codes used in the National Freshwater Ecosystem Priority Area (NFEPA) assessment.
- Column B: River. River Name where available.
- Column C: River Length.
- Column D: Summarised comment on the Sub Quaternary (SQ) and river reach.
- Column E: Score for Ritual Usage. This was scored between 0 – 5. The question that was asked was "How much ritual use of the river takes place?" Typically this would be for ceremonial purposes or for spiritual/religious activities.
- Column F: Weighted score for Ritual Usage. Ritual use is given a weighted score of 40 points. So a score of 3 out of 5 in Column D would result in a weighted score of 120.

- Column G: Aesthetic Value. This was scored between 0 – 5. The question that was asked was "How important is the aesthetic value to people? Does the river stretch add value to people's life as an object of natural beauty? Would changing flows detract from this value?"
- Column H: Weighted score for Aesthetic Value. Aesthetic Value is given a weighted score of 20 points.
- Column I: Resource Dependence. This was scored between 0 – 5. This refers to the goods and services delivered by the river system and peoples dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or "for financial gain" usage of resources is excluded from consideration in this instance. Both intensity and significance of use are valued and the higher of the two scores is adopted.
- Column J: Weighted score for Resource Dependence. Resource Dependence is given a weighted score of 100 points.
- Column K: Recreational Use. This was scored between 0 – 5. The question that was asked was "Does the river stretch provide recreational facilities to people and would this be affected by changing flows?"
- Column L: Weighted score for Recreational Use. Recreational Use is given a weighted score of 50 points.
- Column M: Historical/Cultural Value. This was scored between 0 – 5. The question that was asked was "Does the river have a strong cultural or historical value?"
- Column N: Weighted score for Historical/Cultural Value. Historical/Cultural Value is given a weighted score of 75 points.
- Column O: This is the overall SCI score derived by adding the weighted scores and dividing by the number of criteria and as a proportion of the overall maximum score.

A key component of the SCI model is the category "Resource Dependence". This refers to the goods and services delivered by the river system and people's dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. The categories "Recreational Use" and "Ritual Use" were also examined. The SCI model was compared to the evaluation of likely areas of importance with regard to goods and services.

4.2 DESCRIPTION OF ECOSYSTEM SERVICES

It should be noted that the objective in 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 provides the baseline against which the socio-economic and ecological implications of different catchment configuration scenarios can be compared. It is important to point out that while Ecosystem Services will be identified and described in qualitative terms, a baseline value can often only be described for some of these, as the information required is not available without investing in a costly survey. As such it is therefore more practical to measure changes in Ecosystem Services values relative to a reference point rather than computing a baseline value. For the purposes of this exercise the baseline value is described as a

value of 1. The most important Ecosystem Services associated with the overall system and likely to be impacted by changes in operational and management scenarios are the following:

- Recreational fishing.
- Subsistence fishing.
- Other recreational aspects associated with the rivers and the estuaries.
- Thatch grass harvesting.
- Reed harvesting.
- Other riparian vegetation usage including grazing.
- Livestock watering.
- Sand mining.
- Waste water dilutions.
- Floodplain agricultural usage for subsistence purposes.
- The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the area.
- Dis-benefits associated with Bilharzia, Black fly and livestock disease.

4.3 STATUS QUO ASSESSMENT

The socio-economic profile was defined to place the wider catchment strategy in the existing socio-economic context.

The socio-economic profile was established based on the desktop review of existing studies and information for the applicable district and local municipalities. Specifically, this included a review of the latest versions of the district and local municipal Integrated Development Plans (IDPs). These plans were further supplemented by the analysis of the 2011 Census, Community Survey 2007 data (as provided by Statistics SA) and other applicable sources. Land use was determined via existing GIS coverage and DWA Internal Strategic Perspectives (DWAF, 2004) developed for the WMA.

The study identified areas and communities that are significantly dependent Ecosystem Services provided by the natural resource. The level of dependence can be determined based on the general principle that vulnerable communities will have limited access to formal resources and thus are more likely to be dependent on local natural resources.

The Gouritz WMA falls predominantly within the Western Cape Province, with small portions in the Eastern Cape and the Northern Cape Provinces. The Gouritz WMA is the largest WMA in the Western Cape with a total surface area of 53 139 km^2. The population of the Gouritz WMA was estimated at 452 000 people. This was based on an overlay of the 2011 Census data, at sub-place name level, onto the outline of the geographical area that makes up the WMA. The Urban component is made up of 350 000 people while the rural component is made up of 98 000 people. As such the majority of the population resides in the areas where the most economic activity occurs. These are the urban centres and particularly the major coastal towns.

Overall the population in the WMA is not expected to grow. South Africa at present has a low[1] population growth rate and an overall decline in rural population. Future population trends in the WMA are likely to be influenced by economic opportunities and job creation. Projections therefore are for some population growth in the urban areas and a decline in rural population, attributable to the lack of economic stimulus in small towns and villages

The Gross Geographic Product (GGP) of the Gouritz WMA is estimated at around R22 billion per annum and makes up just under 1% of South Africa's Gross Domestic Product (GDP). This gives a per capita GGP of R26 794 which is just over 50% of the national GDP per capita of R53 260 when based on a population of 50 million (DWA, 2012b). This makes the Gouritz WMA a relatively poor part of the South African economy. The economy of the WMA is dependent on export fruit, PetroSA, mixed agriculture, ostrich farming and tourism.

The agricultural sector provides a wide range of products including wine grapes, fruit, fodder, vegetables, grains, hops, dairy, timber, tobacco, ostriches, game farming, sheep, cattle, and goats. The fish and shellfish industry are significant for the economy of the coastal region. The ostrich industry also plays a part in the region's economy. Land use in the WMA, from a water resources perspective, is dominated by irrigation and afforestation activities (DWA, 2010a).

The topography and climate within the Gouritz WMA is such that three distinct water resource zones linked to land use can be distinguished. These are the:

- The semi-arid Great Karoo consisting of the Gamka River catchment to the north of the Swartberg mountains and the Touws/Buffels/Groot River catchments, to the west of the Klein Swartberg mountains. This is dominated by agricultural activity with stock farming of particular importance.
- The Olifants River which is fed by mountain streams rising in the Swartberg mountains to the north, the central Kammanassie mountains and the coastal Outeniqua mountains in the south. Agriculture, albeit more of a mixed variety, is of importance in this part of the WMA.
- The Coastal Belt which includes the Gouritz/Goukou/Duiwenhoks catchments, extending from the western boundary of the WMA to (and including) the catchment of the lower Gouritz River, and the remaining coastal belt to the eastern boundary of the WMA. Tourism as well as fishing and the petro-chemical industries are important in this part of the WMA. Several important coastal lakes and estuaries are found, with the Knysna Estuary being rated as the estuary of highest conservation importance in South Africa, with high rankings also given to the Swartvlei, Keurbooms and Wilderness estuaries.

Water resource developments in the Gouritz have to a large extent evolved through the implementation of local water supply schemes, augmented as and when necessary. The diverse variation in precipitation has led to distinctly different approaches to water resource management and resource development.

[1] UNDP cites a 1.18 per annum growth rate for 2011. The rate is generally said to be declining and early estimates by the United Nations, Department of Economic and Social Affairs, Population Division, for 2013/2014 show a rate of 0.69.

In the Great Karoo and Olifants River catchments rainfall is very erratic and some dams take up to ten years to fill; only reaching full capacity after major flood events. Thereafter storage levels decrease significantly over periods of up to three years, and fluctuate at low levels until the next flood event of sufficient size allows the dam to fill again. Water quality in the inland (Karoo) rivers is generally poor as a result of natural high salinity and turbidity of the water. Water use by irrigation is highly variable from year to year, as much of the land lies fallow and is only irrigated in years of high runoff when sufficient water is available.

In the interior catchments of the Karoo and Olifants River, runoff from many of the catchments in the Swartberg, the Outeniqua and Langeberg mountains is perennial and the normal flows are diverted into farm dams or into earth canals for run-of-river irrigation on a shared basis (such as at Oudtshoorn for example). Flood runoff from these mountains and from the Great and Little Karoo is also used for opportunistic run-of-river irrigation, but most is stored in dams for later use by irrigators.

Groundwater is used extensively for water supply to the urban sector, and for rural domestic use, stock watering and some, albeit, limited irrigation. Along the coastal belt, the perennial rivers in the eastern areas (from Wilderness eastwards) are predominantly utilised on a run-of-river basis to supply urban areas. Some irrigation with very limited storage is provided.

Towards the west of the catchment, towns and irrigators are mainly supplied via storage dams; the greatest storage being in the dams supplying the urban and industrial areas of George (Garden Route Dam) and Mossel Bay (Wolwedans Dam). Groundwater usage is mainly for stock watering and as a supplement to some urban supplies. Afforestation takes place in the higher rainfall coastal areas in the foothills of the Langeberg and Outeniqua mountains.

Water in the lower reaches of the Gouritz River is unacceptable for most uses due to high salinity levels. It is assumed that this is due to highly saline background levels, exacerbated by agricultural practices.

Water quality in the coastal rivers is generally good and suitable for most uses, although not ideal. Impacts of human activities are also evident in some of these rivers. In the Gouritz River catchment the development of surface water resources has reached its capacity and all the water is considered to be fully utilised (DWA, 2010a).

Based on the results of the DWA (2004) Gouritz Internal Strategic Perspective (ISP), a shortfall in water availability of 43 million m^3/a occurred in the coastal catchments between Mossel Bay and Nature's Valley. In 2011 DWA started undertaking the All Towns Reconciliation Strategy Study DWA (2014a) for the western and Eastern Cape, to identify how to best reconcile water availability and utilisation in the long-term. Mossel Bay, George, Knysna and Plettenberg Bay have all implemented recent water resource augmentation schemes towards managing their shortfalls during drought. The high influx of tourists during the summer holiday season puts major strain on the water resources, but this is more due to lack of adequate storage.

Concerns have been raised about sand mining in some of the coastal catchments and at Wittedrift near Plettenberg Bay. Elevated turbidity causes silting of water ways, smothering of aquatic

ecosystem habitats, and suspended sediment particles create ideal sites for absorbing phosphates and water-borne pathogens (DWA, 2010a).

An index or set of criteria was established to determine which areas and communities may be considered vulnerable and dependant on Ecosystem Services and as such constitute “hot spots”. For each criterion, a number of variables or thresholds were determined to permit the identification of specific areas/communities via spatial mapping. The criteria and thresholds are defined in **Table 4.1**.

Table 4.1 Criteria for defining the status of potentially vulnerable communities

Criteria	Variables/Indicator	Rationale
Rural Areas/Communities	Rural areas as defined by Census 2001	Service delivery in rural areas is usually restricted and poorer communities are likely to be dependent on natural resources.
	Population density of less than 500 people per square kilometre.	Population density as a determinant of urban/rural environment, with variable as defined by Statistics SA (Census, 2001).
Water Supply	Where water supply to a significant percentage of local population (greater than 33%) is provided by natural resources. Census 2011 water supply criteria functions of key variables specifically (1) boreholes, (2) spring, (3) dam/pool/stagnant water, (4) river/stream, (5) water vendor and (6) other.	The lack of formal water infrastructure restricts local communities to source water from natural sources.
Sanitation	Majority of local population dependant on (1) pit latrines, (2) bucket latrine or none (as defined by Census 2001).	Limited formal sanitation is provided to a significant percentage of the local population, which are therefore reliant on natural resources.
Economic Development	1. Poverty Lines. 2. Income Levels. 3. Economic Growth.	Areas or communities where a significant proportion of the population (greater than 33%) are below the poverty line.
Subsistence	1. Areas or communities where subsistence agriculture is the primary land use.	Areas or communities that are largely dependent on subsistence agriculture will likely be dependent on natural resources, with limited access to formal infrastructure.
Recreation / Tourism	1. Popular fishing and recreational areas. 2. Tourism hot-spots. 3. Recreational hot-spots.	Aquatic resources provide for recreational and tourism activities, specifically around fishing, water based recreational activities, and aesthetic value.
Infrastructure Delivery	Developed urban, freehold rural or communal tenure rural/closer settlement.	Indictor of level of development linked to water demand and profiles of usage
Land Tenure	Communal or Freehold title.	Indictor of likely types of service delivery and settlement patterns
Community Health	Health indicators including malnutrition, infectious diseases, waterborne	Health status is a proxy determinant of the overall access and quality of

Criteria	Variables/Indicator	Rationale
	diseases and water quality related diseases.	ecosystem services due to its impacts on community heath.

Census 2011 spatial data formed the basis for the classification of criteria and variables defined in **Table 4.1** as it is the only data source with sufficient coverage of the WMA. The minimum level adopted for this study was determined by Census 2011 as the sub-place.

Priority areas and communities were determined using a combination and qualitative analysis and simple weighted factor analysis. The former is better suited to the identification of areas/communities based on expert judgement, while the latter allows for the determination of degrees of vulnerability of each area/community. Further analysis of the catchment per SQ generated an overview of the overall socio-economic condition that pertains to the likely significance of dependence on Ecosystem Services. Criteria as per **Table 4.1** were summarised in a single score entitled resource dependence and linked to overall socio-cultural importance assessment of the SQ. The score used was between 0 (no resource dependence significance) and 5 (extreme dependence of significant communities on riverine Ecosystem Services).

Table 4.2 below sets out the SQs that have high scores (4) or very high scores (5). A full set of tables that reflect these scores, as well as the other SCI aspects is provided electronically which will entail all such data for this project.

For the most part areas with high resource dependence and associated Ecosystem Services utilisation by communities are in areas that are rural and defined as underdeveloped. Given the nature of the population and the largely formal as opposed to subsistence rural setting there are few communities who are highly dependent on riverine linked Ecosystem Services.

Table 4.2 SQs with high Ecosystem Services dependence

SQ number	River	Summary of Status Quo and linked Ecosystem Services importance
J1		
J11J-08659	Swartberg	Upper reaches in the Klein Swartberg escarpment. Aesthetic value. Middle reaches support extensive agriculture. Ladismith Town noted. No recreational resources noted.
J2		
J23F-08389	Tryntjies	Uniform terrain. Greater presence of agriculture noted. Grazing Possible. No communities noted. No recreational resources noted.
J23F-08403	Dorps	Uniform terrain. Greater presence of agriculture noted. Grazing Possible. Prince Albert town noted. Lodges and guest houses noted.
J3		
J34A-08871	Holdrif	River section extends through a uniform open terrain. Greater presence of agriculture noted in proximity of the river. Grazing likely. The town of Uniondale noted on the extreme upper reaches. Presence of tourism resorts.
J34B-08807	Kammanassie	River section extends through a uniform open terrain. No agriculture noted in proximity of the river. Grazing possible. The town of Uniondale noted on extreme upper reaches. No recreational resources noted. Undeveloped river.

SQ number	River	Summary of Status Quo and linked Ecosystem Services importance
J35F-08600	Vlei	River section extends through the escarpment and through open/natural terrain. Land use on lower reaches includes extensive agriculture on the middle and lower reaches. No communities noted in proximity to the river. Recreational resources (lodges) noted.
J34B-08817	Kammanassie	River section extends through a uniform open terrain. Extensive agriculture noted in proximity of the river. Grazing possible. No communities noted in proximity to the river. No recreational resources noted.
J4		
J40E-09359	Gouritz	River section headwaters located in deeply incised river valleys. River section thereafter extends through commercial agricultural land or open terrain, with commercial plantations located on the lower reaches. No presence of human habitation, with the exception of farm houses, found in proximity to the river. Moderate social value.
J40E-09307	Buffels	River section headwaters start at the small rural settlement of Doornkop. Remaining extent of the river runs through deeply incised river valleys with no human settlement. Moderate social value
J40E-09273	Stink	River section extends through commercial farmland and open terrain. Presence of a small rural settlement (Doornkop) on south bank of river. Moderate social value.
K		
K50B-09117	Knysna	Upper reaches of this river is comprised of open/natural terrain and commercial agriculture on the river valley bottom and coastal plains. The lower reaches of the river extends into the Knysna lagoon/estuarine system. The estuary is flanked on both banks by a number of up-market residential areas. Recreational and ritual use, as well as heritage and aesthetic value are likely to be high.
K30B-09100	(unnamed stream)	River headwaters located in the inland escarpment. The upper reaches extend through an open/natural terrain (including indigenous forest). The lower reaches extend through near exclusively commercial agricultural land. The town of Blanco (formal, affluent) and related tourism establishments are located on the lower reaches. Aesthetic, ritual and recreational use are likely to be elevated.
K60E-09097	Keurbooms	Located in the Keurboomsrivier Nature Reserve. River extent comprised of open/natural terrain. River extends into a lagoon, and a number of resorts are located on both banks of the lagoon. Plettenberg Bay is located near the river mouth. The nature reserve, presence of upscale resorts at the estuary and Plettenberg Bay suggest high levels of tourism and recreational use, as well as elevated heritage and aesthetic value.
K20A-09083	Groot Brak	River headwaters located in the inland escarpment. The upper reaches extend through a mosaic open/natural terrain and commercial forestry plantations. The lower reaches of the river extend through the coastal plain and a mosaic of open/natural terrain, indigenous forests and commercial agriculture. The river drains through the Wolwedans Dam therefore recreational, ritual and aesthetic value are likely to be elevated. River extends towards the coast into the river estuary. The small towns of Groot Brakrivier, Bergsig, Southern Cross and The Island (formal, affluent) are located on the west and east banks of the river/estuary. Recreational, ritual and aesthetic value are likely to be elevated along the lower river reaches and the estuary.
K60F-09092	Bitou	Upper reaches of the river extends through the Knysna Forest, with the presence of plantation forestry on the east bank. Middle and lower reaches of the river comprise of a mosaic of open/natural terrain, small-holdings and commercial agriculture. A number of tourism facilities (lodges, hotels) noted along the river route suggesting elevated

SQ number	River	Summary of Status Quo and linked Ecosystem Services importance
		recreational use, as well as aesthetic value. The small town of Wittedrift (formal, affluent) is located within 1km of the river. The river drains into the Keurbooms lagoon, and there are high levels of recreational use in this lagoon.
K10D-09163	Brandwag	Eleven kilometre river section. The upper, middle and lower reaches extend through a mosaic of open/natural terrain and commercial farmland. The river extends past the small settlement of Brandwacht, Cheetah Lodge and Riverside Holiday Resort. The aesthetic, cultural and recreational use of the river is likely to be elevated due to the presence of tourism facilities and resident population.
K10F-09224	Klein Brak	River section extends toward the coast into the riverine estuary. Upper reaches extend through commercial agricultural land. The town of Klien Brak River (formal, affluent) is located on the northern bank of the estuary. Recreational, ritual and aesthetic value of the estuary is likely to be elevated
K30C-09093	Swart	River headwaters are located in the inland escarpment. Upper reaches of the river extend through open/natural terrain. River drains into the Garden Route Dam therefore recreational, ritual and aesthetic value are likely elevated. Middle and lower reaches extend through a mosaic of open/natural terrain and become commercial agriculture. Tourism facilities (lodges) noted long the river. No communities are noted in direct proximity of the river, however the Rosemore and Thembalethu townships are located within 1 – 4 km from the river.
K40D-09179	Sedgefield	A short river section that drains from the Swarvlei Dam to the Sedgefield River estuary. The town of Sedgefield is located on the eastern bank of the estuary. Recreational and tourism facilities and resources are noted, therefore aesthetic value, recreational and ritual use of the river section and estuary is likely to be elevated.
K60G-09180	(unnamed stream)	The upper reaches of the river extends through plantation forestry, with the township of Hornlee located on the east bank of the river. The middle and lower reaches of the river extend through open/natural terrain (specifically indigenous forest related possibly to the Harkerville Nature Reserve). The river drains into an estuarine system, with the Pezula Private Estate flanking the river on its west bank.
K30B-09082	Malgas	River headwaters are located in the inland escarpment. The upper reaches extend through an open/natural terrain (including indigenous forest). The lower reaches extend through the town of Blanco (formal, affluent) and Heath Park. River drains into a local, small dam. River section is likely to have higher recreational, ritual and aesthetic value.
H		
H80C-09208	Duiwenhoks	The entire river section extends through, near exclusively, commercial farmland. The town of Heidelberg (formal, farm-town) flanks the river on its west bank for approximately 4km on its lower reaches. There is no indication of tourism or recreational resources.
H90E-09383	Goukou	This river section extends into the Goukou estuarine system. The town of Stilbaai is located along much of the west-bank of this river section. The east bank is comprised mostly of open terrain with some development. Likely moderate recreational use of the estuary.

5 STATUS QUO ASSESSMENT: ECOLOGICAL RIVER STATE

5.1 INTRODUCTION

Determination of the Present Ecological State (PES), which in essence represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process (Kleynhans and Louw, 2007). The EcoClassification process consists of four levels which refer increasing complexity and intensity of work ranging from Level I (Desktop) to Level IV. An additional level, also Desktop, was developed by Dr Neels Kleynhans (Kotzé *et al.,* 2012) with the specific purpose of building up a country wide database of PES and Ecological Importance (EI) – Ecological Sensitivity (ES). This project is referred to as the PES/EIS project and has been finalised. All the spreadsheets for the secondary catchments in South Africa have been completed and the information was used as the baseline for the status quo assessment. The work specifically for this WMA was undertaken by Southern Waters (DWA, 2013) and the PES component was reviewed during this study.

5.2 APPROACH

5.2.1 PES model (modified from Kleynhans and Louw, 2007)

The PES of a river is expressed in terms of various components, i.e. **drivers** (physico-chemical variables, geomorphology and hydrology) and **biological responses** (fish, riparian vegetation and aquatic macroinvertebrates), as well as in terms of an integrated state, the **EcoStatus**. Different processes are followed for each component to assign a category ranging from an A to an F category (where A represents a natural state and F a critically modified state) (**Table 5.1**). Ecological evaluation against the expected reference conditions, followed by integration of the categories of each component, provides a description of the Ecological Status or *EcoStatus* of a river. Thus, the EcoStatus can be defined as the total of the features and characteristics of the river (instream and riparian zones) that influence its ability to support an appropriate natural flora and fauna (modified from: Iversen *et al*., 2000). This ability relates directly to the capacity of the system to provide a variety of goods and services.

Table 5.1 Ecological Categories (ECs) and descriptions

EC	Description of EC
A	Unmodified, natural.
A/B	Boundary category between A and B.
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
B/C	Boundary category between B and C.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
C/D	Boundary category between C and D.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
D/E	Boundary category between D and E.

EC	Description of EC
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E/F	Boundary category between E and F.
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

It must be emphasised that the category scale A to F represents a continuum. The boundaries between categories are notional, artificially-defined points along the continuum. Therefore there may be cases where there could be uncertainty as to which category a particular entity belongs to. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson *et al*., 2004). For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D etc. The B/C boundary category, for example, is indicated as the dark-blue to light-green area in **Figure 5.1**.

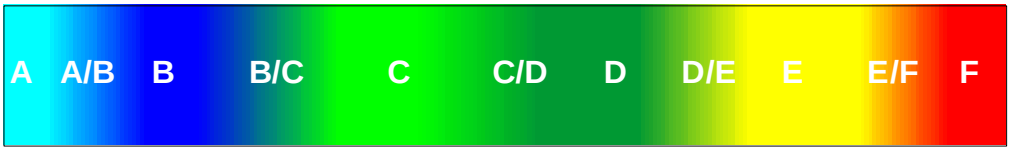


Figure 5.1 Illustration of the distribution of ecological categories on a continuum

The Desktop level EcoClassification was modified for use in the PES/EIS project to deal with numerous SQ river reaches and the relationship between the Desktop Level EcoClassification and the modified desktop level used within the PES/EIS project is illustrated in **Figure 5.2**.

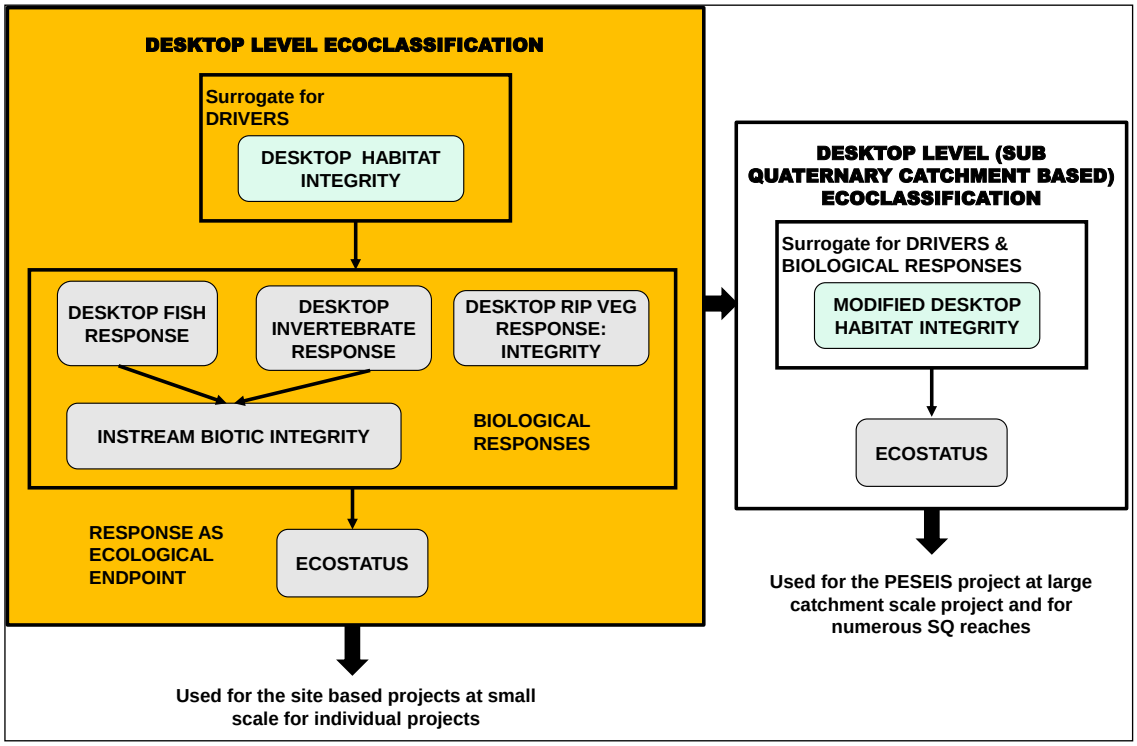


Figure 5.2 Relationship between the Desktop Level EcoClassification and the PES/EIS approach to determine the PES category

The PES is assessed according to six metrics that represents a very broad qualitative assessment of both the instream and riparian components of a river. The metrics used in the PES model and an explanation of what they refer to is explained in **Table 5.2** (DWA, 2013). Each metric is scored from zero to five.

Table 5.2 PES metrics and explanations (DWA, 2013)

Metrics	Comment
Potential instream habitat continuity modification	Modifications that indicate the potential that instream connectivity may have been changed from the reference state. Indicators: Physical obstructions (e.g. dams, weirs, causeways). Flow modifications (e.g. low flows, artificially high velocities, physico-chemical "barriers").
Potential riparian/wetland habitat continuity modification	Modifications that indicate the potential that riparian/wetland connectivity may have been changed. Indicators: Physical fragmentation, e.g. inundation by weirs, dams; physical removal for farming, mining, etc.
Potential instream habitat modification activities.	Modifications that indicate the potential of instream habitats that may have been changed from the reference state. Includes consideration of the functioning of instream habitats and processes, as well as habitat for instream biota specifically. Indicators: Derived likelihood that instream habitat types (runs, rapids, riffles, pools) may have changed in frequency (temporal and spatial). Assessment is based on flow regulation, physical modification and sediment changes. Land use/land cover (erosion, sedimentation), abstraction etc. may indicate the likelihood of habitat modification. The presence of weirs and dams are possible indicators of causes of instream habitat change. Certain introduced biota (e.g. carp, crustacea and mollusca) may also cause habitat modification. Eutrophication and resulting algal growth as well as macrophytes may also result in substantial changes in habitat availability.
Potential riparian/wetland zone modifications	Modifications that indicate the potential that riparian/wetland zones may have been changed from the reference state in terms of structure and processes occurring in the zones. Also refers to these zones as habitat for biota. Indicators: Derived likelihoods that riparian/wetland zones may have changed in occurrence and structure due to flow modification and physical changes due to agriculture, mining, urbanization, inundation etc. Based on land cover/land use information. The presence and impact of alien vegetation is also included.
Potential flow modification	Modifications that indicate the potential that flow and flood regimes have been changed from the reference state. Indicators: Derived likelihood that flow and flood regimes have changed. Assessment based on land cover/land use information (urban areas, inter basin transfers), presence of weirs, dams, water abstraction, agricultural return flows, sewage releases, etc.
Potential physico-chemical modification activities	Activities that indicate the potential of physico-chemical conditions that may have changed from the reference state. Indicators: Presence of land cover/land use that implies the likelihood of a change of physico-chemical conditions away from the reference. Activities such as mining, cultivation, irrigation (i.e. agricultural return flows), sewage works, urban areas, industries, etc. are useful indicators. Algal growth and macrophytes may also be useful response indicators.

5.2.2 PES supporting information

Comments summarising the activities that result in the various PES categories were provided for each SQ. In addition the Ecosystem Services summary as well as the Water Resource Use Importance (WRUI) summary per SQ were also utilised to identify what the impacts are and whether they are flow or non-flow (including water quality) related. Google Earth™ was also used to view each SQ to provide the flow and non-flow impact assessment and to identify the key PES drivers.

5.2.3 Database for PES information in an Excel spreadsheet

The WMA consists of 544 SQ reaches. The final modelled information in the front end model for each secondary catchment is available from Dr Neels Kleynhans, Directorate: Resource Quality Services (D:RQS), DWA. Information was extracted in a "master spreadsheet" that incorporates all the PES/EIS results, modifications to the PES results, as well as the additional information required for this project. The spreadsheets will be available electronically for this project and the columns of the PES sheet (called PES) are described below.

Colour coding used in the spreadsheet relevant to the SQ rows is as follows:

- Blue: SQ that is represented by an estuary and no river PES is determined.

PES sheet column descriptions in the master spreadsheet are:

- Column A: SQ number: Individual code provided for each SQ by DWA and based on the codes used in the NFEPA assessment.
- Column B: River: River name where available. If no name was available the cell was left blank.
- Column C: Length km: River length of SQ.
- Column D – I: A 0 – 5 rating for impacts for metrics as provided from the PES/EIS study (DWA, 2013). The values in yellow cells indicate values that were refined during this study.
- Column J: Physico-chemical confidence ratings (0 - 5) from the PES/EIS study (DWA, 2013).
- Column K: Comments: Comments copied from the front end model providing a valuable summary of activities in the SQ.
- Column L: Water quality hotspots: An evaluation by Dr Patsy Scherman to identify problem (ecology and user) water quality areas. Only hotspots which represent a 3, 4 or 5 rating have been completed.
- Column M: Water quality hotspot comments: Provides an indication of what the reasons are for the water quality hotspots.
- Column N: PES median of all metrics: PES value generated using the metrics as provided in Column D – I.
- Column O: PES category based on median of PES metrics: PES as an EC.
- Column Q: Flow: The flow PES rating from column H is included in the cell.
- Column R: Water quality (WQ): The water quality PES rating from column I is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a WQ impact.
- Column S: Other: The maximum rating is included from the PES ratings other than flow or water quality. If higher than the flow or water quality rating, then it will relate to non-flow related impacts.

- Column U: Primary PES driver: An indication is provided whether the key PES driver that is mostly responsible for the changes from natural reference condition is flow, non-flow or water quality dominated, or a combination of both.
- Column V: Provides comment regarding the changes made of the original PES assessment.

5.3 STATUS QUO ASSESSMENT

The status quo assessment is provided per tertiary and secondary catchment and consists of a table and a short summary for each secondary catchment (**Tables 5.3** to **5.15**). Blank spaces in the river category column on tables indicate an unnamed river in the SQ. No key PES drivers are provided for rivers in a B or higher PES category as the changes from natural are minor. Maps are provided in **Figure 5.3** to **Figure 5.6** at the end of this section to illustrate the PES.

5.3.1 K1 (Hartenbos, Klein Brak)

Table 5.3 River PES and key drivers resulting in modification from natural (K1)

SQ number	River	PES	Primary PES driver
K10A-09292	(unnamed stream)	D	WQ[1]: Mossdustria and WWTW. NF[2]: Agriculture.
K10B-09223	Melkboom	D	NF: Agriculture (wheat).
K10B-09196	Hartenbos	D	NF: Agriculture (Livestock farming/fodder crops).
K10B-09256	Hartenbos	D	F[3]: Hartebeeskuils Dam, irrigation. NF: Livestock farming/fodder crops.
K10C-09089	Hoëkraal	C/D	NF: Agriculture (F: Irrigation).
K10C-09077	Kouma	C/D	NF: Agriculture.
K10D-09121	Ruiterbos	D	NF: Agriculture.
K10D-09159	Palmiet	C/D	NF: Agriculture.
K10D-09163	Brandwag	D	NF: Agriculture.
K10E-09119	Beneke	C	NF: Forestry.
K10E-09064	Moordkuil	B	NF: Forestry.
K10F-09204	(unnamed stream)	C/D	NF: Forestry (F: Lower 30%, large dam: Klipheuwel).
K10F-09139	Moordkuil	C/D	NF: Agriculture.

1 WQ refers to water quality related impacts.
2 NF refers to Non-Flow related activities.
3 F refers to Flow related activities.

K10A-9292 is in a PES of D, primarily related to water quality alterations (Mossdustria industrial area) and limited non-flow related impacts, such as agriculture. The entire Hartenbos River system (including Melkboom) (K10B) is in a PES of D. The primary impacts are non-flow related associated with agriculture (wheat) and livestock farming activities, while flow related impacts are associated with the Hartebeeskuils Dam and irrigation abstraction. The land use in quaternary catchments K10C and K10D is primarily agriculture (non-flow related), resulting in the PES of this entire area ranging between a C/D and D. The primary land use and impacts in quaternary catchment K10E is related to forestry, with the condition still being good (category B) in the Beneke River (K10E-9119) and moderate (category C) in the upper Moordkuil River (K10E-9064). The lower Moordkuil River

(K10F-9139) and unnamed tributary (K10F-9204) are impacted by flow and non-flow related impacts namely forestry and agriculture, as well as the Klipheuwel Dam, resulting in a PES of C/D.

5.3.2 K2 (Groot Brak)

Table 5.4 River PES and key drivers resulting in modification from natural (K2)

SQ number	River	PES	Primary PES driver
K20A-09083	Groot Brak	B/C	NF: Forestry. F: Wolwedans Dam in lower 20%, abstraction lower 50%.

The Groot Brak River (K20A-9083) is impacted by non-flow related (forestry and agriculture) as well as flow related impacts (Wolwedans Dam in lower 20% of reach), resulting in a moderately modified PES of B/C on the river.

5.3.3 K3 (Maalgate, Malgas, Gwaiing and Swart)

Table 5.5 River PES and key drivers resulting in modification from natural (K3)

SQ number	River	PES	Primary PES driver
K30A-09087	Maalgate	D	F: Irrigation. NF: Agriculture
K30B-09100	(unnamed stream)	D	NF: Forestry and Golf estate developments. F: Irrigation (Golf estates).
K30B-09115	Rooi	D	NF: Urban (WQ: urban runoff).
K30B-09082	Malgas	B	NF: Lower 40% cement factory and golf estates. WQ: Cement factory and irrigation return flows.
K30B-09158	Gwaing	D	WQ: upstream cement factory and irrigation return flows. NF: Agriculture.
K30B-09151	Gwaing	D	WQ: Upstream cement factory and irrigation return flows. NF: Agriculture.
K30C-09065	Kaaimans	B	NF: Forestry.
K30C-09093	Swart	D	F: George and Garden Route dams. NF: Forestry.
K30D-09042	Touws	B	NF: Forestry.
K30D-09108	Klein Keurboom	C/D	F: Dam and irrigation. NF: Agriculture and forestry.
K30D-09103	Duiwe	D	F: Dam and irrigation. NF: Agriculture and forestry.
K30D-09171	Duiwe	D	F: Related to upstream dams and irrigation.

The Maalgate River (K30A-9087) is primarily impacted by flow related activities namely abstraction for irrigation, while the non-flow related agricultural impacts also contribute to the largely modified PES of a D. The Malgas River (K30B-9082) and especially the upper reaches of this SQ is in a good condition (PES of B), while the lower reaches are impacted by a cement factory and golf estate (irrigation and return flows, as well vegetation removal). The remaining SQs of K30B has a PES of a D due to the non-flow related impacts (forestry and urban development) with some flow related

(irrigation) impacts in the Rooi River (K30B-9115) and K30B-9100, while water quality impacts (cement factory and irrigation return flows) are the primary causes for deterioration in the Gwaiing River (K30B-9158 and K30B9151). The Kaaimans River (K30C-9065) is still in a relatively good state with a PES of a B with the primary impacts being related to forestry. The Swart River (K30C9177) is, however, largely impacted by flow modification (George and Garden Route dams), resulting in a PES of a D. The Touws River (K30D-9042) is also still in a relatively good state with a PES of a B and the primary impacts being related to forestry. The remainder of K30D (Klein Keurbooms and Duiwe) is subjected to primarily flow related impacts (dams and irrigation abstraction), while non-flow related agriculture and forestry impacts contribute somewhat to the PES of C/D to D prevailing in this area.

5.3.4 K4 (Sedgefield, Diep, Hoëkraal and Karatara)

Table 5.6 River PES and key drivers resulting in modification from natural (K4)

SQ number	River	PES	Primary PES driver
K40A-09027	Diep	C	F: Mainly small farm dams. NF: Forestry and alien vegetation such as Wattle.
K40B-09022	Hoëkraal	B	NF: Forestry. F: Few small farm dams.
K40C-09036	Karatara	B	NF: Forestry.
K40C-09095	Huis	C	NF: Forestry and agriculture.
K40C-09140	Karatara	B	NF: Vegetation clearing; agriculture.
K40E-09016	Homtini	B/C	NF: Agriculture in lower reaches (vegetation clearing); some forestry in upper reaches.

Both the Hoëkraal and Karatara are category B rivers and have large portions with indigenous forest. The Huis River, which is a tributary of the Karatara is in a C category and the main impacts are non-flow related, mainly forestry and agriculture. The Diep River is also in a category C, but the upper half of the SQ is likely a B with more impacts in the lower half. Impacts are mainly forestry encroachment into the riparian zone and invasion by alien plant species.

The Homtini River is in a category B/C with the majority of impacts occurring in the lower portions of the SQ. Impacts are mainly agriculture with associated vegetation clearing.

5.3.5 K5 (Knysna)

Table 5.7 River PES and key drivers resulting in modification from natural (K5)

SQ number	River	PES	Primary PES driver
K50A-09006	Knysna	A/B	N/A
K50A-09041	Kruis	B	N/A
K50A-09069	Knysna	B	N/A
K50B-09111	Gouna	B	N/A

The Knysna River system runs mostly through mountainous terrain with indigenous forests and has low impacts overall. Consequently the PES is high throughout the system although forestry and

invasion by alien plant species does occur especially towards the lower part of the catchment towards the estuary.

5.3.6 K6 (Keurbooms)

Table 5.8 River PES and key drivers resulting in modification from natural (K6)

SQ number	River	PES	Primary PES driver
K60A-08947	Keurbooms	C/D	NF: Agriculture, vegetation removal.
K60B-08969	Kwaai	B	N/A
K60C-08992	Keurbooms	B	N/A
K60D-09017	Palmiet	A	N/A
K60D-08994	Dwars	B	N/A
K60D-08996	Palmiet	A	N/A
K60E-09085	Duiwelsgat	B	N/A
K60E-09114	Keurbooms	B	N/A
K60E-09097	Keurbooms	B	N/A
K60F-09092	Bitou	B/C	NF: Agriculture, vegetation removal. F: Small farm dams, irrigation.
K60G-09200	Piesang	D	NF: Vegetation removal (agriculture, urbanisation). F: One large dam, several small farm dams.
K60G-09180	Noetsie	B	N/A

Most rivers in the Keurbooms system are in a category B or better, with the impacts that exist being non-flow related vegetation removal or the presence of alien plant species. The Keurbooms River has the high biodiversity important Bitou wetlands in the lower parts of the Keurbooms River adjacent to the Keurbooms estuary. The Bitou River (B/C category) also has both flow (small farm dams and irrigation) and non-flow (loss of riparian vegetation to agriculture) related impacts, while the riparian zone of the upper portion of the Keurbooms (K60A-08947) is largely fragmented by agricultural activities. The Piesang River on the other hand is the most impacted system in this secondary catchment with both flow (dams) and non-flow related (loss of riparian vegetation due to agriculture and urban development) impacts.

5.3.7 K7 (Bloukrans)

Table 5.9 River PES and key drivers resulting in modification from natural (K7)

SQ number	River	PES	Primary PES driver
K70A-09075	Groot	B	N/A
K70A-09068	Bobbejaan	B	N/A
K70A-09113	Groot	B	N/A
K70A-09086	Salt	B	N/A
K70A-09110	Matjies	B	N/A
K70B-09055	Bloukrans	B	N/A

All the rivers in K7 are near natural (category B) with minimal removal of riparian vegetation in localised areas and some forestry.

5.3.8 J1 (Groot Catchment)

Table 5.10 River PES and key drivers resulting in modification from natural (J1)

SQ number	River	PES	Primary PES driver
J11A-07820	Komsberg	A	N/A
J11A-07821	Venters	A	N/A
J11A-07912	(unnamed stream)	B/C	NF: Agriculture, some aliens. F: Few small farm dams (some broken).
J11A-07923	Buffels	B	N/A
J11A-07980	Komsberg	A	N/A
J11B-07772	Beerfontein se Laagte	B	N/A
J11B-07782	Dwars	B	N/A
J11B-07863	(unnamed stream)	A	N/A
J11B-07901	Swaerkraal	A/B	N/A
J11B-07984	Koringplaas	B	N/A
J11B-08033	Dwars	A	N/A
J11B-08099	Swaerkraal	A	N/A
J11C-08102	Buffels	A	N/A
J11C-08131	Bloubank se	A	N/A
J11C-08151	Buffels	A	N/A
J11D-07988	Meintjiesplaas	B	N/A
J11D-08035	Rooival	B	N/A
J11D-08065	(unnamed stream)	B/C	NF: Agriculture and some alien plant species. F: Small farm dam.
J11D-08091	Meintjiesplaas	B	N/A
J11D-08094	Meintjiesplaas	B	N/A
J11D-08162	Roggeveld	C	F: Small farm dams. NF: Agriculture in riparian zone.
J11D-08167	(unnamed stream)	B	N/A
J11D-08231	Roggeveld	B	N/A
J11D-08269	Meintjiesplaas	B	N/A
J11E-08244	Wilgehout	B	N/A
J11E-08311	Buffels	B/C	NF: Urban development. F: Irrigation (small).
J11E-08425	Baviaans	C	NF: Agriculture, urban development, alien plant species. F: Irrigation (small.)
J11F-08427	Buffels	C	NF: Agriculture. F: Irrigation (large dam only at end of SQ).
J11F-08460	Buffels	C	NF: Agriculture. F: Irrigation.
J11F-08488	Witbergs	B	N/A
J11G-08230	Geelbek	B	N/A
J11G-08407	Hartebees-spruit	A/B	N/A
J11H-08543	Buffels	C/D	F: Directly downstream of Floriskraal Dam.

SQ number	River	PES	Primary PES driver
			NF: Agriculture.
J11H-08546	(unnamed stream)	A	N/A
J11H-08557	Buffels	C	F: Potential impacts from Floriskraal Dam and irrigation in SQ. NF: Agriculture in riparian zone and floodplains.
J11H-08584	(unnamed stream)	A	N/A
J11H-08585	Klein-Swartberg	D	NF: Removal of riparian and floodplain vegetation for agriculture and invasion by alien plant species. F: Irrigation.
J11H-08647	Buffels	B	N/A
J11J-08659	Swartberg	D	NF: Extensive agriculture and vegetation clearing. F: Irrigation.
J11J-08686	Groot	D	NF: Extensive agriculture and vegetation clearing. F: Irrigation
J11K-08705	Knui	C	NF: Agriculture
J11K-08828	Groot	D	NF: Extensive agriculture and vegetation clearing. F: Irrigation 1 farm dam
J11K-08860	Groot	D	NF: extensive agriculture and vegetation clearing; F: irrigation
J12A-08554	Smalblaar	C	F: Small farm dams. F: Agriculture in riparian zone
J12A-08628	Bok	B	F: Small dam in headwater that feeds canal to reservoir.
J12B-08556	Donkies	C	F: Verkeerdevlei Dam at the start of the SQ.
J12B-08605	Donkies	D	NF: Agriculture, urban development, alien plant species. F: Irrigation.
J12B-08656	(unnamed stream)	E	NF: Agriculture, channel and floodplain disturbance and manipulation. F: Irrigation and some small farm dams.
J12C-08478	Ysterdams	C	NF: Agriculture
J12C-08515	Jan Deboers	C	F: Small farm dams. NF: Agriculture in riparian zone.
J12C-08526	Ysterdams	D	WQ: Touws River town. NF: Agriculture and aliens plant species. F: Irrigation.
J12D-08576	(unnamed stream)	B	N/A
J12D-08643	Touws	D	NF: Agriculture. F: Irrigation
J12D-08663	Touws	D	NF: Vegetation clearing, artificial levees channel manipulation.
J12D-08664	(unnamed stream)	B	F: Several small farm dams, mostly dry.
J12D-08681	Touws	C	WQ: According to rating. F: Irrigation and upstream cumulative effects.
J12D-08695	Touws	C	F: Upstream cumulative effect of abstraction and small dams
J12D-08696	Touws	D	NF: Agriculture, some erosion.
J12D-08704	Dikkopskraal	C	NF: Agriculture.
J12D-08712	Lopende	B/C	F: Farm dams some quite large.
J12D-08735	Touws	D	NF: Clearing of riparian zone.
J12D-08762	Brak	B/C	NF: Agricultural encroachment. F: Few small farm dams.

SQ number	River	PES	Primary PES driver
J12E-08501	Kragga	B/C	F: Large dam at start and Gants Dam at end.
J12E-08645	Kragga	B/C	NF: Riparian zone fragmentation.
J12E-08646	(unnamed stream)	B	F: Kaalpan Dam (notes used - no Google image available).
J12F-08717	Touws	D	NF: Agriculture. F: Irrigation.
J12F-08751	Touws	D	F: Fairly large dam in tributary.
J12F-08810	Doring	B	N/A
J12F-08814	Kruis	B	N/A
J12F-08838	Stinkfontein	B	N/A
J12F-08840	Kruis	C	NF: Floodplain disturbance. F: Farm dams (small).
J12G-08549	Elandskloof	B/C	NF: Agriculture in upper portion.
J12G-08550	(unnamed stream)	A	N/A
J12G-08587	Prins	B	N/A
J12G-08606	(unnamed stream)	B	N/A
J12G-08631	(unnamed stream)	B	N/A
J12G-08699	(unnamed stream)	B	N/A
J12H-08716	Prins	C	F: Prins Dam and several small farm dams. NF: Extensive agriculture in some areas.
J12H-08790	Touws	B	N/A
J12H-08834	Touws	C	F: Dam with canal off take, reed increase due to flow reduction.
J12J-08949	Gatskraal	C	F: Small farm dams. NF: Agricultural encroachment and clearing of vegetation.
J12J-08970	Gatskraal	C	NF: Extensive orchards, backup zone of Bellair Dam. F: Irrigation.
J12J-08979	Wilgebos	A/B	N/A
J12J-08988	Kalkoenshoek	B/C	NF: Agriculture especially and the beginning and end of SQ, extensive physical channel manipulation in places.
J12K-08867	Brak	B/C	NF: Agriculture. F: Upstream Bellair Dam
J12K-08887	Brak	B/C	NF: Agriculture. F: Upstream Bellair Dam.
J12K-08918	(unnamed stream)	A/B	N/A
J12K-08920	Bakoond se Leegte	A	N/A
J12K-08960	Brak	D/E	F: Bellair Dam.
J12L-08831	Touws	B/C	NF: Agriculture.
J12L-08930	Doring	B	N/A
J12L-08950	Koenjekuils	B	N/A
J12L-08983	Doring	C	NF: Extensive agricultural encroachment.
J12L-08985	Doring	C/D	NF: Extensive agricultural encroachment.
J12L-09004	(unnamed	B	N/A

SQ number	River	PES	Primary PES driver
	stream)		
J12L-09035		B	N/A
J12L-09084	Doring	C/D	NF: Extensive agricultural encroachment.
J12M-08904	Touws	D	NF: Agriculture.
J12M-08975	Brand	C/D	NF: Agriculture.
J12M-08976	Touws	C/D	NF: Agriculture.
J12M-08986	(unnamed stream)	C/D	F: Large dam. NF: Agriculture.
J12M-09003	Brand	D	F: Mierjieskraal Dam. NF: Agriculture.
J12M-09067	Brand	C	F: Small farm dams. NF: Agriculture.
J12M-09076	(unnamed stream)	C	F: Fairly large dam and some smaller dams.
J13A-08883	(unnamed stream)	A/B	N/A
J13A-08891	Huis	B	N/A
J13A-08905	Groot	C	NF: Agriculture.
J13A-08933	Groot	C	NF: Agriculture. F: Upstream dam (cumulative).
J13A-08946	Piets	B/C	
J13A-08954	Groot	C	F: Moderately large dam.
J13B-08900	Bos	B	N/A
J13B-08923	Groot	C	F: Dam with backup and resultant reed beds.
J13B-08938	Groot	C	F: Dam with backup and resultant reed beds.
J13B-08993	Derde	B	N/A
J13C-08915	Groot	B/C	F: Dams and upstream dams. NF: Agriculture.
J13C-09081	Wabooms	B	N/A
J13C-09099	Groot	B	N/A

Buffels and tributaries up to Floriskraal Dam:

Most of these streams occur in mountainous areas and have low impacts. Overall, the PES of this area is in a category B or higher, with only four of the 32 SQs in a C category (Roggeveld and Buffels - J11F-08427 and J11F-08460). Impacts are predominantly agriculture, irrigation and small farm dams. Some alien plant species also occur in the area.

Groot and tributaries downstream of Floriskraal Dam to Touws River confluence:

Most of the streams in this portion are in C or D categories with the exception of J11H-08584 and the Buffels (J11H-08647) which are a category A and B, respectively. Other than the mainstream Buffels and Groot rivers being impacted by the Floriskraal Dam there is also extensive irrigation in the area and associated agriculture which fragments and deteriorates the riparian zone and associated floodplains. Alien plant species have invaded some areas.

Touws River and tributaries from source to confluence with Prins River:

The rivers in this area are mixed in terms of their PES. About half of the SQs are in a category B/C or better and about half in a category C or D. There are no category A or A/B SQs and only a single E-category (J12B-08656). The main impacts in the area are both flow and non-flow related. Flow related impacts include multiple small farm dams in areas, irrigation (extensive in some areas), and a few large dams, e.g. Verkeerdevlei and Gants Dams. Non-flow related impacts are mainly agricultural encroachment or clearing of riparian zones and/or floodplains, overgrazing in areas and physical disturbance (manipulation) of morphological features (localised). Some canals exist for off-take to reservoirs and some artificial levees and river course manipulation is evident. Several of the upper SQs fall within the southern extreme of the Riverine Rabbit distribution *(Bunolagus monticularis*), which is a critically endangered riparian mammal.

Prins River to the confluence with the Touws River:
Most of the SQs in this area traverse mountainous areas with few impacts and are predominantly B category rivers. The Prins Dam (large dam) occurs towards the end of the Prins River reach, and several small farm dams occur in some places. Where topography allows there is intense but localised agricultural activities with irrigation in places and some off take via canals. In these areas the PES has deteriorated to a category B/C or C.

Brak River and tributaries to the confluence with the Touws River:
Mostly category B/C and C rivers with some of the mountainous tributaries in category A or A/B (Wilgebos).

5.3.9 J2 (Gamka Catchment)

Table 5.11 River PES and key drivers resulting in modification from natural (J2)

SQ number	River	PES	Primary PES Driver
J21A-07192	Gamka	**B**	N/A
J21A-07211	Kuils	**C**	F: Although only in lower section of SQ, this dam contributes notably to PES. WQ: Beaufort West town.
J21A-07327	Stols	**B**	N/A
J21A-07390	Gamka	**B/C**	F: Various upstream dams. WQ: Beaufort West.
J21A-07479	Gamka	**B/C**	F: Various upstream dams. WQ: Beaufort West.
J21A-07499	Kwagga	**C**	F: Although in lower reach of SQ, the large dam contributes primarily to the reduced PES.
J21B-07373	Steyns	**B**	N/A
J21B-07386	(unnamed stream)	**B**	N/A
J21B-07449	Sand	**A/B**	N/A
J21B-07503	Steyns	**B**	N/A
J21B-07533	Gamka	**B**	N/A
J21B-07538	Boeteka	**C**	NF: Agriculture (Olives). F: Dams.
J21B-07568	Gamka	**B**	N/A
J21B-07597	Gamka	**B**	N/A

SQ number	River	PES	Primary PES Driver
J21B-07611	Gamka	B	N/A
J21C-07641	Put	B	N/A
J21C-07643	Ongeluks	B	N/A
J21C-07664	Put	B	N/A
J21C-07669	Plaatjies	C	F: Farm dams and NF: Agriculture.
J21C-07671	Put	B	N/A
J21D-07572	Keulders	A/B	N/A
J21D-07577	(unnamed stream)	B	N/A
J21D-07610	Gamka	B	N/A
J21D-07626	Gamka	B	N/A
J21D-07665	Gamka	B	N/A
J21D-07700	Gamka	B	N/A
J21D-07754	Brandleegte	A	N/A
J21E-07830	Gamka	B	N/A
J21E-07846	Veldmans	A	N/A
J21E-07856	Veldmans	B	N/A
J21E-07904	Lammerkraal	B	N/A
J22A-07189	Oukloof	A	N/A
J22A-07228	Koekemoers	A	N/A
J22A-07241	(unnamed stream)	A	N/A
J22A-07279	(unnamed stream)	A	N/A
J22B-07173	Teekloof	A/B	N/A
J22B-07277	Hoedemakers	A	N/A
J22B-07311	Teekloof	B	N/A
J22C-07316	Omdraaiskraal	A	N/A
J22C-07318	Slingersfontein	A/B	N/A
J22C-07326	Waaikraal	A	N/A
J22C-07432	Omdraaiskraal	A	N/A
J22C-07446	Waaikraal	B	N/A
J22D-07343	Koekemoers	B	N/A
J22D-07398	(unnamed stream)	A	N/A
J22D-07415	Viskuil	A/B	N/A
J22D-07476	Viskuil	B	N/A
J22D-07559	Waaikraal	B	N/A
J22D-07575	Waaikraal	A/B	N/A
J22D-07656	Koekemoers	A	N/A
J22E-07427	(unnamed stream)	A	N/A
J22E-07470	Wilgerbos	A	N/A
J22E-07561	Wilgerbos	B	N/A
J22E-07638	Wilgerbos	A	N/A
J22E-07653	Puts	B	N/A
J22E-07694	Wilgerbos	B	N/A

SQ number	River	PES	Primary PES Driver
J22E-07697	Rietpoort	A/B	N/A
J22F-07751	Koekemoers	B	N/A
J22F-07766	Boesmans	B	N/A
J22F-07805	Koekemoers	B/C	NF: Farming (fields).
J22F-07897	Leeu	C	WQ: Leeu-Gamka WWTW. NF: Leeu-Gamka town.
J22G-07015	Leeu	B	N/A
J22G-07124	Leeu	A	N/A
J22G-07154	(unnamed stream)	A	N/A
J22G-07187	Leeu	A/B	N/A
J22G-07202	Leeu	A/B	N/A
J22G-07270	Paalhuis	A/B	N/A
J22H-07100	Klipplaatfontein	B	N/A
J22H-07172	Sand	A	N/A
J22H-07280	Leeu	A/B	N/A
J22H-07289	Doringhoek	A	N/A
J22H-07356	Sand	A/B	N/A
J22H-07411	Leeu	B	N/A
J22J-07346	Hottentots	B	N/A
J22J-07359	Brakwater	B	N/A
J22J-07375	Middelwater se	B	N/A
J22J-07517	Klipkuile se	B	N/A
J22J-07529	Hottentots	A	N/A
J22J-07609	Hottentots	A	N/A
J22J-07614	Syfersleegte	A	N/A
J22K-07366	Rietkuil	B	N/A
J22K-07551	Leeu	A	N/A
J22K-07601	Leeu	A/B	N/A
J22K-07655	Leeu	C	F: Leeu-Gamka Dam and irrigation.
J23A-07865	Saai	B	N/A
J23A-07922	Gamka	C/D	F: Leeu-Gamka Dam and irrigation. WQ: Irrigation return flows and Leeu-Gamka town.
J23A-07929	Klip	B	N/A
J23A-07930	Perdewater se Loop	A	N/A
J23A-07962	Gamka	D	F: Dam in reach plus upstream dams, as well as abstraction for irrigation (WQ: Irrigation return flow). NF: Agriculture.
J23A-07967	(unnamed stream)	A	N/A
J23A-07990	Saai	A	N/A
J23A-08007	Gamka	D	F: Dam in reach plus upstream dams, as well as abstraction for irrigation (WQ: Irrigation return flow). NF: Agriculture.
J23B-07991	Groot	A	N/A
J23B-08017	Gamka	C	F: Upstream dams and abstraction. WQ: Irrigation return flows and Leeu-Gamka town to small

SQ number	River	PES	Primary PES Driver
			degree.
J23B-08024	Rietpoort	A	N/A
J23B-08071	Groot	A/B	N/A
J23B-08073	Bloukloofleegte	A	N/A
J23B-08086	Groot	B	N/A
J23B-08113	Waswater	A	N/A
J23B-08123	Gamka	C	NF: Agriculture (small areas). F: Aggregate of upstream abstraction and dams.
J23C-08155	Gamka	B	N/A
J23C-08157	(unnamed stream)	A	N/A
J23C-08176	Gamka	B	N/A
J23C-08180	(unnamed stream)	A	N/A
J23C-08205	Kweekleegte	A	N/A
J23C-08212	Gamka	B	N/A
J23C-08217	Gamka	B	N/A
J23C-08265	Gedenksteen se Leegte	A	N/A
J23D-08214	Tierbergs	A	N/A
J23D-08247	Botterkraal	A	N/A
J23D-08295	Sand	A	N/A
J23D-08317	Sand	A	N/A
J23D-08351	Sand	A	N/A
J23D-08401	Sand	A	N/A
J23D-08413	(unnamed stream)	A	N/A
J23E-08400	Cordiers	D	F: Oukloof Dam. (NF: Agriculture)
J23E-08447	Gang se Leegte	A	N/A
J23E-08456	Cordiers	C/D	NF: Agriculture. F: Farm dams and Oukloof dam in lower 10% of SQ.
J23F-08268	Gamka	B	N/A
J23F-08327	Swart	C	F: Prince Albert abstraction and dams in reach). WQ: Prince Albert town.
J23F-08328	Sand	B	N/A
J23F-08334	Gamka	B	N/A
J23F-08335	Gamka	B	N/A
J23F-08389	Tryntjies	B	N/A
J23F-08403	Dorps	C	NF: Prince Albert town and agriculture. F: Abstraction for irrigation and town).
J23G-08124	Kat	B	N/A
J23H-08359	Gamka	B	N/A
J23H-08415	Gamka	B	N/A
J23H-08439	Dewits	B	N/A
J23J-08490	Huis	B	N/A
J23J-08497	Gamka	C	NF: Mostly associated with inundation by Gamkapoort Dam.
J24A-07570	Driefontein se	A	N/A

SQ number	River	PES	Primary PES Driver
J24A-07608	Dwyka	B	N/A
J24A-07618	Ongeluksfontein	A/B	N/A
J24A-07648	Rotjieskraal se	A	N/A
J24A-07720	Vanwyks	A	N/A
J24A-07746	Tuin	A	N/A
J24A-07756	Dwyka	A	N/A
J24A-07778	Juk	A	N/A
J24A-07786	Dwyka	A	N/A
J24A-07871	Dwyka	A	N/A
J24B-07667	Vanderbylskraal	B	N/A
J24B-07797	Wolwefontein	B	N/A
J24B-07905	Dwyka	A	N/A
J24B-07921	Steenkamp	A	N/A
J24B-07933	Dwyka	A	N/A
J24B-07975	Dwyka	A	N/A
J24B-07998	Dwyka	A	N/A
J24C-07925	Bad	A	N/A
J24C-07985	Droëfontein	A	N/A
J24C-07986	Frieshoek	A	N/A
J24C-08020	Perdelaagte	A	N/A
J24C-08051	Dwyka	A	N/A
J24C-08062	Bad	B	N/A
J24C-08079	Kierie	A	N/A
J24C-08096	Dwyka	A	N/A
J24C-08115	Koeel	A	N/A
J24C-08158	Dwyka	A	N/A
J24C-08194	Bad	A	N/A
J24D-08055	Vlakkraal	B	N/A
J24D-08109	Bloed	A	N/A
J24D-08163	Kalkgat	A	N/A
J24D-08185	Bloed	A/B	N/A
J24D-08227	Wilgerbos	A	N/A
J24D-08234	Dwyka	A	N/A
J24D-08270	Dwyka	A	N/A
J24D-08281	Dwyka	A	N/A
J24D-08345	Dwyka	A	N/A
J24E-08292	Dwyka	A	N/A
J24E-08345	Jakkals	A	N/A
J24E-08370	(unnamed stream)	A	N/A
J24E-08393	Kerks	A	N/A
J24E-08396	Dwyka	A	N/A
J24E-08451	Dwyka	A	N/A
J24F-08496	Elandskloof	A	N/A
J24F-08506	Dwyka	A	N/A
J24F-08509	Bosluiskloof	A	N/A

SQ number	River	PES	Primary PES Driver
J24F-08531	Dwyka	A	N/A
J25A-08536	Gamka	C/D	F: Gamkapoort Dam.
J25A-08567	Gamka	B/C	F: Gamkapoort Dam.
J25A-08577	Oshoekshang	A	N/A
J25B-08591	Kobus	D	NF: Agriculture. F: Farm dams and abstraction for irrigation.
J25C-08776	Gamka	B	N/A
J25C-08789	Taais	A	N/A
J25C-08795	Gamka	C/D	NF: Agriculture.
J25D-08626	Nels	D	F: Calitzdorp Dam and irrigation abstraction (NF: Agriculture. WQ; Irrigation and dam.
J25E-08769	Gamka	C/D	NF: Agriculture. F: Abstraction for irrigation. WQ: Irrigation return flows and Calitzdorp town.
J25E-08870	(unnamed stream)	A/B	N/A
J25E-08884	Gamka	C	F: Upstream abstraction for irrigation. WQ: Irrigation return flows.

Most of the upper reaches of catchment J2 (J21, J22, J23 and J24) is in a good PES ranging between categories A, A/B and B. These areas are generally seasonal or ephemeral, and impacts are limited to livestock farming, some agriculture and dams as well as towns. Some reaches are in a more deteriorated state (C to D) due to primarily non-flow related farming impacts (livestock and agriculture) and limited flow modification associated with farm dams include the Kuils (J21A-07211), Kwagga (21A-07499), Boeteka (J21B-07538), Plaatjies (J21C-07669), Koekemoers (J22F-07805) rivers.

The sub-quaternary reaches of the Leeu (F22F) and the Gamka rivers (J23A and J23B) in the vicinity and especially downstream of the town of Leeu-Gamka are also in a deteriorated PES, ranging between a C and D due to flow modification (dams and abstraction for irrigation), water quality deterioration (Leeu-Gamka town and irrigation return flows) as well as non-flow related impacts associated with farming (cultivated lands in riparian zone, over grazing by livestock).

The Cordier, Swart and Dorps Rivers in the vicinity of Prince Albert are in a deteriorated PES ranging between C and D due to flow modification (Oukloof Dam, farm dams and irrigation), non-flow related impacts (agriculture, towns developments) and water quality impacts (town and irrigation return flows).

The lower Gamka River (J23J, J25A, J25C, J25E) is also in a deteriorated state due to modified flows (Gamkapoort Dam, abstraction for irrigation and towns), as well as non-flow related impacts (extensive agricultural activities along the river) as well as water quality deterioration (irrigation return flows and the town of Calitzdorp). The Kobus River (J25B-08591) is highly cultivated in some section, resulting in a PES of D, while the Nels River (J25D-08626) is impacted by flow modification (Calitzdorp Dam) as well as non-flow related and water quality impacts associated with the extensive agricultural areas.

5.3.10 J3 (Olifants Catchment)

Table 5.12 River PES and key drivers resulting in modification from natural (J3)

SQ number	River	PES	Primary PES driver
UPPER OLIFANTS (J31)			
J31A-08620	Olifants	B	N/A
J31A-08654	Olifants	B	N/A
J31A-08660	Olifants	B	N/A
J31A-08665	Olifants	B	N/A
J31A-08721	(unnamed stream)	B	N/A
J31A-08724	(unnamed stream)	B	N/A
J31A-08728	(unnamed stream)	B	N/A
J31B-08675	Hartbees	B	N/A
J31B-08708	Nouga	B	N/A
J31B-08709	Hartbees	C	NF: Overgrazing, erosion, bank disturbance (agriculture).
J31C-08569	(unnamed stream)	B	N/A
J31C-08638	Olifants	C	NF: Riparian buffer zone compromised, bank and channel disturbance. F: Abstraction for irrigation.
J31D-08592	Olifants	B/C	NF: agricultural practices, erosion in tributaries, In certain places lack of riparian buffer zone.
J31D-08650	Olifants	B/C	NF: Crossings, minimal riparian issues. F: Upstream abstraction.
J31D-08667	(unnamed stream)	B	N/A
TRAKA (J32)			
J32A-08081	Traka	C	NF: Combination of agricultural practices and grazing to be controlled. Impacts appear localised.
J32A-08125	Kapteinskraal	A/B	N/A
J32B-08215	Rondawel	B	N/A
J32B-08279	Traka	B	N/A
J32B-08332	Traka	B	N/A
J32B-08339	Nuwejaarsfontein se Loop	A	N/A
J32B-08341	Traka	B	N/A
J32B-08391	(unnamed stream)	A/B	N/A
J32B-08419	Traka	B	N/A
J32B-08428	Traka	B/C	NF: Main impact associated with grazing, trampling and some removal of vegetation. Buffer zone management required.
J32B-08432	Klein-Elandsfontein	A	N/A
J32B-08454	Bakoondslaagte	B	N/A

SQ number	River	PES	Primary PES driver
J32C-08098	Kouka	B	N/A
J32C-08140	Wildfontein	B	N/A
J32C-08149	Kouka	B	N/A
J32C-08169	Vlieekraal	B	N/A
J32C-08301	Kouka	B	N/A
J32D-08261	Groot-Waterloop	B	N/A
J32D-08263	Loeriesfontein	B	N/A
J32D-08383	Traka	B	N/A
J32D-08452	Soetendalsvlei	C	NF: Inundation impact, barrier, agricultural fields in riparian zone.
J32D-08474	Traka	B	N/A
J32E-08420	Maermanskraal	A/B	N/A
J32E-08426	Sand	A/B	N/A
J32E-08471	Sand	B	N/A
J32E-08480	Donkerhoeks	B	N/A
J32E-08485	Traka	B/C	NF: Agricultural fields (some minor improvement on riparian buffer would be required if river should be improved).
J32E-08491	Matjiesvlei	C	NF: Erosion in lower reaches. Agricultural lands.
J32E-08492	Traka	C	NF: Agricultural lands.
J32E-08519	Matjiesvlei	B/C	NF: Localised farming activities. Barrier impact and inundation. F: Some cumulative flow impact from tributaries, but not dominant impact.
J32E-08521	Grasvlei se Loop	B/C	NF: Overgrazing, sedimentation.
J32E-08528	Varkies	B	N/A
J32E-08529	(unnamed stream)	B/C	NF: Grazing, localised agriculture.
J32E-08545	Traka	C	NF: Railway in river bed and marginal zone as well as irrigated lands.
MIDDLE OLIFANTS (J33)			
J33A-08615	Olifants	C	NF: Irrigated lands and roads in the riparian zone. WQ: Impacts due to return flows. F: Abstraction for irrigation.
J33A-08622	Olifants	C/D	NF: Inundation, barrier, agricultural fields. F: Release of flow into a long canal.
J33A-08706	Buffelsklip	C	NF: Extensive irrigation in approximately 40% of river. Irrigation return flows have increased density of riparian woody vegetation. F: Abstraction for irrigation.
J33A-08736	Wilge	C	NF: Extensive irrigation in the floodplains and riparian.
J33A-08768	Wilge	B	N/A
J33A-08770	(unnamed stream)	B	N/A
J33B-08635	Kuis	C	NF: Lower 50%: Irrigation in riparian zone.
J33B-08636	(unnamed stream)	C	NF: Lower 50%: Irrigation in riparian zone.
J33B-08637	Olifants	D	F: Extensive abstraction for irrigation. NF: Irrigated lands within riparian zone.
J33B-08639	Olifants	D	F: Extensive abstraction for irrigation.

SQ number	River	PES	Primary PES driver
			NF: Irrigated lands within riparian zone. Irrigation return flows.
J33B-08714	Olifants	D	F: Extensive abstraction for irrigation. NF: Irrigated lands within riparian zone (excluding inundation from downstream dam). Irrigation return flows.
J33B-08720	Rooi	C	NF: Lower 50%: Irrigation in riparian zone. F: Abstraction.
J33B-08749	Olifants	C	F: Upstream abstraction. Non-Flow: Irrigation return flow - Water Quality impacts.
J33B-08759	Marthinus	C	SQ situated within dam.
J33B-08773	Witboois	B	NF: Lower 50%: Irrigation in riparian zone. F: Abstraction.
J33C-08445	Groot	B/C	NF: Alien vegetation and encroachment of agricultural lands in the riparian zone.
J33C-08502	Sand	B	N/A
J33C-08522	Aaps	B	N/A
J33C-08524	Groot	D	F: Extensive canal systems and off channel dams. NF: Agricultural fields in riparian zone, irrigation return flows.
J33D-08525	(unnamed stream)	C	NF: Agricultural fields in riparian zone.
J33D-08538	Groot	C	F: Abstraction, tributary dams. NF: Agricultural fields in the riparian zone and irrigation return flows. Urban runoff.
J33D-08571	Meirings	C	Flow: Upstream abstraction. Downstream abstraction. NF: Road and crossings in riparian zone and in river channel at places. Agricultural fields, irrigation return flows.
J33E-08602	Nels	D	NF: Agricultural fields in riparian zone. Irrigation return flows. F: Abstraction for irrigation.
J33E-08649	Olifants	D/E	F: Operation of Stompdrift Dam. Non Flow: Barrier.
J33E-08757	Olifants	D	F: Operation of Stompdrift Dam.
J33E-08763	Olifants	D	F: Operation of Stompdrift Dam.
J33E-08777	Olifants	D	F: Operation of Stompdrift Dam.
J33E-08780	(unnamed stream)	C	NF: Agricultural lands have destroyed the confluence and last section of the actual river.
J33F-08588	Kango	C	NF: Agricultural lands in riparian zone. Agricultural return flows (good condition in upper areas).
J33F-08772	Olifants	E	Flow: Abstraction. NF: Extensive irrigation on banks. Extensive reed growth in channel due to irrigation return flows. Barriers, inundation, bank disturbance.
KAMMANASSIE (J34)			
J34A-08822	Kammanassie	D	NF: Aliens, bank manipulation, sedimentation, barriers, agricultural fields, etc.
J34A-08871	Holdrif	C/D	NF: Aliens, bank manipulation, sedimentation, barriers, agricultural fields, road for long section in river channel and/or riparian zone.
J34B-08807	Kammanassie	C	NF: Impacts related to Union Dale town.
J34B-08817	Kammanassie	C/D	NF: Agricultural lands to edge of river. Irrigation return flows. F: Dry river with significant abstraction to support irrigation.
J34B-08888	Potjies	D/E	NF: Alien vegetation, agricultural fields.
J34C-08859	Klues	B	

SQ number	River	PES	Primary PES driver
J34C-08869	Kammanassie	C	NF: Agricultural fields in riparian zone. Irrigation return flows. F: Upstream abstraction for irrigation and within SQ.
J34C-08937	Kammanassie	C	NF: Agricultural fields in riparian zone. Irrigation return flows. F: Upstream abstraction for irrigation and within SQ.
J34C-08942	Diep	D/E	NF: Extensive alien vegetation.
J34D-08853	Huis	B/C	NF: Improve riparian vegetation buffers and agricultural practices in the small zone of impact.
J34D-08868	Kammanassie	B/C	F: Upstream abstraction.
J34D-08899	Kammanassie	B/C	F: Upstream abstraction.
J34D-08956	Gansekraal	D	NF: Alien vegetation, agricultural fields in river.
J34E-08910	Brak	D	NF: Alien vegetation, agricultural fields in river.
J34F-08843	Kammanassie	E	F: Kamannasie Dam and flow modification. NF: Agricultural fields. Reed growth - return flows.
J34F-08848	Kammanassie	D/E	F: Kamannasie Dam and flow modification. NF: Agricultural fields. Reed growth - return flows.
J34F-08863	Doring	D	NF: Alien vegetation
LOWER OLIFANTS (J35)			
J35A-08544	Grobbelaars	C	NF: Agricultural fields, alien vegetation.
J35A-08551	Klein-Leroux	C/D	F: Two large dams. NF: Migration barriers, inundation, lawns etc.
J35A-08653	Grobbelaars	E	F: Upstream dams in Le Roux River. NF: Impacts associated with intensive irrigation and Oudtshoorn
J35B-08799	Olifants	D/E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, barriers and inundation.
J35B-08820	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, barriers and inundation.
J35B-08841	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, barriers and inundation.
J35B-08861	Klip	D	F: Numerous farm dams and irrigation. NF: Extensive agriculture and heavy invasion by Wattle.
J35B-08881	Kandelaars	D/E	NF: Extensive agriculture and alien vegetation.
J35B-08940	Doring	C	NF: Agriculture and alien vegetation.
J35B-08941	Kandelaars	C	F: Farm dams. NF: Agriculture.
J35C-08821	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35C-08873	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35C-08882	Moeras	D/E	NF: Agriculture and alien vegetation.
J35D-08578	Wynands	C	NF: Irrigated fields in riparian zone, removal of riparian, barriers, irrigation return flows.
J35D-08603	Meul	B/C	NF: Old and current lands. Flow: Many tributary lands.
J35D-08652	Kansa	B	N/A
J35D-08661	Droe	B	N/A

SQ number	River	PES	Primary PES driver
J35D-08742	Wynands	C/D	NF: Alien vegetation and agricultural fields.
J35D-08745	Wynands	C	NF: Alien vegetation and agricultural fields.
J35D-08854	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35E-08764	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35E-08816	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35E-08865	(unnamed stream)	B	N/A
J35F-08600	Vlei	C	NF: Alien vegetation, agricultural lands to edge of river. Irrigation return flows.
J35F-08739	Olifants	D	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35F-08849	Olifants	E	F: Abstractions. NF: Channel changes due to excessive reed growth, irrigation return flows, and inundation (back up from reeds.
J35F-08875		B	N/A

Upper Olifants:

Of the 15 SQs, 11 fall in a B PES Category. Only three of these SQs are in the main Olifants River, the rest are tributaries. Their good condition is due to the dry (mostly ephemeral) nature of the rivers (minimising options of use) and the topography (lack of access).

The remaining four SQs consist of three in the Olifants River (PES of a C and B/C and one in the Hartbees River (PES of a C). The impacts are largely non flow-related and consist of overgrazing, erosion, bank disturbance due to agriculture, and removal of the riparian zone to make place for agricultural fields.

Traka:

Of the 34 SQs, 24 fall in a B PES EC or higher. Their good state is due to the ephemeral nature of many of the rivers which occur in mountains areas and are inaccessible. Impacts are limited to localised agricultural activities and farm dams. The remaining 10 SQs consist of five in the main Traka River, with the rest in tributaries. Most of the impacts in the Traka River are dominated by non-flow related impacts due to grazing, agricultural practices and placing of agricultural fields within the riparian zone. In the lower Traka River, a railway line is situated in the river and marginal zone as it traverses through a Kloof in the Swartberg mountains. The impacts in the tributaries are similar to the Traka River's impacts with farm dams also resulting in barrier and inundation impacts.

Kammanassie River:

Of the 17 SQs, only one SC in the Klues River (J34C-08859) falls into a B PES. Three SQs fall into a B/C state (Huis (J34D-08853) and the Kammanassie (J34D-08868 and 08899). Most of the rest of the SQs fall in a C and C/D state. Sections in the Potjies and Diep rivers fall in a D/E due to extensive alien vegetationa and agricultural fields. The Kammanassie River downstream of

Kammanassie Dam falls into an E and D/E PES due to the flow modification, agricultural fields and return flows and extensive reed growth. Upstream of Kammanassie Dam the impacts are related to urban impacts, agricultural fields in the riparian zone, alien vegetation. The areas which are in the best condition are due to their inaccessibility in a deep river valley.

Middle Olifant and Groot rivers:
This catchment consists of 31 SQs. Due to the extensive utilisation of water for irrigation in this dry area, the river states are showing a negative trajectory leading to a progressive degradation in their ecological states. There are only five SQs which are in a B category whilst 15 SQs are in a PES of a C and only a few in B/C category. The reasons for this are due to abstraction for irrigation (flow-related impacts) and non-flow related secondary impacts from irrigation activities (irrigation fields in the riparian zones, irrigation return flows, etc.). In the main Olifants River downstream of Stompdrif Dam, the Olifants River deteriorates significantly and range from a D, D/E and E PES categories. These states relate to the minimal flow in the river, extensive reed growth in the channel, irrigation return flows and irrigation fields in the riparian zone.

Lower Olifants River:
Ten of the 26 SQs fall in the main Olifants River catchment area. All of these SQs apart from the most downstream SQ have a PES of a D/E and E Categories. This is due to flow modifications, the excessive reed growth in the channel due to the irrigation return flows, alien vegetation and changes in the physical channel. Water quality impacts from the return flows will also be severe.

Three SQs lies within the Grobbelaars River and its tributary, the Klein-Leroux River. Some of the mountainous areas are in reasonable condition, but the lower Grobbelaars River is in an E PES due to flow changes (e.g. Koos Raubenheimer Dam) and extensive irrigation as well as the impacts resulting from Oudtshoorn town through which it flows.

Of the remaining 13 SQs in the tributaries, there are four SQs in a PES of a B category namely the Kansa, Droë and two unnamed rivers. The rest are in lower categories and two SQs that have deteriorated to a PES of a D/E (Moeras and Kandelaars rivers). All impacts are associated with alien vegetation and extensive agriculture and irrigation activities.

5.3.11 J4 (Gouritz)

Table 5.13 River PES and key drivers resulting in modification from natural (J4)

SQ number	River	PES	Primary PES driver
J40A-08924	Gouritz	C	F: Related to upstream modifications (WQ: upstream impacts). Within reach limited NF impacts: Agriculture/livestock farming
J40A-08961	Slang	C	NF: Primarily related to agricultural (dry-land) activities.
J40A-08967	Slang	C	NF: Episodic river primarily impacted by agricultural activities.
J40A-08997	(unnamed stream)	C	NF: Primarily related to agricultural (dry-land) activities.
J40A-09020	Gouritz	C	F: Related to upstream modifications (WQ: upstream impacts). Within reach limited NF impacts: Agriculture/livestock farming
J40B-09054	Kamma	B	N/A

SQ number	River	PES	Primary PES driver
J40B-09073	Gouritz	C	F: Related to upstream modifications (WQ: upstream impacts). Most of inaccessible reach and hence very limited local impacts.
J40B-09106	Gouritz	C	F: Related to upstream modifications (now also including J1) and irrigation within reach. (WQ: upstream impacts). Some of inaccessible reach with some local impacts related to agriculture.
J40C-09105	Langtou	D	NF: Agriculture.
J40C-09156	Weyers	C	NF: Mixed agriculture, grazing, dairy, irrigated (vineyards and vegetables in upper catchment) and dry land cultivation (wheat in lower catchment).
J40C-09169	Gouritz	C/D	F: Related to upstream modifications and irrigation within reach. (WQ: upstream impacts). NF: Within reach related to agricultural activities.
J40D-09178	(unnamed stream)	C/D	NF: Agriculture.
J40D-09185	Vals	C	NF: Agriculture.
J40D-09236	Gouritz	C/D	F: Related to upstream modifications and irrigation within reach. (WQ: upstream impacts). NF: Within reach related to agricultural activities.
J40D-09250	Gouritz	C/D	F: Related to upstream modifications and irrigation within reach. (WQ: upstream impacts). NF: Within reach related to agricultural activities.
J40E-09273	Stink	C	NF: Agricultural activities.
J40E-09284	Gouritz	C	F: Related to upstream modifications and irrigation within reach. (WQ: upstream impacts). NF: Within reach related to agricultural activities.
J40E-09307	Buffels	D	NF: Agriculture/farming. F: Some small dams.
J40E-09371	(unnamed stream)	C/D	F: Flow modification and irrigation adjacent to river.

Main Gouritz, Slang and Kamma rivers:

The main stem of the Gouritz River in J40A (8924 and 9020) is primarily impacted by flow related activities in the upper catchment (J2 and J3), with limited non-flow related activities (agriculture) within this reach, resulting in a PES of a C category. The Slang River (J40A-8967, 8997, 8961) is ephemeral and primarily impacted by non-flow related impacts associated with dry land agriculture, resulting in a PES of a C. The Kamma River (J40B-9054) is mostly natural with limited farming activities (non-flow related) contributing to a PES of a B. The Gouritz River in J40B remains primarily impacted by upstream flow and water quality alterations, with J40B-9106 also impacted by the activities in catchment J1, but still remaining in a category C due to minimal localised impacts (agriculture).

Weyers, Langtou, Gouritz, Vals, and Stink rivers:

The Weyers River (J40C-09156) originates in the Paardeberg Nature Reserve, with the upper reaches therefore being in a close to natural state. The lower reaches of this river is impacted by mixed agriculture, grazing, dairy, irrigated (vineyards and vegetables) and dry land cultivation (wheat), resulting in an overall PES of C. The lower Langtou (J40C) is primarily impacted by agricultural activities while the upper reaches seem to be in a fairly good state with limited impacts. The Gouritz River in J40C remains primarily impacted by upstream flow and water quality

alterations, but with the PES deteriorating to a category C/D due to the inclusion of localised agricultural impacts (flow and non-flow related). This PES is also continued downstream into J40D where localised farming impacts increase and contribute to the deterioration. The upper reaches of J40D-9178 is in a relative undisturbed state, while the lower reaches is impacted by agricultural activities, with the overall reach estimated to be in a PES of a C/D. The Vals River (J40D-09185) is largely impacted by agricultural activities (non-flow related) resulting in an overall PES of a C. The Stink River (J40E-9273) is impacted by agricultural (seems to be mostly dry land) activities resulting in a PES of C.

5.3.12 H8 (Duiwenhoks)

Table 5.14 River PES and key drivers resulting in modification from natural (H8)

SQ number	River	PES	Primary PES Driver
H80A-09154	Duiwenhoks	C	NF: Agriculture (F: Lower section of SQ Duiwenhoks Dam).
H80B-09149	Duiwenhoks	C	NF: Agriculture.
H80C-09209	Spieels	C/D	NF: Farming.
H80C-09290	Hooikraal	D	NF: Agriculture.
H80C-09208	Duiwenhoks	D/E	F: Duiwenhoks Dam. NF: Agriculture, WQ: Dam and agriculture.
H80C-09303	Duiwenhoks	C/D	F: Duiwenhoks Dam. NF: Agriculture, WQ: Dam and agriculture.
H80D-09293	Pienaars	D	NF: Farming (crops and livestock).
H80D-09286	Duiwenhoks	D	F: Duiwenhoks Dam and abstraction. NF: Agriculture.
H80E-09366	(unnamed stream)	B/C	NF: Agriculture (in lower section).
H80E-09314	Duiwenhoks	D	F: Duiwenhoks Dam and abstraction. NF: Agriculture.

The upper reaches of the Duiwenhoks River (H80A-09154 and H80B-09149) is subject to primarily non-flow related impacts (agriculture), with the Duiwenshok Dam situated in the lower reaches of H80A-09154, resulting in an overall PRES of C. The flow modification and water quality impacts of the Duiwenhoks Dam are more significant in the next downstream reach of the Duiwenhoks River (H80C-09208) and, together with the agricultural impacts (including irrigation) and Heidelberg town, result in a deteriorated PES of D/E. The Hooikraal River (H80C-09290) is primarily impacted on by non-flow related activities (farming) resulting in a PES of D. The Spieels River (H80C-09209) is also primarily impacted on by non-flow related activities (farming), which were the primary drivers, causing the PES of C/D. The Duiwenhoks River improves slightly in the lower reaches (H80D-9286 and H80D-9314) to a category D, but is still impacted notably by the flow modification (Duiwenhoks Dam and abstraction for irrigation) as well as non-flow related activities (farming). The Pienaars River (H80D-09293) is primarily impacted by farming activities (crops and livestock) resulting in a PES of D.

5.3.13 H9 (Goukou)

Table 5.15 River PES and key drivers resulting in modification from natural (H9)

SQ number	River	PES	Primary PES Driver
H90A-09165	Kruis	D	NF: Agriculture.
H90A-09166	Goukou	C	NF: Agriculture.
H90B-09155	Korinte	D	F: Korintepoort Dam. NF: Agriculture.
H90C-09211	Naroo	D	NF: Agriculture.
H90C-09220	Vet	E	NF: Riversdale urban area and agricultural impacts (including upstream contribution).
H90C-09229	Goukou	C/D	NF: Agriculture.
H90D-09254	Soetmelks	D	NF: Agriculture.
H90D-09278	(unnamed stream)	D	NF: Agriculture.
H90D-09282	Brak	D	NF: Agriculture.
H90D-09313	Wasfontein	C/D	NF: Agriculture.
H90D-09298	Soetmelks	D	NF: Agriculture.
H90D-09287	Goukou	D	NF: Agricultural. WQ: Riversdale WWTW, urban runoff and Golf course.
H90D-09316	Goukou	D	NF: Agricultural. F: Irrigation and WQ: return flows.
H90D-09318	Goukou	D	NF: Agricultural. F: Irrigation and WQ: return flows.
H90E-09364	(unnamed stream)	D	NF: Agriculture F: Dam in lower 10% of reach.
H90E-09343	Goukou	C	NF: Agricultural. F: Irrigation and WQ: return flows.

The Kruis River (H90A-09165) is impacted on by agricultural activities with the middle section being fairly natural, but overall classified in a PES of a D. The Goukou River originates in the Spioenkop Nature Reserve and later flows through the Broomvlei (Kruis River) Nature Reserve, but impacts related to agricultural activities and alien vegetation result in a PES of C. The primary impact in the Korinte River (H90B-09155) is associated with the Korintepoort Dam, together with agricultural activities resulting in a PES of D. The Naroo River (H90C-09211) is seriously impacted by agricultural activities resulting in a PES of D. After the confluence of these two rivers it becomes the Vet River (H90C-09220) which is in a deteriorated E PES due to the upstream agricultural impacts and Riversdale urban impacts. The lower Goukou River (H90D-09287, H90D-09316 and H90D-09318) downstream of Riversdale is impacted by the aggregate impact of the upstream reaches together with localised agriculture, Riversdale urban runoff and WWTW, resulting in PES of D, with an improvement in the lower reach H90E-09343 to a C due to reduced localised impacts. The Soetmelks River (H90D-09254 and H90D-09298) and SQ reaches H90D-09278 and H90E-09364 flows through agricultural areas falling in a category D.

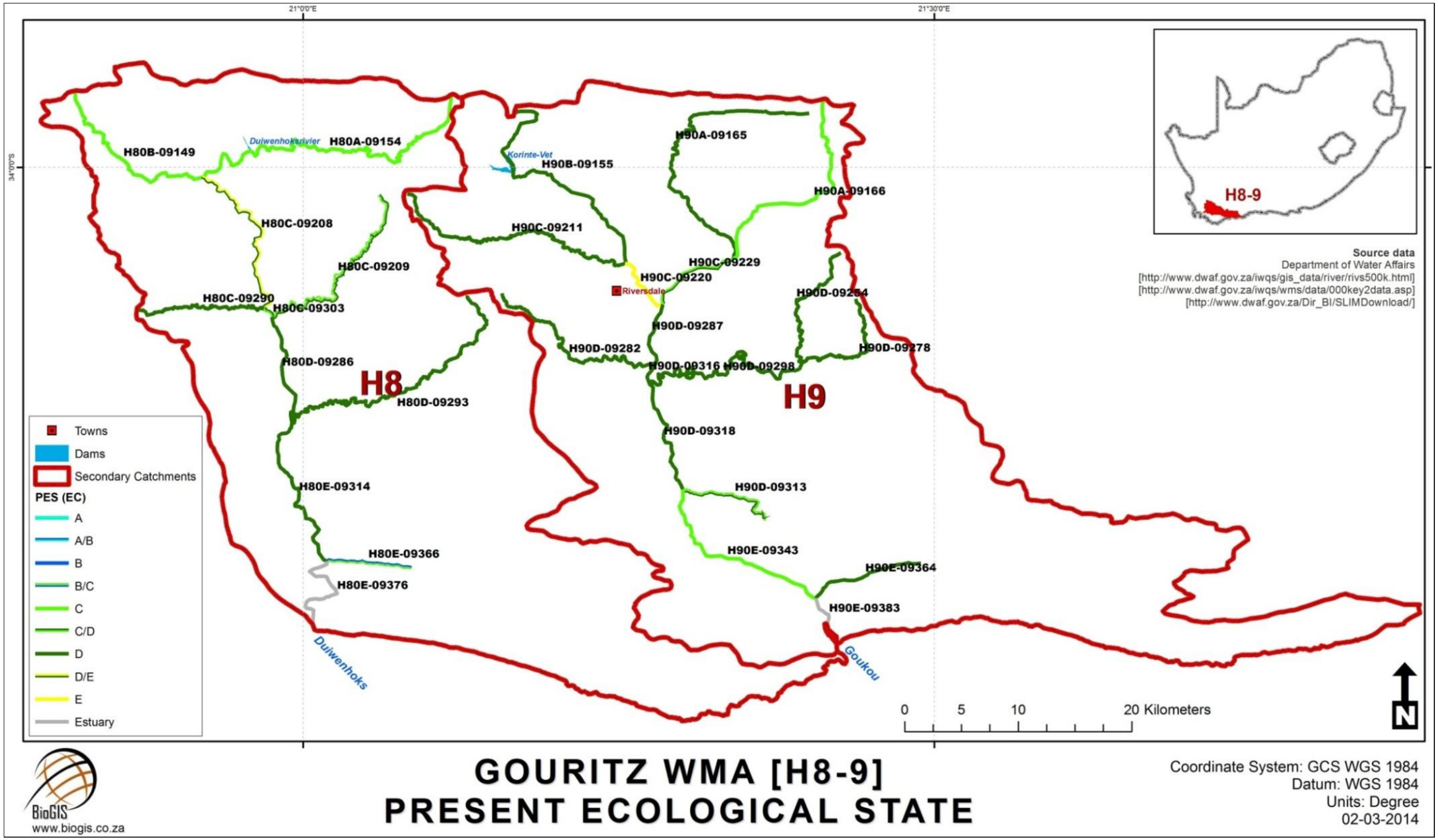


Figure 5.3 PES results (H8 – H9) of the Gouritz WMA

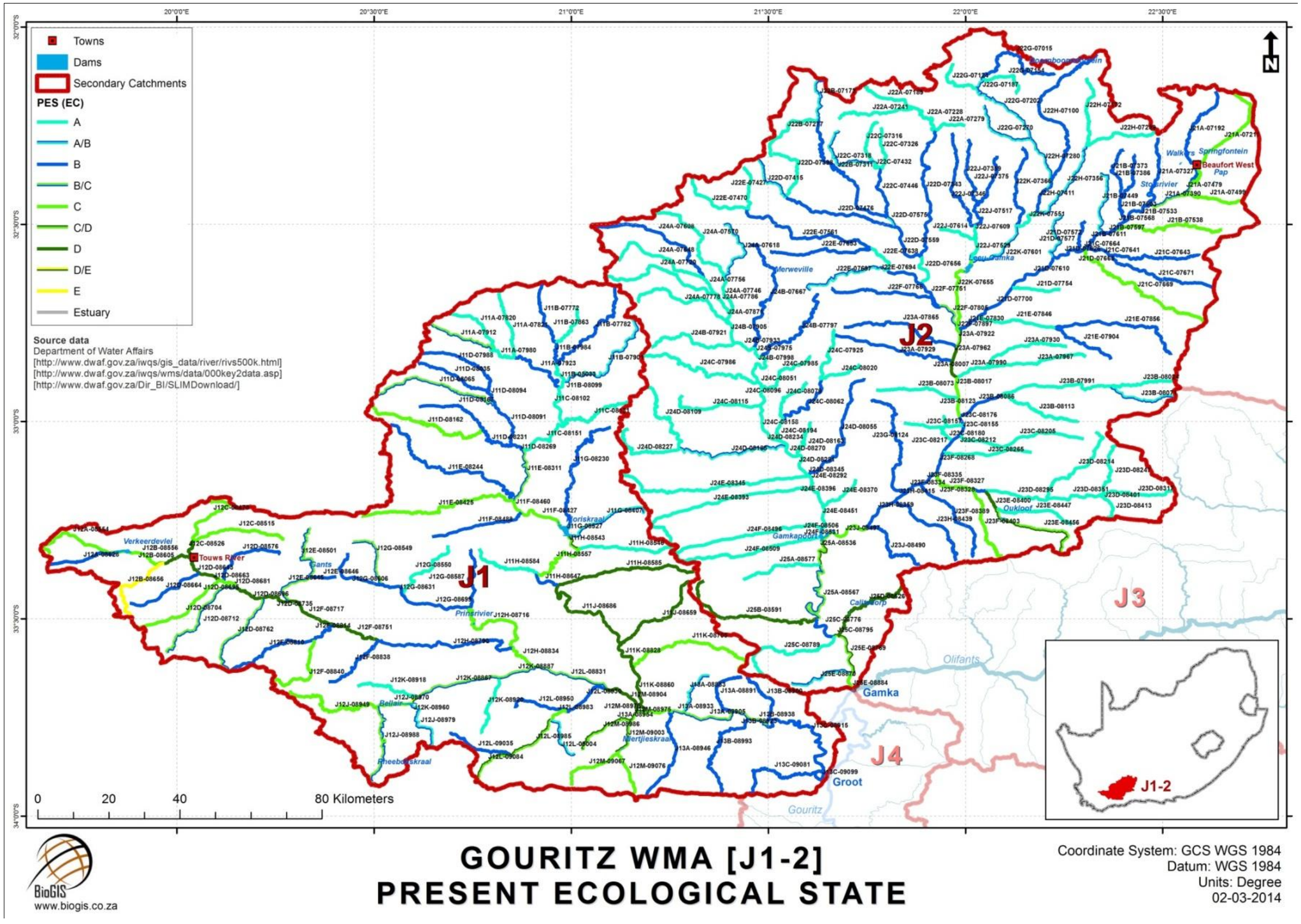


Figure 5.4 PES results (J1 – J2) of the Gouritz WMA

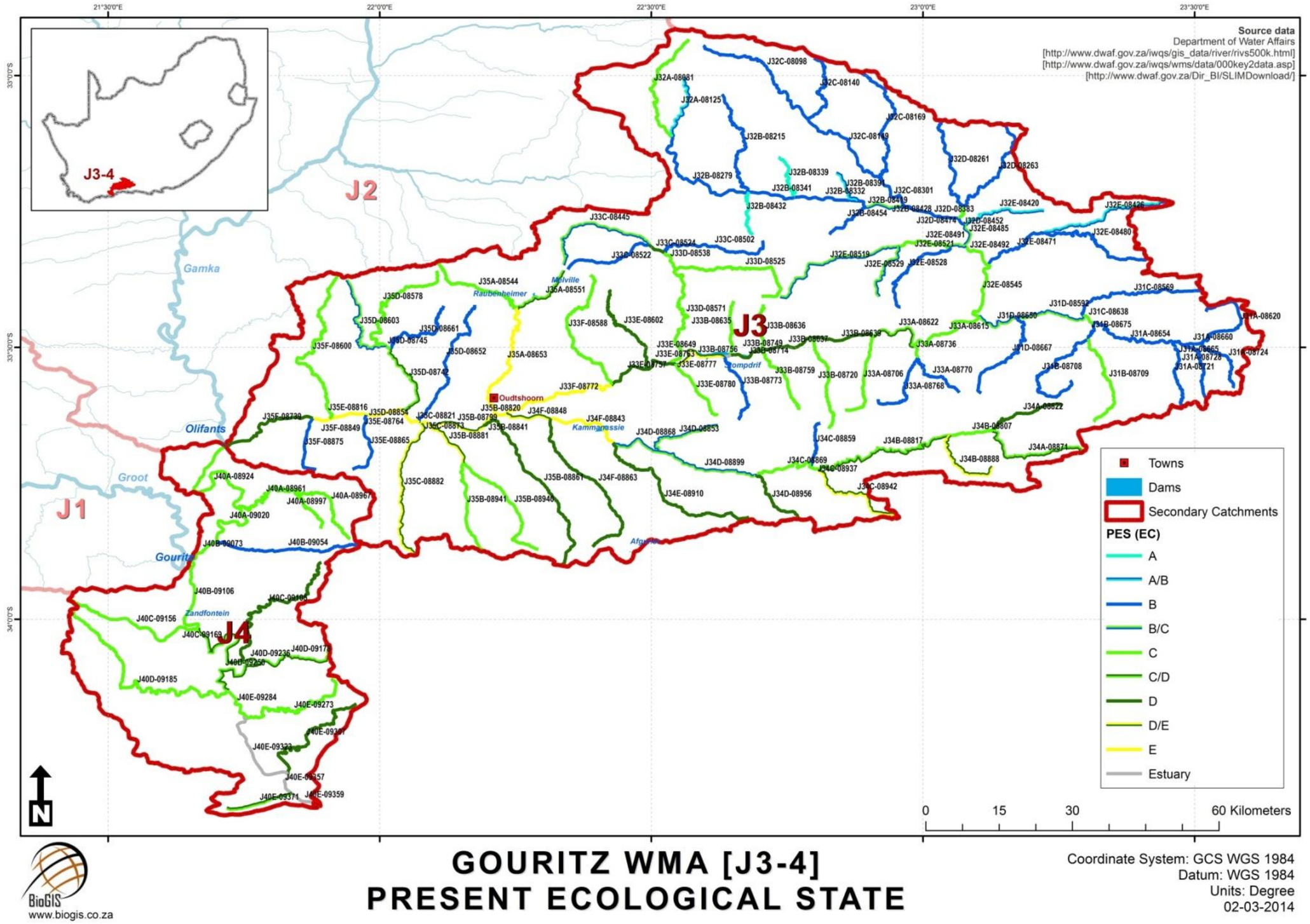


Figure 5.5 PES results (J3 – J4) of the Gouritz WMA

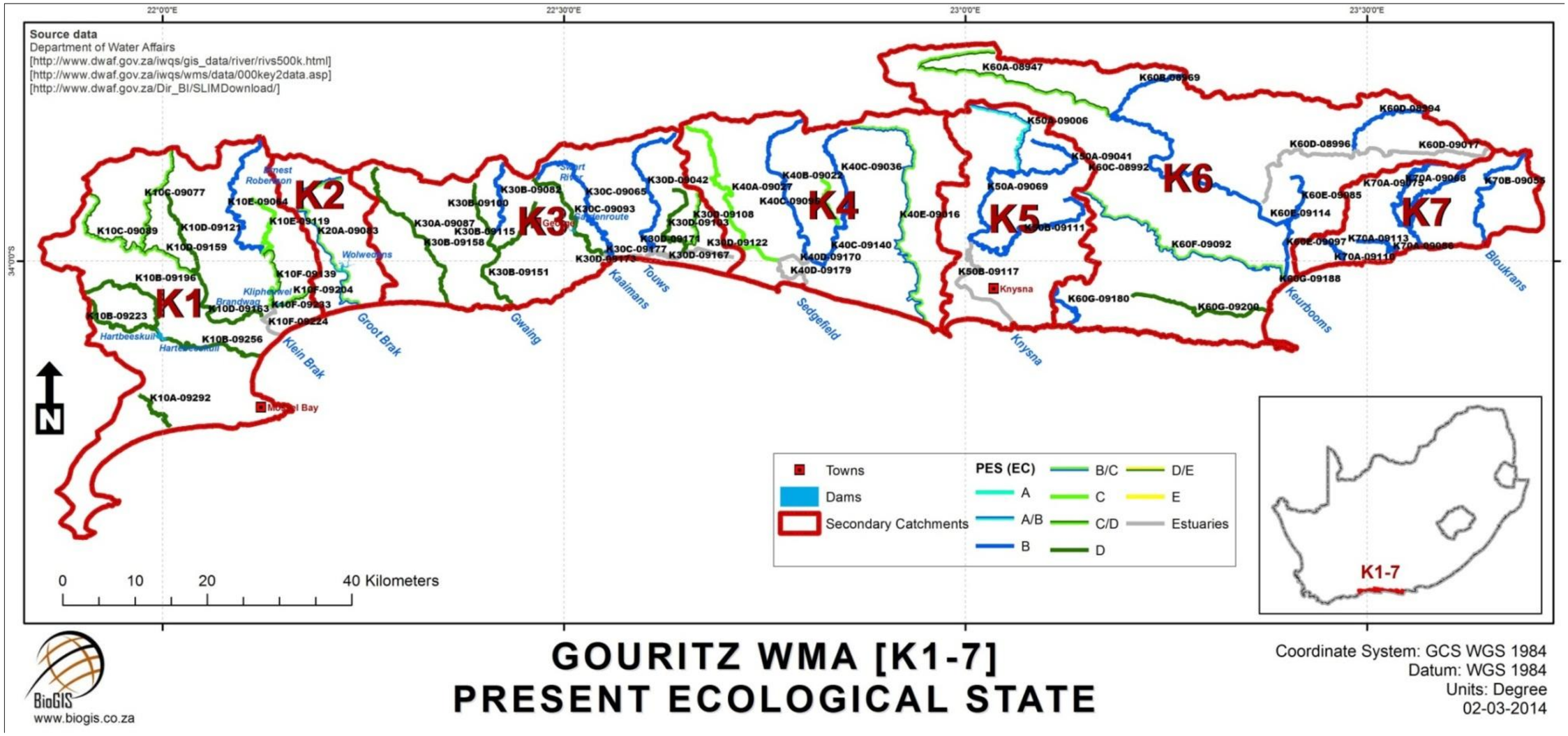


Figure 5.6 PES results (K1 – 7) of the Gouritz WMA

6 RECOMMENDED ECOLOGICAL CATEGORY

An analysis of the revised PES data and EI-ES data from the PES/EIS (11) results were used to derive the Recommended Ecological Category (REC) (**Table 6.1** to **Table 6.6**) for each SQ. In cases where the EI is high or very high, an improved REC is recommended. The EI score is based on a scale of 0 – 5 and where 0 is low and 5 is high. Where an improved REC needs to be achieved, information is supplied regarding the requirement needed to achieve the REC and whether this is attainable (Column 6 and 7 in **Table 6.1** to **Table 6.6**).

Table 6.1 to **Table 6.6** summarises the results for the SQs. Note that this information can be used for licensing and future EWR determination in areas other than those that will be covered in more detail in this study.

Table 6.1 REC results (K Catchment)

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
K1						
K10A-09292	(unnamed stream)	D	2	D	N/A	N/A
K10B-09223	Melkboom	D	2	D	N/A	N/A
K10B-09196	Hartenbos	D	2	D	N/A	N/A
K10B-09256	Hartenbos	D	2	D	N/A	N/A
K10C-09089	Haelkraal	C/D	3	C	Improved agricultural practices (increase riparian buffer zone).	Yes, but half a category only.
K10C-09077	Kouma	C/D	3	C	Improved agricultural practices (increase riparian buffer zone).	Yes, but half a category only.
K10D-09121	Ruiterbos	D	2	D	N/A	N/A
K10D-09159	Palmiet	C/D	2	C/D	N/A	N/A
K10D-09163	Brandwag	D	2	D	N/A	N/A
K10E-09119	Beneke	C	3	C	N/A	N/A
K10E-09064	Moordkuil	B	5	B	N/A	N/A
K10F-09204	(unnamed stream)	C/D	2	C/D	N/A	N/A
K10F-09139	Moordkuil	C/D	2	C/D	N/A	N/A
K2						
K20A-09083	Groot Brak	B/C	4	B	Improved riparian buffer zone.	Unlikely due to extent of forestry.
K3						
K30A-09087	Maalgate	D	2	D	N/A	N/A
K30B-09100		D	2	D	N/A	N/A
K30B-09115	Rooi	D	2	D	N/A	N/A
K30B-09082	Malgas	B	5	B	N/A	N/A
K30B-09158	Gwaing	D	2	D	N/A	N/A
K30B-09151	Gwaing	D	2	D	N/A	N/A
K30C-09065	Kaaimans	B	5	B	N/A	N/A
K30C-09093	Swart	D	2	D	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
K30D-09042	Touws	B	5	B	N/A	N/A
K30D-09108	Klein Keurboom	C/D	2	C/D	N/A	N/A
K30D-09103	Duiwe	D	2	D	N/A	N/A
K30D-09171	Duiwe	D	2	D	N/A	N/A
K4						
K40A-09027	Diep	C	3	B/C	Implement existing EWR. Improve riparian buffer zone and remove alien vegetation in forestry and agricultural areas (in lower section of SQ).	Yes, but probably only half category.
K40B-09022	Hoëkraal	B	5	B	N/A	N/A
K40C-09036	Karatara	B	5	B	N/A	N/A
K40C-09095	Huis	C	3	C	N/A	N/A
K40C-09140	Karatara	B	5	B	N/A	N/A
K40E-09016	Homtini	B/C	4	B/C	Removal of alien vegetation in riparian zone.	Unlikely to improve to B.
K5						
K50A-09006	Knysna	A/B	5	A/B	N/A	N/A
K50A-09041	Kruis	B	5	B	N/A	N/A
K50A-09069	Knysna	B	5	B	N/A	N/A
K50B-09111	Gouna	B	5	B	N/A	N/A
K50B-09117	Knysna	A	5	A	N/A	N/A
K6						
K60A-08947	Keurbooms	C/D	3.4	C	Removal of alien vegetation and riparian zone rehabilitation including increasing buffer zone.	Yes
K60B-08969	Kwaai	B	5	B	N/A	N/A
K60C-08992	Keurbooms	B	5	B	N/A	N/A
K60D-09017	Palmiet	A	5	A	N/A	N/A
K60D-08994	Dwars	B	5	B	N/A	N/A
K60D-08996	Palmiet	A	5	A	N/A	N/A
K60E-09085	Duiwelsgat	B	5	B	N/A	N/A
K60E-09114	Keurbooms	B	5	B	N/A	N/A
K60E-09097	Keurbooms	B	5	B	N/A	N/A
K60F-09092	Bietou	B/C	5	B	Improved agricultural section and riparian buffer zone in lower half of SQ.	Yes
K60G-09200	Piesang	D	2	D	N/A	N/A
K60G-09180	(unnamed stream)	B	5	B	N/A	N/A
K7						
K70A-09075	Groot	B	5	B	N/A	N/A
K70A-09068	Bobbejaan	B	5	B	N/A	N/A
K70A-09113	Groot	B	5	B	N/A	N/A
K70A-09086	(unnamed stream)	B	5	B	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
K70A-09110	(unnamed stream)	B	5	B	N/A	N/A
K70B-09055	Bloukrans	B	5	B	N/A	N/A

Table 6.2 REC results (J1: Groot Catchment)

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J11A-07820	Komsberg	A	5	A	N/A	N/A
J11A-07821	Venters	A	5	A	N/A	N/A
J11A-07912	(unnamed stream)	B/C	3	B/C	N/A	N/A
J11A-07923	Buffels	B	4	B	N/A	N/A
J11A-07980	Komsberg	A	5	A	N/A	N/A
J11B-07772	Beerfontein se Laagte	B	5	B	N/A	N/A
J11B-07782	Dwars	B	5	B	N/A	N/A
J11B-07863	(unnamed stream)	A	5	A	N/A	N/A
J11B-07901	Swaerkraal se	A/B	5	A/B	N/A	N/A
J11B-07984	Koringplaas	B	5	B	N/A	N/A
J11B-08033	Dwars	A	5	A	N/A	N/A
J11B-08099	Swaerkraal se	A	5	A	N/A	N/A
J11C-08102	Buffels	A	5	A	N/A	N/A
J11C-08131	Bloubank se	A	5	A	N/A	N/A
J11C-08151	Buffels	A	5	A	N/A	N/A
J11D-07988	Meintjiesplaas	B	5	B	N/A	N/A
J11D-08035	Rooival	B	5	B	N/A	N/A
J11D-08065	(unnamed stream)	B/C	4	B	Reduce agriculture on floodplains to increase wetland and riparian buffer.	Y
J11D-08091	Meintjiesplaas	B	5	B	N/A	N/A
J11D-08094	Meintjiesplaas	B	5	B	N/A	N/A
J11D-08162	Roggeveld	C	3	C	Riparian zone buffer can be improved through better agricultural practices but impacts due to small farm dams will predominate, improvement to abetter category is unlikely.	No
J11D-08167	(unnamed stream)	B	5	B	N/A	N/A
J11D-08231	Roggeveld	B	5	B	N/A	N/A
J11D-08269	Meintjiesplaas	B	5	B	N/A	N/A
J11E-08244	Wilgehout	B	5	B	N/A	N/A
J11E-08311	Buffels	B/C	3	B/C	N/A	N/A
J11E-08425	Baviaans	C	3	B/C	Remove alien plants in the riparian zone, improve riparian zone buffer by better agricultural	Yes, but only by a half category.

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
					practices.	
J11F-08427	Buffels	C	3	C	N/A	N/A
J11F-08460	Buffels	C	3	C	N/A	N/A
J11F-08488	Witbergs	B	5	B	N/A	N/A
J11G-08230	Geelbek	B	5	B	N/A	N/A
J11G-08407	Hartebeesspruit	A/B	5	A/B	N/A	N/A
J11H-08543	Buffels	C/D	2	C/D	N/A	N/A
J11H-08546		A	5	A	N/A	N/A
J11H-08557	Buffels	C	3	B	Implement EWR from Floriskraal Dam, and improve riparian zone continuity by increasing buffer zone.	Yes
J11H-08584		A	5	A	N/A	N/A
J11H-08585	Klein-Swartberg	D	2	D	N/A	N/A
J11H-08647	Buffels	B	5	B	N/A	N/A
J11J-08659	Swartberg	D	2	D	N/A	N/A
J11J-08686	Groot	D	2	D	N/A	N/A
J11K-08705	Knui	C	3	B	Improve riparian zone buffer in areas impacted by agriculture.	Yes
J11K-08828	Groot	D	2	D	N/A	N/A
J11K-08860	Groot	D	2	D	N/A	N/A
J12A-08554	Smalblaar	C	3	B/C	Improve riparian zone buffer in first half of the SQ but is unlikely to improve a full category.	Unlikely
J12A-08628	Bok	B	5	B	N/A	N/A
J12B-08556	Donkies	C	3	C	N/A	N/A
J12B-08605	Donkies	D	2	D	N/A	N/A
J12B-08656	(unnamed stream)	E	1	D/E	Intensive river rehabilitation required and removal of alien plant species.	Yes
J12C-08478	Ysterdams	C	3	B	Improve riparian zone continuity by increasing buffer zone.	Yes
J12C-08515	Jan Deboers	C	3	B/C	Improve riparian zone continuity by increasing buffer zone.	Yes, half category
J12C-08526	Ysterdams	D	1	D	N/A	N/A
J12D-08576	(unnamed stream)	B	5	B	N/A	N/A
J12D-08643	Touws	D	2	D	N/A	N/A
J12D-08663	Touws	D	2	D	N/A	N/A
J12D-08664	(unnamed stream)	B	4	B	N/A	N/A
J12D-08681	Touws	C	3	C	N/A	N/A
J12D-08695	Touws	C	3	C	N/A	N/A
J12D-08696	Touws	D	2	D	N/A	N/A
J12D-08704	Dikkopskraal	C	3	C	N/A	N/A
J12D-08712	Lopende	B/C	4	B	Unlikely to be able to address farm dams, but may be able to improve riparian continuity by	Yes

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
					improving buffer zone.	
J12D-08735	Touws	D	2	D	N/A	N/A
J12D-08762	Brak	B/C	4	B	Improve riparian continuity to one by increasing the riparian buffer where agriculture exists.	Yes
J12E-08501	Kragga	B/C	4	B	Improve riparian buffer zone.	Yes
J12E-08645	Kragga	B/C	3	B/C	N/A	N/A
J12E-08646	(unnamed stream)	B	5	B	N/A	N/A
J12F-08717	Touws	D	2	D	N/A	N/A
J12F-08751	Touws	D	2	D	N/A	N/A
J12F-08810	Doring	B	5	B	N/A	N/A
J12F-08814	Kruis	B	5	B	N/A	N/A
J12F-08838	Stinkfontein se	B	5	B	N/A	N/A
J12F-08840	Kruis	C	3	C	N/A	N/A
J12G-08549	Elandskloof	B/C	3	B/C	N/A	N/A
J12G-08550	(unnamed stream)	A	5	A	N/A	N/A
J12G-08587	Prins	B	5	B	N/A	N/A
J12G-08606	(unnamed stream)	B	5	B	N/A	N/A
J12G-08631	(unnamed stream)	B	4	B	N/A	N/A
J12G-08699	(unnamed stream)	B	5	B	N/A	N/A
J12H-08716	Prins	C	3	B	Improve riparian zone buffer where agriculture occurs; implement EWR from Prins Dam.	Yes
J12H-08790	Touws	B	5	B	N/A	N/A
J12H-08834	Touws	C	3	C	N/A	N/A
J12J-08949	Gatskraal se	C	3	B/C	Restore riparian zone at start of SQ.	Yes (half category)
J12J-08970	Gatskraal se	C	3	C	N/A	N/A
J12J-08979	Wilgebos	A/B	5	A/B	N/A	N/A
J12J-08988	Kalkoenshoek	B/C	3	B/C	N/A	N/A
J12K-08867	Brak	B/C	3	B/C	N/A	N/A
J12K-08887	Brak	B/C	3	B/C	N/A	N/A
J12K-08918	(unnamed stream)	A	5	A	N/A	N/A
J12K-08920	Bakoond se Leegte	A	5	A	N/A	N/A
J12K-08960	Brak	D/E	1	D	Short SQ directly below Bellair Dam, can ensure EWR flows.	Yes
J12L-08831	Touws	B/C	4	B/C	N/A	N/A
J12L-08930	Doring	B	4	B	N/A	N/A
J12L-08950	Koenjekuils	B	5	B	N/A	N/A
J12L-08983	Doring	C	3	C	N/A	N/A
J12L-08985	Doring	C/D	2	C/D	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J12L-09004		A/B	5	A/B	N/A	N/A
J12L-09035		B	5	B	N/A	N/A
J12L-09084	Doring	C/D	2	C/D	N/A	N/A
J12M-08904	Touws	D	2	D	N/A	N/A
J12M-08975	Brand	C/D	2	C/D	N/A	N/A
J12M-08976	Touws	C/D	2	C/D	N/A	N/A
J12M-08986	(unnamed stream)	C/D	2	C/D	N/A	N/A
J12M-09003	Brand	C/D	3	C/D	N/A	N/A
J12M-09067	Brand	C	3	C	N/A	N/A
J12M-09076	(unnamed stream)	C	3	C	N/A	N/A
J13A-08883	(unnamed stream)	A/B	5	A/B	N/A	N/A
J13A-08891	Huis	B	5	B	N/A	N/A
J13A-08905	Groot	B/C	3	B/C	N/A	N/A
J13A-08933	Groot	B/C	3	B/C	N/A	N/A
J13A-08946	Piets	B	5	B	N/A	N/A
J13A-08954	Groot	C	3	C	N/A	N/A
J13B-08900	Bos	B	5	B	N/A	N/A
J13B-08923	Groot	B/C	3	B/C	N/A	N/A
J13B-08938	Groot	B/C	3	B/C	N/A	N/A
J13B-08993	Derde	B	5	B	N/A	N/A
J13C-08915	Groot	B	5	B	N/A	N/A
J13C-09081	Wabooms	B	5	B	N/A	N/A
J13C-09099	Groot	B	5	B	N/A	N/A

Table 6.3 REC results (J2: Gamka Catchment)

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J21A-07192	Gamka	B	4	B	N/A	N/A
J21A-07211	Kuils	C	2	B/C	Depends on dam structure and outlets	Unlikely
J21A-07327	Stols	B	4	B	N/A	N/A
J21A-07390	Gamka	B/C	1	B	Improve water quality (WWTW). Flow release from dams	Yes
J21A-07479	Gamka	B/C	1	B	Improve water quality (WWTW). Flow release from dams	Yes
J21A-07499	Kwagga	C	2	B/C	Improved flow management/releases from dam.	Depends on outlet structures.
J21B-07373	Steyns	B	4	B	N/A	N/A
J21B-07386		B	4	B	N/A	N/A
J21B-07449	Sand	A/B	4	A/B	N/A	N/A
J21B-07503	Steyns	B	4	B	N/A	N/A
J21B-07533	Gamka	B	4	B	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J21B-07538	Boeteka	C	5	C	N/A	N/A
J21B-07568	Gamka	B	4	B	N/A	N/A
J21B-07597	Gamka	B	4	B	N/A	N/A
J21B-07611	Gamka	B	4	B	N/A	N/A
J21C-07641	Put	B	4	B	N/A	N/A
J21C-07643	Ongeluks	B	4	B	N/A	N/A
J21C-07664	Put	B	4	B	N/A	N/A
J21C-07669	Plaatjies	C	2	B/C	Improve releases from dam (if attainable) and best practice farming.	Unlikely.
J21C-07671	Put	B	4	B	N/A	N/A
J21D-07572	Keulders	A/B	4	A/B	N/A	N/A
J21D-07577	(unnamed stream)	B	4	B	N/A	N/A
J21D-07610	Gamka	B	4	B	N/A	N/A
J21D-07626	Gamka	B	4	B	N/A	N/A
J21D-07665	Gamka	B	4	B	N/A	N/A
J21D-07700	Gamka	B	4	B	N/A	N/A
J21D-07754	Brandleegte	A	4	A	N/A	N/A
J21E-07830	Gamka	B	4	B	N/A	N/A
J21E-07846	Veldmans	A	4	A	N/A	N/A
J21E-07856	Veldmans	B	4	B	N/A	N/A
J21E-07904	Lammerkraal	B	4	B	N/A	N/A
J22A-07189	Oukloof	A	4	A	N/A	N/A
J22A-07228	Koekemoers	A	4	A	N/A	N/A
J22A-07241	(unnamed stream)	A	4	A	N/A	N/A
J22A-07279	(unnamed stream)	A	4	A	N/A	N/A
J22B-07173	Teekloof	A/B	4	A/B	N/A	N/A
J22B-07277	Hoedemakers	A	4	A	N/A	N/A
J22B-07311	Teekloof	B	4	B	N/A	N/A
J22C-07316	Omdraaiskraal	A	4	A	N/A	N/A
J22C-07318	Slingersfontein	A/B	4	A/B	N/A	N/A
J22C-07326	Waaikraal	A	4	A	N/A	N/A
J22C-07432	Omdraaiskraal	A	4	A	N/A	N/A
J22C-07446	Waaikraal	B	4	B	N/A	N/A
J22D-07343	Koekemoers	B	4	B	N/A	N/A
J22D-07398	(unnamed stream)	A	4	A	N/A	N/A
J22D-07415	Viskuil	A/B	4	A/B	N/A	N/A
J22D-07476	Viskuil	B	4	B	N/A	N/A
J22D-07559	Waaikraal	B	4	B	N/A	N/A
J22D-07575	Waaikraal	A/B	4	A/B	N/A	N/A
J22D-07656	Koekemoers	A	4	A	N/A	N/A
J22E-07427	(unnamed	A	4	A	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
	stream)					
J22E-07470	Wilgerbos	A	4	A	N/A	N/A
J22E-07561	Wilgerbos	B	4	B	N/A	N/A
J22E-07638	Wilgerbos	A	4	A	N/A	N/A
J22E-07653	Puts	B	4	B	N/A	N/A
J22E-07694	Wilgerbos	B	4	B	N/A	N/A
J22E-07697	Rietpoort	A/B	4	A/B	N/A	N/A
J22F-07751	Koekemoers	B	4	B	N/A	N/A
J22F-07766	Boesmans	B	4	B	N/A	N/A
J22F-07805	Koekemoers	B/C	4	B/C	N/A	N/A
J22F-07897	Leeu	C	5	C	N/A	N/A
J22G-07015	Leeu	B	4	B	N/A	N/A
J22G-07124	Leeu	A	4	A	N/A	N/A
J22G-07154	(unnamed stream)	A	4	A	N/A	N/A
J22G-07187	Leeu	A/B	4	A/B	N/A	N/A
J22G-07202	Leeu	A/B	4	A/B	N/A	N/A
J22G-07270	Paalhuis	A/B	4	A/B	N/A	N/A
J22H-07100	Klipplaatfontein	B	4	B	N/A	N/A
J22H-07172	Sand	A	4	A	N/A	N/A
J22H-07280	Leeu	A/B	4	A/B	N/A	N/A
J22H-07289	Doringhoek	A	4	A	N/A	N/A
J22H-07356	Sand	A/B	4	A/B	N/A	N/A
J22H-07411	Leeu	B	4	B	N/A	N/A
J22J-07346	Hottentots	B	4	B	N/A	N/A
J22J-07359	Brakwater	B	4	B	N/A	N/A
J22J-07375	Middelwater	B	4	B	N/A	N/A
J22J-07517	Klipkuile se	B	4	B	N/A	N/A
J22J-07529	Hottentots	A	4	A	N/A	N/A
J22J-07609	Hottentots	A	4	A	N/A	N/A
J22J-07614	Syfersleegte	A	4	A	N/A	N/A
J22K-07366	Rietkuil	B	4	B	N/A	N/A
J22K-07551	Leeu	A	4	A	N/A	N/A
J22K-07601	Leeu	A/B	4	A/B	N/A	N/A
J22K-07655	Leeu	C	2	B/C	Improved flow management from Leeu-Gamka Dam (if possible), improve water quality (return flows), improve riparian buffer zone in agricultural areas.	Yes
J23A-07865	Saai	B	4	B	N/A	N/A
J23A-07922	Gamka	C/D	5	C/D	N/A	N/A
J23A-07929	Klip	B	4	B	N/A	N/A
J23A-07930	Perdewater se Loop	A	4	A	N/A	N/A
J23A-07962	Gamka	D	5	D	N/A	N/A
J23A-07967	(unnamed	A	4	A	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
	stream)					
J23A-07990	Saai	A	4	A	N/A	N/A
J23A-08007	Gamka	D	5	D	N/A	N/A
J23B-07991	Groot	A	4	A	N/A	N/A
J23B-08017	Gamka	C	2	B/C	Improved flow managament from Leeu-Gamka Dam and other instream dams in upstream SQs (if possible), improve water quality (irrigation return flows), improve riparian buffer zone in agricultural area.	Yes (half category)
J23B-08024	Rietpoort	A	4	A	N/A	N/A
J23B-08071	Groot	A/B	4	A/B	N/A	N/A
J23B-08073	Blouklоofleegte	A	4	A	N/A	N/A
J23B-08086	Groot	B	4	B	N/A	N/A
J23B-08113	Waswater	A	4	A	N/A	N/A
J23B-08123	Gamka	C	5	C	N/A	N/A
J23C-08155	Gamka	B	4	B	N/A	N/A
J23C-08157		A	4	A	N/A	N/A
J23C-08176	Gamka	B	4	B	N/A	N/A
J23C-08180		A	4	A	N/A	N/A
J23C-08205	Kweekleegte	A	4	A	N/A	N/A
J23C-08212	Gamka	B	4	B	N/A	N/A
J23C-08217	Gamka	B	4	B	N/A	N/A
J23C-08265	Gedenksteen se Leegte	A	4	A	N/A	N/A
J23D-08214	Tierbergs	A	4	A	N/A	N/A
J23D-08247	Botterkraal	A	4	A	N/A	N/A
J23D-08295	Sand	A	4	A	N/A	N/A
J23D-08317	Sand	A	4	A	N/A	N/A
J23D-08351	Sand	A	4	A	N/A	N/A
J23D-08401	Sand	A	4	A	N/A	N/A
J23D-08413		A	4	A	N/A	N/A
J23E-08400	Cordiers	D	5	D	N/A	N/A
J23E-08447	Gang se Leegte	A	4	A	N/A	N/A
J23E-08456	Cordiers	C/D	5	C/D	N/A	N/A
J23F-08268	Gamka	B	4	B	N/A	N/A
J23F-08327	Swart	C	2	B/C	Improve water quality from irrigation return flows and Prince Albert town	Yes (half category)
J23F-08328	Sand	B	4	B	N/A	N/A
J23F-08334	Gamka	B	4	B	N/A	N/A
J23F-08335	Gamka	B	4	B	N/A	N/A
J23F-08389	Tryntjies	B	4	B	N/A	N/A
J23F-08403	Dorps	C	2	B/C	Improve riparian buffer zone (in Prince Albert town area).	Yes (half category)
J23G-08124	Kat	B	4	B	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J23H-08359	Gamka	B	4	B	N/A	N/A
J23H-08415	Gamka	B	4	B	N/A	N/A
J23H-08439	Dewits	B	4	B	N/A	N/A
J23J-08490	Huis	B	4	B	N/A	N/A
J23J-08497	Gamka	C	5	C	N/A	N/A
J24A-07570	Driefontein se	A	4	A	N/A	N/A
J24A-07608	Dwyka	B	4	B	N/A	N/A
J24A-07618	Ongeluksfontein	A/B	4	A/B	N/A	N/A
J24A-07648	Rotjieskraal se	A	4	A	N/A	N/A
J24A-07720	Vanwyks	A	4	A	N/A	N/A
J24A-07746	Tuin	A	4	A	N/A	N/A
J24A-07756	Dwyka	A	4	A	N/A	N/A
J24A-07778	Juk	A	4	A	N/A	N/A
J24A-07786	Dwyka	A	4	A	N/A	N/A
J24A-07871	Dwyka	A	4	A	N/A	N/A
J24B-07667	Vanderbylskraal	B	4	B	N/A	N/A
J24B-07797	Wolwefontein	B	4	B	N/A	N/A
J24B-07905	Dwyka	A	4	A	N/A	N/A
J24B-07921	Steenkamp	A	4	A	N/A	N/A
J24B-07933	Dwyka	A	4	A	N/A	N/A
J24B-07975	Dwyka	A	4	A	N/A	N/A
J24B-07998	Dwyka	A	4	A	N/A	N/A
J24C-07925	Bad	A	4	A	N/A	N/A
J24C-07985	Droëfontein	A	4	A	N/A	N/A
J24C-07986	Frieshoek	A	4	A	N/A	N/A
J24C-08020	Perdelaagte	A	4	A	N/A	N/A
J24C-08051	Dwyka	A	4	A	N/A	N/A
J24C-08062	Bad	B	4	B	N/A	N/A
J24C-08079	Kierie	A	4	A	N/A	N/A
J24C-08096	Dwyka	A	4	A	N/A	N/A
J24C-08115	Koeel	A	4	A	N/A	N/A
J24C-08158	Dwyka	A	4	A	N/A	N/A
J24C-08194	Bad	A	4	A	N/A	N/A
J24D-08055	Vlakkraal	B	4	B	N/A	N/A
J24D-08109	Bloed	A	4	A	N/A	N/A
J24D-08163	Kalkgat	A	4	A	N/A	N/A
J24D-08185	Bloed	A/B	4	A/B	N/A	N/A
J24D-08227	Wilgerbos	A	4	A	N/A	N/A
J24D-08234	Dwyka	A	4	A	N/A	N/A
J24D-08270	Dwyka	A	4	A	N/A	N/A
J24D-08281	Dwyka	A	4	A	N/A	N/A
J24D-08345	Dwyka	A	4	A	N/A	N/A
J24E-08292	Dwyka	A	4	A	N/A	N/A
J24E-08345	Jakkals	A	4	A	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J24E-08370	(unnamed stream)	A	4	A	N/A	N/A
J24E-08393	Kerks	A	4	A	N/A	N/A
J24E-08396	Dwyka	A	4	A	N/A	N/A
J24E-08451	Dwyka	A	4	A	N/A	N/A
J24F-08496	Elandskloof	A	4	A	N/A	N/A
J24F-08506	Dwyka	A	4	A	N/A	N/A
J24F-08509	Bosluiskloof	A	4	A	N/A	N/A
J24F-08531	Dwyka	A	4	A	N/A	N/A
J25A-08536	Gamka	C/D	2	C	Improved release managament from Gamkapoort Dam (if possible).	Yes (half category)
J25A-08567	Gamka	B/C	1	B	Improved release managament from Gamkapoort Dam (if possible).	Yes (half category)
J25A-08577	Oshoekshang	A	4	A	N/A	N/A
J25B-08591	Kobus	D	2	C	Improve riparian buffer zone in agricultural area, manage irrigation abstraction.	Yes
J25C-08776	Gamka	B	4	B	N/A	N/A
J25C-08789	Taais	A	4	A	N/A	N/A
J25C-08795	Gamka	C/D	5	C/D	N/A	N/A
J25D-08626	Nels	D	2	C	Improve flow managament from Calitzdorp Dam, improved riparian buffer zone in agricultural areas.	Yes
J25E-08769	Gamka	C/D	5	C/D	N/A	N/A
J25E-08870	(unnamed stream)	A/B	4	A/B	N/A	N/A
J25E-08884	Gamka	C	2	B/C	Manage abstraction, improve water quality (irrigation return flows and Calitzdorp).	Yes (half category)

Table 6.4 REC results (J3: Olifants Catchment)

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J31A-08620	Olifants	B	5	B	N/A	N/A
J31A-08654	Olifants	B	4	B	N/A	N/A
J31A-08660	Olifants	B	5	B	N/A	N/A
J31A-08665	Olifants	B	5	B	N/A	N/A
J31A-08721	(unnamed stream)	B	5	B	N/A	N/A
J31A-08724	(unnamed stream)	B	5	B	N/A	N/A
J31A-08728	(unnamed stream)	B	5	B	N/A	N/A
J31B-08675	Hartbees	B	4	B	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J31B-08708	Nouga	B	5	B	N/A	N/A
J31B-08709	Hartbees	C	3	B	Improve riparian buffer zone in small section impacted.	Yes
J31C-08569	(unnamed stream)	B	5	B	N/A	N/A
J31C-08638	Olifants	C	3	C	N/A	N/A
J31D-08592	Olifants	B/C	4	B	Improve riparian buffer zone in small section impacted.	Yes
J31D-08650	Olifants	B/C	4	B	Improve riparian buffer zone in small section impacted.	Yes
J31D-08667	(unnamed stream)	B	5	B	N/A	N/A
J32A-08081	Traka	C	3	B/C	Improve riparian buffer zone in localised spots, reduce erosion, best practice farming, improved flow managament from Traka Dam if possible.	Yes
J32A-08125	Kapteinskraal	A/B	5	A/B	N/A	N/A
J32B-08215	Rondawel	B	5	B	N/A	N/A
J32B-08279	Traka	B	5	B	N/A	N/A
J32B-08332	Traka	B	5	B	N/A	N/A
J32B-08339	Nuwejaarsfontein se Loop	A	5	A	N/A	N/A
J32B-08341	Traka	B	5	B	N/A	N/A
J32B-08391	(unnamed stream)	A/B	5	A/B	N/A	N/A
J32B-08419	Traka	B	4	B	N/A	N/A
J32B-08428	Traka	B/C	4	B	Improve riparian buffer zone.	Yes
J32B-08432	Klein-Elandsfontein	A	5	A	N/A	N/A
J32B-08454	Bakoondslaagte	B	4	B	N/A	N/A
J32C-08098	Kouka	B	5	B	N/A	N/A
J32C-08140	Wildfontein	B	5	B	N/A	N/A
J32C-08149	Kouka	B	5	B	N/A	N/A
J32C-08169	Vlieekraal	B	5	B	N/A	N/A
J32C-08301	Kouka	B	5	B	N/A	N/A
J32D-08261	Groot-Waterloop	B	5	B	N/A	N/A
J32D-08263	Loeriesfontein	B	5	B	N/A	N/A
J32D-08383	Traka	B	4	B	N/A	N/A
J32D-08452	Soetendalsvlei	C	3	C	Flow and non-flow related impacts associated with dam. Dam removal unlikely.	No
J32D-08474	Traka	B	4	B	N/A	N/A
J32E-08420	Maermanskraal	A/B	5	A/B	N/A	N/A
J32E-08426	Sand	A/B	5	A/B	N/A	N/A
J32E-08471	Sand	B	5	B	N/A	N/A
J32E-08480	Donkerhoeks	B	5	B	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J32E-08485	Traka	B/C	3	B/C	N/A	N/A
J32E-08491	Matjiesvlei	C	3	C	N/A	N/A
J32E-08492	Traka	C	3	C	N/A	N/A
J32E-08519	Matjiesvlei	B/C	4	B	Improve riparian buffer zone.	Yes
J32E-08521	Grasvlei se Loop	B/C	4	B	Over grazing needs to be addressed.	Yes
J32E-08528	Varkies	B	5	B	N/A	N/A
J32E-08529	(unnamed stream)	B/C	4	B	Reduce over grazing.	Yes
J32E-08545	Traka	C	3	B/C	Limited scope for improving agricultural impact due to topography and railway line impact cannot be addressed.	Unlikely
J33A-08615	Olifants	C	3	C	N/A	N/A
J33A-08622	Olifants	C/D	2	C/D	N/A	N/A
J33A-08706	Buffelsklip	C	3	B/C	Riparian zone management (harvesting *A. karoo* and possible aliens) to decrease woody cover.	Very unlikely
J33A-08736	Wilge	C	3	C	N/A	N/A
J33A-08768	Wilge	B	5	B	N/A	N/A
J33A-08770	(unnamed stream)	B	5	B	N/A	N/A
J33B-08635	Kuis	C	3	C	N/A	N/A
J33B-08636	(unnamed stream)	C	3	C	N/A	N/A
J33B-08637	Olifants	D	2	D	N/A	N/A
J33B-08639	Olifants	D	2	D	N/A	N/A
J33B-08714	Olifants	D	2	D	N/A	N/A
J33B-08720	Rooi	C	3	B/C	Recreate riparian buffer zone. Best agricultural practices.	Unlikely
J33B-08749	Olifants	C	3	C	N/A	N/A
J33B-08759	Marthinus	C	3	B/C	Recreate riparian buffer zone. Best agricultural practices.	Unlikely
J33B-08773	Witboois	B	5	B	N/A	N/A
J33C-08445	Groot	B/C	4	B	Remove alien vegetation and create buffer zone.	Yes
J33C-08502	Sand	B	5	B	N/A	N/A
J33C-08522	Aaps	B	5	B	N/A	N/A
J33C-08524	Groot	D	2	D	N/A	N/A
J33D-08525	(unnamed stream)	C	3	B	Reinstate riparian buffer zone.	Difficult
J33D-08538	Groot	C	3	B	Reinstate riparian buffer zone; manage abstractions (provide EWR); best practice in terms of irrigation return flows.	Difficult
J33D-08571	Meirings	C	3	B/C	Only mitigation possible is to manage abstractions (provide EWR) and to recreate riparian	Yes, but probably only half a category.

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
					buffer zone.	
J33E-08602	Nels	D	2	D	N/A	N/A
J33E-08649	Olifants	D/E	2	D	Release EWR from dam	Yes
J33E-08757	Olifants	D	2	D	N/A	N/A
J33E-08763	Olifants	D	2	D	N/A	N/A
J33E-08777	Olifants	D	2	D	N/A	N/A
J33E-08780	(unnamed stream)	C	3	C	N/A	N/A
J33F-08588	Kango	C	3	C	N/A	N/A
J33F-08772	Olifants	E	2	E	Problems are too extensive. Providing the Reserve will not address the problems sufficiently to change to an E.	No
J34A-08822	Kammanassie	D	2	D	N/A	N/A
J34A-08871	Holdrif	C/D	3	C	Due to impacts such as the roads that cannot change improvement is only likely by half a category. This can be achieved by improving the riparian zone in areas impacted on by agriculture and physical manipulation of the river.	Yes
J34B-08807	Kammanassie	C	3	C	N/A	N/A
J34B-08817	Kammanassie	C/D	2	C/D	N/A	N/A
J34B-08888	Potjies	D/E	2	D	Remove alien vegetation and create buffer zone.	Yes
J34C-08859	Klues	B	5	B	N/A	N/A
J34C-08869	Kammanassie	C	3	B	Implement an EWR. Recreate buffer zone.	Yes
J34C-08937	Kammanassie	C	3	B	Implement an EWR. Recreate buffer zone.	Yes
J34C-08942	Diep	D/E	2	D	Remove alien vegetation.	Difficult
J34D-08853	Huis	B/C	3	B/C	N/A	N/A
J34D-08868	Kammanassie	B/C	3	B/C	N/A	N/A
J34D-08899	Kammanassie	B/C	4	B	Implement an EWR.	Yes
J34D-08956	Gansekraal	D	2	D	N/A	N/A
J34E-08910	Brak	D	1	D	N/A	N/A
J34F-08843	Kammanassie	E	2	D/E	Implementing an EWR and recreating a buffer zone will not address problems like the infestation of reeds in the channel. The importance of an EWR will be more relevant for the downstream sections which might be in a better condition in terms of channel structure.	No
J34F-08848	Kammanassie	D/E	2	D/E	Implementing an EWR and recreating a buffer zone will not address problems like the infestation of reeds in the	No

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
					channel. The importance of an EWR will be more relevant for the downstream sections which might be in a better condition in terms of channel structure.	
J34F-08863	Doring	D	3	C	Remove alien vegetation. This should also improve the river flow.	Yes, extensive alien eradication necessary though.
J35A-08544	Grobbelaars	C	3	B	Improve buffer zone, remove alien vegetation.	Yes
J35A-08551	Klein-Leroux	C/D	3	B/C	Providing the EWR will improve the stretches below the lower dam possibly to a B/C. The stretch above the upper Dam is already in very good condition and this change should therefore result in an overall improvement.	Yes, difficult to huge demand on yield of dams.
J35A-08653	Grobbelaars	E	2	D	EWR flows will improve the top 1/6th of river which is already in a reasonable condition. However, these flows will not, (on its own) contribute to the lower sections which are dominated by agriculture and Oudtshoorn town impacts. Physical rehabilitation of the river will be required in places.	Very difficult
J35B-08799	Olifants	D/E	2	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35B-08820	Olifants	E	2	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35B-08841	Olifants	E	1	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35B-08861	Klip	D	3	C	Remove alien vegetation, improve riparian buffer zones.	Yes
J35B-08881	Kandelaars	D/E	2	D	Remove alien vegetation, improve riparian buffer zones.	yes
J35B-08940	Doring	C	3	B/C	Remove alien vegetation, improve riparian buffer zones.	Unlikely but half category possible
J35B-08941	Kandelaars	C	3	C	N/A	N/A
J35C-08821	Olifants	E	2	D	EWR implementation. However, reed growth and channel changes are such that	No

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
					improvement will be extremely problematic.	
J35C-08873	Olifants	E	1	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35C-08882	Moeras	D/E	2	D	Remove alien vegetation, improve riparian buffer zones.	yes
J35D-08578	Wynands	C	3	B	Lower section already in a B. Upper section requires non-flow actions, e.g. buffer zone management and best agricultural practices.	Yes, difficult
J35D-08603	Meul	B/C	4	B	Riparian zone management. EWR implementation.	Yes
J35D-08652	Kansa	B	5	B	N/A	N/A
J35D-08661	Droë	B	5	B	N/A	N/A
J35D-08742	Wynands	C/D	2	C/D	N/A	N/A
J35D-08745	Wynands	C	2	C	N/A	N/A
J35D-08854	Olifants	E	2	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35E-08764	Olifants	E	2	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35E-08816	Olifants	E	2	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35E-08865		B	5	B	N/A	N/A
J35F-08600	Vlei	C	3	B/C	Buffer zone management, alien eradication	Difficult
J35F-08739	Olifants	D	2	D	N/A	N/A
J35F-08849	Olifants	E	1	D	EWR implementation. However, reed growth and channel changes are such that improvement will be extremely problematic.	No
J35F-08875		B	5	B	N/A	N/A

Table 6.5 REC results (J4: Lower Gouritz Catchment)

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
J40A-08924	Gouritz	C	3	C	Implement EWR.	Unlikely
J40A-08961	Slang	C	3	C	N/A	N/A
J40A-08967	Slang	C	3	C	N/A	N/A
J40A-08997	(unnamed stream)	C	3	C	N/A	N/A
J40A-09020	Gouritz	C	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Unlikely
J40B-09054	Kamma	B	5	B	N/A	N/A
J40B-09073	Gouritz	C	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Unlikely
J40B-09106	Gouritz	C	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Unlikely
J40C-09105	Langtou	D	3	D	Improve riparian buffer zone, best-practise farming.	Yes
J40C-09156	Weyers	C	3	C	Improve riparian buffer zone, best-practise farming.	Unlikely
J40C-09169	Gouritz	C/D	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Yes, probably a half category.
J40D-09178	(unnamed stream)	C/D	2	C/D	N/A	N/A
J40D-09185	Vals	C	3	C	Improve riparian buffer zone, best-practise farming.	Unlikely
J40D-09236	Gouritz	C/D	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Yes, probably a half category.
J40D-09250	Gouritz	C/D	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Yes, probably a half category.
J40E-09273	Stink	C	3	C	Improve riparian buffer zone, best-practise farming.	Unlikely
J40E-09284	Gouritz	C	3	C	Implement EWR. Improve buffer zone and limit channel modification.	Unlikely
J40E-09307	Buffels	D	2	C	Improve riparian buffer zone, best-practise farming, erosion control.	Yes
J40E-09371	(unnamed stream)	C/D	2	C/D	N/A	N/A

Table 6.6 REC results (H8-9)

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
H80A-09154	Duiwenhoks	C	3	B/C	Improved riparian buffer zone, and flow release managament from Duiwehoks Dam (if possible).	Unlikely.
H80B-09149	Duiwenhoks	C	3	B/C	Improved riparian buffer zone.	Unlikely.
H80C-09209	Spieels	C/D	2	C/D	N/A	N/A

SQ number	River	PES	EI	REC	REC comment	Improvement attainable?
H80C-09290	Hooikraal	D	2	D	N/A	N/A
H80C-09208	Duiwenhoks	D/E	1	C/D	Improved release managament from Duiwenhoks Dam, together with riparian buffer zone improvement.	Yes
H80C-09303	Duiwenhoks	C/D	2	C/D	N/A	N/A
H80D-09293	Pienaars	D	2	D	N/A	N/A
H80D-09286	Duiwenhoks	D	1	D	N/A	N/A
H80E-09366	(unnamed stream)	B/C	4	B	Improve riparian zone (lower section)	
H80E-09314	Duiwenhoks	D	2	D	N/A	N/A
H90A-09165	Kruis	D	3	D	Improved riparian buffer zone and best-practice farming.	
H90A-09166	Goukou	C	3	C	Improved riparian buffer zone and best-practice farming.	
H90B-09155	Korinte	D	2	D	N/A	N/A
H90C-09211	Naroo	D	2	D	N/A	N/A
H90C-09220	Vet	E	2	E	Improved riparian buffer zone and best-practice farming (especially upstream reaches) as well as Riversdal urban impacts.	Impacts to extensive. Cannot achieve with flow
H90C-09229	Goukou	C/D	2	C/D	N/A	N/A
H90D-09254	Soetmelks	D	2	D	N/A	N/A
H90D-09278		D	2	D	N/A	N/A
H90D-09282	Brak	D	2	D	N/A	N/A
H90D-09313	Wasfontein	C/D	2	C/D	N/A	N/A
H90D-09298	Soetmelks	D	2	D	N/A	N/A
H90D-09287	Goukou	D	2	D	N/A	N/A
H90D-09316	Goukou	D	2	D	N/A	N/A
H90D-09318	Goukou	D	2	D	N/A	N/A
H90E-09364	(unnamed stream)	D	2	D	N/A	N/A
H90E-09343	Goukou	C	3	B/C	Improved riparian buffer zone, best-practice farming.	Yes, half a category.

7 METHOD TO IDENTIFY RIVER HOTSPOTS

A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia. org/wiki/Biodiversity_hotspot). In the context used here, the hotspot represents a river reach with a high Integrated Environmental Importance (IEI) which could be under threat due to its importance for water resource use. The hotspots are therefore an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future (Louw and Huggins, 2007; Louw *et al.,* 2010). The hotspot identification will therefore provide an indication of the level of EWR assessment required at SQ. In essence, this would be similar to a filtering process where the most detailed assessment is undertaken at hotspots, and less detailed assessments at the other areas. Nodes that are EWR sites represent the areas where most detailed EWR methods will be required.

The purpose of the identification of hotspots for this study was the following:

- To select rivers where new EWR sites should be selected.
- To select river reaches where new EWR sites should be selected.
- To provide guidance to levels of Reserve that might be required for licensing purposes within the framework provided by the National Water Resource Classification System (NWRCS).
- To provide an indication where scenario development and testing would be important.

The process used is described in **Figure 7.1** and relied on the results (with modifications during this study) of the PES/EIS study. As part of this assessment, the WRUI and SCI was undertaken on a sub-quaternary scale but grouped where similar.

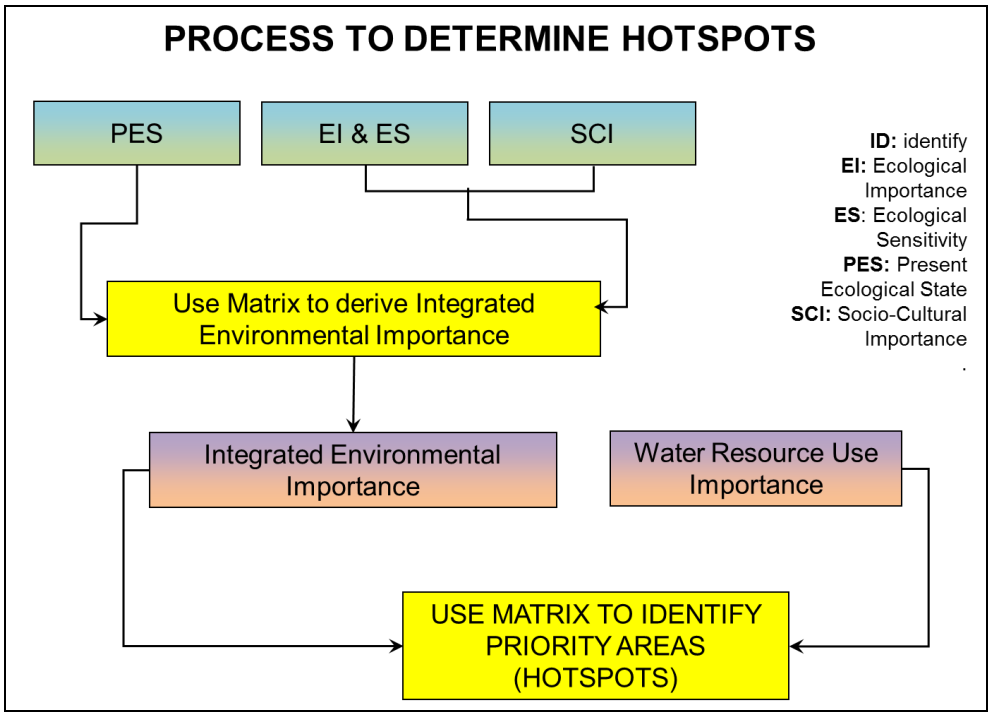


Figure 7.1 Summary of the process to identify biophysical nodes for EWR assessment

The steps used to identify the priority areas (hotspots) were:

- Desktop EcoClassification which included the determination of the Ecological Importance and Sensitivity (EIS); SCI and PES.
- Determination of the IEI by integrating the EIS, SCI and the PES.
- Determining the WRUI.
- Identification of the areas which were priority hotspots because of high IEI and/or WRUI and required more detailed studies.
- Provide recommendations for the locality of detailed EWR sites.

7.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

7.1.1 Present Ecological State

The PES approach is described in **Section 5.2**.

7.1.2 Ecological Importance and Sensitivity

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh *et al*., 1988; Milner, 1994). Both abiotic and biotic components of the system were taken into consideration in the assessment.

The importance evaluation for rivers used for this study were those generated as part of the PES/EIS study (Kotzé *et al.,* 2012) from the front end models as provided by Dr Kleynhans, D:RQS, DWA. The EI and ES of SQs were assessed to obtain an indication of its vulnerability to environmental modification within the context of the PES. This would relate to the ability of the SQ to endure, resist and able to recover from various forms of human use (DWA, 2013). Further explanations of the functions of the model must be referred to D: RQS.

7.1.3 Socio-Cultural Importance (SCI)

The SCI was generated by scoring each quaternary catchment based on the following features (Huggins *et al*., 2010):

Ritual Use: This was scored between 0 – 5. The question that was asked was "How much ritual use of the river takes place?" Typically this would be for ceremonial purposes or for spiritual/religious activities. An example would be pools used for traditional initiation purposes. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to make use of the river for ritual use and significance relates to the degree to which the river is of critical importance to people.

Aesthetic Value: This was scored between 0 – 5. The questions that were asked were "How important is the aesthetic value to people? Does the river stretch add value to people's life as an object of natural beauty? Would changing flows detract from this value?" Both intensity and significance of appreciation are valued and the higher of the two scores is adopted. Intensity relates

to the number of people likely to view the river and appreciate its aesthetic value and significance relates to the degree to which the river is of critical aesthetic importance to people.

Resource Dependence: This was scored between 0 – 5. This refers to the goods and services delivered by the river system and peoples dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or "for financial gain" usage of resources is excluded from consideration in this instance. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to make use of the river for resource importance and significance relates to the degree to which the river is of critical importance to people. A sustainability modifier is allowed for.

Recreational Use: This was scored between 0 – 5. The question that was asked was "Does the river stretch provide recreational facilities to people and would this be affected by changing flows?" Both intensity and significance of use are valued and the higher of the two scores is adopted Intensity relates to the number of people likely to make use of the river for recreational purposes and significance relates to the degree to which the river is of critical importance to people.

Historical/Cultural Value: This was scored between 0 – 5. The question that was asked was "Does the river have a strong cultural or historical value?" Examples would be Fugitives Drift on the Buffalo River or components of the Mzimvubu River that have played a central role in Xhosa cultural history. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to appreciate the river for its historical or cultural significance and significance relates to the degree to which the river is of critical importance to people

Scores were then modified to reflect the adjudged importance of each component relative to the other. The following mechanism for arriving at the final score has been adopted in the model with a relative weighting for the importance within the context of the catchment. So "Ritual Use" has a weighting of 40 points, "Aesthetic Value" a weighting of 20 points, "Resource Dependence" a weighting of 100 points, "Recreational Use" a weighting of 50 points, and "Historical Cultural" Value a weighting of 75 points.

The final scores were then combined to generate an overall score between 0 and 5. The meaning of the score is as set out in **Table 7.1**.

Table 7.1 SCI rating

SCI score	Category	Comment
0 - 0.99	**VERY LOW**	Of little or no socio-cultural importance.
1 - 1.99	**LOW**	Of some importance. PES not critical, but caution should be displayed with regard to negative impact on dependent communities.
2 - 2.99	**MODERATE**	Of moderate importance. PES should not be allowed to be negative affected without strong motivation.
3 - 3.99	**HIGH**	Of high importance. A score in this range motivates for maintain or

SCI score	Category	Comment
		potentially positive change to PES.
4 - 5	**VERY HIGH**	Of extreme importance. A score in this range motivates for positive change to PES.

7.1.4 Integrated Environmental Importance Assessment

As described above, the Ecological and Socio-Cultural importance were assessed separately and were then integrated with the PES to determine the IEI. The PES forms part of the IEI as rivers in good condition are scarce, and therefore important in their own right. A river that is in very good condition, but of low EIS, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that type of river that is in good condition. The IEI also provides an indication of the restoration potential. The restoration potential refers to the probability of achieving the rehabilitation of the river to an improved state. For example, if a river has very high Ecological and Socio-Cultural importance, but is in bad condition, the restoration potential is often low and that will result in a low IEI.

The EIS and SCI ratings were not averaged, but the highest score of the two are used to integrate it with the PES. A matrix (**Table 7.2**) to aid in consistently providing an integrated rating comparing EIS, SCI, and PES was designed during 2006 (Louw and Huggins, 2007) and modified during this study to automate the process and thereby produce more consistent answers.

Table 7.2 Matrix used to determine a combined EIS/SCI and PES value which provides an IEI value

EIS &SCI (max)											
	Very high	**4-5**	**<5.1**	3	3	3	4	5	5	5	5
	High	**3-3.9**	**<4**	2	3	3	3	4	5	5	5
	Moderate	**2-2.9**	**<3**	2	2	2	3	3	4	5	5
	Low	**1-1.9**	**<2**	1	1	2	2	3	4	4	4
	Very low	**0-0.9**	**<1**	1	1	1	2	2	3	4	4
				D/E to F	**D**	**C/D**	**C**	**B/C**	**B**	**A/B**	**A**
				>3.2	**>2.6**	**>2.2**	**>1.6**	**>1.2**	**>0.6**	**>0.2**	**>=0**
				>3.2	**2.7-3.2**	**2.3-2.6**	**1.7-2.2**	**1.3-1.6**	**0.7-1.2**	**0.3-0.6**	**<0.3**
				PES							

7.1.5 Water Resource Use Importance

The WRUI (DWAF, 2007) was assessed by assigning a qualitative score to a river reach for four variables that represented the status of the in-stream flow. The scores of the four variables were combined to determine (qualitatively) an overall score which represented the importance of the river reach in terms of the water resource use. Most often, the maximum value was used to represent the final score. Severity and extent of the variables had to be considered to determine whether the maximum was the appropriate rating for the quaternary catchment.

The variables included in the rating method aimed to represent the status and function of the river reach. The variables and the associated characteristics associated with a score ranging from zero to four are presented in **Table 7.3**.

Table 7.3 Water Resource Use Priority rating variables and scoring characteristics

Variables	Score range and associated characteristic descriptions	
	0	4
Current water balance of catchment contributing flow to the river reach.	Very little water use occurs in the upstream catchment. Low, maintenance and high flow is largely natural.	Significant utilisation of water from the upstream catchment. Low and maintenance flows have been reduced and/or there exists significant regulating storage in the catchment.
Utilisation of the river reach for operational purposes.	Minimum changes in the river flow due to operational purposes.	The river reach is utilised as a conveyance conduit.
Possible future developments and/or water use expected in the catchment.	No known development planned in the catchment that could change the flow in the river reach.	It is expected that future developments which could change the flow in the river could occur.
Water quality related problems, assimilative capacity.	The water quality in the river reach is excellent and large assimilative capacity is present.	The river contains very high loads of pollutants.
Overall score:	There is no reason to determine the EWR in the river reach from a water resource management perspective.	A comprehensive EWR determination is necessary from a water use point of view.

7.2 PRIORITY AREAS – HOTSPOTS

Hotspots (priority areas with overall importance) are identified by comparing (or overlaying) IEI with Water Resource Use Importance (WRUI). The hotspot represents a river reach with a high IEI which could be under threat due to its importance for water resource use.

The hotspots are an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future. This assessment can therefore guide decision-making with regards to which areas are in need of detailed EWR and other studies (modified from Louw and Huggins, 2007).

A matrix was designed (Louw and Huggins, 2007) and modified during this study to guide the consistent identification of hotspots (**Table 7.4**). The Y-axis is based on the IEI value derived from the first matrix (**Table 7.2**). The X-axis depicts an estimate of water resource use, with 0 being of no importance and 4 being of very high importance. The information derived from the matrix provides an indication of the level of studies required. Although the terminology used is the same as that used for the different levels of EWR studies in South Africa, it is a descriptive term which is relevant for any environmental assessment required.

As an example – an IEI of 2.5 and WRUI value of 3.5 would require a comprehensive EWR assessment and this specific SQ would represent a hotspot.

Table 7.4 Matrix used in assessing hotspots

IEI	**Very high**	**4-5**	2	2	2	2	3	3	4	4	4
	High	**3-3.99**	1	2	2	2	2	3	3	4	4
	Moderate	**2-2.99**	1	1	1	2	2	2	3	3	3
	Low	**1-1.99**	1	1	1	1	1	2	2	2	3
	Very low	**0-0.99**	1	1	1	1	1	1	1	2	2
			0	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**
			Very low	**Low**		**Moderate**		**High**		**Very high**	
			Water Resource Importance								

8 IDENTIFICATION OF HOTSPOTS

8.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

8.1.1 Present Ecological State results

The PES results are provided in **Section 5**.

8.1.2 River Ecological Importance and Sensitivity results

The River Ecological Importance and Sensitivity results are available from the PES/EIS study (DWA, 2013). No review or adjustments have been made to these results during this study and they have been taken as is. The number of HIGH or VERY HIGH (≥ 3.5) Ecological Important areas is provided per catchment in **Table 8.1**). The pink shading shows any Integrated Unit of Analysis (IUA) with 70% or higher HIGH EI SQs.

Table 8.1 Number of SQs per IUA with a HIGH EI score (≥3.5)

Catchment	Number of SQs	Number of HIGH scoring (≥3.5) SQs	% of HIGH scoring (≥3.5) SQs
K1	13	0	0
K2	1	1	100
K3	13	4	31
K4	6	3	50
K5	5	4	80
K6	13	5	38
J1	118	30	25
J2	189	127	67
J3	124	25	20
J4	19	3	16
H8	11	0	0
H9	16	0	0

8.1.3 Socio-Cultural Importance

The following SQs, as set out in **Table 8.2**, scored HIGH. There were no scores in the VERY HIGH range. The bulk of those scoring HIGH did so either because of the recreation and aesthetic value associated with the coastal and tourist dependent areas or the high dependence on resources associated with poor and vulnerable communities located within the SQ. As has been set out in **Section 7.1.3**, the score for SCI is an integrated and weighted score based on five factors, namely ritual use, aesthetic value, resource dependence, recreational use and historical/cultural value.

Table 8.2 SCI evaluation for SQs with a HIGH score (≥3)

SQ	River	HIGH SCI score (≥3)	Comment
H90E-09383	Goukou	3.2	This river section extends into the Goukou estuarine system. The town of Stilbaai is located along much of the west bank of this river section. The east bank is comprised mostly of open terrain with some development. Likely moderate to high recreational use of the estuary.
J33D-08571	Meirings	3.1	River section extends through a gorge with some aesthetic value. Limited farming is noted on the upper and middle reaches, but more extensive on the lower reaches. The town of De Rust is located to the west of the river. Guest houses and lodges were noted.
J34A-08871	Holdrif	3.1	River section extends through a uniform open terrain. Greater presence of agriculture noted in proximity of the river. Grazing likely. The town of Uniondale noted on the extreme upper reaches. Presence of tourism resorts.
J40E-09359	Gouritz	3	Coastal plains with agricutlure. Estuary with Gouritz Mouth town on West Bank and elevated aesthetic and recreational values.
K50B-09117	Knysna	4	The lower reaches of the river extends into the Knysna lagoon/estuarine system. The estuary is flanked on both banks by a number of up-market residential areas. Recreational and ritual use, as well as heritage and aesthetic value are high.
K60E-09097	Keurbooms	3.3	Located in the Keurboomsrivier Nature Reserve. The river extent is comprised of open/natural terrain. The river extends into a lagoon, and a number of resorts are located on both banks of the lagoon. Plettenberg Bay is located near the river mouth. The nature reserve, presence of upscale resorts at the estuary and Plettenberg Bay suggest high levels of tourism and recreational use, as well as elevated heritage and aesthetic value.
K20A-09083	Groot Brak	3.2	River headwaters located in the inland escarpment.The lower reaches of the river extends through the coastal plain and a mosaic of open/natural terrain, indigenous forests and commercial agriculture. The river drains through the Wolwedans Dam therefore recreational, ritual and aesthetic value are likely to be elevated. River extends towards the coast into the river estuary. The small towns of Groot Brakrivier, Bergsig, Southern Cross and The Island (formal, affluent) are located on the west and east banks of the river/estuary. Recreational, ritual and aesthetic values are likely to be elevated along the lower river reaches and the estuary.
K60F-09092	Bitou	3.2	Upper reaches of the river extends through the Knysna Forest, with the presence of plantation forestry on the east bank. Middle and lower reaches of the river comprise of a mosaic of open/natural terrain, small-holdings and commercial agriculture. A number of tourism facilities (lodges, hotels) noted along the river route suggesting elevated recreational use, as well as aesthetic value. The small town of Wittedrift (formal, affluent) is located within 1 km of the river. The river drains into the Keurbooms lagoon, and there are high levels of recreational use in this lagoon.

SQ	River	HIGH SCI score (≥3)	Comment
K60G-09188	Keurbooms	3.1	River section completely contained in the Keurbooms lagoon. A number of resorts are located on the north bank of the lagoon. Plettenberg Bay is located near the river mouth. The presence of upscale resorts at the estuary and Plettenberg Bay suggest high levels of tourism and recreational use, as well as elevated heritage and aesthetic value.
K30D-09173	Touws	3	Short river section extends through Wilderness Town into the Touws River estuary. Tourism and recreational facilities and resources are noted, therefore recreational, aesthetic, ritual and heritage use is elevated.
K70B-09055	Bloukrans	3	The river nearly exclusively extends through indigenous forest (potentially linked to a nature reserve). Some plantation forestry is noted on the banks of the lower reaches of the river. The river drains into an estuarine system used for recreation.

8.1.4 Integrated Environmental Importance results

Due to the few SQs with high SCI results, the results are similar to the Ecological Importance results provided in **Table 8.1**.

8.2 WATER RESOURCE USE IMPORTANCE

The WRUI was assessed by assigning a qualitative score to a river reach for four variables that represent the status of the in-stream flow as discussed in **Section 7.1.5**. The detailed Excel spreadsheet will be made available on the CD with all data provided with the main report. The HIGH evaluation and the metric resulting in the evaluation are provided in **Table 8.3**.

Table 8.3 WRUI evaluation for SQs with a VERY HIGH rating ((≥3.5)

SQ	River	Comment
K20A-09083	Groot Brak	Wolwedans Dam, abstraction for Mossel Bay.
J11H-08543	Buffels	Impact of Floriskraal Dam plus irrigation from and downstream (DS) of dam.
J11H-08557	Buffels	Impact of Floriskraal Dam plus irrigation from and DS of dam.
J11H-08647	Buffels	Impact of Floriskraal Dam plus irrigation from and DS of dam.
J11J-08686	Groot	Impact of Floriskraal Dam plus irrigation from and DS of dam.
J11K-08828	Groot	Impact of Floriskraal Dam plus irrigation from and DS of dam.
J11K-08860	Groot	Impact of Floriskraal Dam plus irrigation from and DS of dam.
J33E-08649	Olifants	Irrigation plus impact of Stompdrift Dam.
J33E-08757	Olifants	Irrigation plus impact of Stomdrift Dam.
J33E-08763	Olifants	Irrigation plus impact of Stompdrift Dam.
J33E-08777	Olifants	Irrigation plus impact of Stompdrift Dam.
J33F-08772	Olifants	Irrigation plus impact of Stompdrift Dam.
J34F-08843	Kammanassie	Irrigation plus impact of Kammanassie Dam.
J34F-08848	Kammanassie	Irrigation plus impact of Kammanassie Dam.
J35B-08799	Olifants	Irrigation plus cumulative upstream (US) impacts.

SQ	River	Comment
J35B-08820	Olifants	Irrigation plus cumulative US impacts.
J35B-08841	Olifants	Irrigation plus cumulative US impacts.
J35C-08821	Olifants	Irrigation plus cumulative US impacts.
J35C-08873	Olifants	Irrigation plus cumulative US impacts.
J35D-08854	Olifants	Irrigation plus cumulative US impacts.
J35E-08764	Olifants	Irrigation plus cumulative US impacts.
J35E-08816	Olifants	Irrigation plus cumulative US impacts.
J35F-08739	Olifants	Irrigation plus cumulative US impacts.
J35F-08849	Olifants	Irrigation plus cumulative US impacts.

8.3 PRIORITY AREAS – HOTSPOTS

The identified hotspots are illustrated in **Table 8.4** and the maps in **Figure 9.1** to **Figure 9.5**. Only hotspots with the maximum evaluation, i.e. a 4 scoring, has been provided.

Table 8.4 Hotspot results

SQ	River	IEI (0 - 5)	WRUI (0 - 4)	Hotspot
K				
K20A-09083	Groot Brak	4	4	4
K30C-09065	Kaaimans	5	3	4
K50A-09069	Knysna	5	3	4
K60C-08992	Keurbooms	5	3	4
K60E-09114	Keurbooms	5	3	4
K60F-09092	Bietou	5	3	4
J1				
J11H-08647	Buffels	5	4	4
J11K-08828	Groot	3	4	4
J11K-08860	Groot	3	4	4
J12K-08960	Brak	5	3	4
J12M-08904	Touws	5	3	4
J12M-08975	Brand	5	3	4
J13A-08905	Groot	5	3	4
J13A-08933	Groot	5	3	4
J13A-08954	Groot	5	3	4
J13B-08923	Groot	4	3	4
J13B-08938	Groot	4	3	4
J13C-08915	Groot	5	3	4
J13C-09099	Groot	4	3	4
J2				
J23A-07922	Gamka	5	3	4
J23A-07962	Gamka	5	3	4
J23A-08007	Gamka	5	3	4
J23B-08017	Gamka	5	3	4
J23B-08123	Gamka	5	3	4

SQ	River	IEI (0 - 5)	WRUI (0 - 4)	Hotspot
J23C-08155	Gamka	5	3	4
J23C-08176	Gamka	5	3	4
J23C-08212	Gamka	5	3	4
J23C-08217	Gamka	5	3	4
J23E-08400	Cordiers	5	3	4
J23F-08268	Gamka	5	3	4
J23F-08334	Gamka	5	3	4
J23F-08335	Gamka	5	3	4
J23H-08359	Gamka	5	3	4
J23H-08415	Gamka	5	3	4
J23J-08497	Gamka	5	3	4
J25A-08536	Gamka	4	3	4
J25A-08567	Gamka	5	3	4
J25C-08776	Gamka	4	3	4
J25C-08795	Gamka	4	3	4
J25E-08769	Gamka	4	3	4
J3				
J33E-08777	Olifants	5	4	4
J34B-08888	Potjies	4	3	4
J34C-08942	Diep	5	3	4
J34D-08956	Gansekraal	4	3	4
J34E-08910	Brak	4	3	4
J34F-08843	Kammanassie	5	4	4
J34F-08848	Kammanassie	4	4	4
J35A-08551	Klein-Leroux	5	3	4
J35A-08653	Grobbelaars	5	3	4
J35B-08799	Olifants	5	4	4
J35B-08820	Olifants	4	4	4
J35B-08841	Olifants	4	4	4
J35B-08881	Kandelaars	5	3	4
J35C-08821	Olifants	4	4	4
J35C-08873	Olifants	4	4	4
J35D-08745	Wynands	4	3	4
J35D-08854	Olifants	4	4	4
J35E-08764	Olifants	4	4	4
J35E-08816	Olifants	4	4	4
J35F-08600	Vlei	5	3	4
J35F-08739	Olifants	4	4	4
J35F-08849	Olifants	4	4	4
J4				
J40A-08924	Gouritz	4	3	4
J40A-09020	Gouritz	5	3	4
J40B-09073	Gouritz	4	3	4
J40B-09106	Gouritz	5	3	4
J40C-09169	Gouritz	5	3	4

SQ	River	IEI (0 - 5)	WRUI (0 - 4)	Hotspot
J40D-09236	Gouritz	4	3	4
J40D-09250	Gouritz	4	3	4
J40E-09284	Gouritz	5	3	4
J40E-09323	Gouritz	5	3	4
J40E-09357	Gouritz	4	3	4
J40E-09359	Gouritz	5	3	4
J40E-09371	(unnamed stream)	4	3	4

The rivers where hotspots dominate are:

- Keurbooms (Forestry).
- Buffels/Groot (Floriskraal Dam and irrigation).
- Gamka (Various dams, irrigation, nature reserve and World Heritage site).
- Olifants (Various dams and irrigation).
- Gouritz (Extensive irrigation).

9 LEVEL OF EWR ASSESSMENT

9.1 PROCESS TO SELECT EWR SITES IN HOTSPOTS

The process to select EWR sites in hotspots is summarised in **Figure 9.1** with each associated step discussed below in separate headings. The table illustrating the detailed analysis and comments are provided at the end of the section (**Table 9.1**). The EWR sites (existing and new) are illustrated in **Figure 9.2** to **Figure 9.5**.

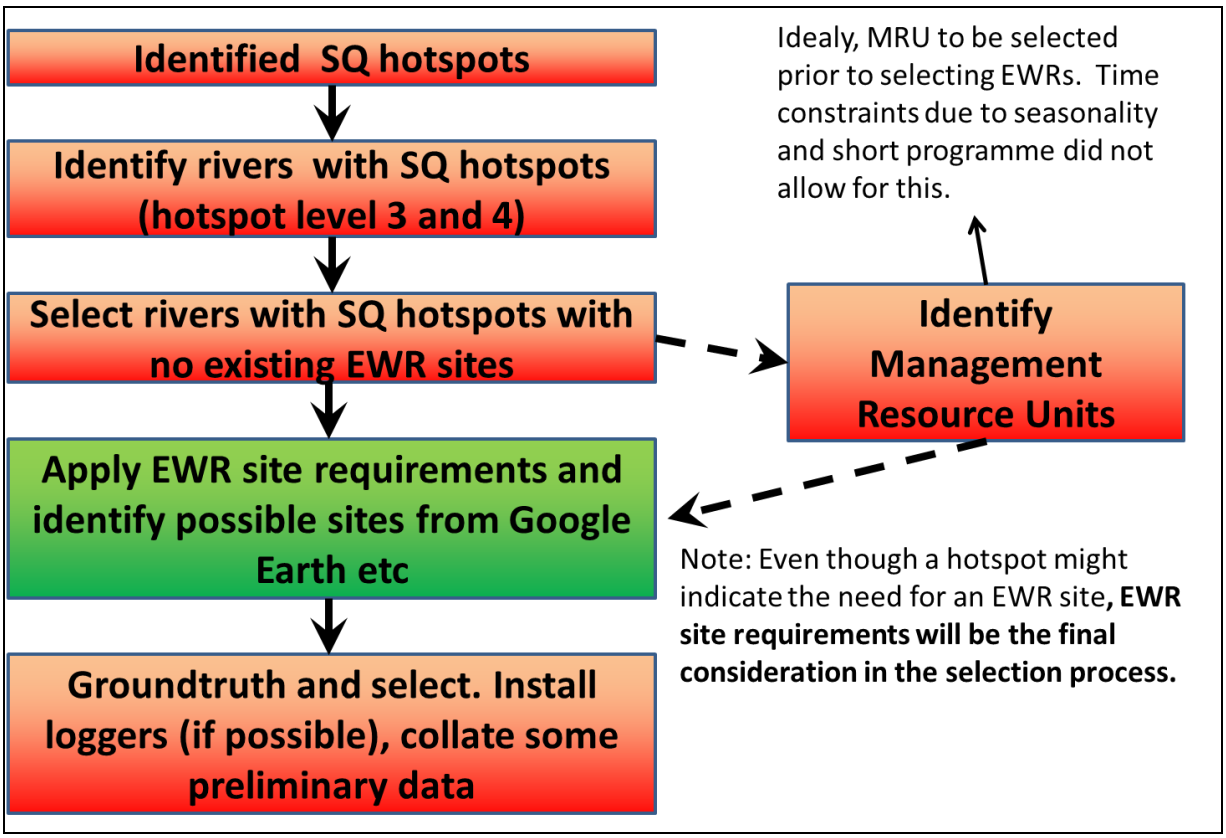


Figure 9.1 Process to select EWR sites in hotspots

9.2 IDENTIFY SQ HOTSPOTS

The hotspots were identified as described in **Sections 7** and **8** and illustrated in **Figure 9.2** to **Figure 9.5**.

9.3 IDENTIFY KEY RIVERS CONTAINING SQ HOTSPOTS

All hotspots with a 3 and 4 rating were identified as indicated in **Table 9.1** and illustrated in the maps as per **Figures 9.2** to **9.5**. The rivers and number of SQs which are hotspots are listed below:

- Duiwenhoks (Two SQ hotspots)
- Goukou and tributaries (Four SQ hotspots)
- Buffels/Groot (13 SQ hotspots)

- Touws (Three SQ hotspots)
- Doring (Three SQ hotspots)
- Gamka (20 SQ hotspots)
- Olifants (20 SQ hotspots)
- Kammanassie (Three SQ hotspots)
- Klein-Leroux (One SQ hotspot)
- Grobbelaars (One SQ hotspot)
- Groot (One SQ hotspot)
- Various small tributaries in J3 (Seven SQ hotspots)
- Gouritz (11 SQ hotspots)
- Groot Brak (One SQ hotspot)
- Kaaimans (Three SQ hotspots)
- Karatarra (Two SQ hotspots)
- Diep or Hoëkraal (One SQ hotspot)
- Goukamma/Homtini (One SQ hotspot)
- Knysna (One SQ hotspot)
- Keurbooms (Two SQ hotspots)
- Malgas and Gwaing (Two SQ hotspots)
- Hartenbos (One SQ hotspot)
- Moordkuil (One SQ hotspot)
- Maalgate (One SQ hotspot)
- Bitou (One SQ hotspot)
- Various tributaries in J1 and J2 (Five SQ hotspots)

9.4 SELECT HOTSPOT RIVERS WITH NO EXISTING EWR SITES

Previous studies which focussed on the coastal rivers (DWA, 2010b) as well as the rivers around Oudtshoorn (J3) (Ninham Shand, 2007) determined the EWRs at various sites. These results are being utilised for this study and no further work is required. The above list of rivers where EWR sites are required were therefore modified to contain only the rivers requiring new sites. The locality of both the existing and new EWR sites is illustrated in **Figure 9.2** to **Figure 9.5** and listed below:

- Duiwenhoks (Two SQ hotspots)
- Goukou and tributaries (Four SQ hotspots)
- Buffels/Groot (13 SQ hotspots)
- Touws (Three SQ hotspots)
- Doring (Three SQ hotspots)
- Gamka (20 SQ hotspots)
- Olifants (20 SQ hotspots) (upper section only)
- Kammanassie (Three SQ hotspots)
- Gouritz (11 SQ hotspots)
- Keurbooms (Two SQ hotspots)

9.5 SELECTION OF EWR SITES

General comments on the selection of sites within the above rivers are included in **Table 9.1.** The site selection process and information on the EWR sites will be documented in the River Delineation Report (DWA, 2014b).

Ten EWR sites were selected in the above 10 rivers and the locality is provided in **Figure 9.2** to **Figure 9.5**.

Table 9.1 Hotspot information used in a DSS to determine hotspot rivers and EWR sites

SQ	River	EIS	SCI	PES	IEI	WRUI	HOT-SPOT	Hotspot rivers	EWR site	Comment
H80A-09154	Duiwenhoks	3.1	2.0	C	3	3	3	Duiwenhoks	Duiwenhoks_EWR 1	Important river areas are more upstream, but needed to select a site near a gauge AND a further advantage is that it is close to estuary.
H80C-09303	Duiwenhoks	2.4	1.1	C/D	2	3	3			
H90B-09155	Korinte	2.7	2.1	D	2	3	3	Goukou	Goukou_EWR 2	Goukou is the main river - final decision guided by locality of gauging weir.
H90C-09211	Naroo	2.8	2.3	D	2	3	3			
H90C-09220	Vet	1.5	2.4	E	2	3	3			
H90C-09229	Goukou	2.2	1.7	C/D	2	3	3			
J11H-08543	Buffels	2.5	1.0	C/D	2	4	3	Buffels/Groot	Buffels_EWR 5	Site selected in the Comprehensive SQ.
J11H-08557	Buffels	3.1	1.7	C	3	4	4			
J11H-08647	Buffels	3.2	1.0	B	5	4	4			
J11J-08686	Groot	2.7	2.3	D	2	4	3			
J11K-08828	Groot	2.2	1.9	D	2	4	3			
J11K-08860	Groot	2.1	1.8	D	2	4	3			
J13A-08905	Groot	2.9	1.5	B/C	3	3	3			
J13A-08933	Groot	2.9	1.7	B/C	3	3	3			
J13A-08954	Groot	3.0	1.4	C	3	3	3			
J13B-08923	Groot	3.0	1.0	B/C	3	3	3			
J13B-08938	Groot	2.7	1.0	B/C	3	3	3			
J13C-08915	Groot	3.8	2.1	B	5	3	4			
J13C-09099	Groot	3.0	1.0	B	5	3	4			
J12H-08790	Touws	3.4	1.6	B	5	2	3	Touws	Touws_EWR 3	Site situated close to a gauge, vital in seasonal system.
J12L-08831	Touws	3.2	2.0	B/C	4	3	4			
J12M-08904	Touws	2.5	1.9	D	2	3	3			
J12L-08930	Doring	2.9	2.0	B	4	2	3	Doring	Doring_EWR 7	No gauge – therefore selected best possible site. Difficult river for
J12L-08985	Doring	2.2	1.8	C/D	2	3	3			

SQ	River	EIS	SCI	PES	IEI	WRUI	HOT-SPOT	Hotspot rivers	EWR site	Comment
J12L-09084	Doring	2.5	1.6	C/D	2	3	3			assessment due to overgrown state with reeds (due to irrigation).
J23A-07922	Gamka	2.7	1.6	C/D	2	3	3	Gamka	Gamka_EWR4	Need location close to gauge and as far DS as possible to be representative of upstream areas. Site complies with these requirements and lies in the comprehensive SQ.
J23A-07962	Gamka	2.5	1.2	D	2	3	3			
J23A-08007	Gamka	2.2	1.2	D	2	3	3			
J23B-08017	Gamka	3.1	1.2	C	3	3	3			
J23B-08123	Gamka	2.9	1.2	C	3	3	3			
J23C-08155	Gamka	3.0	1.1	B	4	3	4			
J23C-08176	Gamka	3.2	1.5	B	5	3	4			
J23C-08212	Gamka	3.0	1.5	B	5	3	4			
J23C-08217	Gamka	3.1	1.1	B	5	3	4			
J23F-08268	Gamka	3.2	1.0	B	5	3	4			
J23F-08334	Gamka	3.1	1.3	B	5	3	4			
J23F-08335	Gamka	3.1	1.0	B	5	3	4			
J23H-08359	Gamka	3.3	1.6	B	5	3	4			
J23H-08415	Gamka	3.2	1.0	B	5	3	4			
J23J-08497	Gamka	2.8	1.8	C	3	3	3			
J25A-08536	Gamka	3.1	2.0	C/D	3	3	3			
J25A-08567	Gamka	3.4	2.3	B/C	4	3	4			
J25C-08776	Gamka	3.7	1.4	B	5	3	4			
J25C-08795	Gamka	2.3	1.0	C/D	2	3	3			
J25E-08769	Gamka	2.4	1.6	C/D	2	3	3			
J31D-08592	Olifants	3.0	1.0	B/C	4	2	3	Olifants	Old sites: EWR 1, EWR 2. New site: Olifants_EWR 9	Added new site in the upper Olifants River which was not addressed by old sites in level 3 hotspot. Site is extremely complex – vadoze zone dependant, no gauge, EWR will be of low confidence.
J31D-08650	Olifants	3.1	1.0	B/C	4	2	3			
J33B-08637	Olifants	2.5	2.0	D	2	3	3			
J33B-08714	Olifants	2.5	2.0	D	2	3	3			
J33B-08749	Olifants	2.4	2.0	C	3	3	3			
J33E-08649	Olifants	1.8	2.2	D/E	2	4	3			

SQ	River	EIS	SCI	PES	IEI	WRUI	HOT-SPOT	Hotspot rivers	EWR site	Comment
J33E-08757	Olifants	2.2	1.6	D	2	4	3			
J33E-08763	Olifants	2.2	1.4	D	2	4	3			
J33E-08777	Olifants	2.0	1.0	D	2	4	3			
J33F-08772	Olifants	2.4	2.0	E	2	4	3			
J35B-08799	Olifants	2.2	2.0	D/E	2	4	3			
J35B-08820	Olifants	2.0	1.2	E	2	4	3			
J35B-08841	Olifants	2.0	1.2	E	1	4	3			
J35C-08821	Olifants	2.0	1.0	E	2	4	3			
J35C-08873	Olifants	2.0	1.0	E	1	4	3			
J35D-08854	Olifants	2.1	1.1	E	2	4	3			
J35E-08764	Olifants	2.2	1.2	E	2	4	3			
J35E-08816	Olifants	2.4	1.2	E	2	4	3			
J35F-08739	Olifants	2.3	1.7	D	2	4	3			
J35F-08849	Olifants	2.0	1.0	E	1	4	3			
J34D-08899	Kammanassie	3.0	1.9	B/C	4	2	3	Kammanassie	Kammanassie_EWR 10	River difficult to access, very disturbed, site not good, no gauge – but best available.
J34F-08843	Kammanassie	2.1	2.2	E	2	4	3			
J34F-08848	Kammanassie	2.1	1.9	D/E	2	4	3			
J35A-08551	Klein-Leroux	3.4	2.3	C/D	3	3	3	Klein-Leroux	Old site: EWR 5,	
J35A-08653	Grobbelaars	2.7	2.4	E	2	3	3	Grobbelaars	Old site: EWR 4	
J33D-08571	Meirings	3.7	2.8	C	3	1	2	Groot	Old site: EWR 3	
J34C-08942	Diep	2.5	2.3	D/E	2	3	3	Small tribs	No sites	No hydrology. Was not previously identified as important from water resource point of view.
J34D-08956	Gansekraal	2.7	1.4	D	2	3	3			
J35B-08881	Kandelaars	1.9	2.2	D/E	2	3	3			
J35D-08603	Meul	3.8	2.1	B/C	4	2	3			
J35D-08745	Wynands	1.8	1.0	C	2	3	3			
J35F-08600	Vlei	3.7	2.2	C	3	3	3			

SQ	River	EIS	SCI	PES	IEI	WRUI	HOT-SPOT	Hotspot rivers	EWR site	Comment
J34B-08888	Potjies	2.2	1.9	D/E	2	3	3			
J40A-08924	Gouritz	3.3	1.5	C	3	3	3	Gouritz	Gouritz_EWR6	Main criterion is that it is close to the gauge. The gauge however was located on a rated section and extremely inaccurate (useless?) for low flows. Not been calibrated recently and floods could be problematic.
J40A-09020	Gouritz	3.0	2.1	C	3	3	3			
J40B-09073	Gouritz	3.2	1.5	C	3	3	3			
J40B-09106	Gouritz	3.5	2.3	C	3	3	3			
J40C-09169	Gouritz	3.3	2.0	C/D	3	3	3			
J40D-09236	Gouritz	3.1	1.0	C/D	3	3	3			
J40D-09250	Gouritz	3.4	1.9	C/D	3	3	3			
J40E-09284	Gouritz	3.3	2.1	C	3	3	3			
J40E-09323	Gouritz		2.0	A	5	3	4			
J40E-09357	Gouritz		1.7	A	4	3	4			
J40E-09359	Gouritz		2.5	A	5	3	4			
K20A-09083	Groot Brak	3.5	3.2	B/C	4	4	4	Groot Brak	Old site: GB1	
K30C-09065	Kaaimans	4.1	2.6	B	5	3	4	Kaaimans	Old site: Ka1	
K40C-09036	Karatara	3.1	2.4	B	5	2	3	Karatarra	Old site: EWR4	
K40C-09140	Karatara	3.1	2.3	B	5	2	3			
K40B-09022	Hoëkraal	3.8	2.4	B	5	2	3	Diep or Hoëkraal	Old site: EWR 3	Rivers similar – only one site, can extrapolate. Selected site on river with best site indicators AND gauge.
K40E-09016	Homtini	3.5	2.4	B/C	4	2	3	Goukamma/ Homtini	Old site: Gou 1	
K50A-09069	Knysna	3.6	2.2	B	5	3	4	Knysna	Old site: EWR 1	
K50B-09111	Gouna	4.0	2.2	B	5	2	3	Gouna	Old site: EWR 2	
K60C-08992	Keurbooms	3.3	2.2	B	5	3	4	Keurbooms	Keurbooms_EWR8	Has to be at a gauge – lower site is not suitable. Now between two gauges further upstream.
K60E-09114	Keurbooms	3.6	2.7	B	5	3	4			
K30B-09082	Malgas	3.0	2.6	B	5	1	2		Old site: Mal1	
K30B-09158	Gwaiing	2.2	2.0	D	2	2	2		Old site: Gwa 1	

SQ	River	EIS	SCI	PES	IEI	WRUI	HOT-SPOT	Hotspot rivers	EWR site	Comment
									Old site: Sout (Wit trib)	
									Old site: Matjies (Buffels trib)	
K10B-09256	Hartenbos	2.3	2.2	D	2	3	3	Hartenbos	Estuary	River site is not possible. Previously not identified as necessary/possible by Southern Waters.
K10F-09139	Moordkuil	2.5	2.1	C/D	2	3	3	Moordkuil	Klein Brak Estuary	River site is not possible. Previously not identified as necessary/possible by Southern Waters.
K10F-09204		1.8	1.1	C/D	2	3	3		Trib of Moordkuil	See above.
K30A-09087	Maalgate	3.0	2.4	D	2	3	3	Maalgate		See above.
K60F-09092	Bietou	4.1	3.2	B/C	5	3	4	Bitou	River runs into estuary	Impact of proposed dam will be felt in the estuary and wetland – no river assessment necessary.
J11J-08659	Swartberg	2.4	2.3	D	2	3	3		No site	All small tributariess to main rivers above. Whole river one SQ. Did not warrant an EWR site. Main river will suffice. Do not have the hydrology to deal with these rivers at intermediate/comprehensive level.
J12M-08975	Brand	2.2	1.0	C/D	2	3	3			
J13C-09081	Wabooms	3.6	2.1	B	5	2	3			
J23E-08400	Cordiers	2.5	1.0	D	2	3	3			All small tributaries to above main rivers. Whole river one SQ. Did not warrant an EWR site. Main river will suffice. Do not have the hydrology to deal with these rivers at intermediate/comprehensive level.
J23F-08328	Sand	3.1	1.0	B	5	2	3			

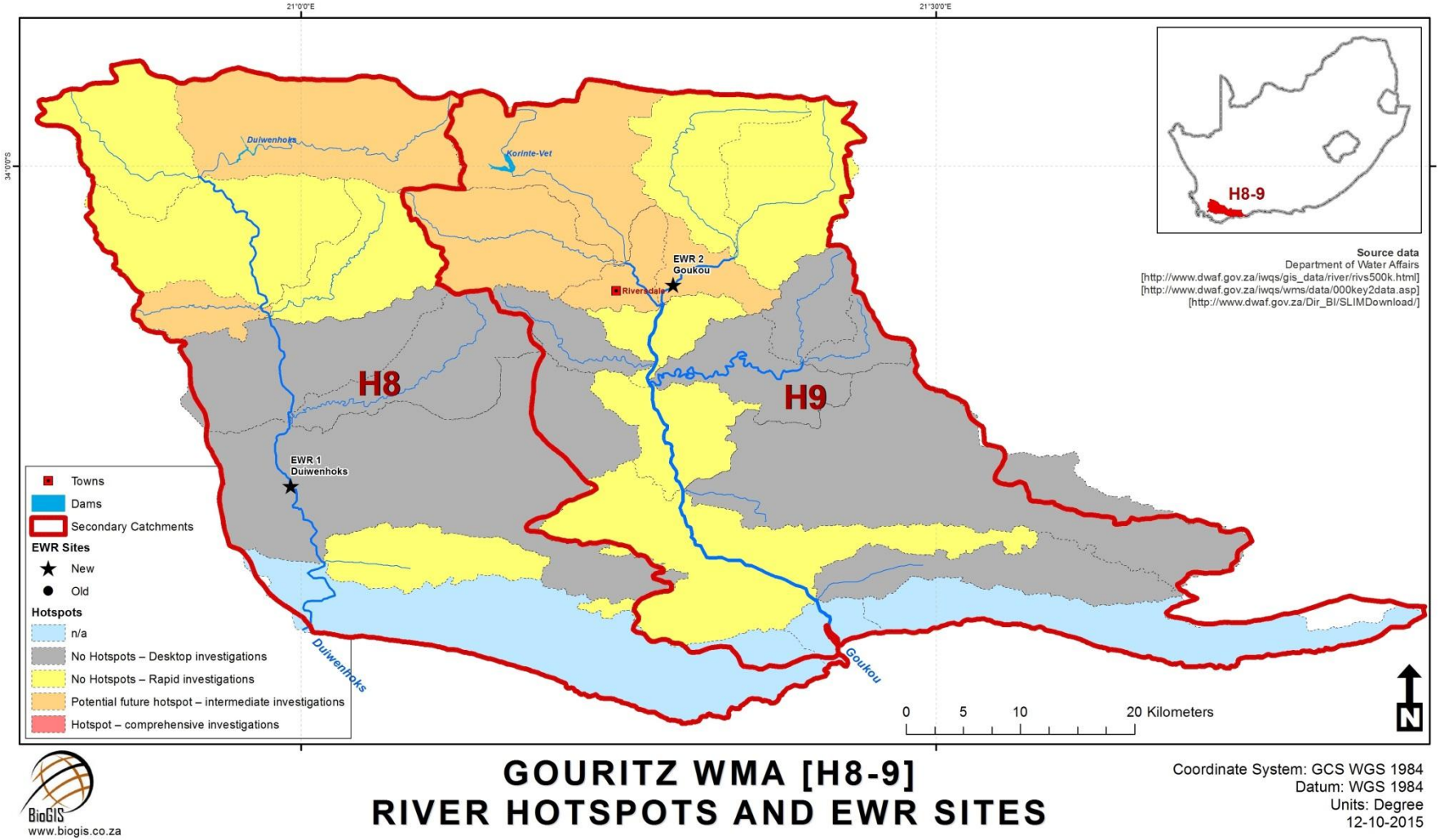


Figure 9.2 Hotspots, existing and new EWR sites (H8 - H9) in the Gouritz WMA

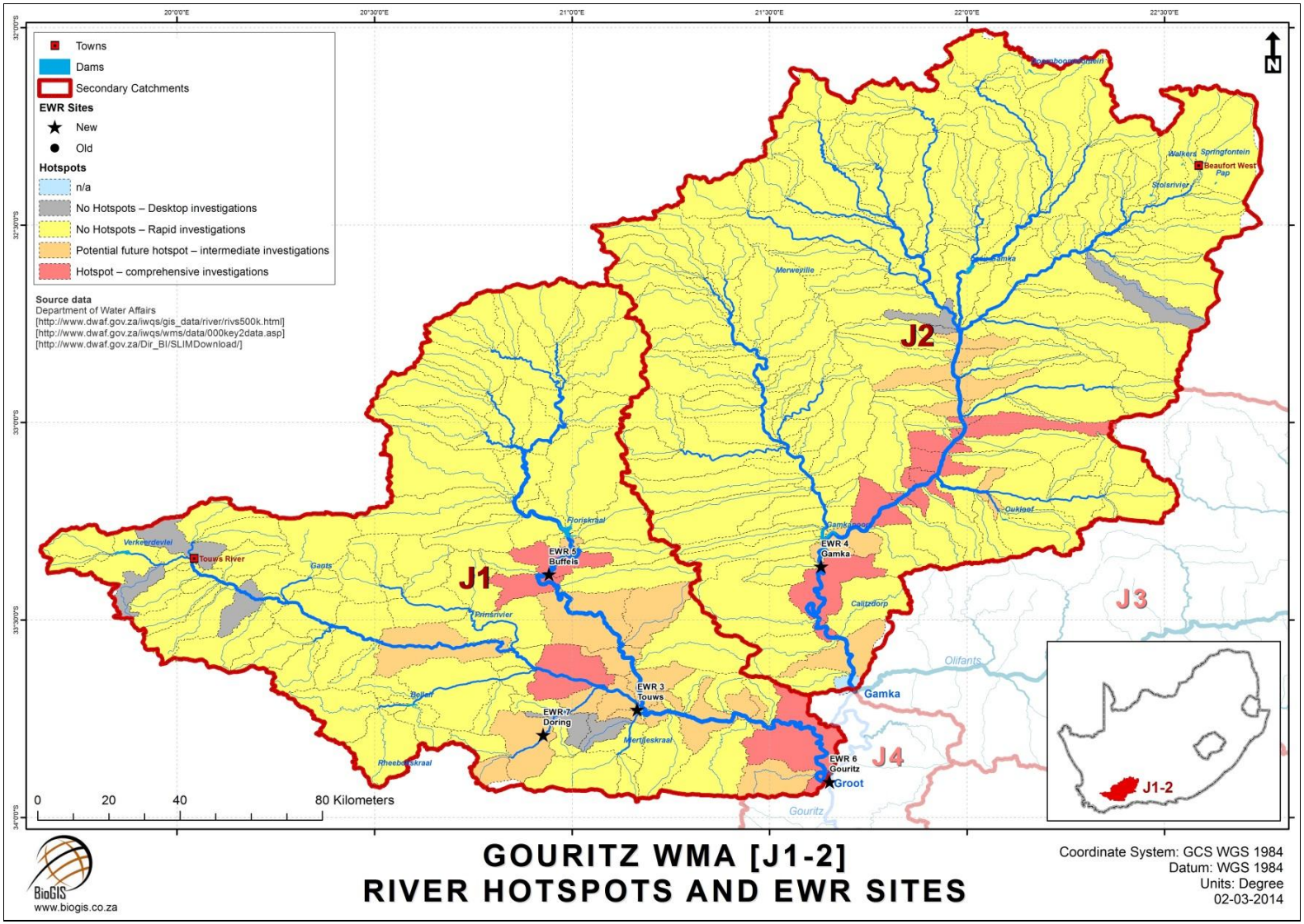


Figure 9.3 Hotspots, existing and new EWR sites (J1 and J2) in the Gouritz WMA

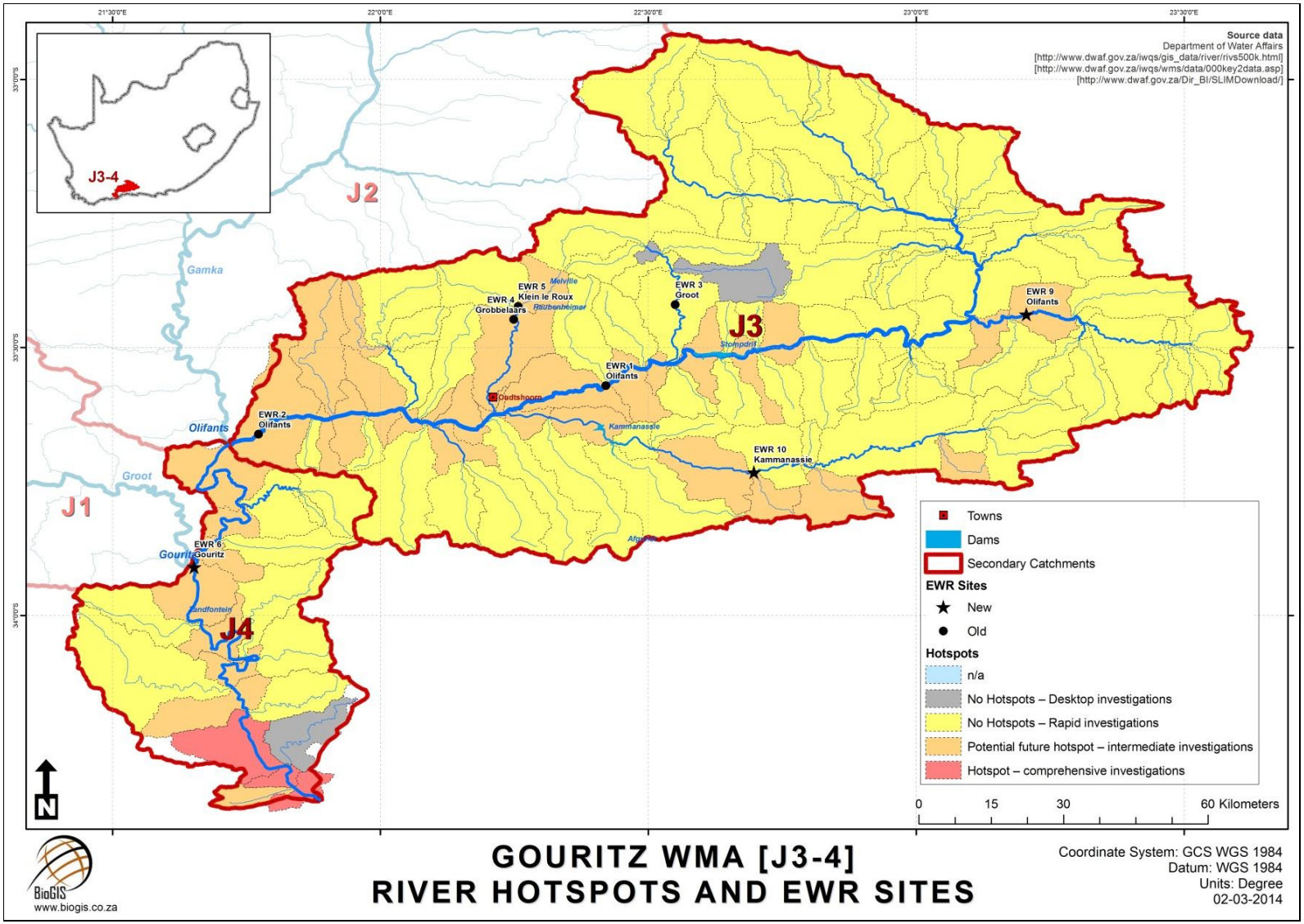


Figure 9.4 Hotspots, existing and new EWR sites (J3 - J4) in the Gouritz WMA

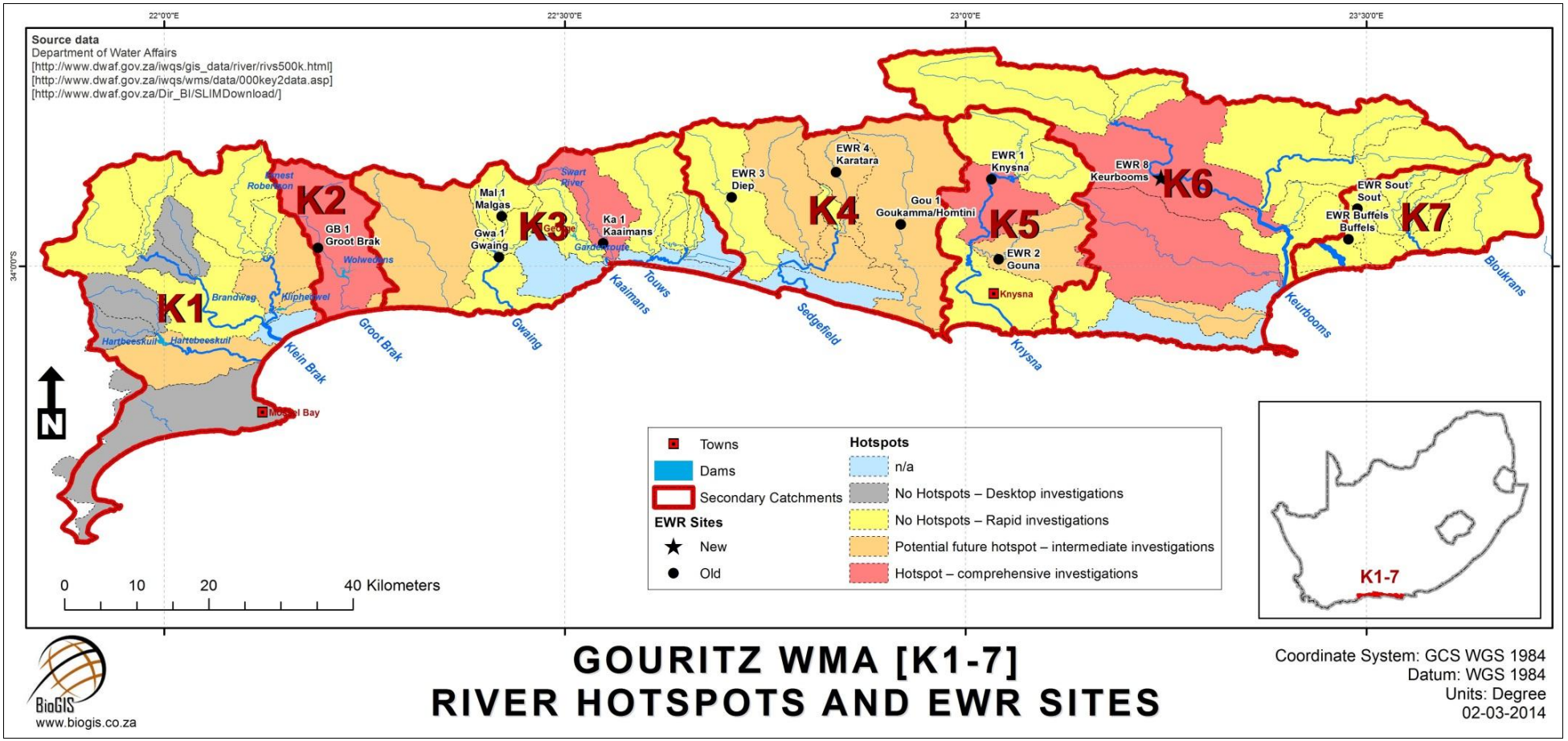


Figure 9.5 Hotspots, existing and new EWR sites (K1-7) in the Gouritz WMA

10 REFERENCES

Census. 2001. Investigation into appropriate definitions of urban and rural areas for South Africa: Discussion document/ Statistics South Africa. Pretoria: Statistics South Africa, 2003 195p. [Report No. 03-02-20 (2001)].

Department of Water Affairs (DWA). 2009. Resource Directed Measures: Reserve Determination studies for selected surface water, groundwater, estuaries and wetlands in the Outeniqua catchment: Ecological Water Requirements Study. Riverine RDM Report, Volume 2: Appendices. Edited by Louw, MD and Koekemoer, S for Scherman Colloty & Associates. Report no. RDM/K40-50/00/CON/0607, Volume 2.

Department of Water Affairs, (DWA). 2010a. Strategic Assessment of Water Re-use Potential to Augment the Western Cape Water Supply System. Final Report, Feb 2010. Undertaken for the Department of Water Affairs as part of the Western Cape Reconciliation Strategy Support by Milkwood Communications in association with Aurecon.

Department of Water Affairs (DWA). 2010b. Resource Directed Measures: Reserve Determination studies for selected surface water, groundwater, estuaries and wetlands in the Outeniqua catchment: Ecological Water Requirements Study – Main Report: Outeniqua Reserve Study (K10-K50, K60G). Report No. RDM/K000/02/CON/0907.

Department of Water Affairs (DWA). 2011. Directorate Water Resource Planning Systems: Water Quality Planning. Resource Directed Management of Water Quality. Planning Level Review of Water Quality in South Africa. Sub-series No. WQP 2.0. Pretoria, South Africa.

Department of Water Affairs (DWA). 2012a. Green Drop Report: Western Cape – Chapter 13.

Department of Water Affairs, (DWA). 2012b. Business Case for the Breede- Gouritz Catchment Management Agency. June 2012, V2.0.

Department of Water Affairs, (DWA). 2013. Review and update of the Desktop Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) of South African Rivers according to sub-quaternary catchments: Breede/Ber/Gouritz WMAs. Prepared by Southern Waters.

Department of Water Affairs (DWA). 2014a. All town reconciliation strategies. Gouritz WMA reconciliation strategies prepared by Umvoto Africa.

Department of Water Affairs (DWA), 2014b. Reserve Determination Studies for Selected Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area: Delineation Report, Volume 2. Prepared by Scherman Colloty & Associates. Report no. RDM/WMA16/00/CON/0313, Volume 2.

Department of Water Affairs and Forestry (DWAF). 2004. Gouritz Water Management Area: Internal Strategic Perspective. Prepared by Ninham Shand (Pty) Ltd in association with Jakoet & Associates and Umvoto Africa, on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA16/000/00/0304.

Department of Water Affairs and Forestry (DWAF). 2005. Gouritz WMA: Proposal for the Establishment of a Catchment Management Agency for the Gouritz Water Management Area.

Department of Water Affairs and Forestry (DWAF). 2007. Chief Directorate: Resource Directed Measures. Development of the Water Resource Classification System (WRCS) Volume 1 Overview and 7-step classification procedure. October 2006.

Huggins, G., Rydgren, B., Lappeman, G. 2010. Deliverable 7 & 13: The Assessment of Goods and Services in the Orange River Basin. Produced for WRP a**s** part of Support to Phase II ORASECOM Basin Wide Integrated Water Resources Management Plan.

Iversen, T.M., Madsen, B.L., and Bøgestrand, J. 2000. River conservation in the European Community, including Scandinavia. In: "Global Perspectives on River Conservation: Science Policy and Practice", Edited by P.J. Boon, B.R. Davies and G.E. Petts, John Wiley & Sons Ltd.

Kleynhans, C.J. and Louw, M.D. 2007. Module A: EcoClassification and EcoStatus determination. In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Kotzé, P., Deacon, A., Louw, D., and Mackenzie, J. 2012. Review and update of the Desktop Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) of South African Rivers according to sub-quaternary catchments: Olifants WMA. WRC Project Number: K5/2041.

Louw, M.D. and Huggins, G. 2007. Desktop Assessment of the Importance and Ecological State of the Maputo River Quaternary catchments. Produced by Water for Africa as part of the Joint Maputo River Basin Water Resources Study – Moçambique, Swaziland and South Africa.

Louw, D., Kotze, P., and Mackenzie, J. 2010. Scoping study to identify priority areas for detailed EWR and other assessments. Produced for WRP as part of Support to Phase II ORASECOM Basin Wide Integrated Water Resources Management Plan.

Malan, H.M. 2008. Ecological Water Requirements for the Groot Brak (K10 and K20) and water resources in K30, K40E and K60G: Assessment of water quality, provision of ecospecifications and description of a monitoring programme. Input to the Outeniqua Reserve study.

Milner, A.M. 1994. System recovery. In, P.Calow & G.E. Petts (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

National Water Act (NWA) (1998). Act No 36 of 1998. Republic of South Africa Government Gazette, Vol 398, No 19182, Government Printer, Pretoria, South Africa. pp. 200.

Ninham Shand. 2007. Oudtshoorn Agricultural Water Feasibility Study, Department of Agriculture Report No. 411/2005/02. Rapid III Ecological Reserve Determination - Olifants, Kammanassie, Groot, Le Roux and Grobbelaars Rivers. Prepared IWR Source-to-Sea. January 2006.

Ogden, M.B. 2013. Land use impact on water quality in two river systems in South Africa. Masters degree thesis, Department of Physical Geography and Ecosystems Science, Lund University, Sweden.

Resh, V.H., Brown, A.V., Covich, A.P., Gurtz, M.E., Li, H.W., Minshall, G.W., Reice, S.R., Sheldon, A.L., Wallace, J.B. and Wissmar, R.C. 1988. The role of disturbance theory in stream ecology. Journal of the North American Benthological Society. 7: 433-455.

River Health Programme. 2007. State of the Rivers Report: River of the Gouritz Water Management Area. Department of Water Affairs and Forestry, Pretoria, South Africa. ISBN No: 0-620-38676-0.

Robertson, M.P., Villet, M.H. and Palmer, A.R. 2004. A fuzzy classification technique for predicting species' distributions: applications using invasive alien plants and indigenous insects. Diversity and Distributions 10: 461–474.

Scherman, P-A., Vorwerk, O. and Ngwenya, P. 2007. Water quality summary: Sout and Matjies River Reserve study. Prepared for JMM Stassen Consulting.

The Water Wheel. March/April 2014. Broadening the perspective: Water quality and land uses in the Wilderness area. Water Research Commission, Pretoria, South Africa.

APPENDIX A: COMMENTS AND RESPONSE REGISTER

Section	Report Statement	Comments	Addressed in Report?	Author Comment
Comments: Thapelo Machaba - DWA, received May 2014				
Acronym table		Add a glossary of terminology	No	Terminology is either standard terms or briefly explained in the text.
1.2		Add a map of the study area for easy reference	Yes	
4.1	In order to generate the SCI model, information was extracted in a 'master spreadsheet' that incorporates all the SCI results. Each secondary catchment within the WMA has its own set of spreadsheets. Column descriptions in the SCI sheet in the master spreadsheet are as follows and provided electronically	I don't see how this information fits in here?? Please relook at it. How relevant is it?	No	This section is relevant when using and interpreting the electronic information, as these guidelines are not provided electronically.
5.2.3	PES sheet column descriptions in the master spreadsheet:	This describes the information that is not attached in this report, how relevant is this information? How must the reader make use of this information?	No	This section is relevant when using and interpreting the electronic information, as the guidelines provided here are not provided with the electronic data.
5.3.6	Bietou	Is this correct	Yes	Changed to Bitou.
Table 5.11		Why are these sub-quads indicated with 0? Others are left blank and others are indicated with N/A?	Yes	
Section 5, Figures		Maps not clear. Consider breaking them down.		Maps reviewed. Considered appropriate if printed at high resolution.
Table 6.1		There is no indication if the ES was considered in developing the REC.		The EI was High for nearly all SQs and it was therefore decided to rather use the ES as it was a more realistic parameter in determining the REC.
		The report does not indicate what the numbers mean?	Yes	

Section	Report Statement	Comments	Addressed in Report?	Author Comment
Table 9.1		Will there be extrapolation sites?	No	This was not part of the study Terms of Reference or accepted Inception Report.
Comments: Barbara Weston - DWA, received May 2014				
Table 5.9		J12D-08664: How is this still a B?	No	The information contained in the tables originate from the PES/EIS project undertaken by Southern Waters. Queries regarding the rationale or results cannot be addressed and tables cannot be populated comprehensively.
		J12K-08960: Is it only the dam pushing it in a D/E.		
		J13A-08946: Description of main impact driver.		
Table 5.11		Please fill this table in the same as the other ones; be consistent and populate comprehensively.		
Table 5.12		J33E-08649: Why D/E what is worse here than below.		
Table 6.1 – 6.6		Please indicate as a general statement above the table what the reasons is if there is no REC comment provided or If some of the tables or lines are not filled in.	Yes	